Fecal Coliform Total Maximum Daily Load (TMDL) - North Branch of the Sunrise River

Final Report

Minnesota Pollution Control Agency
Chisago County

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Fecal Coliform Total Maximum Daily Load (TMDL) – North Branch of the Sunrise River

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Summary

In 1998, the Minnesota Pollution Control Agency (MPCA) listed the North Branch of the Sunrise River as an impaired water, under Section 303(d) of the Clean Water Act. The river, from its headwaters near Weber in Isanti County to its confluence with the main stem of the Sunrise River near Hay Creek in Chisago County, was listed as impaired for primary contact recreation and swimming. Over a period of 20 years, data have shown often excessive levels of fecal coliform bacteria loading in these waters, especially during times of increased flow due to rain or snow melt.

The indicator for this impairment, fecal coliform, is a group of bacteria that lives in the intestines of warm blooded animals, including humans. Its presence means the water has likely to have been contaminated by human or animal feces, indicating the possible presence of waterborne pathogenic bacteria, viruses or protozoa. These organisms can cause gastric or diarrheal diseases, including such diseases as typhoid and cholera.

The fecal coliform bacteria found in the North Branch of the Sunrise River came from a number of different sources. This Total Maximum Daily Load (TMDL) study looked at a number of different possible sources to try to pinpoint specific sources of the pollution. Point sources such as the North Branch waste water treatment plant were examined and found not to be a substantial source of fecal coliform. Non-point sources such as poorly functioning individual sewage treatment systems, unregulated livestock facilities, and pastures near streams and the river were the main sources of fecal coliform contamination in the watershed.

This study assessed the current fecal coliform concentrations in the river and determined the TMDL of fecal coliform which the river could accept and still meet Minnesota water quality standards for fecal coliform. Loading capacities were allocated among point sources (wasteload allocation), nonpoint sources (load allocation) and a margin of safety. A loading capacity (i.e., TMDL) is the product of stream flow for the impaired reach and the water quality standard. Five flow zones, ranging from low flow to high flow, were utilized so that the entire range of conditions is accounted for in the TMDL. A watershed-wide reduction of approximately 52% in fecal coliform loadings would be needed to comply with Minnesota water quality standards.

The strategy to bring about the necessary reductions is outlined in the implementation section of this report. The next step will be the development of an implementation plan to identify specific measures to be taken to remove the fecal coliform impairment. This plan will envision a timeline of approximately five to ten years to achieve all of the implementation practices as outlined. After this, the river will again be monitored to see if it meets the water quality standard. Once it does, the North Branch of the Sunrise River will be de-listed for fecal coliform and safe once again for swimming.

1.0 Problem Statement and Watershed Background

Section 303(d) of the Clean Water Act provides authority for completing total maximum daily loads (TMDLs) to achieve state water quality standards and/or designated uses.

A TMDL is a calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards and/or designated uses. It is the sum of the loads of a single pollutant from all contributing point and non-point sources. TMDLs must include the following eight elements to be approved by the U.S. Environmental Protection Agency (EPA):

The TMDL must:

1. Be designed to implement applicable water quality criteria
2. Include a total allowable load as well as waste load allocations
3. Consider the impacts of background pollutant contributions
4. Consider critical environmental conditions
5. Consider seasonal environmental variations
6. Include a margin of safety
7. Provide opportunity for public participation
8. For waters impaired by point sources, have a reasonable assurance that the TMDL can be met

In general, the TMDL is developed according to the following relationship:

TMDL = WLA + LA + MOS

Where:

TMDL	=	Total Maximum Daily Load of a pollutant (may be seasonal, for critical conditions or other constraints)
WLA	=	Waste Load Allocation (point sources)
LA	=	Load Allocation (nonpoint sources)
MOS	=	Margin of Safety (may be implicit and factored into a conservative WLA or LA, or explicit).

The MOS is a required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant load and the quality of the receiving waterbody.

This TMDL report applies to the following reach, which is listed for impaired aquatic recreation due to fecal coliform bacteria:

Sunrise River North Branch; Headwaters to Sunrise R (assessment unit ID#: 07030005-501)

The reach and its watershed are shown in Figure 1.1.

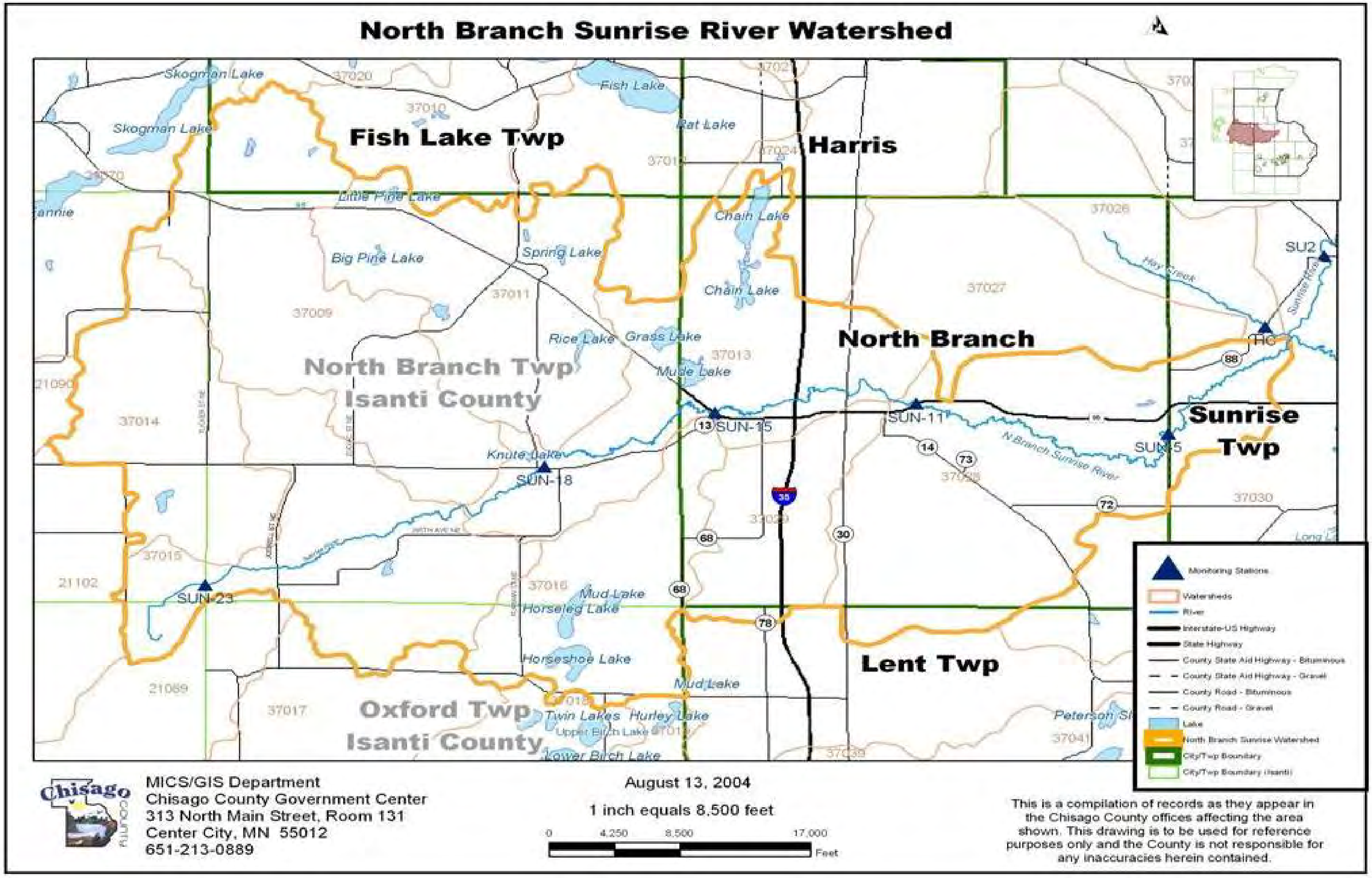


Figure 1.1 Map of the North Branch of the Sunrise River Watershed.

1.1 PROBLEM STATEMENT

In 1998, the North Branch Sunrise River from the headwaters in Isanti County to its confluence with the Sunrise River main stem was placed on the 303(d) list of impaired waters due to violations of water quality standards for fecal coliform bacteria making the river unsuitable for all types of aquatic recreation, including swimming.

The target dates for start and completion for this TMDL study are 2002 and 2005, respectively, reflecting the priority ranking.

The applicable fecal coliform bacteria water quality standards for Class 2Bd, 2B, and 2C waters are:

200 orgs/100 mL	Not to be exceeded as a geometric mean of not less than 5 samples per calendar month, and
2,000 orgs/100 mL	No more than 10% of samples per calendar month can individually exceed.

The determination of non-compliance was derived from samples taken at three sites on the North Branch Sunrise River during 1997 and 1998: SUN-14.9 located at the County Road 64 bridge in the city of North Branch, SUN-13.73 located at the County Road 67 (8^{th} Ave.) bridge in North Branch, SUN-5 located at the State Highway 95 bridge, east of North Branch. Sampling was conducted in August - September 1997 and May - July 1998. Analysis of these results showed that monthly geometric mean fecal coliform concentrations frequently exceeded the water quality standard of 200 organisms per 100 milliliters of water. See Table 1.1.

Table 1.1 – Fecal coliform water quality standards violations (1997-1998), North Branch of the Sunrise River at Station SUN-5.

Month/Year	Number of Samples	Range (orgs/100 mL)	Geometric Mean (orgs/100 mL)	No. Samples Exceeding 2,000 orgs/100 mL	Water Quality Standard Exceeded? Yes	No
Aug 1997	6*	240 - 680	353	0	X	
Sept 1997	5	190 - 740	338	0	X	
May 1998	4	36 - 240	92	0	insufficient sample	
June 1998	5	140 - 340	218	0	X	
July 1998	5	150 - 1200	418	0	X	

*****Includes two samples from late July 1997.

During 2002 and 2003, additional fecal coliform monitoring was conducted at several locations within the watershed to determine the extent of impairment, calculate an acceptable maximum daily load of bacteria from point and non-point sources, identify and evaluate potential sources of fecal coliform bacteria, develop reduction goals, and evaluate implementation strategies to achieve reduction goals. Eight sites in Isanti and Chisago Counties were sampled by the Chisago County SWCD. Five sites were on the North Branch of the river (SUN-5, SUN-11, SUN-15, SUN-18, SUN-23) and relevant to this study. Two sites were on main branch of the Sunrise (SU-2, SU-4) and one was on Hay Creek. All the sites are shown on the watershed map in

Figure 1.1 of this report. The sites were monitored up to five times per month between April – October during 2002 & 2003. The fecal coliform data are shown in Appendix A and discussed in Section 3.1.

1.2 Watershed Background

The North Branch of the Sunrise River is located in east central Minnesota. The river is a tributary of the Sunrise River and is part of the larger St. Croix River basin. This great watershed was created during the last ice age as the glacial advance was from west to east. As the glaciers melted and retreated to the west, the melt water flowed to the east as it still does today.

The Sunrise River has four larger subwatersheds: the West Branch near Stacy, the South Branch near Wyoming, Hay Creek which is northwest of the North Branch, and the North Branch which flows from west to east through the city of North Branch.

The North Branch of the Sunrise River watershed drains approximately 70.5 square miles of land, with the water flowing in an easterly direction from the headwaters in southeastern Isanti County to the terminus near Hay Creek in the east central part of Chisago County. At its mouth, the river empties into the main stem of the Sunrise River, which winds its way north approximately two miles where it meets the St. Croix River.

1.3 Pre-Settlement Vegetation

The headwaters of the North Branch of the Sunrise River are located in the wet prairies, marshes and sloughs of North Branch Township in eastern Isanti County. The river runs through the Anoka sand plain where the primary pre-settlement vegetation types were oak woodlands and oak barrens whose main species were bur and pin oaks, with aspen and hazel thickets and occasional prairie openings. Lowland hardwood forests containing oak, basswood, ash and elm were found at lower elevations along the river. There are still a few pockets of original vegetation left in inaccessible areas along the river banks.

1.4 Wildlife

Today, the watershed of the North Branch of the Sunrise River contains many of the types of birds, amphibians, reptiles and mammals that you would expect to occupy the river bottom and upland areas. The river itself is home to many vertebrates and invertebrates including diverse communities of freshwater mussels.

1.5 Geology and Soil Types

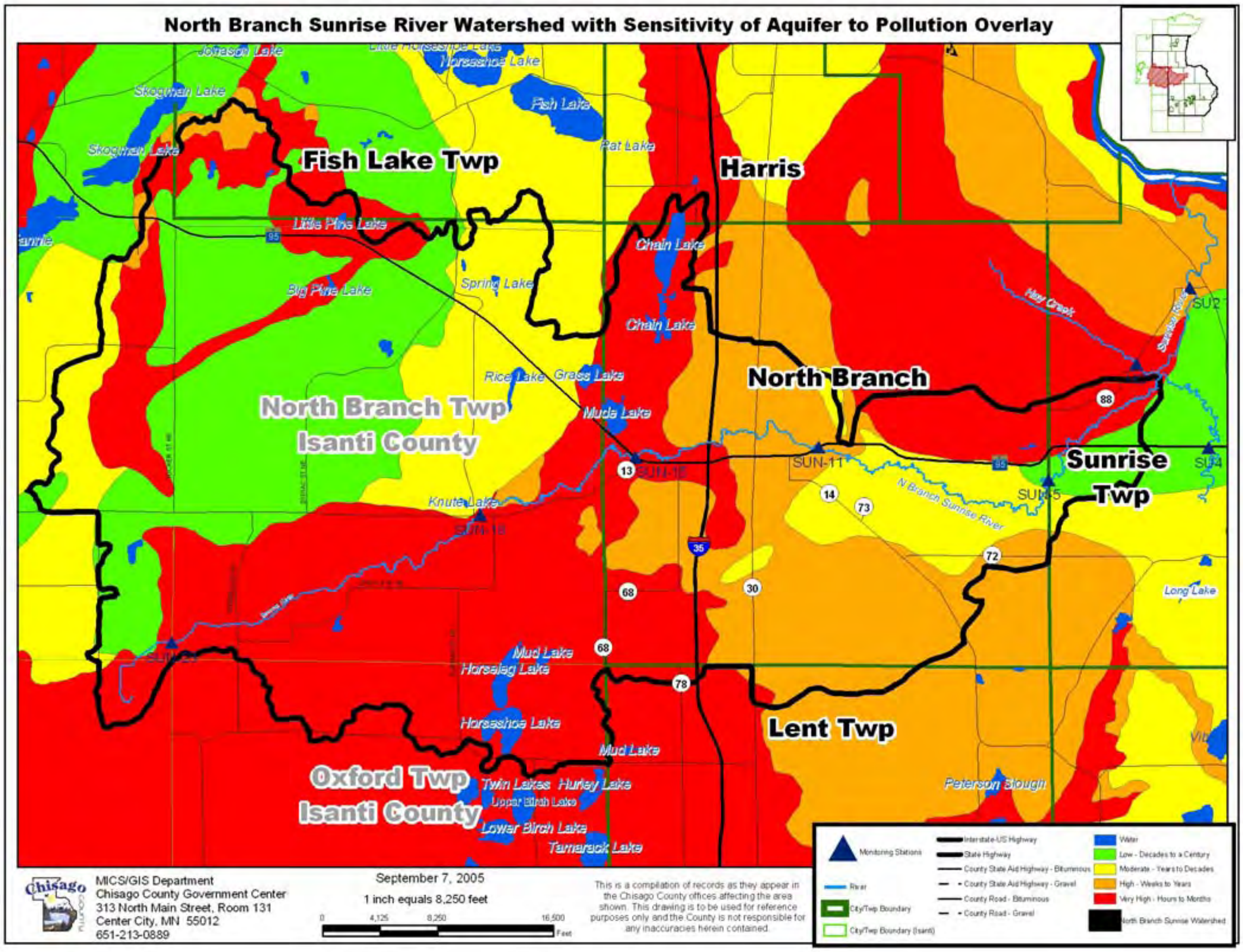
The landscape in Chisago County is gently sloping, nearly level. The local relief ranges from 20 to 40 feet and the area is about 840 to 900 feet above sea level. The upper reaches of the river are typically slow moving, with river bottoms made of sand, organic materials and muck. The lower reaches pick up a little speed and have more gravel and rocks.

The Sunrise River cuts mainly through the Anoka sand plain, whose soil type is a Zimmerman-Isanti association. The land is nearly level to rolling with the Zimmerman comprising 40% of the area, Isanti comprising 25%, and minor soils comprising 35% of the area. Zimmerman is an excessively drained sandy loam that forms the knolls, summits and side slopes of the valley. Isanti is very poorly drained fine loamy sand that forms the shallow depressions and drainage ways of the outwash plains.

The valley of the North Branch of the Sunrise River is of a different soil type, the Fordum-Caryville association. It is composed of loamy and sandy soils that formed in alluvial deposits making up the low rises, swales and channels of the flood plain of the river. The Fordum soils make up 40% of the area, Caryville 25%, and minor soils 35%. Fordum is a very poorly drained soil, prone to flooding and wetness. Caryville is a moderately well drained soil prone to flooding and drought. The major uses for this soil type are wildlife habitat, pasture and woodland. It is prone to erosion due to its fine and sandy texture.

The Anoka sand plain also has the capability to be easily polluted as the sandy soils of the plain allow for fast recharging of the aquifers below them. Fecal coliform is known to pass through soil and can pollute aquifers. The aquifer sensitivity to pollution is shown in Figure 1.2 and also at a larger scale in Appendix C.

Figure 1.2 – Map of aquifer sensitivity to pollution.



1.6 INHABITANTS

The first inhabitants of the area around 1000 B.C. were mound builders. Later the Dakota inhabited the area and were later replaced by the Ojibwa. After treaties opened up the area, the great pine forests of northern Minnesota and the river channels that they used to bring these logs to market attracted settlers to the area. They also came and stayed for the rich fertile land created by the geologic conditions and vegetation of the area. Settlers started arriving in the area in the 1860s from New England, but later many from Sweden. After lumbering declined, the main crop from 1914 until about 1930 was potatoes to a major extent, with some vegetables. The agricultural activities dramatically altered the landscape within the last 150 years as the forests and prairies were removed to make way first for agriculture, and now urban development.

1.7 LAND USE

The watershed is on the northern fringe of the productive agricultural area, and less and less farming is done every year; although agriculture is still the main land use and actively pursued in the two counties. Corn, soybeans, oats and rye are the main crops farmed, plus some sod and hay. There are dairy, beef, poultry, hogs, and also some horse operations (Table 1.2).

Table 1.2 - Land use in the two-county watershed

Type	**Percentage**
Agriculture	58.1
Forest	8.3
Open Water	5.3
Forested Wetland	17.7
Non-Forested Wetland	8.0
Barren	0.1

(USGS, 2001 by Lenz et al.)

1.8 CLIMATE

Going hand-in-hand with the type of agriculture in the watershed are the conditions in which the agricultural crops are grown. The average climate information for the area follows in Table 1.3.

Table 1.3 - The average climate information for the watershed.

Climate Description	Amount
Winter temperature average	13° F
Winter daily minimum temperature average	3° F
Lowest temperature on record	- 41° F
Summer temperature average	68° F
Highest recorded temperature	100° F
Annual precipitation average	29”
Precipitation during growing season	22”
Growing season average length	124 days
Heaviest 1-day rainfall on record 7/22/72	5.47”
Thunderstorm days per year	38
Seasonal snowfall average	45”
Average days per year with snow	110
Humidity average in afternoon	60%
Summer days with sunshine	70%
Winter days with sunshine	50%
Prevailing wind	From NW
Wind-speed average in spring	12 mph

1.9 URBANIZATION

The river runs through one city, the city of North Branch. The city is located about halfway along the river just across the western county line, in Chisago County. In 1994, the city of North Branch merged with the surrounding township/city of Branch. Since then, the city has been on a fast track growth trend, and its population increased 88% above the combined pre-merger population between the years 1990 and 2000, to a total of just over 8,000 in the year 2000 (MN Dept. of Admin).

This housing and commercial growth may in part be due to the fact the city is bisected along the north-south route by I-35 and is about 30-plus miles north of the Twin Cities metro area. As the population of the Twin Cities metropolitan area grows, it is now considered reasonable to live in the North Branch area and work in the Twin Cities. North Branch is also bisected along the east-west route by State Highway 95 which connects Cambridge in Isanti County with Taylors Falls in Chisago County.

1.10 WASTEWATER TREATMENT

The city of North Branch, the only city in the watershed, contains the only wastewater treatment plant in the watershed. The plant discharges effluent directly and continuously into the river.

1.11 GOVERNMENT

There are six local units of government within the watershed: two counties, two townships, one city and one village, which is administered by the township (Table 1.4).

Table 1.4 - Local units of government.

Counties	Townships	Cities	Village
Isanti	North Branch		
Chisago	Sunrise	North Branch	Sunrise

1.12 POPULATION

The population of the two counties has been growing rapidly, especially in the urban center of North Branch (Table 1.5).

Table 1.5 - Population of Chisago and Isanti Counties and their townships.

County	Entity	2000 Census	2005 Extrapolated
Chisago	Chisago County	40,346	46,650
Chisago	Lent Township	1,990	2,277
Chisago	City of North Branch	8,023	9,681
Chisago	Sunrise Township	1,594	1,792
Isanti	Isanti County	30,817	33,730
Isanti	North Branch Township	1,654	1,683
Isanti	Oxford Township	799	845

*From MN Dept. of Administration. Extrapolated population based on State Demographic Center county projections.

2.0 Water Quality Standards and Numeric Targets

This TMDL addresses non-compliance with state standards for fecal coliform bacteria in the North Branch Sunrise River of Minnesota. A discussion of water classes in Minnesota and the standards for those classes is provided below in order to define the regulatory context and desired environmental outcome of the TMDL.

All waters of Minnesota are assigned classes based on their suitability for two or more of the following beneficial uses:

1. Domestic consumption
2. Aquatic life and recreation
3. Industrial consumption
4. Agriculture and wildlife
5. Aesthetic enjoyment and navigation
6. Other uses
7. Limited resource value

The impaired reach covered in this TMDL is classified as Class 2B, 3B, 4A, 4B, 5 and 6 waters (Minn. Rules Ch. 7050.0430). Aquatic recreation standards apply to Class 2 waters. The designated beneficial use for 2B waters is as follows:

> Aquatic life support refers to cool or warm water sport and commercial fish and associated aquatic life. Recreation support refers to aquatic recreation of all kinds, including bathing.

Fecal coliform bacteria are an indicator organism, meaning that not all the species of bacteria of this category are harmful but are usually associated with harmful organisms transmitted by fecal contamination. They are found in the intestines of warm-blooded animals (including humans). The presence of fecal coliform bacteria in water suggests the presence of fecal matter and associated harmful bacteria (e.g., some strains of *E. coli*), viruses and protozoa (e.g., *Giardia* and *Cryptosporidium*) that are pathogenic to humans when ingested (USEPA, 2001). Minnesota, like many other states and jurisdictions, uses fecal coliform bacteria for its standard rather than actual pathogenic organisms because they are more easily sampled and measured.

Minn. Rules ch. 7050.0222 subpart 4, fecal coliform water quality standard for Class 2B waters, states that fecal coliform concentrations shall "not exceed 200 organisms per 100 milliliters as a geometric mean[1] of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 2,000 organisms per 100 milliliters. The standard applies only between April 1 and October 31."
The 200 organisms/100 mL monthly geometric mean fecal coliform standard was frequently exceeded in the North Branch Sunrise River during 2002 and 2003 (Appendix B). Consequently,

[1] Geometric means are used to represent average fecal coliform concentrations. A geometric mean is appropriate for summarizing the central tendency of environmental data that are not normally distributed (Helsel and Hirsch, 1991). Unlike an arithmetic mean, a geometric mean tends to dampen the effect of very high or very low values. It is calculated by taking the n^{th} root of the product of n numbers (or by taking the antilog of the arithmetic mean of log-transformed numbers).

This TMDL evaluation focuses on the geometric mean standard as an environmental endpoint for the impaired reach. Developing the TMDL to meet the geometric mean standard of 200 org/100 mL rather than the exceedance standard of 2000 org/100 mL in more than 10% of single samples is consistent with material in EPA's recent promulgation of water quality criteria for coastal recreation waters. The preamble of the coastal recreational water rule states, "the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality because it is a more reliable measure, being less subject to random variation" (EPA 2004). The same source-reduction measures that are required to attain compliance with the chronic standard also will lead to attainment of compliance with the acute standard. The TMDL requires compliance with both parts of the standard.

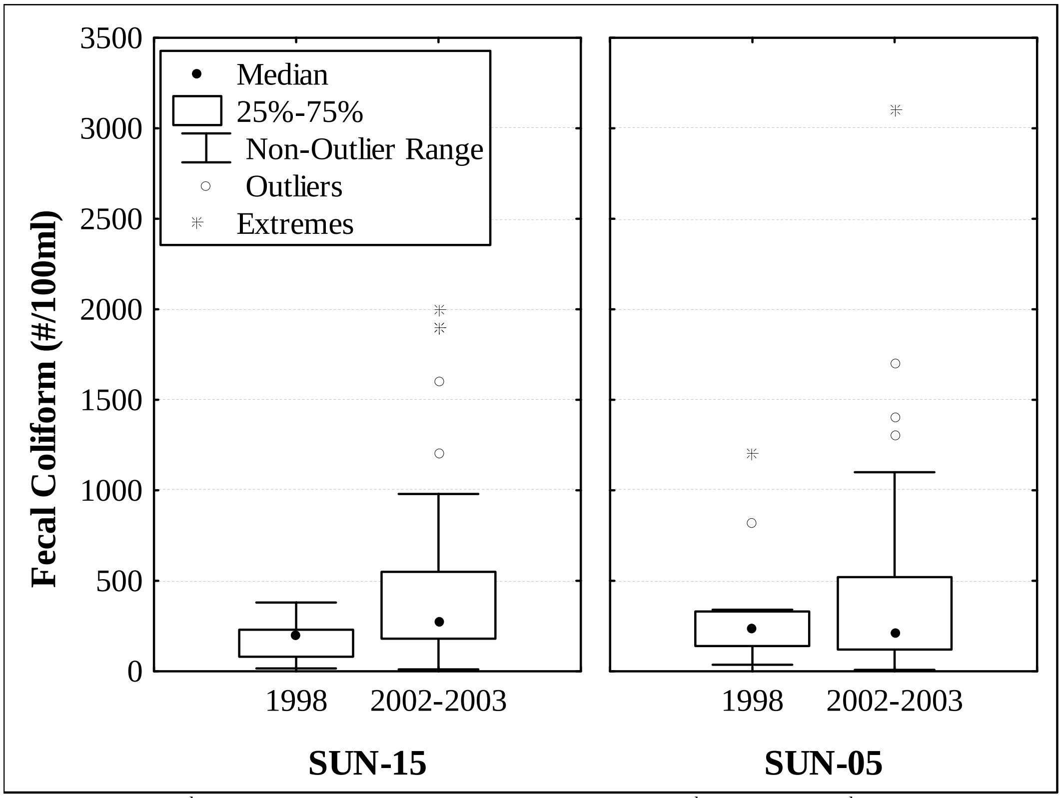
3.0 Surface Water Quality Conditions

Monitoring data from 2002 and 2003 were used to describe current conditions in the North Branch Sunrise River. Average concentrations were compared to the fecal coliform standard, and an approximation of the necessary overall percent reduction in fecal coliform loadings was calculated for the month of June, the month during which the water quality standards were most likely to be exceeded. Five sites along the river were monitored for fecal coliform in 2002 and 2003; two of these sites (SUN-05 and SUN-15) had also been monitored in 1997-98. Site SUN-5 is the only site on the North Branch Sunrise River for which continuous stream flow records were available.

Monitoring data comparison: 1998 vs. 2002-2003

Fecal coliform concentrations in 1998 were compared to conditions in 2002-2003 to evaluate if in-stream concentrations had changed significantly since the stream was first assessed (Figure 3.1). Data collected during the periods of May-July 1998, June – October 2002 and May – July 2003 were used to this comparison. At SUN-15, the mean concentrations were higher in 2002-2003 than in 1998 (ANOVA, $p < 0.05$). At SUN-05, the range of values in 2002-2003 was greater than in 1998; however, the means did not significantly differ from one another (ANOVA, $p = 0.83$). ANOVAs were performed on log-transformed data so that the assumptions of constant variance and normality were met.

Figure 3.1 – North Branch Sunrise River Fecal Coliform Monitoring Data Summary. Station SUN-15 and SUN-05 (1998 and 2002/2003)



"Median" = 50th percentile; "25% - 75%" = Range of 25th through 75th percentiles (interquartile range); "Non-outlier range" includes those values within +/- 1.5 x interquartile range; "Outliers" and "Extremes" use an outlier coefficient of 1.5: Outliers are greater (or less) than the upper (or lower) box value + 1.5 x height of the box, and outliers are greater (or less) than the upper (or lower) box value + 3 x height of the box.

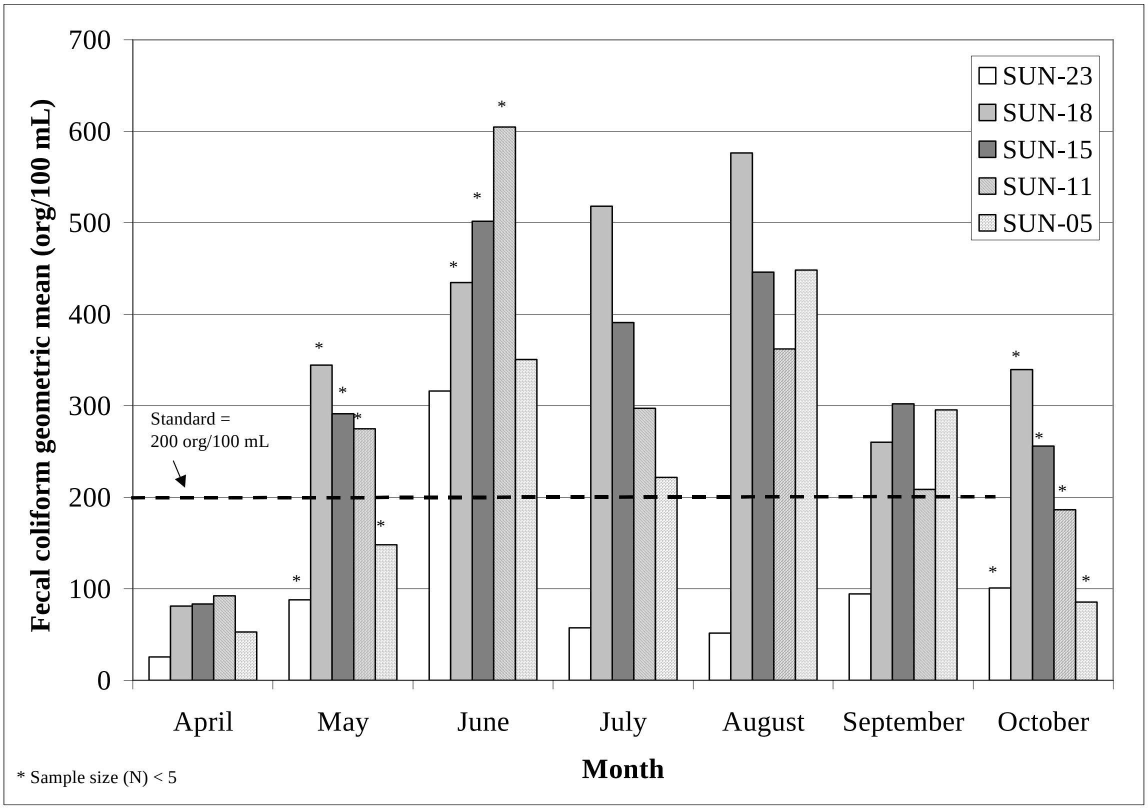
Current conditions (2002-2003) data summary

Monthly geometric means

Fecal coliform concentrations were compared to the in-stream standard of 200 organisms per 100 mL (org/100 mL). Data are summarized using the geometric mean; therefore, a minimum of five samples per month is preferred, although not required. If there are not at least five samples per month within one year, data from multiple years can be lumped together (MPCA, 2004). Even though some individual samples may exceed 200 org/100 mL, the standard is only exceeded if the geometric mean exceeds 200 org/100mL.

In the case of the North Branch Sunrise River, data from 2002 and 2003 were combined and grouped by month. The fecal coliform standard was exceeded at all sites at least once (Figure 3.2). At the most upstream site, SUN-23, the standard was exceeded in June only. At the remaining sites, the standard was exceeded during a majority of the months. Over all sites except SUN-18, the magnitude of the exceedance of the standard was greatest in June. Appendix B contains the tabular data from this figure.

Figure 3.2 - Fecal coliform geometric means by month, 2002-2003 data combined



Wet vs. dry sampling events

Fecal coliform delivery to water bodies varies with weather conditions. During some stormwater runoff events, fecal coliform located even in the upland portions of the watershed not directly adjacent to the river can be transported to the river through watershed runoff. When the river water is sampled during a runoff event, the event is referred to here as a wet sampling event. A dry sampling event, on the other hand, is when the river is sampled when there is little or no runoff coming off of the watershed. Fecal coliform in the river during a dry sampling event suggests that the source is not through overland runoff, but rather through wildlife or livestock depositing fecal coliform directly in the river or through a constant source such as a wastewater treatment plant or septic systems. The distinction between a wet and a dry event refers to the conditions during the 48 hours previous to the time of sampling.

Monitoring data were summarized according to wet and dry sampling events. A sampling event was considered wet if 0.5 inches of precipitation or more fell in the preceding 24 hours, or if 1.0 inches of precipitation or more fell in the preceding 48 hours. Stream discharge records were also examined, and exceptions were made if a sampling event coincided with a noticeable increase in discharge, even if the precipitation records did not suggest a substantial precipitation event. A situation such as this could occur if rain fell within a localized area within the watershed but not at the actual rain gage location.

Data used in this analysis were from the 2002 and 2003 monitoring seasons. Precipitation patterns between the two years differed: 2002 was characterized as having a wet summer, and 2003 was characterized as having a wet spring (Table 3.1). Despite these differences in precipitation patterns, data from both years were grouped together for the water quality analysis and setting of the TMDL.

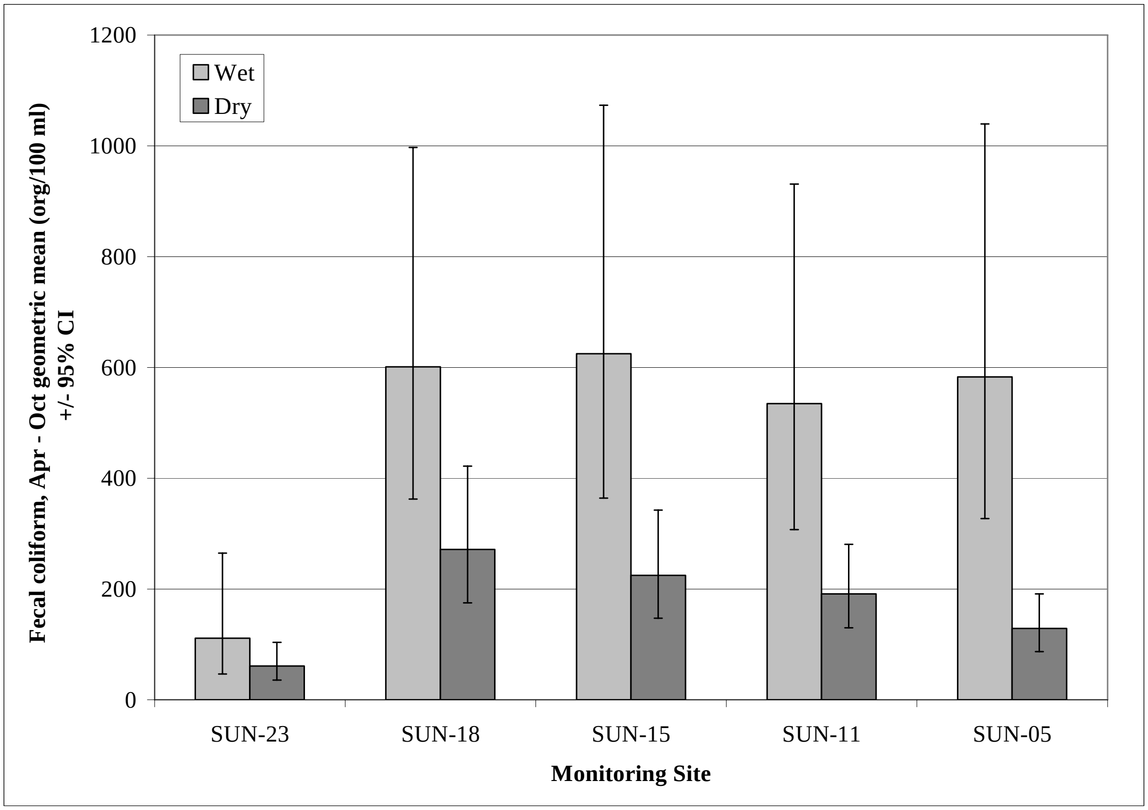
Table 3.1 – Precipitation Totals, North Branch (SWCD Site T35N R21W S29)

Season (months)	2002 Precipitation (inches)	2003 Precipitation (inches)	Long term average (inches)*
Spring (April-May)	6.2	9.3	5.9
Summer/Fall (June – October)	31	17	20

*Long term averages from Minnesota Climatology Working Group website, North Branch, MN

Fecal coliform concentrations in the river varied between the wet and dry sampling events (Figure 3.3), with generally higher concentrations during the wet sampling events. Although a level of 200 org/100 mL was exceeded more frequently during the wet sampling events, this concentration was at times exceeded during the dry sampling events. This suggests that although more of the fecal coliform that ends up in the river is from watershed runoff than other sources, some exceedance does occur due to sources other than watershed runoff (e.g. leaky septic systems, wildlife and livestock directly in the water).

Figure 3.3 – North Branch Sunrise River fecal coliform monitoring data, 2002-2003. Comparison of wet and dry sampling events.



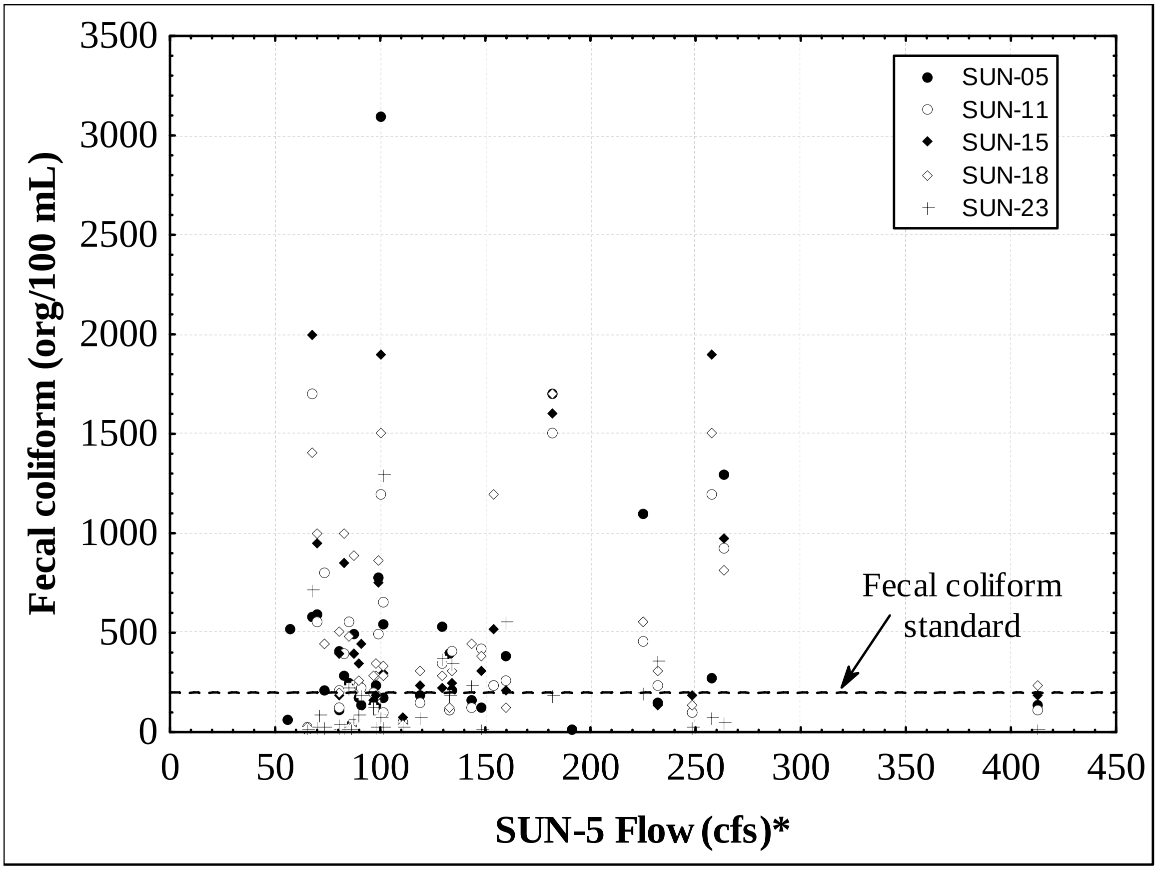
*A sampling event was considered wet if 0.5 inches of precipitation or more fell in the preceding 24 hours, or if 1.0 inches of precipitation or more fell in the preceding 48 hours
**The 95% confidence interval (CI) refers to the range of values in which the true geometric mean is likely to lie, and is used here to represent the degree of variability in the data within each category. The 95% confidence refers to the method used to construct the interval estimate; that is, the sampling approach. Hypothetically, if 100 different agencies all monitored this stream for fecal coliform during the same time period and subsequently used their data to construct confidence intervals, 95% of these intervals would capture the true geometric mean.

Relationship of fecal coliform concentration to in-stream flow

Another way to evaluate the monitoring data is to examine how the fecal coliform concentration varies with flow. If the fecal coliform concentrations were high only at high flow, this would suggest that the fecal coliform were entering the river primarily through runoff events. If the fecal coliform were high only during low flow periods, this would suggest that the organisms were entering the river through a more constant source (for example, septic systems or livestock grazing in the water).

In order to assess the extent to which high fecal coliform concentrations were related to flow conditions, individual fecal coliform concentrations (2002-2003) for all sites were plotted against the same-day flows measured at station SUN-5. (Figure 3.4) For this comparison, flows at upstream sites within this relatively small (70.5 sq mi) watershed were assumed to be proportional to the flow at SUN-5, the site located furthest downstream. For these data, high fecal coliform concentrations occurred during both high and low flows in the river, suggesting that the fecal coliform originates in both watershed runoff and from the sources that enter the river during low flow.

Figure 3.4 – Fecal coliform concentrations (individual samples) at all monitoring sites vs. flow, 2002-2003 data



*Flow data are only available for site SUN-5.

Approximation of desired reduction in fecal coliform loadings

To further relate existing water quality with the goals of this TMDL, additional consideration was given to June data to approximate the overall percent reduction in fecal coliform loadings which might be necessary to bring about compliance with water quality standards. The month of June was chosen because it is the month that exhibited the highest geometric mean concentration (420 org/100 mL) based on data for all sites sampled. To attain the standard of 200 org/100 mL, a reduction of approximately 52% may be necessary:

Geometric mean, all sites =	420 org/100 mL
Standard =	200 org/100 mL
% reduction needed to attain standard =	(420 – 200) / 420 = 52%

This reduction percentage is only intended as a rough approximation, as it does not account for flow. It serves to provide a starting point based on recent water quality data for assessing the magnitude of the reduction needed in the watershed to achieve the standard. Because it is based on the highest observed water quality standard violations it is likely a protective guideline. This reduction percentage does not supersede the allocations provided in part 5.0.

4.0 Source Assessment

This section details the fecal coliform source assessment. The goal of this assessment is to characterize the type, magnitude and location of sources of fecal coliform and provide an estimate of the percent contribution of each source to the total amount of fecal coliform in the river. A series of tables are presented, in which the daily fecal coliform load from each source is estimated. The final table summarizes the load estimates for all of the sources, with each presented as a percentage of the total daily load.

4.1 APPROACH

An inventory of the predominant fecal coliform sources in the watershed was completed. These sources of fecal coliform are livestock, septic systems, wastewater treatment plant, septage land application sites, wildlife, and pets. The approach and some of the assumptions used in this study were modeled after the MPCA's S.E. Regional TMDL (MPCA 2006). For each source category, the following three steps were taken to determine source load contributions:

1) *Determine the amount of fecal coliform produced daily in each category*: First, the number of individuals in each category was estimated. This population count was multiplied by the expected amount of fecal coliform produced daily by that type of animal. See Table 4.1. For livestock, the average load produced per animal was normalized to the load produced per animal unit (AU) per day. An AU is a concept used to be able to compare different types of animals with each other, and is defined as 1000 lbs of that type of animal.

Table 4.1 - Fecal coliform production rates for source categories

Category	FC Produced (orgs/animal-day)	Average animal weight (lbs.) [e]	FC Produced (orgs / AU-day)
Dairy	1.00×10^{11} [a]	1400	7.14×10^{10}
Beef	1.00×10^{11} [a]	1000	1.00×10^{11}
Horses	4.20×10^{8} [a]	1000	4.20×10^{8}
Deer	5.00×10^{8} [b]	(FC estimates for these categories were based on # of animals, as opposed to # AUs.)	
People	2.00×10^{9} [c]		
Dogs/cats	5.00×10^{9} [d]		

(a) ASAE, 1998

(b) Dry Creek Watershed TMDL, Alabama, 2001 (interpolated from Metcalf and Eddy, 1991).

(c) Metcalf and Eddy, 1991

(d) Horsley and Witten, 1996

(e) As defined in MN Rule 7020.0300

2) *Determine the amount of fecal coliform available daily for delivery to the North Branch Sunrise River*: Not all of the fecal coliform produced becomes available for delivery to the river. For example, human waste is treated in septic systems and wastewater treatment plants, and a portion of pet waste is collected. In this step, the amount of fecal coliform available daily for delivery was estimated for each category. The availability of fecal coliform can vary according to season and runoff conditions; therefore, for each source, four availability loads are given – spring-wet, spring-dry, summer-wet, and summer-dry.

3) *Determine the amount of fecal coliform delivered daily to the North Branch Sunrise River*: Not all fecal coliform available for delivery will actually reach, or be delivered to, the river. Delivery proportions are dependent on management practices, storm intensity, and septic system quality, among other factors. The delivery potential is the proportion of the available load that will wash off the landscape and reach the river. Table 4.2 presents the delivery potentials for all categories used in the analysis, according to season and runoff conditions (wet – during runoff events; dry – no runoff occurring). The delivery potentials are multiplied by the available daily fecal coliform loads (from step 2) to estimate the daily load delivered to the river.

   The concept for the qualitative and quantitative fecal coliform delivery potential shown in this table came from Mulla et al. (2001), which describes water quality risk associated with different types of livestock, animal housing operations, and land application practices on a 1-5 scale (1 = very low risk, 5 = very high risk). For this TMDL evaluation, a similar scale (very low to high) was used to describe fecal coliform delivery potential and takes into account the various physical, microbiological, climatic, and other factors at play. In order to satisfy the requirement for a numeric load allocation, these qualitative rankings were translated into delivery potentials. One percent is considered a low delivery potential and the percentage is doubled for each step up the scale (moderate = 2%, high = 4%). The exception to this is that for some sources a delivery of 0.1% was assigned, an order of magnitude below 1%, to reflect the very low delivery expected with those. Most of the delivery potentials are the same as those used in the MN S.E. Regional Fecal Coliform TMDL (MPCA 2006). The watersheds addressed in the S.E. Regional TMDL are relatively similar to the North Branch Sunrise River watershed and thus the delivery potentials should not substantially differ. The approach yields only an approximation of the relative source loadings and should only be used as a guide for development of the implementation plan. In comparison with the S.E. Regional TMDL, the following exceptions were made for the North Branch Sunrise River:

   - Unregulated feedlots or stockpiles are slightly lower based on more specific knowledge of the status of the relatively few feedlots in this watershed and how extensive runoff would be expected to occur relative to other sources.
   - Septic systems determined to be an imminent threat to public health (such as systems that are surfacing, backing up into a house, not properly connected, etc.) are lower due to the absence of agricultural drainage systems or straight pipes in the watershed that septic systems could be connected to. (For more information on straight pipes, see Humans, Section 4.2: Source Inventory.)

- An “other pasture” category was added and assigned a very low delivery potential to reflect the effects of vegetation and the distance from the river.
- A “septage land application” category was added and assigned a very low delivery potential to reflect the site-specific nature of this site, i.e. flat gradient and presence of buffer area.

Table 4.2 - Delivery potential: Estimated proportion of each source in runoff

Source	Proportion of source load delivered to river			
	Spring-wet	**Spring-dry**	**Summer-wet**	**Summer-dry**
Unregulated feedlots or stockpiles	Moderate 0.02		Low 0.01	
Pasture near streams or waterways	High 0.04	Low 0.01	High 0.04	Low 0.01
Other pasture	Very Low 0.001		Very Low 0.001	
Stockpiled, then surface-applied manure	Low 0.01		Low 0.01	
Stockpiled, then incorporated / injected manure	Very Low 0.001		Very Low 0.001	
Septic systems determined to be an imminent threat to public health	High 0.04	Low 0.01	High 0.04	Low 0.01
Municipal wastewater treatment facilities (effluent)	Directly estimated from discharge reports			
Septage land application site	Very Low 0.001		Very Low 0.001	
Deer and other wildlife	Low 0.01	Low 0.01	Low 0.01	Low 0.01
Dogs and cats in city – waste not collected	High 0.04		High 0.04	
Dogs and cats outside city	Very Low 0.001		Very Low 0.001	

4.2 SOURCE INVENTORY

The source inventory was divided up among livestock, humans, wildlife, and pets. A complete discussion of the derivation of the following source loads can be found in Appendix F.

Livestock

The locations of feedlots within the watershed are illustrated in Appendix E. Livestock numbers were determined using a level II feedlot inventory (inventory of number of livestock, their location with respect to surface water bodies, and basic information about manure storage) in Chisago County and a windshield survey in Isanti County, both conducted by Chisago County Soil and Water Conservation staff (per Feedlot Inventory Guidebook, Minnesota Board of Water and Soil Resources, June 1991). Beef, dairy cows, and horses are the only types of livestock known to be in the watershed.

The amount of fecal coliform originating from livestock that eventually washes off of the watershed was estimated taking into account the manure management practices at the livestock operations.

Humans

Fecal coliform from humans can reach the North Branch Sunrise River through several pathways: the North Branch Wastewater Treatment Plant (WWTP; NPDES Permit # MN0024350), septic systems determined to be an imminent threat to public health, and septage land application sites. Straight pipes that directly connect septic systems to a surface water discharge site are a subcategory of septic systems determined to be an imminent threat to public health. Through Chisago County's regular septic inspections and with its work on the septic system pilot program grant (see goal #3 under the Implementation Strategy), there is no evidence of any septic system directly discharging into the North Branch of the Sunrise River. If a straight pipe were to be identified, the county (or other local jurisdiction) would take action to ensure that it would be corrected within 60 days, according to the county's septic ordinance.

It was estimated that 20% of septic systems are imminent threats to public health in the watershed area under Chisago County's jurisdiction (Chisago County, personal communication) and Isanti County's jurisdiction (Isanti County Zoning Administrator, personal communication). A handful of these imminent threats to public health have recently been found by Chisago County as part of their regular septic inspections, and these have all been fixed. It is estimated that 5 to 10% of the septic systems are an imminent threat to public health in the city of North Branch (personal communication).

The fecal coliform available for runoff from the population with adequate septic system was assumed to be zero. The available load from the WWTP was calculated from discharge monitoring reports from the WWTP.

Wildlife

The fecal coliform contribution from wildlife was estimated based on watershed area. A deer density of 23 deer/mi^2 was assumed, based on a DNR deer density estimate (DNR Area Wildlife Office, Cambridge). The contribution from other wildlife was assumed to be half as that contributed by deer. This estimate, at approximately 12 individuals per square mile, was approximately the same density as was used in the S.E. Regional fecal coliform TMDL (10 individuals per square mile). This is a very rough approximation, but lacking any information to the contrary we have no reason to believe that "other wildlife" numbers in this watershed are significantly higher than in southeast Minnesota. Other wildlife includes geese, other waterfowl, and small mammals. Precise estimates of those populations are not available.

The fecal coliform available from deer and other wildlife was combined into one category, which represents the background load.

Pets

The number of pets in the watershed was estimated based on the human population, and was divided up among pets in the city whose waste is not collected, pets in the city whose waste is collected, and pets outside of the city. It was assumed that 10% of the waste from pets within the city is not collected. Pet waste that enters the storm sewers is not treated.

4.3 Summary Tables

The following tables summarize the fecal coliform available (Table 4.3), the fecal coliform delivered (Table 4.4), and the percent contribution (Table 4.5). The estimates are categorized by season (spring vs. summer) and by runoff condition (wet – during a runoff event; dry – not during a runoff event).

Table 4.3 - Fecal coliform available

Source	Fecal coliform load available (org/day)			
	Spr-wet	Spr-dry	Sum-wet	Sum-dry
Unregulated feedlots or stockpiles	5.45×10^{12}		5.45×10^{12}	
Pasture near streams or waterways	4.33×10^{12}	4.33×10^{12}	4.33×10^{12}	4.33×10^{12}
Other pasture	4.69×10^{12}		4.69×10^{12}	
Stockpiled, then surface-applied manure	4.68×10^{12}		5.25×10^{11}	
Stockpiled, then incorporated / injected manure	7.65×10^{12}			
Imminent threat to public health septic systems	1.41×10^{12}	1.41×10^{12}	1.41×10^{12}	1.41×10^{12}
Municipal wastewater treatment facilities	4.32×10^{7}	4.32×10^{7}	4.32×10^{7}	4.32×10^{7}
Septage land application site	1.14×10^{11}		1.14×10^{11}	
Deer + other wildlife	1.31×10^{12}	1.31×10^{12}	1.31×10^{12}	1.31×10^{12}
Dogs + cats in city – waste not collected	5.75×10^{11}		5.75×10^{11}	
Dogs and cats outside city	1.63×10^{13}		1.63×10^{13}	

Table 4.4 - Fecal coliform load delivered

Source	Fecal coliform load delivered (org/day)			
	Spr-wet	Spr-dry	Sum-wet	Sum-dry
Unregulated feedlots or stockpiles	1.09×10^{11}		5.45×10^{10}	
Pasture near streams or waterways	1.73×10^{11}	4.33×10^{10}	1.73×10^{11}	4.33×10^{10}
Other pasture	4.69×10^{9}		4.69×10^{9}	
Surface-applied manure	4.68×10^{10}		5.25×10^{9}	
Incorporated / injected manure	7.65×10^{9}			
Imminent threat to public health septic systems	5.63×10^{10}	1.41×10^{10}	5.63×10^{10}	1.41×10^{10}
Municipal wastewater treatment facilities	4.32×10^{7}	4.32×10^{7}	4.32×10^{7}	4.32×10^{7}
Septage land application site	1.14×10^{8}		1.14×10^{8}	
Deer + other wildlife	1.31×10^{10}	1.31×10^{10}	1.31×10^{10}	1.31×10^{10}
Dogs + cats in city – waste not collected	2.30×10^{10}		2.30×10^{10}	
Dogs and cats outside city	1.63×10^{10}		1.63×10^{10}	
TOTAL	*4.50×10^{11}*	*7.05×10^{10}*	*3.46×10^{11}*	*7.05×10^{10}*

Table 4.5 - Fecal coliform load by source as a percent of the estimated total daily load delivered

Source	Fecal coliform load delivered (% of total daily load)			
	Spr-wet	**Spr-dry**	**Sum-wet**	**Sum-dry**
Unregulated feedlots or stockpiles	24%		16%	
Pasture near streams or waterways	38%	61%	50%	61%
Other pasture	1.0%		1.4%	
Surface-applied manure	10%		1.5%	
Incorporated / injected manure	1.7%			
Imminent threat to public health septic systems	13%	20%	16%	20%
Municipal wastewater treatment facilities	<0.1%	<0.1%	<0.1%	<0.1%
Septage land application site	<0.1%		<0.1%	
Deer + other wildlife	2.9%	19%	3.8%	19%
Dogs + cats in city – waste not collected	5.1%		6.6%	
Dogs and cats outside city	3.6%		4.7%	
TOTAL	*100%*	*100%*	*100%*	*100%*

Wet sampling event: if 0.5 inches of precipitation or more fell in the preceding 24 hours, or if 1.0 inches of precipitation or more fell in the preceding 48 hours; dry sampling event: all others. See section 3.1 for more detail.

5.0 Linkage Analysis and Allocations

This section seeks to define the relationship between the fecal coliform water quality standards and the sources within the watershed of the North Branch Sunrise River. This linkage is used to determine what fecal coliform loads or load reductions are needed to achieve water quality standards.

5.1 APPROACH

The loading capacity determination used for the listed reach is based on the process developed for the "Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota" (MPCA 2006). This process is known as the "Duration Curve" method.

The loading capacity for fecal coliform bacteria is the greatest amount of loading that the stream can receive without violating the water quality standards. The loading capacity is related directly to flow volume; as flows increase, the loading capacity of the stream will also increase. Thus, it is necessary to determine loading capacities that exist for a variety of flow zones.

For this approach daily flow values for each site are sorted by flow volume, from highest to lowest and a percentile scale is then created (where a flow at the X^{th} percentile means X% of all measured flows equal or exceed that flow). Five flow zones are used in this approach: "high" (0-10^{th} percentile), "moist" (10^{th}- 40^{th} percentile), "mid-range" (40^{th}-60^{th} percentile), "dry" (60^{th}-90^{th} percentile) and "low" (90^{th}-100^{th} percentile). The flows at the mid-points of each of these zones (i.e., 5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} percentiles) are multiplied by the fecal coliform standard (200 organisms/100 mL) and a conversion factor to yield the allowable maximum loads in units of billions of organisms per day. For example, if the "mid-range" (50^{th} percentile) flow is 100 cubic feet/sec the loading capacity or TMDL for that flow zone would be:

100 cubic feet/sec x 200 orgs/100ml x 28,312 mL/cubic ft x 86,400 sec/day ÷ 1 billion = 489 billion organisms per day

The flow monitoring data used in this project was from the flow gage at SUN-5 and includes three monitoring seasons of daily flow data consisting of 566 daily average flow values that cover a wide range of flow conditions.

TMDLs were calculated for all the flow zones for the listed reach. The TMDLs represent the sum of the individual wasteload allocations (WLAs) for point sources, load allocation (LAs) for nonpoint sources and natural background, and a margin of safety (MOS):

TMDL = LA + WLA + MOS

The MOS accounts for uncertainty in the TMDL allocation process. The MOS was established not to exceed the load associated with the minimum flow for each zone. Each zone MOS is the difference between the central and lowest flow value for each zone. For example, to determine the MOS for the high flow zone, the 10^{th} percentile flow value was subtracted from the 5^{th}

percentile flow value. The resulting value was converted to a load and used as the MOS. The final available load and wasteload allocation is the TMDL minus the MOS.

The next step in the process was determining the portion of the load that needs to be allocated for the wastewater treatment plant (WWTP; North Branch) and the one permitted stormwater municipal separate storm sewer system (MS4) community in the watershed (North Branch).

The allowable wasteload allocated to the WWTP was determined by using the average wet weather design flow for the facility and the permitted concentration limit (200 organisms/100 ml as a monthly geomentric mean) along with a conversion factor to arrive at a load in billions of organisms per day. The specific equation is:

gallons/day x 200 orgs/100mL x 3785 mL/gallon ÷ 1 billion
= *X* billions organisms per day.

The wasteload allocation for a given WWTP will be the same under all flow zones since its allocation is based on the volume it is permitted to discharge.

The WWTP allocation and MOS were subtracted from the total loading capacity. The remaining capacity was divided between MS4 permitted stormwater and all nonpoint sources (load allocation) based on the percentage of land in the watershed covered by the MS4 permit versus the remaining land area. In addition to being a practical way to allocate between MS4 permits and all other nonpoint sources, it is also equitable from the standpoint all land areas being held to the same "standard."

5.2 Wasteload Allocations (WLA)

North Branch Wastewater Treatment Plant

The only currently permitted fecal coliform source in the watershed is the North Branch wastewater treatment plant (WWTP). As estimated in the source inventory, this load represents less than 0.1% of the total load to the river (Table 4.5). The WWTP currently treats the wastewater to a level below that of the permitted concentration (200 org/100 mL), with an average of approximately 6 org/100 mL. Further reductions below that of the permitted concentration are not warranted. The wasteload allocation for this source was calculated based on the average wet weather design flow (0.812 MGD) the 200 org/100 mL permit limit, and a conversion factor. This load was calculated to be 6 billion organisms/day for all flow zones.

City of North Branch MS4

Stormwater runoff from the City of North Branch is managed through the city's municipal separate storm sewer system (MS4). The city's MS4 falls under the category of a "designated MS4," in that it has been designated by the MPCA, under MN Rule Chapter 7090, for permit coverage. The city is required to obtain an NPDES stormwater permit by February 15, 2007. It is a designated MS4 because the city contains a population of between 5,000 and 10,000 and discharges or has the potential to discharge to a valuable or impaired water body. In addition to its proximity to the North Branch Sunrise River, it also has the potential to discharge to three trout streams (Beaver Creek, County Ditch #3, and unnamed trout streams).

The percentage of land area covered by North Branch is 32%, so 32% of the remaining capacity (i.e., after the WWTP WLA and MOS are accounted for) was allocated to that permit. This WLA varies with flow and is provided in Table 5.1 below.

Other

If there were straight pipes that directly connect septic systems to a surface water discharge site in the watershed, they would be considered a wasteload allocation, and their allocated load would be zero since they would be an illegal discharge. However, there is no knowledge of any septic systems that are straight pipes (see *Humans* under *4.2 Source Inventory*); therefore, the estimated current load from straight pipes is zero, and the wasteload allocation is being met.

5.3 LOAD ALLOCATIONS (LA)

The load allocation is the allocated load that originates from nonpoint sources and natural background from those jurisdictions that do not fall under an MS4 permit (68% of the watershed area). Therefore, 68% of the remaining capacity (after the WLA and MOS are taken out, is allocated to the LA. This LA varies with flow and is provided in Table 5.1 below.

The sources of this non-point source load are livestock, septic systems (non-straight pipe), wildlife and pets not located within the MS4 boundary. These sources are delivered under both wet and dry conditions.

5.4 MARGIN OF SAFETY

The margin of safety (MOS) required in calculating a TMDL accounts for uncertainties in both characterizing current conditions and in the relationship between the load and wasteload allocations and in-stream water quality. An explicit margin of safety (MOS) was used for this TMDL and the methodology was described in section 5.1. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. Because the allocations are a direct function of daily flow, accounting for potential flow variability is an appropriate way to address the MOS.

5.5 TMDL AND ALLOCATION SUMMARY

Based on the approach outlined above the TMDL, allocations and margins of safety for the listed reach are shown in Table 5.1.

Table 5.1 – TMDLs, Allocations and Margins of Safety

	FLOW ZONE				
	High	Moist	Mid	Dry	Low
	Billion organisms per day				
TOTAL DAILY L0ADING CAPACITY	1206	618	397	284	204
Wasteload Allocation					
North Branch Wastewater Treatment Plant	6	6	6	6	6
North Branch MS4 NPDES Requirements	286	149	107	71	50
"Straight Pipe" Septic Systems	0	0	0	0	0
Load Allocation	608	317	228	151	106
Margin of Safety	305	147	55	55	42
	Percent of total daily loading capacity				
TOTAL DAILY L0ADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
North Branch Wastewater Treatment Plant	0.5%	1%	2%	2%	3%
North Branch MS4 NPDES Requirements	24%	24%	27%	25%	24%
"Straight Pipe" Septic Systems	0%	0%	0%	0%	0%
Load Allocation	50%	51%	58%	53%	52%
Margin of Safety	25%	24%	14%	19%	21%

5.6 Seasonal Variation

Seasonal variation was investigated in the surface water quality analysis (*Section 3.1*). The magnitude of the water quality standard exceedance was greatest in June. The duration curve approach used in this project accounts for this seasonal variation by varying the TMDL, allocations, etc. based on flow variability.

5.7 Critical Conditions

The critical condition is the combination of environmental factors that results in just meeting the water quality standard and has an acceptably low frequency of occurrence. (USEPA, 2001) As described in section 2.0, two fecal coliform standards apply during the period April 1 – October 31, a geometric mean standard and a standard based on the percent of individual sample exceeding a 2,000 org/100 mL. The determination of compliance with either standard requires a representative number of samples collected during a single calendar month. Based on the water quality and stream flow monitoring that was conducted, the critical condition for both standards may be defined as storm events, during which the delivery of fecal coliform to surface waters was in all likelihood enhanced due to increased runoff. This is illustrated in Figure 3.3. The critical condition may be further defined as the month of June, during which rainfall events are more likely to occur and which tended to show higher mean fecal coliform concentrations. June was also the only month in which violations of the mean monthly standard occurred at all sampling locations. The duration curve approach provides allocations that account for all flow regimes and, therefore, will be protective during the higher flow, rainfall-driven events of this observed critical condition.

5.8 Reserve Capacity

Reserve capacity refers to the load allocated for future growth. A reserve capacity is not included in this TMDL since, as this watershed develops, the fecal coliform load is likely to decrease. The sewered population with disinfection will continue to increase, while livestock populations will tend to decrease. New homes with ISTS are expected to be fully complying with the septic ordinance. Although the number of pets might increase at the same time that the population density increases, the increase in fecal coliform load from pets is not likely to be greater than the decrease expected by the decrease in livestock. Additionally, the North Branch WWTP currently treats wastewater to a level below that of the permitted concentration of 200 org/100 mL, with an average of approximately 6 org/100 mL. To the extent that this degree of disinfection continues, some extra capacity would tend to be available for the wastewater effluent.

6.0 Monitoring Plan

The goal of the monitoring plan will be to assess the effectiveness of future source reduction strategies for attaining water quality standards and designated uses. The impaired reach will remain listed until water quality standards for bacteria are met. In draft revisions to MR Ch. 7050, standards for fecal coliform will be replaced by *E. coli* at a concentration that will provide an equivalent level of protection.

Monitoring of *E. coli* should be performed at the same sites that were monitored for this assessment/study and with samples taken five times per month from April 1 through October 31. Ideally, monitoring should be conducted on a continuing basis to track effectiveness of controls on a continuing basis. At a minimum, monitoring should be completed for two seasons, commencing in 2012, by which time substantial implementation is expected to have taken place (approximately five years after anticipated approval of the implementation plan.)

A detailed monitoring plan will be developed during the implementation planning process. Chisago County Environmental Services likely will again take the lead role with Chisago County SWCD performing the field work and samples analyzed by a state certified laboratory.

Discussions on funding this monitoring effort have already started. The MPCA has money available for ongoing support of this kind of effort but no specific funding has been dedicated to this point. A funding source will need to be secured prior to the initiation of follow up monitoring.

If the monitoring shows improvement has occurred and the reduction goal has been met, the river will go through the de-listing process. If the monitoring shows this goal has not been met, the implementation strategies will have to be reviewed and revised as necessary (with current conditions taken into account) in order to accomplish the needed reduction.

7.0 Public Participation

The TMDL project was administered locally through the Chisago County Department of Environmental Services/Zoning, and managed by the Chisago County Water Planner. The county's local Water Plan is overseen by a Water Plan Policy Team (see Appendix G for list of members and affiliations) which meets bimonthly, and this policy team monitored the development of the TMDL project. The Policy Team consists of representatives from County Environmental Services/Zoning, Chisago County SWCD, Minnesota Department of Natural Resources, County Board and five citizen members.

A separate steering committee (see Appendix G for list of names and affiliations) was formed for this TMDL project and was assembled in the fall of 2002 with members representing a wide range of interests within the watershed. Some were government related, some were from organizations, and some were individual citizens. The steering committee included a member of the North Branch City Council and the North Branch City Engineer. Other members included representatives from Chisago SWCD, MPCA, DNR and Wild River State Park, U of M Extension, volunteer stream monitors, landowners and interested citizens from both Chisago and Isanti Counties. The group met several times, first in December of 2002 when they reviewed TMDL monitoring data and discussed their role as steering committee members. At that time they also added their observations about possible fecal loading sites and mechanisms, and this information was included in the exploration of this TMDL.

As the TMDL process was nearing completion, the steering committee was asked to attend a public informational meeting relating initial findings in April 2004. The committee was also asked to review the TMDL draft, and to take part in a public informational meeting to present the results to the general public. The meeting was held on September 22, 2005, in the city of North Branch. Please see Appendix G for a copy of the postcard announcing the public informational meeting that was sent to 3,925 landowners in the watershed. The steering committee continued to be a part of the public process into 2006, by helping the TMDL authors address the concerns and comments received from the public. These two meetings were both informational meetings and were not conducted as part of the official public notice of the TMDL report.

In addition to the steering committee, the Chisago County Water Planner educated the general public about the TMDL process and how it was progressing. This was done by publishing a number of newspaper and newsletter articles, press releases, and letters to the editor in the local papers – Chisago County Press, Cambridge Star, Forest Lake Times (see Appendix G for news articles), Chisago County Environmental Connections Newsletter (distributed to every household in the County see Appendix for two newsletters with articles about the project), SWCD newsletter, etc. Information was also posted on the county website (see Appendix G for article on county website) and was sent out to local environmental groups in order to let them know about the TMDL process.

Upon completion of the draft TMDL report, Chisago County conducted a public informational meeting on October 24, 2007, in North Branch, MN. The meeting was held to present information on the report and to discuss implementation planning being conducted by local governmental units. The draft TMDL report was made available to the public via the MPCA web site. *http://www.pca.state.mn.us/water/tmdl.html* Public notice of the availability of the draft TMDL report was provided prior to the start of the 30-day review period on October 30, 2006. The public review period ended on November 29, 2006.

8.0 Implementation Strategy

A detailed implementation plan will be developed following completion and approval of this TMDL. This section provides the general approach and goals of the implementation phase and evaluates options that will serve as a roadmap for the implementation plan.

8.1 Approach

The fecal coliform source inventory provides an estimate of the proportion of the total load of each of the various sources (Table 4.5). This load distribution will be used to focus implementation efforts. The top three sources are unregulated livestock facilities, pasture near streams, and septic systems that are determined to be an imminent threat to public health. Together, these three sources represent approximately 80% of the total daily fecal coliform load to the river and will be the primary focus of reduction efforts. Efforts will also be pursued for those sources that appear to provide a low to moderate contribution to the total load during certain times of the year, namely surface-applied manure, pets, and wildlife.

At this time there are several financial incentives that can help local landowners with implementation efforts. Some of these programs are as follows:

- **State Cost-Share** is a program of the Minnesota Board of Water and Soil Resources. It is administered through local SWCDs and is designed to provide base grants of up to 75% of a project cost in order to help local landowners/occupiers with projects that protect and improve water quality, such as controlling soil erosion and reducing sedimentation. By reducing soil loss there should be commensurate reduction in pathogens (that are attached to the soil) delivered to surface water.
- **EQIP** (Environmental Quality Incentives Program) is a program of the Natural Resources Conservation Service whose funds are provided through the Federal Farm Bill. It is designed to help private landowners with technical assistance and a cost-share of up to 50% in order to protect local soil and water resources. They fund such things as nutrient management plans, designs for animal waste structures, wetland restoration, rotational grazing management plans and conservation tillage.
- **AgBMP Loan Program** (Agriculture Best Management Practices Loan Program) is a program of the Minnesota Department of Agriculture. It is administered through local SWCDs, and offers low interest loans (currently 3%) for implementation of best management practices to improve water quality problems that are caused by agricultural activities or failing septic systems.
- **Section 319/CWP** (Clean Water Partnership) programs, administered by the MPCA, provide, respectively, federal and state funding to local project sponsors to support the development and implementation of non-point source control projects.
- **Clean Water Legacy** funding was approved by the Minnesota State Legislature for the 2006/2007 fiscal year. Additional funding will require future legislative approval.

The time frame for implementation is estimated to be five to ten years, consistent with the uncertainties associated with funding that landowners may need to adopt or install non-point source control measures. It is expected that compliance with water quality standards can be achieved in ten years or less. If the water quality goal is not achieved, the MPCA is required to re-open the TMDL.

8.2 GOALS AND OPTIONS ANALYSIS

The following goals and options form the basis for the necessary reduction from significant sources of fecal coliform in the watershed. Options for management practices are identified for each goal, and a relative evaluation (High, Medium & Low) for each option with respect to their effectiveness in controlling fecal coliform, applicability in the watershed, and the relative cost.

Goal #1: Reduce the contribution of fecal coliform from unregulated livestock facilities

If runoff from an open lot enters surface water without being filtered through a vegetative buffer, then the likelihood that the open lot will serve as a fecal coliform source to the water increases. Various management practices exist that can address this problem. Cost share assistance can be pursued for producers adopting an Open Lot Agreement.

Management Practice	Effectiveness (H,M,L)	Applicability in Watershed (H,M,L)	Relative Cost (H,M,L)
1) Waste storage facilities	H	H	H
2) Clean water diversions	H	M	M
3) Vegetated filter strips	H	H	L
4) Move fences	H	H	L
5) Improved lot cleaning	M	H	L

1) Waste storage facilities
Total confinement facilities present the least amount of risk for surface water contamination, since surface water runoff does not come into contact with the manure. Although one of the more effective practices for manure management, this is also more costly than other options, due to the need for structural facilities.

2) Clean water diversions
Surface water runoff that passes through the lot has the potential to pick up fecal coliform bacteria and transport it to the river. Berms that physically prevent cleaner surface water runoff from entering the lot and divert it around the lot will prevent this runoff water from picking up fecal coliform in the lot. Gutters and other roof drainage away from lots is another method of diverting clean runoff around the lot. A relatively effective way to reduce the amount of contact between runoff and manure, this method can be less expensive than waste storage facilities.

3) Vegetated filter strips
Vegetative buffers in between the lot and any surface water body will lessen the amount of fecal coliform that reaches the water body. Different options are available, including the following:

- Vegetated infiltration area (with a settling basin before the infiltration area)
- Controlled discharge vegetated treatment strip

- Vegetated buffer strip

Vegetated filter strips are less costly than structural BMPs, and require less maintenance.

4) Move fences
Moving fences can reduce the feedlot area so that there is less surface area with fecal coliform on it and a reduced opportunity for contact with runoff. This is a relatively inexpensive option, although it reduces the amount of space for housing livestock.

5) Improved lot cleaning
Removing the manure more frequently will decrease the amount of time that stormwater has the potential to come into contact with the manure. Costs for this option are more time-related than for materials.

Implementation Partners: MPCA, MDA, Chisago and Isanti SWCD's, Chisago and Isanti Counties, NRCS, feedlot owners

Possible Funding: MN State Cost-Share Program, MDA AgBMP Loan Program, NRCS EQIP Program.

Goal #2: Reduce the contribution of fecal coliform from pasture near streams

Management Practice	Effectiveness	Applicability in Watershed	Relative Cost
1) Livestock exclusion	H	H	L
2) Rotational grazing	M	M	M

1) Livestock exclusion
Physically excluding (with fencing) the livestock from having access to streams or other water bodies is a relatively low-cost and effective means of reducing the delivery of fecal coliform. A combination of technical assistance, education, and incentives can be used to reach this goal.

2) Rotational grazing
Rotational grazing will help maintain ground cover on the pasture. Less time near the water body will reduce, but not eliminate, the amount of manure that is deposited into the water body.

Implementation Partners: MPCA, MDA, Chisago and Isanti SWCD's, Chisago and Isanti Counties, NRCS, feedlot owners

Possible Funding: MN State Cost-Share Program, MDA AgBMP Loan Program, NRCS EQIP Program.

Goal #3: Reduce the contribution of fecal coliform from septic systems determined to be an imminent threat to public health

Management Practice	Effectiveness	Applicability in Watershed	Relative Cost
1) Bring septic systems determined to be an imminent threat into compliance with the septic ordinance.	H	H	M
2) Switch from septic systems to sewer service	H	H	H

1) Bring septic systems determined to be an imminent threat into compliance with the septic ordinance.
Septic systems in both Chisago County and Isanti County that are an imminent threat to public health will have to be identified and brought into compliance. A pilot program in Chisago County has already been initiated to address this problem (see below). Similar efforts will need to be implemented in Isanti County.

Chisago County septic system pilot program:
Chisago County received a $240,000 grant in 2004 from the Minnesota Pollution Control Agency to initiate a septic system pilot program. The purpose of the grant is to identify and address individual sewage treatment systems (commonly known as septic systems) that have been determined to pose an imminent threat to the public health and safety.

Minnesota Rules Chapter 7080 defines a septic system as an imminent health threat if it causes “ground surface or surface water discharges and sewage back up into a dwelling or other establishment.” Chisago County’s septic ordinance, which has been in effect since 1998, requires that an owner of a septic system determined to be an imminent threat to public health threat either upgrade, repair, replace or discontinue use of the system within 60 days.

Certified septic inspectors from County Environmental Services are evaluating septic systems under the county’s jurisdiction to determine if the system poses an imminent public health threat. If a property has been identified as having an imminent public health threat system, county staff will work with the homeowner on the process required to bring their system into compliance with the septic ordinance. Chisago County recently identified a handful of systems which were imminent threats to public health, and these have all been fixed.

For purposes of the TMDL, the area under Chisago County’s jurisdiction in the North Branch of the Sunrise River watershed includes portions of Lent, Sunrise and Fish Lake Townships, with an estimated 224 septic systems. Research into septic records during the past eight years show that approximately 20% of the septic systems inspected in the county are considered an imminent threat to public health. The city of North Branch estimates that out of a total of 1620 septic systems[2], 5 to 10% of the systems in their jurisdiction are categorized as imminent public health threats. This translates into between 125 and 206 systems that are an imminent treat to public health in Chisago County alone. None of these are considered straight pipes. A map showing the numbers of individual sewage treatment systems and the location of septage land application sites is contained in the Appendix D.

The septic pilot program is a four year grant. If the estimated number of septic systems under the jurisdiction of Chisago County and the city of North Branch are upgraded, that would mean 488 systems that are currently discharging to the ground or surface water will cease doing so, which could have a direct impact on the amount of fecal coliform pollution in the Chisago County portion of the North Branch of the Sunrise watershed.

Clean Water Partnership funds may be available through the MPCA.

2) Switch from septic systems to city sewer service.
As new development and redevelopment occur, bringing more residences on to city sewer service will reduce the fecal coliform contribution from septic systems. With effluent disinfection prior to discharge, the overall delivery of fecal coliform bacteria will tend to be reduced as more existing septic systems are abandoned in favor of a central sewage system.

Implementation Partners: Chisago County Environmental Services, city of North Branch, landowners, MPCA, MDA

Possible Funding: MDA AgBMP Loan Program, Minnesota State Revolving Fund

Goal #4: Reduce the contribution of fecal coliform from surface-applied manure

Management Practice	**Effectiveness**	**Applicability in Watershed**	**Relative Cost**
1) Manure application setbacks and dates	H	M	L
2) Certified nutrient management plan	H	M	M

1) Manure application setbacks:
Manure application should follow the requirements set forth by the MPCA in "Land Application of Manure: Minimum State Requirements," MPCA document #Wq-f8-11. This document specifies the setback requirements for land application of manure. Stricter setback requirements may be necessary if it is determined that fecal coliform still reaches surface water with implementation of these setbacks.

2) Certified nutrient management plan:

[2] This analysis is based on records of the number of septic systems. The source analysis in Section 4.2 is based on population census data, or the number of people served by septic systems, as opposed to the number of septic systems. Since these estimates were derived from two distinct sources, the numbers are not directly comparable.

Using soil tests, crop input needs (U of MN Extension recommendations) and manure analysis to determine proper manure application rates to all farm fields will decrease the amount of excessive manure applied to fields.

Implementation Partners: MPCA, Chisago and Isanti SWCD's, Chisago and Isanti Counties, NRCS

Possible Funding: MN State Cost-Share Program, MDA AgBMP Loan Program, NRCS EQIP Program.

Goal #5: Reduce the contribution of fecal coliform from pets

Management Practice	Effectiveness	Applicability in Watershed	Relative Cost
1) Stormwater management practices	H	H	M
2) Education	M	M	L

1) Stormwater management practices
Stormwater management (SWM) practices in the city of North Branch that treat stormwater runoff before it reaches the North Branch Sunrise River will decrease the fecal coliform load that originates as uncollected pet waste in the city.

North Branch requires new subdivisions (commercial, industrial, and residential) to provide stormwater treatment either on a per-lot or a regional basis, in accordance with MPCA BMP standards. Stormwater ponds are used to settle particulates in stormwater runoff and to control stormwater rates. Most fecal coliform bacteria are removed from stormwater when it travels through a stormwater pond.

As other projects occur in areas that are already developed, stormwater management retrofits are implemented as resources allow.

According to new stormwater rules, the city of North Branch will soon be classified in the Phase II category and will be required to obtain an MS4 NPDES permit. The city is also currently preparing a Comprehensive Stormwater Management Plan, which will establish guidelines on how the city plans to manage their stormwater. Although fecal coliform is not directly addressed in the plan, stormwater management practices designed to treat stormwater runoff will remove fecal coliform from runoff.

The city of North Branch also has a section in their code (Part T of Section 4.03.030) that states that dog and cat owners must clean up animal feces and dispose of them in a sanitary manner.

2) Education
The Boy Scouts and other service organizations have assisted with stenciling of storm drains to indicate that the storm drains connect directly to surface water. Other educational efforts will be

explored, such as combining the message of cleaning up pet waste with other efforts regarding fertilizer use and yard waste management.

Implementation Partners: City of North Branch

Possible Funding: City of North Branch

Goal #6: Reduce the contribution of fecal coliform from wildlife

Management Practice	Effectiveness	Applicability in Watershed	Relative Cost
1) Reduce size of deer population	L	M	L

1) Reduce size of deer population
In the portion of the watershed north of Highway 95 (DNR Permit Area 225), the DNR's 2004 estimate for spring pre-fawn population is 20 deer per square mile of habitat. The DNR's population goal for that area is six deer per square mile.

For the portion of the watershed east of I-35 and south of Highway 95 (DNR Permit Area 236), the DNR's 2004 estimate for spring pre-fawn population is 26 deer per square mile of habitat. The DNR's population goal for that area is three deer per square mile.

The DNR has been issuing either-sex licenses with up to four additional bonus antlerless permits for the past eight years; they will continue to do so into the future. They have also initiated a two-day mid-October antlerless-only season for the fall of 2005. This will allow hunters to take up to two antlerless deer using a special $14 permit per deer.

These goals are for DNR deer and habitat management practices only and not directly related to this TMDL. Less fecal coliform produced from a reduced deer population is a small, indirect benefit for the watershed. The time line of these goals is ten years; however the DNR is likely to revisit the goals and include additional public input within the next two years.

Implementation Partners: DNR

Possible Funding: MN DNR

9.0 Reasonable Assurance

There is reasonable assurance that this TMDL will be met, as there has been much effort to inform the stakeholders of the problem and to come up with a reasonable implementation strategy to solve the problem.

At a minimum, the implementation plan should have a five year window to be put into action. This effort seeks to direct the combined administrative, technical and financial resources of each entity to implement measures to correct the existing impairment. The SWCDs, in particular, will work with landowners to help establish BMPs (best management practices) at agricultural operations, as listed in the implementation section. The goal of these BMPs is to reduce the fecal coliform loading to the river. The counties will be responsible for addressing septic problems. Other government entities will be involved as needed, such as city, state, DNR, MPCA, NRCS, etc.

There are also many local individual citizens and several local environmental groups that have an interest in seeing the river cleaned up. They want the TMDL to be met so that their local environment and their local back yards are a safer place to live and to recreate.

After acceptance and approval of this TMDL by the EPA, implementation should be followed by at least two years of monitoring to see if standards are met. If more implementation work needs to be done after that, it will extend the timeline out further, and this will be followed by more monitoring. For planning purposes, the timeline for implementation and achievement of the fecal coliform standards for the North Branch of the Sunrise River should occur in five to ten years.

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Appendix

APPENDIX TABLE OF CONTENTS

A. FECAL COLIFORM, RAW DATA.

Table Appendix-A
Fecal coliform concentrations at the 5 monitoring sites, with flow data at SUN-05.
Values in red indicate values greater than 200 col/mL.

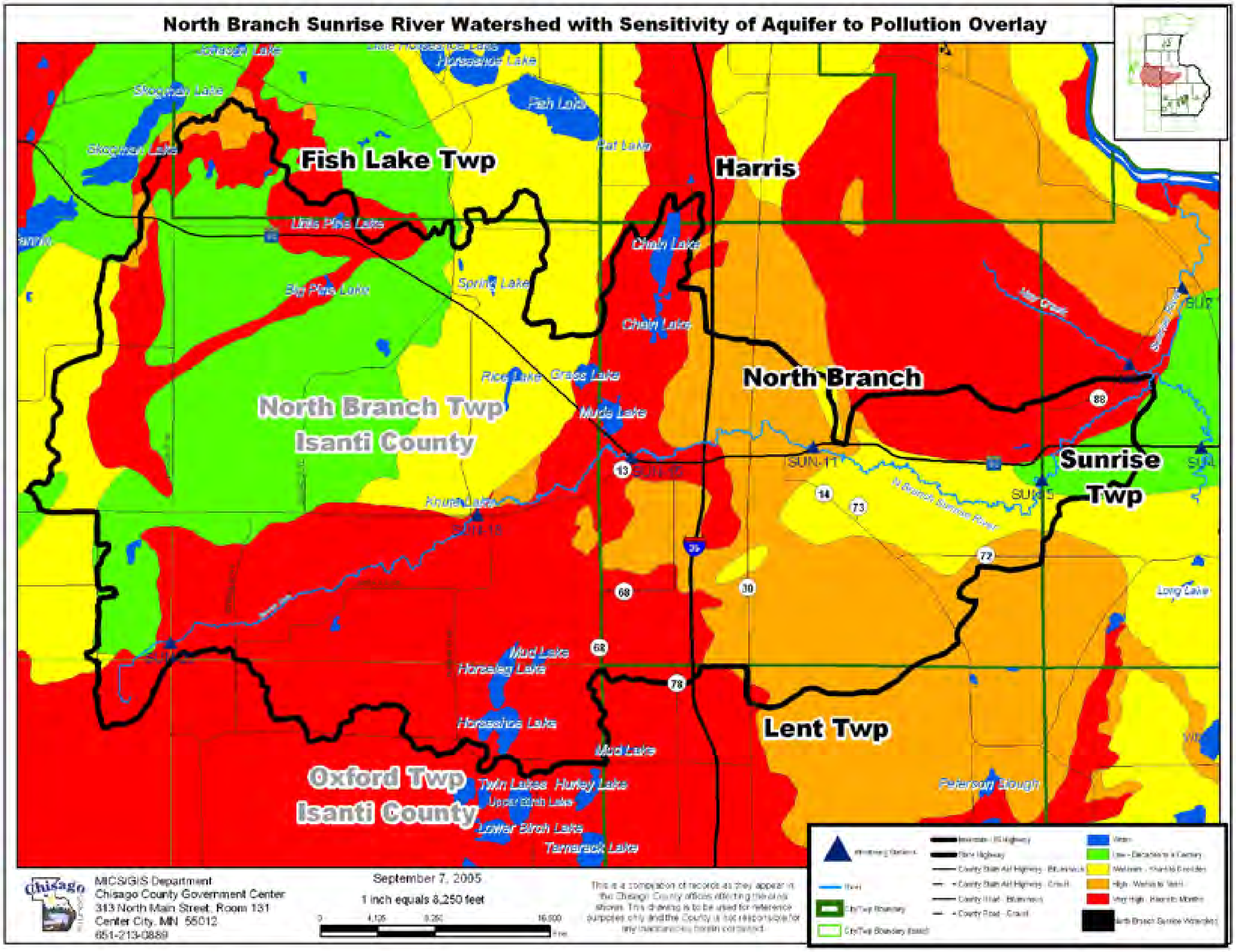
Date	SUN-5 Flow (cfs)	Fecal coliform (col/100 mL)					
		SUN-5	SUN-11	SUN-13.73	SUN-15	SUN-18	SUN-23
2/25/1998		45					
5/5/1998		56		60	16		
5/14/1998		36		44	76		
5/20/1998		150		220	180		
5/26/1998		240		150	110		
6/4/1998		160		110	76		
6/11/1998		340		140	210		
6/17/1998		140		120	140		
6/23/1998		260		230	230		
6/29/1998		250		180	230		
7/1/1998		330		180	230		
7/7/1998		820		1100	380		
7/13/1998		270		480	270		
7/21/1998		1200		250	210		
7/29/1998		150		260	80		
4/23/2002		8					
5/19/2002	191.0	16					
6/12/2002	57.2	520					
6/24/2002	67.2	580	1700		2000	1400	720
7/1/2002	231.8	150	230		130	310	360
7/8/2002	70.2	590	550		950	1000	30
7/15/2002	147.9	120	420		310	380	10
7/16/2002	154.1	230	230		520	1200	
7/24/2002	82.5	290	390		850	1000	20
7/29/2002	99.5	780	490		750	860	90
8/6/2002	129.5	530	340		220	290	370
8/12/2002	87.9	490	230		390	890	60
8/14/2002	80.2	410	210		180	500	10
8/19/2002	97.9	240	150		180	280	10
8/21/2002	100.2	3100	1200		1900	1500	70

Date	SUN-5 Flow (cfs)	Fecal coliform (col/100 mL)					
		SUN-5	SUN-11	SUN-13.73	SUN-15	SUN-18	SUN-23
8/26/2002	89.5	170	230		350	260	90
8/29/2002	257.2	270	1200		1900	1500	70
9/3/2002	263.3	1300	920		980	810	50
9/9/2002	159.5	380	260		210	120	560
9/12/2002	133.3	110	110		190	120	190
9/19/2002	132.5	400					
9/23/2002	119.5	180	150		230	310	70
9/30/2002	101.0	170	100		280	330	20
10/3/2002	97.9	130	180		140	350	30
10/7/2002			1200		1200	1400	570
10/14/2002		80	30		100	80	60
4/1/2003	86.645	40	30		20	20	10
4/8/2003	64.946	10	30		10	20	10
4/17/2003	182.450	1700	1500		1600	1700	180
4/21/2003	247.949	100	100		180	130	30
4/29/2003	110.865	40	50		70	40	20
5/7/2003	133.916	210	410		250	310	340
5/12/2003	412.212	130	110		180	240	10
5/20/2003	225.427	1100	460		550	550	200
6/10/2003	101.864	540	650		300	280	1300
6/12/2003	91.430	130	220		440	190	180
6/23/2003	85.652	250	550		240	480	220
7/1/2003	143.125	160	120		240	440	240
7/8/2003	96.927	140	200		160	290	120
7/22/2003	80.578	110	120		390	200	40
7/30/2003	72.927	210	800		440	450	30
10/6/2003	55.462	60					

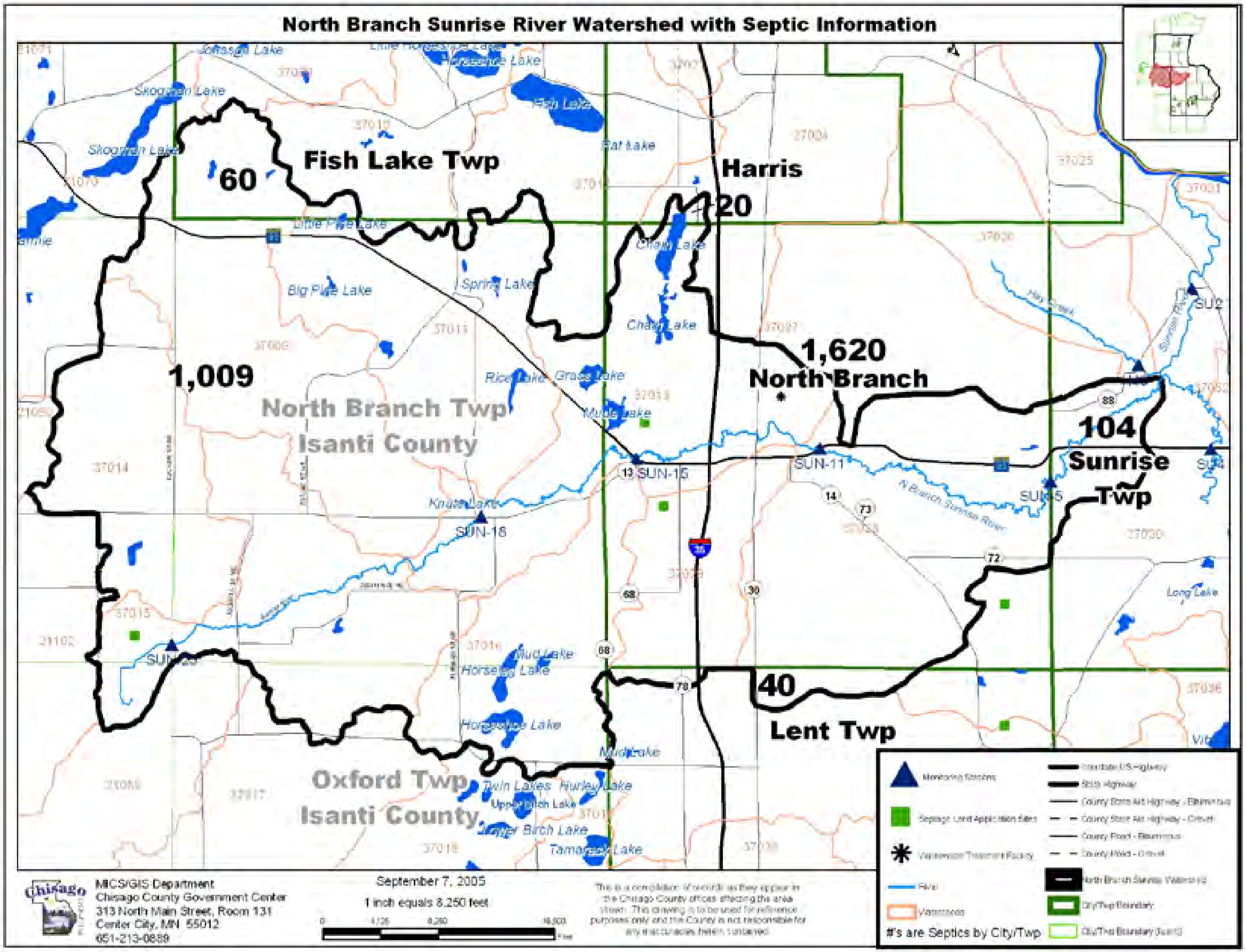
B. DATA SUMMARY BY MONTH

Table Appendix-B
Fecal Coliform Data Summary, 2002-2003
Means in red are those > 200 org/100 mL

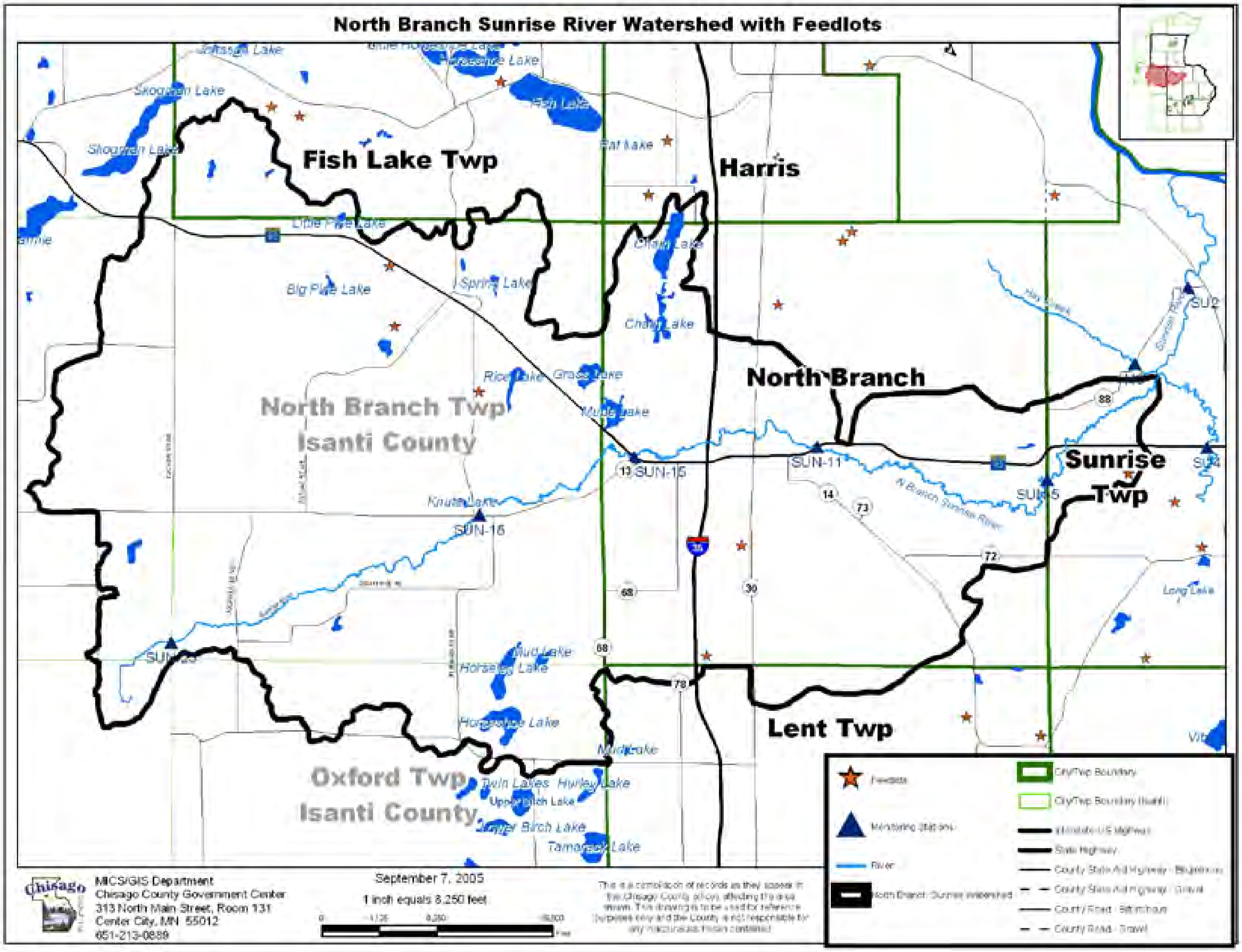
Site	Summary Statistics (org/100mL)						Monthly Geometric Means (org/100 mL)													
	Geo Mean	N	Min	Max	25th %	75th %	April		May		June		July		August		September		October	
							Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
SUN-23	74	37	10	1300	30	200	26	5	88	3	316	5	57	9	52	7	94	5	101	3
SUN-18	344	37	20	1700	240	860	81	5	345	3	435	4	518	10	576	7	260	5	340	3
SUN-15	305	37	10	2000	180	550	83	5	291	3	502	4	391	10	446	7	302	5	256	3
SUN-11	259	37	30	1700	120	550	92	5	275	3	605	4	297	10	362	7	209	5	186	3
SUN-05	200	41	8	3100	120	490	53	6	148	4	351	5	222	10	448	7	295	6	85	3
All sites	209	189	8	3100	110	500	61	26	201	16	420	22	245	49	293	35	217	26	169	15



Appendix Map 1: Sensitivity of Aquifer to Pollution



Appendix Map 2: Number of individual sewage treatment systems and septage land application sites.



Appendix Map 3: Locations of Feedlots within the Watershed.