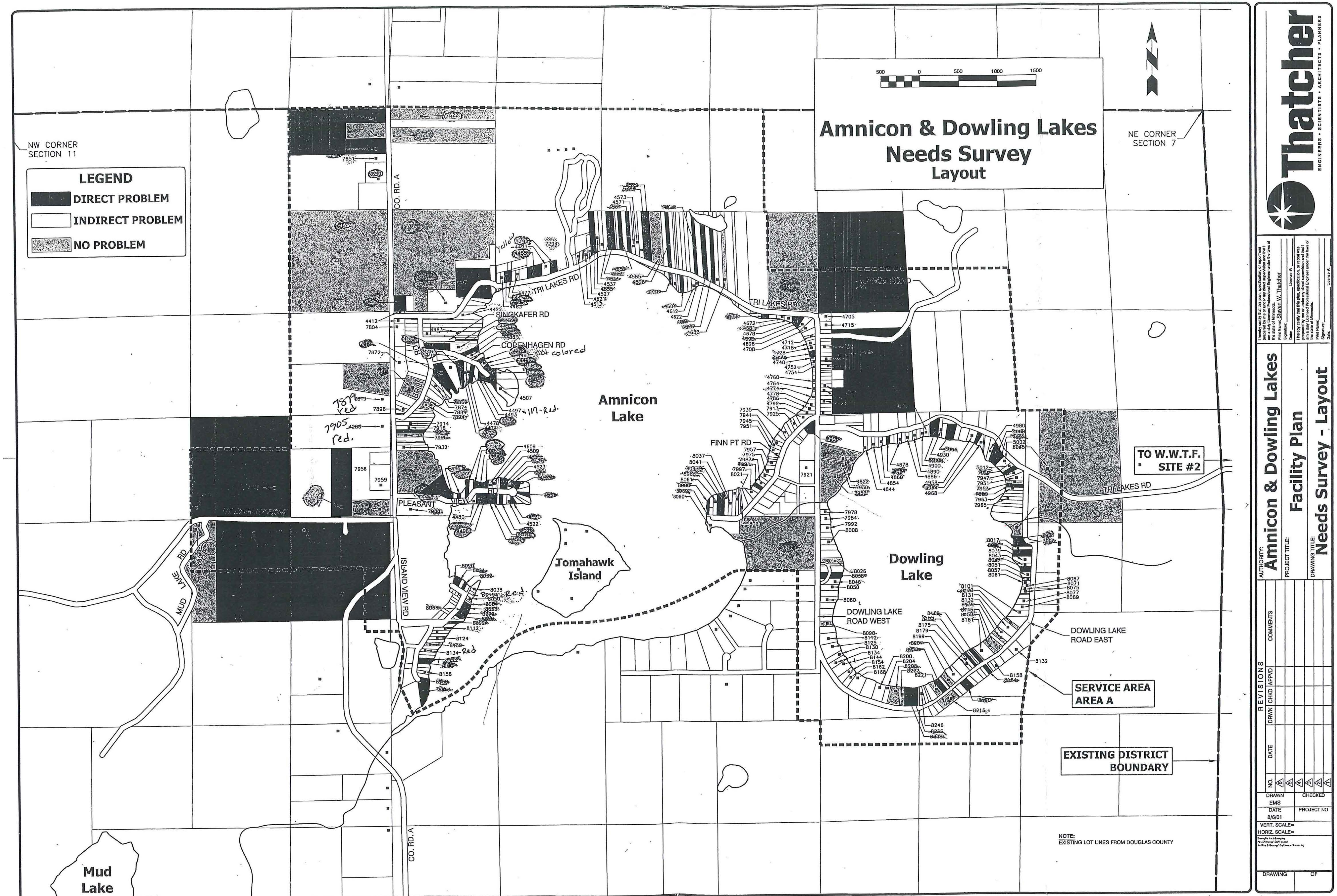
Appendix 5

Septic Tank Loading Information


Amnicon & Dowling Lakes
Needs Survey
Layout
500 0 500 1000 1500
NW CORNER
SECTION 11
NE CORNER
SECTION 7
LEGEND
DIRECT PROBLEM
INDIRECT PROBLEM
NO PROBLEM
CO. RD. A
TRI LAKES RD
SINGKAFER RD
COPENHAGEN RD
Amnicon
Lake
Dowling
Lake
Tomahawk
Island
FINN PT RD
PLEASANT VIEW
ISLAND VIEW RD
MUD LAKE RD
DOWLING LAKE
ROAD WEST
DOWLING LAKE
ROAD EAST
TO W.W.T.F.
SITE #2
SERVICE AREA
AREA A
EXISTING DISTRICT
BOUNDARY
Mud
Lake
NOTE:
EXISTING LOT LINES FROM DOUGLAS COUNTY
Thatcher
ENGINEERS • SCIENTISTS • ARCHITECTS • PLANNERS
AUTHORITY:
Amnicon & Dowling Lakes
PROJECT TITLE:
Facility Plan
DRAWING TITLE:
Needs Survey - Layout
REVISIONS
NO. DATE DRWN CHKD APPVD COMMENTS
DRAWN
EMS
CHECKED
DATE
8/6/01
PROJECT NO
VERT. SCALE=
HORIZ. SCALE=
DRAWING
OF

SANITARY SURVEY QUESTIONNAIRE
AMNICON/DOWLING LAKE MANAGEMENT
AND SANITARY DISTRICT NEEDS ASSESSMENT

SUMMARY

This property is (check all that apply): **283 Surveys, 254 Valid, 89% Return Rate**

241 ☐ residential (owner-occupied) **95%**
1 ☐ residential (rental property) **<1%**
1 ☐ residential (mixed use) **<1%**
5 ☐ business/commercial **2%**
☐ private (tax exempt)
☐ industrial
2 ☐ public **<1%**
4 ☐ other (specify) **Mobile Home Court, Trailer Park, Pole Barn, Garage** **2%**

1. RESIDENTIAL (may be part of mixed-use properties): of the 243 valid surveys

A. TYPE OF PERMANENT STRUCTURE(S) on your property (check all that apply):

222 ☐ Single family dwelling **91%**
☐ Multi-family dwelling
13 ☐ Mobile home **5%**
☐ Vacant land – no structure
1 ☐ Other type of structure (business/commercial) **<1%**
8 **Unanswered** **4%**

B. GENERAL CONSIDERATIONS – (general information for residential buildings)

1. Number of persons living at this address? **2.19**
2. Was building built before October 7, 1972? **203** ☐ Yes **84%** **32** ☐ No **13%**
   8 Unanswered 3%
3. Number of bedrooms in the building? **1.92 average**
4. Number of bathrooms in the building? **1.13 average**
5. This property is occupied:

133 ☐ Permanent basis – year round **55%**
97 ☐ Seasonally (___ days per year seasonally occupied – **average 111 days**) **40%**
13 **Unanswered** **5%**

2. BUSINESS/COMMERCIAL/INDUSTRIAL/OTHER (may be part of mixed-use properties):

A. TYPE OF PERMANENT STRUCTURE(S) **Of the 11 valid surveys**

5 ☐ Single business building **45%**
☐ Multi-business building
☐ Mobile unit
2 ☐ Storage facility **18%**

☐ Workshop/industrial/manufacturing building
☐ Vacant land – no structures
4 **Unanswered** **37%**

B. GENERAL CONSIDERATIONS - (general information for non-residential buildings)

1. If commercial/business: number of persons employed? **19-31 varied**
2. If commercial/business: maximum number of customers at one time? **35-94 varied**
3. If school: number of faculty and students? **N/A**
4. Number of hours of operation per day? **6, 12, 16-18, 19, 24**
5. Are any industrial/toxic/strong wasted discharged? **5** ☐ No **46%** **1** ☐ Yes **9%**
   5 Unanswered 45%
   What type of wastes are discharged? **2 – Domestic, 9 Unanswered**
6. If commercial/business: indicated type? **Bars, Supper Club, Storage, Mobile Home Court**
7. If business is a motel, campground or other multi-unit: number of units? **5-50**
8. What part of the year is your facility in use?

6 ☐ Year round **55%**
1 ☐ Seasonal **9%**
4 **Unanswered** **36%**
☐ Weekends only: approximate number of weekends per year **N/A**

3. WASTEWATER DISPOSAL SYSTEM

A. GENERAL INFORMATION

1. What type of system currently serves this property?

31 ☐ No disposal system/outhouse **12%**
60 ☐ Holding tank **24%**
☐ Pit or cesspool
4 ☐ Septic tank and mound **1.5%**
3 ☐ Septic tank and overflow unknown **1%**
55 ☐ Septic tank and seepage bed/drywell **22%**
96 ☐ Septic tank and drainfield **38%**
☐ Discharge directly to land or water
4 ☐ Other (specify) **# Concrete and 1 steel tank, Biotoilet, Sealed solid and liquid, Composting Toilet** **1.5%**
1 **Unanswered** **<1%**

2. Age of your system

23 ☐ 10 years or less **9%**
76 ☐ 10-20 years **30%**
91 ☐ Over 20 years **36%**
22 ☐ Unknown **9%**
42 **Unanswered** **16%**

3. If system age is 10 years or less provide date installed **1993 – 2001 varied**

4. How many gallons does the tank hold?

32 ☐ 500 or less 13%
72 ☐ 501 – 800 28%
45 ☐ 801 – 1000 18%
30 ☐ 1001 – 2000 12%
29 ☐ Unknown 11%
1 **8500 gallons** **<1%**
45 **Unanswered** **18%**

5. Identify problems you have experienced with your disposal system (check all that apply).
Is there or has there ever been any:

104 ☐ No problems 34%
5 ☐ Sewage overflow on ground 1.5%
1 ☐ Overloaded/Insufficient system <1%
1 ☐ Standing water in drain field vent pipe <1%
4 ☐ Freezing in winter 1%
17 ☐ Back-up in basement 6%
2 ☐ Surface breakout of effluent <1%
117 ☐ System backup 39%
14 ☐ Slow-flushing toilets 5%
2 ☐ Water/rain filling system <1%
☐ Flowing effluent pipe
3 ☐ Offensive odors 1%
5 ☐ Other **Plugged line, In past discharged directly to lake, Pipe broke, Pressurized system with alert system, Wants resolution to sewer issue so can decide on whether to install tank system** **1.5%**
29 **Unanswered** **10%**

Not Failing (adversely impacting GW), in my opinion

Failing = 151/275 systems or 55%

6. How often do you pump out your tank?

19 ☐ Never 8%
36 ☐ Once every 3 years 14%
15 ☐ Once every year 6%
4 ☐ 12+ times per year 2%
8 ☐ 6-12 times per year 3%
3 ☐ 2-4 times per year 1%
25 ☐ Other **Every 2 months, 1 time every year or twice, 1 time every 1-2 years, (5) 1 time every 2 years, 1 time every 2-3 years, 1 time every 4 years, 1 time in 5 years, 1 time every 5-6 years, 2 times in 26 years, 2 times per year, 3 times per year, 4 times per year, 1 time every 10 years, 3 years ago, 12 years ago, 15 years ago, Just once, (3) Not often, Usually 2 times per summer** **10%**
143 **Unanswered** **56%**
1 **Unknown** **<1%**

7. Have you ever had to repair your system? **10** ☐ Yes **4%** **85** ☐ No **33%**
159 Unanswered 63%
If yes, when were the last repairs made? **1975, (2) 1990, 1993-1995, 2001**
What work was done? **Repair Lid, Septic tank repair vent pipe, Fixed pipes, Move tank, Repair broken pipe, Line froze**

Cost of the repair? **Unknown**

8. Other comments or concerns? **Yes – Odor, Surface release, Want new system for lakes**

B. OTHER CONCERNS (community wide)

1. Are there other wastewater problems in your community that you believe need correction?
52 ☐ Yes **20%** **23** ☐ No **9%** **26** ☐ Unaware **10%** **152 Unanswered 60%**
1 Skeptical 1%
If yes, briefly described the problems and the approximate location(s)**Other failing systems, Neighbor, Area wide, Preservation of lake, Would like new system, Want to save the lake, Want new system, Sewage piped directly into the lake, Systems need to be updated, Need community system, Want community system, Historical discharge direct to lake**

This is a needs data gathering exercise and will not be used to force any individual to upgrade their system.

Although the Sanitary District is considering only the potential need for wastewater collection and treatment in Amnicon/Dowling, some basic information on drinking water supply is requested as drinking water quality is influenced by wastewater treatment. Questions pertaining to water supply are following:

4. WATER WELL (source of drinking water)

A. GENERAL INFORMATION

1. Do you have your own well?

237	☐ Yes	**93%**
2	☐ No Well	**1%**
4	☐ No, share with others	**2%**
9	**Unanswered**	**4%**
1	**Unknown**	**<1%**
1	**Not Applicable**	**<1%**

2. Type of well?

59	☐ Sand Point	**23%**
85	☐ Drilled	**34%**
92	☐ Don't know	**36%**
18	**Unanswered**	**7%**

3. Approximate age of your well?

135	☐ Don't know	**53%**
15	☐ 0-10 Years	**6%**
16	☐ 11-20 Years	**6%**
17	☐ 21-30 Years	**6%**
14	☐ 31-40 Years	**6%**
9	☐ 41-50 Years	**4%**
3	☐ 51 Years or older]	**1%**
45	**Unanswered**	**18%**

4. Depth of the well?

151 ☐ Don't know 59%
☐ No well
3 ☐ 40-50 Feet 1%
5 ☐ 51-60 Feet 2%
2 ☐ 61-70 Feet 1%
8 ☐ 71-80 Feet 3%
21 ☐ 81-150 Feet 8%
5 **<40 Feet 2%**
8 **>150 Feet 3%**
2 **Shallow 1%**
49 **Unanswered 19%**

5. Is the well cased?

48 ☐ Yes 19%
132 ☐ No/Unknown 52%
☐ No well
Depth: **9 answers, 60 feet – 400 feet**
74 **Unanswered 29%**

6. Has your water been tested?

102 ☐ Yes 40%
☐ No well
89 ☐ Don't know/not tested 35%
63 **Unanswered 25%**

What were the results?

101 ☐ Safe 40%
☐ Contaminated
15 ☐ Don't know 6%
138 **Unanswered 54%**

What contaminants were found? **Iron, Sulfur**

7. Do you regularly use bottled drinking water? 12 ☐ Yes 5% 76 ☐ No 30%
164 Unanswered 64% 2 Filtered 1%

8. Other Comments: **Well has filter for tasted, bring in own drinking water, well not hooked up, drink bottled water on occasion, tastes great**

B. OTHER CONCERNS (community-wide):

1. Are there drinking water problems in your community that you believe need correction?
10 ☐ Yes 4% 60 ☐ No 24% 31 ☐ Unsure 12% **153 Unanswered 60%**

5. **LOT** (site specific concerns):

A. GENERAL CONCERNS

1. Are you aware of underlying bedrock or high groundwater table on your property?

Bedrock:
1 ☐ Yes <1% 223 ☐ No 88% **30 Unanswered 12%** Depth to bedrock: **N/A** feet

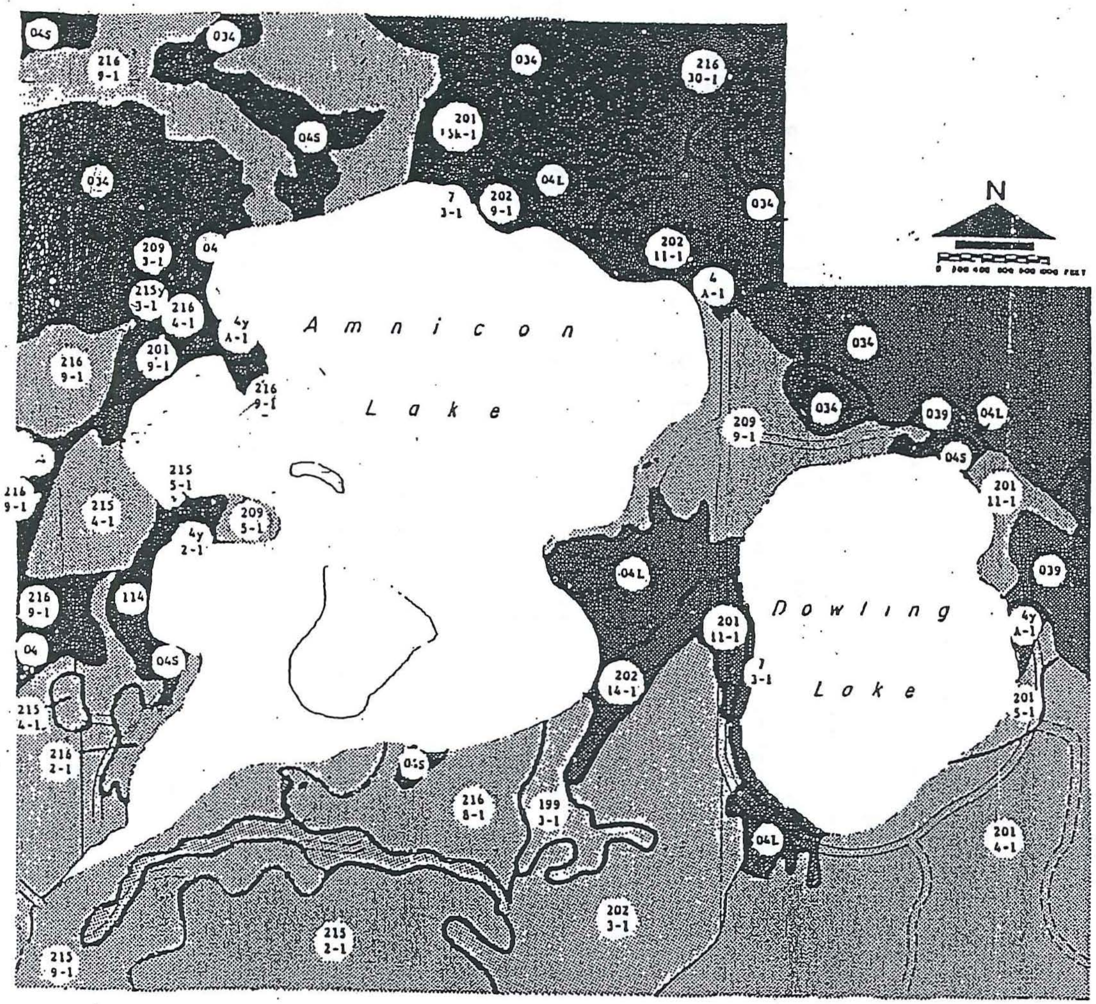
Groundwater:
201 ☐ Yes 79% 42 ☐ No 17% **11 Unanswered 4%** Depth to water: **Avg. 5.47** feet

AMNICON & DOWLING LAKE AREA,
DOUGLAS COUNTY

SOIL SURVEY

Prepared by the: NORTHWESTERN WISCONSIN REGIONAL PLANNING & DEVELOPMENT COMMISSION with technical assistance of DAVY ENGINEERING COMPANY

Preparation of this report has been aided through technical and financial assistance from the:
FARMERS HOME ADMINISTRATION
US DEPARTMENT of AGRICULTURE



SOIL SURVEY LEGEND

Symbol	Soil Name & Type
03	Loxley, Beseman, and Dawson Peat
04	Lupton, Cathro, and Marley Mucks
04L	Lupton, Cathro, and Marley Mucks
04S	Lupton, Cathro, and Marley Mucks
034	Loxley, Beseman, and Dawson Peat
039	Loxley, Beseman, and Dawson Peat
4	Beaches
7	Beaches
114	Cathro Muck, Ponded
199	Moodig Sandy Loam
201	Gogebic Fine Sandy Loam
202	Gogebic Fine Sandy Loam
205	Keweenaw Loamy Sand
209	Gogebic Fine Sandy Loam
215	Pence Sandy Loam
216	Vilas Loamy Sand

Example: 211 = Soil Name & Type
18 = % Slope
1 = Degree of Erosion

Shading	Limitations For Septic tank Filter field
Slight	
Moderate	
Severe	

Source: U.S. Department of Agriculture, Soil Conservation Service

EXHIBIT 2

4,800 FT / 2.9" = 1,655 FT/inch

BARR

Technical Memorandum

To: Marvin Hora, Doug Hall and Mark Tomasek, Minnesota Pollution Control Agency

From: Greg Wilson and Tim Anderson

Subject: Final — Detailed Assessment of Phosphorus Sources to Minnesota Watersheds — Individual Sewage Treatment Systems/Unsewered Communities

Date: January 16, 2004

Project: 23/62-853 ISTS 009

c: Henry Runke

The purpose of this memorandum is to provide a discussion about unsewered communities and Individual Sewage Treatment Systems (ISTS) as sources of phosphorus to Minnesota watersheds. This discussion is based on a review of the available literature, monitoring data and the results of phosphorus loading computations done for each of Minnesota's major watershed basins as part of this study. This memorandum is intended to:

- Provide an overview and introduction to these sources of phosphorus
- Describe the results of the literature search and review of available monitoring data
- Discuss the characteristics of each watershed basin as it pertains to these sources of phosphorus
- Describe the methodology used to complete the phosphorus loading computations and assessments for this study
- Discuss the results of the phosphorus loading computations and assessments
- Discuss the uncertainty of the phosphorus loading computations and assessment
- Provide recommendations for future refinements to phosphorus loading estimates and methods for reducing error terms
- Provide recommendations for lowering phosphorus export from unsewered communities and individual sewage treatment systems

Overview and Introduction to Unsewered Communities and ISTS Sources of Phosphorus

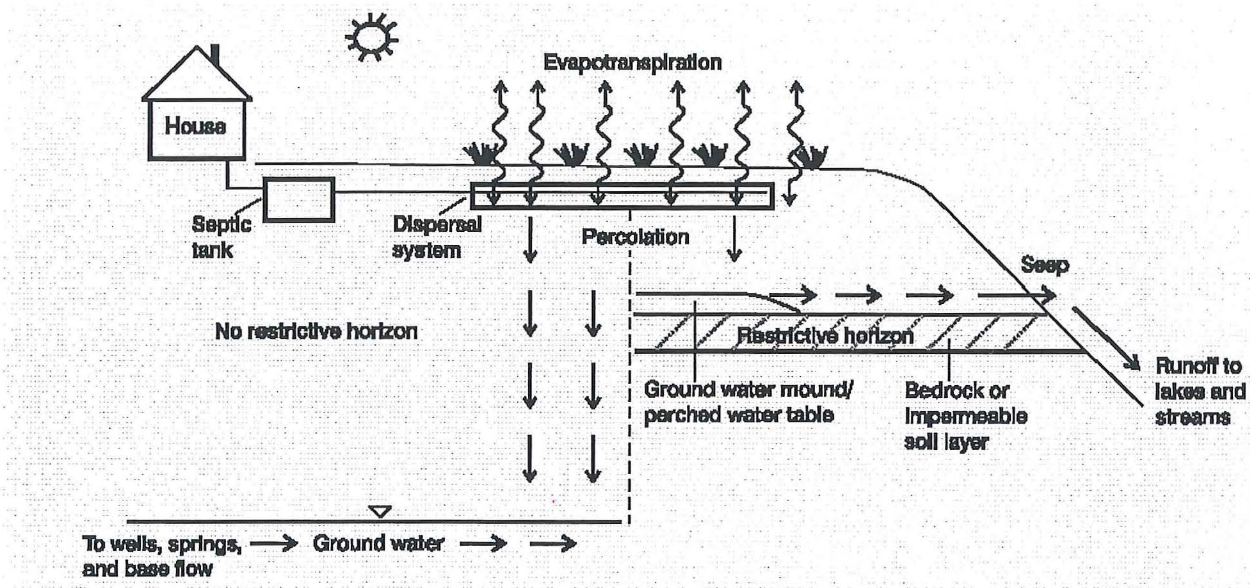
"Unsewered" or "undersewered" areas are communities or residential areas which have inadequate or no centralized wastewater treatment (sewer) systems. In many cases they may have a sanitary sewer system. Individual sewage treatment system (ISTS) refers to a sewage treatment and disposal system located on a property, using subsurface soil treatment and disposal for an individual home or establishment. MPCA

(2002a) states that most unsewered communities and many failing septic systems have relatively direct connections to surface waters through tiles lines, resulting in a very high delivery potential. Failing systems are systems that are adversely impacting groundwater, while those systems which discharge partially treated sewage to the ground surface, road ditches, tile lines, and directly into streams, rivers and lakes are considered an imminent threat to public health and safety (ITPHS).

Unsewered areas include but are not limited to incorporated cities (some), unincorporated communities, clusters of homes, trailer parks or other rural residential areas where wastewater collection is not done through a large sewer system. Undersewered areas may include unincorporated communities, incorporated cities (some), clusters of homes, trailer parks, or rural residential areas where existing wastewater treatment methods are not adequate to protect public health or the environment. The situations range from failing individual systems to cities with inadequate collection and treatment infrastructure.

Minnesota Rules Chapter 7080 contains minimum standards and criteria for the location, design, installation, use, maintenance and abandonment of ISTS, a licensing program for ISTS professionals and administrative requirements for local units of government. The conventional ISTS consists primarily of a septic tank and a soil absorption field. Septic tanks remove most settleable and floatable material and function as an anaerobic bioreactor that promotes partial digestion of retained organic matter (EPA, 2002). Septic tank effluent, which contains significant concentrations of pathogens and nutrients, has traditionally been discharged to soil, sand, or other media absorption fields for further treatment through biological processes, adsorption, filtration, and infiltration into underlying soils. Conventional systems work well if they are installed in areas with appropriate soils and hydraulic capacities; designed to treat the incoming waste load to meet public health, ground water, and surface water performance standards; installed properly; and maintained to ensure long-term performance (EPA, 2002).

Phosphorus is present in significant concentrations in most wastewaters treated by ISTS. After treatment and percolation of the wastewater through the infiltrative surface biomat and passage through the first few inches of soil, the wastewater plume begins to migrate downward until nearly saturated conditions exist (EPA, 2002). Reduced treatment occurs when the plume is mixing with an elevated water table (see Figure 1). At that point, the wastewater plume will move in response to the prevailing hydraulic gradient. The movement of subsurface aqueous contaminant plumes is highly dependent on soil type, soil layering, underlying geology, topography, and rainfall (EPA, 2002). In regions with moderate to heavy rainfall, descending effluent plumes remain relatively intact as the water table is recharged from above. Monitoring below ISTS systems has shown that the amount of phosphorus leached to ground water depends on several factors: the characteristics of the soil, the thickness of the unsaturated zone through which the wastewater percolates, the applied loading rate, and the age of the system (EPA, 2002). The amount of phosphorus in ground water varies from background concentrations to concentrations comparable to that of septic tank effluent. The capacity of the soil to retain phosphorus is finite. With continued loading, phosphorus movement deeper into the soil profile and downgradient water resources can be expected.



Source: Adapted from Venhuizen, 1995.

Figure 1: Schematic of ISTS wastewater discharge.

As previously discussed, conventional treatment systems work well if they are installed in areas with appropriate soils and hydraulic capacities; designed to treat the incoming waste load to meet public health, ground water, and surface water performance standards; installed properly; and maintained to ensure long-term performance (EPA, 2002). As a result, phosphorus export to surface waters from ISTS and unsewered communities is dependent on the following factors:

- Phosphorus content of waste load
- Population served by ISTS or unsewered communities
- Compliance of treatment systems with performance standards
- Characteristics of soil absorption field, groundwater conditions and proximity to surface waters

Review of Available Data and Estimation of Population Served by ISTS/ Unsewered Communities

Data pertaining to the phosphorus content of the untreated waste load from unsewered communities was addressed in the Point Sources Technical Memorandum (Barr, 2003), prepared for this project. For the purposes of this analysis, the phosphorus contained in untreated sewage discharge from ISTS or unsewered communities consists of the following sources, with the corresponding per capita loadings of phosphorus (taken from the Point Sources Technical Memorandum):

Source	Phosphorus Load (kg/cap/yr)
Automatic dishwasher detergent	0.1250
Dentifrices	0.0115
Food soils and garbage disposal wastes	0.1895
Ingested Human wastes	0.5585
Total	0.8845

Dentifrices include toothpaste and other dental care products. Food soils include waste food and beverages poured down the sink, and food washed down the drain as a result of dish rinsing and washing (Barr, 2003). The total per capita phosphorus load of 0.8845 kg/yr, which corresponds to 1.946 lbs/cap/yr, was assumed to apply to the population served by ISTS or unsewered communities throughout the state.

The number of people served by ISTS was estimated from a variety of data sources.
Table 1 provides a summary of population served by ISTS by basin using four data sources. A description of each of these data is discussed below. Two of the data sources were spreadsheets provided by the Minnesota Pollution Control Agency, another was the 1990 Census (United States Census Bureau, 1990), and the last was estimated based on the results from the Point Sources Technical Memorandum. Table 1 contains a summary of the population served by ISTS by major drainage basin for each of the four methods examined.

The method using the difference between the 2000 Census (United States Census Bureau, 2000) population and the POTW population served totals were used in the study to estimate phosphorus loadings from ISTS. This data showed good consistency with the other data available for ISTS in

Table 1
Estimates of Population Served

Major Basin	1990 Census Population	2000 Census Population	POTW Data				1990 Census Data		LUG Spreadsheet		Unsewered Areas	
			2000 POTW Population Served	Loss or gain of Population due to Basin Transfer	2000 ISTS by Difference	ISTS Percentage of 2000 Population	1990 Population Served by ISTS	ISTS Percentage of 1990 Population	Population Served by ISTS	ISTS Percent of 2000 Population	2002 Unsewered Population	Percentage of 2000 Population
Cedar River	66,144	66,934	49,280	0	17,654	26%	16,687	25%	11,207	17%	299	0%
Des Moines River	34,517	34,955	28,137	0	6,818	20%	12,231	35%	13,198	38%	1,028	3%
Lake Superior	212,223	221,000	181,581	0	39,419	18%	62,885	30%	20,306	9%	342	0%
Lower Mississippi	471,122	558,351	378,098	-36787	143,466	26%	136,049	29%	81,967	15%	11,272	2%
Minnesota River	763,066	861,292	743,145	-40110	158,257	18%	169,309	22%	162,244	19%	25,872	3%
Missouri	35,377	33,777	17,080	0	16,697	49%	13,992	40%	12,858	38%	509	2%
Rainy River	48,476	46,946	13,413	0	33,533	71%	26,855	55%	40,380	86%	6,216	13%
Red River	237,920	244,216	131,742	0	112,474	46%	105,823	44%	100,025	41%	8,966	4%
St. Croix River	157,613	206,190	52,242	-43,428	110,520	54%	85,184	54%	110,427	54%	32,612	16%
Upper Mississippi	2,350,483	2,645,132	2,231,380	40105	453,857	17%	458,195	19%	520,096	20%	154,696	6%
TOTAL	4,376,940	4,918,793	3,826,098	0	1,092,695	22%	1,087,208	25%	1,072,708	22%	241,812	5%

LUG: Local Unit of Government

Minnesota. By using the by difference method, a total accounting of domestic waste disposal is provided in this study.

Below is a description of the data used to develop the summary in Table 1.

MPCA Unsewered Communities Spreadsheet

The MPCA developed a spreadsheet, updated in September, 2003, providing a list of unsewered communities within Minnesota (MPCA, 2003a). Included in the spreadsheet are 841 communities. The major basin for each of these communities was estimated by assigning an approximate geographic location based on a city, township, lake/county, or township-range-section location (whichever provided the most detailed location). The locations were determined for 785 of the 841 communities. The remaining 57 communities were not located. Many of the communities that were not located were subdivisions or unmapped communities using local names.

The sum of the population served by ISTS in these communities was approximately 253,000. The total for unsewered communities under-represents the amount of ISTS systems in the state since it includes only systems within a community. Although summarized in Table 1, these data were not directly used in the comparison of methods.

MPCA ISTS Local Units of Government (LUG) Spreadsheet

This spreadsheet consists of a summary of ISTS by local units of governments with ISTS ordinances in 2002 (MPCA, 2002b). Included in the spreadsheet was the LUG name and type (e.g. city, township or county). An estimate of the number of full time and seasonal residences served by ISTS was included in the spreadsheet. There was also an estimate of the number of failing systems and an estimate for the number of systems which are considered an ITPHS. The population served was estimated by multiplying the number of full time residences by the population per household values (for the 2000 census) for the LUG's respective county.

The LUGs in this spreadsheet were located geographically as polygons using MnDOT's base map GIS layers for municipalities, townships, and counties. To prevent overlap between counties and the smaller governmental units, ArcInfo GIS was used to clean the boundaries between the overlapping jurisdictional boundaries. For example, if a municipality had its own ISTS ordinance, the city boundary was excluded from the area of the County (which would also have an ordinance) in which it is located.

The resulting polygons were overlaid with the ten major basins to estimate the ISTS totals for each major basin. In cases where a jurisdiction was in two or more major basins, the ISTS population served for each basin was weighted by area. The sum of all the population served for the State of Minnesota was approximately 1,073,000 based on the LUG spreadsheet.

1990 Census of the United States

The 1990 Census (United States Census Bureau, 1990) included questions regarding sewage disposal for both vacant and occupied housing units. Below is a description of the data provided by the Census Bureau:

> *SEWAGE DISPOSAL*
> *The data on sewage disposal were obtained from questionnaire item H16, which was asked at both occupied and vacant housing units. This item was asked on a sample basis. Housing units are either connected to a public sewer, to a septic tank or cesspool, or they dispose of sewage by other means. A public sewer may be operated by a government body or by a private organization. A housing unit is considered to be connected to a septic tank or cesspool when the unit is provided with an underground pit or tank for sewage disposal. The category, "Other means" includes housing units which dispose of sewage in some other way.*
>
> *Comparability--Data on sewage disposal have been collected since 1940. In 1970 and 1980, data were shown only for year-round housing units. In 1990, data are shown for all housing units.*

Note that sewage disposal data were not collected in the 2000 census (United States Census Bureau, 2000). The "septic tank or cesspool" and "other units" were combined as an estimate for ISTS in this study.

In the 1990 census, the sewage disposal data were not split between year-round and vacant/seasonal housing., For this study, it was assumed that the percentage of all housing units with ISTS were equal to the percentage of year-round housing units with ISTS. Therefore, the total ISTS in each census-blockgroup was estimated by multiplying the ratio of year-round housing to all housing units by the total number of households with ISTS in that census-blockgroup. The population served was calculated by multiplying the number of households with ISTS by the population per household for the census blockgroup.

The estimated population served by ISTS in Minnesota using the 1990 census data is 1,087,000.

Estimation of Population Served by ISTS by Difference Between 2000 Census and WWTP Population Served (Difference Method)

The sum of the population served by public/private wastewater treatment systems and ISTS can be assumed to be the population of the State of Minnesota during the 2000 census. The estimate of population served using ISTS by basin can be estimated by calculating the difference between the total population of each basin and the number of persons served by wastewater treatment plants in the basin.

The population served for each of the POTWs and privately owned wastewater treatment facilities were estimated. The population served for each facility was not readily available for all of the permitted facilities. Therefore, the following approach was taken and the following assumptions made (as per the Point Sources Technical Memorandum):

1. MPCA Delta Database. When available, the population served by a treatment facility as listed in the Delta database was used.
2. MNPRO Database. If population data was not available from the Delta database, the population of the community corresponding to the permit was assumed to equal the population served by the WWTP. This information was obtained from the MNPRO data base.
3. ISTS unsewered communities and LUG spreadsheets. These communities and the population served by ISTS systems were compared to the communities having an NPDES permit as listed in the Delta database. If a community had both a NPDES permit to discharge to

surface water and was listed as being served by an ISTS, the difference of the City's population and the ISTS population was used as the population served by the treatment facility. If no information could be located, the permit holder was called to determine the population served by each system.

4. MNPRO Database. The complete listing of communities within the state of Minnesota as contained in the MNPRO database was compared to both the NPDES list and the unsewered communities list to verify that all communities within the state were accounted for. Any communities with a population greater than 1,000, that were unaccounted for, were contacted and the final disposition of their wastewater was determined. In many cases these communities transferred their wastewater to another community's treatment facilities.
5. Communities with a population of less than 1,000 that did not have either an NPDES permit, or were listed as an ISTS or unsewered community, were assumed to be served by an ISTS system.
6. Finally, the population served by unsewered and ISTS systems was tallied on a major basin basis. These results are presented in Table 1.

The state-wide estimate for population served by ISTS based on the difference between the 2000 census and the POTW totals is approximately 1,094,000. The basin total ISTS values in Table 1 were corrected for the number of people whose domestic wastewater is treated in a wastewater treatment plant outside of the basin where they live. This correction was done for the four basins that include Twin City Metro Area. To determine the areas where there are basin transfers, 1997 Metropolitan Council sewersheds, showing the areas draining to specific wastewater treatment plants in the Metropolitan Area, were overlaid with the major basins. The result of this analysis was the area in each of the basins which discharge to a WWTP in a different basin. These data were then overlaid on the 2000 Census blockgroup data to determine the populations of the areas. The net results of this analysis are shown in Table 1.

The breakdown of population served by major basin presented in Table 1 was relatively consistent between the three methods summarized. The LUG spreadsheet and the POTW by difference methods showed the same overall percentage (22 percent) of the total population of the state is served by ISTS. The 1990 Census total had approximately the same state-wide population served value, but its percentage usage was higher since the population of the state was lower in 1990 compared to 2000.

In general, the three methods indicate that the total number of people served by ISTS in Minnesota is approximately 1,080,000, 22 percent of the total population in 2000.

The comparison shows a good match between the three methods for the Upper Mississippi River, Cedar River, St. Croix River, Red River of the North and Minnesota River basins. The Lake Superior and Rainy River basins have the largest discrepancy between the three methods, but the difference method value is near the average of the other two methods for both basins.

The smaller basins in southwest Minnesota (Missouri and Des Moines rivers) had the largest percentage differences, although their numerical differences were small since the populations of these basins are low. The reason the differences are so great in these two basins, on a percentage basis, is not clear.

The results in Table 1 show that using the difference method provides a good estimate for the number and distribution of ISTS users across the state. By using the difference method, the entire population of the state is accounted for in the phosphorus calculations for domestic wastewater generation.

Basin Characteristics

Population served by ISTS or unsewered communities, compliance of treatment systems with performance standards, groundwater conditions, and characteristics of soil absorption field and proximity to surface waters are important factors in determining phosphorus export. As previously discussed, the major basin for each of the communities in MPCA unsewered communities spreadsheet was determined by assigning an approximate geographic location based on the available city, township, lake/county, or township-range-section location data. The MPCA ISTS LUG spreadsheet provided estimates of the number of full time and seasonal residences served by ISTS, along with the number of failing systems and an estimate for the number of systems which are an ITPHS. The population data used for both ISTS and unsewered communities are included in Tables 1 and 2. Table 2 also shows the number of residential systems in each basin. The Upper Mississippi River basin accounts for almost one-quarter of the population served by ISTS and more than 60 percent of the unsewered areas population. The Minnesota, Lower Mississippi, Red and St. Croix River basins serve ISTS populations of between 110,000 and 160,000, while the Minnesota and St. Croix River basins have unsewered area populations between 25,000 and 33,000. The remaining basins represent small fractions of the statewide populations served by ISTS and unsewered communities.

Table 2 shows the percentages of failing systems and systems which discharge partially treated sewage (or are considered an ITPHS), estimated for each of the basins and the state. These estimates show that the Des Moines River basin has the highest percentage (41%) of ISTS systems considered an ITPHS, followed by the Minnesota and Missouri River basins with 29 and 22 percent, respectively. The St. Croix, Lake Superior, Rainy and Upper Mississippi River basin estimates for percentages of ISTSs considered an ITPHS were all less than 8 percent. Table 2 shows that the Rainy River basin had the highest (43%), while the St. Croix basin had the lowest (11%), percentages of failing ISTS systems. All of the other basins had estimated percentages of failing ISTS systems between 24 and 35 percent. The high percentage for the Rainy River basin may be partially due to the presence of high water tables relative to the other basins.

Retardation of phosphorus contamination of surface waters from ISTSs is enhanced in fine-textured soils without continuous macropores that would allow rapid percolation. Increased distance of the system from surface waters is also an important factor in limiting phosphorus discharges because of greater and more prolonged contact with soil particle surfaces. The risk of phosphorus contamination, therefore, is greatest in karst regions and coarse-textured soils without significant iron, calcium, or aluminum concentrations located near surface waters (EPA, 2002). The presence of karst regions in portions of the Lower Mississippi River basin means that the 27 percent of failing ISTSs (from Table 2) might be lower than the actual percentage of systems adversely impacting groundwater. For this analysis, no attempt has been made to vary the estimates of phosphorus discharged to surface waters from conforming and non-conforming systems, based on the presence of karst regions, elevated water tables or various types of soils in each basin.

Table 2
Estimated Annual Phosphorus Loadings for ISTS/Unsewered Communities

tal dential stems	Percent Partially Treated	Percent Failing	Unsewered Areas Population	Avg. Pop. per Household	Direct-to-Tile Systems	Direct-to-Tile Pop.	Remaining ISTS Pop.	Seasonal Pop.	Estimated P Load Produced (kg)				Estimated P Loa	
									Unsewered Areas	Direct-to-Tile Systems	Seasonal ISTS	Remaining ISTS	Unsewered Areas	Direct Til Syste
4,500	15.7%	34.6%	299	3.92	514	2,016	15,339	0	264	1,784	0	13,568	114	
5,420	41.1%	23.8%	1,028	1.28	419	536	5,254	191	909	474	56	4,647	391	
16,000	5.5%	35.0%	342	4.80	0	0	39,077	16,363	303	0	4,825	34,565	130	
31,002	10.6%	26.8%	11,272	4.75	450	2,137	130,057	1,676	9,971	1,891	494	115,041	4,287	
67,100	29.4%	32.8%	25,872	2.55	7,399	18,847	113,538	10,437	22,885	16,671	3,077	100,430	9,841	[illegible]
5,233	22.1%	33.4%	509	3.27	227	743	15,445	281	450	658	83	13,662	194	
23,928	7.0%	43.1%	6,216	2.02	0	0	27,317	15,395	5,498	0	4,539	24,163	2,364	
46,447	13.1%	27.0%	8,966	2.92	0	0	103,508	16,655	7,931	0	4,911	91,558	3,410	
45,249	2.3%	11.4%	32,612	2.76	0	0	77,908	10,857	28,847	0	3,201	68,913	12,404	
227,515	7.8%	24.7%	154,696	2.32	436	1,014	298,147	67,809	136,836	897	19,993	263,725	58,839	
472,394	11.6%	26.4%	241,812	2.69	9,445	25,294	825,589	139,665	213,894	22,373	41,180	730,271	91,974	[illegible]

The Minnesota River basin had a significant number of households served by sewage treatment systems that involved direct discharge to a tile drain line (Tetra Tech, 2002). The majority of these systems, referred to as direct-to-tile ISTS, include a septic tank with no other treatment. Assuming that most of the direct-to-tile ISTS are located in rural areas with tile lines, Tetra Tech (2002) extracted data from the Minnesota River Assessment Project, or MRAP (MPCA, 1994), to develop a relationship between the number of direct-to-tile ISTS and cropland. The ISTS densities and cropland were then mapped by minor watersheds across the Minnesota River basin. The higher densities of direct-to-tile ISTS occurred in the southeastern watersheds, while the lower densities occurred in the northwestern watersheds (Tetra Tech, 2002). The geographic trend in density was assumed to be consistent with the MRAP designations for three nutrient source regions, and the average density of direct-to-tile ISTS per 10,000 acres of cropland was determined for each source region. The average densities determined for Source Regions 1, 2, and 3 were 0.78, 4.88, and 18.17 direct-to-tile ISTS per 10,000 acres of cropland, respectively (Tetra Tech, 2002). Source Regions 1, 2, and 3 progress from the northwest to the southeast in the Minnesota River basin.

For this analysis, the assumptions about direct-to-tile ISTS density per 10,000 acres of cropland for each source region were retained for the Minnesota River basin. Since no assessments of direct-to-tile ISTS had been published for any other basins in Minnesota, several of the minor watersheds in surrounding basins were assumed to have direct-to-tile ISTS densities comparable to Source Regions 1, 2, and 3, based on knowledge of the presence of drain tiles, cropland and their proximity to the MRAP study areas. Figure 2 shows how these minor watersheds, with their assumed Source Region designations, provide a transition in the direct-to-tile ISTS densities assumed to exist outside of the areas studied in MRAP (MPCA, 1994). The amount of cropland and area of each Source Region was determined and multiplied to determine the total number of direct-to-tile systems for each basin (shown in Table 2). The population served by direct-to-tile ISTS was estimated by multiplying the number of systems by the average household size for each basin (shown in Table 2).

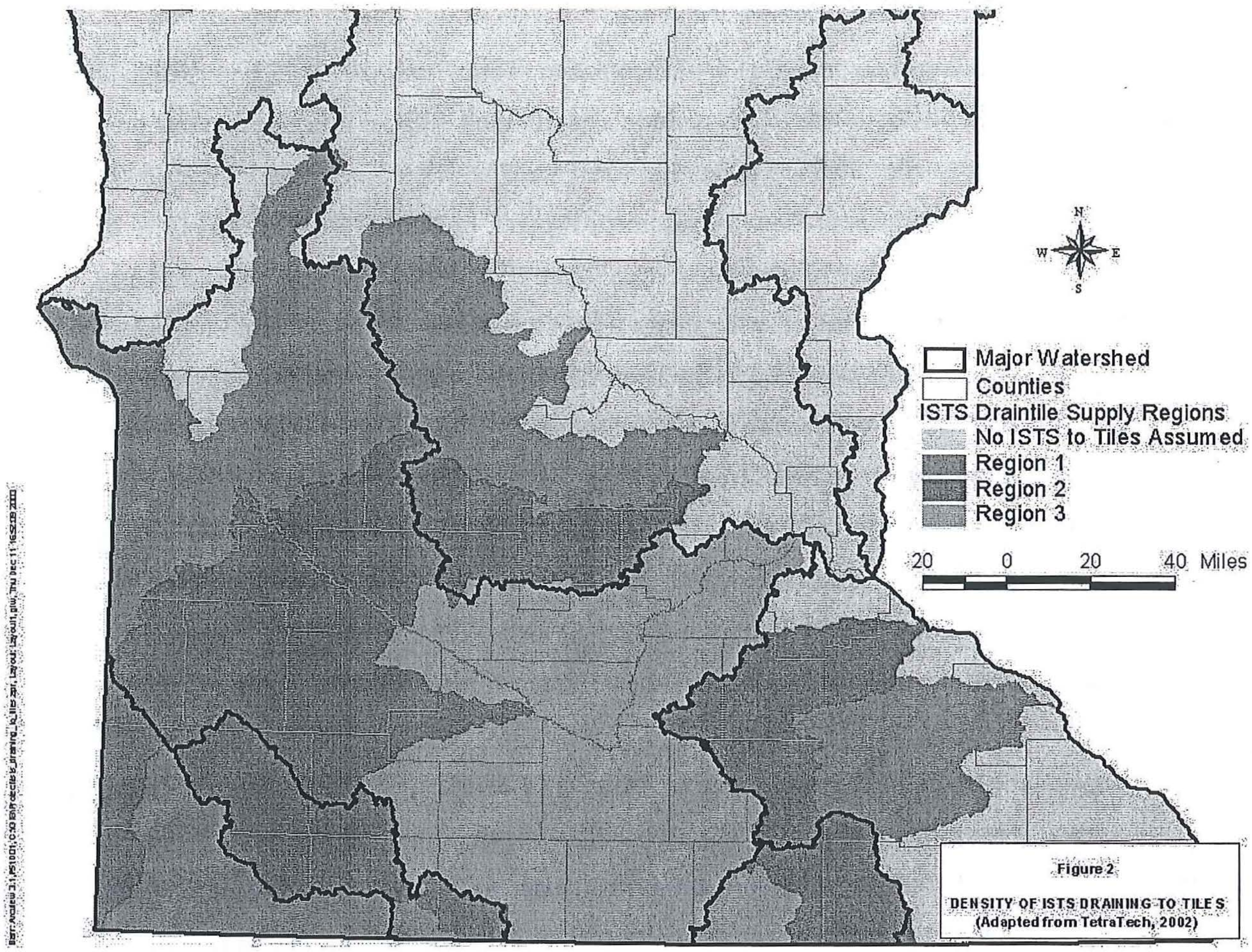


Figure 2

DENSITY OF ISTS DRAINING TO TILES
(Adapted from TetraTech, 2002)

Approach and Methodology for Phosphorus Loading Computations

Based on the availability of data and the potential for variation in phosphorus export from unsewered communities and the various types of conforming and nonconforming ISTS, phosphorus loadings were estimated for each of the following source categories:

- Unsewered communities
- Direct-to-tile ISTS
- Conforming and nonconforming seasonal ISTS
- Remaining conforming and nonconforming ISTS

As previously discussed, Table 2 presents the populations associated with unsewered communities and direct-to-tile ISTS in each basin. The per capita total phosphorus wastewater load of 0.8971 kg/yr was applied to the population served by direct-to-tile ISTS and unsewered communities for each basin. Both of these source categories were assumed to receive treatment from septic tanks before discharging to surface waters. Forty-three percent of the incoming wastewater load from each source category was assumed to pass through the septic tank, which is consistent with the assumptions made for the Minnesota River Basin Model (Tetra Tech, 2002).

As previously discussed, the number of seasonal residences had been estimated in the MPCA ISTS LUG spreadsheet (MPCA, 2002). Since no data was available for the population served by seasonal ISTS, a household size of 2.1 was assumed and applied to the number of seasonal residences in each basin. This assumption is consistent with the household size used for the Minnesota River Basin Model (Tetra Tech, 2002). No literature was found, so it was assumed that each of the seasonal residences were occupied for four months each year. It was further assumed that, since seasonal residences are typically located in close proximity to surface waters, nonconforming ISTS (both failing and ITPHS) would contribute all of the 43 percent of phosphorus passing through a septic tank to surface waters. Conforming seasonal ISTS were assumed to remove 80 percent of the total phosphorus loading, due to treatment from the septic tank and soil absorption field, before discharging to surface waters in each basin.

As previously discussed, the total number of residential residences had been estimated in the MPCA ISTS LUG spreadsheet (MPCA, 2002) and the population served by ISTS had been estimated by difference (shown in Table 1). Since most of the permanent residences are not typically located as close in proximity to surface waters as seasonal residences, it was assumed that both fully conforming and failing ISTS would provide higher phosphorus attenuation for permanent residences than what was assumed for seasonal residences. Conforming ISTS were assumed to remove 90 percent of the overall total phosphorus loading, while failing ISTS were assumed to remove 70 percent of the overall total phosphorus loading, before discharging to surface waters in each basin. The nonconforming ISTS, considered an ITPHS, were assumed to be contributing all of the 43 percent of phosphorus passing through a septic tank to surface waters. The phosphorus removal and soil phosphorus attenuation percentages assumed for conforming and nonconforming ISTS in this analysis are within the range of literature values (Viraraghavan and Warnock, 1975; Reckhow and Simpson, 1980; Kellog et al., 1995; EPA, 2002; ENSR, 2003).

Results of Phosphorus Loading Computations and Assessments

Table 2 presents the results of the phosphorus loading computations done for the assessment of ISTS and unsewered communities. The last five columns of Table 2 show the estimated total phosphorus loadings to surface waters from unsewered communities, direct-to-tile ISTS, all seasonal ISTS, the remaining ISTS, and the total load in each basin (and the state) from all four source categories. On a statewide basis, Table 2 shows that more than half of the phosphorus load from unsewered communities/ISTS is coming from permanent ISTS, while approximately 35 percent of the total load originates from unsewered communities. Unsewered communities represent a large percentage of the total load to the St. Croix and Upper Mississippi River basins (56 and 53 percent, respectively). Unsewered communities represent less than 27 percent of the total phosphorus load for the remaining basins. Direct-to-tile ISTS represents 20, 16 and 11 percent of the total phosphorus load in the Cedar Minnesota, and Des Moines River basins, respectively; but less than 8 percent for the remaining basins. The estimated seasonal ISTS contributions are 16 and 18 percent of the total phosphorus loads in the Rainy River and Lake Superior basins, respectively, and less than 7 percent for the remaining basins. The remaining ISTS contributions (from both conforming and nonconforming systems) accounts for more than 40 percent of the total phosphorus load from ISTS/unsewered communities in all of the basins. The highest total phosphorus contribution from the remaining ISTS category is 87 percent in the Missouri River basin.

Phosphorus Loading Variability and Uncertainty

The primary sources (and estimated magnitudes) of variability and uncertainty in the total phosphorus loading computations done for this assessment, in descending order, include:

- Percentage of phosphorus attenuation in soil absorption field for permanent and seasonal residences—(these percentages are likely to vary by 50 percent or more, depending on the proximity to surface water, soils and water table characteristics, etc.; if the all of the conforming systems from the remaining ISTS category removed 100% of the P load produced, the 140,510 kg total P load discharged to surface waters [in Table 2] would be reduced by approximately 30%)

- Portion of unsewered communities receiving various levels of treatment, more or less than septic tank removals (as assumed)—(these percentages are likely to vary by 50 percent or more, as some of the unsewered communities may be receiving good treatment with soil absorption, while others may not even receive treatment from septic tanks)
- Population of unsewered communities—(population figures may vary significantly within each basin depending on each counties ability to determine, report or verify and update the presence and population of unsewered communities)
- Population served and portion of direct-to-tile ISTS receiving various levels of treatment, more or less than septic tank removals (as assumed)—(these values are likely to vary by 100 percent or more, as the number of systems and population served are extrapolated from a small subset of areas studied in the MRAP which may or may not have already been counted with the ITPHS percentages, and some of the direct-to-tile ISTS may not even receive treatment from septic tanks)
- Population served and per capita P loadings for permanent versus seasonal residences—(the current P loading estimates assume that all of the population served by seasonal residences [2.1 people per seasonal residence for 4 months each year] is in addition to all of the P loadings generated by the current permanent residents of Minnesota, which may overestimate the P load from permanent Minnesota residents that maintain seasonal residences, but helps to offset both the fact that seasonal residences may be under-represented in the databases and the fact that people from other states maintain seasonal residences; in addition, the per capita loadings for dishwashing detergents and dentifrices are based on actual nationwide consumption, while the per capita loadings for human waste and food soils are based on monitoring of permanent residences)

Table 2 shows that the average ISTS household size determined for each basin can vary significantly from the statewide average of 2.7. The average ISTS household size was determined by dividing the total population served by ISTS by the total number of residential systems. The low household size value of 1.3 for the Des Moines River basin, may be the result of an underestimate of the population served by ISTS and unsewered communities or an overestimate of the number of residential systems. The high household sizes of approximately 4.8 for the Lower Mississippi and Lake Superior basins indicate that there may be an overestimate of the population served by ISTS and unsewered communities or an underestimate of the number of residential systems. There was much smaller variability from the statewide average for household size in the remaining basins. Over- or underestimates of population are much more important in the calculations of the total phosphorus loadings for each basin than the estimates of the number of residential systems because the population figures determine the amount of wastewater (and phosphorus) that is generated and available for export in each basin.

Recommendations for Future Refinements

The following refinements are recommended to reduce the error terms or uncertainty of the phosphorus loading estimates:

- The counties should work with the MPCA to develop, populate and maintain a geographic database, similar to MPCA's feedlot database that shows where each of the failing systems, straight pipe discharges and other types of ITPHS are located
- County personnel should be trained to assess the proper functioning of each type of system and be provided with an incentive to track all inspected and nonconforming systems, such that uniform assessments can be made throughout the state
- The estimates for population served by conforming and nonconforming systems, as well as unsewered communities and direct-to-tile ISTS, should be refined, updated and linked to a geographic database
- Additional analyses should be done to study the treatment effectiveness of conforming and nonconforming treatment systems, throughout the state, to evaluate the variability of the estimated phosphorus loadings to surface waters under various settings

Recommendations for Lowering Phosphorus Export

Many of the counties are delegated to implement the Minnesota Rules (Chapter 7080) for ISTS, which require conformance with state standards for new construction and disclosure of the state of the ISTS when a property transfers ownership. Several counties require ISTS upgrades at property transfer.

Lack of knowledge is thought to be a major impediment to making more rapid progress toward goals and objectives for ISTS and unsewered communities (MPCA, 2003b). This includes a lack of awareness of the management and operational requirements of ISTS, and the environmental consequences of widespread system failure. The complexity of addressing unsewered community issues tends to discourage county activity in this area. The availability of financial assistance, particularly low-interest loans, is thought to be an essential catalyst to accelerating fixes of failing ISTS. This and other forms of financial assistance are needed to accelerate progress with unsewered communities (MPCA, 2003b).

Owners of ISTS that are failing and pose an "Imminent Public Health Threat," through direct discharge to tile lines or surface ditches or system failure caused by lack of proper management should be targeted through mail surveys (and one-to-one visits in targeted watersheds) to help residents determine whether their ISTS are adequately functioning, inadequately installed, or are failing to function properly because of poor management (MPCA, 2003b). Programs proposed to follow up on specific problems include ISTS management workshops for failing systems and technical and financial assistance to owners needing new systems.

Residents of unsewered communities would be targeted to help them understand the need for wastewater treatment and assist them through each phase of the community decision-making process, while building the capacity of local and regional government staff to provide such assistance to other communities in the future (MPCA, 2003b).

County ISTS inspectors, Planning and Zoning Administrators, and County Water Planners should be targeted with MPCA audits of county ISTS programs to determine adequacy of performance in a number of key areas, including spot checks on recent ISTS installations, level of effort on ISTS inspections and follow-through on noncompliant systems, and dealing with contractors (MPCA, 2003b).

Since septic system failure is a widespread problem, a basinwide approach to reducing fecal coliform from this source should be pursued (MPCA, 2003b). Failing systems with potential for high delivery of pollutants to public waters, such as straight pipe discharges and other types of ITPHS should be given priority attention. Careful targeting is needed to ensure that resources devoted to providing wastewater treatment yield environmental results in the form of reduced concentrations of total phosphorus. The counties should work with the MPCA to develop, populate and maintain a database, similar to MPCA's feedlot database that shows where each of the failing systems, straight pipe discharges and other types of ITPHS are located. County personnel should be trained about the assessment of each type of system and provided with an incentive to track all inspected and nonconforming systems, such that uniform assessments can be made throughout the state.

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