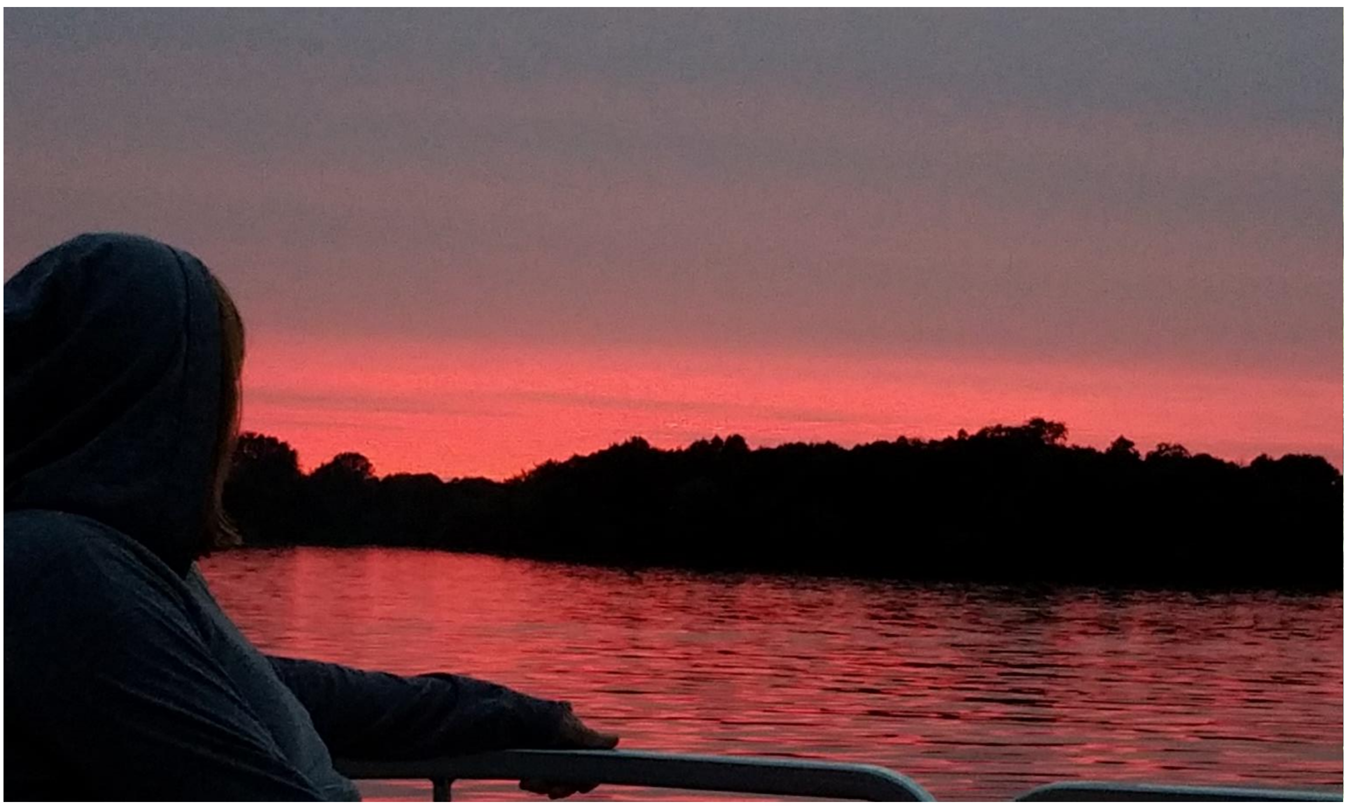
Sauk River Watershed

July 2023

Sauk River Watershed Restoration and Protection Strategy Report Update 2023



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Key terms and abbreviations

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the U.S. Geological Survey (USGS) eight-digit Hydrologic Unit Code (HUC) plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, DO, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus and either chlorophyll-*a* or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A HUC is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Minnesota River Basin is assigned a HUC-4 of 0702 and the Pomme de Terre River Watershed is assigned a HUC-8 of 07020002.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic Integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the water body. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the water bodies.

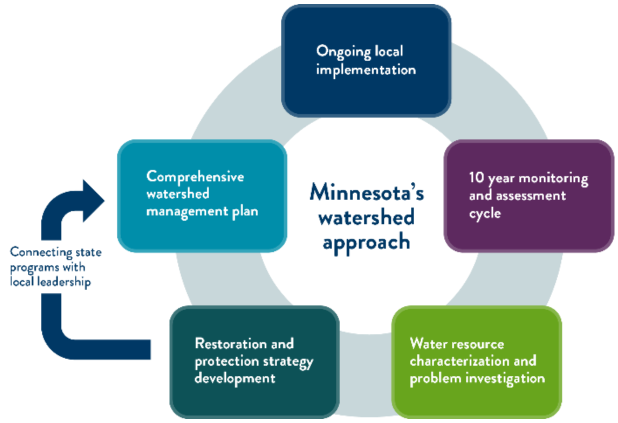
Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the water bodies.

Source (or pollutant source): This term is distinguished from ‘stressor’ to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or biological stressor): This is a broad term that includes both pollutant sources and nonpollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

Minnesota's Watershed Approach



The arrow emphasizes the important connection between state water programs and local water management. Local partners are involved – and often lead – in each stage of this framework.

The State of Minnesota developed a watershed approach to focus holistically on each watershed's condition as the scientific basis of permitting, planning, implementation, and measurement of results. This process looks strategically at the drainage area as a whole instead of focusing on lakes and stream sections one at a time, thus increasing effectiveness and efficiency.

Every 10 years, each of Minnesota's 80 major watersheds are evaluated through monitoring/data collection and assessed against water quality standards to show trends in water quality and the impact of permitting requirements, as well as any restoration, or protection actions. A watershed restoration and protection strategies (WRAPS) report is then updated to provide technical information to support the implementation of restoration and protection projects by local partners through their One Watershed One Plan (1W1P) comprehensive local water plan. The Minnesota Pollution Control Agency's (MPCA's) watershed work is tailored to meet local conditions and needs, based on factors such as watershed size, landscape diversity, and geographic complexity.

To identify and address threats to water quality in each watershed, WRAPS reports address both strategies for restoration for impaired waters, and strategies for protection for waters that are not impaired. Waters not meeting state standards are listed as impaired and total maximum daily load (TMDL) studies are developed for them. The TMDLs are incorporated into the WRAPS reports.

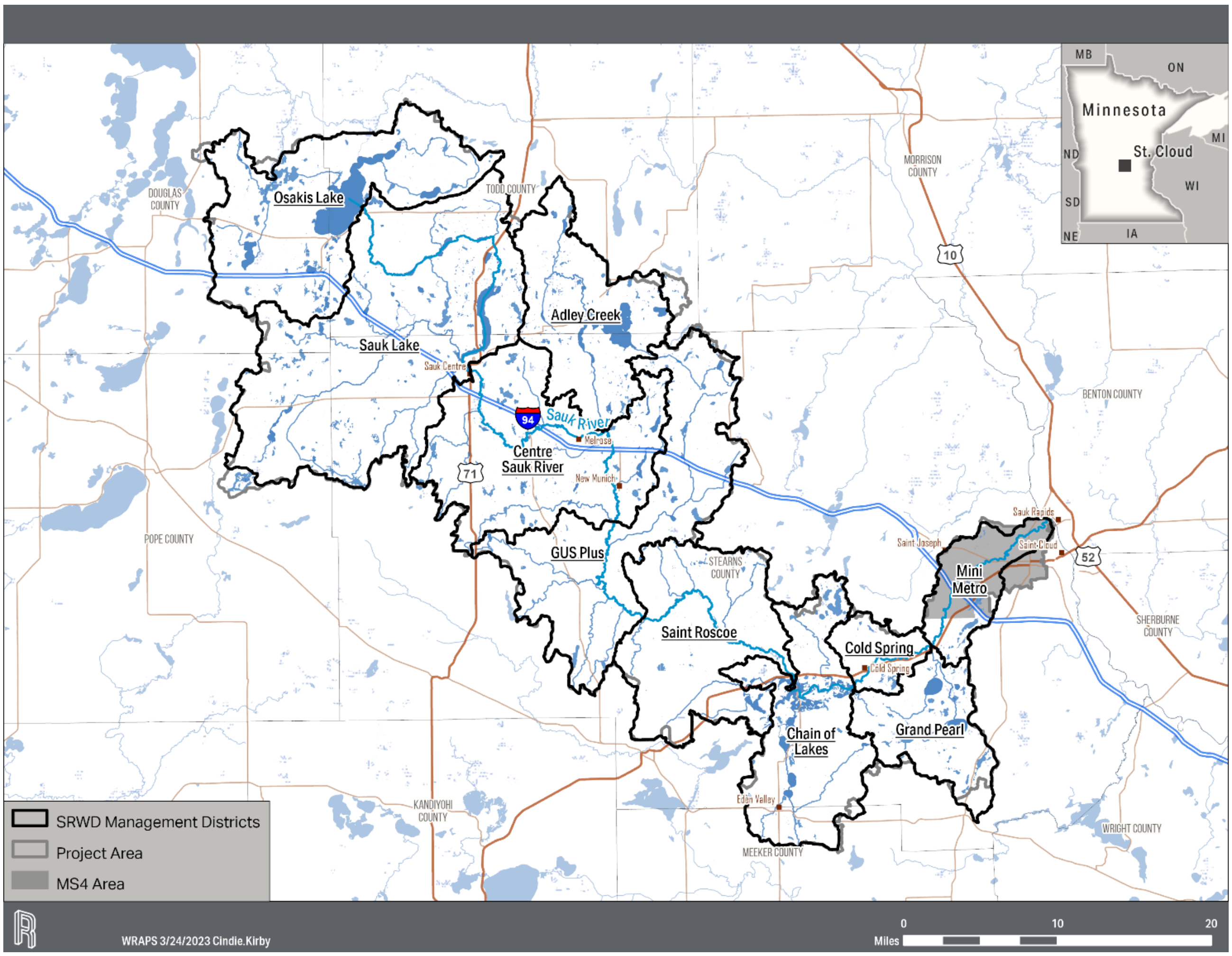
Key aspects of the MPCA's watershed work are to develop and utilize watershed-scale computer models, perform biological stressor identification, conduct problem investigation monitoring, and use other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. Point source pollution comes from sources such as wastewater treatment plants (WWTP) or industrial facilities; nonpoint source pollution is the result of runoff or containments not being absorbed in the soil. For nonpoint source pollution, the WRAPS report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans.

Minn. Stat. § 114D, also known as the Clean Water Legacy Act (CWLA), sets out the policy framework for the Watershed Approach, including requiring the development and updating of WRAPS for all watersheds of the state. The Clean Water, Land and Legacy Amendment approved by Minnesota voters in 2008 directs dollars from an increase in sales tax to a Clean Water Fund, which is overseen by the Clean Water Council. The Clean Water Fund provides resources to implement the CWLA to achieve and maintain water quality standards in Minnesota through activities such as monitoring, watershed characterization and scientific study, planning, research, and on-the-ground restoration and protection activities.

Executive summary

Setting

The Sauk River Watershed (SRW), 8-digit Hydrologic Unit Code [HUC-8] 07010202, is located in south central Minnesota and covers approximately 667,000-acres. The Sauk River originates in Lake Osakis and flows to the southeast approximately 126 miles to the city of St. Cloud, where the Sauk River enters the Mississippi River.



Key Findings

Water Quality Conditions

In 2008 and 2009, the MPCA began an intensive watershed monitoring (IWM) effort of rivers, streams, and lakes within the SRW. The MPCA returned in 2018 and 2019 to reevaluate these resources. According to the *Sauk River Watershed Water Assessment and Trends Update (state.mn.us)* [MPCA, 2021a], overall, positive and negative changes have occurred in the SRW since the first round of IWM.

- Phosphorus (P) concentrations at the mouth of the Sauk River decreased, while nitrate concentrations increased. Continued problems in the watershed include higher-than-preferred P (despite some improvement) and bacteria levels, and low dissolved oxygen (DO) levels.
- Sixteen lakes had improving clarity, including Maple, Maria, Sand, Schneider, and Westport Lakes, which are all currently impaired. Two large and deeper lakes in the watershed (Carnelian and North Brown's Lakes) had decreasing clarity trends, as did King's Lake.
- Macroinvertebrate Index of Biological Integrity (MIBI) scores improved when averaged across the watershed, whereas Fish Index of Biological Integrity (FIBI) scores were similar between monitoring periods, with FIBI scores increasing on average across the watershed by approximately 1.5 points (little change) and MIBI scores increasing by 8.5 points As a whole, the aquatic life in the smaller headwater streams and ditches was in worse condition than in the larger streams and rivers, including the Sauk River. Similarly, the sections of the Sauk River below the Chain of Lakes had lower bacteria levels than the upstream sections of the Sauk River and its tributaries.
    - Three water bodies have been delisted in the watershed: County Ditch 6 (AUID 07010202-521) benthic macroinvertebrates bioassessments impairment was delisted in 2022 based on a change in use class designation to modified use and new data indicating that the aquatic life use is attained.
    - Faille Lake (AUIC 77-0195-00) nutrients impairment was delisted in 2020 based on operational improvements at the Osakis WWTP
    - Sauk River (AUID 07010202-501) fecal coliform impairment was delisted in 2012 based on additional data.
- Forty-seven lakes were assessed for aquatic life use based on fish populations, and all were supporting aquatic life.

Strategy development

In order to advance water quality goals, the MPCA and partners determined that the approach of this WRAPS Update process would be to: use prioritization metrics in the Comprehensive Watershed Management Plan (CWMP) to identify priorities in each management district, then identify strategies to address those priorities; and complete additional TMDLs to help address impaired waters.

Addressing Impaired Waters – Total Maximum Daily Loads

A body of water is considered "impaired" if it fails to meet one or more water quality standards. Minnesota water quality standards protect lakes, rivers, streams, and wetlands by defining how much of a pollutant can be in water before it is no longer drinkable, swimmable, fishable, or useable in other, designated ways, called "beneficial uses". TMDLs are created to set pollutant-reduction goals needed to restore impaired waters. In this WRAPS Update process, 15 TMDLs were developed for 12 impairments in 9 stream reaches and 3 impairments in 3 lakes.

Impairments in the SRW for which TMDLs were completed in this WRAPS update process include:

- P and other nutrients that grow algae
- Sediment that clouds water and negatively affects fish and invertebrates/bugs
- Bacteria that can make water unsafe for swimming
- Chloride levels that are toxic for fish and aquatic bugs

Successful implementation efforts

Understanding what types of projects have been implemented in the watershed, and whether or not they are working as intended, is important information when determining future implementation strategies. This report describes 17 projects that have been installed, implemented, or maintained in the SRW since the 2008 WRAPS cycle. In addition to educational benefits, various models show the projects reducing sediment transport to water bodies in the watershed by hundreds of tons, and total phosphorus (TP) by hundreds of pounds annually. One of the more successful projects with regard to pollutant removal is the JD ditch 2 sediment ponds, which were installed in 2002 and 2003, and have removed over 23,000 tons of sediment that would otherwise have entered Lake Osakis.

1. Watershed background and WRAPS Update process description

Watershed background

The SRW (070102020) is located northwest of the Twin Cities in central Minnesota. The watershed drains approximately 1,040 square miles, in Stearns (64% of the watershed area), Todd (21%), Douglas (9%), Pope (5%), and Meeker (1%) counties. The Sauk River originates in Lake Osakis and flows to the southeast approximately 126 miles to the city of St. Cloud, where the Sauk River flows into the Mississippi River. The watershed has abundant surface-water resources with approximately 1,700 river miles and 280 lakes greater than 10 acres in size.

The most prominent land use in the watershed is row crops (61%), followed by hay/pasture (10%), wetlands (9%), forest (8%), urban (6%), and open water (5%), as shown in Figure 1. The watershed is located in the North Central Hardwood Forests Ecoregion. Major cities in the watershed include St. Cloud, St. Joseph, Waite Park, and a small portion of Sartell. The watershed as a whole is approximately 75 miles long and up to 30 miles wide. The river drop is roughly 340 feet (ft) between Lake Osakis and the Mississippi River, on average more than 2.5 ft per mile.

The watershed is divided into 10 management districts: Osakis Lake, Sauk Lake, Adley Creek, Centre Sauk River, GUS Plus, Saint Roscoe, Chain of Lakes, Grand Pearl, Cold Spring, and Mini Metro. As the Sauk River moves downstream, the percentage of cropland and feedlots increases, before transitioning to mostly urban land use near the watershed outlet. This report is the second WRAPS report written for the SRW and is designed to build upon the MPCA's first version [MPCA, 2015]; information that was already covered in the first version will only be briefly mentioned and cited in this report.

WRAPS Update process

The first WRAPS cycle for the SRW began with water quality monitoring in 2008-2009 and was completed with the SRW WRAPS in 2015. The WRAPS included: assessments and identification of stressors for many water bodies in the watershed, TMDLs, HSPF watershed computer model outputs, and strategies recommended to achieve reductions for various pollutants in the watershed.

In 2020, stakeholders and agencies working in the SRW completed the SRW CWMP through the 1W1P process. The process and plan prioritized, and targeted implementation strategies and actions that would result in measurable water resource improvements in the watershed. In some areas of the watershed, the types and numbers of best management practices (BMPs) were estimated to achieve specified reduction goals. Information presented for the CWMP is often more detailed than information included in a WRAPS document and is, therefore, summarized in this report. The management districts are the same as those in the Sauk River CWMP.

The MPCA returned to conduct a second round of IWM in 2018 and 2019 to reevaluate the water resources pf the SRW. The subsequent WRAPS Update process discussion among local and state water resource managers determined how to make the WRAPS Update a useful product that would inform ongoing CWMP implementation and future revision, enabling adaptive management.

As a key parts of the WRAPS process, partners in the SRW: summarized water quality conditions, including comparisons of the two cycles of IWM and identification of water quality trends where possible; used prioritization metrics from the CWMP to identify priorities in each management district of the SRW, and strategies to address those priorities; and completed additional TMDLs to help address impaired waters.

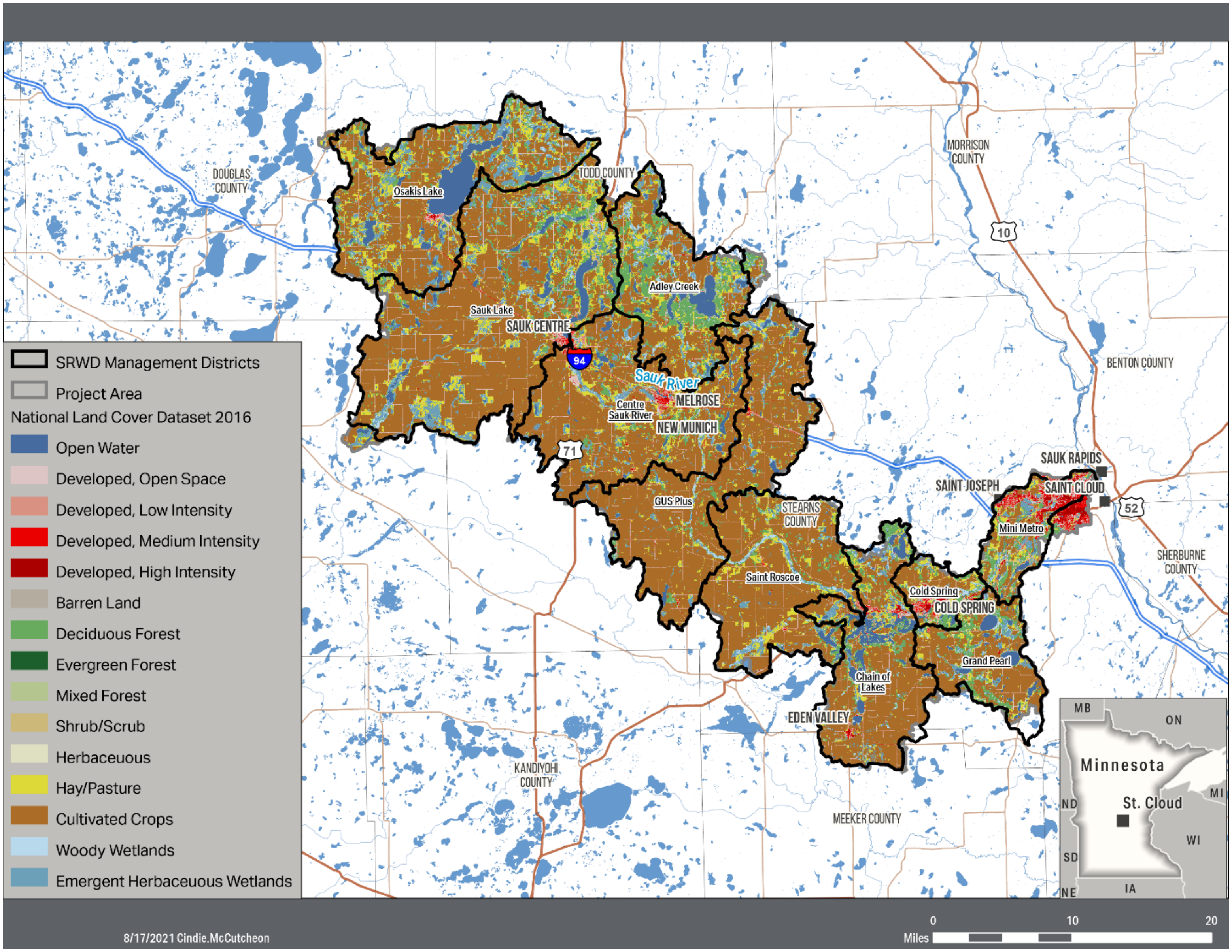
Additional Sauk River Watershed resources

U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Sauk River Watershed: MN NRCS Sauk River | NRCS Minnesota (usda.gov)

Minnesota Department of Natural Resources (DNR) Watershed Health Assessment Framework Watershed Report Card for the Sauk River Watershed: Watershed Health Report Card: Sauk River (state.mn.us)

MPCA Sauk River Watershed: Sauk River | Minnesota Pollution Control Agency (state.mn.us)

Figure 1. Land cover map for the Sauk River Watershed.

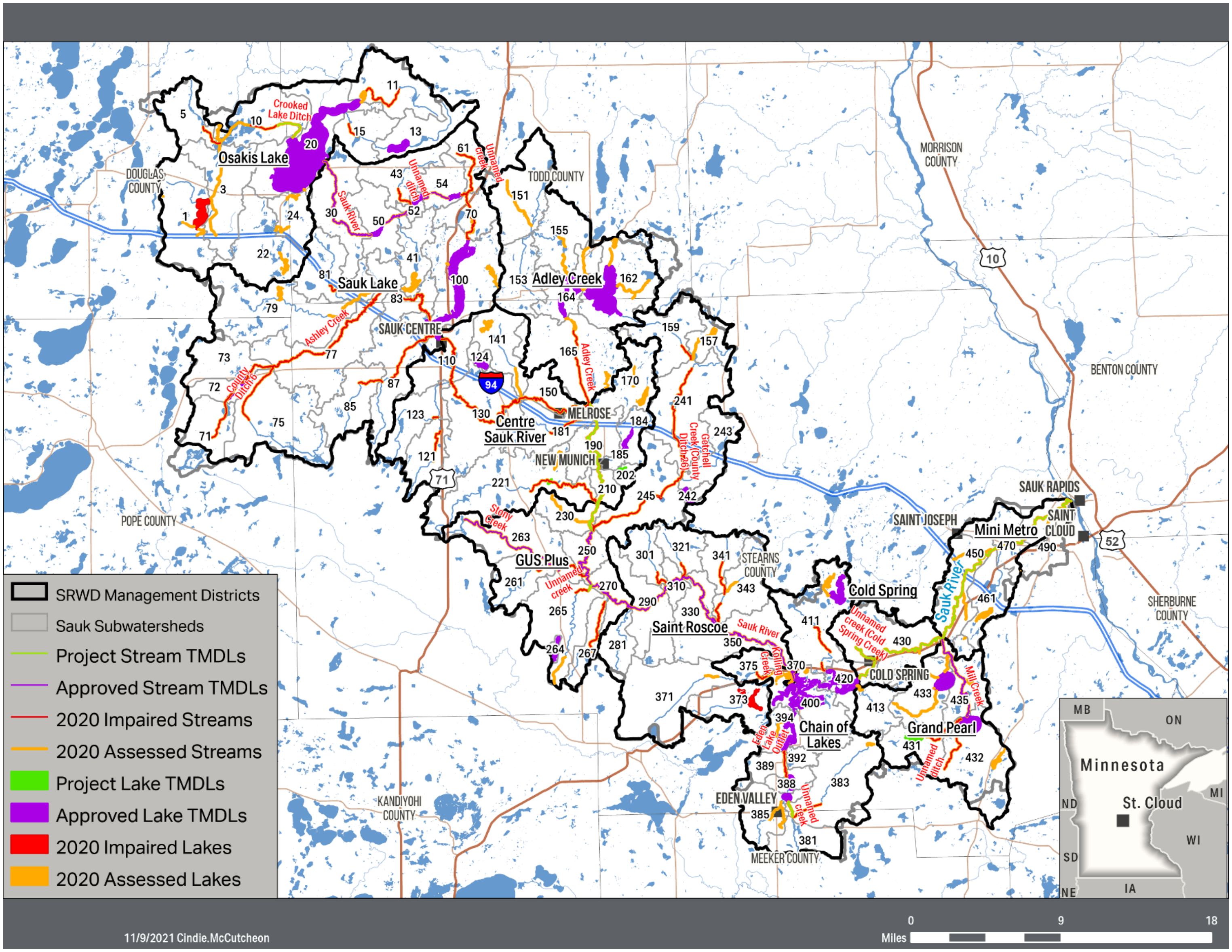


2. Watershed conditions and analysis

Assessed and impaired water bodies in each management district of the SRW are shown in Figure 2. Separating the watershed into the management districts allows for planning consistency with the CWMP and helps develop a targeted approach to better assess watershed conditions as they relate to regional land uses and stressors. The management districts do not align exactly with the subwatershed boundaries. The primary differences are in the Mini Metro Management District where Municipal Separate Storm Sewer System (MS4) entities determined that edits were needed to properly represent the areas draining from within their municipal boundaries to the Sauk River.

In this WRAPS report, “nutrients” refers to both P and nitrogen species. In Minnesota waters, reducing P will generally reduce algae growth; however, reducing nitrogen species (especially nitrate) is important in protecting drinking water, which is sourced from surface water and groundwater, and for protecting aquatic life that is sensitive to nitrogen.

Figure 2. Sauk River Watershed water bodies that have been assessed, have impairments, and/or have TMDLs.



2.1 Condition status

The MPCA conducted its IWM efforts in 2008 to 2009 and again in 2018 to 2019 for the SRW lakes and streams.

2008 to 2009 IWM

Results from the 2008 to 2009 efforts showed that lake water quality in the SRW overall was modest to poor, with nutrient eutrophication being the most common concern across the watershed's lakes. The results also showed that most stream Assessment Unit Identifiers (AUIDs) were not supporting aquatic recreation and/or aquatic life standards, and an aquatic consumption impairment spanned the entire length of the Sauk River. The IWM efforts showed that on the mainstem Sauk River aquatic biological impairments were isolated to specific reaches, but were widely dispersed across tributary streams. Three mainstem nutrient impairments occur downstream of large stretches of riverine lakes, and water chemistry impairments involving low DO and high bacteria are very common across the watershed's tributaries.

For the 2008 to 2009 monitoring, 39 AUIDs were assessed. Biological monitoring at 54 sites resulted in 8 AUIDs supporting aquatic life and 23 AUIDs not supporting aquatic life. Water quality monitoring to determine if AUIDs support aquatic recreation resulted in 11 AUIDs supporting and 24 AUIDs not supporting aquatic recreation. Some overlap does occur with these impairments with some streams being impaired for both aquatic life and aquatic recreation. The biological impairments found in streams were likely a result of low DO, deposited and bedded sediment, excessive nutrients causing increased plant and algae growth, increased runoff from ditching and tile drain, a lack of habitat, and/or decreased stream connectivity.

2018 to 2019 IWM

The biological monitoring component of the more recent IWM was completed during the 2018 field season. To evaluate the health of aquatic life in streams, fish and macroinvertebrates were sampled as well as the general water chemistry. Fish and macroinvertebrate samples were used to generate the FIBI and MIBI. The index scores for a sampled monitored point were compared to their respective thresholds to determine if the stream supported aquatic life. Water chemistry results help evaluate the causes of a biological impairment, if present. Similar to streams, water quality and biological sampling were conducted on lakes across the SRW. Sufficient data were available to assess aquatic recreation in 46 lakes, 30 of which were nonsupporting and 16 of which were supporting. Sufficient data were available to assess aquatic life in 47 lakes, all of which were supporting.

Comparing the two rounds of IWM

According to the *Water Assessment and Trends Update* [MPCA, 2021a], positive and negative changes have occurred in the SRW overall since the first round of IWM. MIBI scores improved when averaged across the watershed, whereas FIBI scores were similar between monitoring periods. P concentrations at the mouth of the Sauk River decreased, while nitrate concentrations increased. The clarity in most lakes in the watershed did not change between 2008 and 2018. Sixteen lakes had improving clarity, including Maple, Maria, Sand, Schneider, and Westport Lakes, which are all currently impaired. Two large and deeper lakes in the watershed (Carnelian and North Brown's lakes) had decreasing clarity trends, as did Kings Lake. As a whole, the aquatic life in the smaller headwater streams and ditches was in a worse condition than the larger streams and rivers, including the Sauk River. Similarly, the sections of the Sauk River downstream the Chain of Lakes, which ends at the outlet of Knaus Lake near Cold Spring, had lower bacteria levels than the upstream sections of the Sauk River and its tributaries. Continued problems in the watershed include higher-than-preferred P (despite some improvement), high bacteria levels, and low DO levels. Note that waters not listed as impaired should be protected from deterioration and impairment.

Some of the water bodies in the SRW are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments, see the statewide mercury TMDL (https://www.pca.state.mn.us/water/statewide-mercury-tmdl).

Streams

Some differences in approach and findings occurred between the 2011 [MPCA, 2011a] and 2021 [MPCA, 2021a] Monitoring and Assessment Reports. The 2021 report discusses 27 altered (ditched) reaches that were not assessed in the 2011 report. These altered reaches were now assessed because the MPCA adopted new rules to assess water bodies that were legally altered (https://www.pca.state.mn.us/water/tiered-aquatic-life-uses-talu-framework). Of the 27 altered reaches, 22 had impaired fish communities. Another difference between the two reports were that two new reaches were listed as impaired for macroinvertebrates - the Sauk River between Sauk Centre and Melrose, and a small tributary to an Unnamed Creek west of Farming. Two reaches were also delisted for impairments of macroinvertebrates communities: Getchell Creek and CD 6. MIBI scores improved substantially at Getchell Creek and CD 6 had a nearly 30-point increase in the MIBI score. The riparian zone surrounding the site where MPCA conducted its CD 6 sampling has been put into the Reinvest In Minnesota (RIM) conservation program. The overall health of fish and macroinvertebrate communities in the watershed improved from the 2011 to the 2021 report with FIBI scores increasing on average across the watershed by approximately 1.5 points (little change) and MIBI scores increasing by 8.5 points. Table 1 shows the number of assessed reaches with sufficient data and how many of those reaches were impaired or fully supporting their beneficial use. Table A-1of Appendix A shows all of the impaired water bodies in the SRW.

Table 1. Number of assessed reaches and lakes with sufficient data and impairment status.

PCA	Beneficial Use	2011			2021		
		Assessed with sufficient data	Fully supporting	Impaired	Assessed with sufficient data	Fully Supporting	Impaired
Reaches	Aquatic Life	30	8 (27%)	22 (73%)	53	11 (21%)	42 (79%)
	Aquatic Recreation	25	10 (40%)	15 (60%)	27	10 (37%)	17 (63%)
	Aquatic Consumption	11	0 (0%)	11 100%)	13	0 (0%)	13 100%)
Lakes	Aquatic Life	NA	NA	NA	47	47 (100%)	0 (0%)
	Aquatic Recreation	44	13 (30%)	31 (70%)	46	16 (35%)	30 (65%)
	Aquatic Consumption	16	0 (0%)	16 (100%)	20	0 (0%)	20 100%)

Streams that are not supporting their beneficial use are included in Table A-1 of Appendix A, separated by management district. Impairments with a U.S. Environmental Protection Agency (EPA) Category 4A have an existing TMDL, and impairments with an EPA Category 5 still need a TMDL. Streams with TMDLs in progress are shown in the EPA Category column as 5 in Table A-1. The number and type of impairments are shown in Table 2. The impairments shown are all-inclusive and include reaches listed in the previous cycles in addition to the current, cycle.

Table 2. Number of Impaired Segments and Impairments by Management District.

Management District	Impaired Reach Segments	Total Impairments	MIBI	FIBI	DO	Nutrients	TSS/ Turbidity	*E. coli*/ Fecal Coliform
Osakis Lake	5	9	3	4	1			1
Sauk Lake	8	16	5	8	2			1
Adley Creek	1	2		1				1
Centre Sauk	7	13	5	7				1
GUS Plus	10	21	5	4	3		2	7
Saint Roscoe	5	7	3	3				1
Chain of Lakes	6	9	2	2	3			2
Cold Spring	4	5	1	1		1		2
Grand Pearl	3	5	1	1				3
Mini Metro	1	1				1		

Lakes

The SRW lakes were assessed for aquatic recreation and aquatic life uses. To determine if a lake supported aquatic recreation, the MPCA, with the help of the Sauk River Watershed District (SRWD), collected water quality samples from lakes across the watershed. For a lake to be assessed as impaired, the long-term summer average TP concentrations that are measured in the water body must exceed the TP standard from Minn. R. ch. 7050.0222, along with one or both of the eutrophication response standards for chlorophyll-a (chl-*a*) and Secchi disk depth. Aquatic life assessments in lakes were not a part of the data presented in the 2011 Monitoring and Assessment Report.

By 2018, 62 lakes in the SRW had been assessed for aquatic recreation. Of the 62 lakes, 16 fully supported aquatic recreation, 16 had insufficient data, and 30 did not support aquatic recreation. The previous WRAPS report [MPCA, 2015] mentioned that 19 lakes in the SRW were impaired for aquatic recreation uses at that time. Similarly, by 2018, 51 lakes were assessed for aquatic life. Of the 51 lakes assessed for aquatic life, 47 lakes fully supported aquatic life and four had insufficient data.

Impaired lakes are shown by management district in Table A-2 of Appendix A. Impairments with an EPA Category 4A have an existing TMDL, and impairments with an EPA Category 5 still need a TMDL. Lakes with TMDLs in progress are shown in the EPA Category column as 5. Table 3 shows the number of nutrient impaired lakes in each management district.

Table 3. Number of Nutrient Impaired Lakes by Management District.

Management District	Nutrient Impaired Lakes
Osakis Lake	3
Sauk Lake	6
Adley Creek	0

Management District	Nutrient Impaired Lakes
Centre Sauk	4
GUS Plus	2
Saint Roscoe	0
Chain of Lakes	13
Cold Spring	0
Grand Pearl	2
Mini Metro	0

2.2 Trend analysis

Minnesota Milestone Monitoring - Streams

Long-term water quality trends were calculated by the MPCA for major watershed sites as part of the Minnesota Milestone Monitoring Program [MPCA, 2014]. Long-term data were available for the Sauk River downstream of the bridge on CSAH-1 at Sauk Rapids (S000-017) for the period from 1953 to 2011. Table 4 summarizes the trends of several pollutants over the entire period of record as well as the more recent time period of 1995 to 2010. Historical trends show decreases of 44% and 85% for TP and ammonia, respectively, and increases of 131% and 796% for nitrate/nitrite and chloride, respectively. Chloride data were not collected at this location after 2013. No historical trend occurred for total suspended solids (TSS) and biochemical oxygen demand (BOD). An 80% increase in nitrate/nitrite occurred between 1995 and 2010. No trends were detected for TSS, TP, ammonia, or BOD for the time period from 1995 to 2010 at this site. When no trend is detected, the meaning is that enough data were available for the analysis, but the trend was neither increasing nor decreasing. A trend analysis at key points along the Sauk River was performed for this WRAPS at the outlet of Lake Osakis (S002-649) and on the Sauk River at Richmond (S000-517). Results of this trend analysis are shown in

Table 5 for the outlet of Lake Osakis and in Table 6 for the Sauk River at Richmond. These analyses were completed using the seasonal Kendall test reviewing all of the available data and data available during the past 15 years.

Table 4. Water quality trends of the Sauk River outlet (S000-017).

Parameter	Historical trend	Recent trend (15 years)
TSS	No Trend	No Trend
Total Phosphorus	Decreasing (–44%)	No Trend
Nitrite/Nitrate	Increasing (131%)	Increasing (80%)
Ammonia	Decreasing (–85%)	No Trend
BOD	No Trend	No Trend
Chloride	Increasing (796%)	Little Data

Table 5. Water quality trends of the Lake Osakis outlet (S002-649).

Parameter	Historical trend	Recent trend (15 years)
TSS	Decreasing (–113%)	No Trend
Total Phosphorus	No Trend	No Trend
Nitrite/Nitrate	No Trend	No Trend
Ammonia	Increasing (290%)	No Trend
Chloride	Increasing (58%)	No Trend

Table 6. Water quality trends of the Sauk River at Richmond (S000-517).

Parameter	Historical trend	Recent trend (15 years)
TSS	Decreasing (–124%)	Decreasing (–80%)
Total Phosphorus	Decreasing (–49%)	No Trend
Nitrite/Nitrate	No Trend	No Trend
Ammonia	No Trend	No Trend
Chloride	No Trend	No Trend

Note: Improving water quality trends have green text, and declining water quality trends have red text.

Clarity in Lakes

The MPCA has analyzed 78 lakes in the SRW for transparency trends using Secchi disk data from its Citizens Lake Monitoring Program (CLMP), as listed in Table A-3 of Appendix A. Sixteen of the lakes are improving in transparency, while three have degrading transparency. The rest of the lakes either had insufficient data to detect a trend, or did not demonstrate a trend. The MPCA analysis of the CLMP data [MPCA, 2021b] was conducted using the R statistical program to run a seasonal Mann-Kendall test that was applied to all of the June to September Secchi disk transparency data. The analysis used the Tobit Regression Model, which detects changes in water quality over time by comparing months across years (e.g., May is compared to May and June to June).

Streamflow

Since 2008, no significant change has occurred in stream flow; however, from 1998 to 2008, TSS significantly decreased.). Based on drought conditions in 2008 and normal conditions in 2018, the observed changes in conditions could be at least partially caused by differences in climatic conditions between the two periods.

IBI and Clarity Summary Map

Figure 3 shows trends in the MIBI and FIBI and water clarity throughout the SRW. MIBI and FIBI are indicators of water quality and give an idea of overall water quality trends. Boundaries shown in Figure 3 are drainage boundaries and not watershed district boundaries.

Figure 3. Water quality trends in the Sauk River Watershed [MPCA, 2021a].

2.3 Nearly and barely impaired lakes

The MPCA generated a spreadsheet with lake information, such as the Lake Phosphorus Sensitivity Score (LPSS), Lakes of Biological Significance (LOBS), and Lake Benefit:Cost Assessment (LBCA) in 2019 and 2021. The 2019 and 2021 LPSS_LBCA_LOBS spreadsheets were used to determine lakes that were not impaired but were within 25% of their nutrient standard (nearly impaired), and lakes that were exceeding their nutrient standard within 25% (barely impaired). The 25% standard is consistent with the analysis conducted for the Sauk River CWMP, where lakes were given the highest nearly/barely impaired score when within 25% of the standard. Table A-4 of Appendix A summarizes these lakes and whether the impairment trend is increasing or decreasing in the lakes. These lakes mostly have an improving trend, no evidence of a trend, or have not had a trend analysis completed. Only one lake had a degrading trend (Kings Lake). Steps should be taken to either keep the lakes in compliance with their standards or bring the lakes back into compliance. Grand and Little Birch Lakes) were nearly impaired in 2019 but not in 2021, and Becker Lake was barely impaired in 2019 but not in 2021. and Long and Big Birch Lakes were nearly impaired in 2021 but not in 2019, and Kings and Westport Lakes were barely impaired in 2021 but not in 2019. The 2019 nearly/barely impaired lakes were also prioritized in the Sauk River CWMP. Overall, lakes that are on this list in 2019 or 2021 should be priority lakes.

According to the MPCA [2021a] (*Sauk River Watershed Water Assessment and Trends Update [state.mn.us]*), the SRW experienced a moderate to severe drought in 2008, and when monitoring occurred between May and September 2008, the temperature was abnormally cool. During the same time frame in 2018 when monitoring was occurring, the watershed had near-normal rainfall amounts and near-normal temperatures. Given the dry conditions affecting the watershed in 2008 and the near-normal conditions in 2018, any observed changes in biological conditions at either the watershed or individual site scale were likely to be at least partially caused by differences in climatic conditions [MPCA, 2021a]. This difference can be used to explain some of the differences occurring between the nearly/barely impaired lakes shown in Table A-4 of Appendix A.

2.4 Protection considerations

Within the SRW, several nonimpaired resources may currently meet water quality standards but are at risk of decreased water quality because of increasing development, increased flooding impacts, and invasive species. The watershed is also home to several outstanding resources, such as WMAs, state forest land, and preservation areas owned by The Nature Conservancy. These areas provide critical habitat for many species and support various recreational activities.

Various entities have been working collaboratively to monitor and assess the biodiversity and ecology of the watershed in a watershed-wide approach. Moving forward, protection efforts by these entities and other organizations will become increasingly important to protect current water quality conditions and prevent further degradation. Examples of protection efforts for the nonimpaired water resources within the SRW are listed below.

Entities including but not limited to the MPCA, Minnesota Department of Natural Resources (DNR), Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH), SRWD, Natural Resources Conservation Services (NRCS), U.S. Fish and Wildlife Service (USFWS), soil and water conservation districts (SWCDs), counties, municipalities, townships, lake associations, and conservation groups should work together to protect waters that are still in good condition from becoming impaired.

- To reduce septic system loading, countywide septic system inventories should continue, and watershed residents should be encouraged to address noncompliant or substandard septic systems.
- Technical assistance and financial assistance should be provided to increase groundwater, stormwater, wetland protection, stream bank and erosion, agricultural, drainage management, and drainage/shoreland BMPs.
- To prevent the further spread of aquatic invasive species (AIS), the DNR, lake associations, and counties and SWCDs should continue to assess for the presence and density of invasive species and implement AIS prevention plans.
- Public awareness is also important in protecting and restoring the water resources of the SRW. The Sauk River Watershed Collaborative (SRWC) includes nine partners in the CWMP, the SRWD, four SWCDs (Douglas, Todd, Stearns, and Pope), and the four counties (Douglas, Todd, Stearns, and Pope). The SRWC continues to circulate information to the watershed residents. These expanded educational efforts use various social media to reach residents of all demographics and have become an important factor in civic engagement. The SRWD, SWCD, and NRCS, as well

as local environmental groups, continue to work together to improve the overall level of understanding and awareness for watershed citizens using available technology, such as interactive websites and Facebook.

- Although the Sauk River is not a Class 1 water body (which means the river has a domestic consumption beneficial use), the SRW contributes drinking water to the city of St. Cloud downstream. Degrading water quality could lead to public health issues downstream. Drinking water nutrient concerns are centered mostly around nitrate. Nitrate is extremely hard and costly to treat in drinking water, so preventing nitrate concentration increases is crucial to ensuring that the Sauk River continues to support St. Cloud's drinking water needs downstream.

2.5 TMDL studies summary

Per the EPA [2021], "a TMDL is the calculation of the maximum amount of a pollutant allowed to enter a water body so that the water body will meet and continue to meet water quality standards for that particular pollutant." TMDLs serve as the starting point or planning tool for restoring water quality. The TMDL study concurrently completed as a part of this WRAPS project [Kirby et al., 2021] addresses six stream reach *E. coli* impairments, two stream reach biology impairments of fish and macroinvertebrates communities, two stream nutrient impairments, and three lake nutrient impairments for the SRW. The impaired water bodies are in Douglas, Todd, Stearns, and Meeker Counties. Impairments addressed in this TMDL are listed in Table A-5 and shown in Figure A-1 of Appendix A. Before the TMDL was developed as a part of this project, multiple other TMDLs were developed for this watershed. The Sauk River Chain of Lakes TMDL [MPCA and Emmons & Olivier Resources, Inc., 2021], which was finalized in 2021, addresses the lakes listed in Table A-6 and shown in Figure A-2 of Appendix A. A bacteria and nutrient TMDL [MPCA, 2018] was also approved in 2018 that addresses the water bodies listed in Table A-7 and shown in Figure A-3 of Appendix A. Other previous TMDL studies completed in the SRW include the Lake Osakis Excess Nutrient TMDL [Wenck Associates, Inc., 2013]; the turbidity TMDL assessment for Stony, Unnamed, and Getchell Creeks [Wenck Associates, Inc., 2010]; the Pearl Lake Nutrient and Mill Creek Bacteria TMDLs [Barr Engineering, Inc., 2012]; the Sauk Lake-North Bay Excess Nutrient TMDL [MPCA, 2013]; and the Sauk Lake-Southwest Bay Excess Nutrient TMDL [MPCA, 2016]. Figure 2 shows the assessed reaches, previously completed TMDLs, TMDLs completed as a part of this project, and impaired reaches still needing TMDLs. The TMDL studies were established in accordance with Section 303(d) of the Clean Water Act (CWA) and define the wasteload allocations (WLAs), load allocations (LAs), and pollutant reductions needed to achieve state water quality standards.

Information about the TMDLs that are not listed in Tables A-5 through A-7 of Appendix A was included in the first Sauk River WRAPS Report [MPCA, 2015] and is not included in this WRAPS report.

Completed *E. coli* TMDLs during this WRAPS Update

Load duration curves (LDCs), or the allowable daily *E. coli* loads under wide-ranging flow conditions, were used to represent the *E. coli* loading capacity and allocations for each impaired reach. This approach resulted in a flow-variable target that considered the entire flow regime within the time period of interest. Five flow intervals were developed for each reach, and the loading capacity and allocations were developed for each flow interval. The five resulting flow intervals were very high (0% to 10%), high (10% to 40%), mid (40% to 60%), low (60% to 90%), and very low (90% to 100%) in adherence to guidance provided by the EPA [2007]. Six *E. coli* impairments (Reaches 505, 542, 550, 552, 560, and

567) were addressed as part of the TMDL studies conducted as a part of this WRAPS Update. Before these reaches were addressed, reaches 503, 508, 527, and 541 were addressed as a part of the Phase 1 TMDL projects [MPCA, 2018]. Reductions across the five flow zones for each reach are presented in Table A-8 of Appendix A. Based on the geometric mean of available data, reductions are needed in varying flow zones, which suggests that sources are direct for some reaches and more indirect for other reaches. The percent of load reduction needed to meet the loading capacity in each flow interval provides the overall magnitude of the required reductions. Reduction magnitudes also help to focus future management actions; if higher reductions are needed in a certain flow interval, management practices should focus on the sources that most likely influence concentrations in those flow conditions. *E. coli* target exceedances during high flows are typically caused by larger, area-induced, indirect pollutant sources that reach surface waters through watershed runoff. Low-flow exceedances are usually caused by direct pollutant loads or sources near the stream, such as wastewater effluent, direct defecation by wildlife or livestock in the stream channel or septic system failures [EPA, 2007].

Completed TSS (aquatic macroinvertebrate) TMDL during this WRAPS Update

The Sauk River SID Report [MPCA, 2021c] suggests that the main stressors to the biological community in the Centre Sauk Minor (Sauk River Reach 505) are a lack of habitat diversity because of a sand-dominated substrate (loss of riffle-pool complex); bank failure along the Sauk River corridor from the dam at Sauk Lake downstream to the city of Melrose (increase in TSS concentration, sediment deposition); and elevated nutrients, particularly TP during the summer to early fall period. Johnson [2020] noted that the Sauk River has a fair amount of bank erosion and channel substrate is dominated by sand with a fairly limited habitat. An assumption is that reduced TSS and erosion in this reach will improve the habitat and, therefore, the aquatic communities. Thus, the FIBI/MIBI TMDLs for Sauk River Reach 505 were addressed using TSS as a surrogate.

The TSS fish/invertebrate TMDL in Sauk River (Adley Creek to Getchell Creek) Reach 505 was addressed with the LDC approach. LDCs represent the allowable daily load under wide-ranging flow conditions and were used to represent the loading capacity and allocations of each impaired reach. This approach resulted in a flow-variable target that considered the entire flow regime within the time period of interest. Five flow intervals were developed for each reach, and the loading capacity and allocations were developed for each flow interval. The five flow intervals were very high (0% to 10%), high (10% to 40%), mid (40% to 60%), low (60% to 90%), and very low (90% to 100%) in adherence to guidance provided by the EPA [2007]. Current loads for the Sauk River (Adley Creek to Getchell Creek) Reach 505 surrogate TSS TMDL were calculated using the median flow in each flow zone and the simulated maximum TSS concentration in each flow zone, and the percent load reduction that was needed to meet the loading capacity in each flow interval was calculated to provide the magnitude of the required reductions at different flows. Calculating reduction magnitudes by flow helps to focus future management actions; if higher reductions are needed in a certain flow interval, management practices should focus on the sources that most likely influence concentrations in those flow conditions. TMDL target exceedances during higher flows are typically caused by storm-related wash-off or high-flow-related instream/near-stream erosion and scour (bed and bank loads). Low-flow exceedances are more likely to be caused by direct pollutant loads or sources near the stream [EPA 2007]. In the Sauk River MIBI/FIBI TSS TMDL, reductions are needed during all but the very low flows to obtain the fish/macroinvertebrate standard. Observed data collected during the TMDL time period had exceedances of the 30 mg/L TSS standard in 2010 and 2012. The implementation for the TSS improvements should focus on the high-flow sediment contributions. Reductions across the five flow zones for Reach 505 are presented in Table A-9 of Appendix A.

Completed stream nutrient TMDLs during this WRAPS Update

Three stream nutrient TMDLs were addressed downstream of Knaus Lake along the Sauk River (Reach 517 from Knaus Lake to Cold Spring Dam, Reach 520 from Cold Spring WWTP to Mill Creek, and Reach 501 from Mill Creek to the Mississippi River). Two of the three (517 and 501) were listed as impaired by nutrients on the 303(d) list while one was listed as an MIBI/FIBI impairment (520). The SRW SID Report suggests that the Sauk River [Cold Spring WWTP to Mill Creek] Reach 520) has elevated nutrient concentrations along with very high algal biomass, which is impacting the DO. The high algal biomass is likely a leading cause of fish and invertebrate impairments. Channel substrate is dominated by sand, which is also causing habitat constraints for macroinvertebrates and lithophilic-spawning fish. Stormwater discharge and agricultural drainage are causing altered flow patterns, which are leading to some bank failure and variability in stream flow patterns. Johnson [2020] indicated that the main issue is low DO driven by elevated TP concentrations and high chl-*a* concentrations during low-flow periods. The assumption is that reduced TP in this reach will improve the habitat and, therefore, the aquatic communities. Thus, the FIBI/MIBI TMDLs for Sauk River (Cold Spring WWTP to Mill Creek) Reach 520 will be addressed using TP as a surrogate.

The TMDL is the reach loading capacity, which is the sum of the LA, WLA, and a margin of safety (MOS), as shown in Equation 4. The loading capacity for the Sauk River TP TMDLs was set using a unique approach. The three impaired reaches are all directly below Knaus Lake, which is a part of the Sauk River Chain of Lakes TMDL. The Knaus Lake TMDL was developed based on a site-specific TP criterion of 90 micrograms per liter (µg/L) [MPCA and Emmons & Olivier Resources, Inc., 2021]. Therefore, developing a watershed runoff concentration that could be allowed in nonpoint source runoff and stormwater flows (MS4s, construction, and industrial) that could be used throughout the drainage area made sense. This concentration was developed based on the most downstream reach, Reach 501 (Mill Creek to Mississippi River), being able to meet the TMDL concentration of 100 µg/L with all of the point sources and the MOS included. Once this concentration was calculated (207 µg/L), it was used for all three TP stream TMDLs. Flows used to calculate loads with the 207 µg/L concentration were based on the Hydrological Simulation Program - FORTRAN (HSPF) model application.

The outlet of the first Reach (Reach 517, Knaus Lake to Cold Spring Dam) is located at the Knaus Lake Dam approximately 1.6 miles downstream of the Knaus Lake outlet. The allowable load for Reach 517 was based on the load calculated from the watershed runoff concentration of 207 µg/L plus the sum of the Knaus Lake boundary condition (adjusted for flows during this TMDL time period) and the MOS. Similarly, Reach 520 (Cold Spring WWTP to Mill Creek) is roughly 6.3 miles long and less than 10 miles below Knaus Lake. The loading capacity for Reach 520 was calculated using the load calculated from the watershed runoff concentration of 207 µg/L plus the sum of the Reach 517 boundary condition, the MOS, and the point source WLA. The most downstream Reach 501 loading capacity was calculated using the load calculated from the watershed runoff concentration of 207 µg/L plus the sum of the Reach 520 boundary condition, the MOS, the point source WLAs, and the stormwater WLAs (MS4, construction, and industrial), as shown in Equation 4.

$$TMDL = \sum(WLA) + \sum(LA) + MOS. \quad (1)$$

The reduction needed in Reach 517 was 40%, in Reach 520 was 39%, and in Reach 501 was 29%. Reductions required for the TP TMDLs are included in Table A-10 of Appendix A. The largest source of P to all of these reaches is the upstream lake that has an existing TMDL (Knaus Lake) [MPCA and Emmons & Olivier Resources, Inc., 2021], which makes up approximately 95% of the TP load at the outlet of Sauk River Reach 501 (Mill Creek to Mississippi River). The TMDL states that "if the Knaus Lake TMDL is met, further reductions will not be needed in the reaches below the lake" in regard to the three reaches meeting the stream TMDLs. The P standard was developed such that when a stream is in compliance with the P standard, the stream is expected to also be in compliance with the DO standard [Heiskary and Bouchard, 2014]; therefore, the stream is expected to be in compliance with the MIBI/FIBI standards when in compliance with the P standard. Improving the P loads will, in turn, improve the other components of concern within the system.

Completed lake nutrient TMDLs during this WRAPS Update

The loading capacity for impaired lakes was determined by using calibrated BATHTUB models based on HSPF loads and the growing-season-monitored mean values for TP, chl-*a*, and Secchi disk depth. The allowable loading capacity (or the TMDL) is defined as the maximum allowable pollutant load that will meet water quality standards. Loading capacities were defined by using the calibrated BATHTUB models and reducing source loads until the appropriate standards for each lake were achieved. Numerous nutrient (TP) impairments were addressed as part of the recent TMDL studies. The LAs and reductions that are required to achieve lake standards for lakes in the recent lake TMDLs are listed in Table A-10 of Appendix A. Table A-11 lists TMDL allocations for lakes addressed by TMDLs in the SRW.

TMDL scenarios

Numerous protection and restoration scenarios were run using the Scenario Application Manager (SAM) and HSPF as a part of the Sauk River TMDL project to determine costs to meet the three most downstream stream TP TMDLs. Scenario 1 was a scenario that increased cropland acreage by 20% watershed-wide to evaluate what kind of impact this scenario would have. Scenario 2 was a scenario that increased developed acreage by 20% watershed-wide. Scenario 3 was to target the average growing-season TP concentration to meet the standard of 0.1 mg/L at the outlet. The BMPs that were used for this scenario included restoring wetlands that have been drained with tile, 100-ft riparian buffers, conservation cover perennials, no-till cropland, and urban infiltration basins. Each BMP was needed at approximately 60% participation, meaning that the cropland scenarios would be needed on 60% of the cropland and the urban infiltration scenario would be needed on 60% of the developed land throughout the entire watershed. Scenario results are shown in Table 7.

Table 7. TMDL scenario results.

Scenario	Flow Change	Total Phosphorus Change	Total Nitrogen Change	Total Suspended Solids Change
1, 20% Cropland Increase	No Change	10% Increase	9% Increase	8% Increase
2, 20% Urban Increase	1% Increase	1% Reduction	1% Reduction	2% Increase
3, Targeting BMPs	2% Reduction	25% Reduction	19% Reduction	36% Reduction

2.6 Stressors and sources

To develop appropriate strategies for restoring or protecting water bodies, the stressors and/or sources impacting or threatening the water bodies must be identified and evaluated. Biological SID is conducted for river reaches with either fish or macroinvertebrate biota impairments and encompasses evaluating both pollutant- and nonpollutant-related (e.g., altered hydrology, fish passage, habitat) factors as potential stressors. Pollutant-source assessments are done where a biological SID process identifies a pollutant as a stressor as well as for the typical pollutant impairment listings. More detailed information on the SID process can be found on the EPA website (https://www.epa.gov/caddis).

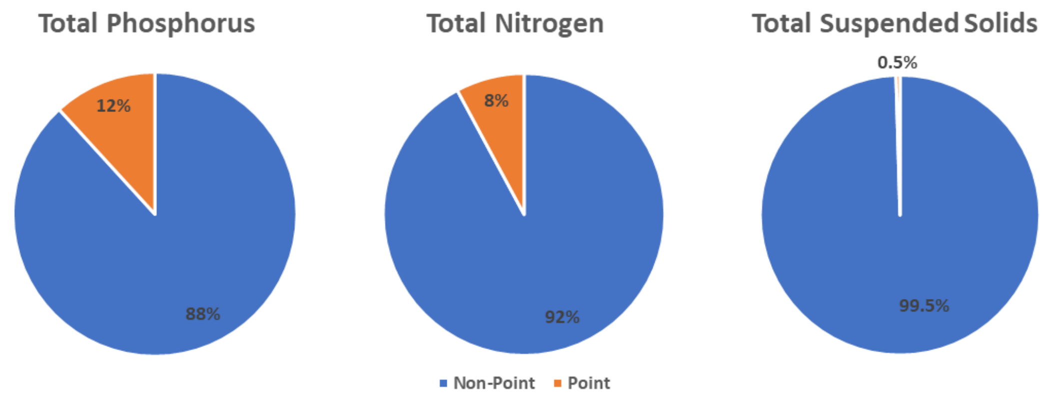
Stressors of biologically impaired river reaches

The SRW Cycle 2 SID Report identified various stressors for the biologically impaired reaches, as included in Table A-13 of Appendix A, and corroborates findings from previous Sauk River WRAPS and SID reports [MPCA, 2015; 2012]. Of the 24 impaired streams, 21 streams identified altered hydrology as a stressor, and nearly two-thirds of the impaired streams identified habitat, connectivity, DO, and TP as stressors. The SID analysis lists land conversion from mature forest to cultivated fields, channelization of natural streams and wetlands, and road crossings as reoccurring contributors to the biological impairments. Stream channelization can decrease suitable substrate for fish and macroinvertebrates and produces an unstable DO regime. During precipitation events, anoxic water held within wetlands is quickly flushed, which reduces DO levels downstream. Shortly after the event, the flow regime quickly transitions to low flow, which further reduces the capacity to maintain healthy DO levels. This flow alteration, combined with excess nutrients (P) from agricultural runoff, further compounds DO issues. Increased P concentrations increase algae growth, which leads to increased decomposition and oxygen consumption. The Cycle 1 SID report is discussed in the Cycle 1 WRAPS report. The Cycle 1 SID report assessed different reaches than the Cycle 2 SID report; therefore, direct comparison between stressors over time in assessed reaches from Cycle 1 to Cycle 2 was not possible.

Pollutant sources

This section summarizes the pollutant (e.g., P, nitrogen, bacteria, or sediment) sources to lakes and streams in the SRW, including point sources (e.g., sewage treatment plants) or nonpoint sources (e.g., runoff from the land). By using the calibrated HSPF model, loading from all of the nonpoint sources was compared to loading from point sources for TP, total nitrogen, and TSS, and the percent contributions are shown in Figure 4. Point source contributions for TP and total nitrogen are not negligible, but the analysis indicates that nonpoint source pollution is the major concern in the SRW. Pollutant sources vary across the watershed and should be addressed at a finer scale, but these results indicate that many of the restoration and protection efforts will be addressing nonpoint sources.

Figure 4. Modeled point source versus nonpoint source contributions in the Sauk River Watershed.



Point sources

Point sources, listed in Table A-13 of Appendix A, are defined as facilities that discharge stormwater or wastewater to a lake or stream and have a National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) permit. Twelve municipal wastewater facilities, 6 industrial wastewater facilities of which 4 have individual permits and 2 have MNG490000 nonmetallic mining and associated activities general permits, 31 industrial stormwater facilities with 33 permits, and 9 MS4 permits are in the SRW. In addition, 45 concentrated animal feeding operations (CAFOs) are located in the SRW, as listed in Table A-14 of Appendix A. Figure 5 shows the location of all of the NPDES/SDS permittees, except for CAFOS, in the watershed. Figure 6 shows the locations of CAFOs and all of the other animal feeding operations (AFOs), which are not NPDES/SDS permitted but fall under other provisions of Minnesota law and are considered nonpoint sources. Four of the industrial facilities were represented in HSPF. The remaining industrial facilities were not included in the HSPF model because data were not available or reported for the simulation period, the facilities did not have a specified design-flow, or discharge events were very intermittent (e.g., special discharges or dewatering discharges once every five years).

Figure 5. Point sources (also shown in Table A-13 of Appendix A).

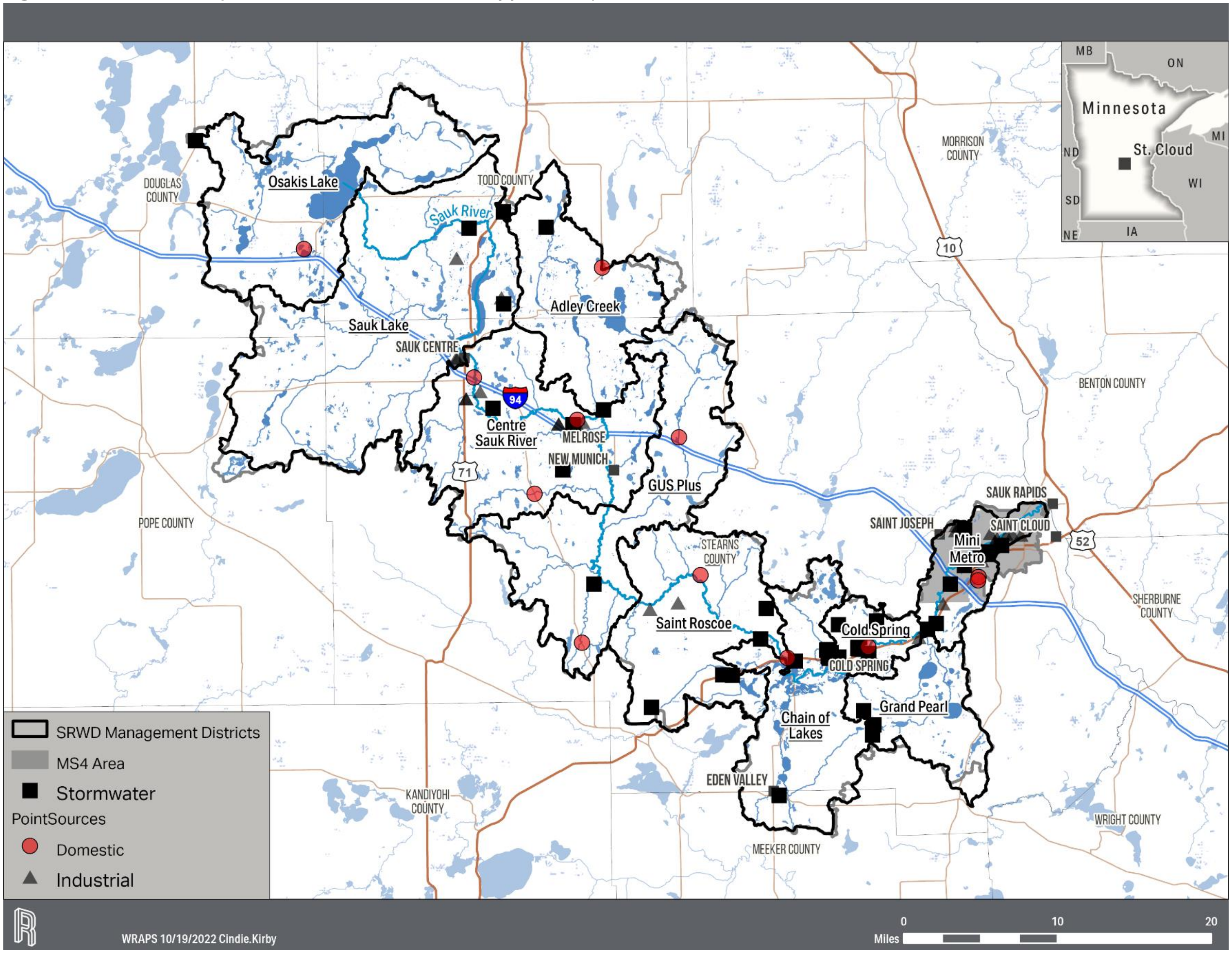
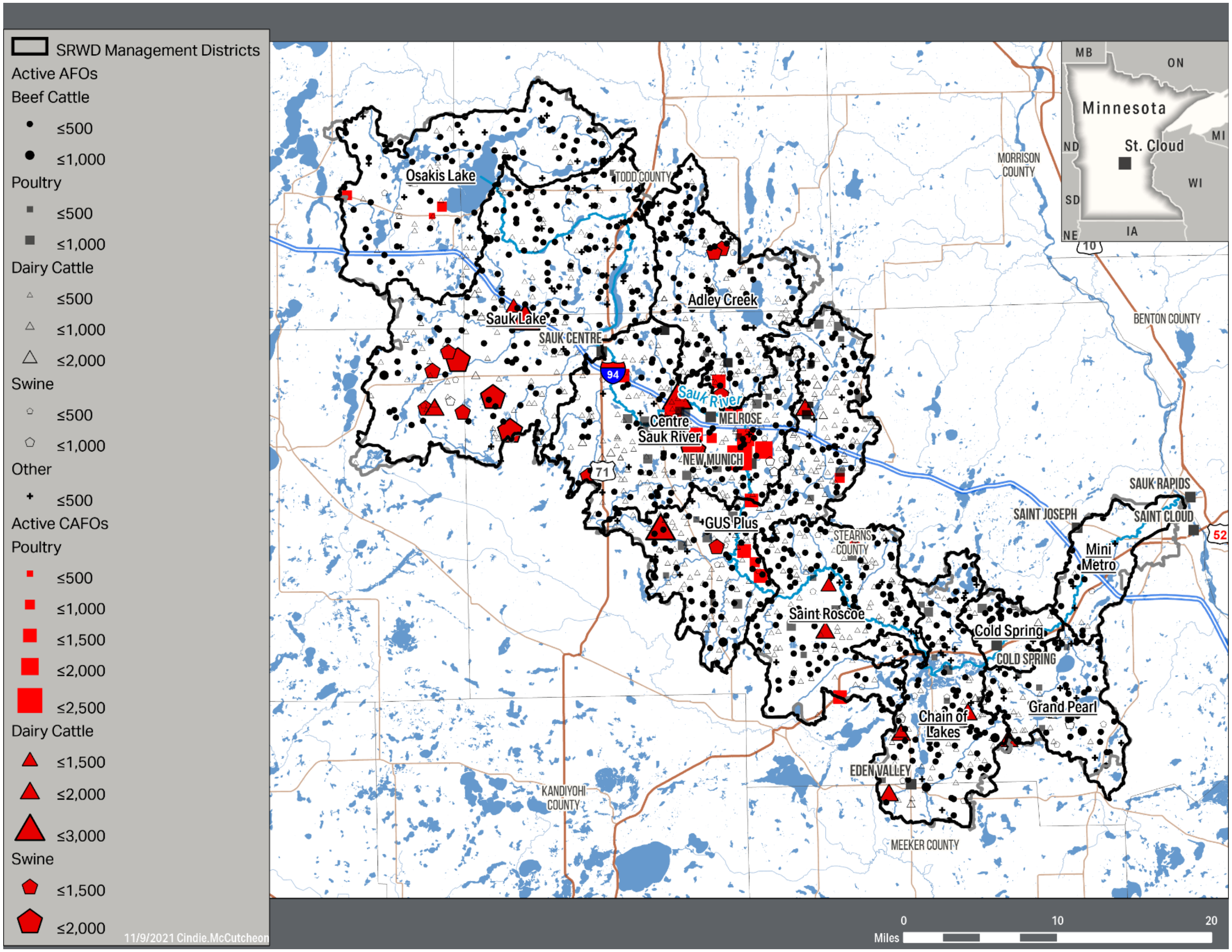


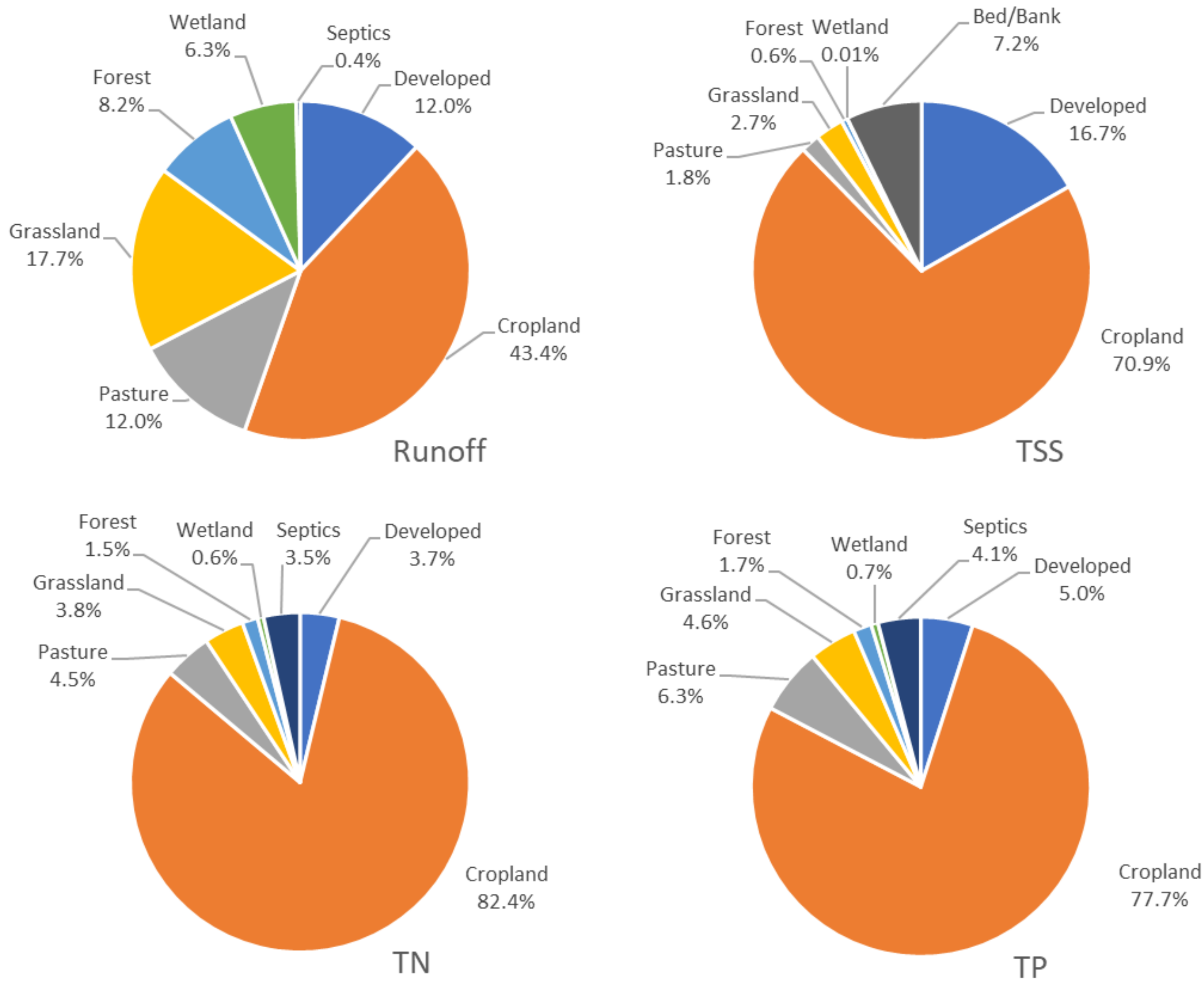
Figure 6. Feedlot locations.



Nonpoint sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, the runoff collects and carries away natural and anthropogenic pollutants and deposits those pollutants into lakes and streams. The SRW Cycle 2 SID Report identifies altered hydrology and agricultural runoff as the main nonpoint pollutant sources contributing to excess nutrients and low DO. The HSPF model further verifies these findings by assessing the nonpoint source loads shown in Figure 7. The crop land categories account for only 43% of the nonpoint source runoff (water volume) but account for approximately 71%, 82%, and 78% of the TSS, total nitrogen, and TP nonpoint source load contributions, respectively.

Figure 7. Nonpoint source allocation for the Sauk River HSPF model.



Common possible nonpoint and natural pollutant sources in the SRW are as follows:

- **Fertilizer and/or manure runoff**: Fertilizer and manure contain high concentrations of P, nitrogen, and bacteria that can run off into lakes and streams when not properly managed.
- **Feedlots**: Minnesota law requires most feedlot owners to register their feedlots with the MPCA or MPCA-delegated counties. Feedlots located in shoreland that maintain 10 or more animal units (AUs), and feedlots located outside of shoreland that maintain 50 or more AUs, are required to register with the MPCA or the delegated county. AU is a term used to compare the differences in animal-manure production. Table A-14 of Appendix A shows the number of feedlots (AFOs and CAFOs) that are registered in each SRW management district. Any feedlot with more than 1,000 AUs is required to obtain an NPDES/SDS operating permit and is defined as a CAFO. Any operation with less than 1,000 AUs is only required to apply for a permit if constructing or expanding. Forty-five CAFOs are within the watershed. The feedlots that are under 300 AUs have an operating requirement to maintain current registration and notify the MPCA of any construction activities taking place.
- **Urban stormwater runoff**: Stormwater collects and transports pollutants deposited on impervious surfaces, such as sidewalks and streets, directly to local water bodies if not properly managed.
- **Failing septic systems**: Septic systems that are not maintained or are failing near a lake or stream can contribute excess P, nitrogen, and bacteria.
- **Peatlands/wetlands**: Peatlands and wetlands in the watershed have high levels of P and low levels of DO that can pollute downstream streams and lakes. Peatlands and wetlands also capture pollutants and increase evaporation, which improves issues caused by altered hydrology.
- **Internal loading**: Lake sediments contain large amounts of P that can be released into the lake water through physical mixing or under certain chemical conditions.
- **Upstream-lake loading**: Some lakes receive most of their P from upstream lakes. For these lakes, restoration and protection efforts should focus on improving the water quality of the upstream lake.
- **Livestock overgrazing in streams**: Livestock grazing/watering in the riparian zone can cause localized damage and erosion of the stream bank and is a direct source of P and bacteria pollutants through livestock defecation.
- **Wildlife fecal runoff**: Dense or localized wildlife (e.g., beaver or geese) populations can contribute P and bacteria pollutants to streams or ponds, though typically in relatively small, dispersed amounts.

Strategies for restoration and protection

The CWLA requires that WRAPS contain strategies that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources, including water quality goals, strategies, and targets by parameter of concern, and an example of the scales and timeline of adoption to meet water quality protection and restoration goals.

This chapter of the WRAPS report provides the results of such strategy development. Because the nonpoint source strategies outlined in this section often rely on voluntary implementation by landowners, land users, and watershed residents, creating social capital (e.g., trust, networks, and positive relationships) with those who will be needed to voluntarily implement BMPs is imperative. Thus, effective, ongoing civic engagement and public participation are fully a part of the overall restoration and protection approach.

The implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed-modeling efforts and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on the needed funding being secured; as such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation, and course correction.

For consistency across the watershed, prioritization metrics determined in the Sauk River CWMP [RESPEC, 2021], are summarized in this WRAPS report. Ranking metrics for target endpoints included the amount of contributing altered hydrology, the number of contributing impairments, reduction achievability, whether or not the water body was connected to an impaired lake, and the amount of disturbed area contributing to the water body. Figure 8 shows the priority streams along the Sauk River from the CWMP, and Table A-15 of Appendix A shows the priority target endpoints from the Sauk River CWMP. More information about the prioritization process is included in the CWMP (https://srwdmn.org/one-watershed-one-plan/).

Lakes were prioritized similarly to streams in the Sauk River CWMP. Metrics for prioritizing lakes included nearly/barely impaired (i.e., how close the lake was to achieving the TP water quality standard), public access, lake-size-to-drainage area ratio, and immediate impact on priority downstream waters. The ranking of the prioritized lakes is included in Table A-16 of Appendix A.

High water quality lakes were also prioritized in the Sauk River CWMP. Metrics were similar to the normal lake metrics and included lake-size-to-drainage-area ratio, lakeshed land use disturbance percent, nearly/barely impaired (i.e., distance from impairment), P sensitivity, water clarity trend, biological significance, and a lake benefit-cost analysis. The source for this information was the 2019 LPSS_LBCA_LOBS spreadsheets provided by the DNR [Radomski, 2021]. A 2021 version of this spreadsheet is available, and lakes from that spreadsheet are included for comparison to the 2019 version. The high-quality lake prioritization is shown in Table A-17 of Appendix A. Differences in spreadsheets are likely because of different monitoring periods and climate conditions.

Overall, the high-quality lakes in the Sauk River CWMP were prioritized using three tiers:

First Tier: The four lakes that were prioritized overall are:

- Big Fish Lake
- Big Birch Lake
- Long Lake (Todd County)
- Long Lake (by Big Fish Lake)

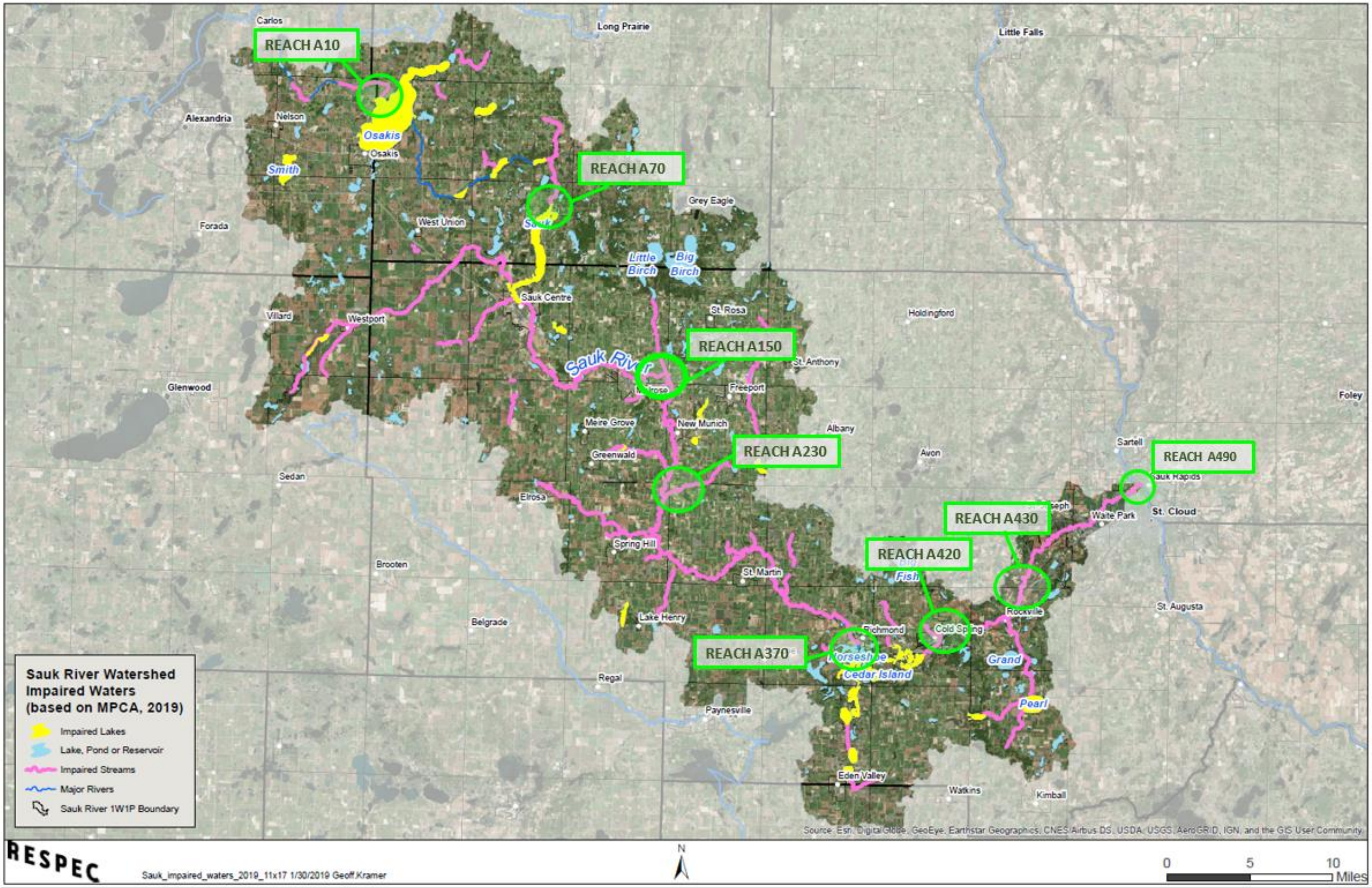
Second Tier: Nine lakes generally scored in Ranks 5 through 13, depending on if water clarity was trending downward or upward and whether or not the LBCA ratio was applied:

- Improving Transparency Trend
    - Big Lake
    - Fairy Lake
    - Grand Lake
    - Pleasant Lake
- Declining Transparency Trend
    - Bass Lake
    - Kings Lake
    - Cedar Lake (north of Sauk Lake)
    - Carnelian Lake
    - Cedar Lake (east of Sauk Lake)

Third Tier: Ten lakes initially remained after the first two tiers were identified. Black Oak, St. Anna, and Goose Lakes were recommended to be removed from the high water quality lakes list because these lakes have TP levels that are more than double their lake standard and should be reevaluated for impairment status; therefore, seven third-tier lakes were identified:

- Little Birch Lake
- Cedar Lake (near Freeport)
- Sylvia Lake
- Long Lake (near St. Rosa)
- Little Osakis Lake
- Becker Lake
- Mud Lake

Figure 8. Priority reaches along the mainstem of the Sauk River.



2.7 Targeting geographic areas

In the following sections, each management district is summarized, priorities in each management district are identified, and the best methods to improve each priority water body are outlined. Information for this section was taken from the Sauk River CWMP and more detailed information on targeting and prioritizing areas is included in the Sauk River CWMP. In this section, both priority lakes and high-quality lakes are discussed and are prioritized. Also, although *E. coli* was not identified as one of the top two overall priorities, streams that are impaired by *E. coli* are still listed below as priority streams. In the CWMP, targeting was completed by HSPF reach and can be reviewed in Appendix H of the document [RESPEC, 2021].

Osakis Lake Management District

Lake Osakis is the headwaters of the Sauk River and a popular fishing and recreation destination. The 138-square-mile Osakis Lake Management District offers some of the best fish and wildlife habitat in the SRW, but also has significant water quality challenges. The area is relatively flat and mostly agricultural with poorly drained soils. Most of the water courses have been altered, and public-drainage systems are prevalent throughout the management district; this district has the most miles of public-drainage systems in the SRW. Many wetlands have been eliminated, and the quality of the remaining wetlands have been impacted by upstream agricultural drainage.

Protection and Restoration Priorities

The priority lakes located in the Osakis Lake Management District include Osakis, Smith, and Maple Lakes. Lake Osakis is a mainstem lake, while Smith Lake is a Tier 1 priority lake and Maple Lake is a Tier 2 priority lake. The Sauk River technically starts below Lake Osakis with Crooked Lake Ditch flowing into Lake Osakis. For the CWMP, Crooked Lake Ditch was included in the ranking of mainstem priority streams/reaches and ranked fourth. Table A-3 of the Sauk River CWMP shows stream rankings. Altered hydrology and habitat are also overall priorities in this management district.

According to the CWMP, efforts to address Lake Osakis should focus on reducing pollution that comes from the area draining to the lake, particularly from the Judicial Ditch (JD) 2 Subwatershed, which contributes 30% of the TP load. Crooked Lake Ditch above Lake Osakis should focus on restoring natural hydrology in the JD 2 drainage area. Upgrading noncompliant septic systems around Lake Osakis will be beneficial for water quality improvements. Smith and Maple Lakes should focus on reducing sediment and nutrient runoff in the watershed through conservation tillage, cover crops, high-quality buffers, and upgraded septic systems.

The CWMP goal for the Osakis Lake Management District is to create 1,561 acre-feet of storage to maintain the current average discharge volume relative to expected changes in precipitation. Practices to combat altered hydrology include restoring wetlands and implementing practices that hold water on the land. Runoff from roads and other impervious surfaces should be treated, and culverts should be sized and replaced as appropriate.

Strategies to address habitat include expanding and enhancing current permanent protection areas, restoring stream habitat, and restoring upland native vegetation.

Sauk Lake Management District

At nearly 235 square miles, the Sauk Lake Management District is the largest management district in the watershed. It spans from the headwaters of Ashley Creek in Glenwood Township (Pope County) to the outlet of Sauk Lake in Todd County. The management district also covers portions of Stearns and Douglas counties. The Ashley Creek drainage area, where most of the 38 miles of public-drainage systems are located, is of primary concern in this management district. The middle portion of the Ashley Creek Watershed is a major source of *E. coli*, nutrients, and sediment that have contributed to poor water quality within Ashley Creek and downstream resources, including Sauk Lake-South Bay, which is impaired because of excess nutrients. Hoboken Creek to the south of Sauk Centre is also a major contributor of nutrients and sediment to Sauk Lake-South Bay and downstream resources.

Protection and Restoration Priorities

The priority lakes in the Sauk Lake Management District include four mainstem lakes (Guernsey, Little Sauk, Juergens, and Sauk Lakes) and one Restoration Tier 2 priority lake (Westport Lake). Multiple high-quality lakes (Long, Fairy, and Cedar Lakes) are in the Sauk Lake Management District and are a high priority for protection. The Sauk River above Sauk Lake ranked 6th of the mainstem priority streams/reaches. Table A-3 of the Sauk River CWMP shows stream rankings. Ashley, Silver, and Hoboken Creeks and the Sauk River are impaired and are priorities. Altered hydrology, groundwater availability, drinking water quality, and habitat are also overall priorities in this management district.

According to the CWMP, efforts to address Sauk Lake should focus on areas that have high-erosion rates, exposed soils, and stream bank failures by establishing permanent vegetation for the north side of the lake and focus on field and gully erosion, runoff from agricultural fields, and riparian pastures that are degraded for the south side of the lake. Efforts for the other mainstem lakes (Guernsey, Little Sauk, and Juergens lakes) should focus on reducing stream bank erosion and field and gully erosion as well as curly-leaf pondweed, and for the Restoration Tier 2 lake (Westport Lake) should focus on reducing P loading from agricultural sources of watershed runoff. The mainstem Sauk River above Sauk Lake efforts should focus on restoring wetlands in headwaters reaches, particularly in those areas that have the greatest potential for groundwater recharge, and on working with drainage authorities to implement drainage-water management projects. Ashley Creek (AUID 07010202-503) is an *E. coli* impaired priority stream that would benefit from efforts to restrict livestock access to surface waters and provide alternative water sources for cattle. This stream would also benefit from improved pasture management. To address altered hydrology, wetlands in headwater reaches should be restored, and projects that slow the flow rate through the streams, such as controlled tile drainage and increased storage capacity, should be implemented.

For groundwater availability, the primary focus (by the State of Minnesota) should be on developing a groundwater management plan for the Bonanza Valley area. For groundwater quality, the primary focus should be on preventing unsuitable land management practices and removing existing threats.

For improved habitat, the focus should be on building connections between and expanding core habitat complexes in Westport, Grove Lake, Ashley, Raymond, Getty, and West Union Townships.

Centre Sauk River Management District

The 136-square-mile Centre Sauk Management District starts just downstream of the Sauk Lake Dam in Sauk Centre. The Sauk River flows to the east through another impoundment in Melrose before turning southward through the city of New Munich. The hydrology in this management district has been highly altered, with approximately 200 miles of altered-water courses, 16 miles of public-drainage systems, and a dam in Melrose. The Melrose Dam results in an immediate transition upstream of it from riverine habitat to lake habitat, has reduced aquatic habitat connectivity, and limits the migration of fish species throughout this river stretch.

Protection and Restoration Priorities

The priority lakes located in the Centre Sauk River Management District include one Tier 1 lake, McCormic Lake and one Tier 2 lake, Uhlenkolts Lake. The high-quality lakes include two Tier 2 lakes, Cedar and Kings Lakes. The Sauk River above Adley Creek ranked 2 of 8 on the mainstem priority streams/reaches list in Table A-3 of the Sauk River CWMP. The Sauk River from Adley Creek through the rest of the length of this management district is impaired by *E. coli* and is a priority stream. Two CDs (CDs 9 and 11) and the Sauk River throughout this management district are listed as impaired for impacted fish and/or macroinvertebrates communities and are priorities. Altered hydrology, groundwater quality, and habitat are also overall priorities in this management district.

According to the CWMP, McCormic Lake efforts should focus on addressing watershed runoff loads. Uhlenkolts Lake efforts should focus on internal loading, which is likely occurring because of the carp population. The protection efforts for mainstem lakes (Cedar and Kings Lakes) should focus on reducing P loading from agricultural sources of watershed runoff. The mainstem Sauk River efforts should focus on increasing storage on the landscape, restoring natural hydrology, and implementing BMPs with the potential to reduce bacteria. CDs 9 and 11 are ranked as some of the highest contributors of excess sediment and nutrients to downstream waters. Practices to reduce sediment and nutrients should be prioritized. To address altered hydrology, wetlands in headwater reaches should also be restored, and projects that slow the flow rate through the streams, such as controlled tile drainage and increased storage capacity, should be implemented.

For groundwater quality, the primary focus should be on forming a local advisory committee for the City of Melrose to address nitrate contamination by using available tools; converting land uses to those uses that pose the least threat; reducing nitrogen-fertilizer use; and implementing nitrogen-fertilizer BMPs in agricultural, urban, and other areas to prevent unsuitable land management practices and remove existing threats. For groundwater quality in the city of New Munich, actions should be taken to reduce the risks associated with unsuitable land management practices. Agricultural land should be converted to conservation land where appropriate, the number of acres covered by manure management plans should be increased, nitrogen-fertilizer use should be reduced, and nitrogen management BMPs should be implemented.

For improved habitat, the focus should be mitigating altered hydrology and reducing channel and stream bank erosion while providing excellent habitat.

Adley Creek Management District

The Adley Creek Management District is 93 square miles. The management district's northern portion has extensive forest and contains some of the highest-quality natural resources in the SRW. Hallmark resources in the northern portion include the Big Birch State Forest, Grey Eagle Wildlife Management Area (WMA), and Trout Creek, which are all protection priorities for the Sauk River CWMP. This district has a relatively low year-round population with only a portion of the town of Grey Eagle within its boundaries, but the high-quality Little Birch and Big Birch Lakes draw concentrated development and increased population to the area, especially during the summer months.

Protection and Restoration Priorities

One high-quality protection lake (Big Birch Lake) is in the Sauk Lake Management District and is a high priority. Adley Creek from Sylvia Lake to the Sauk River is impaired by *E. coli* and has an impaired fish community and is a priority stream. Altered hydrology, drinking water quality, and habitat are also priorities in this management district.

According to the CWMP, Big Birch Lake has some of the highest water quality of lakes in the SRW. Maintaining existing native and forested land cover is of primary importance to this lake, and implementation efforts should be focused on private forest management and zoning controls that limit development or adverse land use changes. The area draining to Adley Creek has 66 feedlots with nearly 10,000 AUs, and more than two-thirds of those AUs are within 500 ft of the creek. Restricting livestock access to surface waters and providing an alternative water source for cattle, as well as improving pasture management, are the most important implementation strategies. Trapping and treating runoff from feedlots with manure-storage facility upgrades, including clean-water diversions and filter strips, as well as increasing the number of acres implementing manure management plans, are priority practices. For altered hydrology, the northern portion that drains to the high-quality lakes should be restored to the natural drainage of the area. Implementation actions that will increase water storage on the landscape and restore natural-stream function should be prioritized in the upper portion of the watershed. In the lower portion of the watershed, the priority is to reduce the volume and rate of water entering Adley Creek by retaining water through wetland restoration and drainage-water management practices.

For groundwater quality, the primary focus should be on education and outreach efforts involving routinely testing private wells. If facilities for petroleum- or chemical-storage tanks are to be sited in this area, careful review should be completed, including mitigation and emergency management plans.

Maintaining the high-density forest area and improving the channelization of CD 33 are priorities for habitat.

GUS Plus Management District

The 132-square-mile GUS Plus Management District (GUS Plus) comprises Getchell Creek, Unnamed Creek, and Stony Creek Watersheds. GUS Plus is almost entirely in Stearns County with a small portion in Todd County. Of the three main tributaries, the Getchell Creek Subwatershed is the largest and contributes the highest amount of sediment and P to the Sauk River [Wenck Associates, Inc., 2010], and is also impaired by *E. coli*. Stony Creek is impaired by *E. coli*, and portions of the creek are also designated as a cold-water resource, which is one of only five such designations in the SRW. The downstream portion of Unnamed Creek, which begins near the town of Lake Henry and flows to the north, is impaired because of excess suspended solids. These three main tributaries, particularly Stony Creek and Unnamed Creek, have massive stream bank failures. These stream bank failures are a result of altered hydrology, particularly wetland drainage, which increases the rate and volume of runoff into the streams [MPCA, 2012]. Portions of these streams are also accessed by livestock. If livestock are not properly managed, they can degrade buffers and cause stream banks to collapse. Animal agriculture is important in this management district as approximately one-fifth of the feedlots in the SRW [MPCA, 2012] are located here. Riparian pasturing also appears to be more widespread in GUS Plus than in the other management zones [MPCA, 2012]. Reducing the livestock impact is a critical component of restoring natural resources in GUS Plus.

Protection and Restoration Priorities

In the GUS Plus, the Sauk River above Getchell Creek ranked three out of eight on the mainstem priority streams/reaches list within the CWMP. Five reaches (Sauk River, Stony Creek, Getchell Creek, and two Unnamed Creeks [one from Unnamed Creek to Sauk River and one from Unnamed Creek to Getchell Creek]) in the GUS Plus are impaired by *E. coli* and are priority streams. Getchell Creek is also listed as impaired by DO, fish, and macroinvertebrates; Sauk River (from Adley Creek to Getchell Creek) is listed as impaired for fish and macroinvertebrates; Stony Creek is impaired by TSS; Unnamed Creek (Unnamed Creek to Sauk River) is impaired by turbidity; Unnamed Creek (Unnamed Ditch to Unnamed Creek) is listed as impaired for macroinvertebrates; and Unnamed Creek (Unnamed Creek to Stony Creek) is listed as impaired for fish. These impaired reaches are priorities. Altered hydrology for County Ditch 15, Getchell Creek, Stony Creek, Unnamed Creek, and habitat for Getchell Creek, Stony Creek, and Unnamed Creek are also priorities in this management district.

The restoration recommended for streams with *E. coli* impairments would require implementing practices that address the *E. coli* sources as determined by the river-flow conditions. Reductions needed during low-flow conditions indicate that riparian pastures, particularly those pastures that allow for livestock access to streams, are the main source of *E. coli*; therefore, restricting livestock access to surface waters and providing an alternative water source for cattle, as well as improving pasture management, are important. Where reductions are needed during high-flow conditions, trapping and treating runoff from feedlots and increasing the number of acres using manure management plans will be more important. *E. coli* targeting should begin with facilities with animals within 500 ft of the stream. To improve other impaired reaches in the GUS Plus, practices that decrease gully erosion and runoff from agricultural fields and riparian pastures, as well as increase fencing and off-stream watering to keep cattle out of streams, should be implemented. To improve issues related to altered hydrology, practices such as large-scale wetland restoration and reducing the rate and flow of drainage systems should be prioritized.

For improved habitat, the focus should be on wetland restorations to restore baseflow, buffer improvements to provide shade, and reduced drainage that increases water temperature and restores the cold-water conditions in Stony Creek. Saint Roscoe Management District

The Saint Roscoe Management District encompasses 108-square-miles and is dominated by agricultural land use. This district contains a few small wildlife lakes and Big Lake (Lake I.D. No. 73-0159-00), a high-quality water resource with improving water quality trends. The southern portion of this district begins just outside the city of Paynesville and extends to the city of Roscoe. Wet meadow and mesic prairie native habitat can be found in this unique glacial-outwash and sand-plain area. Some of this habitat is protected by three WMAs, two wildlife protection areas, and one scientific and natural area (SNA). Stream bank failure, over-widened and channelized streams, and field erosion have caused downstream sediment accumulation and sand deltas to form within sections of the Sauk River in and downstream of this Management District.

Protection and Restoration Priorities

The Saint Roscoe Management District has one high-quality Tier 2 protection lake, Big Lake, that is a high priority. Sauk River above the Chain of Lakes was ranked one of eight on the mainstem priority streams/reaches list from Table A-3 of the Sauk River CWMP. Throughout the management district, the Sauk River is impaired by *E. coli* and is a priority. Four sections of different Unnamed Creeks (07010202-554, -556, -660, and -662) have impaired fish and/or macroinvertebrates communities and are priorities. Altered hydrology, groundwater quality, and habitat are also overall priorities in this management district.

According to the CWMP, priorities to protect Big Lake from declining water quality include additional buffering along Kolling Creek and implementing soil-health practices on agricultural fields in the immediate-drainage area. The Sauk River *E. coli* TMDL shows *E. coli* criteria exceedances during all flow conditions. For low-flow exceedance, priority practices include restricting livestock access to surface waters and providing an alternative water source for cattle, as well as improving pasture management. For high-flow exceedance, trapping and treating runoff from feedlots and manured lands, and increasing the number of acres using manure management plans, will be important. *E. coli* targeting should begin with facilities with animals within 500 ft of the stream. The fish/macroinvertebrate concerns should be addressed using methods to improve the altered hydrology and habitat. A key implementation approach to improve altered hydrology should be restoring wetlands and using practices that slow the flow rate through the streams, such as controlled tile drainage and restoring the hydrologic function of stream channels by restoring and stabilizing stream banks. Providing temporary water-storage structures, such as water and sediment control basins (WASCOBs), terraces, and grade stabilization structures, will also improve issues with flow caused by altered hydrology. To improve habitat, key strategies include expanding existing conservation areas and creating habitat complexes and corridors.

To improve groundwater quality, the cities of Roscoe and Richmond should focus on using available tools, converting land uses to those that pose the least threat, reducing nitrogen-fertilizer use, and implementing nitrogen-fertilizer BMPs in agricultural and urban areas. The City of St. Martin should reduce risks associated with land management practices and convert agricultural land to conservation lands as appropriate, as well as identify and remove or contain petroleum- and chemical-storage tanks. The City of St. Martin should also implement emergency preparedness exercises to contain threats in the event of an emergency spill.

Chain of Lakes Management District

The Chain of Lakes Management District is 95-square-miles and contains abundant lakes. Big Fish and Long Lakes are the high water quality lakes located in the northern portion of the management district. As the Sauk River begins to run through this management district, the river transitions into a complex reservoir system known as the Sauk River Chain of Lakes, which formed in 1856 when the Cold Spring Dam was constructed [Heiskary 2015]. The Sauk River Chain of Lakes is a significant recreational and economic resource to Stearns County and central Minnesota that contains the following lakes: Becker, Vails, Eden, North Browns, Long, Horseshoe South, Horseshoe West, Horseshoe North, East, Cedar Island-Main, Koetter, Zumwalde, Schneider, Great Northern, Krays, Bolfing, and Knaus Lakes. The Chain of Lakes is highly influenced by the Sauk River, which drains 760 miles of upstream watershed area and is the source of 85% of the nutrient loading to these lakes. Because of the impact that the Sauk River has on this significant resource, monitoring the Sauk River inlet to the Sauk River Chain of Lakes is the number-one priority location to track results of efforts for reducing the impacts of excess sediment and nutrients. The subwatersheds that have the highest pollutant levels loading to the Sauk River Chain of Lakes have been identified in the upstream management districts. The Sauk River Chain of Lakes generally have a short-residence time, which means that water quickly flows into and out of most of the lakes; therefore, the reductions in excess nutrient loading from upstream areas will result in overall improved water quality in the Sauk River Chain of Lakes. Not all lakes in the Sauk River Chain of Lakes have a short-residence time – including Bolfing Lake, Horseshoe Lake West, and Cedar Island Main. The Sauk River Chain of Lakes has a second headwaters region that lies in the southern portion of the management district and is referred to as the Eden Valley Creek Chain of Lakes. This area includes Eden Lake, Vails Lake, North Brown's Lake, and Long Lake (73-0139-00). These lakes do not meet water quality standards and, as the lakes flow into the Sauk River Chain of Lakes at Horseshoe Lake (South) via Long Lake Creek, they also contribute excessive nutrients to the Sauk River Chain of Lakes.

Protection and Restoration Priorities

The priority lakes located in the Chain of Lakes Management District include seven mainstem lakes (Cedar Island East, Cedar Island [Koetter Lake], Great Northern, Horseshoe, Knaus, Krays, and Zumwalde Lakes). Other priority lakes in the watershed include two Tier 1 lakes (Bolfing and Schneider Lakes) and four Tier 2 lakes (Long, North Brown's, Eden, and Vails Lakes). Two high-quality Tier 1 protection lakes (Big Fish and Long Lakes) are also in the Chain of Lakes Management District and are high priority. The Sauk River below the Chain of Lakes was ranked five of eight on the mainstem priority streams/reaches list from Table A-3 of the Sauk River CWMP; this section of river is also impaired by nutrients and is a priority. Altered hydrology, groundwater quality, land use, and habitat are also overall priorities in this management district.

According to the CWMP, the most notable water quality benefits that the Sauk River Chain of Lakes will obtain will be from improvement actions that are performed in the upstream watershed areas, nearly all of which drain to unnamed creeks in the Chain of Lakes Management District. Reductions can also be obtained in immediate shoreland and drainage areas. Implementation actions that can be taken to reduce near-shore and lakeshed pollution loading include upgrading septic systems, repairing gullies, and improving shoreland buffers. Land use management tools that limit runoff, such as increasing restrictions on impervious areas and requiring stormwater management practices, should also be employed. Similar local practices should be implemented for the nonmainstem priority lakes. Other actions that should take place to improve the nonmainstem priority lakes include BMP and/or Capital Improvement Project implementation to address altered hydrology and agricultural practices that keep soil in place, such as cover crops and reduced tillage, volume controls on drainage systems, and upgrading septic systems. Key implementation measures to protect the two high-quality lakes include land protection to keep the forests in place, continual AIS monitoring, and response and containment efforts. To improve issues caused by altered hydrology, wetland and upland-area restorations will reduce the flow volume and rate into creeks and channels. Steps should also be taken to reduce the velocity of creeks that are eroding into gullies. Urban stormwater improvement and retrofit projects should be targeted in highly developed lands in the immediate lakeshore areas along State Highway 23, and impacts from future development should be minimized by implementing Minimal Impact Design Standards (MIDS).

For groundwater quality, the City of Cold Spring should use available tools and convert land use and management in priority areas to those uses that pose the least threat. The cities of Eden Valley, Watkins, and Richmond should use BMPs, such as converting agricultural land to conversion lands, increasing the number of acres covered by manure management plans, reducing nitrogen-fertilizer use, and implementing nitrogen management. For improved habitat, variances and conditional use permits should be carefully reviewed to ensure that unintentional consequences, such as forest fragmentation, are minimized. An important part of reviewing Conditional Use Permits includes educating elected officials. Priority actions to maintain the high-quality habitat in this area include forest management, permanent conservation easements, and reducing near-shore impacts to lakes by upgrading septic systems and enhancing shoreline and riparian habitat quality.

Cold Spring Management District

The Cold Spring Management District is the smallest management district at only 18 square miles. The management district begins at the Cold Spring Dam and ends a few miles downstream at the city of Rockville. Cold Spring Creek is the main tributary in the management district. This creek is a designated trout stream that is impaired by *E. coli*. Flows in the creek are highly dependent on groundwater. The CWMP mentions that excessive groundwater pumping was impacting the flow in the creek, which could have impacted the trout in the creek. A MDH grant in 2021 paid to seal Well #3 near the stream, which should help limit pumping in this area. The Minnesota Legislature has directed the DNR to develop a groundwater model that, when completed, will be used to establish sustainable groundwater-pumping rates for groundwater appropriation permits. Groundwater quality is also a major concern for this management district. The City of Cold Spring Drinking Water Supply Management Area is rated as very high risk to nitrate contamination by the MDH. It has been designated by the MDA under the Groundwater Protection Rule as a Level 2 area for mitigation of nitrate contamination because wells have tested at 8.0 milligrams per liter (mg/L) at some time during the last 10 years, which is close to the 10 mg/L limit.

The Cold Spring Management District is potentially a high-growth area because of its proximity to the St. Cloud/Waite Park area and accessibility on State Highway (SH) 23, which is just a few miles off Interstate 94.

Protection and Restoration Priorities

The Sauk River above Mill Creek was ranked seven of eight on the mainstem priority streams/reaches list in Table A-3 of the SRW CWMP. Cold Spring Creek is impaired by *E. coli* and is a priority stream. The Sauk River within the Cold Spring Management District has impairments of fish and macroinvertebrates that are related to nutrients and is a priority. Altered hydrology, groundwater availability, groundwater quality, St. Cloud drinking water, and habitat are also overall priorities in this management district.

According to the CWMP, the *E. coli* impaired Cold Spring Creek priority stream should include feedlot upgrades within 500 ft of the creek, manure management practices, and education and outreach on proper pet-waste handling. For the nutrient impaired Sauk River, improvement actions that are performed in the upstream watershed areas will help significantly. Reductions can also be obtained in immediate-drainage areas. Implementation actions that can be taken to reduce pollutant loading include land use management tools that limit runoff, such as increasing restrictions on impervious areas and stormwater management practices. For the altered hydrology, hydrology restoration should include restoring wetlands and natural channels; increasing storage in urban areas through stormwater management and rate/volume control; and urban stormwater improvement, infiltration, and retrofit projects.

For groundwater availability, the model simulating groundwater use along Cold Spring Creek should be evaluated and used to impact decisions for pumping from Cold Spring Creek. For groundwater quality, the City of Cold Spring should reduce the threat of additional contamination by using available tools: converting land uses to those uses that pose the least threat, including converting agricultural land to conservation land; reducing nitrogen-fertilizer use; and implementing nitrogen-fertilizer BMPs in agricultural and urban areas.

For improved habitat, the focus should be on stormwater management, practices that slow down or divert stormwater runoff, protecting the upstream areas with permanent conservation easements, restoring and narrowing the downstream reaches, and removing a sheet-pile structure that restricts fish movement downstream.

Also, in addition to the information provided in the CWMP discussing agricultural reductions, urban reductions should be evaluated because Cold Spring Creek runs through the city of Cold Spring. The Sauk River TMDL for Cold Spring Creek shows that the high *E. coli* concentrations were observed in the city under low flows, which could indicate illicit connections to storm sewers. However, since data collected on Cold Spring Creek were collected before the TMDL period (2006 through 2020), it is recommended that new monitoring occurs on the reach to determine if the low flow pattern is still observed. If the pattern is still observed, illicit connections should be evaluated.

Grand Pearl Management District

The 55-square-mile area of the Grand Pearl Management District is highly agricultural with numerous livestock operations. Surface water quality is of special concern due to the district's proximity to the drinking-water intake for the city of St. Cloud. Four priority lakes are in this management district: two lakes that are impaired (Pearl and Goodners) and two lakes that have high water quality (Grand and Carnelian). Kinzer Creek is a cold water creek that no longer supports trout populations but remains a priority for the planning partnership. The Grand Pearl Management District ranks second highest in the SRW for groundwater availability and groundwater quality concerns. The lower portion of the district has sandy soils that are irrigated for agricultural productivity. Sandy soils allow for high-infiltration rates that can restore groundwater; however, care must be taken to prevent groundwater contamination from upland practices. The water quality for private drinking water wells in the area around Grand and Pearl Lakes is of concern, as is the drinking water source for the city of Rockville.

Protection and Restoration Priorities

High priority lakes located in the Grand Pearl Management District include two Tier 1 priority lakes, Pearl and Goodners Lakes. Two high-quality protection lakes (Grand Lake, Tier 1; and Carnelian Lake, Tier 2) are in the Grand Pearl Management District. Mill Creek is impaired by *E. coli* and is a priority stream. Altered hydrology, groundwater availability, groundwater quality, St. Cloud drinking water, and habitat are also overall priorities in this management district.

According to the CWMP, Pearl Lake efforts should focus on managing curly-leaf pondweed, and both priority lakes should have cover crop and conservation cover implemented in the immediate lake area, eroding stream banks stabilized, and native vegetation planted along shorelines. For the high-quality protection lakes, Grand Lake should focus on ongoing control of starry stonewort and agricultural/feedlot-related practices, and Carnelian Lake should focus on agricultural practices. The *E. coli* impaired Mill Creek priority stream efforts should restrict livestock access to surface waters and provide alternative water sources for cattle. Pasture management should also be improved in the area. Trapping and treating runoff from feedlots and increasing the number of acres using manure management plans will also reduce *E. coli* loading. To improve altered hydrology, implementation actions that increase the storage on the landscape and allow for sediment and nutrient settling to occur upstream from the priority lakes will result in the greatest impact. Projects could include completely restoring drained wetlands as well as temporarily holding water, such as by using WASCOBs. Wetland restorations should be targeted to locations that allow for infiltration and groundwater recharge.

For groundwater availability, the primary focus should be on-the-ground conservation measures that reduce the demand for groundwater consumption and groundwater recharge. Restoring wetlands, improving soil health, and supporting irrigation management are key actions, and consideration should be given to increasing incentives for wetland banking in areas with high-recharge potential. For groundwater quality, the City of Rockville should implement land management practices to protect its groundwater supply from contamination. Options include converting agricultural land to conservation lands, identifying and removing or containing petroleum and chemical-storage tanks, and implementing emergency preparedness exercises to contain threats in the event of an emergency spill. Prevention measures include properly siting suitable land management activities. For the City of St. Cloud, surface-water quality is of special concern because of the district's proximity to the drinking water intake for the city.

For improved habitat, Kinzer Creek should remain a priority high-quality resource. Field investigations should be undertaken to determine opportunities for habitat improvement.

Mini Metro Management District

The Mini Metro Management District covers 35 square miles and is the furthest downstream management district in the SRW. This is the most populous district, encompassing the city of Waite Park and major portions of St. Joseph and St. Cloud. The Sauk River outlets to the Mississippi River just above the drinking water intake for St. Cloud, which provides clean and safe drinking water to over 70,000 people each day. The Sauk River's importance to the city of St. Cloud's drinking water is the priority concern for this management district. Therefore, targeting implementation actions for this management district is weighted to those practices that address known contaminant sources, such as manure-storage facilities, stormwater discharge, cropland-sediment runoff, stream bank erosion, failing septic systems and aging sanitary sewer infrastructure. Stearns County sends most land use notices to the cities of St. Joseph, Waite Park, and St. Cloud with the intent that the city reviews the applications for compliance with Drinking Water Supply Management Area protection policies and provides comments to the county for possible permit conditions. The Sauk River in the Mini Metro Management District experiences high levels of nutrients. Most of the areas draining to the Sauk River in the Mini Metro Management District are developed, therefore planning for and managing stormwater is one of the primary implementation strategies. Proper planning for land use conversion along growth corridors will be important because of the potential for an increase in altered hydrology. The upstream portions of the management district are mixed land use, including pasture, cultivated crops, some forested areas, and approximately 15 feedlots. The cities of St. Joseph and Waite Park obtain their drinking water from groundwater and have Drinking Water Supply Management Areas with very high (St. Joseph) and high (Waite Park) vulnerability. Groundwater supplies for private well owners are also a concern as much of the area rates as highly sensitive to pollution. Protection and Restoration Priorities

One high-quality Tier 2 protection lake (Pleasant Lake) is in the Mini Metro Management District and is a high priority. The Sauk River above the outlet to the Mississippi River was ranked eight of eight on the mainstem priority streams/reaches list in Table A-3 of the SRW CWMP. Throughout the Mini Metro Management District, the Sauk River is impaired by nutrients. Altered hydrology, groundwater quality, drinking water quality (surface water and groundwater), land use, and habitat are also overall priorities in this management district.

According to the CWMP, managing stormwater in the immediate-drainage area of Pleasant Lake and maintaining naturally vegetated buffers in shoreland and riparian areas are the key implementation strategies for this high-quality protection lake. To improve issues related to altered hydrology, stormwater management options that reduce the rate, volume, and flow of stormwater to the Sauk River, as well as retrofits to currently developed areas, should be considered. New development options should include low-impact development tools that provide open space and natural areas. Wetland banking could be used as a tool to encourage drained-wetland restoration.

For groundwater quality, the cities of St. Joseph and Waite Park should focus on changing land uses to those uses that pose the least threat, such as converting agricultural land within the Drinking Water Supply Management Area to permanent conservation land, reducing nitrogen-fertilizer use, and implementing nitrogen-fertilizer BMPs in agricultural and urban areas. Consideration should be given to land use suitability as development occurs, and measures should be taken to protect the areas of the highest vulnerability.

For improved habitat, projects to restore wetland habitats that will provide multiple benefits for flood, sediment, and nutrient reduction to downstream waters should be completed. For drinking water protection, the City of St. Cloud should prioritize strategies that identify sources of known drinking water contaminants and reduce the risk that these contaminants will reach the Sauk River. Key implementation actions include:

- Improving feedlot and manure-storage facilities upstream
- Providing composting facilities for areas with excess manure compared to available land
- Increasing outreach to ensure that manure management plans are being followed
- Implementing stormwater projects that treat pollutants and reduce the runoff rate, flow, and volume
- Upgrading failing subsurface sewage treatment systems (SSTSs) that are likely to impact surface water

- Installing high-value, pilot stormwater-reuse projects to demonstrate value and provide outreach to appropriate audiences on the value of stormwater reuse

More intensive stormwater monitoring would be very helpful to understand loads and sources from different intensities of developed lands.

2.8 Public Participation and Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful public participation and civic engagement. Civic engagement is distinguished from the broader term public participation in that civic engagement encompasses a higher, more interactive level of involvement, which is not always practical or possible to conduct.

Accomplishments and future plans

Efforts to facilitate public education, review, and comments when developing the Sauk River WRAPS/TMDL included meetings with local groups in the watershed on the assessment findings and a 30-day public notice period for public review of and comment on the draft TMDL document. All of the input, comments, responses, and suggestions from public meetings and the public notice period were addressed or taken into consideration in developing the TMDL and WRAPS. The draft TMDL report was made available via public notice in the state register from May 1, 2023 to May 31, 2023. Regular updates regarding the TMDL process with the Sauk River WRAPS team included meetings to discuss the TMDL processes and results. Project team meetings were held on the first Wednesday of each month during the project duration as needed to discuss the project timeline, methods, and TMDL segments to be addressed.

Civic engagement has always been a complicated part of the watershed planning process. Improving civic engagement is an important aspect of this project. The Sauk River CWMP partners have been conducting outreach and education programs for at least 20 years. Watershed citizenship and targeted civic engagement were identified in the CWMP as necessary to make meaningful progress toward goals. The Watershed Citizenship Program goals are to develop a comprehensive outreach and education program that establishes watershed citizenship norms, assesses current knowledge and understanding, engages in programming to build a watershed stewardship effort, assesses change and the effectiveness of programming, and addresses needed changes in programming through an adaptive management process. Regular, periodic updates on program accomplishments and results will be provided to the Policy Committee and local governmental partners. The program also calls for driving implementation through civic engagement and targeted outreach. The “Prioritize, Target, and Measure” framework approach will be implemented to strategically identify targeted audiences and implement education and outreach programs with the explicit purpose of increasing the adoption of practices identified in the implementation tables that are necessary to meet plan goals. Barriers to adoption will be identified and strategies to address those barriers will be pursued. An adaptive management approach to evaluating program effectiveness will be implemented and will allow for changes in the targeted delivery of programming efforts to meet the goals outlined in the CWMP.

The CWMP mentions that effective communication with stakeholders begins with clearly identifying stakeholders and being clear about the commitments made to each stakeholder group. One way to frame this communication is with the International Association of Public Participation (IAP2) Spectrum of Public Participation, where the SRWD might identify stakeholder groups and then determine what level of involvement is most important for each of the groups based on the following categories: Inform, Consult, Involve, and Collaborate. In the area of communication, there is always room for improvement. An important concept to remember is to package messages for communication (printed or oral) using specific content for audiences. Some suggestions are as follows:

- **Inform** the public using printed materials (e.g., fact sheets, brochures), the news media (e.g., newspapers, radio, television), and websites. Do not overlook the opportunity to give reports at meetings where stakeholders are gathered (e.g., community meetings, county board meetings).
- **Consult** with the public by encouraging their input in a variety of ways. Suggestions include letters asking for input, invitations to public meetings, and website surveys.
- **Involve** by ensuring that stakeholders know that their concerns are directly reflected in the alternatives developed and provide feedback on how their input influenced the decisions. Develop an ongoing relationship with stakeholders through work sessions. Other methods for involving stakeholders are deliberative polling and blogs.
- **Collaborate** by focusing on ways to make the project team process most effective by encouraging ongoing communication between project team members, the watershed district, and groups/agencies critical to the work. Using a consensus-building process is one of the best ways to collaborate with your stakeholders.

In addition to the information provided in the CWMP, the Stearns SWCD has been compiling landowner profiles for use as outreach tools with landowners as the partners move forward with implementation. Each profile includes proposed practices/improvements, associated costs, and estimated reductions for a specific landowner.

Environmental justice

The MPCA is committed to making sure that pollution does not have a disproportionate impact on any group of people — the principle of environmental justice. This means that all people — regardless of their race, color, national origin or income — benefit from equal levels of environmental protection and have opportunities to participate in decisions that may affect their environment or health.

There are a number of tools available to determine where underserved communities could receive the most benefit from watershed work in the Sauk River. Using these tools, the MPCA staff can identify areas of the watershed where low income, linguistically isolated, or minority people are most likely to benefit from the work done in the watershed approach and 1W1P process. The MPCA will work with partners to look for opportunities to engage and offer our assistance in these areas. More information on environmental justice can be found on the MPCA website at Environmental justice | Minnesota Pollution Control Agency (state.mn.us). The EPA EJScreen Tool identifies locations within the MS4 to have higher Environmental Justice indexes than those throughout the remainder of the watershed, as does the Recovery Potential Screening Tool, also developed by the EPA.

Public notice for comments

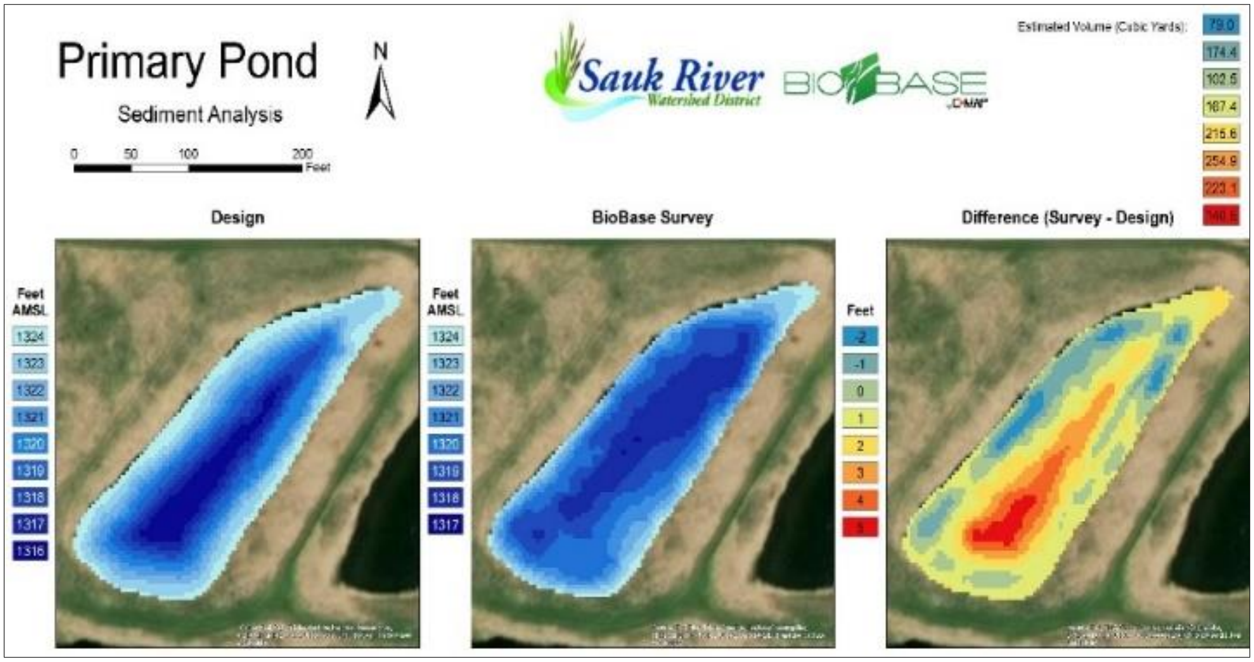
An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from May 1, 2023, through May 31, 2023. One comment was received and responded to as a result of the public comment period.

3. Successes and challenges in improving water quality

A primary purpose of this Sauk River WRAPS Update report is to gain an understanding of what has been done so far in the watershed, what has been working to improve water quality, what some of the challenges have been, and what has not been working. This section outlines different projects that have been done and how these projects are impacting the water quality in the watershed. This information will help indicate what practices should continue to be added and educate on what practices are the most likely to be successful. Through the 1W1P planning process, the local partners had a number of discussions on their different roles and strengths. The CWMP outlines the focus areas for each entity based on their unique strengths and abilities. This collaboration creates a stronger partnership and promotes a focused path for implementation geared toward making progress and improving water quality and quantity concerns.

3.1 Judicial Ditch 2 Sediment Pond Maintenance – Osakis Lake Management District

In 2002 and 2003, two ponds were built off of the main JD 2 channel near the city of Osakis to capture sediment before the sediment entered Lake Osakis. Because of a massive rain event shortly after the original construction, the ponds were reconstructed in 2004 and 2005. Water is now diverted off of the ditch channel, as shown on the right side of the figure below, and into the primary pond. The primary pond is narrow and deep (0.75 acre) to capture the larger particles. Water flows from the primary pond to the secondary pond, which is significantly wider and shallower (10 acres). The finer, smaller particles are captured in the secondary pond. The water is then routed back into the ditch through a culvert. The design plans estimated a sediment reduction rate of 50% or more. Particulate P (attached to sediment) was also estimated to be reduced by 20% to 30%. Over the past several years, the SRWD has performed water quality monitoring in an attempt to understand the performance of the ponds. In 2009 and 2012, the primary JD 2 ponds were cleaned out. In 2019, both ponds were cleaned out. The total sediment that has been removed to the current date is approximately 23,508 tons; therefore, the ponds are working as designed to keep this sediment out of Lake Osakis. To maintain the performance of the ponds, periodical maintenance is needed. The operation and maintenance plan states that the ponds need to be cleaned out when 25% to 30% of their capacity has been reached so that the ponds will properly operate. Based on the rate of sediment buildup in the primary pond, cleanout may be required more frequently than the estimated five years. To date, the primary pond has been cleaned out three times. The secondary pond has been cleaned once. The removed sediment has already exceeded the original modeling projection of 14,172 tons over 16.5 years.


Primary Pond
Sediment Analysis
N
0 50 100 200
Feet
Sauk River
Watershed District
Estimated Volume (Cubic Yards):
79.0
174.4
102.5
187.4
215.6
254.9
223.1
Design
BioBase Survey
Difference (Survey - Design)
Feet AMSL
1324
1323
1322
1321
1320
1319
1318
1317
1316
Feet AMSL
1324
1323
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1
2
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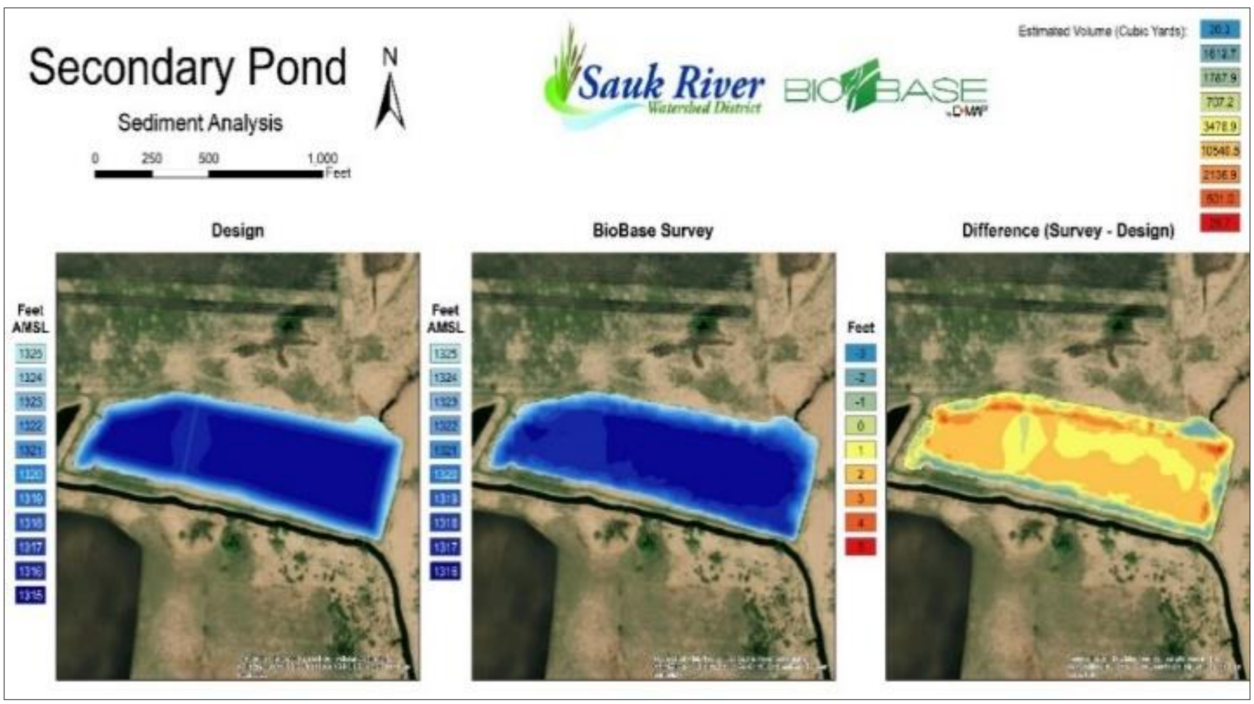
4
5


Secondary Pond
Sediment Analysis
N
0 250 500 1,000
Feet
Sauk River
Watershed District
Estimated Volume (Cubic Yards):
1612.7
1787.9
707.2
3478.9
10540.5
2136.9
Design
BioBase Survey
Difference (Survey - Design)
Feet AMSL
1325
1324
1323
1322
1321
1320
1319
1318
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Feet AMSL
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1321
1320
1319
1318
1317
1316
Feet
-3
-2
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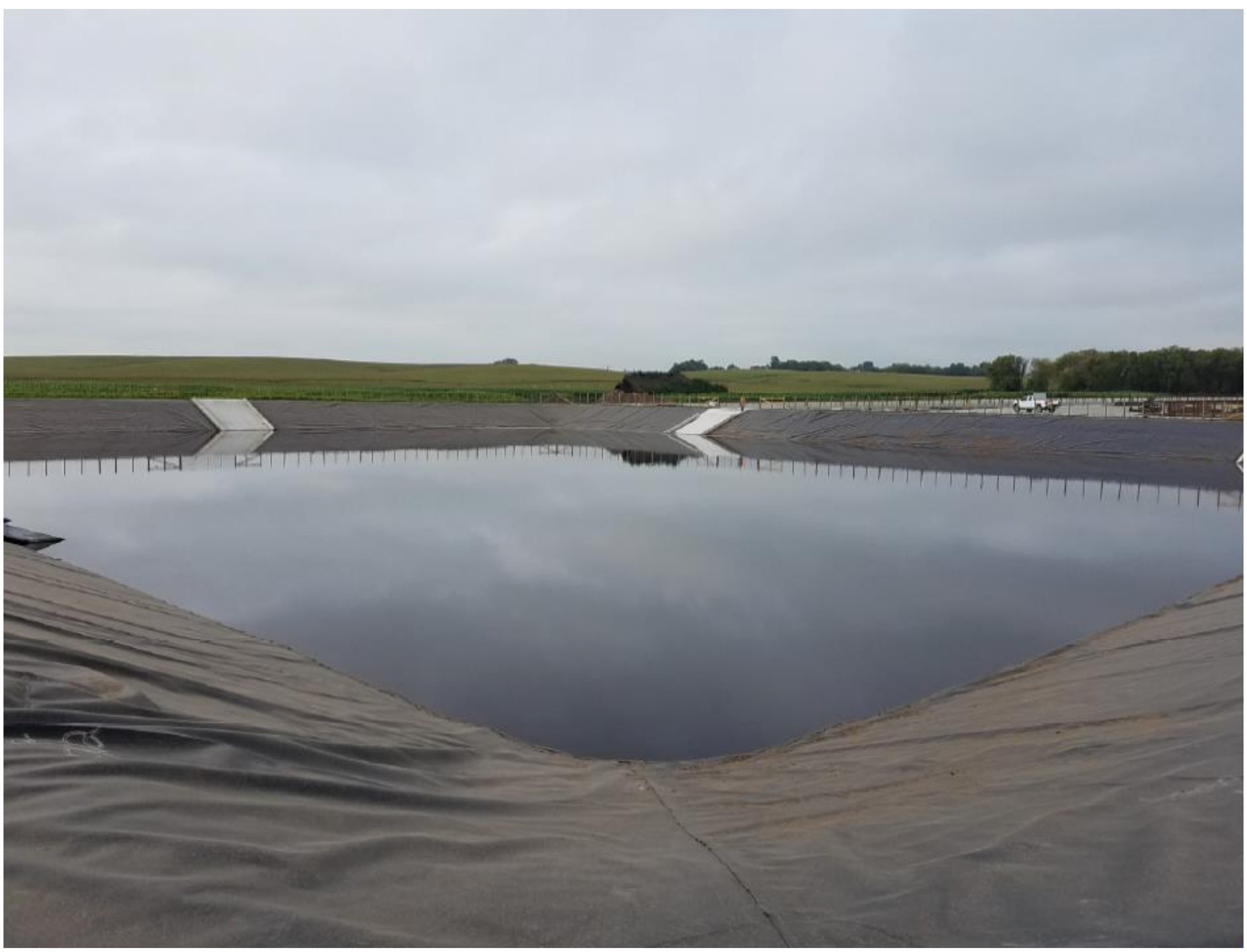
0
1
2
3
4
5

3.2 Conservation Easements and Wetland Restorations – Sauk Lake Management District

Conservation easements and wetland restorations were installed throughout the SRW in 2018, 2019, and 2020. Partners included landowners, the Stearns County SWCD, the SRWD, the Minnesota Land Trust (MLT), the Longspur Prairie Fund, the USDA/Farm Service Agency (FSA), the USDA/NRCS, and the Board of Water and Soil Resources (BWSR). The project was to enhance and permanently protect more than 300 acres within the SRW. The partnership worked together to complete Conservation Reserve Enhancement Program (CREP) easements, MLT easements, and wetland restorations to protect and improve water quality and wildlife habitat while simultaneously helping the landowners build a legacy of habitat protection. This project used approximately $469,000 in state funds, $559,000 in federal funds, $31,000 in landowner funds, and $5,000 in other funds.

3.3 Sauk River Waste Management System – Centre Sauk River Management District

A water management system was installed in 2017. Partners included the landowner, the Stearns County SWCD, the MDA, the NRCS, and the SRWD. This project consisted of an earthen basin lined with a high-density polyethylene (HDPE) liner and a concrete-stacking slab. The runoff from the feedlot flowed to a waterway that emptied into a tributary of the Sauk River. The earthen basin now collects the feedlot runoff so that those nutrients do not enter the waters of the state. The feedlot runoff water from the basin is applied through the irrigation system. The concrete-stacking slab stores solid manure from the feedlot. This manure is applied to the cropland at agronomic rates to better use these nutrients. The crop rotation is a corn/soybean/alfalfa/small-grain rotation. The landowners are also experimenting with using cover crops as a nutrient source while helping to control erosion in their cropland. This project should reduce pollution discharge, improve water quality, lead to the environmentally sound and efficient application of manure, and sustain the agriculture industry. The project was estimated to reduce P loss by 41 lbs per year, chemical oxygen demand (COD) by 2,975 lbs per year, 5-day biochemical oxygen demand (BOD_5) by 661 lbs per year, and nitrogen by 156 lbs per year. This project used approximately $450,000 in federal funds and $25,000 in MDA funds.

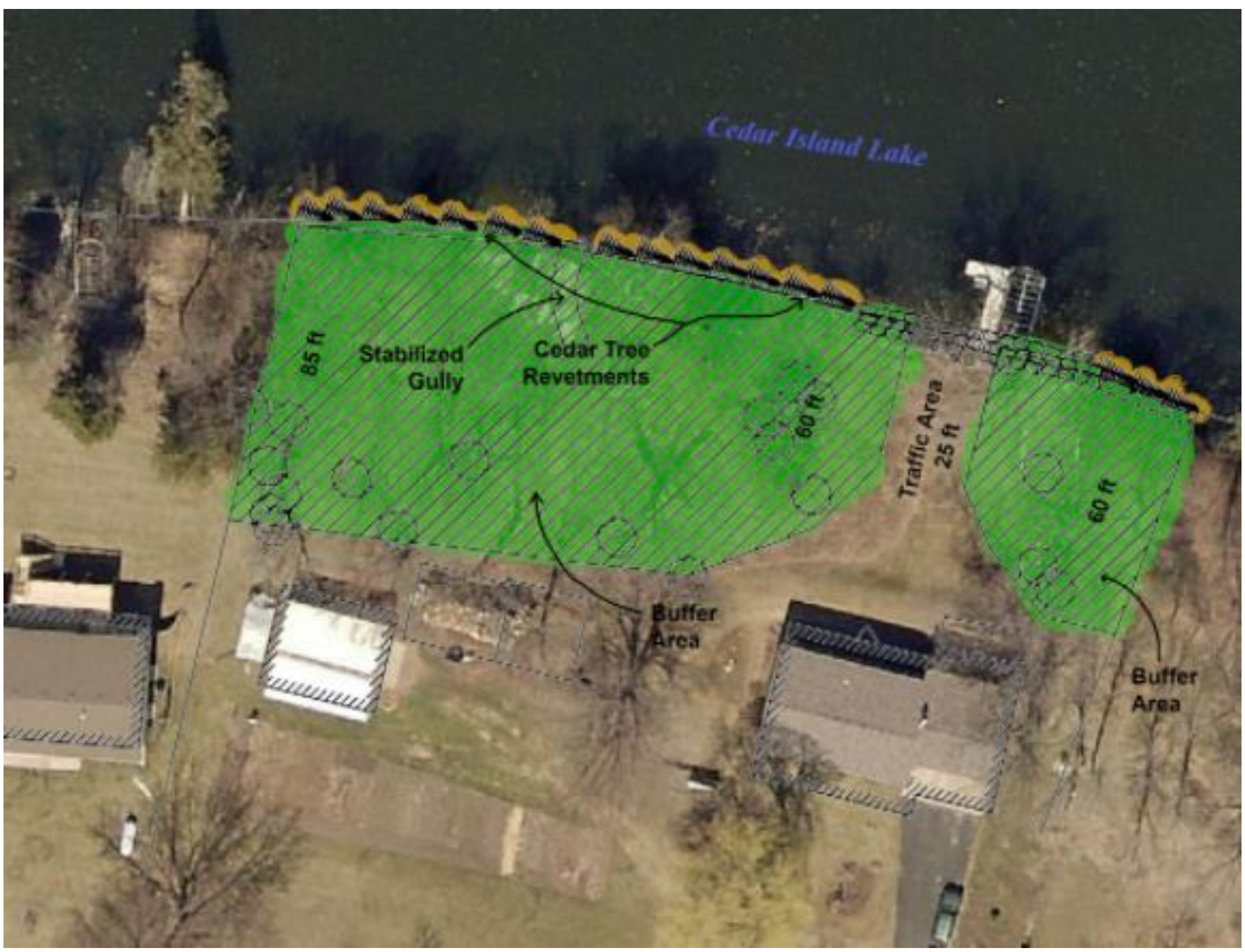


3.4 City of Sauk Centre Stormwater Improvements – Sauk Lake and Centre Sauk River Management Districts

A 2018 petition project from the City of Sauk Centre helped with stormwater improvements in conjunction with the City of Sauk Centre Street Improvements project. The SRWD helped to fund the installation of three stormwater retention ponds and a stormwater separator placed to receive stormwater discharging to Sauk Lake and the Sauk River. It was estimated that the project removes 16,882 lbs of TSS per year and 46.9 lbs of TP per year (per Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds [P8] modeling).

3.5 Cedar Island Lake Shoreland Stabilization 1 – Chain of Lakes Management District

Shoreland stabilization was completed on Cedar Island Lake in 2009. Partners were the landowner, the Stearns County SWCD, the DNR, and BWSR. This project combined a unique design and implementation that addressed an existing gully as well as erosion along the shoreline. Cedar tree revetments were used to stabilize the shoreline and allow the native vegetation to establish itself. The landowners preferred to leave a large area along the shoreline natural and unmown. This project was estimated to prevent 6 lbs of P loss per year and 6 tons of sediment loss per year. The project used approximately $10,300 in state funds and $3,400 in landowner funds.



3.6 Cedar Island Lake Shoreland Stabilization 2 – Chain of Lakes Management District

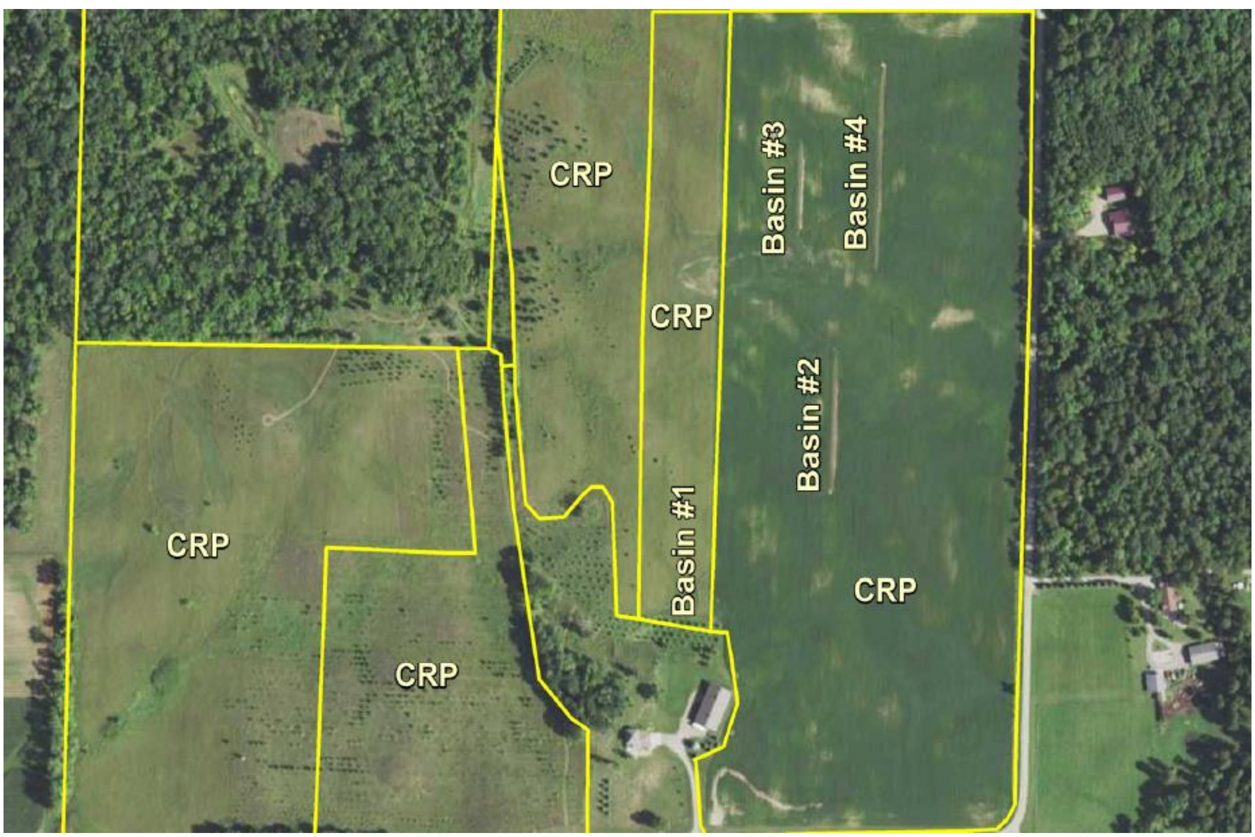
Shoreland stabilization was completed on Cedar Island Lake in 2015. Partners were the landowner, the Stearns County SWCD, and the DNR. This project incorporated multiple practices to stabilize a failing slope near Cedar Island Lake. Tile trenches were installed into the slope to intercept the surface water and groundwater for stabilization purposes. A stormwater storage tank was installed to capture the runoff from the building site. This water is now used for irrigation purposes. In addition, the shoreline and adjacent slope were restored by regrading and planting with native vegetation. This project was estimated to prevent 545 lbs of P loss per year and 474 tons of sediment loss per year. The project used approximately $22,800 in state funds and $6,200 in landowner funds.

3.7 Great Northern Lake Shoreland Restoration – Chain of Lakes Management District

Shoreland restoration was completed on Great Northern Lake in 2006. Partners were the landowner, the Stearns County SWCD, and the DNR. The project involved removing a failing retaining wall and grading and restoring the slope with native vegetation. The landowner expanded the native planting on their property to an extra adjacent lot, which created a true native-landscape ambiance. This project was estimated to prevent 9.5 lbs of P loss per year and 9.4 tons of sediment loss per year. The project used approximately $17,800 in state funds and $5,900 in landowner funds.

3.8 Sauk River Erosion Control 1 – Gully Control and Wildlife Habitat – Chain of Lakes Management District

WASCOBs were constructed in 2015, while native tree and grass planting for uplands and wildlife and wetland restoration (Conservation Reserve Program [CRP]) were constructed in 2006, 2010, and 2017 in the SRW. Partners were the NRCS, Minnesota Agricultural Water Quality Certification Program (MAWQCP) project funds, the Stearns County SWCD, and the FSA. The landowners attempted to solve soil-erosion problems on areas of their farm. In 2006, the landowners turned to the NRCS and SWCD for technical and financial assistance and enrolled some land into the federal CRP program, which helped to solve erosion issues and allowed the owners to view wildlife while generating income from the property. In 2010, the landowners enrolled more land into the CRP, and in 2015, they installed four basins on the remaining cropland. In 2017, the landowners enrolled the remaining cropland into the CRP and planted native grasses and wildflowers. The project components included underground outlets, subsurface drains, critical area planting, native grass planting, and hardwood planting. Expected benefits included ephemeral and classic gully control, sheet and rill erosion control, wildlife habitat, and improved farmability. This project used approximately $4,100 in state funds, $31,700 in federal funds, and $11,900 in landowner investment.



3.9 Sauk River Erosion Control 02 – Erosion and Water-Runoff Control – Chain of Lakes Management District

WASCOBs and grassed waterways were constructed in 2018 in the Horseshoe Lake Watershed. Partners on this job were the landowner, the Stearns County SWCD, the NRCS, the SRWD, the Sauk River Chain of Lakes, and Munson Township. This watershed that feeds into Horseshoe Lake had been dealing with erosion problems and water-runoff-control issues. The landowner and Munson Township worked with the Stearns County SWCD to implement a series of conservation practices, including three WASCOBs, a grass waterway, and associated erosion-control methods on the direct outlets. The project components included basins, waterways, and runoff control. Expected benefits included sediment reduction, nutrient reduction, farming efficiency, and reductions in P loss of 59 lbs per year and sediment of 59 lbs per year. This project used approximately $16,200 in state funds, $8,300 in federal funds, $1,400 in landowner investment, $4,000 in Sauk River Chain of Lakes Association funds, and $2,800 in Munson Township funds.

3.10 Conservation Partners – Cold Spring Fen Legacy Grant Project – Cold Spring Management District

In 2018, the SRWD, in partnership with The Nature Conservancy, DNR, MLT, and other organizations, received a Conservation Partners Legacy (CPL) grant to restore a 70-acre property as a fen wetland. The MLT permanently protected the property with a conservation easement and the partners collaborated to restore the site. The site contains a floodplain along the Sauk River and is adjacent to a SNA. Before the MLT easement was in place, the property was at risk of development. A natural drainage that borders the site was previously straightened to facilitate drainage, and through this project, the drainage was redirected to the wetland area. This redirection created a unique habitat for fish and wildlife while also improving the water quality by stabilizing the area and minimizing future runoff from the site. The grant of $127,000 ended on June 30, 2021. The partners provided $15,400 in match funds, which was a landowner donation for the easement via the MLT.




3.11 Sauk River Conservation Reserve Enhancement and Watershed Habitat Protection and Restoration – Cold Spring Management District

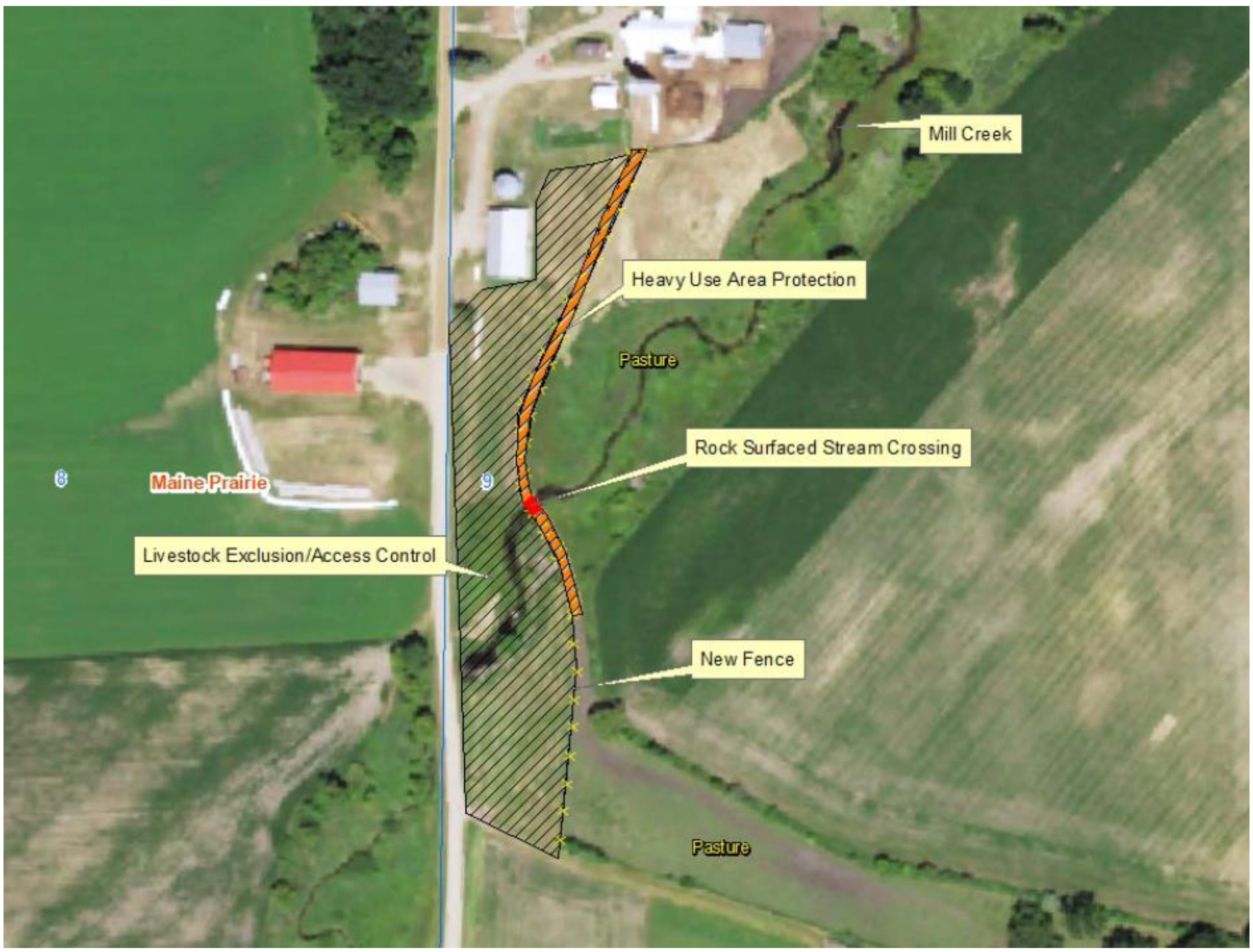
Conservation reserve enhancement and watershed habitat protection and restoration were completed in the Cold Spring Wellhead Protection Area to protect the Cold Spring Wellhead, protect and restore wildlife habitat, and reduce nitrate pollution. These practices will lead to improved drinking water quality in the Cold Spring area. A landowner in the Cold Spring Wellhead Protection Area who was interested in permanent protection for his land began working with a Stearns SWCD soil conservationist to enroll his cropland in the CREP; however, the landowner also had 45 acres of non-cropland that were not eligible for the CREP. The SRW Easement Program was fortunately available and helped the landowner to protect the entire property. The landowner agreed to donate the easement value of his property to protect the entire parcel. With a current RIM easement on an adjacent parcel, this step was influential in protecting the Cold Spring Wellhead. By combining multiple programs, the Stearns County SWCD was able to meet the landowner's goals for his property. This project was estimated to add 54 acres of the CREP and 45 acres of SRWD easements, protect 99 acres of habitat, and restore 44 acres of habitat. The project was estimated to reduce P loss by 37.4 lbs per year and sediment by 24.6 tons per year. The project used approximately $112,300 in state funds, $146,400 in federal funds, and $26,700 in landowner investments.

3.12 Mill Creek Waste-Storage Facility – Grand Pearl Management District

A waste-storage facility was created on Mill Creek in 2015. Partners were the landowner, the Stearns County SWCD, the West Central Technical Service Area, and the USDA/NRCS. The landowner also expressed interest in seeding the disturbed areas with pollinator habitat. The landowner gained four to five months of manure storage. Nutrients in surface water were the identified resource of concern because of a lack of long-term manure storage. Manure was improperly being applied to cropland during sensitive times of the year. The dairy operation did not have enough storage space for manure to properly apply the manure to cropland in areas identified in a Comprehensive Nutrient Management Plan. From 2013 to 2015, the project was in the design phase and plans were being completed. A waste-storage lagoon was installed to handle manure and water from the dairy barn. In addition to the lagoon, a stacking slab was installed to handle the manure from the feedlots. This project used approximately $250,000 in federal funds coordinated with assistance from the Stearns SWCD and $42,800 in landowner funds.

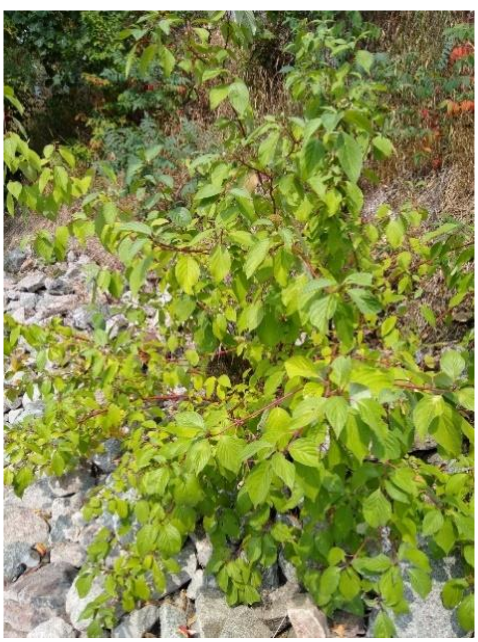
3.13 Rock-Surfaced Stream Crossing – Grand Pearl Management District

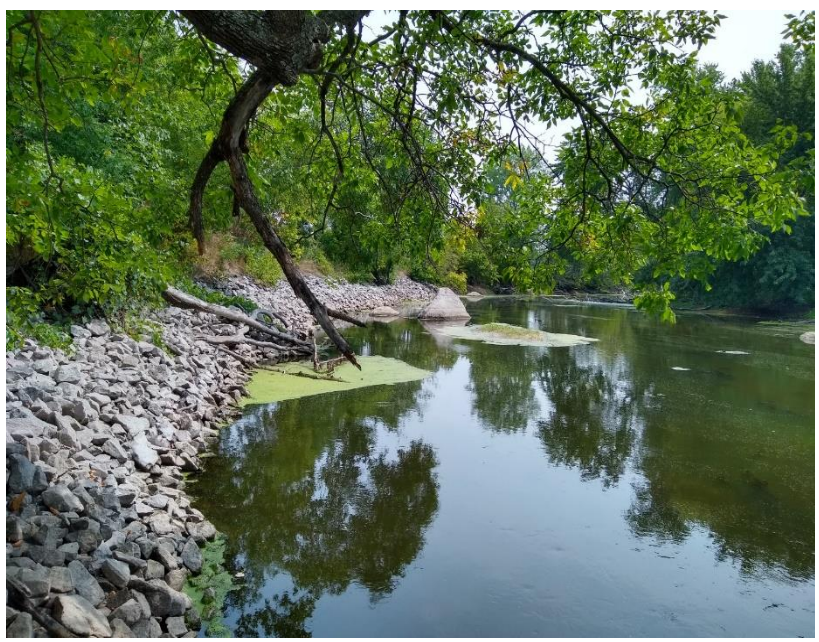
A rock-surfaced stream crossing, livestock exclusion/access control, and hayland seeding were installed in 2015. The project components included heavy use area protection, a silt fence, rock riprap in the stream, fencing, and perennial cover establishment. Expected benefits included stream bank erosion control, reduced nutrient and bacterial loads to Mill Creek, reduced nutrient loading to Pearl Lake, and better livestock control between the farmstead and back pasture. This project was expected to reduce P loss by 8.17 lbs per year and sediment by 6.95 tons per year. The project used approximately $10,100 in funding with the Environmental Quality Incentives Program (EQIP) covering 75% and the landowner covering 25% of the cost.



3.14 City of Rockville Stream Bank Stabilization – Cold Spring and Mini Metro Management Districts

A 2018 petition project from the City of Rockville helped to restore approximately 275 ft of the Sauk River. The SRWD helped to fund the project with technical oversight by the Stearns County SWCD and a West Central Technical Service Area engineer. The project was expected to reduce P loss by 46.92 lbs per year and sediment by 46.92 tons per year.





3.15 City of St. Cloud – Whitney Park Project Dam Removal and Sauk River Stream Bank Stabilization – Mini Metro Management District

Dam removal and stream bank stabilization were completed on the Sauk River in St. Cloud at Whitney Park in 2016 and 2017. Partners were the West Central Technical Service Area, the City of St. Cloud, the SRWD, and the DNR. The Whitney Park site had a severely eroded outside bank. This steep slope along 450 ft of stream bank has areas that are up to 30 ft in elevation. The City of St. Cloud approached the Stearns County SWCD for technical and financial assistance to address the problem. The SWCD, along with the West Central Technical Service Area, designed a low-impact approach to stabilizing the stream bank. The project involved constructing a toewood bench and using field stone rock for stream barbs. In addition, when the slope was regraded, a native grass and wildflower seeding was completed. Trees and shrubs were also planted from potted stock. The entire site was covered with an erosion-control blanket to ensure stabilization. As a part of the project, the low-head dam in the river upstream of the slope failure was determined to be causing the stream bank erosion problem and was removed. This project was estimated to prevent loss of 389 lbs of P per year and 388 tons of sediment per year. The project used approximately $338,000 in state funds and $15,800 in funds from the City of St. Cloud.

3.16 Sauk River Watershed District School Visits and Water Festivals

The SRWD staff have been giving in-class presentations to kindergarten through Grade 12 students. Generally, presentations are given to Grades 4, 7, and 10 and high school elective classes at Melrose, ROCORI, Osakis, and Sartell School Districts. Topics include macroinvertebrates, water chemistry, habitats/conservation, and water properties. Presentations are given to approximately 5,000 students per year.

Each year, approximately 2,500 Grade 4 students, 500 teachers and parents, and 550 volunteers gather for water festivals (WaterFests) in the district. The SRWD funds the supplies, venues (if applicable), volunteer lunches, and bussing costs. Volunteers provide time, talent, and supplies to teach children about the watershed, rivers/streams, and lakes.

3.17 Melrose Mitigation Groundwater Protection Rule Level 2 and Roscoe Mitigation Level 1 (MDA)

The MDA uses monitoring data provided by the MDH to determine which wells are subject to mitigation requirements. Wells that have nitrate levels greater than or equal to 5.4 mg/L but less than 8 mg/L at any point in the previous 10 years fall within the guidelines for a Mitigation Level 1 determination. Wells with nitrate at or above 8 mg/L at any point in the last 10 years, or that are projected to exceed 10 mg/L in the next 10 years, are within the guidelines for Mitigation Level 2. Melrose is Level 2 and Roscoe is Level 1. Nitrate levels are used to determine the mitigation level unless the MDA determines that a point source is causing the well to exceed these levels or the MDA delays the determination of a mitigation level decision for good cause.

Final mitigation level determinations are made after the MDA conducts a review of the quality of the monitoring data; the condition and vulnerability of the well; the hydrogeology and groundwater flow paths for groundwater flowing into the well; and potential point sources, such as an agricultural chemical facility, septic system(s), feedlot(s), or a poorly constructed well that may be contributing significantly to nitrate levels in the well.

Level 2 sites will progress to Level 3 (the first regulatory level) if one of the following occurs: after not less than 3 growing seasons or the estimated lag time, whichever is longer, the recommended BMPS are not adopted on 80% of the cropland acres (excluding soybeans); or the nitrate concentrations in groundwater continue to increase; or, after not less than three growing seasons the residual soil nitrate below the root zone increases. If Level 3 is reached, requirements kick in. Level 4 is the second regulatory level. If nitrate-nitrogen in the public water supply well exceed 9 mg/L for any three samples in the previous 10 years; or after three years the residual soil nitrate below the root zone increases; or after three years or the estimated lag time, whichever is longer, the nitrate levels continue to increase, then the DWSMA would be increased to Level 4, were landowners can be required to implement additional practices (https://www.mda.state.mn.us/gwpr-faqs).

4. Monitoring plan

The intent of the SRWD, as a local partner conducting water quality monitoring, is to track water quality improvements and degradation. As a general guideline, progress benchmarks have been established for this watershed with a goal that improvements will occur each year that result in a water quality pollutant concentration decline that is equivalent to approximately 1% of the starting (i.e., long-term) pollutant concentration. For example, for a lake with a long-term growing-season TP concentration of 90 µg/L, by Year 10, the concentration would be 90 – (10 × 0.9) = 81 µg/L. The SRWD monitoring program is adjusted as needed, but the overall plan is kept consistent to ensure that long-term-trend data are available for tracking purposes and to avoid data gaps.

As mentioned above, this guideline is general. Factors that may cause slower progress include limits in funding and/or landowner acceptance, challenging fixes (e.g., unstable bluffs and ravines, invasive species), and unfavorable climatic factors. Conversely, progress may be faster for some impaired waters, especially where high-impact fixes are slated to occur.

Data from four monitoring programs will continue to be collected and analyzed for the SRW as part of the Minnesota Water Quality Monitoring Strategy for 2011 through 2021 and for 2021 through 2031 [MPCA, 2011b and MPCA, 2021d]. These monitoring programs are summarized as follows:

1. Through the IWM approach, chemistry and biological data are collected throughout each major watershed once every 10 years. (See Watershed Approach to Restoring and Protecting Water Quality.) The second cycle of IWM for the SRW was completed in 2018 and 2019. A third cycle of IWM would occur in 2028-2029. These data provide a periodic but intensive snapshot of water quality throughout the watershed. In addition to the monitoring conducted in association with this process, other watershed partner organizations (e.g., local, state, federal, tribal) within the watershed may request monitoring through the State and Local Needs process and/or may have their own monitoring activities. All of the data collected locally should be submitted regularly to the MPCA for entry into the Environmental Quality Information System (EQuIS) database for ultimate use in water quality assessments.

2. The Watershed Pollutant Load Monitoring Network intensively collects pollutant samples and flow data to calculate sediment and nutrient loads on either an annual or seasonal (no-ice) basis. In the SRW, two subwatersheds and one watershed pollutant load-monitoring sites exist. The two subwatershed sites include the Ashley Creek at Westport CSAH33 (16002002) and the Sauk River near St. Martin CR 12 (16051001). The watershed site is located on the Sauk River near St. Cloud (16058004).

3. The Volunteer Monitoring Network is a network of volunteers who make monthly lake and river transparency readings (Figure 9). These data provide a continuous record of one water quality parameter (transparency/turbidity) throughout much of the watershed.

4. The SRWD has a robust water quality monitoring program that includes water chemistry sampling and flow measurements along with continuous water-level data collection. This monitoring occurs on the mainstem of the Sauk River, at several locations on primary tributaries to the Sauk River, and in lakes throughout the watershed. The monitoring program objectives are to track long-term water quality trends; evaluate project and program effectiveness; and use the monitoring results in making

sound, science-based decisions on future projects/programs. The SRWD also assisted the MPCA with IWM data collection to prepare for the original WRAPS and this Update. The SRWD has collected TP, orthophosphate, total Kjeldahl nitrogen, nitrate-nitrite, chloride, TSS, instantaneous DO, specific conductivity, pH, temperature, flow, and water-level data on the Sauk River and primary tributaries. The SRWD collected TP, orthophosphate, chl-*a*, total Kjeldahl nitrogen, chloride, Secchi disk depth, instantaneous DO profile, specific conductivity, pH, and temperature data on approximately 20 lakes within the watershed on a rotating basis. The SRWD has also collected bottom samples as needed.

In addition to the monitoring conducted via the programs noted above, other monitoring programs have collected, and will continue to collect, data on surface-water resources within or associated with this watershed. These programs are described as follows.

Minnesota's Fish Contaminant Monitoring Program [MPCA, 2008] – This program helps to support human health and environmental protection programs within Minnesota by providing information on fish consumption, mercury cycling/trends, and the analysis of potential newly identified bioaccumulative pollutants.

Wetland Monitoring and Assessment - Wetlands are an integral part of Minnesota's water resources, and wetland-monitoring information will be an essential component in the implementation of efforts to protect and restore lakes and streams.

Further monitoring of stormwater ponds in urban areas would be a helpful source of additional data.

Other than stormwater ponds, the dataset in the SRW is very robust, especially when combined with the HSPF modeling effort. Additional data that would be helpful throughout the watershed would include more continuous-type data, such as DO and temperature, for longer time periods. DO can be extremely variable in a stream during different times of the year. These data would be helpful to further inform the model application.

Figure 9. Citizen lake monitor volunteers using Secchi disk to measure lake clarity.

The Sauk River CWMP [RESPEC, 2021] outlines further monitoring needs to fill data gaps. Needs in the CWMP include assessment of baseflow in public-drainage systems in the watershed for developing hydrographs and a better understanding of storage goals; further assessment of how groundwater contamination is occurring from surficial uses; assessment of the existing stormwater ponds and P release; assessment of wetland water quality benefits to P discharge; stormwater monitoring in the Mini Metro Management District; and monitoring the time of travel to the city of St. Cloud drinking water. A helpful piece of information for any watershed is a summary of what has been done so far and what is going to be happening. To have the community go through and flag locations online where they have made improvements or plan to make improvements would be a very helpful exercise. More information about future monitoring is included in Section 6 of the CWMP.

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Sauk River Reports

All Sauk River reports referenced in this watershed report are available at the Sauk River Watershed webpage: Sauk River | Minnesota Pollution Control Agency (state.mn.us)

6. Appendix

Tables throughout Appendix A include information from reports found at [Sauk River | Minnesota Pollution Control Agency (state.mn.us)], from [Minnesota's Impaired Waters List | Minnesota Pollution Control Agency (state.mn.us)], from the Sauk River CWMP [RESPEC, 2021], and from the associated TMDL project [Kirby et al., 2021].

Table A-1. Summary of impaired streams/rivers in the Sauk River Watershed from [Minnesota's Impaired Waters List | Minnesota Pollution Control Agency (state.mn.us)].

Management district	Name	Description	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Boss Creek	Baugh Cr to Pitt Lk	2020	07010202-589	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Boss Creek	Baugh Cr to Pitt Lk	2020	07010202-589	2Bg, 3C	Fish bioassessments	AQL	5
	Crooked Lake Ditch	Unnamed cr to Lk Osakis	2006	07010202-552	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Crooked Lake Ditch	Unnamed cr to Lk Osakis	2020	07010202-552	2Bg, 3C	DO	AQL	5
	Crooked Lake Ditch	Unnamed cr to Lk Osakis	2012	07010202-552	2Bg, 3C	*E. coli*	AQR	5, In progress
	Crooked Lake Ditch	Unnamed ditch to Unnamed cr	2020	07010202-581	2Bg, 3C	Fish bioassessments	AQL	5
	Crooked Lake Ditch	Unnamed cr to Fairfield Cr	2020	07010202-637	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Crooked Lake Ditch	Unnamed cr to Fairfield Cr	2020	07010202-637	2Bg, 3C	Fish bioassessments	AQL	5
Osakis Lake	Unnamed creek	Unnamed lk (77-0168-00) to Little Lk Osakis	2020	07010202-638	2Bg, 3C	Fish bioassessments	AQL	5
	Ashley Creek	Headwaters to Sauk Lk	2012	07010202-503	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Ashley Creek	Headwaters to Sauk Lk	1998	07010202-503	2Bg, 3C	DO	AQL	5
	Ashley Creek	Headwaters to Sauk Lk	2012	07010202-503	2Bg, 3C	Fish bioassessments	AQL	5
	Ashley Creek	Headwaters to Sauk Lk	2010	07010202-503	2Bg, 3C	*E. coli*	AQR	4A
	County Ditch 6	Unnamed cr to Ashley Cr	2006	07010202-521	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	County Ditch 6	Unnamed cr to Ashley Cr	2002	07010202-521	2Bg, 3C	Fish bioassessments	AQL	5
	Hoboken Creek	Co Rd 18 to Sauk Lk	2020	07010202-721	2Bg, 3C	Fish bioassessments	AQL	5
	Sauk River	Juergens Lk to Sauk Lk	1994	07010202-673	2Bg, 3C	DO	AQL	5
	Sauk River	Juergens Lk to Sauk Lk	2012	07010202-673	2Bg, 3C	Fish bioassessments	AQL	5
Sauk Lake	Silver Creek	West Union Lk outlet to Unnamed cr	2020	07010202-640	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5

Management district	Name	Description	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Silver Creek	West Union Lk outlet to Unnamed cr	2020	07010202-640	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Headwaters to Sauk R	2012	07010202-592	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Hoboken Cr	2020	07010202-624	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Hoboken Cr	2020	07010202-624	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed ditch	Unnamed cr to Sauk Lk	2012	07010202-666	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed ditch	Unnamed cr to Sauk Lk	2012	07010202-666	2Bg, 3C	Fish bioassessments	AQL	5
Adley Creek	Adley Creek	Sylvia Lk to Sauk R	2020	07010202-527	2Bg, 3C	Fish bioassessments	AQL	5
	Adley Creek	Sylvia Lk to Sauk R	2010	07010202-527	2Bg, 3C	*E. coli*	AQR	4A
Centre Sauk River	County Ditch 44	Unnamed cr to Sauk R	2020	07010202-723	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	County Ditch 44	Unnamed cr to Sauk R	2020	07010202-723	2Bg, 3C	Fish bioassessments	AQL	5
	Sauk River	Adley Cr to Getchell Cr	2012	07010202-505	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5, In progress
	Sauk River	Adley Cr to Getchell Cr	2012	07010202-505	2Bg, 3C	Fish bioassessments	AQL	5, In progress
	Sauk River	Adley Cr to Getchell Cr	2012	07010202-505	2Bg, 3C	*E. coli*	AQR	5, In progress
	Sauk River	Melrose Dam to Adley Cr	2012	07010202-506	2Bg, 3C	Fish bioassessments	AQL	5
	Sauk River	Sauk Lk to Melrose Dam	2012	07010202-507	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Unnamed lk	2020	07010202-647	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Unnamed lk	2020	07010202-647	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2020	07010202-654	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2020	07010202-654	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	-94.964, 45.672 to Unnamed cr	2020	07010202-733	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5

Management district	Name	Description	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Unnamed creek	–94.964, 45.672 to Unnamed cr	2020	07010202-733	2Bg, 3C	Fish bioassessments	AQL	5
	Getchell Creek (County Ditch 26)	Unnamed cr to Getchell Lk	2020	07010202-727	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Getchell Creek (County Ditch 26)	Unnamed cr to Getchell Lk	2020	07010202-727	2Bg, 3C	DO	AQL	5
	Getchell Creek (County Ditch 26)	Unnamed cr to Getchell Lk	2020	07010202-727	2Bg, 3C	Fish bioassessments	AQL	5
	Getchell Creek (County Ditch 26)	Unnamed cr to Getchell Lk	2012	07010202-727	2Bg, 3C	*E. coli*	AQR	5
	Getchell Creek (County Ditch 26)	Getchell Lk to Sauk R	2006	07010202-729	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Getchell Creek (County Ditch 26)	Getchell Lk to Sauk R	2020	07010202-729	2Bg, 3C	DO	AQL	5
	Getchell Creek (County Ditch 26)	Getchell Lk to Sauk R	2012	07010202-729	2Bg, 3C	*E. coli*	AQR	5
	Stony Creek	Headwaters (Unnamed lk 73-0261-00) to –94.836, 45.55	2010	07010202-724	2Bg, 3C	*E. coli*	AQR	4A
	Stony Creek	–94.836, 45.55 to T124 R33W S22, east line	2010	07010202-725	2Bg, 3C	*E. coli*	AQR	4A
	Stony Creek	T124 R33W S23, west line to Sauk R	2020	07010202-726	2Bg, 3C	TSS	AQL	4A
	Stony Creek	T124 R33W S23, west line to Sauk R	2010	07010202-726	2Bg, 3C	*E. coli*	AQR	4A
	Unnamed creek	Unnamed cr to Sauk R	2008	07010202-542	2Bg, 3C	Turbidity	AQL	4A
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-542	2Bg, 3C	*E. coli*	AQR	5, In progress
	Unnamed creek	Unnamed ditch to Unnamed cr	2012	07010202-598	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Getchell Cr	2020	07010202-615	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
GUS Plus	Unnamed creek	Unnamed cr to Getchell Cr	2020	07010202-615	2Bg, 3C	DO	AQL	5

Management district	Name	Description	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Unnamed creek	Unnamed cr to Getchell Cr	2020	07010202-615	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Getchell Cr	2012	07010202-615	2Bg, 3C	*E. coli*	AQR	5
	Unnamed creek	Unnamed cr to Stony Cr	2020	07010202-655	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Unnamed cr	2020	07010202-657	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Unnamed cr	2020	07010202-657	2Bg, 3C	Fish bioassessments	AQL	5
Saint Roscoe	Sauk River	Getchell Cr to State Hwy 23	2010	07010202-508	2Bg, 3C	*E. coli*	AQR	4A
	Unnamed creek	Unnamed cr to Unnamed cr	2006	07010202-554	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-556	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-556	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-660	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-660	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Sauk R	2012	07010202-662	2Bg, 3C	Fish bioassessments	AQL	5
Chain of Lakes	Eden Lake Outlet	Headwaters (Eden Lk 73-0150-00) to Browns Lk	2012	07010202-545	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Eden Lake Outlet	Headwaters (Eden Lk 73-0150-00) to Browns Lk	2010	07010202-545	2Bg, 3C	DO	AQL	5
	Eden Lake Outlet	Headwaters (Eden Lk 73-0150-00) to Browns Lk	2012	07010202-545	2Bg, 3C	Fish bioassessments	AQL	5
	Eden Lake Outlet	Headwaters (Eden Lk 73-0150-00) to Browns Lk	2012	07010202-545	2Bg, 3C	*E. coli*	AQR	5
	Kolling Creek	Unnamed cr to Becker Lk	2010	07010202-575	2Bg, 3C	DO	AQL	5

Management district	Name	Description	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Unnamed creek	Unnamed cr to Vails (Mud) Lk	2012	07010202-550	7	*E. coli*	AQR	5, In progress
	Unnamed creek	Unnamed cr to Schneider Lk	2010	07010202-616	2Bg, 3C	DO	AQL	5
	Unnamed creek	Unnamed cr to Unnamed cr	2020	07010202-648	2Bg, 3C	Fish bioassessments	AQL	5
	Unnamed creek	Unnamed cr to Unnamed cr	2012	07010202-663	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
Cold Spring	Sauk River	Knaus Lk to Cold Spring Dam	2016	07010202-517	2Bg, 3C	Nutrients	AQR	5, In progress
	Sauk River	Cold Spring WWTP to Mill Cr	2012	07010202-520	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5, In progress
	Sauk River	Cold Spring WWTP to Mill Cr	2012	07010202-520	2Bg, 3C	Fish bioassessments	AQL	5, In progress
	Unnamed creek	Grand Lk to Mill Cr	2022*	07010202-560	2Bg, 3C	*E. coli*	AQR	5, In progress
	Unnamed creek (Cold Spring Creek)	T123 R30W S15, west line to Sauk R	2012	07010202-567	1B, 2Ag, 3B	*E. coli*	AQR	5, In progress
Grand Pearl	Mill Creek	Headwaters (Goodners Lk 73-0076-00) to Pearl Lk	2012	07010202-674	2Bg, 3C	Benthic macroinvertebrates bioassessments	AQL	5
	Mill Creek	Headwaters (Goodners Lk 73-0076-00) to Pearl Lk	2012	07010202-674	2Bg, 3C	Fish bioassessments	AQL	5
	Mill Creek	Headwaters (Goodners Lk 73-0076-00) to Pearl Lk	2012	07010202-674	2Bg, 3C	*E. coli*	AQR	4A
	Mill Creek	Pearl Lk to Sauk R	2006	07010202-676	2Bg, 3C	Fecal coliform	AQR	4A
	Unnamed ditch	Headwaters to Pearl Lk	2012	07010202-665	2Bg, 3C	*E. coli*	AQR	5
Mini Metro	Sauk River	Mill Cr to Mississippi R	2016	07010202-501	2Bg, 3C	Nutrients	AQR	5, In progress

Table A-2. Impairment status (nutrient impaired, aquatic recreation) of lakes in the Sauk River Watershed, presented (mostly) from west to east by management district from Minnesota's Impaired Waters List | Minnesota Pollution Control Agency (state.mn.us).

Management district	Name	Year listed	ID	Proposed use subclass	Impairment	Affected use	EPA category
	Maple	2010	77-0181-00	2B, 3C	Nutrients	AQR	4A
	Osakis	2004	77-0215-00	2B, 3C	Nutrients	AQR	4A
Osakis Lake	Smith	2008	21-0016-00	2B, 3C	Nutrients	AQR	4A
	Guernsey	2012	77-0182-00	2B, 3C	Nutrients	AQR	4A
	Juergens	2012	77-0163-00	2B, 3C	Nutrients	AQR	4A
	Little Sauk	2012	77-0164-00	2B, 3C	Nutrients	AQR	4A
	SAUK (NORTH BAY)	2004	77-0150-02	2B, 3C	Nutrients	AQR	4A
	Sauk (Southwest Bay)	2004	77-0150-01	2B, 3C	Nutrients	AQR	4A
Sauk Lake	Westport	2010	61-0029-00	2B, 3C	Nutrients	AQR	4A
	Ellering	2012	73-0244-00	2B, 3C	Nutrients	AQR	5, In progress
	Maria	2006	73-0215-00	2B, 3C	Nutrients	AQR	5, In progress
	McCormic	2010	73-0273-00	2B, 3C	Nutrients	AQR	4A
Centre Sauk River	Uhlenkolts	2012	73-0208-00	2B, 3C	Nutrients	AQR	4A
	Henry	2012	73-0237-00	2B, 3C	Nutrients	AQR	4A
GUS Plus	Sand	2010	73-0199-00	2B, 3C	Nutrients	AQR	4A
	Bolfing	2004	73-0088-00	2B, 3C	Nutrients	AQR	5
	Cedar Island (Koetter Lk)	2004	73-0133-03	2B, 3C	Nutrients	AQR	5
	Cedar Island (Main Bay)	2004	73-0133-01	2B, 3C	Nutrients	AQR	5
	Eden	2010	73-0150-00	2B, 3C	Nutrients	AQR	5
	Great Northern	2004	73-0083-00	2B, 3C	Nutrients	AQR	5
	Horseshoe	2004	73-0157-00	2B, 3C	Nutrients	AQR	5
	Knaus	2004	73-0086-00	2B, 3C	Nutrients	AQR	5
	Krays	2004	73-0087-00	2B, 3C	Nutrients	AQR	5
	Long	2004	73-0139-00	2B, 3C	Nutrients	AQR	5
	North Brown's	2008	73-0147-00	2B, 3C	Nutrients	AQR	5
	Schneider	2004	73-0082-00	2B, 3C	Nutrients	AQR	5
	Vails	2010	73-0151-00	2B, 3C	Nutrients	AQR	5
Chain of Lakes	Zumwalde	2004	73-0089-00	2B, 3C	Nutrients	AQR	5
	Goodners	2012	73-0076-00	2B, 3C	Nutrients	AQR	5, In progress
Grand Pearl	Pearl	2008	73-0037-00	2B, 3C	Nutrients	AQR	4A

Table A-3. Water clarity trends for lakes from CLMP data ([Transparency trends | Minnesota Pollution Control Agency [state.mn.us]])

Management district	Lake ID	County	Lake name	Trend
	21-0003-00	Douglas	Clifford (Swims)	Insufficient Data
	21-0007-00	Douglas	Herberger	Insufficient Data
	21-0016-00	Douglas	Smith	No Trend
	21-0729-00	Douglas	Unnamed	Insufficient Data
	77-0181-00	Todd	Maple	Improving
	77-0195-00	Todd	Faille	Insufficient Data
	77-0201-00	Todd	Little Osakis	Insufficient Data
	77-0215-00	Todd	Osakis	No Trend
Osakis Lake	77-0202-00	Todd	Unnamed	Insufficient Data
	21-0011-00	Douglas	Kuntz	Insufficient Data
	21-0012-00	Douglas	Schultz	Insufficient Data
	61-0029-00	Pope	Westport	Improving
	77-0149-01	Todd	Long (Main Basin)	Improving
	77-0149-02	Todd	Long (South Bay)	Improving
	77-0150-01	Todd	Sauk (Sw Bay)	No Change
	77-0150-02	Todd	Sauk (North Bay)	No Change
	77-0151-00	Todd	Mud	Insufficient Data
	77-0154-00	Todd	Fairy	Improving
	77-0163-00	Todd	Juergens (Joergens)	Insufficient Data
	77-0164-00	Todd	Little Sauk (Longbridge)	No Trend
	77-0182-00	Todd	Guernsey	Insufficient Data
	77-0258-00	Todd	Unnamed	Insufficient Data
	77-0160-00	Todd	Cedar	Insufficient Data
	77-0180-00	Todd	William	Insufficient Data
Sauk Lake	77-0259-00	Todd	Unnamed	Insufficient Data
	73-0226-00	Stearns	Cedar	Insufficient Data
	73-0249-00	Stearns	Sylvia	No Trend
	77-0010-00	Todd	Bass	Insufficient Data
	77-0084-01	Todd	Big Birch (North)	Improving
	77-0084-02	Todd	Big Birch (South)	No Change
	77-0089-00	Todd	Little Birch	Improving
	77-0018-00	Todd	Goose	Insufficient Data
Adley Creek	77-0115-00	Todd	Felix	Insufficient Data
	73-0208-00	Stearns	Uhlenkolts	Insufficient Data
	73-0215-00	Stearns	Maria	Improving
	73-0231-00	Stearns	Long	Insufficient Data
	73-0233-00	Stearns	Kings	Degrading
Centre Sauk River	73-0241-00	Stearns	Black Oak	No Trend

Management district	Lake ID	County	Lake name	Trend
	73-0244-00	Stearns	Ellering	Insufficient Data
	73-0255-00	Stearns	Cedar	Insufficient Data
	73-0273-00	Stearns	McCormic	No Trend
	73-0251-01	Stearns	Melrose (Se Basin)	Insufficient Data
	73-0183-00	Stearns	St. Anna	No Trend
	73-0199-00	Stearns	Sand	Improving
	73-0237-00	Stearns	Henry	Insufficient Data
	73-0217-00	Stearns	Getchell	Insufficient Data
	73-0219-00	Stearns	Lovell	Insufficient Data
GUS Plus	73-0220-00	Stearns	Mud	Insufficient Data
Saint Roscoe	73-0159-00	Stearns	Big	Improving
	73-0082-00	Stearns	Schneider	Improving
	73-0083-00	Stearns	Great Northern	No Trend
	73-0086-00	Stearns	Knaus	No Change
	73-0087-00	Stearns	Krays	No Change
	73-0088-00	Stearns	Bolfing	No Trend
	73-0089-00	Stearns	Zumwalde	No Change
	73-0106-00	Stearns	Big Fish	Improving
	73-0107-00	Stearns	Long	Improving
	73-0132-00	Stearns	Thein	Insufficient Data
	73-0133-01	Stearns	Cedar Island (Main Bay)	No Change
	73-0133-02	Stearns	Cedar Island (Mud Lk)	Insufficient Data
	73-0133-03	Stearns	Cedar Island (Koetter Lk)	No Trend
	73-0133-04	Stearns	Cedar Island (East Lk)	Insufficient Data
	73-0139-00	Stearns	Long	No Change
	73-0147-00	Stearns	North Brown's	Degrading
	73-0150-00	Stearns	Eden	No Trend
	73-0151-00	Stearns	Mud (Vails)	No Trend
	73-0156-00	Stearns	Becker	No Trend
	73-0157-00	Stearns	Horseshoe	No Trend
	73-0133-05	Stearns	Cedar Island (Little)	Insufficient Data
Chain of Lakes	73-0173-00	Stearns	School	Insufficient Data
	73-0037-00	Stearns	Pearl	No Change
	73-0038-00	Stearns	Carnelian	Degrading
	73-0055-00	Stearns	Grand	Improving
	73-0057-00	Stearns	Rausch	Insufficient Data
Grand Pearl	73-0076-00	Stearns	Goodners	Insufficient Data
	73-0051-00	Stearns	Pleasant	Improving
	73-0317-00	Stearns	Unnamed	Insufficient Data
Mini Metro	73-0703-00	Stearns	Unnamed (Quarry 11)	Improving

Table A-4. Lakes that are nearly or barely impaired from the LPSS, LBCA, LH, LOBS DNR spreadsheets [Radomski, 2021].

AUID	Name	Mean TP (µg/L) (2019/2021)	Standard (µg/L)	% of standard (2019/2021)	Annual change (2019–2021) (%)	2019 status	2019 trend	2021 status	2021 trend	CLMP trend
73-0231-00	Long	31/34	40	–23/–15	5	Nearly	Insufficient Data	Nearly	Insufficient Data	Insufficient Data
73-0055-00	Grand	33/30	40	–18/–26	5	Nearly	Improving	NA (<25% below standard)	No Change	Improving
77-0089-00	Little Birch	33/17	40	–18/–59	5	Nearly	Improving	NA (<25% below standard)	Improving	Improving
73-0037-00	Pearl	34/37	40	–15/–8	4	Nearly	No Trend	Nearly	No Trend	No Trend
77-0201-00	Little Osakis	35/35	40	–14/–14	0	Nearly	Insufficient Data	Nearly	Insufficient Data	Insufficient Data
77-0151-00	Mud	64/70	60	6/16	5	Barely	Insufficient Data	Barely	Insufficient Data	Insufficient Data
73-0156-00	Becker	49/58	40	22/44	5	Barely	No Trend	NA (>25% above standard)	No Trend	No Trend
73-0107-00	Long	22/35	40	–46/–13	5	NA (>25% below the standard)	Increasing	Nearly	Improving	Improving
77-0084-02	Big Birch	27/32	40	33/–20	5	NA (>25% below the standard)	No Trend	Nearly	No Trend	No Trend
73-0233-00	Kings	29/42	40	–28/5	23	(>25% below the standard)	Degrading	Barely	No Trend	Degrading
61-0029-00	Westport	76/73	60	27/22	–2	(>25% above the standard)	Improving	Barely	Improving	Improving

Table A-5. Water quality impairments that are addressed in the Sauk River TMDL Report completed as part of this WRAPS Update project [Kirby et al., 2021].

Name	Lake/ stream	ID	Proposed use subclass	Impairment	Year listed
Sauk River (Mill Creek to Mississippi River)	Stream	07010202-501	2Bg, 3C	Nutrients	2016
Sauk River (Adley Creek to Getchell Creek)	Stream	07010202-505	2Bg, 3C	*E. coli*	2012
				MIBI	2012
				FIBI	2012
Sauk River (Knaus Lake to Cold Spring Dam)	Stream	07010202-517	2Bg, 3C	Nutrients	2016
Sauk River (Cold Spring WWTP to Mill Creek)	Stream	07010202-520	2Bg, 3C	MIBI	2012
				FIBI	2012
Unnamed Creek (Unnamed Creek to Sauk River)	Stream	07010202-542	2Bg, 3C	*E. coli*	2012
Unnamed Creek (Unnamed Creek to Vails Lake)	Stream	07010202-550	7	*E. coli*	2012
Crooked Lake Ditch (Unnamed Creek to Lake Osakis)	Stream	07010202-552	2Bg, 3C	*E. coli*	2012
Unnamed creek (Grand Lake to Mill Creek)	Stream	07010202-560	2Bg, 3C	*E. coli*	2022[(a)]
Cold Spring Creek (T123 R30W S15, West Line to Sauk River)	Stream	07010202-567	1B, 2Ag, 3B	*E. coli*	2012
Goodners	Lake	73-0076-00	2B, 3C	Nutrients	2012
Maria	Lake	73-0215-00	2B, 3C	Nutrients	2006
Ellering	Lake	73-0244-00	2B, 3C	Nutrients	2012

(a) Proposed for inclusion in the 2022 303d Impaired Waters List.

Figure A-1. TMDLs completed as part of this WRAPS Update project [Kirby et al., 2021].

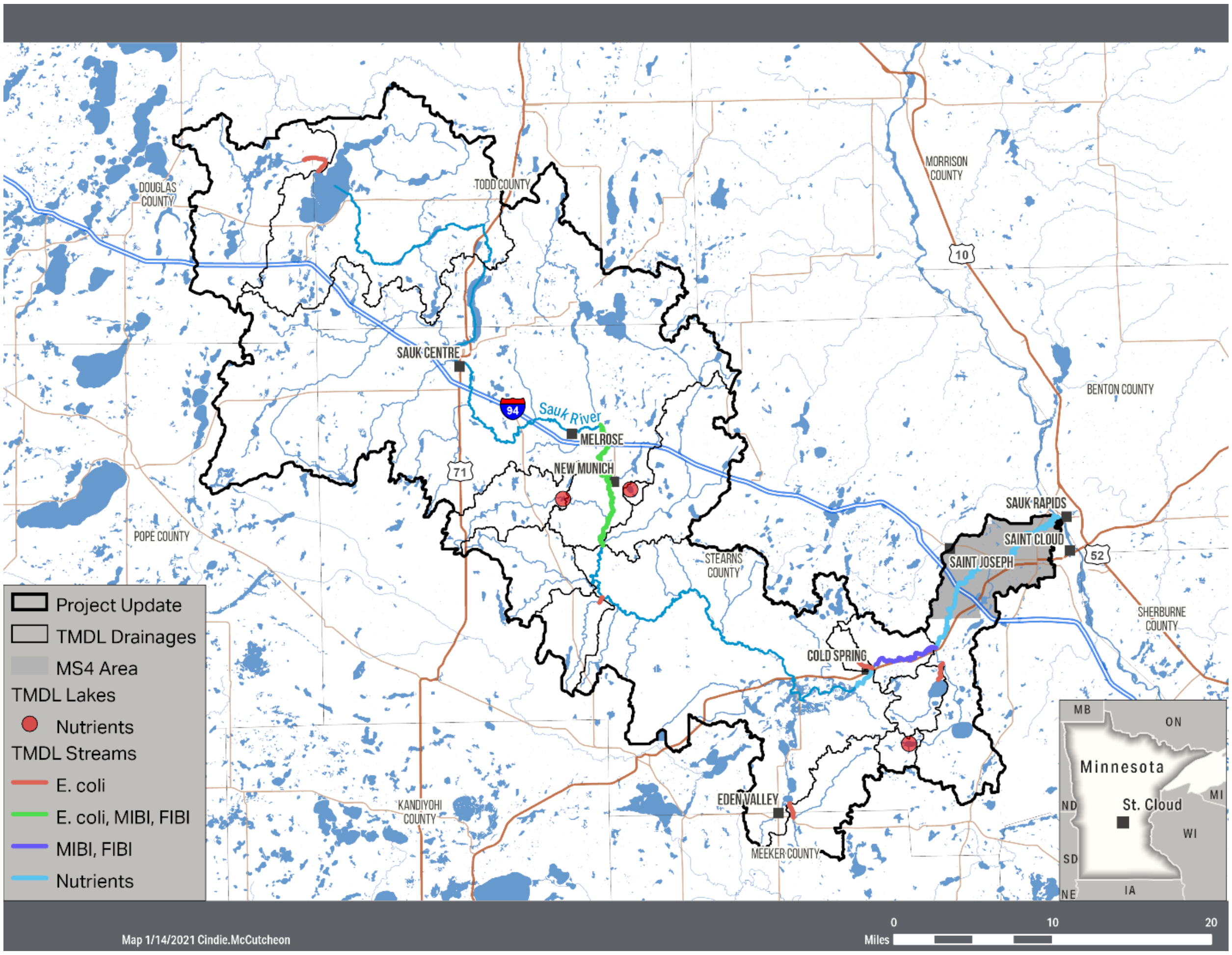

Table A-6. Water quality impairments that are addressed in the Sauk River Chain of Lakes TMDL Report [MPCA and Emmons & Oliver Resources, Inc., 2021].

Name	Lake/ stream	ID	Proposed use subclass	Impairment	Year listed
Bolfing	Lake	73-0088-00	2B, 3C	Nutrients	2004
Cedar Island (East Lake)	Lake	73-0133-04	2B, 3C	Nutrients	2022[(a)]
Cedar Island (Koetter Lake)	Lake	73-0133-03	2B, 3C	Nutrients	2004
Cedar Island (Main Bay)	Lake	73-0133-01	2B, 3C	Nutrients	2004
Eden	Lake	73-0150-00	2B, 3C	Nutrients	2010
Great Northern	Lake	73-0083-00	2B, 3C	Nutrients	2004
Horseshoe	Lake	73-0057-00	2B, 3C	Nutrients	2004
Knaus	Lake	73-0086-00	2B, 3C	Nutrients	2004
Krays	Lake	73-0087-00	2B, 3C	Nutrients	2004
Long	Lake	73-0139-00	2B, 3C	Nutrients	2004
North Browns	Lake	73-0147-00	2B, 3C	Nutrients	2008
Zumwalde	Lake	73-0089-00	2B, 3C	Nutrients	2004
Vails	Lake	73-0151-00	2B, 3C	Nutrients	2010
Schneider	Lake	73-0082-00	2B, 3C	Nutrients	2004

(a) Proposed for inclusion in the 2022 303d Impaired Waters List

Figure A-2. TMDLs completed as a part of the Chain of Lakes TMDLs [MPCA and Emmons & Oliver Resources, Inc., 2021]

Table A-7. Water quality impairments that are addressed in the 2018 Sauk River Bacteria and Nutrients TMDL Report [MPCA, 2018].

Name	Lake/ stream	ID	Proposed use subclass	Impairment	Year listed
Ashley Creek (Headwaters to Sauk Lake)	Stream	07010202-503	2B, 3C	*E. coli*	2010
Sauk River (Getchell Creek to State Highway 23)	Stream	07010202-508	2B, 3C	*E. coli*	2010
Adley Creek (Sylvia Lake to Sauk River)	Stream	07010202-527	2B, 3C	*E. coli*	2010
Stony Creek (Headwaters to Sauk River)	Stream	07010202-541	2B, 3C	*E. coli*	2010
Maple	Lake	73-0181-00	2B, 3C	Nutrients	2010
Little Sauk	Lake	73-0164-00	2B, 3C	Nutrients	2012
Guernsey	Lake	73-0182-00	2B, 3C	Nutrients	2012
Juergens	Lake	73-0163-00	2B, 3C	Nutrients	2012
Westport	Lake	61-0029-00	2B, 3C	Nutrients	2010
Sand	Lake	73-0199-00	2B, 3C	Nutrients	2010
Henry	Lake	73-0237-00	2B, 3C	Nutrients	2012
Uhlenkolts	Lake	73-0208-00	2B, 3C	Nutrients	2012
McCormic	Lake	73-0273-00	2B, 3C	Nutrients	2010

Figure A-3. TMDLs completed in the 2018 Sauk River Nutrients and Bacteria TMDL [MPCA, 2018].

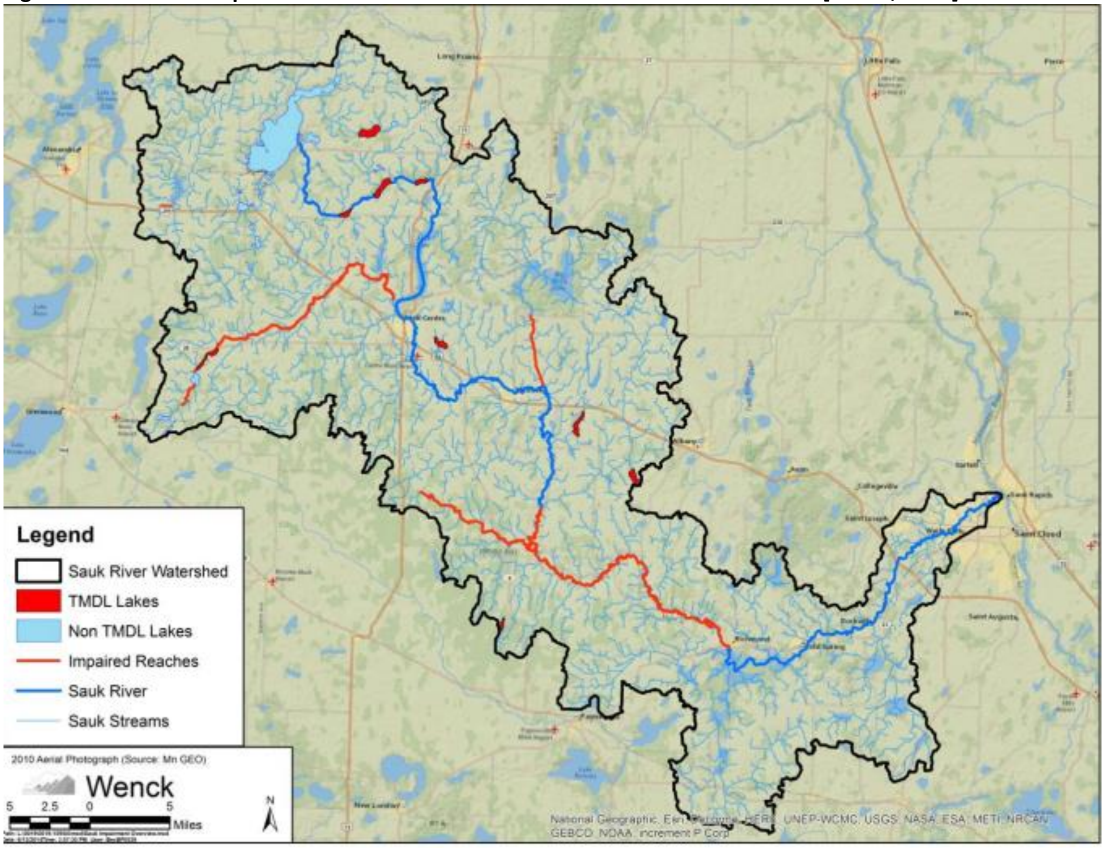

Table A-8. Required *E. coli* reductions by flow zone as determined from the TMDL studies [Kirby et al., 2021 and MPCA, 2018].

Name/ description	Stream ID	Flow zone reduction needed				
		Very high (%)	High (%)	Mid (%)	Low (%)	Very low (%)
Sauk River (Adley Creek to Getchell Creek	07010202-505	0	22	0	0	0
Unnamed Creek (Unnamed Creek to Sauk River)	07010202-542	90	89	86	90	19
Unnamed Creek (Unnamed Creek to Vails Lake)	07010202-550	0	0	0	0	(a)
Crooked Lake Ditch (Unnamed Creek to Lake Osakis)	07010202-552	90	0	0	0	0
Unnamed Creek (Grand Lake to Mill Creek)	07010202-560	(a)	0	42	38	(a)
Cold Spring Creek (T123 R30W S15, West Line to Sauk River)	07010202-567	0	0	0	29	2
Adley Creek (Sylvia Lake to Sauk River)	07010202-527	0	0	26	67	0
Stony Creek (Headwaters to Sauk River)	07010202-541	0	50	0	86	80
Ashley Creek (Headwaters to Sauk Lake)	07010202-503	0	0	0	31	37
Sauk River (Getchell Creek to State Highway 23)	07010202-508	0	0	0	15	0

(a) No data available to calculate current load

Table A-9. Required TSS reductions by flow zone as determined from the TMDL studies [Kirby et al., 2021].

Description	Stream ID	Pollutant	Flow zone reduction needed				
			Very high (%)	High (%)	Mid (%)	Low (%)	Very low (%)
Sauk River (Adley Creek to Getchell Creek)	07010202-505	TSS	81	63	51	42	0

Table A-10. Required total phosphorus reductions as determined from the TMDL studies [Kirby et al., 2021].

Description	Stream ID	Reduction Needed (%)
Sauk River (Knaus Lake to Cold Spring Dam)	07010202-517	40
Sauk River (Cold Spring WWTP to Mill Creek)	07010202-520	39
Sauk River (Mill Creek to Mississippi River)	07010202-501	29

Table A-11. Required TP allocations for each impaired lake as determined from the TMDL studies [Kirby et al., 2021 and MPCA and Emmons & Oliver Resources, Inc., 2021].

Name	ID	Allocations (lb/year)									Reduction needed (%)
		Wasteload allocation			Load allocation					Margin of safety	
		WWTFs	Construction and industrial stormwater	MS4 communities	Watershed load	Internal load	Upstream lakes	Septic	Atmosphere		
Maple	73-0181-00	—	8	—	384	183	0	0	93	35	64
Little Sauk	73-0164-00	—	70	—	362	131	4,760	0	68	285	31
Guernsey	73-0182-00	—	54	—	960	260	3,286	0	29	246	28
Juergens	73-0163-00	—	75	—	470	777	4,562	0	28	311	30
Westport	61-0029-00	—	16	—	978	164	0	0	49	63	36
Sand	73-0199-00	—	2.0	—	28	193	0	0	50	10	79
Henry	73-0237-00	—	0.4	—	1.9	4.5	0	0	16.9	1.2	98
Uhlenkolts	73-0208-00	—	8	—	199	113	0	0	57	19	85
McCormic	73-0273-00	—	7	—	427	34	0	0	49	27	37
Bolfing	73-0088-00	—	0.4	—	181	0	167	0	32	34	26
Cedar Island (East Lake)*	73-0133-04	—	0.2	—	109	0	64,665	0	81	11,814	35
Cedar Island (Koetter Lake)	73-0133-03	—	0.2	—	119	0	65,302	0	39	5,865	29
Cedar Island (Main Bay)	73-0133-01	—	1.6	—	680	85	738	0	152	0.2	34
Zumwalde	73-0089-00	—	0.2	—	91	360	65,497	0	39	Implicit	36
Eden	73-0150-00	—	0.4	—	166	0	1,838	0	78	110	73
Schneider	73-0082-00	—	2	—	1032	0	0	0	16	55	38
Great Northern	73-0083-00	—	2	—	123	0	66,316	0	56	1,814	34
Vails	73-0151-00	—	4	—	2,390	0	0	0	45	128	73
Horseshoe North	73-0157-00	10,750	106	—	49,497	0	4,976	0	19	3,439	45
Horseshoe South	73-0057-00	—	0.4	—	88	237	2353	0	94	146	51

Name	ID	Allocations (lb/year)									Reduction needed (%)
		Wasteload allocation			Load allocation					Margin of safety	
		WWTFs	Construction and industrial stormwater	MS4 communities	Watershed load	Internal load	Upstream lakes	Septic	Atmosphere		
Horseshoe West	73-0057-00	—	0.6	—	273	0	203	0	75	0.5	7
Knaus	73-0086-00	—	2	—	1,179	983	67,465	0	64	Imp	42
Krays	73-0087-00	—	0.2	—	64	248	67,379	0	27	Imp	38
Long	73-0139-00	—	1	—	571	21	1,719	0	146	130	63
North Browns	73-0147-00	—	1.2	—	2,344	0	0	0	94	128	83
Goodners	73-0076-00	—	0.6	—	264	0	0	0	46	29	41
Maria	73-0215-00	—	1.0	—	407	0	0	0	23	48	35
Ellering	73-0244-00	247	6.9	—	2,823	0	0	0	10	343	75

Table A-12. Probable stressors to aquatic life in biologically impaired reaches in the Sauk River Watershed from Sauk River Watershed Cycle 2 Stressor Identification Report (state.mn.us).

Management zone	Stream	AUID	Aquatic Life impairment	DO	Total phosphorus	Nitrate toxicity	TSS	Connectivity	Altered hydrology	Habitat	Flow	No definitive stressor
Osakis Lake (1)	Crooked Lake Ditch	552	M-Inverts, Fish, DO, TSS	•	•		•		○	•		
	Crooked Lake Ditch	581	Fish, DO	•	○				○	•		
	Boss Creek	589	M-Inverts, Fish, DO	•	◊			◊	•	•		
	Crooked Lake Ditch	637	M-Inverts, Fish, DO	•					○	•		
	Trib. to Little Lake Osakis	638	Fish	◊	X			•	•			
Sauk Lake (2)	Pope County Ditch 6	521	Fish	•	•		◊		•	•	•	
	Unnamed Creek	592	Fish							?		•
	Unnamed Creek	613	Fish	X	•		◊	○	•	•		
	Unnamed Creek	624	M-Inverts, Fish		•			•	◊			
	Silver Creek	640	M-Inverts, Fish, DO	•	•	◊	◊	•	•	•	•	

Management zone	Stream	AUID	Aquatic Life impairment	DO	Total phosphorus	Nitrate toxicity	TSS	Connectivity	Altered hydrology	Habitat	Flow	No definitive stressor
Adley Creek (3)	Adley Creek	527	Fish, DO	•	◊			X	•			
	Unnamed Creek	647	M-Inverts, Fish	?	•		•	•	•	•		
	Unnamed Creek	654	M-Inverts, Fish	•				◊				
	Stearns County Ditch 44	723	M-Inverts, Fish		◊			•	•			
Centre Sauk River (4)	Unnamed Creek	733	M-Inverts, Fish	?	◊	○		•	•	•		
	Unnamed Creek	615	M-Inverts, Fish, DO	•	•				•	•		
	Trib. to Stony Creek	655	Fish					•	•			
	Unnamed Creek	657	M-Inverts, Fish					•	•			
	Stony Creek	724	Fish					•	•	•		
	Stony Creek	725	M-Inverts, Fish	◊			?	•	•			
	Getchell Creek	727	Fish, DO	•	•				•	•		
GUS Plus (5)	Getchell Creek	729	M-Inverts, Fish, DO	•	•	○			•	•		
Saint Roscoe (6)	Unnamed Creek	735	M-Inverts, Fish					•		•		
Chain of Lakes (7)	Unnamed Creek	633	M-Inverts, Fish	•	•			X	•	•		

○ A "root cause" stressor, which leads to consequences that become direct stressors

◊ Possible contributing root cause

• Determined to be a direct stressor

X A secondary stressor

? Inconclusive

Table A-13. Point sources in the Sauk River Watershed.

District	Facility	Permit	Type
Osakis Lake	Osakis WWTP	MN0020028	Domestic
Sauk Lake	Wayne Transports Inc.	MNR053CNR	Industrial
	Jacks Auto Parts LLC	MNR053BDK	Industrial
	Kens Iron Salvage and Recycling Inc.	MNR053CYG	Industrial
	Standard Iron & Wire Works Inc	MNR0539DT	Industrial
Centre Sauk River	GEM Sanitary District	MNG580205	Domestic
	New Munich WWTP	MN0025631	Domestic
	Melrose WWTP	MN0020290	Domestic
	Sauk Centre WWTP	MN0024821	Domestic
	Sauk Centre WTP	MNG820025	Domestic
	Carstens Industries Fiberglass Manufacturing	MNR0539MS	Industrial
	Carstens Industries Fiberglass Manufacturing	MNR0539MS	Industrial
	Jennie-O Turkey Store - Melrose Plant	MNR0539H5	Industrial
	Land O' Lakes Inc.	MNR053CCJ	Industrial
	Sauk Centre Municipal Airport	MNR0538DY	Industrial
	Waste Management - Sauk Centre Transfer Station	MNR053DJ4	Industrial
	Waste Management - Sauk Centre Transfer Station	MNR053DJ4	Industrial
	Jennie-O Turkey Store Inc - Melrose East	MNR053B3H	Industrial
	Duininck Inc	MNG490046	Industrial
Adley Creek	Central Specialties Inc	MNG490071	Industrial
GUS Plus	Lake Henry WWTP	MN0020885	Domestic
	Freeport WWTP	MNG580019	Domestic
Saint Roscoe	Roscoe WWTP	MN0066133	Domestic
	Richmond WWTP	MN0024597	Domestic
	Saint Martin WWTP	MN0024783	Domestic
	Liberty Tire Services of Ohio LLC - Sauk Valley	MNR053C27	Industrial
	FedEx Freight Inc - STC	MNR053C6V	Industrial
	Rotochopper, Inc	MNR053CTM	Industrial
Chain of Lakes	Eden Valley WWTP	MN0023281	Domestic
	RIE Coatings LLC	MNR053B8K	Industrial
	TK Demolition Disposal	MNR053CV4	Industrial
Cold Spring	Cold Spring WWTP	MN0023094	Domestic
	Cold Spring Brewing Co	MNR05387S	Industrial
	North Central Auto Parts	MNR053B3C	Industrial
	Cold Spring Brewing Co - Plant B	MNR053F4V	Industrial
Grand Pearl	Kraemer Trucking & Excavating	MNG490327	Industrial
	Cold Spring Granite Company	MNG490143	Industrial
Mini Metro	Park Industries	MNR053CJC	Industrial
	DCI Inc.	MNR05384Y	Industrial
	Grede LLC - Saint Cloud	MNR05396J	Industrial
	CWMF Corporation	MNR0539GC	Industrial

District	Facility	Permit	Type
	Joe's Auto Parts	MNR0539XZ	Industrial
	PAM's Auto, Inc	MNR0538FY	Industrial
	WestRock Converting LLC	MNR053CF8	Industrial
	Park Industries	MNR0535V9	Industrial
Mini Metro (cont.)	XPO Logistics Freight, Inc. - XBD	MNR053BJS	Industrial
	Northland Choice	MNR053CGS	Industrial
	American Manufacturing Co	MNR0539D8	Industrial
	Fabral	MNR053BG8	Industrial
	Salzl Floor Center Inc dba StoneCrafters	MNR053D84	Industrial
	Knife River Central Minnesota	MNG490003	Industrial
	Hardrives Inc – Nonmetallic	MNG490083	Industrial

Table A-14. Feedlots in the Sauk Watershed.

District	Animal units	CAFOS	AFOS
Osakis Lake	10,918	3	121
Sauk Lake	49,094	10	293
Centre Sauk River	65,674	12	346
Adley Creek	28,333	5	191
GUS Plus	58,757	8	364
Saint Roscoe	32,135	4	211
Chain of Lakes	26,543	3	170
Cold Spring	3,409	0	40
Grand Pearl	11,272	0	88
Mini Metro	1,325	0	22
Total	287,460	45	1,846

Table A-15. Individual metric and ranking for mainstem Sauk River priority breakpoints from the CWMP [RESPEC, 2021].

Description	Target endpoints	Altered hydrology	Number of impairments	Achievability (TSS)	Achievability (total phosphorus)	Connected to impaired lakes	Disturbed area	Total score	Total ranking
Above Chain of Lakes	370	0.5	1	0.83	0.99	1	1	5.32	1
Above Adley Creek	150	0.5	1	0.91	0.93	0	0.75	4.09	2
Above Getchell Creek	230	0.5	0.75	1.00	1.00	0	0.5	3.75	3
Above Lake Osakis	10	1	0.25	0.02	0.30	1	0.75	3.32	4
Below Chain of Lakes	420	0.5	0.5	0.35	0.94	0	0.5	2.78	5
Above Sauk Lake	70	0.5	0.5	0.00	0.00	1	0.5	2.50	5
Above Mill Creek	430	0.25	0.25	0.37	0.88	0	0.5	2.24	7
Outlet to Mississippi River	490	0.25	0.5	0.33	0.85	0	0.25	2.18	8

Table A-16. Individual metric and ranking for impaired lakes in the Sauk River Watershed from the CWMP [RESPEC, 2021].

Lake name	DNR ID	Depth class	Nearly/barely	Public access (number)	Watershed to lake area ratio	Immediate impact on priority downstream waters	Total score	Presence of water clarity trend	Total ranking
Pearl	73003700	deep	1	1	0.75	1	3.75	No evidence of trend	1
Bolfing	73008800	deep	0	1	1	1	3	Increasing trend	2
Goodners	73007600	deep	0	1	0.75	1	2.75		3
Schneider	73008200	deep	0.75	1	0	1	2.75	Increasing trend	4
McCormic	73027300	shallow	0.75	1	1	0	2.75	No evidence of trend	5
Smith	21001600	deep	0.75	1	0.75	0	2.5	Increasing trend	6
Long	73013900	deep	0	1	0.25	1	2.25	Increasing trend	7
North Brown's	73014700	deep	0	1	0.25	1	2.25	Decreasing trend	8
Eden	73015000	deep	0	1	0.25	1	2.25	Decreasing trend	9
Westport	61002900	shallow	0.75	1	0.5	0	2.25	Increasing trend	10
Sand	73019900	shallow	0	1	1	0	2	Increasing trend	11
Maple	77018100	deep	0.25	1	0.75	0	2	Increasing trend	12
Vails	73015100	deep	0	1	0	1	2	No evidence of trend	13
Uhlenkolts	73020800	deep	0	1	0.75	0	1.75	NA	14
Maria	73021500	deep	0	0	1	0	1	Increasing trend	15
Henry	73023700	shallow	0	0	1	0	1	NA	16
Faille	77019500	shallow	0	0	0	1	1	NA	17
Ellering	73024400	deep	0	0	0	0	0	NA	18

Table A-17. Overall prioritization results from the CWMP [RESPEC, 2021].

Lake name	Composite scores				Ranking			
	With LCBA		*Without LCBA*		*With LCBA*		*Without LCBA*	
	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend
Big Fish	5.32	5.32	6.32	4.32	1	2	1	2
Big Birch	4.66	5.66	5.66	4.66	4	1	3	1
Long (Todd County)	5.32	4.98	5.98	4.32	1	3	2	2
Long (by Big Fish)	5.32	4.65	5.65	4.32	1	4	4	2
Bass	3.32	4.32	4.32	3.32	8	5	7	6
Grand	3.65	3.31	4.31	2.65	7	14	8	15
Kings	2.66	4.32	3.32	3.66	12	5	12	5
Cedar (North of Sauk Lake)	2.99	3.99	3.99	2.99	10	7	9	9
Big	3.98	3.64	4.64	2.98	5	10	5	11
Fairy	3.98	3.64	4.64	2.98	5	10	5	11
Pleasant	3.16	3.82	3.82	3.16	9	9	10	8
Carnelian	2.32	3.98	2.98	3.32	16	8	14	6
Black Oak (97 mg/l = 57 over deep lake standard)	2.66	2.99	2.99	2.66	12	15	13	14
St. Anna (80 mg/l = 40 over deep lake standard)	1.99	3.32	2.32	2.99	17	13	17	9
Cedar (East of Sauk Centre)	2.82	3.48	3.48	2.82	11	12	11	13
Little Birch	2.65	1.98	2.98	1.65	14	19	15	19
Cedar (by Freeport)	2.48	2.81	2.81	2.48	15	16	16	16
Goose (178 mg/l = 118 over shallow lake standard)	1.82	2.15	2.15	1.82	18	17	18	17
Sylvia	1.82	2.15	2.15	1.82	19	18	19	18
Long (by St. Rosa)	1.65	1.98	1.98	1.65	20	19	20	19

Lake name	Composite scores				Ranking			
	With LCBA		*Without LCBA*		*With LCBA*		*Without LCBA*	
	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend	Prioritized for upward WQ trend	Prioritized for downward WQ trend
Little Osakis	1.49	1.82	1.82	1.49	21	21	21	21
Becker	1.16	1.49	1.49	1.16	23	23	23	23
Mud	1.33	1.66	1.66	1.33	22	22	22	22