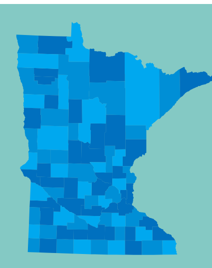
Grant

December 2024

Chisago Chain of Lakes Watershed Nine Key Element (NKE) Plan

A plan to achieve the water quality goals and water quality standards in the Chisago Chain of Lakes in 10 years.

MINNESOTA POLLUTION CONTROL AGENCY



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Document number: wq-cwp2-38

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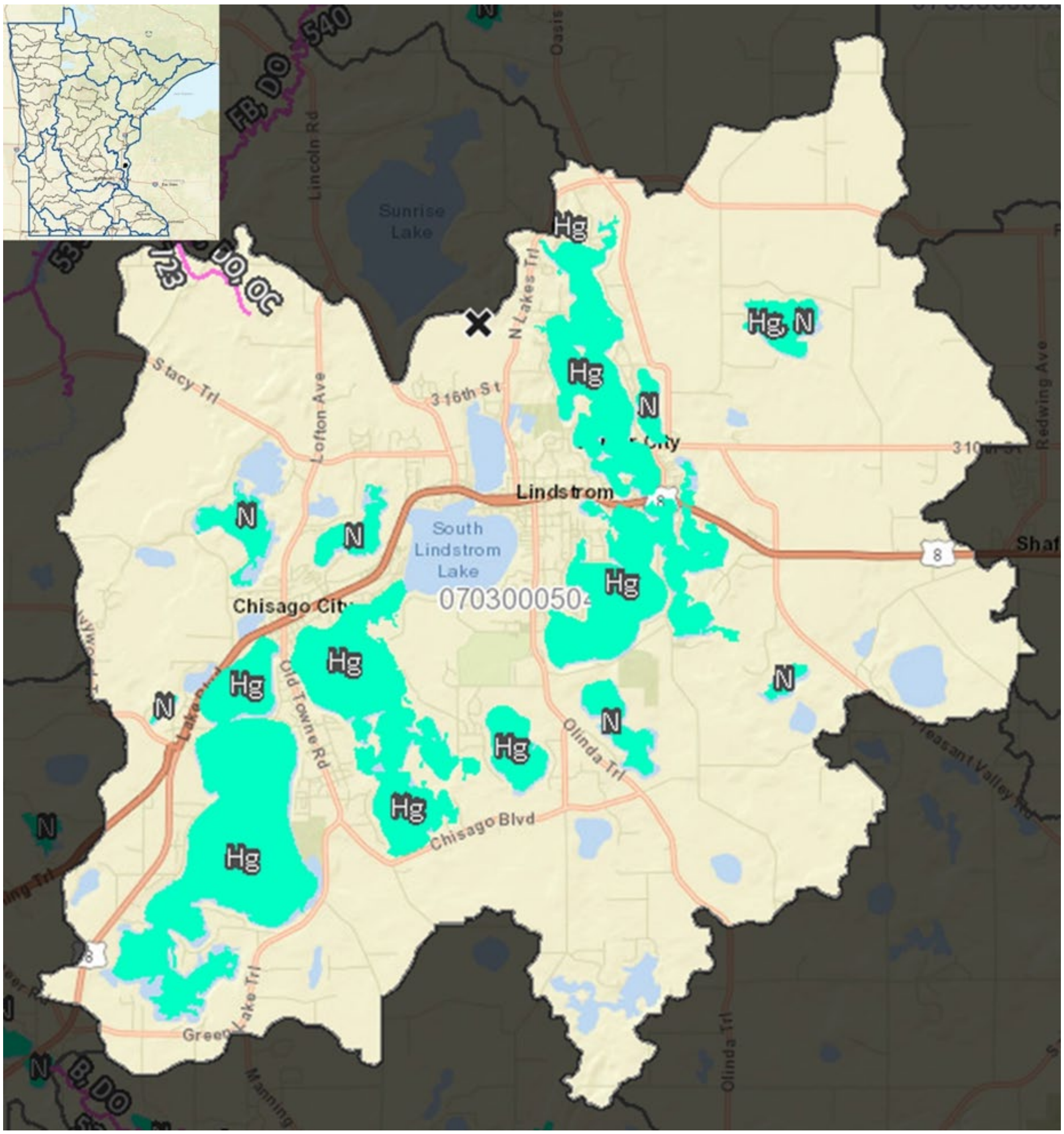
Executive summary

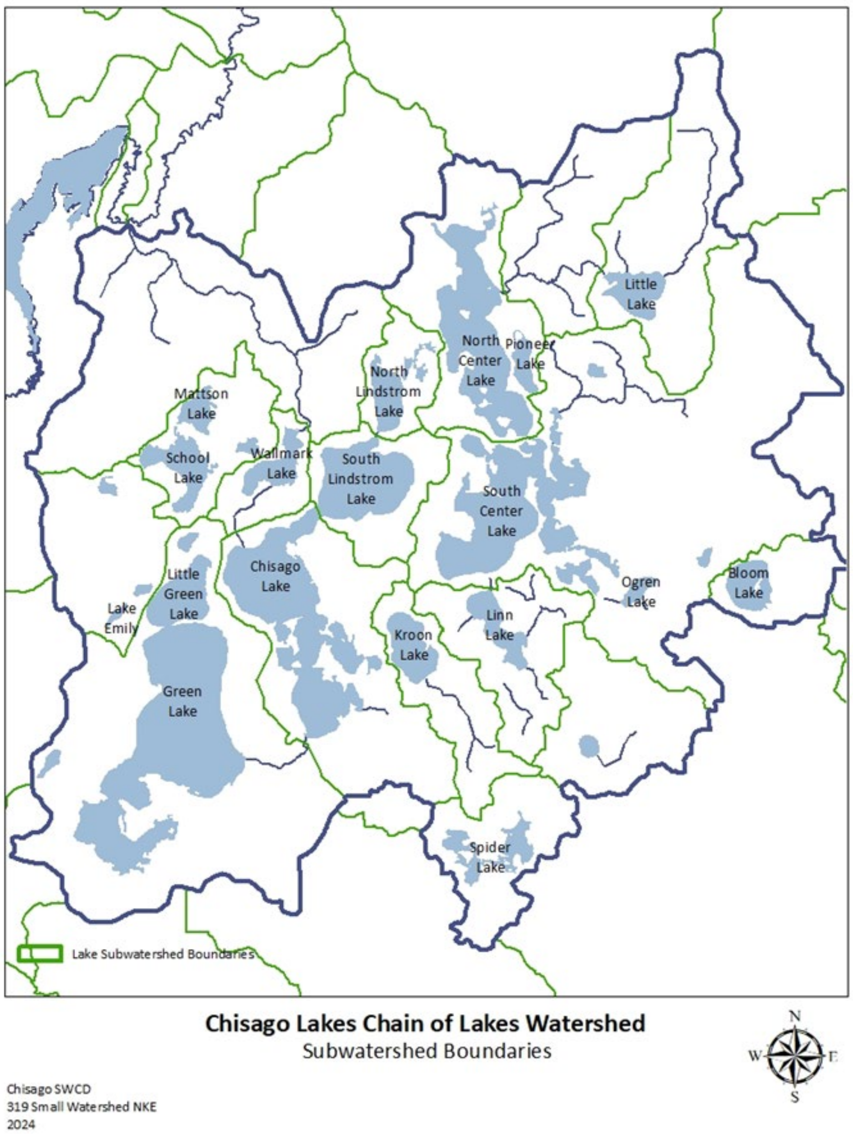
The Chisago Chain of Lakes is in Chisago County, Minnesota, and is comprised of 20 lakes and many streams. The watershed of the chain of lakes is a single hydrological unit code (HUC) 12 (070300050406) watershed (Figure 1). There are four cities (Chisago City, Lindstrom, Center City and Wyoming) in the watershed. This area is rapidly growing and is highly populated. This watershed is part of the Sunrise River Watershed, which is a tributary of the St. Croix River. One downstream segment of the St. Croix River and Lake St. Croix are currently impaired for excess nutrients.

Figure 1. Chisago Chain of Lakes Watershed impaired waters and location (WHAF, 2023).



The Chisago Chain of Lakes NKE Plan (plan) represents a compilation of extensive work completed by the Chisago Soil and Water Conservation District (SWCD) and partners. The SWCD embarked on a deliberate and targeted approach to achieve water quality goals through lake total maximum daily loads (TMDLs), development of a detailed TMDL implementation plan, followed by development of small rural, urban, and gully focused assessments that brought the implementation plan down to the individual parcel and practice scale. This plan draws heavily upon these three main plans: 1) The Chisago Chain of Lakes TMDL, Chisago Chain of Lakes TMDL Implementation Plan, Urban, Rural, and Gully subwatershed assessments. These plans are provided at Chisago SWCD website (Assessments – Chisago SWCD).

Figure 2. Chisago Chain of Lakes Watershed subwatershed boundaries (2024).



Implementation activities completed since the completion of the TMDLs has resulted two lakes achieving their eutrophication water quality standards and being delisted from the Clean Water Act (CWA) Section 303(d) impaired waters list by the Minnesota Pollution Control Agency (MPCA). Implementation work continues by the SWCD and their partners.

The NKE plan integrates the TMDLs, implementation plan, and subwatershed assessments in addressing pollutants, sources and solutions in the watershed. For purposes of the Section 319 Grant program, only practices and activities eligible for funding under the EPA 2014 Section 319 program guidance and Minnesota's Nonpoint Source Pollution Program Management Plan (NPSPPMP) 2019-2029 are eligible for Section 319 funding. All match activities must be eligible for Section 319 funding, except where noted in the NPSPPMP.

Water quality conditions

Land use

Land use is the Chisago Chain of Lakes Watershed is primarily rural, with cropland, and pastureland, and forested land making up the bulk of the watershed. Land uses are summarized in Table 1. There are four urban centers located along the road corridor of the six largest recreational lakes in the watershed (Green Lake, Chisago Lake, North and South Lindstrom Lakes, and North and South Center Lakes).

Table 1. Land uses by acre in the Chisago Chain of Lakes Watershed (PLET, 2024).

Developed	Cropland	Pastureland	Forested	Total
4,199	7,794	8,412	9,308	29,731

Impairments

Nine lakes have been listed as impaired for eutrophication on the CWA Section 303(d) list. TMDLs were completed for each of the nine lakes in one overall TMDL analysis and document. Some of the nine lakes along with other lakes have been listed as impaired for mercury in fish tissue and/or fish bioassessments. The original lake impairments are listed and summarized in Table 2. In addition to the lake listings, a single stream is listed as impaired (Table 3).

Table 2. Lake impairments in the Chisago Chain of Lakes Watershed.

Water body name	Year added	AUID	Use class	Affected designated use	Pollutant or stressor
Chisago (north portion)	2012	13-0012-01	2B	Aquatic consumption	Mercury in fish tissue
Chisago (south portion)	2012	13-0012-02	2B	Aquatic consumption	Mercury in fish tissue
Emily	2012	13-0046-00	2B	Aquatic recreation	Nutrients
Green (Little Green)	2012 2022	13-0041-01	2B	Aquatic consumption Aquatic life	Mercury in fish tissue Fish bioassessments
Green (Main Basin)	2012 2022	13-0041-02	2B	Aquatic consumption Aquatic life	Mercury in fish tissue Fish bioassessments
Kroon	2020 2022	13-0013-00	2B	Aquatic consumption Aquatic life	Mercury in fish tissue Fish bioassessments
Linn	2012	13-0014-00	2B	Aquatic recreation	Nutrients
Little	2010	13-0033-00	2B	Aquatic consumption Aquatic recreation	Mercury in fish tissue Fish bioassessments
North Center Lake	2012 2022	13-0032-01	2B	Aquatic consumption Aquatic life	Mercury in fish tissue Fish bioassessments
North Center Pond	2012	13-0032-02	2B	Aquatic consumption	Mercury in fish tissue
North Lindstrom	2022	13-0035-00	2B	Aquatic life	Fish bioassessments
Ogren	2012	13-0011-00	2B	Aquatic recreation	Nutrients
Pioneer	2012	13-0034-00	2B	Aquatic recreation	Nutrients
South Center	2010	13-0027-00	2B	Aquatic consumption	Mercury in fish tissue

	2022			Aquatic life	Fish bioassessments
South Lindstrom	2022	13-0028-00	2B	Aquatic life	Fish bioassessments
Wallmark	2008	13-0029-00	2B	Aquatic recreation	Nutrients

Table 3. Summary of stream impairment listing in the Chisago Chain of Lakes Watershed.

Water body	Water body description	Year added to list	AUID	Use class	Affected designated use	Pollutant or stressor
Unnamed ditch	T34 R21W S24, east line to Sunrise Road	2010 2012 2022	07030005-723	2Bg	Aquatic life	Benthic macroinvertebrates bioassessments Dissolved oxygen Fish bioassessments

Mercury

Five lakes in the Green Lake (Chisago) Watershed are impaired for aquatic consumption by mercury in fish tissue (Kroon, Little, North Center and South Center Lakes, and North Center Pond) (MPCA, 2022). These are addressed in the statewide Mercury TMDL Report (2007) and statewide Mercury TMDL Implementation Plan (2007), and best management practices (BMP) are mostly implemented at the state and federal levels.

Aquatic life impairments

Seven lakes (Little Green, Green (Main Bay), Kroon, North and South Center, and North and South Lindstrom Lakes)) are impaired for aquatic life by fish bioassessments, and unnamed ditch (WID 07030005-732) is also impaired for aquatic life by dissolved oxygen and macroinvertebrates bioassessment. No TMDLs have been developed for these impairments. Improvement to habitat including reductions in nutrient and sediment loading, shoreline/streambank habitat, and streambank restoration can help to restore fish and macroinvertebrate populations.

Total Maximum Daily Loads

The TMDLs that have been completed are summarized in this section.

Delisted lakes

North Center Lake (13-0032-01)

Based on analysis from the 2013 Chisago Lake Chain of Lakes TMDL, North Center met the definition of shallow lake, with greater than 80% of the lake is considered littoral zone (less than 15’ deep). North Center Lake was delisted from the Impaired Waters list due to watershed implementation activities in 2019. Since 2010, there have been hundreds of water quality BMPs installed throughout the watershed on both the urban and rural sectors. These BMPs have collectively reduced hundreds of pounds of phosphorus from reaching the lakes within the Chisago Lakes Chain of Lakes Watershed. North Center

Lake is at the “top” of the watershed and the targeting efforts have been on this side of the watershed directly affecting North Center Lake. BMPs project include iron enhanced sand filters, water and sediment control basins, rain gardens, vegetated swales, grassed waterways, etc. BMPs have yielded improvements in all parameters since the original listing. Phosphorus and Secchi met standards; with an improving trend in Secchi detected. North Center Lake was found fully supporting recreation use and was subsequently removed from the Impaired Waters list. A summary of the TMDL is not included in the NKE Plan.

South Center Lake (13-0027-00)

Since 2010, there have been hundreds of water quality BMPs installed throughout the watershed on both the urban and rural sectors. These BMPs have collectively reduced hundreds of pounds of phosphorus from reaching the lakes within the Chisago Lake Chain of Lakes Watershed. South Center Lake is at the “top” of the watershed and the targeting efforts have been on this side of the watershed directly affecting South Center Lake. BMPs projects include iron enhanced sand filters, water and sediment control basins, rain gardens, vegetated swales, grassed waterways, etc. BMPs have yielded improvements in all parameters since the original listing. Phosphorus concentrations and Secchi transparency have met the standard since 2013. Ongoing work continues in the watershed through the Chisago Lakes Lake Improvement District and Chisago County through the Lake Improvement District Water Resource Management Plan. The lakes meet definition in guidance for delisting for lake eutrophication and data supports that the water quality is holding steady. South Center Lake was delisted with watershed implementation activity in 2019. A summary of the TMDL is not included in the NKE Plan.

School Lake (13-0044-00)

In 2021, School Lake was recommended for delisting of a nutrient impairment based on data from 2016-2020 easily meeting NCHF shallow lake standards. School Lake has been delisted for unspecified reasons. A summary of the TMDL is not included in the NKE Plan.

Lakes still listed as impaired

The remaining lakes are small, shallow lakes. Water quality observations have shown some improvement in water quality; however, some have small watersheds that limit the amount of phosphorus reductions attainable through upland watershed activities. The TMDLs for the lakes identify internal loading as a major source though the loads are better described as having an uncertain or unknown source in addition to actual internal load. The internal load in the lakes will be addressed in further evaluations of the source of the load and treatment of the internal load will be developed when needed. The progress made since the TMDLs were completed also needs to (and will) be done to evaluate the lake and watershed load conditions to determine adaptations for the load reduction goals.

Lake Emily (13-0046-00)

Lake Emily is a 220-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a mean depth of 1 meter (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 3). The TMDL was calculated with a 10% margin of safety and that an equal percentage of reductions were assigned for both internal load and watershed runoff. Lake Emily does not support aquatic recreation (MPCA, 2014).

Table 4. TMDL summary for Lake Emily (13-0046-00) (MPCA, 2013).

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	percent
WLA					
Construction stormwater permit #MNR100001	0.0099	0.0099	0.000027	0	0
Industrial stormwater permit #MNR50000	0.0099	0.0099	0.000027	0	0
Total WLA	**0.020**	**0.020**	**0.000054**	**0**	**0**
LA*					
Watershed	106	6.2	0.017	100	94
Atmospheric	4.6	4.6	0.013	0	0
Internal	278	16	0.044	262	94
Total LA	**389**	**27**	**0.074**	**362**	**93**
MOS		3	0.0082		
Total	**389**	**30**	**0.082**		

*LA components are broken down for guidance in implantation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

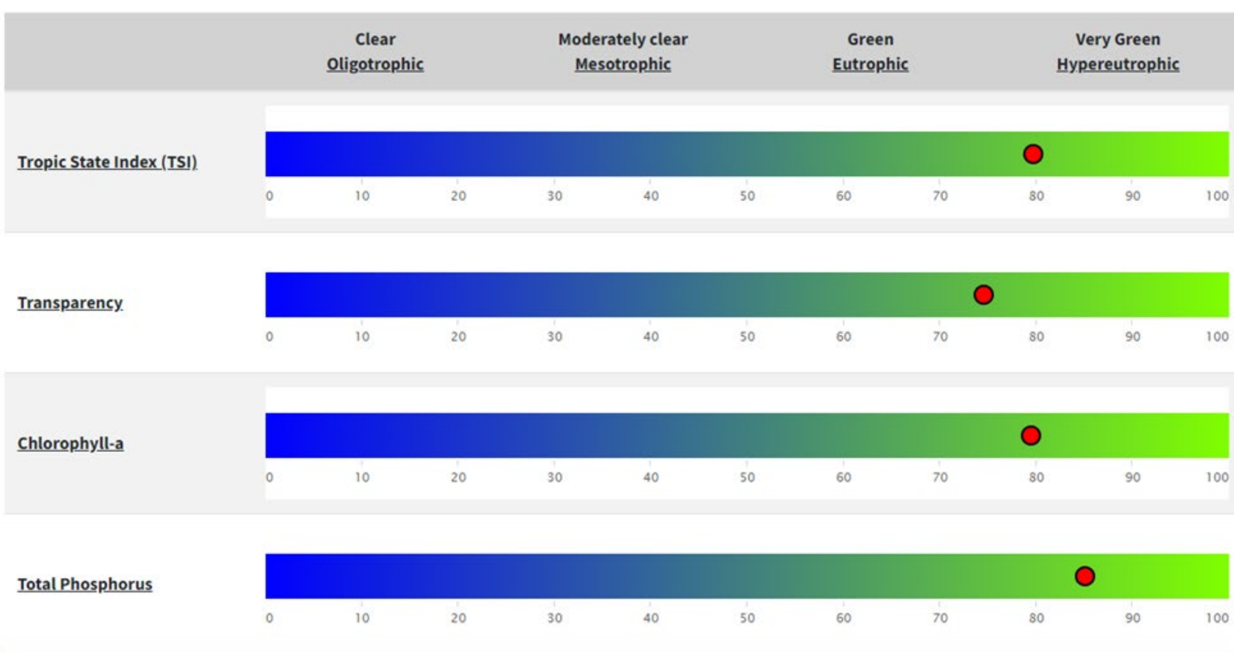
Load reduction to meet the TMDL are described in Table 5.

Table 5. Load reductions to meet Lake Emily (13-0046-00) Nutrient TMDL (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Percent reduction (%)
Watershed	106	6.2	100	94
Atmospheric deposition	4.6	4.6	0	0
Internal	389	27	362	93

Figure 3 illustrates the TSI calculated for the period 2008 to 2017 for Lake Emily that falls between eutrophic and hypereutrophic.

Figure 3. TSI for Lake Emily (13-0046-00) (MPCA, 2023).



Overall Trophic State Index for this lake: 80

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	0	75	43 - 54	22
Chlorophyll-a (parts per billion)	146	79	46 - 61	15
Total Phosphorus (parts per billion)	273	85	49 - 61	22

Linn Lake 13-0014-00

Linn Lake is a 1,149-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a mean depth of 6-feet (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 5). The TMDL was calculated with a 10% margin of safety and that an equal percentage of reductions were assigned for both internal load and watershed runoff. Linn Lake does not support aquatic recreation (MPCA, 2014).

Table 6. TMDL summary for Linn Lake (13-0014-00) (MPCA, 2013).

	TP existing	TP TMDL allocation		TP reduction	
Load component	**lb/yr**	**lb/yr**	**lb/day**	**lb/yr**	**Percent (%)**
WLA					
Construction stormwater permit # MNR100001	0.16	0.16	0.00044	0	0

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
Industrial stormwater permit #MNR50000	0.16	0.16	0.00044	0	0
Total WLA	**0.32**	**0.32**	**0.00088**	**0**	**0**
LA*					
Watershed	945	97	0.27	848	90
Atmospheric	49	49	0.13	0	0
Internal	1,725	178	0.49	1,547	90
Total LA	**2,719**	**324**	**0.89**	**2,395**	**88**
MOS		**36**	**0.10**		
Total	2,719	360	0.99		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

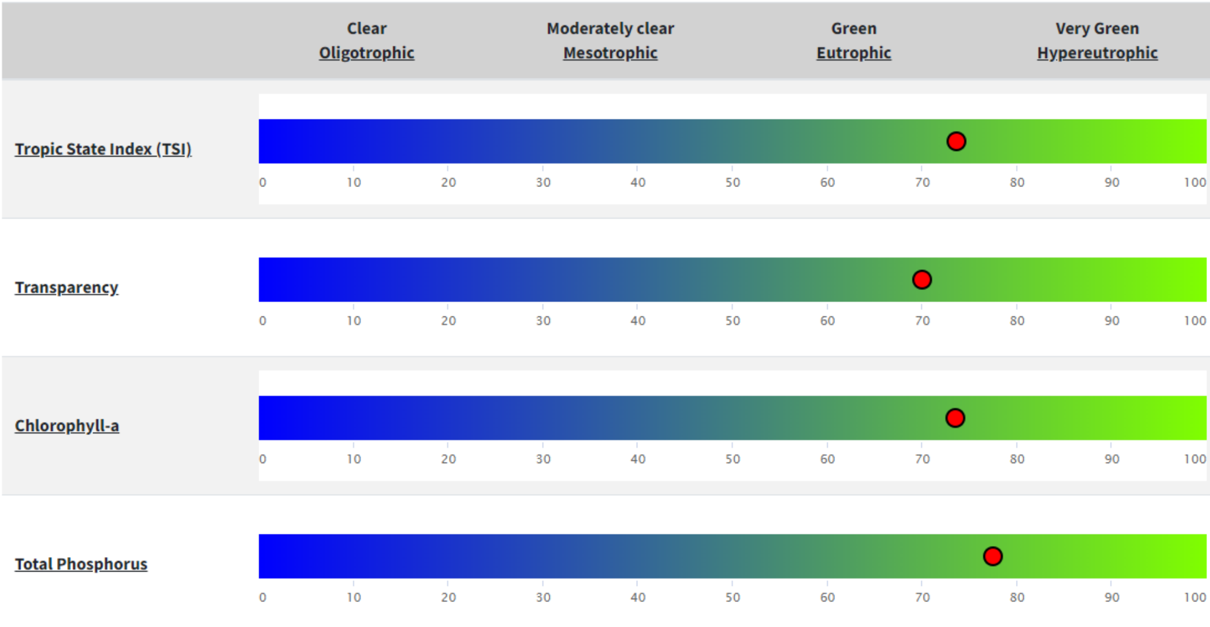
Load reductions to meet the TMDL are described in Table 7.

Table 7. Load reductions to meet Linn Lake (13-0014-00) Nutrient (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Precent reduction (%)
Watershed	945	97	848	90
Atmospheric deposition	49	49	0	0
Internal	1,725	178	1,547	90
Total	**2,719**	**324**	**2,395**	**88**

The Trophic State Index (TSI) was calculated using data that were collected September 2008 to 2017. A summary of these data can be found here on the MPCAs water quality dashboard. Figure 4 illustrates the TSI for Linn Lake that falls slightly higher than eutrophic.

Figure 4. TSI for Linn Lake (13-0014-00) (MPCA, 2023).



Overall Trophic State Index for this lake: **74**

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	1	70	43 - 54	21
Chlorophyll-a (parts per billion)	79	73	46 - 61	16
Total Phosphorus (parts per billion)	161	77	49 - 61	21

Little Lake 13-0033-00

Little Lake is a 12.3-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a mean depth of 9.4-feet (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 7). The TMDL was calculated with a 10% margin of safety and that an equal percentage of reductions were assigned for both internal load and watershed runoff. Little Lake does not support aquatic recreation (MPCA, 2014).

Little Lake is also impaired for aquatic consumption by mercury in fish tissue. A TMDL and implementation plan was developed for Minnesota, including Little Lake, in 2009. This plan remains outside the scope of control for Local Governmental Unit (LGUs); however, efforts continue at the state and federal levels to reduce mercury deposition.

Table 8. TMDL summary Figure 2 for Little Lake (13-0033-00) (MPCA, 2013).

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
WLA					
Construction stormwater permit #MNR100001	0.24	0.24	0.00066	0	0
Industrial stormwater permit #MNR50000	0.24	0.24	0.00066	0	0
Total WLA	**0.48**	**0.48**	**0.0013**	**0**	**0**
LA*					
Watershed	1,710	148	0.41	1,562	91
Atmospheric	44	44	0.12	0	0
Internal	1,200	104	0.28	1,096	91
Total LA	**2,954**	**296**	**0.81**	**2,658**	**90**
MOS		**33**	**0.09**		
Total	**2,954**	**330**	**0.90**		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

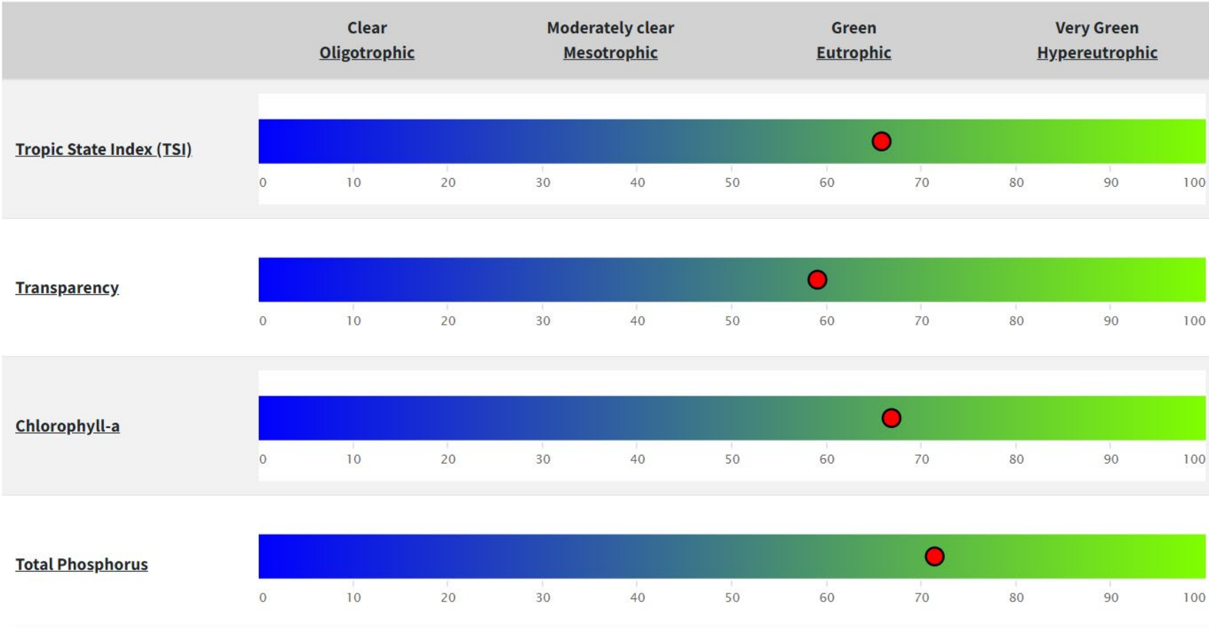
Load reductions to meet the TMDL are described in Table 9.

Table 9. Load reductions to meet Little Lake (13-0033-00) Nutrient TMDL (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Percent reduction (%)
Watershed	1,710	148	1,562	91
Atmospheric deposition	44	44	0	0
Internal	1,200	104	1,096	91
Total	**2,954**	**296**	**2,658**	**90**

The TSI was calculated using data that were collected September 2008 to 2017. A summary of these data can be found here. Figure 4 illustrates the TSI for Little Lake that falls between mesotrophic and eutrophic.

Figure 5. TSI for Little Lake (MPCA, 2023).



Overall Trophic State Index for this lake: 66

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	1	59	43 - 54	127
Chlorophyll-a (parts per billion)	40	67	46 - 61	32
Total Phosphorus (parts per billion)	106	71	49 - 61	32

Ogren Lake 13-0011-00

Ogren Lake is an 84-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a man depth of 15-feet (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 9, Table 7, Table 5). The TMDL was calculated with a 10% margin of safety and that watershed runoff should be reduced by 50% (430 P lbs/yr) and internal loading by 22% (37 P lbs/yr). Orgen Lake does not support aquatic recreation (MPCA, 2014).

Table 10. TMDL summary for Ogren Lake (13-0011-00) (MPCA, 2013).

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
WLA					
Construction stormwater permit #MNR100001	0.69	0.69	0.0019	0	0
Industrial stormwater permit #MNR50000	0.69	0.69	0.0019	0	0

Total WLA	**1.38**	**1.38**	**0.003**	**0**	**0**
LA*					
Watershed	859	429	1.2	430	50
Atmospheric	13	13	0.036	0	0
Internal	170	133	0.36	37	22
Total LA	**1,042**	**575**	**1.6**	**467**	**45**
MOS		**64**	**0.18**		
Total	**1,043**	**640**	**1.8**		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

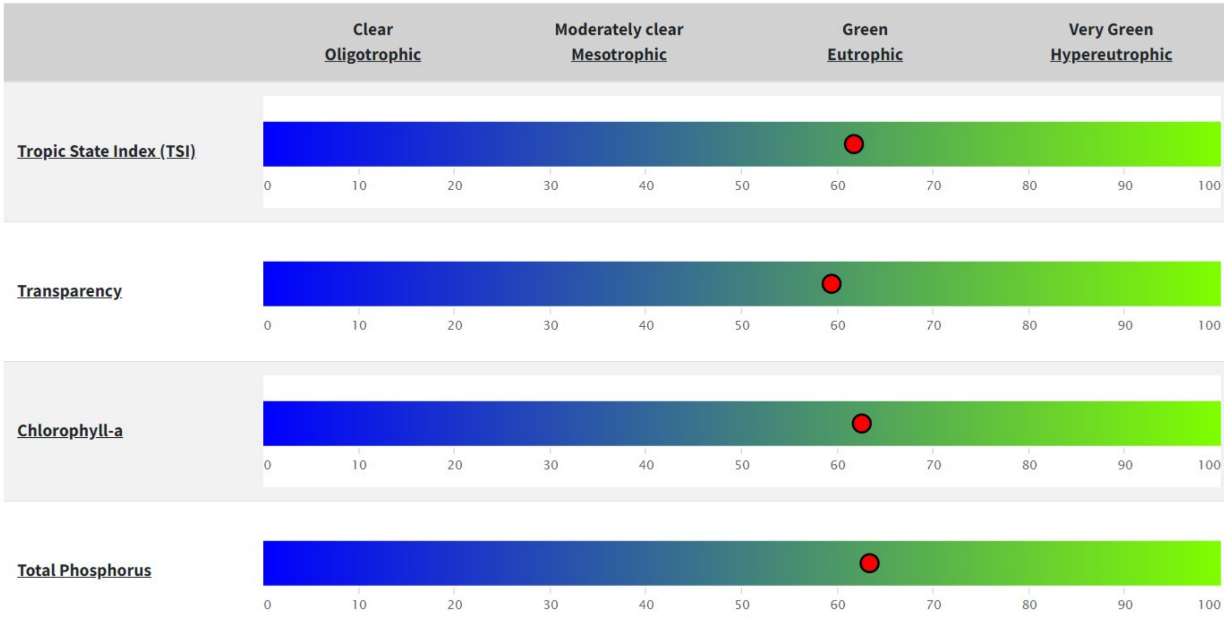
Load reductions to meet the TMDL are described in Table 10.

Table 11. Load reductions to meet Ogren Lake (13-0011-00) Nutrient TMDL (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Percent reduction (%)
Watershed	860	430	430	50
Atmospheric deposition	13	13	0	0
Internal	170	133	37	22
Total	1,043	576	467	45

The TSI was calculated using data that were collected September 2008 to 2017. A summary of these data can be found here. Figure 5 illustrates the TSI for Little Lake that falls between mesotrophic and eutrophic.

Figure 6. TSI for Ogren Lake (13-0011-00) (MPCA, 2023).



Overall Trophic State Index for this lake: 62

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	1	59	43 - 54	14
Chlorophyll-a (parts per billion)	26	63	46 - 61	14
Total Phosphorus (parts per billion)	61	63	49 - 61	14

Pioneer Lake 13-0034-00

Pioneer Lake is a 1.2-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a mean depth of 5-feet (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 7, Table 5). The TMDL was calculated with a 10% margin of safety and that an equal percentage of reductions were assigned for both internal load and watershed runoff. Pioneer Lake does not support aquatic recreation (MPCA, 2014).

Table 12. TMDL summary for Pioneer Lake (13-0034-00) (MPCA, 2013).

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
WLA					
Construction stormwater permit #MNR100001	0.00099	0.00099	0.0000027	0	0
Industrial stormwater permit #MNR50000	0.00099	0.00099	0.0000027	0	0

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
Total WLA	**0.0020**	**0.0020**	**0.0000054**	**0**	**0**
LA*					
Watershed	22	0.61	0.0017	21	95
Atmospheric	21	21	0.058	0	0
Internal	1,800	50	0.14	1,750	97
Total LA	**1,843**	**72**	**0.20**	**1,771**	**96**
MOS		**8**	**0.022**		
Total	**1,843**	**80**	**0.22**		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

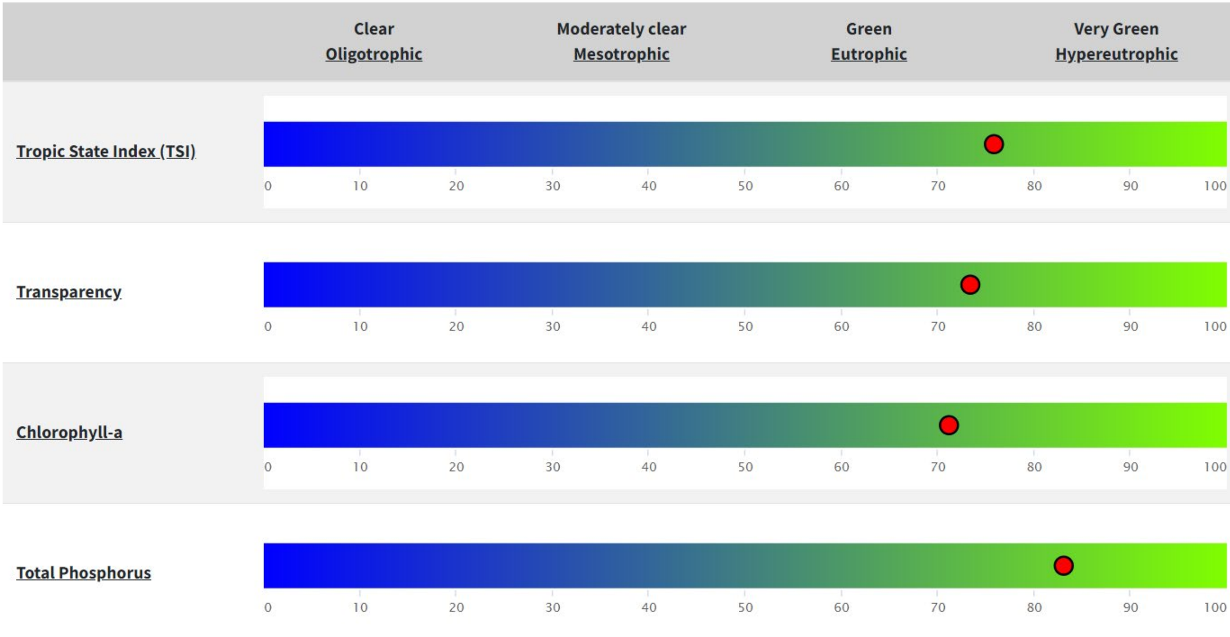
Load reductions to meet the TMDL are described in Table 10.

Table 13. Load reductions to meet Pioneer Lake (13-0034-00) Nutrient TMDL (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Percent reduction (%)
Watershed	22	0.61	21	95
Atmospheric deposition	21	21	0	0
Internal	1,800	50	1,750	97
Total	1,843	72	1,771	96

The TSI was calculated using data that were collected September 2008 to 2017. A summary of these data can be found here. Figure 6, Figure 5 illustrates the TSI for Little Lake that falls between eutrophic and hypereutrophic.

Figure 7. TSI for Pioneer Lake (13-003400) (MPCA, 2023).



Overall Trophic State Index for this lake: 76

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	0	73	43 - 54	18
Chlorophyll-a (parts per billion)	62	71	46 - 61	18
Total Phosphorus (parts per billion)	238	83	49 - 61	18

Wallmark Lake 13-0029-00

Wallmark Lake is a 397-acre watershed that is impaired for aquatic recreation by phosphorus and is not always suitable for swimming and wading due to low clarity or excessive algae. The lake is a shallow lake, with a mean depth of 6.6-feet (MPCA, 2014). A TMDL was calculated in 2013 for the water body (Table 14). The TMDL was calculated with a 10% margin of safety and that watershed runoff should be reduced by 96% (1,052 P lbs/yr) and internal loading by 96% (2,945 P lbs/yr). Wallmark Lake does not support aquatic recreation (MPCA, 2014).

Table 14. TMDL summary for Wallmark Lake (13-0029-00) (MPCA, 2013).

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
WLA					
Construction stormwater permit #MNR100001	0.074	0.074	0.00020	0	0
Industrial stormwater permit #MNR50000	0.074	0.074	0.00020	0	0
Total WLA	**0.15**	**0.15**	**0.00040**	**0**	**0**

Load component	TP existing	TP TMDL allocation		TP reduction	
	lb/yr	lb/yr	lb/day	lb/yr	Percent (%)
LA*					
Watershed	1,098	46	0.13	1,052	96
Atmospheric	40	40	0.11	0	0
Internal	3,075	130	0.36	2,945	96
Total LA	**4,213**	**216**	**0.60**	**3,997**	**95**
MOS		**24**	**0.066**		
Total	**4,213**	**240**	**0.67**		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

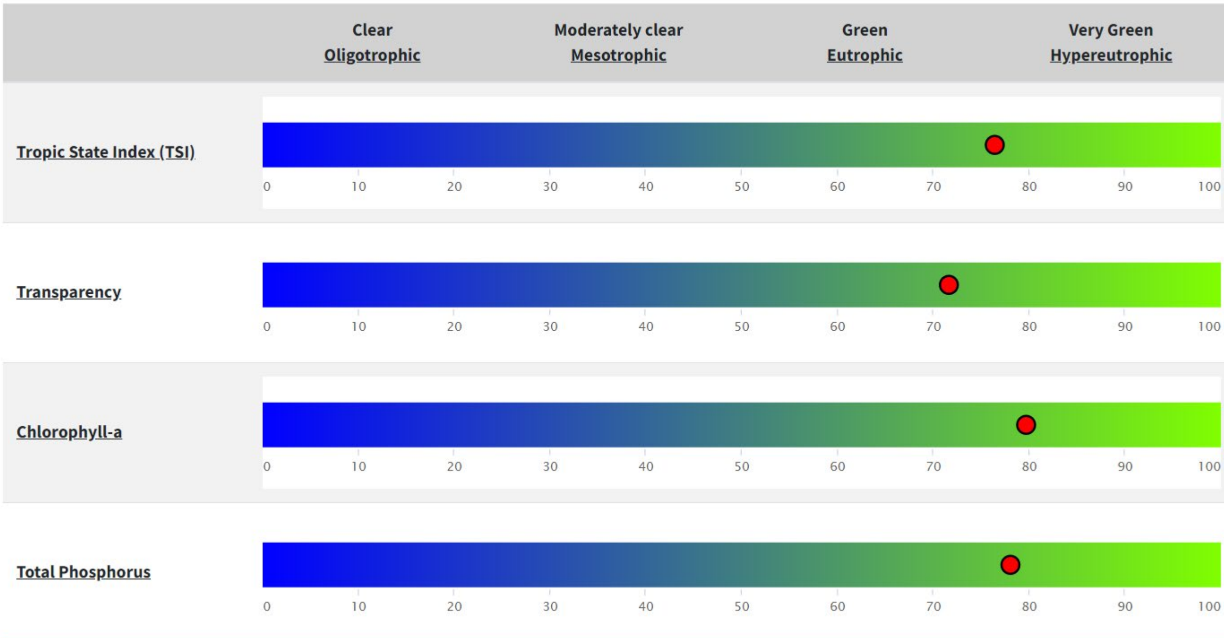
Load reductions to meet the TMDL are described in Table 15. Approximately 818 lb/yr should come from the watershed load and approximately 773 lb/yr should come from internal load.

Table 15. Load reductions to meet Wallmark Lake (13-0029-00) Nutrient TMDL (MPCA, 2013).

Phosphorus source	Existing annual TP load (lb/yr)	Implementation scenario annual TP load (lb/yr)	Load reduction needed (lb/yr)	Percent reduction (%)
Watershed	1,098	46	1,052	96
Atmospheric deposition	40	40	0	0
Internal	3,075	130	2,945	96
Total	4,213	216	3,997	95

The TSI was calculated using data that were collected September 2008 to 2017. A summary of these data can be found here. Figure 7 illustrates the TSI for Little Lake that falls between eutrophic and hypereutrophic.

Figure 8. TSI for Wallmark Lake (13-0029-00) (MPCA, 2023).



Overall Trophic State Index for this lake: 76

Parameters	10-Year average of all summer samples	Parameter TSI	Expected TSI range of lakes in same ecoregion	Number of samples
Transparency (meters)	0	72	43 - 54	13
Chlorophyll-a (parts per billion)	148	80	46 - 61	13
Total Phosphorus (parts per billion)	168	78	49 - 61	13

Implementation strategies

The implementation strategies, schedule, milestones, assessments, costs and the estimated pollutant reductions by practice are described in Table 16. The plan is estimated to yield the reductions need to meet the water quality standards for phosphorus within ten years. Estimated pollutant reductions by practice were calculated per practice using the EPAs PLET for decision-making purposes. The complete reductions for this plan were calculated using the PLET combined efficiencies; therefore, the summation of individual practice estimates may not equal the reductions estimated for the entire plan. Complete plan reductions are summarized in Table 16.

Eligibility for funding refers to current practice eligibility in 2024, as described in the EPAs 2014 Guidance and Minnesota's 2021 NPPMP. Practices are subject to final verification at the time of any financial award and must meet all current and necessary rules and guidelines for eligibility . Any stormwater activities that take place in a Municipal Separate Storm Sewer System (MS4) permitted conveyance system are not eligible for Section 319 grant funding, nor can they be used for match funding. Monitoring to determine the effectiveness of this plan and the BMPs implemented is eligible for Section 319 funding. General diagnostic and exploratory monitoring activities are not eligible for funding or match purposes.

Table 16. Implementation types, eligibility, activities, schedule, milestones, assessment criteria, costs and estimated per practice pollutant reductions (PLET, 2024).

Category/theme	Activities	Milestones 2-year (2026)	4-year (2028)	6-year (2030)	8-year (2032)	10-year (2034)	Assessment	Cost (dollars)	Reductions TSS (t/yr)	P (lbs/yr)	N (lbs/yr)
Chisago Lakes Chain of Lakes TMDL and Implementation Plan	TMDL WQ goals listed in plan*	Update TMDL modeling for impaired (or FKA impaired) water bodies.					Number of updates	$125,000.00			
Subwatershed assessments	Continue to work on BMPs that are identified in the Subwatershed assessments through BWSR Clean Water Funding (work already done – Flink reported – CWF Grants 2010-2022).	Update to existing assessments to reflect completed work and new projects needed.					Number of assessments	$30,000.00			
	Create new Lakeshore Owners Guide, update as necessary.	40 produced and handed out.					Number of guides Number of landowners	$500.00			
	Runoff display/demo that could be set up at events.	8 days for 4 events.					Number of events	$24,000.00			
	Audience specific trainings: Lakeshore Backyard Chats, Maintaining Native Plantings, Shoreline Realtor Workshop, Backyard Gardening, Raingarden Benefits.	4 events					Number of events. Number of landowners.	$48,000.00			
	Demonstration plots for learning, testing and education.	2 test plots.					Number of test plots.	$27,000.00			
	Farmer led council – Producer Showcases	1 event					Number of events. Number of landowners.	$15,000.00			
	Whole lakeshore lot plan – shoreline stewardship plans	20 landowners					Number of plans. Number of landowners.	$75,000.00			
	Expand L2L/LID shoreline restoration programs	10 restorations					Number of projects.	$300,000.00			
	No-mow/low-mow outreach (local SWCD and County staff)	60 hours					Number of outreach hours. Number of landowners. Number of new projects.	$22,500.00			
	No-mow/low-mow programs	20 landowner incentives					Number of projects.	$50,000.00			
Education/outreach materials	Free milkweed on buffers program (habitat improvement)*	2,500 milkweed plants					Number of plants. Number of habitat improvement.	$15,000.00			
	Watershed-Wide Soil Health Plan including where we're at and steps to move forward to increase/improve soil health (local SWCD and County staff)	0.1 FTE					Number of FTEs. Number of landowners. Number of outreach.	$150,000.00			
	Soil Health booklets		40 booklets				Number of booklets. Number of landowners.	$600.00			
	Financial assistance for Cover Crop/No till equipment		3 grants				Number of equipment. Number of outreach.	$100,000.00			
Soil health	Outreach for Cover Crop/NT equipment* (local SWCD and County staff)	80 hours					Number of landowners. Number of hours.	$30,000.00			
	SSTS – failing system updates* (match eligible)		5	10	10	10	Number of SSTS upgrades	$1,000,000.00	4	33	480
SSTS and unsewered systems	Sewer the lakes/eliminate septic's on lakeshore properties*		10	10	20	20	Number of properties. Number of sewer lines.	$3,000,000.00	$12,727	571	0

Category/theme	Activities	Milestones					Assessment	Cost (dollars)	Reductions		
		2-year (2026)	4-year (2028)	6-year (2030)	8-year (2032)	10-year (2034)			TSS (t/yr)	P (lbs/yr)	N (lbs/yr)
	Promote/incentivize 3rd crop in rotation (hay or small grain)	80 acres					Number of acres. Number of producers.	$66,000.00	17.84	48.49	285.41
	Increase cover crops and no-till	200 acres					Number of acres. Number of producers.	$135,000.00	107.02	297.57	545.11
	No Fall Till on 90% of acres (7014.6)	1,402 acres					Number of acres. Number of producers.	$10,000.00	1,236.18	3,708.95	8,993.8
	Cover crops	200 acres					Number of acres. Number of producers.	$30,000.00	46.73	126.77	730.59
	Strip Till/reduced tillage on 10% acres	200 acres					Number of acres. Number of producers.	15,000.00	23.54	61.43	656.39
	Tillage/cover crop/3rd crop outreach	200 hours					Number of landowners.	$75,000.00			
	Inventory alternative tile intakes	Inventory					Number of inventory. Number of tile intakes	$25,000.00			
	Outreach to recruit/ATI (local SWCD and County staff)		400 hours outreach and design				Number of landowners. Number of FTEs	$45,000.00			
	Install 10 alternative tile intakes			10 installations			Number pf projects	$75,000.00	2.54	3.13	8.13
	Ag BMP outreach (local SWCD and County staff)	0.2 FTE					Number of landowners. Number of FTEs.	$300,000.00			
	Ag BMP design (local SWCD and County staff)	1.5 FTE					Number of designs. Number of FTEs.	$1,560,000.0 0			
	WasCOB	Install 10 BMPs					Number of projects. Number of acres.	$625,000.00	23.18	63.67	254.34
	Grassed waterway installation	32,315 feet				32,316 feet	Number of feet. Number of landowners.	$166,961.87	39.7	48.91	127.03
	Rotational grazing design	2 designs					Number of acres. Number of projects.	$30,000.00			
	Rotational grazing installation	Install 2 BMPs					Number of projects. Number of acres.	$100,000.00	15.59	95.94	1866.1
	Rock lined channel installation	Install 4 BMPs					Number of projects. Number of feet.	$500,000.00	3.03	11.31	75.06
	Perennial vegetation establishment	500 acres					Number of acres.	$250,000.00	603.4	1,464.80	7,007.47
	Grade stabilization structures	Install 10 BMPs					Number of projects	$625,000.00	50.81	117.46	448.02
	Diversions	Install 5 BMPs					Number of projects.	$200,000.00	25.41	58.73	224.01
	Filter strips	50 acres					Number of acres.	$25,000.00	25.41	58.73	224.01
	Livestock use exclusion	200 feet					Number of feet.	$20,000.00	1.02	4.07	20.71
Soil and Health Agriculture BMPs	Manure management plans	4 plans					Number of plans. Number of landowners.	$50,000.00	101.86	235.48	898.13
Urban programs	Urban agriculture programs	10 projects					Number of projects.	$10,000.00			

Category/theme	Activities	Milestones 2-year (2026)	4-year (2028)	6-year (2030)	8-year (2032)	10-year (2034)	Assessment	Cost (dollars)	Reductions TSS (t/yr)	P (lbs/yr)	N (lbs/yr)
	Develop sump cleaning incentive program (local SWCD and County staff)	100 hours	20 hours				Number of FTEs. Number of hours. Number of programs.	$13,500.00			
	Scheduled additional slump cleaning – vac truck incentive		25 sumps 2X per year				Number of sump cleanings.	$40,000.00			
	Develop scheduled leaf pick up program (local SWCD and County staff)	100 hours	20 hours				Number of FTEs. Number of hours. Number of programs.	$13,500.00			
	Schedule leaf pickup		50 miles				Number of miles.	$20,000.00			
	Pave dirt roads that end at the lake or that add sediment directly to lakes (Lindstrom – Mentzer, Olinda N, Marine, Bonnie Glen, 300th)*		1,000 feet			2,000 feet	Number of projects. Number of feet.	$350,000.00			
Education/outreach materials	Habitat, LO-relationships, mindset stuff, socioeconomic, etc. working with landowners – shoreline, farmers, urban and rural (local SWCD and County staff).	0.25 FTE					Number of FTEs. Number of landowners.	$390,000.00			
	Adopt a drain promotion (local SWCD and County staff)	50 hours					Number of landowners. Number of FTEs.	$15,000.00			
	Enhanced street sweeping	40 new miles					Number of miles.	$39,000.00	15.88	19.56	5081
	Outreach/admin enhanced street sweeping (the enhanced street sweeping program is to help offset costs to local LGUs to add additional sweeping passes in specific locations of heavily treed areas within a city – local SWCD and County staff).	30 hours					Number of hours. Number of FTEs.	$11,000.00			
	City of Lindstrom groundwater conservation/water use program (local SWCD and County staff)	40 hours					Number of landowners. Number of FTEs.	$15,000.00			
	Establish erosion control inspection program for new development and redevelopment (local SWCD and County staff).	0.2 FTE					Number of FTEs. Number of inspections.	$312,000.00			
	Minimal impact design standards (MIDS) execution and staffing. For better stormwater management at an ordinance level (local SWCD and County staff).	0.2 FTE					Number of FTEs. Number of landowners.	$312,000.00			
	Urban BMP outreach (local SWCD and County staff).	0.2 FTE					Number of landowners. Number of FTEs.	$300,000.00			
	Urban BMP design (local SWCD and County staff)	1.5 FTE					Number of designs. Number of FTEs.	$1,560,000.00			
Urban stormwater BMPs	Urban BMP installation – rain gardens, vegetated swales, pervious pavement, turf conversions, buffers	Install 10 BMPs					Number of projects. Number of acres. Number of feet.	$1,250,000.00	99	477	3,740
	Spring tillage transect: every 3 years	Spring survey		Spring survey		Spring survey	Number of surveys.	$36,000.00			
	Fall cover crop/tillage transect: every 3 years	Fall survey		Fall survey		Fall survey	Number of surveys.	$36,000.00			
Inventories	Livestock: every 3-5 years	Livestock inventory		Livestock inventory		Livestock inventory	Number of livestock. Number of landowners.	$36,000.00			

Category/theme	Activities	Milestones 2-year (2026)	4-year (2028)	6-year (2030)	8-year (2032)	10-year (2034)	Assessment	Cost (dollars)	Reductions TSS (t/yr)	P (lbs/yr)	N (lbs/yr)
	Historic feedlot inventory/historic farmstead septic inventory/ historic well sites for sealing		Historic inventory				Number septic's. Number of wells. Number of feedlots.	$9,000.00			
	Conduct a lakeshore survey to identify areas of concern, areas that would be suitable for restoration, areas of good aquatic habitat, and areas that can be used for education/examples. Surveys will be looking for critical areas that are high pollution loaders and have high potential for restoration. Lakes with public accesses will be prioritized.	Lakeshore inventory 4 lakes	Lakeshore inventory 4 lakes	Lakeshore inventory 2 lakes			Number of surveys. Number of inventories.	$36,000.00			
	Snow storage planning	Identify potential locations for storage	Design/build new snow storage facility.				Number of plans. Number of designs. Number of buildings.	$75,000.00			
	Ki-Chi Saga park boardwalk outreach	Outreach, meet with partners, hire consultants					Number of landowners.	$20,000.00			
	Ki-Chi Saga park boardwalk design		Consultant to design.				Number of designs.	$75,000.00			
	Ki-Chi Saga park boardwalk installation			Project installation.			Number of projects.	$250,000.00			
	Inventory drained wetland locations (local SWCD and County staff)		0.1 FTE				Number of locations. Number of FTEs.	$15,600.00			
	Wetland restoration outreach			Outreach to all identified restoration locations			Number of landowners. Number of restorations.	$24,000.00			
	Wetland restoration design			Design 4 wetland restoration.	Design 2 wetland restorations.		Number of designs.	$168,000.00			
Wetlands	Wetland restoration			Install 2 wetland restorations.	Install 4 wetland restorations.		Number of projects. Number of acres.	$175,000.00	22.38	64.97	331.89
Monitoring	Monitoring	Element i monitoring					Number of locations. Number of samples.	$230,000.00			
	Internal load project coordination (local SWCD and County staff)	0.3 FTE					Number of projects.	$468,000.00			
	Internal loading study	Loading study on 1 lake					Number of studies.	$150,000.00			
	Internal loading treatment			Treatment for 2 lakes		Treatment for 1 lake	Number of projects. Number of acres. Number of treatments.	$2,000,000.00		4,500	
Internal loading	Trophic state alteration (including carp management, curly leaf pondweed management, floating vegetation mat installation, lake drawdown, algaecide application, barley straw installation)		2				Number of projects. Number of acres.	$1,200,000.00		5,425	
Total								$19,529,161.87	15,210	17,842	26,975

*Not 319 eligible.

Element a. Sources identified

An identification of the cause and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

EPA Handbook for Restoring and Protecting Our Waters.

Nonpoint source

Nonpoint source pollution loads are the diffuse sources of pollution that are not subject to regulation by permit. These sources can be anthropogenic or natural. Human activity, zoning, land cover, and hydromodification all contribute to pollutant loading. These sources come from both developed and rural areas in this watershed.

The TMDL, TMDL implementation plan and detailed subwatershed assessments identify sources and magnitudes of the phosphorus loads in the watershed.

The watershed sources are largely characterized by the land use and cover distribution in the watershed (Table 17, Figure 9 and Table 18).

Table 17. Percent land use and cover in the Chisago Chain of Lakes Watershed (NLCD, 2019).

Open water	Urban	Forest/shrub	Pasture/hay/grassland	Cropland	Wetland
13%	11%	17%	23%	21%	16%

Figure 9. Chisago Chain of Lakes landcover map (NLCD, 2019).

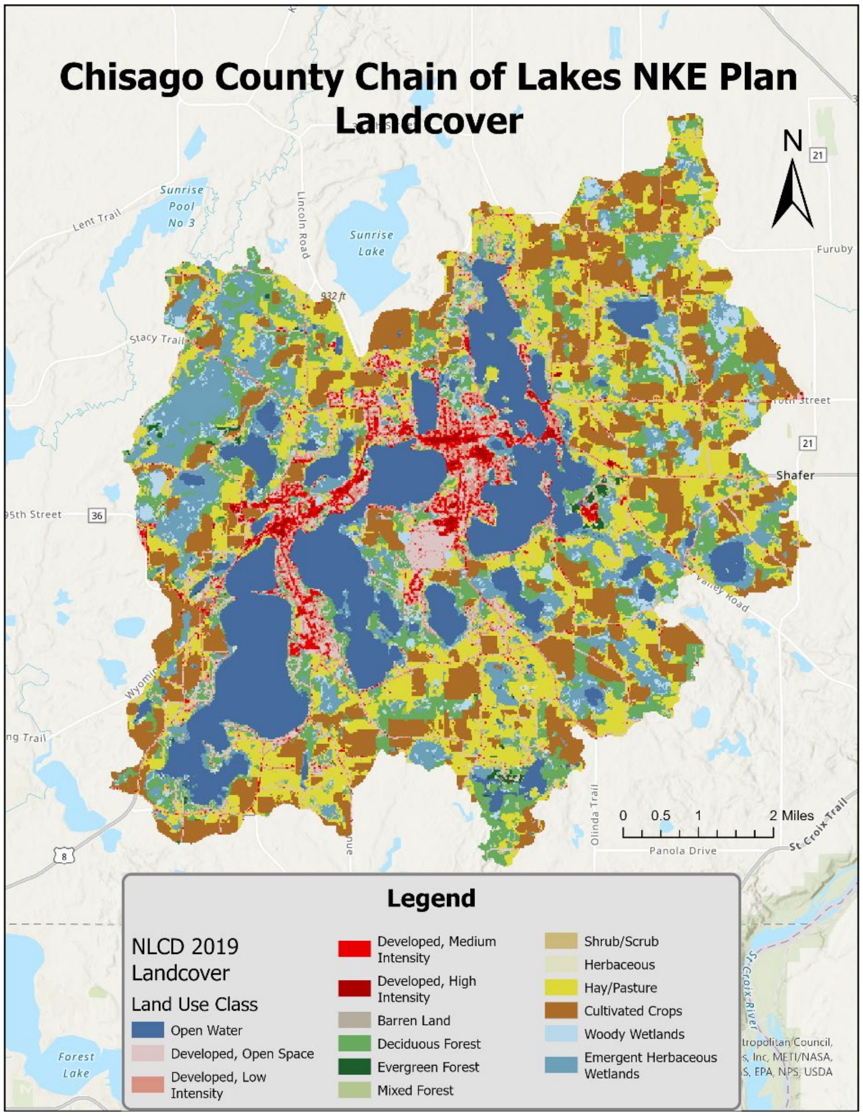


Table 18. NPS pollution loads to Chisago Chain of Lakes Watershed estimated using PLET (2024).

Sources	N load (lb/yr)	P load (lb/yr)	TSS (t/yr)
Urban	15,889	2,407	347
Cropland	23,979	5,229	1,985
Pastureland	30,777	2,835	531
Forest	1,361	664	44
Feedlots	2,683	537	0
Septic	769	301	0
Total	75,457	11,972	2,907

Developed areas

Stormwater runoff from developed areas and cities carry pollutants to surface waters. The majority of stormwater runoff is not regulated through NPDES permits. Residential, single-family developments can impact nutrient runoff through impervious surfaces, driveways and mowed lawns. Proximity to surface waters, such as lakeshore properties or river front can speed the transfer of pollutants to surface waters. Cities or other urban areas can contribute to loads from runoff from impervious surfaces including roads, parking lots and sidewalks. Additionally, stormwater conveyance systems can transfer chloride and other road debris to surface waters via gutters and storm drains. The Chisago SWCD has conducted three city stormwater retrofit assessment studies within the Chisago Lakes Chain of Lakes Watershed. Stormwater retrofit assessments break down urban areas into small watershed (or catchments) and are evaluated for the best locations for future BMPs and associated pollutant loading reductions. More information can be found at: https://chisagoswcd.org/assessments/.

Upstream waters

Lakes and streams upstream of impaired waters may contribute to pollutant loading. The SWAT model used to develop the Chain of Lakes TMDL identified potential loading to downstream waterbodies. (Table 16).

Table 19. Summary of phosphorus loading from upstream waters (adapted from MPCA, 2013).

Receiving water	Upstream Lake	Averaging period	In-lake TP (µg/L)	Flow volume[1] (AF/yr)	Drainage area (acres)[2]	Equivalent depth of flow (in/yr)	Phosphorus load (lb/yr)
North Center	Little	2007-2008	161	1,307	2,178	7.2	570
	Pioneer[3]	2009	311	125	168	8.9	53
	South Center	2002-2009	46	6,968	11,000	7.6	870
School	Mattson	2008-2009	23	301	602	6.0	19
South Center	Ogren	2009-2010	61	2,490	4,150	7.2	410
	Linn[3]	2008-2009	214	983	1,326	8.9	290
Wallmark	Chisago[4]	2002-2010	37	0	N/A	N/A	N/A

[1]Watershed runoff plus shallow groundwater flow.

[2]Calculations are from lake outlet; includes lake area and drainage area.

[3]Pioneer and Linn Lake are land-locked on an average annual basis. However, because the lakes are connected through shallow groundwater movement, they both contribute dissolved phosphorus to downstream waters. It was assumed that the modeled volume (from SWAT) of discharge from Pioneer and Linn Lake was shallow groundwater only. Dissolved phosphorus concentration in shallow groundwater was estimated to be half of total phosphorus concentration in the lake. The actual ratio of groundwater to surface water discharge from the other four upstream lakes (Little, South Center, Mattson and Ogren) was uncertain; therefore, no adjustments were made to estimated loadings from those lakes.

[4]Wallmark Lake receives water from Chisago Lake when the elevation is above 899.2'. this has only occurred a few times since the weirs were installed in 1986. Currently the water in Chisago Lake is 6-feet below this point. The water quality of Chisago Lake far exceeds the quality of Wallmark Lake.

Subsurface sewage treatment systems (SSTS)

Failing and nonconforming SSTS can contribute to nutrient loading in a watershed. Chisago County has completed extensive inspections of septic systems throughout the county. They have identified and worked with landowners to upgrade Imminent threat to Public Health Septic Systems. There are still septic systems within the County that are failing due to many factors and have not been identified yet. It is estimated that 10% of lakeshore systems are still failing.

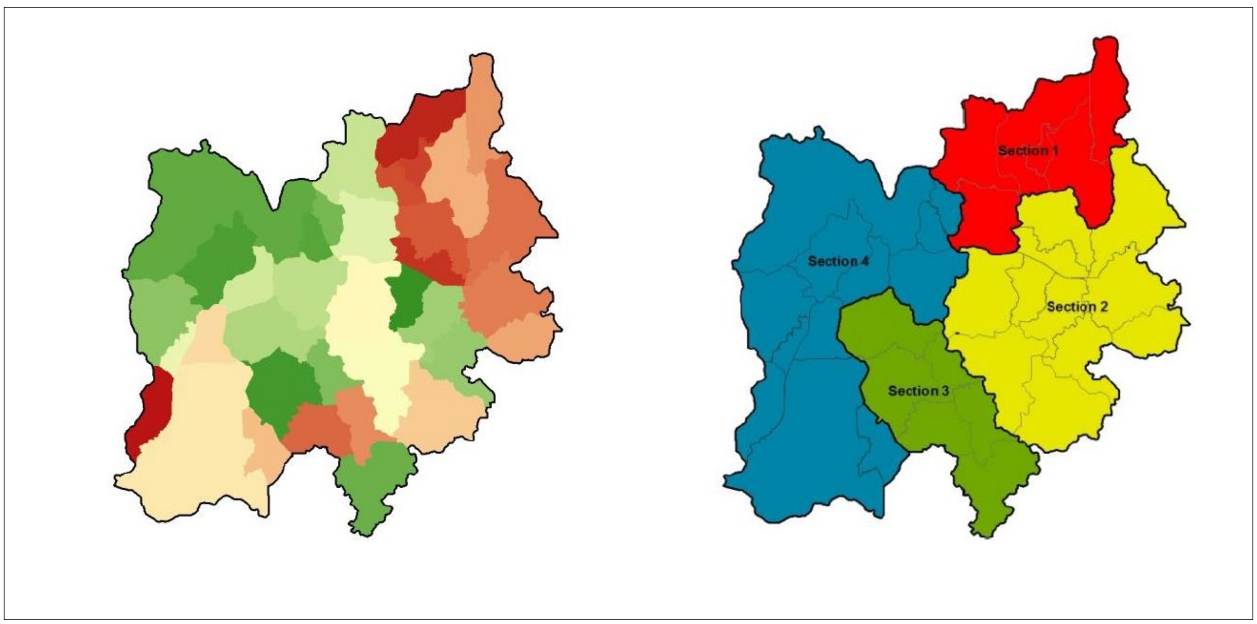
Internal loading

Internal loading from legacy phosphorus in the lakebed, vegetation and certain species contribute to algal blooms and phosphorus in the water column. Shallow lakes are more prone to mixing water through wind and human and aquatic life disturbances. Curly leaf pondweed (*Potamogeton crispus*) is more prevalent in shallow lakes and contributes to phosphorus release during its decay. A list is being developed of priority lakes within the County that could benefit from internal load treatments. In the future, it is possible that internal loading treatments within the watershed will be prioritized to focus on funding on the immobilize phosphorus in the water column to help reach TMDL goals.

Rural subwatershed assessment

Chisago SWCD developed four Rural Subwatershed Assessment reports in 2014 by aggregating multiple data sources (water quality monitoring, TMDL studies, impairments, etc.) (Figure 8). The assessments were developed for North Center Lake (Section 1, red); South Center Lake (Section 2, yellow); Chisago Lae (Section 3, green); North and South Lindstrom, and Green Lake (Section 4, blue). The HUC-12 watershed was divided into 36 subwatersheds, prioritizing them by the highest pollutant loading potential (Figure 8) and examined by lakesheds, with the red subcatchments on the left side identifying the highest priority for implementation.

Figure 10. Highest pollutant loading (nutrient/sediment) subcatchments (left) and Section designations (right) in the Chisago Chain of Lakes Watershed (RSA, p. 14).



The development of the Rural Subwatershed Assessment analyzed all cropland in the watershed no matter what the current crop cover. Many fields rotate crops and choosing a single crop cover could be problematic as it changes (e.g., assuming it will be hay, but followed by corn and bean). The most common practice in this watershed is corn and bean rotation with fall tilling. Steep slopes (over 6%), concentrated flow areas (ditches, gullies), ditches that are adjacent to cropland, pastured wetlands, animal operations, and altered/ditched wetlands are considered critical area pollutant loading sources.

Cropland

Cropland that has a greater than 6% slope and corn/bean rotations is identified as a critical loading point. All cropland in the rural areas would benefit from implementing soil health practices, including tillage management and nutrient management. The improvement of soil health reduces runoff by holding more water on the land. Organic matter in the soil will reduce the need for additional nutrient application.

Gullies

Gullies have been identified as large critical area sources of sediment and phosphorus reaching surface waters in near shore locations. Gullies are symptoms of concentrated upland runoff. The large gullies identified in these reports are often perennial gullies that have been eroding for 100 years or more. They often have large watersheds upstream of the gully head. Some occur in developed areas and others are the result of agricultural runoff (Rural Subwater Assessment, p. 114). Upland practices (cover crops, permanent vegetation and reduced tillage practices, etc.) will be used to address the concentrated runoff first and these gullies will then be repaired to further reduce loading.

Drained wetlands

An inventory of drained Type 1 or Type 2 wetlands will be completed to identify potential locations for restoration. These types of wetlands are potentially large sources of phosphorus to nearby waterbodies due to seasonal flooding, then drying out. Some of these wetlands can be changed from a source of phosphorus to a location to bind up phosphorus. The restoration of wetlands improves the function of the wetland as water storage and natural treatment. Restoration must include establishing native and perennial vegetation, as they tend to revert to reed canary monocultures (example plan be found here: https://chisagoswcd.org/assessments/). After identifying the locations of these wetlands, the SWCD will work to contact landowners and find which ones are eligible to be restored to original functionality.

Animal operations

Rotational grazing of animals, especially large herds, helps reduce the impact of the animals to a single site. Some of the animal operations identified in this report are also identified as wetlands by the National Wetland Inventory. The locations where animal operations and wetlands combine are a potential source of excess nutrients in surface water. Fencing animals out of the wetlands, drainage ditches, and streams, and allowing a buffer to grow between the water body and the animals is a potential solution (Rural Subwater Assessment, p. 175).

The storage and application of manure from animal operations can be a source of nutrient loading. Developing manure management plans to manage the timing and application of manure to fields can reduce pollutant loading.

Pastured wetlands are a potential source of excess nutrients reaching surface waters. Often farmers used the best land for crops and pastured the rest of their property, which was usually the wet or low area. Therefore, many wetlands in the area have at some point been pastured. Only those pastures that appear active and have evident wetlands within them were identified here (RSA, p. 186).

Point sources

Point sources are loads originate from a permitted source. These loads are regulated by permit limits and are not considered to be sources of pollutant loading.

MS4 stormwater

There are no municipalities that fall under the MS4 permit.

Construction

Any land disturbance that exceeds one acre or more is subject to permitting and the creation of SWPPP that minimizes runoff from the site for the duration of the project.

Industrial

Chisago County Highway Department

MNG490147 (MCPA id 67983)

Coverage issuance

Activity id: GEN20210001

Status: active

Issued/expiration: January 12, 2023 – May 30, 2027

Industrial – NPDES/SDS – EPA minor

Wastewater treatment systems

The Preserve at Birch Lake Wastewater Treatment Plant (WWTP)

MN0066362 (MPCA id 74046)

Permit reissuance

Activity id: IND20190001

Status: active

Chisago Lakes Joint STC

MN0055808 (MPCA id 3,902)

Domestic – NPDES/SDS – EPA major

Access monthly monitoring data where available

Station description and location

Surface discharge

SD 001

001 total facility discharge

Chisago Lakes Joint STC

MN0055808 (MPCA id 3902)

Domestic – NPDES/SDS – EPA major

Activity id: IND20160002

Status: active

Permits for these facilities can be reviewed here: https://experience.arcgis.com/experience/eb3ead75cfa64382b0b8d139c19db83c/.

NPDES permitted feedlots

There are no NPDES feedlots in this watershed. There are no CAFOs in this watershed or feedlots with an NPDES permit, but there are many registered feedlots.

Element b. Estimated reductions

An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded stream banks).

EPA Handbook for Restoring and Protecting Our Waters.

The implementation activities described in Table 17 will exceed the phosphorus load reduction (13,241 lb/yr) needed to achieve the reductions described in the Chisago Chain of Lakes TMDL. The activities will provide phosphorus load reductions toward meeting the nutrient reduction goals for the Lake St. Croix TMDL. Table 17 lists the practices and individual estimated reductions by practice. The reductions in this section are calculated using PLET to calculate the impact of this plan as a system (Table 20).

Table 20. Load reduction targets and estimated combined efficiencies load reductions for implementation activities (PLET, 2024).

	TSS 9t/yr)	P (lbs/yr)	N (lbs/yr)
Estimated load reductions	15,210	17,842	26,975

Element c. Best management practices

A description of the BMPs (NPS management measures) that are expected to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas (by pollutant or sector) in which those measures will be needed to implement this plan.

EPA Handbook for Restoring and Protecting Our Waters.

The Chisago SWCD, in partnership with others, has developed multiple subwatershed assessments to restore water quality in the Green Lake (Chisago) Watershed. The subwatershed assessments are an analysis of sources and BMP placement to maximize the reductions in pollutant loading to the system. The subwatershed assessments focus on City Stormwater Retrofit Assessments (RSAs), rural subwatershed assessments (RSA), and gully BMPs. The Stormwater Retrofit Assessment process starts by using GIS data (land cover, topography, historical aerial photography, flow data, etc.) to create small subwatersheds called catchments. Within each catchment, potential best management practices are pinpointed on the landscape in critical areas appropriate for BMPs. After all BMPs are identified, pollutant loading is modeled (model is chosen based on BMP, these include, but are not limited to: RUSLE2, P8, MIDS Calculator, WinSlamm, BWSR Pollution Reduction Estimator, etc.) to determine how many pounds/tons of phosphorus, sediment, and volume comes from each individual BMPs and would reach the nearest water body. These practices are then ranked and detailed lists of practices are used to contact landowners for future projects.

City stormwater retrofit assessments

The Chisago SWCD conducted three city stormwater retrofit assessment (SRA) studies. The relevant practices are included in Table 16. A summary of the practice types is provided in table 23. An example of BMP location, catchment summary and treatment reductions for the SRAs are shown in Figure 10: Example stormwater retrofit assessment BMP citing. An example of BMP location, catchment summary and treatment reductions RSAs are shown in Table 21.

Table 21. Stormwater BMPs considered for SRA.

Area	BMPs	Potential retrofit project
5-500 acres	Extended detention	12–24-hour detention of stormwater with portions drying out between events (preferred over wet ponds). May include multiple cell design, infiltration benches, sand/peat/iron filter outlets and modified choker outlet features.
	Wet ponds	Permanent pool of standing water with new water displacing pooled water from previous event.
	Wetlands	Depression less than 1-meter deep and designed to emulate wetland ecological functions. Residence times of several days to weeks. Best constructed off-line with low-flow bypass.
0.1-5 acres	Bioretention	Use of native soil, soil microbe and plant processes to treat, evapotranspiration, and/or infiltrate stormwater runoff. Facilities can either be fully infiltrating, fully filtering or a combination thereof.
	Filtering	Filter runoff through engineered media and passing it through an under-drain. May consist of a combination of sand, soil, peat, compost and iron.

Area	BMPs	Potential retrofit project
	Infiltration	A rock-filled trench or sump with no outlet that receives runoff. Stormwater is passed through a conveyance and pretreatment system before entering infiltration area.
	Swales	A series of vegetated, open channel practices that can be designed to filter and/or infiltrate runoff.
	Other	On-site, source-disconnect practices such as rain-leader raingardens, rain barrels, green roofs, cisterns, stormwater planters, dry wells or permeable pavements.

Subwatershed plans:

Table 22. BMP overview table.

BMP	Type	Abbreviation	Units	Cost	O and M term
Water and Sediment Control Basin (WASCOB) 0-10 acres	Rural	W	Each	$10,000	10
WASCOB 10-20 acres	Rural	W	Each	$20,000	10
WASCOB 20-40 acres	Rural	W	Each	$30,000	10
Grassed waterway	Rural	GW	Linear feet	$10/ft.	10
Filter strip (per 10 acres)	Rural	FS	Linear feet	$4/ft.	10
Gully	Gully	G	Each	$30,000	10
Permanent vegetation	Rural	V	Acre	$3,000	10
Ditched/drained Type 1 or 2 wetland	Rural		Each	$20,000	10
Bioretention (infiltration and/or filtration)	Urban stormwater	B	Square foot	$20/sq. ft.	10
Filtration (sand curtain, surface sand filter, sumo, etc.).	Urban stormwater	F	Square foot	$25/sq. ft.	10
Pond modification (increased area/depth, additional cells, forebay and/or outlet modification).	Urban stormwater	PM	Square foot	$10/ft.	10
Vegetated swale (wet or dry)	Urban stormwater	VS	Square foot	$15/ft.	10
Permeable surface (infiltration and/or filtration)	Urban stormwater	PS	Square foot	$25/ft.	10

Figure 11. Example Chisago City 3 – stormwater retrofit assessment BMP citing.

Proposed Bioretention Areas

	Cost/Benefit Analysis	Highly Impervious Retrofit – Annual Marginal Treatment Enhancement – Min		Mid		Max	
Treatment	TP (lb/yr)	2.7	20%	4.1	30%	6.8	50%
	TSS (lb/yr)	1,935	46%	2,378	56%	3,106	73%
	Volume (acre-feet/yr)	2.0	17%	3.10	27%	5.3	46%
	Live Storage Volume (cubic feet)	1,015		1,708		3,520	
Costs	Materials/Labor/Design	$18,168		$30,565		$63,002	
	Promotion & Admin Costs	$1,200		$1,200		$1,200	
	Total Project Cost	$19,368		$31,765		$64,202	
	Annual O&M	$761		$1,281		$2,640	
	Term Cost/lb/yr (30 yr)	$485		$538		$659	

CHISAGO CITY – 3

Catchment Summary	
Acres	5.3
Dominant Land Cover	Building/ Parking lot
Parcels	1
Volume (acre-feet/yr)	5.2
TP (lb/yr)	6.1
TSS (lb/yr)	1,922

Model Inputs – Parameter	Input
Pervious Curve Number	69
Indirectly connected Impervious Fraction	0
Directly Connected Impervious Fraction	0.47
Hydraulic Conductivity (in/hr)	0.51

Rural subwatershed analyses

The Rural Subwatershed Analyses (RSA) were conducted on four areas of the watershed: Chisago Lakes; North and South Lindstrom and Green Lakes; North Center Lake; and South Center Lake. These assessments focus on cropland management, gully management, and other specifically rural land use concerns. Project profiles are provided for fields that require water and sediment control basins, grassed waterways, filter strips, gullies, wetland restorations, animal operations, and pastured wetlands (RSA, 2014). Descriptions of these BMPs are summarized in Table 24.

Table 23. Agricultural BMPs identified for Green Lake (Chisago) Watershed (RSA, 2014).

BMPs	Definition
Filter strip (F)	Minimum of a 50-foot strip of perennial grasses and legumes planted along a stream, ditch or wetland to capture sediment before it runs into the water body.
Grassed waterway (GW)	A strip of grass in a crop field planted to reduce erosion where water concentrates.
Water and sediment control basin (WASCOB) (W)	An earthen embankment that traps water and sediment running off cropland upslope from the structure and reduces gully erosion by controlling flow within the drainage area. The basin releases water slowly, usually through infiltration or a pipe outlet and tile line.
Animal operation improvements	Changes to animal operations that include animal operation improvements, use exclusion, fencing and manure management.
Nutrient management	Time and type of application and incorporation.
Conservation tillage	Mulch till (partially incorporate residue), no till (maintain most of residue on soil surface year-round).
Wetland restoration	Restoring hydrology, often by plugging a drainage ditch. Plant native wetland species.
Permanent vegetation	Planting of permanent hay or native grasses, usually on a field with steep slopes over 6%.
Lined waterway	A waterway having an erosion-resistant lining or concrete, stone, synthetic turf reinforcement fabrics, or other permanent material.
Diversion	A channel generally constructed across the slope with a supporting ridge on the lower side to break up concentrations of water on long slopes.
Sediment basin	A constructed basin designed to collect and store waterborne debris or sediment.
Use exclusion/access control/fencing	Temporarily or permanently excluding animals, people, or vehicles from an area. Usually achieved through fencing.
Rotational grazing	A system of grazing animals in several areas for determined periods of time to prevent overgrazing and allow vegetation regeneration.
Critical area seeding	Planted vegetation such as trees, shrubs, vines, grasses or legumes on highly erodible or critically eroding areas.
Grade stabilization	A structure used to control the grade and head-cutting in natural or artificial channels.

Critical loading areas

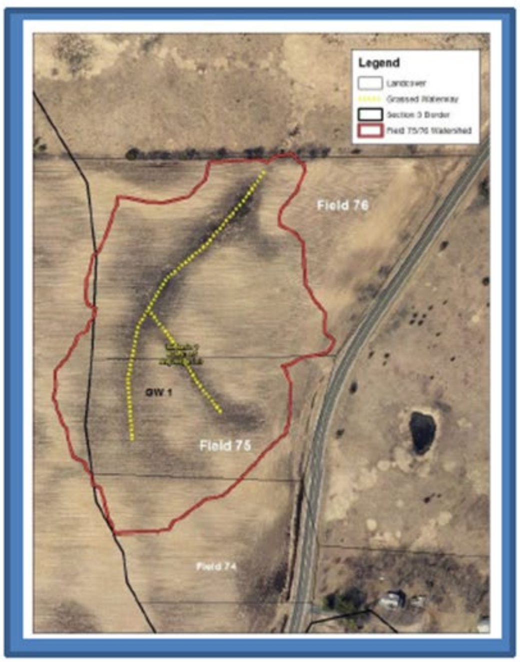
The fields that should be converted to permanent cover are listed ranking tables in all Rural Subwatershed Assessments listed in the bibliography, ranked by annual loading of Total Phosphorus with the highest loading field first. The profiles for WASCOB, grassed waterways, and filter strips are ranked in order of annual loading Total Phosphorus, with the highest loading field first. The profiles for gullies ranked separately by annual loading of Total Phosphorus, with the highest loading field first. The wetland restorations, animal operations and pastures are not ranked in any order.

Cropland

Cropland that has greater than 6% slope has been determined to be a critical loading point. Flow paths, including ditches, manipulated waterways, and gullies, is a consideration for targeting high loads, especially when features are close to surface waters or wetlands.

Soil health practices are recommended for all cropland parcels and nutrient management on all cropland and pasture lands. Soil health practices include cover crops, low tillage, no tillage, nutrient reduction and management strategies, and alternate rotations (e.g., small grains, etc.).

Figure 12. Rural Subwatershed assessment BMP example



Catchment Summary	
Field Acres	21.6
Current Cover	Corn/Beans
# of Landowners	1
Removed TP (Lb/yr)	31
Removed TSS (Ton/yr)	31
Estimated Cost	$5,337.00
Cost/Lb TP	$172
Model Inputs	
Soil Type	40B;40C;346
Slopes >6%	Yes

Practice	Removed TP (Lb/yr)	Removed TSS (Ton/yr)	Watershed Size (Acres)	Average Watershed Slope (%)	Distance to Surface Water (Feet)	Length (Feet)	Estimated Cost	Cost/Lb TP
GW 1	31	31	6.5	3.3	145	900	$5,337.00	$172

Gullies

For the purpose of this plan, a “gully” is a large, perennial erosion problem that is generally not directly adjacent to an agricultural field. Fifty-three gullies have been identified in this watershed by aerial photography and/or a windshield survey (Chisago County SWCD, 2014). Thirty-six have been addressed in past project, with seventeen number remaining. In-channel BMPs such as rock-lined channels and check dams, as well as upstream BMPs, should be explored for each individual gully. Other upstream field-based implementation strategies such as rain gardens, vegetative swales, wetland restorations, WASCOBs, grassed waterways and ditch checks may trap water and sediment running off cropland upslope from the structure. This is turn reduces gully erosion by controlling flow within the drainage area.

Element d. Expected costs and technical assistance

> An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the entire plan (include administrative, Information and Education, and monitoring costs). Expected sources of funding, states to be used Section 319, State Revolving Funds, USDA’s Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local and private funds to assist in implementing this plan.

The estimated costs of the activities in this plan are shown in Table 16. The costs to implement this NKE plan are estimated at $19,529,161.87 when fully implemented.

Funding for this plan will be through Section 319 funding, BWSR One Watershed One Plan (1W1P) funding, implementation grants, NRCS/EQIP funding, Conservation Stewardship Program, and other opportunities.

Partnerships within the Chisago Lakes Chain of Lakes Watershed are plentiful (Table 24). The watershed has a long history of collaborative work. Chisago SWCD works regularly with state partners (MnDNR, BWSR, MPCA) to execute monitoring, regulation and obtain funding to complete BMPs. There is one Lake Improvement District within the watershed – the Chisago Lakes Lake Improvement District is very active. The CLLID monitors lake level, water quality, and aquatic invasive species. Chisago SWCD works with the CLLID to fund high priority BMPs throughout the watershed. The CLLID provides matching funds to the Clean Water Fund grants that the Chisago SWCD is able to secure from the State of Minnesota. Working with local government units is an important partnership in the watershed. This allows the LGUs to contact the SWCD when problems arise, problems are looked at, and solutions are identified. Through the 1W1P program, there are several education and outreach specialists that support this watershed.

Table 24. Partners’ potential roles and responsibilities.

	Partner	General roles	Potential responsibilities
Citizen groups	Lake associations: Center Lake, Chisago-Lindstrom Lake, Green Lake	Provide education to residents. Support implementation efforts.	Coordinate projects.
	Landowners and residents	Provide input, information and feedback. Share information. Provide leadership.	Attend meetings, share information, monitor projects, tree planting, ditch/culvert maintenance.

	Partner	General roles	Potential responsibilities
	Wild Rivers Conservancy North Woods and Waters	Civic engagement, education.	Hold meetings, education, assist advocates' group, provide links to other environmental groups.
Non-profit organizations	Minnesota Environmental Partnership Minnesota Trout Unlimited Izaak Walton League Regional Stormwater Protection Team The Nature Conservancy	Pursue funding proposals, provide outreach and civic engagement.	Generate ideas for projects, provide civic engagement, educate their members, organize watershed resident meetings, support forest management and water quality goals through grant funds.
	Chisago SWCD	SWCD serves as project lead in partnership with MPCA, manage grant projects, identify, design and evaluate BMPs, pursue and develop funding proposals, initiate and maintain landowners contacts and relationships.	SWCD implements Chisago Chain of Lakes Nine Key Element Plan, maintain lists of potential and finished projects, provide technical assistance to landowners, provide cost share opportunities, provide engineering assistance to project, write funding requests.
	Chisago County (Public Works, Planning and Development, Highway and Environmental Services)	Manage lands and forests, oversee county roads, enforce planning and zoning, enforce wetland rules, construction setbacks and lot width, and SSTS. Highway Department is the County weed inspector, AIS programming.	Maintain and construct transportation infrastructure, consult implementation plan in zoning decision.
	Chisago Lakes Lake Improvement District	Provide Cost Share, education and AIS programming.	
Local government	Townships: North Chisago Lakes, South Chisago Lakes, Franconia, Shafer and Lent	Oversee township roads, enforce planning and zoning, stormwater information.	
	BWSR	Administer Mn Clean Water Fund projects, provide technical assistance, serves on County Technical Evaluation Panels for wetland permits.	Keep stewardship committee aware of opportunities, provide project management.
State government	MnDNR (Divisions of Fisheries, Forestry and Ecological and Water Resources)	Administer MnDNR programs, issue Public Waters Permits, conduct wetland rule enforcement, provide technical assistance for hydrology, fisheries, geomorphology and forestry. Assist in development and evaluation of project proposals.	Review/approve projects under MnDNR programs, assist with project design, provide technical comments on project design.

	Partner	General roles	Potential responsibilities
	MPCA	Administer MPCA and Section 319 funding programs, provide technical assistance for hydrology, geomorphology and water quality. Assist in development and evaluation of project proposals.	Oversee implementation plan, keep stewardship committee aware of opportunities, provide data administration.
	MnDOT	Oversee state highway	Maintain Highway 61 corridor.
Federal government	EPA (Region 5, ORD-Duluth laboratory)	Provide Section 319 grants and guidance, watershed monitoring.	Provide temperature loggers.
	NRCS	Provide technical review, administer USDA funding programs, meet with landowners.	Assist with project design.
	USACE	Provide watershed modeling.	Update models with new data, explain and educate local stakeholders.
	FEMA	Provide floodplain mapping, provide hazard mitigation funding and assistance.	Updated floodplain maps, hazard mitigation planning and grants.

Element e. Education and outreach

An information/education component that will be implemented to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, implementing and maintaining the NPS management measures that will be implemented.

Urban, agricultural, and rural education programs are in place for communities and landowners to access. Each year, the Chisago hosts or participates in many workshops, events and presentations. The watershed has access to several great staff people who are part time to full time educators. Field days, brochures, articles, and presentations happen throughout the watershed on a very regular basis. Agricultural field days focusing on tillage practices and equipment and project tours are especially well attended. Urban presentations about rain gardens, shoreline restorations and backyard conversation are popular for people with smaller city lots. Educations local government officials and staff is also very important, these educational opportunities are usually in the form of a tour of projects or a workshop to learn how projects an ordinances can enhance the community they represent. Additional workshops and materials will be presented and created as outlined in the activities table (Table 16). Educating landowners is critical in the process of implementing BMPs to reduce non-point source pollution. Relationships take years to build to get landowners in the place to actually install the BMP – the first step (and often steps) are educating them on how it works, and why it needs to be completed.

Ongoing education and outreach is provided through Chisago SWCD staff and Lower St. Croix Partnership staff throughout the watershed. Examples include newsletters, social media, local events, lake association meetings, presentations, displays, field days and tours. Education is step 1 on reaching landowners about non-point pollution issues. Outreach activities are listed in Table 12.

Element f. Reasonably expeditious schedule

A schedule for implementing the activities and NPS management measures identified in this plan that is reasonably expeditious.

Timelines for proposed implementation are shown in Table 16.

Implementation activities described in Table 16 will yield estimated reductions greater than estimated reductions needed to reach water quality standards within 10 years. This schedule will be updated using adaptive management as funding, partnerships, effectiveness of implementation and new information becomes available.

Element g. Milestones

A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

The milestones column in Table 17 provides interim, measurable milestones for determining successful implementation of practices in Table 25. The milestones in this plan serve the purpose of measuring continuous progress toward the restoration of the Chisago Chain of Lakes Watershed.

Table 25. Milestone table Chisago Chain of Lakes (PLET, 2024).

Chisago Chain of Lakes Watershed		**Milestones**			**Total**
	Indicator	**Short term (0-4 yrs)**	**Mid term (4-8 yrs)**	**Long term (8-10 yrs)**	
	Total suspended solids (t/yr)	3,103	7,364	4,4743	15,211
	Phosphorus (lbs/yr)	4,277	9,008	4,556	17,841
	Nitrogen (lbs/yr)	10,531	10,944	5,501	26,975

Element h. Assessment criteria

A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

The entries in the assessment column of Table 16 provide the measures that will be used to determine the degree that various practices have been implemented in the watershed. The assessment criteria and achievement of milestones goals will be used to measure the progress of this NKE plan.

Load reductions achieved through implementation of the NKE plan will be evaluated using the PLET model estimates of the total load reductions estimated for the activities in the plan and the number of activities completed with associated estimated load reductions compared with a five-year load reduction goal and the total load reduction goal (Table 26).

Table 26. Load reduction assessment criteria table for watershed activities.

Lakeshed	5-year load reduction estimate	Total load reduction estimate
Chisago	258	515
North and South Lindstrom Green	1,239	2,478
North Center	717	1,434
South Center	1,283	2,566

Significant progress has been made in implementing BMPs and achieving load reductions. Progress towards meeting the water quality standards for the lakes has been demonstrated in the attainment of the standards in North and South Center Lakes. Progress toward achieving the goals in the other lakes will be documented through on-going lake monitoring.

Adaptive management

Adaptive management is an approach to water quality restoration efforts where BMP implementation efforts are combined with an on-going evaluation of the water quality issues. Effects of implemented BMPs are reflected by adjustments to the resource goals, implementation plan and/or implementation efforts when needed. Adjustments are made to incorporate the knowledge gained through the combined efforts. Adaptive management¬—sometimes referred to as adaptive implementation—is critical when various uncertainties are significant in a watershed (Shabman et al., 2007). This approach is essentially a “learning while doing” approach. It means that uncertainty is not forgotten once implementation begins. Rather, a focus is placed on reducing the uncertainty present through implementation, monitoring and evaluation, research, and experimentation. The knowledge gained through these efforts is then focused on reducing the uncertainties in the TMDL, the implementation approaches and/or water uses and criteria. The approach goes beyond just asking “when” in implementation to include “where, what, how and why” (Shabman et al., 2007).

Through an adaptive management approach, this initial implementation plan has been developed to begin implementation activities, continue survey and inventory efforts and evaluate the progress toward meeting the aquatic life goals for the river. As this work is completed, the TMDL implementation goals, priorities and BMPs will be examined and revised, as needed.

Element i. Monitoring

> The monitoring and evaluation component to track progress and evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

A robust monitoring program is in place within the watershed. Chisago Count Water Resources and Chisago Lakes Lake Improvement District employees monitor lakes within the watershed yearly and streams within the watershed when projects seek more information about water quality improvements, if funding is available (Table 27 and Figure 13).

The purpose of the Chisago County Water Quality Monitoring program is to help achieve goals identified in the Lower St. Croix Comprehensive Watershed Management Plan and Chisago County Local Priorities Appendix, and the Chisago Lakes Lake Improvement District Water Resource Management Plan.

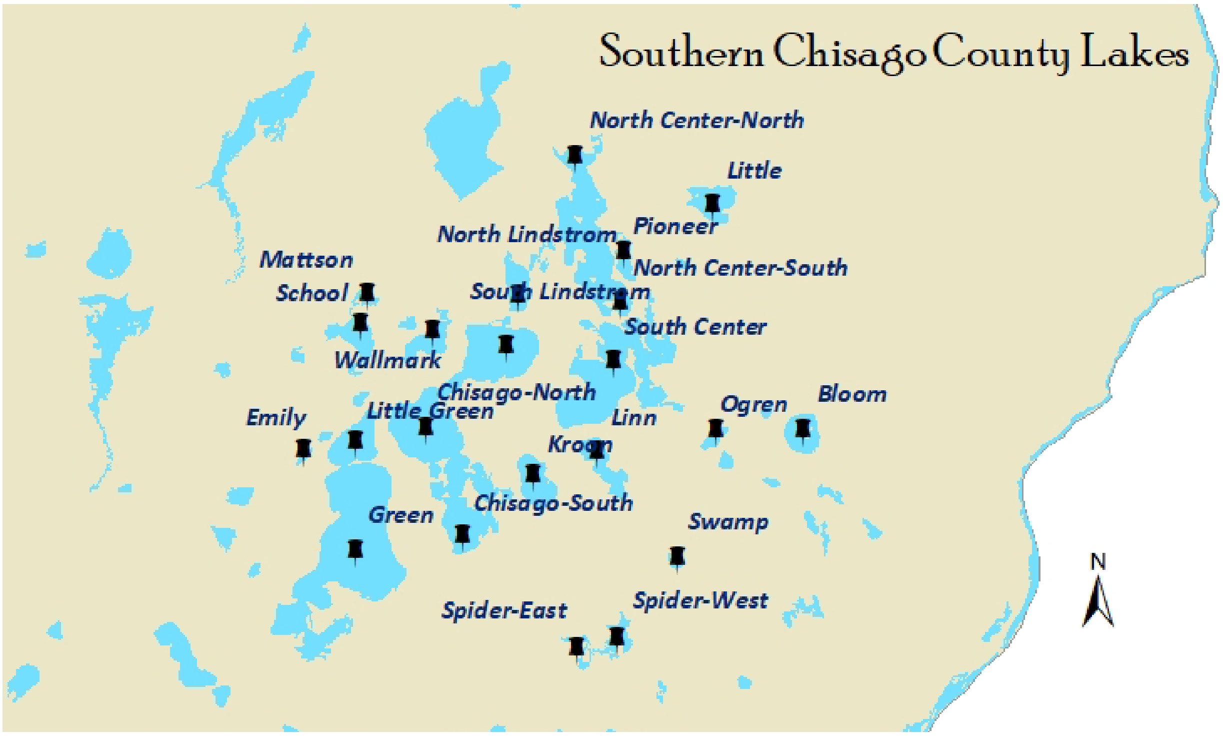
- Lower St. Croix Comprehensive Watershed Management Plan, Chisago County Local Priorities Appendix:
  - Implementation for prioritization analysis:
    1. Develop a countywide annual water quality monitoring plan for nutrients, aquatic life and other parameters to determine ambient water quality concentration trends and loading for all public waters in Chisago County, including lakes with public accesses and the main stems and selected tributaries of Rock Creek, Rush Creek, Goose Creek, Sunrise River and Lawrence Creek.
    2. Implement a countywide lake water quality monitoring plan.
    3. Develop an annual water quality monitoring report for Chisago County describing the water resources monitored and their parameters, the annual report will provide a complete summary of the monitoring results.
- Chisago Lakes Lake Improvement District Water Resource Management Plan:
  - Goal 1: preserve, protect and enhance water quality within the Chisago Chain of Lakes Watershed. Objective 2: annually monitor nutrients, aquatic life and other parameters to determine water quality concentrations, trends and loading. The resultant report will provide information about lake water quality and interpretation of trends.

Table 27. Chisago Chain of Lakes Watershed monitoring program.

Water quality monitoring program	Monitoring dates	Responsibility	Years sampled	Parameters	Notes	Waterbodies
Chisago County Water quality monitoring program	May – September	Chisago County	2008-2024	TP, Chl-a, Secchi disk, Nitrogen, temperature	One sample per month May – September	Chisago, North Center, South Center, North Lindstrom, South Lindstrom, Green, Little Green, Kroon, Spider
Volunteer water quality monitoring	May – September	Volunteer landowners	2008-2024	TP, Chl-a, Secchi disk, Nitrogen, temperature	One sample per month May – September	Bloom, Emily, Linn, Mattson, Pioneer, School, Swamp, Wallmark

Past water quality monitoring has been useful in determining long term water quality trends. In addition, water quality monitoring data is essential for completing the Total Maximum Daily Load Studies within the County. Continuing the water quality monitoring will help determine progress in obtaining water quality goals.

Figure 13. Lakes monitored within the Chisago Lakes Chain of Lakes Watershed.



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Appendix A: RSA activities table

This table details the results of the rural sub-watershed analysis (RSA) undertaken by the Chisago SWCD. The RSA provided recommended locations at the field scale for implementation of BMPs to address the goals of the Chisago County SWCD within the highest priority sub-watersheds. Results of this analysis are based on the development of project-specific conceptual BMPs that provide non-point source water quality and volume treatment. Annual pollution loading of Total Phosphorus (TP) and Sediment (TSS) was modeled for identified concentrated flow areas, areas that need a filter strip, fields that require permanent vegetation due to steep slopes, and gullies. Total Phosphorus (TP) was modeled for potentially restorable wetlands. Modeling of each project is done by one or more methods such as: BWSR Spreadsheet for Filter Strips, Sheet and Rill Erosion, and Gully Erosion, RUSLE2, and PONDNET. Sediment and phosphorus loading information are provided in the table below.

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
North Center	358	GW		157	157	189
North Center	274	GW, FS		87	80	108
North Center	236	GW, FS		83	81	136
North Center	441	GW, FS	x	62	56	145
North Center	351	GW, FS	x	58	50	192
North Center	164	GW, FS		46	45	140
North Center	125	GW, FS		46	44	132
North Center	352/353	GW		43	43	113
North Center	404	GW, FS		41	37	117
North Center	371	GW		40	40	480
North Center	367	GW		35	35	272
North Center	235	GW, FS		31	29	139
North Center	85	GW, FS		31	29	246
North Center	218	GW, FS		30	26	241
North Center	508*	GW, W		29	29	1168
North Center	232	GW, W, FS		29	28	474
North Center	176	GW, FS	Hay	29	27	123
North Center	126	GW, FS		29	29	180
North Center	206	GW, FS		27	23	108
North Center	66	GW		26	26	220
North Center	71	GW, FS		25	23	148
North Center	442	FS		24	18	62
North Center	148	GW		23	23	139
North Center	78	GW		21	21	163
North Center	296	GW, FS		19	18	147
North Center	184	GW, FS		19	17	121
North Center	401	GW, FS		18	17	157
North Center	300	FS		16	10	72
North Center	394	GW, FS		15	11	171

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
North Center	473	W		14	14	700
North Center	150	GW, FS		13	13	394
North Center	103	FS		13	8	193
North Center	568	GW, FS		12	9	147
North Center	294	FS		12	8	40
North Center	174	GW	Hay	12	12	134
North Center	129/130	GW, FS		12	10	179
North Center	2	GW, W		12	12	1838
North Center	95	FS		10	6	81
North Center	328*	GW, W	Hay	9	9	3383
North Center	159	GW		9	9	145
North Center	90	GW, FS		9	9	341
North Center	266	FS	Hay	8	6	68
North Center	409	GW		7	7	324
North Center	311*	W	X	7	7	4201
North Center	147	GW	Hay	7	7	407
North Center	137	GW, FS	Hay	7	7	360
North Center	105	GW, FS		7	7	404
North Center	295	GW		6	6	148
North Center	260*	W		6	6	4902
North Center	213	W	X	6	6	2181
North Center	183	FS		6	5	34
North Center	63/64	GW		6	6	633
North Center	189	GW	X	5	5	352
North Center	67	FS	Hay	5	3	149
North Center	34	FS		5	3	54
North Center	0	GW		5	5	445
North Center	525	GW		4	4	556
North Center	408	FS	Hay	4	3	170
North Center	402	FS		4	3	136
North Center	170	GW		4	4	546
North Center	108	FS		4	2	136
North Center	92	GW, FS		4	3	376
North Center	405	FS		3	2	68
North Center	303	GW	Hay	3	3	468
North Center	269	FS		3	2	181
North Center	38	FS		3	2	136
North Center	33	FS	Hay	3	2	158
North Center	447	FS		2	1	170
North Center	395	W, FS	Hay	2	2	5071
North Center	344	W		2	2	4902

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
North Center	128	FS		2	2	170
North Center	107	FS	Hay	2	1	271
North Center	56	FS		2	1	203
North Center	47	FS	Hay	2	2	170
North Center	590	FS	Hay	1	1	339
North Center	552*	W	X	1	1	9804
North Center	476	W	Hay	1	1	9804
North Center	406	FS	Hay	1	1	271
North Center	366	FS		1	1	203
North Center	350	FS		1	1	68
North Center	318*	W	Hay	1	1	9804
North Center	292	FS		1	1	339
North Center	230*	W	Hay	1	1	9804
North Center	133	FS	Hay	1	1	203
North Center	102	FS	Hay	1	1	271
North Center	48	FS		1	1	203
South Center	824	GW,FS,W		111	103	823
South Center	40	GW,FS		110	106	184
South Center	638	GW,FS,W		91	90	250
South Center	822	FS,W		90	80	361
South Center	280 & 275	GW,W		76	76	322
South Center	599	FS,W		70	65	476
South Center	798	GW,W		69	69	1120
South Center	831	GW		67	67	217
South Center	191	GW	x	55	55	250
South Center	48	GW,FS		53	48	127
South Center	351	GW,FS,W		53	51	281
South Center	632	GW,W		51	51	977
South Center	446	GW	x	48	48	208
South Center	167 & 168	GW, FS		47	41	49
South Center	120	GW,FS		47	42	138
South Center	654	W		46	46	426
South Center	50	GW		44	44	275
South Center	676	GW,FS,W		44	44	853
South Center	163	GW,FS		43	37	139
South Center	602	W		42	42	233
South Center	274	W		38	38	1118
South Center	630	GW,W		36	36	564
South Center	803	GW,W	x	36	36	703
South Center	627	GW,W		34	34	725
South Center	671	GW,FS		34	33	372

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
South Center	12 & 13	GW,FS		31	26	119
South Center	114	GW,FS		31	31	282
South Center	691	GW,W		31	31	510
South Center	683	W	x	31	31	1265
South Center	700	GW,FS,W		31	29	796
South Center	717	W		30	30	1307
South Center	29 & 30	GW,FS		30	27	120
South Center	391	W	x	29	29	1352
South Center	38	GW		27	27	636
South Center	296	GW,FS,W		27	26	853
South Center	757	GW,W		25	25	800
South Center	354	W		24	24	817
South Center	873	GW		22	22	137
South Center	718	GW,W		22	22	1755
South Center	101	FS		22	18	34
South Center	706	FS,W		22	20	480
South Center	511	GW		21	21	242
South Center	47	GW,W		20	20	666
South Center	314	GW,FS		19	17	244
South Center	321	W		19	19	1721
South Center	16 & 17	GW		19	19	436
South Center	790	W		18	18	1089
South Center	290	W		17	17	577
South Center	444	GW		17	17	743
South Center	451	WG		17	17	362
South Center	698	FS,W	x	17	16	1746
South Center	566	W		16	16	613
South Center	544	W		16	16	3064
South Center	643	GW,W		14	14	3747
South Center	197	GW,FS		14	13	202
South Center	288	GW,FS		14	13	333
South Center	601	W		13	13	754
South Center	774	GW	x	13	13	289
South Center	171	GW,W		12	12	911
South Center	52	FS		12	10	28
South Center	180	GW,FS	x	11	11	215
South Center	672	FS,W		11	11	1805
South Center	123	FS		11	11	43
South Center	151	FS,W		11	10	939
South Center	146	FS	x	11	9	68
South Center	480	W		11	11	891

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
South Center	639	FS,W		11	11	941
South Center	385	FS,W		11	11	1795
South Center	769	GW,FS		11	10	149
South Center	44	FS		10	8	95
South Center	119	FS		9	7	83
South Center	164	FS		9	7	151
South Center	166	GW		9	9	424
South Center	221	FS		9	7	68
South Center	252	GW		9	9	123
South Center	490	GW		9	9	320
South Center	773	GW		8	8	138
South Center	560	W		8	8	2451
South Center	60	FS		8	6	153
South Center	206	FS		8	6	144
South Center	216	FS		8	5	136
South Center	276	FS	x	8	6	170
South Center	537	GW		8	8	288
South Center	502	GW		7	7	259
South Center	814	GW,FS		7	7	234
South Center	303	GW	x	7	7	234
South Center	255	FS		6	5	170
South Center	291	GW		6	6	219
South Center	445	GW		6	6	198
South Center	489	W	x	6	6	1634
South Center	784	W		6	6	1634
South Center	859	W		6	6	1634
South Center	900	FS		6	6	102
South Center	633	W		6	6	4902
South Center	156	FS		5	5	54
South Center	170	FS		5	4	54
South Center	178	FS		5	4	122
South Center	518	GW		5	5	602
South Center	523	W		5	5	1961
South Center	600	FS		5	5	137
South Center	807	W		5	5	3922
South Center	901	FS		5	3	108
South Center	235	FS		4	3	237
South Center	287	FS		4	3	119
South Center	448	GW		4	4	337
South Center	454 & 455	FS		4	3	102
South Center	512	W		4	4	4902

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
South Center	660	W		4	4	2451
South Center	856	W		4	4	2451
South Center	77	FS		3	1	203
South Center	129	FS		6	5	113
South Center	175	FS		3	2	90
South Center	457	FS		3	2	113
South Center	43	FS		2	1	102
South Center	62	FS		2	1	136
South Center	165	FS	Hay	2	2	170
South Center	251	FS		2	2	170
South Center	254	FS		2	1	305
South Center	306	FS		2	1	203
South Center	105	FS		1	1	203
South Center	115	FS		1	1	203
South Center	126	FS		1	1	271
South Center	815	FS		1	1	136
South Center	176	FS		1	0	203
Chisago	233	W		46	46	213
Chisago	130*	W,FS	Hay	44	42	894
Chisago	103	GW,FS		41	39	133
Chisago	2	GW,W	x	36	36	688
Chisago	75/76	GW		31	31	172
Chisago	223	GW		25	25	223
Chisago	255	FS		21	16	81
Chisago	322	GW	x	18	18	137
Chisago	263	FS	Hay	17	13	100
Chisago	114/115/116	GW		17	17	500
Chisago	225	GW,FS	Hay	17	17	146
Chisago	258	FS	Hay	15	12	36
Chisago	119*	GW,W	Hay	15	15	2701
Chisago	60	GW,FS		14	13	115
Chisago	48*	W	x	14	14	700
Chisago	110	GW,FS		14	11	448
Chisago	92	GW	x	12	12	429
Chisago	260	GW	Hay	11	11	407
Chisago	150	GW,FS	Hay	10	10	326
Chisago	144	GW		9	9	424
Chisago	27	GW	X	9	9	545
Chisago	95*	GW	Hay	7	7	388
Chisago	265*	FS	Hay	7	5	77
Chisago	94	GW		6	6	336

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
Chisago	59	FS		6	5	57
Chisago	28	GW,FS	x	5	5	348
Chisago	170	GW	Hay	5	5	650
Chisago	136	GW,W	Hay	5	5	6113
Chisago	222*	GW		4	4	363
Chisago	167	GW		4	4	489
Chisago	254	FS		4	3	153
Chisago	154*	W		4	4	4902
Chisago	56	W		4	4	7353
Chisago	309	GW,W		4	4	12499
Chisago	219	GW	X	3	3	401
Chisago	284*	FS		2	2	271
Chisago	289	GW		2	2	474
Chisago	238	GW	Hay	2	2	504
Chisago	163	GW	Hay	2	2	537
Chisago	52	W	X	1	1	9804
Chisago	142	FS	Hay	1	1	136
Chisago	230	FS	Hay	1	1	136
Lindstrom Green	879, 884, 885 & 886	GW, FS		163.1	163.1	234
Lindstrom Green	428	GW, W		146.6	146.6	229
Lindstrom Green	772 & 773	GW, FS	X	135.5	129.9	129
Lindstrom Green	420 & 421	GW		124.2	124.2	140
Lindstrom Green	649 & 653	GW	X	117.4	117.4	148
Lindstrom Green	877* & 878	GW		97.7	97.7	184
Lindstrom Green	464	GW, W		96.2	96.2	402
Lindstrom Green	841	GW, W	X	94.4	94.4	382
Lindstrom Green	433	W	Hay	91.5	91.5	321
Lindstrom Green	651*	GW		77.3	77.3	222
Lindstrom Green	682	GW, FS		73.9	70.2	123
Lindstrom Green	880, 881, 882, & 883	FS		64	44.1	44
Lindstrom Green	371*	GW, FS		58.5	53.9	146
Lindstrom Green	171	GW		52.5	52.5	193
Lindstrom Green	683	GW		51.6	51.6	140
Lindstrom Green	756 & 757*	GW, FS		51.6	49.3	144
Lindstrom Green	846	GW, FS		50.7	43.7	123
Lindstrom Green	374	GW		45	45	210
Lindstrom Green	95	GW, FS		38.6	27.5	85
Lindstrom Green	744*	GW	x	37.6	37.6	240
Lindstrom Green	219*	GW, W		34.4	34.4	442
Lindstrom Green	681	GW, FS		33.8	33.1	275

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
Lindstrom Green	546	GW, W		32.9	32.9	1028
Lindstrom Green	105	GW		30.8	30.8	373
Lindstrom Green	65	GW, W		28.6	28.6	767
Lindstrom Green	167	GW, FS		27.6	26.7	352
Lindstrom Green	82	GW, FS		25.3	17.8	93
Lindstrom Green	381	GW, W		24.7	24.7	959
Lindstrom Green	520*	GW, W		23.7	23.7	1406
Lindstrom Green	523	GW, W		23.6	23.6	1363
Lindstrom Green	282*	GW		23.1	23.1	139
Lindstrom Green	970	GW, FS		21.5	21.2	543
Lindstrom Green	863, 864, & 866	GW		20.8	20.8	553
Lindstrom Green	60 & 67	GW		20.1	20.1	404
Lindstrom Green	658 & 659	GW		20.1	20.1	325
Lindstrom Green	459	GW		19.7	19.7	140
Lindstrom Green	922	GW		19.7	19.7	140
Lindstrom Green	690	GW		19.4	19.4	112
Lindstrom Green	265	GW, W		18.8	18.8	1888
Lindstrom Green	665	GW		18.7	18.7	140
Lindstrom Green	446	GW		16.6	16.6	234
Lindstrom Green	888*	GW		16.1	16.1	234
Lindstrom Green	655	GW		15.6	15.6	139
Lindstrom Green	760	GW, FS		15.2	15	148
Lindstrom Green	594*	GW		15.2	15.2	328
Lindstrom Green	901	GW		15.2	15.2	312
Lindstrom Green	110	GW		15.1	15.1	237
Lindstrom Green	686	GW		13.1	13.1	140
Lindstrom Green	738	GW		12.6	12.6	140
Lindstrom Green	327*	GW, FS		11.6	10.6	120
Lindstrom Green	334*	GW, FS		11.5	9.4	124
Lindstrom Green	266	GW, W	x	11.5	11.5	1178
Lindstrom Green	945	GW	Hay	11.3	11.3	140
Lindstrom Green	787	GW		10.8	10.8	358
Lindstrom Green	907	GW		10.8	10.8	427
Lindstrom Green	589*	GW, W		10.8	10.8	2394
Lindstrom Green	414	GW	x	9.6	9.6	502
Lindstrom Green	751	GW		8.3	8.3	139
Lindstrom Green	980	FS		7.5	4.8	63
Lindstrom Green	74	GW, FS		6.6	6	247
Lindstrom Green	910	FS		6.6	4.1	123
Lindstrom Green	66* & 68*	GW		6.3	6.3	361
Lindstrom Green	889	GW, W		6.1	6.1	2439

Lakeshed	Field#	PracticeID	Completed/ hay	TP (Lb/yr)	TSS (Ton/yr)	Cost/lb TP
Lindstrom Green	174*	GW		5.9	5.9	388
Lindstrom Green	58	GW		5	5	585
Lindstrom Green	96	FS		4.3	2.8	126
Lindstrom Green	323*	GW		4.3	4.3	342
Lindstrom Green	730	FS		4.1	2.8	33
Lindstrom Green	604	GW		3.6	3.6	428
Lindstrom Green	824	FS		3.5	1.8	426
Lindstrom Green	203	FS		3.2	1.8	191
Lindstrom Green	480	GW		2.8	2.8	343
Lindstrom Green	198*	FS		1.8	1.2	226
Lindstrom Green	911	FS		1.8	1.1	339
Lindstrom Green	731	FS		1.8	1.2	226
Lindstrom Green	363	GW		1.7	1.7	324
Lindstrom Green	732*	FS		1.7	1.2	160
Lindstrom Green	601	W		1.6	1.6	6127
Lindstrom Green	236	FS		1.3	0.8	365
Lindstrom Green	712*	FS		1.2	0.8	170
Lindstrom Green	979	FS		1.2	0.7	339
Lindstrom Green	184	FS		1.1	0.6	370
Lindstrom Green	360	FS		1	0.6	610
Lindstrom Green	230	W		0.8	0.8	12255
Lindstrom Green	984	W		0.8	0.8	24508
Lindstrom Green	25	FS		0.7	0.5	387
Lindstrom Green	325*	FS		0.7	0.5	291
Lindstrom Green	758	FS		0.6	0.3	339
Lindstrom Green	544	FS		0.4	0.3	339
Lindstrom Green	135*	FS		0.5	0.2	678
Lindstrom Green	229	W		0.4	0.4	24509
Lindstrom Green	545	FS		0.3	0.2	226
Lindstrom Green	194	FS		0.2	0.1	339
Lindstrom Green	202	FS		0.1	0.04	542