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Watershed

Chippewa River Watershed Restoration and Protection Strategy Report Update 2026

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Key terms and abbreviations

1W1P	One Watershed, One Plan
AQL	aquatic life
AQR	aquatic recreation
AU	animal unit
BMP	best management practice
BWSR	Board of Water and Soil Resources
CE	Civic Engagement
chl-*a*	chlorophyll-a
CRW	Chippewa River Watershed
CRWA	Chippewa River Watershed Association
CWF	Clean Water Fund
DNR	Minnesota Department of Natural Resources
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FIBI	fish community-based index of biological integrity
FWMC	flow weighted mean concentration
HSPF	Hydrologic Simulation Program-Fortran
HSPF-SAM	Hydrologic Simulation Program-Fortran Scenario Application Manager
IBI	index of biological integrity
IWM	intensive watershed monitoring
LGU	Local Government Unit (County, City, SWCD, Watershed JPE, etc.)
mg/L	milligrams per liter
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
N	nitrogen
NCHF	North Central Hardwood Forests
NGP	Northern Glaciated Plains
NLF	Northern Lakes and Forests

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRS	Nutrient Reduction Strategy
P	phosphorus
RNR	River Nutrient Regions
RVA	Range of Variability Approach
SAM	Scenario Application Manager
SID	stressor identification
SSTS	Subsurface Sewage Treatment Systems
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Program
TALU	tiered aquatic life uses
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USGS	United States Geological Survey
VWMP	Volunteer water monitoring program
WASCOB	water and sediment control basin
WBIF	watershed based implementation funding
WCP	Western Cornbelt Plains
WID	Water Unit IDs
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	Watershed Restoration and Protection Strategy
WWTF	Wastewater Treatment Facility

Executive summary

The Chippewa River Watershed (CRW) Restoration and Protection Strategy (WRAPS) Update 2025 builds upon more than two decades of data, local knowledge, and collaborative management to guide future water quality actions in one of Minnesota's most diverse and agriculturally intensive watersheds. This update captures both measurable progress and persistent challenges, providing strategies for decision-makers, local partners, and community members committed to protecting and restoring the watershed's lakes, streams, and rivers.

Purpose and audience

This update is designed for local governments, resource managers, conservation organizations, agricultural producers, and engaged citizens. It summarizes the latest science, identifies trends and stressors, and outlines targeted actions to improve aquatic health. The document is both a technical reference and a practical tool for aligning community priorities with state and federal restoration goals.

Local perspective

The CRW is experiencing profound hydrologic change, becoming flashier, wetter, and less stable due to a combination of intensified precipitation and extensive landscape modification. Local monitoring shows encouraging improvements in sediment reduction and phosphorus (P) control in some subwatersheds, but rising nitrogen levels, ongoing bacteria impairments, and persistent nutrient hot spots, such as Shakopee Creek, highlight the need for targeted action. The community's deep connection to its lakes and rivers, and the reliance on these resources for recreation, agriculture, and habitat, make local engagement central to the plan's success.

Key findings by section

- **Lakes:** Over the past two decades, average total phosphorus (TP) concentrations declined significantly (-0.017 mg/L, p-value=0.003), indicating modest but meaningful improvement. Water clarity trends show more lakes improving than declining, but several lakes, including Goose, Jennie, and Ann, have seen nutrient levels rise, signaling localized concerns. Eight lakes are impaired for aquatic life (AQL) use, and nutrient-related impairments remain widespread.
- **Streams and biological health**: Since 2010, 50 new AQL impairments have been identified; however, 8 stream reaches have been delisted. Even so, biological monitoring shows a statistically significant improvement in macroinvertebrate communities (MIBI +7.6 points), while fish community gains were modest and not statistically significant. Stressor analysis identifies hydrologic alteration, habitat loss, connectivity barriers, nutrient enrichment, and sedimentation as key factors.
- Pollutant concentration trends
  - **Phosphorus**: High overall, with a long-term downward trend in concentrations in three of four monitored subwatersheds, with Shakopee Creek remaining persistently high.
  - **Nitrogen**: Concentrations increased 65% at the watershed outlet since early 2000s, driven largely by Shakopee Creek. Concentrations are still relatively low compared to other Minnesota River tributaries.

    - **Total suspended solids (TSS)**: Statistically significant improvement in concentrations at the watershed outlet site, exceedance rates of the water quality standard dropped from 50% to 33%, and annual flow weighted mean concentrations (FWMC) declined from 86 mg/L to 51 mg/L.
- **Bacteria**: All 24 assessed stream reaches remain impaired by *E. coli*, underscoring the need for continued manure management, septic upgrades, and stormwater controls.
- **Hydrologic Change**: Average annual discharge at the Chippewa River HW40 site (Lower Chippewa) increased 50% between cycles, reflecting more intense runoff and reduced storage. Baseflow, peak flow, and median flow volumes are all substantially higher than historic conditions.
- **Sources and risks**: Point sources such as wastewater treatment facilities contribute relatively small portions of the watershed's total nutrient and sediment load. Nonpoint sources dominate, especially from agricultural runoff and altered drainage systems. Septic replacement rates have been steady, supported by low-interest loan programs since 2010.

Looking ahead

The data confirm that targeted, locally led actions work, but also that success depends on addressing persistent hotspots and adapting to a rapidly changing hydrologic system. Priorities for the next decade include:

- Reducing nutrient and sediment loads from high-contributing subwatersheds, especially Shakopee Creek.
- Expanding water storage, wetland restoration, and perennial cover to slow flows and stabilize hydrology.
- Strengthening bacteria source controls through livestock, septic, and stormwater management.
- Leveraging local monitoring networks and community partnerships to track progress and refine strategies.

This WRAPS Update is both a progress report and a call to action, aiming to safeguard the ecological integrity, recreational value, and community benefits of the CRW for future generations.

1.0 Minnesota's watershed approach

The State of Minnesota developed a watershed approach to focus on each watershed's condition as the scientific basis of permitting, planning, implementation, and measurement of results (Figure 1). This process looks strategically at the drainage area as a whole instead of focusing on lakes and stream sections one at a time, increasing effectiveness and efficiency.

Figure 1. 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.

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 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 Update reports address both strategies for restoration of impaired waters, and strategies for protection of 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 Update reports.

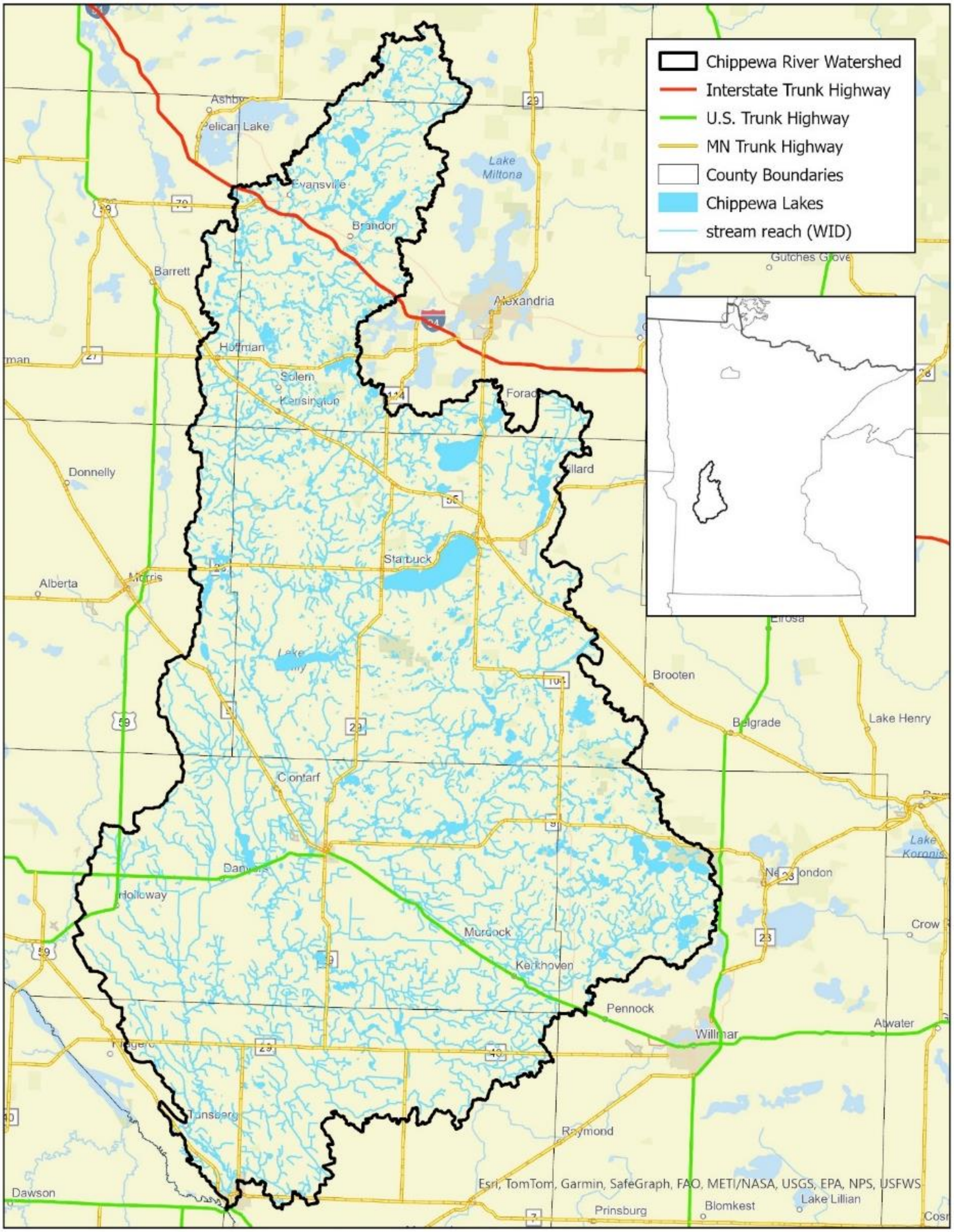
Key aspects of the MPCA's watershed work are to develop and utilize watershed-scale computer models, perform biological stressor identification (SID), conduct problem investigation monitoring, and use other tools to identify strategies for addressing point and nonpoint-source pollution that will cumulatively achieve water quality targets. Point-source pollution comes from sources such as wastewater treatment plants or industrial facilities; nonpoint-source pollution is the result of runoff or contaminants delivered off the landscape. For nonpoint source pollution, the WRAPS Update 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, 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 (CWF), which is overseen by the Clean Water Council. The CWF provides resources to implement the Clean Water Legacy Act 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.

2.0 Watershed description

The CRW, located in west-central Minnesota, spans over 1.3 million acres (2,080 square miles) across eight counties (Swift, Pope, Kandiyohi, Douglas, Stevens, Grant, Otter Tail, and Chippewa (Figure 2). This rural watershed is an important part of the Upper Minnesota River Basin, making the health of its surface waters significant for both local communities and the greater river system. A diverse range of streams, lakes, and wetlands define this watershed, supporting agriculture, wildlife, and recreational activities.

Figure 2. Chippewa River Watershed map.



One of the most striking features of the watershed is its inflection point at the meeting of three different ecoregions. The region's glacial history has resulted in the three ecoregion boundaries: Northern Glaciated Plains (NGP), Western Cornbelt Plains (WCP), and North Central Hardwood Forests (NCHF). The boundaries of these three ecoregions in the CRW follow the line where the glacier moraines end, and the outwash plains begin (Figure 3). These lines also correspond roughly to the dividing line of the Southern Region and Central Region for Minnesota water quality standards for TSS and nutrients (Figure 4).

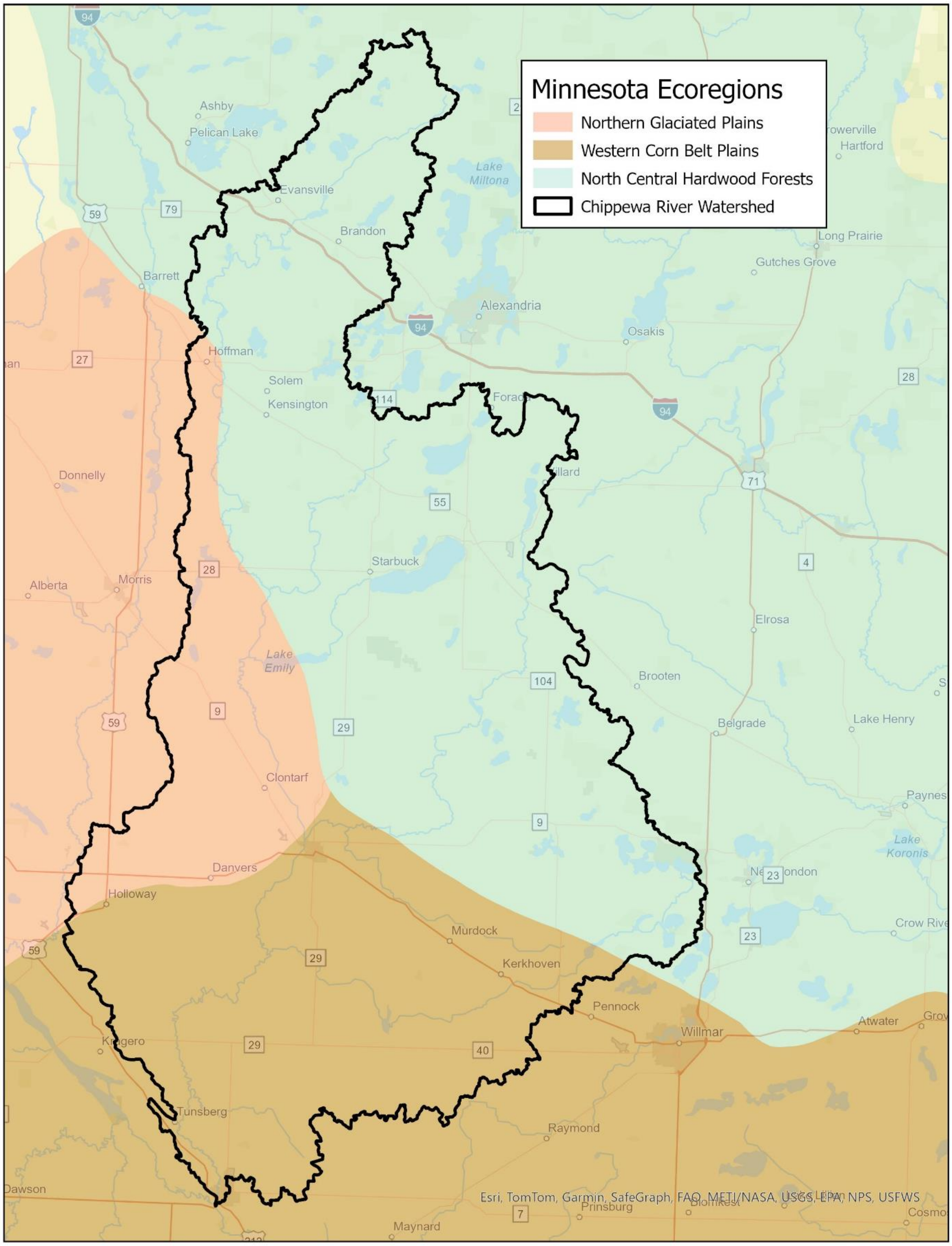
The connection between surface water and groundwater is also noteworthy. In many parts of the CRW, coarse soils and shallow groundwater feed directly into lakes and streams, maintaining flows and lake levels in the dry season and in some cases delivering pollutants like nitrogen quickly from groundwater to surface water. Protecting both resources is critical for maintaining overall water health. Geology and soil maps are useful in understanding where groundwater is most vulnerable, especially in areas with coarse soils that allow for easy movement of water.

Surface water quality in this watershed is shaped by the interplay between natural processes and human activity, particularly the agricultural practices that dominate the landscape. Thirty-two small rural communities are scattered throughout the region, but it is agriculture that plays the most significant role in influencing water quality due to about 79% of the watershed being used for agricultural production (Figure 36). Activities such as tillage, the use of fertilizers, and manure from feedlots, while critical for local farming economies, contribute to runoff, especially bacteria, nitrogen, and P. This runoff can lead to sedimentation, eutrophication, harmful algal blooms, and depleted oxygen levels in local lakes and streams, threatening aquatic ecosystems. Given these challenges, effective land management is essential to mitigate the impacts of these activities and protect the watershed's surface water quality.

Partnerships have been key to successful water quality improvements. Organizations like The Nature Conservancy, Ducks Unlimited, and the many local lake associations are actively engaged in conservation efforts. These partnerships, alongside local government conservation staff, landowners and operators, and residents, are vital in protecting water quality, restoring wetlands, and implementing conservation farming practices.

An example of the kinds of partnerships that are doing good work in the CRW can be found in Pope County. The Pope SWCD works closely with the Pope Coalition of Lake Associations to protect and improve local lakes. Through this partnership, citizen scientists have gathered more than 20 years of lake monitoring data, which the SWCD helps coordinate and fund through local water management planning. These data guide conservation projects such as the Lake Minnewaska Subwatershed project, aimed at reducing erosion and improving water quality. Together, the partnership combines citizen science, technical expertise, and funding to advance shared goals for healthy, resilient water resources in Pope County (Pope SWCD Lake Reporting).

Figure 3. Ecoregions of the Chippewa River Watershed.



3.0 Assessing water quality

Assessing the condition of the CRW's water quality and aquatic biological communities was completed in 2022 following two years (2019-2020) of intensive watershed monitoring (IWM). This second comprehensive assessment of water chemistry and AQL data considered all data gathered between 2008 and 2020 in the CRW including data deferred from the first cycle. The assessment allowed MPCA to evaluate recent data and review Cycle 1 data and decisions.

Assessing water quality is a complex process with many steps including: developing water quality standards, monitoring the water, ensuring the monitoring data set is comprehensive and accurately represents the water, and local professional review. A summary of some process steps is included below.

Water quality standards

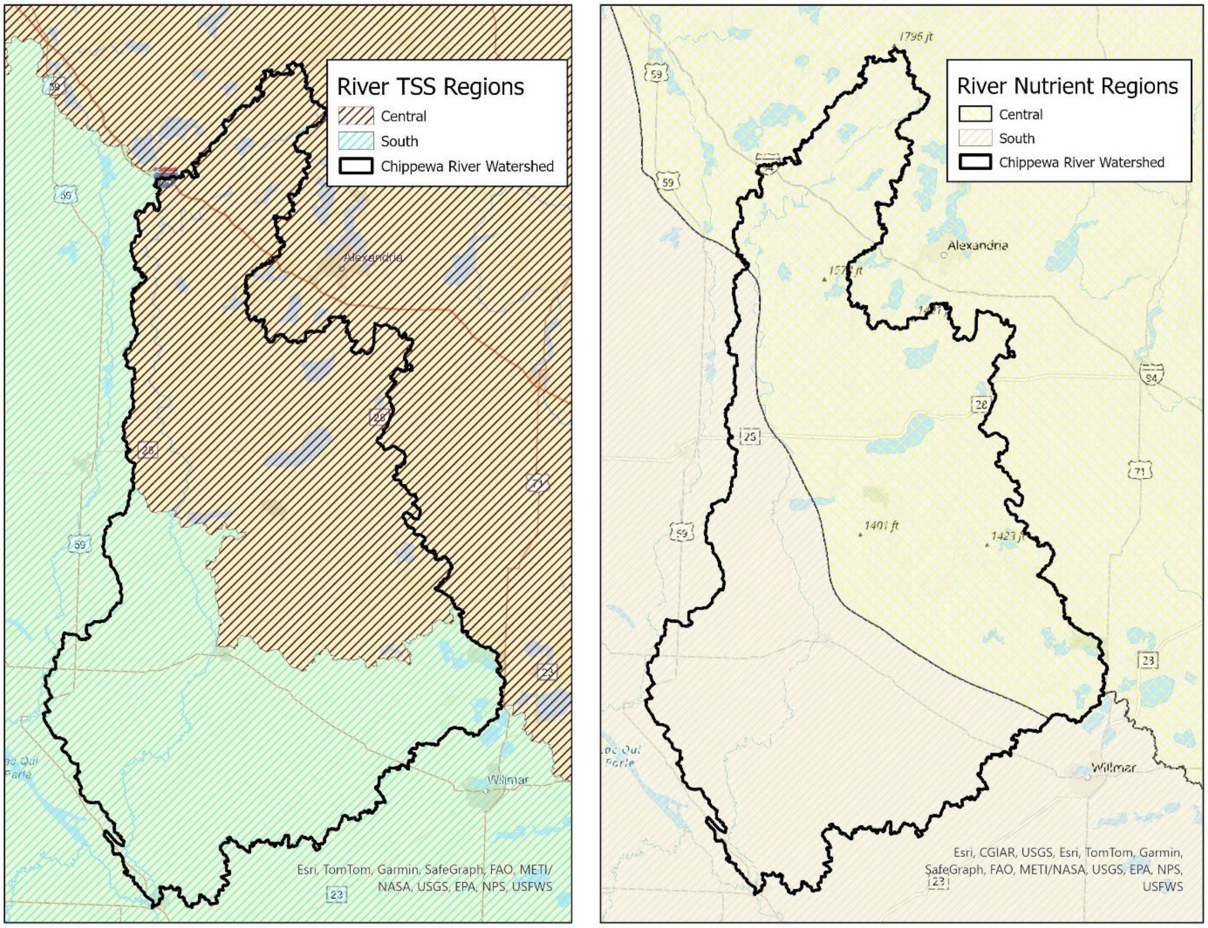
Water quality of surface waters is not expected to be as good as it would be under undisturbed, "natural background" conditions. However, water bodies are expected to support designated beneficial uses including fishing (AQL), swimming (aquatic recreation [AQR]), and eating fish (aquatic consumption). Water quality standards [(Water quality standards | Minnesota Pollution Control Agency); also referred to as "standards")] are set after extensive review of data about pollutant concentrations that support different beneficial uses and include natural background conditions.

Minnesota has long recognized regional patterns in surface water quality and uses U.S. Environmental Protection Agency (EPA) Level III Nutrient Ecoregions as a foundation for developing nutrient criteria. Lakes are assessed using three primary regional groupings—Northern Lakes and Forests (NLF), NCHF, and WCP/NGP (*Minnesota Lake Water Quality Assessment Report: Developing Nutrient Criteria*, MPCA 2005).

Minnesota's rivers also show distinct regional patterns in water quality, particularly in nutrient concentrations, which has led to the development of River Nutrient Regions (RNRs) to support more accurate and regionally appropriate nutrient criteria. These RNRs—North, Central, and South—generally align with EPA Level III Nutrient Ecoregions and reflect differences in land use, geology, and natural background conditions. Defining RNRs allows for a more targeted approach to managing river nutrients, recognizing that rivers often flow across multiple ecoregions and are influenced by diverse upstream conditions. The CRW spans both the Central and South RNRs, highlighting the need to account for varying regional influences when assessing and managing water quality (*Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria*, MPCA 2019).

The CRW has three lake standard regions (NPG, NCHF and the WCP; Figure 3) and two stream standard regions (Southern and Central; Figure 4). Different standards for lakes and streams in the CRW add to the complexity of watershed management and communication with stakeholders.

Figure 4. Chippewa River Watershed River TSS standard regions and Nutrient standard regions.



Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS

Esri, CGIAR, USGS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS

Tiered aquatic life uses

TALU background

In 2018, Minnesota revised its water quality standards (Minn. R. ch. 7050 and 7052) to establish the Tiered Aquatic Life Uses (TALU) framework for rivers and streams (*Technical Guidance for Reviewing and Designating Tiered Aquatic Life Uses in Minnesota Streams and Rivers*, MPCA 2018). Minnesota's assessment for TALU is a method to evaluate the health of streams based on their ability to support different types of AQL. The state divides streams into tiers depending on their natural conditions and ecological potential. This approach helps determine the water quality standards needed to protect the AQL in each stream, ensuring that the right level of protection is applied based on the stream's specific characteristics and uses. TALU provides targeted protection for high-quality waters while setting realistic restoration goals for altered or impacted waters. These amendments affected Class 2 (AQL) standards and were approved by the EPA in 2018.

In the previous assessment of the CRW (Cycle 1), the assessment of biological data from stations on 48 channelized streams was deferred until assessment standards for TALU were approved. In 2020, the TALU framework was applied to the deferred Cycle 1 monitoring data for the CRW. This assessment of 48 Water Unit IDs (WIDs) resulted in 29 new AQL impairments.

For more details on TALU in the CRW, see the *Chippewa River Watershed SID Report Update 2024* (MPCA 2024c).

Water quality assessment

Water quality is assessed by comparing monitoring data to relevant standards. A water body is considered impaired if pollutant levels exceed the state standards (Minn. R. chs. 7050 and 7052) and supporting if water quality meets the standard, indicating it can sustain beneficial uses. If the data set is too small to be representative or results are unclear, the water quality assessment is delayed until more data are collected—this is classified as an inconclusive or insufficient finding (2024 Assessment Guidance Manual, MPCA 2024b). Impaired waters are then listed by the MPCA every two years on Minnesota's impaired waters list.

Monitoring data

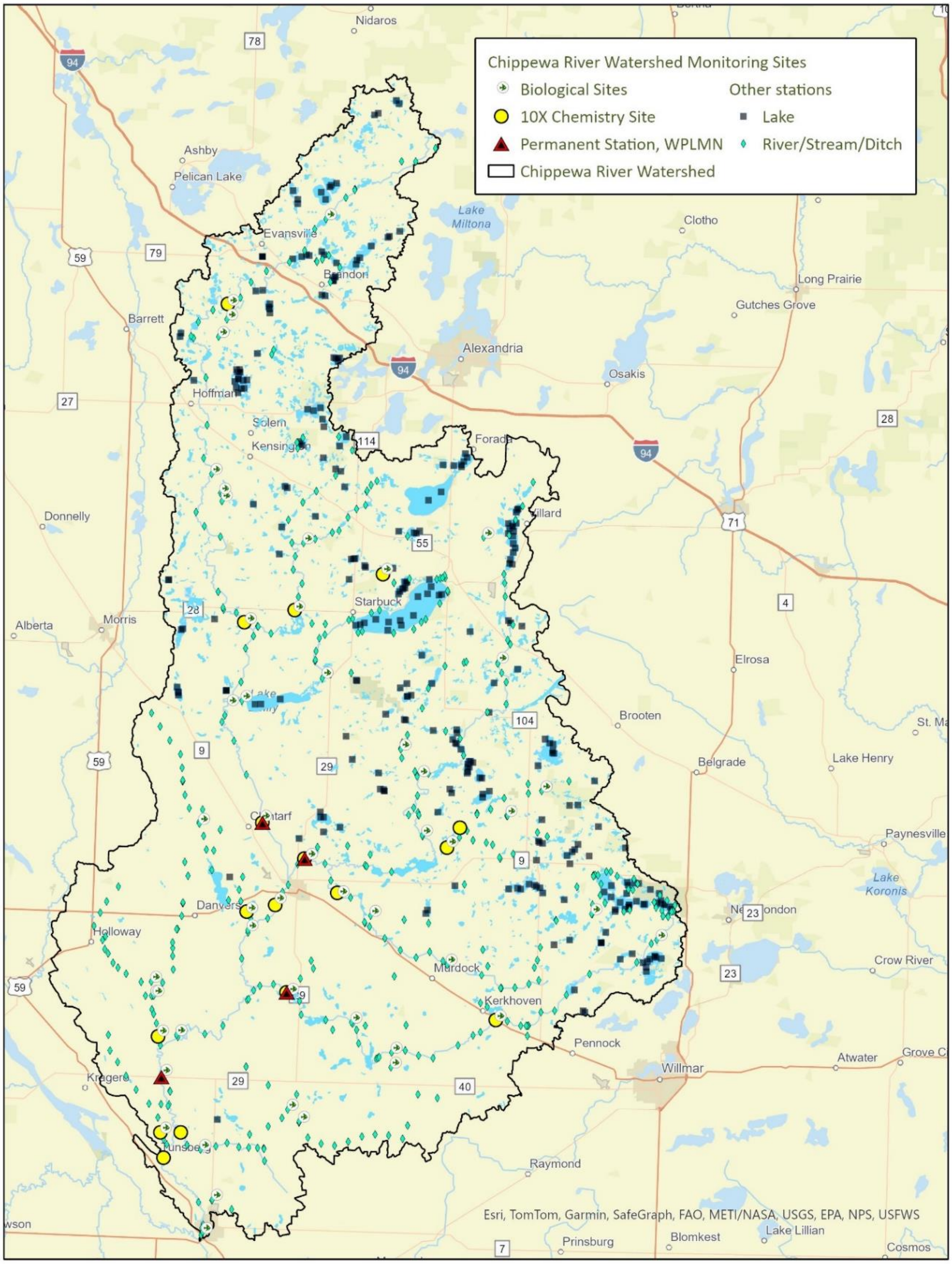
Four water quality monitoring programs support long-term data collection and assessment in the CRW as part of Minnesota's Water Quality Monitoring Strategy (MPCA 2021). These programs track progress toward water quality goals, with additional monitoring implemented as needed. Together, they collect data at dozens of locations (Figure 5), with varying parameters at each site. Local partners supplement MPCA programs with additional data collection.

Monitoring Programs

- **Intensive Watershed Monitoring** (IWM) provides periodic assessments of water quality and AQL (fish and macroinvertebrates). Conducted every 10 years, this program offers a "snapshot" of watershed conditions sampled over a 2-year period.
- **Watershed Pollutant Load Monitoring Network** (WPLMN) collects continuous, long-term data on pollutants, flow, sediment, and nutrient loads at the watershed and subwatershed scale. Sampling in the CRW is conducted at three flow stations linked to U.S. Geological Survey (USGS) gauges or the Minnesota Department of Natural Resources (DNR)/MPCA Cooperative Stream Gaging network. At the time of this report's analysis the latest data set available was 2021 data.
- **Stream and Lake Monitoring Program** relies on volunteers to track water body transparency through monthly measurements. About twenty-four volunteer-monitored locations exist in the CRW, increasing the number of monitored sites and contributing to long-term datasets.
- **Surface Water Pesticide Monitoring Program** operated by the Minnesota Department of Agriculture (MDA) is a statewide program designed to assess how agricultural chemical use affects Minnesota's rivers and streams. Each year the program collects dozens of samples from key sites, including two in the CRW (at Dry Weather Creek and Shakopee Creek) targeting periods of runoff after pesticide application. The analyses screen for over a hundred f pesticide compounds and their breakdown products, compare concentrations against aquatic-life benchmarks, and support decision-making for pesticide regulation and best management practices (BMPs).

- **Additional Data Sources** include MPCA's Long-Term Biological Monitoring Program, local governments, nonprofits, and other entities. These datasets are accessible through [MPCA's surface water data portal](#).

Figure 5. Chippewa River Watershed monitoring locations (2011 – 2023).



3.1 Lakes and streams

The MPCA, DNR, and their partners studied CRW lakes, rivers, and streams in 2009-2010 (Cycle 1) and again in 2019-2021 (Cycle 2) to determine if these waters met standards for AQL, AQR, and fish consumption. Cycle 2 sampling was initially expected to be completed in two years. However, sampling fish in streams faced setbacks. In 2019, heavy rainfall limited samples to only 18 out of 51 planned sites. In 2020, the pandemic delayed further sampling. To make up for this, 24 stream sites were sampled in 2021 (MPCA 2022a).

Biological and water quality data were assessed and then compared between the two sampling periods to identify which waters need protection and which require restoration and to identify changes in water conditions. Monitoring locations (shown in Figure 5) provided data for these assessments and trend evaluations.

The collection of samples for both water chemistry and biological sampling is relatively straightforward.

- Sampling for stream chemistry involves collecting bottles of water that are analyzed by a certified lab for various chemicals, sediment, and bacteria.
- Biological sampling involves collection of fish and invertebrate species to understand population numbers and the species present.

The information is compared to state standards, which are expected to support AQR, AQL, and maintain healthy populations. These standards are different for each region of the State and for the different stream types including:

- Modified Use Streams - Generally streams that have been straightened and ditches. The standard for these streams is lower than general use.
- General Use Streams - Majority of streams such as the Chippewa River.
- Exceptional Use Streams - North Shore of Lake Superior trout waters, other high-quality streams. Higher standard to be met so the streams remain protected from pollution.

State of Minnesota standards reflect water quality or fish and bug populations, which will differ in different parts of the state. For example, the CRW will have quite different aquatic biota populations and water quality when compared to North Shore streams. Streams that don’t meet the standards are considered “impaired” and studied further to develop a plan to meet the standards.

Minnesota’s lake eutrophication standards vary by ecoregion and lake depth and include numeric criteria for TP, chl-*a*, and Secchi disk transparency. TP is considered the causal variable, while chl-*a* (a measure of algal abundance) and Secchi depth (a measure of water clarity) are response variables. A lake is considered impaired if it exceeds the TP standard and either the chl-*a* or Secchi standard (MPCA 2024b).

The MPCA developed these standards using data from a wide range of lakes across Minnesota’s ecoregions, establishing clear relationships between TP and the response variables. Because of this, meeting the TP standard is generally expected to result in compliance with the chl-*a* and Secchi criteria.

Assessment decisions rely on data collected between June and September over a 10-year period. Summer-mean values for TP, corrected chl-*a* (adjusted for pheophytin), and Secchi depth are calculated using surface samples (upper three meters), with daily averages computed when multiple samples are collected on the same day. A minimum of eight individual data points for each variable is typically required to make an assessment.

If only TP or only one response variable (corrected chl-*a* or Secchi) exceeds its threshold, despite high-quality data, the lake is considered to have insufficient data for assessment. Both the causal (TP) and at least one response variable must either meet standards (to indicate support) or exceed them (to indicate impairment). Lakes that do not meet the minimum data requirements for all three parameters are also classified as having insufficient data.

The CRW eutrophication standards for Class 2B AQR use lakes across major ecoregions are summarized in Table 1.

Table 1. Eutrophication standards for Class 2B AQR use lakes across major ecoregions in the CRW.

Ecoregion	Lake Type	TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
North Central Hardwood Forest	Deep	< 40	< 14	> 1.4
North Central Hardwood Forest	Shallow	< 60	< 20	> 1.0
Western Corn Belt Plains & Northern Glaciated Plains	Deep	< 65	< 22	> 0.9
Western Corn Belt Plains & Northern Glaciated Plains	Shallow	< 90	< 30	> 0.7

More information on how waters are assessed can be found in the Guidance Manual for Assessing the Quality of Minnesota Surface Waters (MPCA 2024b). Additional watershed data specific to the CRW can be found in the *Chippewa River Watershed Assessment and Trends Update* (MPCA 2022a) and through the MPCA's Water Quality Assessment Results Data Viewer. See Section 4 (Watershed Conditions) for a summary of this information.

3.2 Stressor identification

When streams and lakes are found to have impaired fish and macroinvertebrate communities, the causes of these biological impairments are studied and identified in a process called SID. SID identifies the parameters negatively impacting the AQL populations, referred to as "stressors". Stressors are identified using the EPA Causal Analysis/Diagnosis Decision Information System (CADDIS) process (Cormier et al 2000). In short, stressors are identified based on the characteristics of the aquatic community in tandem with water quality information and other observations. This WRAPS Update report summarizes stream SID results in Section 4.2.2, and the full report is available at *Chippewa River Watershed SID Report Update 2024* (MPCA 2024c). Results for the CRW Lake SID and the full report are stored in the Minnesota Digital Library.

3.3 Modeling

With the Watershed Approach, monitoring for pollutants and stressors is generally extensive, but not every stream or lake can be monitored due to financial and logistical constraints. Computer modeling based on this data can extrapolate the known conditions of the watershed to areas with less monitoring data. Computer models, such as Hydrological Simulation Program - FORTRAN (HSPF), represent complex natural phenomena with numeric estimates and equations of natural features and processes. HSPF incorporates data including stream pollutant monitoring, land use, weather, and soil type to estimate flow, sediment, and nutrient conditions within the watershed. HSPF model output provide a reasonable estimate of water flow and pollutant concentrations across watersheds. The output can be used for TMDL calculations, source assessment, and prioritizing and targeting conservation efforts. As an example of how HSPF outputs can be used see the maps in section 4.2.4 that indicate higher loading areas/subwatersheds.

The watershed pollutant load reduction calculator is an online tool that can be used as a quick and simple way to approximate N, P, and sediment load reductions resulting from implementation of BMPs in Minnesota watersheds. It's ideal for broad watershed planning, where average results across subwatershed areas are sufficient. The tool provides estimates based on the HSPF model. Users input the number of acres with new BMPs for a specific watershed, and the calculator determines reductions using loading rates for different pathways, such as surface runoff, tile drainage, and groundwater flow, and standard pollution reduction percentages from researched BMPs. Results can be reported at three levels: the nearest water modeled by HSPF, the outlet of HUC-12 watersheds (smaller units), or the outlet of HUC-8 watersheds (larger units).

These tools provide a starting point to identify areas that may be contributing higher loads and concentrations of pollutants and be able to narrow down areas that may provide the highest rate of return when installing implementation practices. This information can be used by local staff on an on-going basis to begin discussions with landowners, building trust and relationships that can provide options for implementation activities and funding. The MPCA can provide support to local partners to help develop this information for use in targeting implementation activities.

4.0 Watershed condition

Water monitoring is a crucial step for determining whether lakes and streams meet water quality standards, which ensure they remain fishable and swimmable. In Minnesota, the MPCA and local partners undertake extensive biological and water chemistry monitoring across the state's watersheds every decade. This monitoring is vital for detecting changes in water quality, enabling agencies to refine strategies for protecting healthy waters and restoring degraded ones. The CRW, which has been significantly altered by human activities, presents a case study in the ongoing challenges and successes of watershed management efforts.

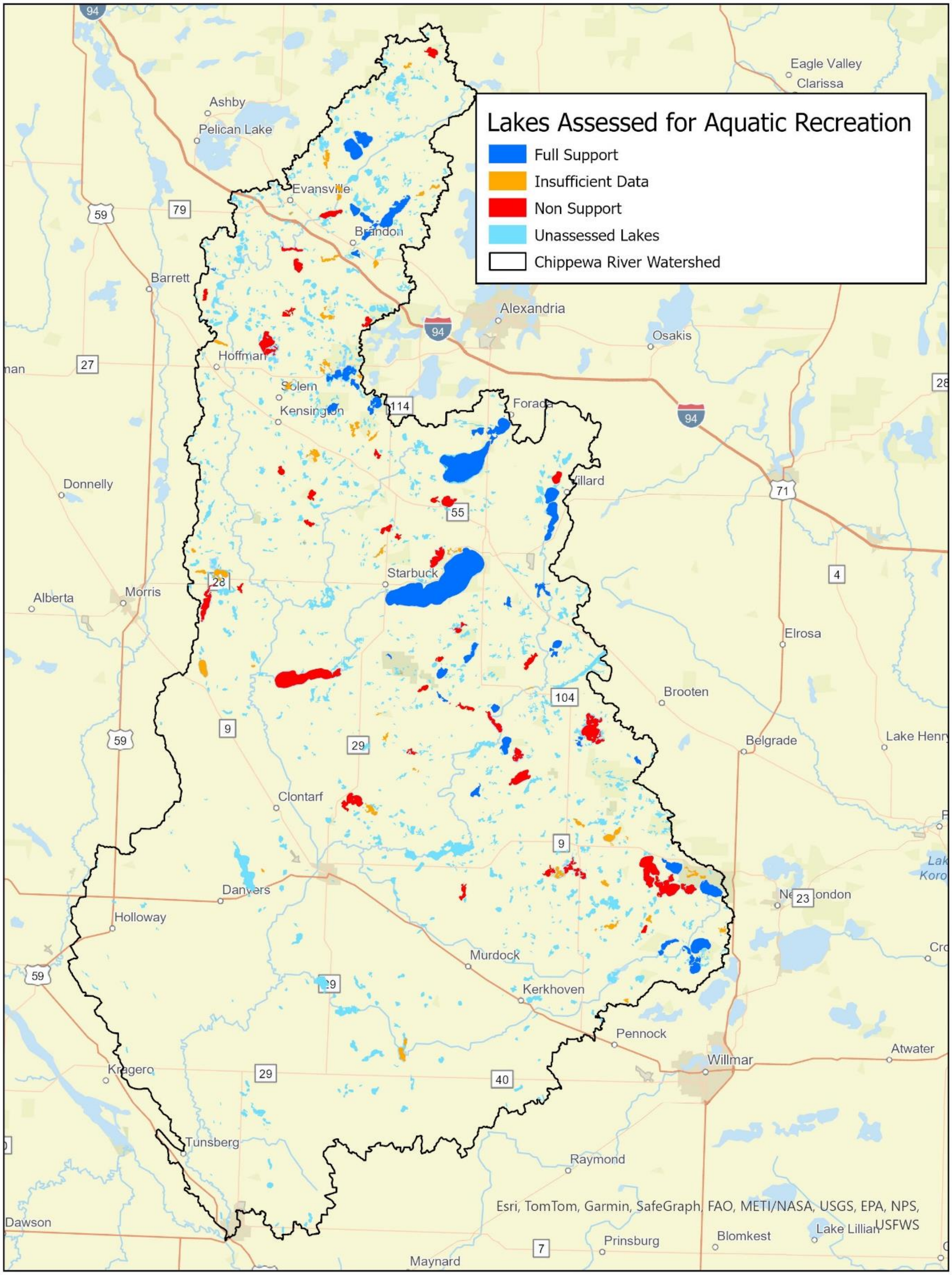
The monitoring efforts in the CRW provide a comprehensive overview of the current state of water quality, aquatic biology, and water chemistry in the region. While there are areas with high levels of water quality and healthy aquatic biology and signs of improvement in some of the impacted areas, particularly in macroinvertebrate communities and sediment levels, significant challenges remain. Many parts of the CRW continue to face high *E. coli* levels, rising nitrate levels, ongoing erosion, high levels of P, and impaired fish and macroinvertebrate communities. These challenges highlight the need for continued conservation efforts and adaptive management strategies.

By closely monitoring these challenges and implementing targeted restoration and protection activities, there is potential to protect and restore water quality in the CRW. These efforts are particularly important as the region faces increasing pressures from lakeshore development, agricultural practices, and a changing climate, which threaten the health of its lakes, streams, and aquatic ecosystems.

4.1 Water quality conditions - lakes

Summary: This section provides an overview of the water quality data from 2010 to 2020 used for assessment of CRW lakes including a discussion on existing impaired lakes. Of the 70 lakes assessed or reassessed for AQR by the MPCA, there were 7 new lakes found to be impaired due to nutrients and a further 32 lakes had their impairments reconfirmed (Figure 6; MPCA 2022a). Average summer chemistry data over the last two assessment windows are presented in Figure 11 in the appendix of this report. The DNR also assessed 37 lakes for AQL (Lake Index of Biological Integrity | Minnesota DNR), determining 8 lakes are impaired by fish community-based index of biological integrity [FIBI] (see Section 4.1.1 and Figure 7).

Figure 6. Assessment status of Chippewa River Watershed lakes.



4.1.1 New lake impairments and delisted lakes

Aquatic recreation

There were 70 lakes assessed in Cycle 2. There were seven new AQR lake impairments identified in the watershed (MPCA 2022a). The seven lakes newly listed as impaired for AQR have had TMDL studies completed for each of them in the *Chippewa River Watershed TMDL Report 2025* (MPCA 2025a). Two lakes in the CRW, Reno (61-0078-00) and Middle (34-0208-00), had enough improvement in water quality to de-list them from Minnesota's impaired waters list for AQR.

This comprehensive assessment of water chemistry and AQL data against state pollution standards considered all qualified data gathered between 2008 and 2020. More detail about this process can be found in Section 3.0 Assessing Water quality. Notes derived from the MPCA assessment process for the AQR impaired lakes are included Table 2. This information provides a summary of the lake water quality data collected from the monitoring and assessment process and background information on the lake status.

Details on lakes previously listed as impaired for AQR can be found in the *Chippewa River Watershed TMDL Report* (MPCA 2017a), the *Chippewa River WRAPS Report* (MPCA 2017b) and the *Pope County 8 Lakes TMDL Report* (MPCA 2017c).

Table 2. Cycle 2 impairment assessments of lakes in the Chippewa River Watershed 2009-2024 (MPCA Assessment Database).

Lakes with AQR Nutrient Impairment	**Lake ID**	**TP** (µg/L)	**Chl-*a*** (µg/L)	**Secchi** (m)
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
Stowe Lake	**21-0264-00**	68.4 (n=28)	41 (n=28)	1.4 (n=85)
Extensive data on eutrophication were collected between 2016 and 2020. Total phosphorus (TP) and chlorophyll-a (chl-*a*) levels consistently exceeded the water quality standards for shallow lakes. Secchi depth averages 1.4 meters, which meets the clarity standard, but is close to the threshold, considering the standard error, it could drop to 1.3 meters. Water clarity tends to be relatively high in early June but declines noticeably by July and August, often exceeding the standard through September. These conditions indicate the lake does **not support AQR use.**				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
Venus	**21-0305-00**	88.1 (n=8)	59.1 (n=8)	0.7 (n=93)
Profile data for Venus Lake indicate weak potential for stratification. TP concentrations are similar between surface and bottom samples, suggesting limited vertical separation. Given the lake's maximum depth of approximately 17 feet, it is assessed using shallow lake standards. TP and chl-*a* data were collected in 2015 and 2016, while Secchi depth measurements span over a 10-year period. All three indicators (TP, chl-*a*, and Secchi depth) consistently exceed water quality criteria for shallow lakes. These results indicate **nonsupport for AQR use**.				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0

Lakes with AQR Nutrient Impairment	**Lake ID**	**TP** (µg/L)	**Chl-*a*** (µg/L)	**Secchi** (m)
Swenson	**34-0321-00**	136.2 (n=11)	47.7 (n=11)	0.8 (n=10)
Based on comment history, this lake was likely intended to be opted in for assessment in 2012, as only one year of data was available in 2011. Eutrophication data were collected in both 2011 and 2019. TP, chl-*a*, and Secchi depth all exceed the water quality criteria for shallow lakes. These conditions indicate **nonsupport for AQR use**.				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
East Sunburg	**34-0336-00**	193.4 (n=4)	86.4 (n=4)	1.2 (n=4)
Eutrophication data were collected in 2011. Based on prior assessment records and comments, the lake was likely intended to be opted in and listed as impaired in 2011, following one year of sampling in 2010. Data from both 2010 and 2011 exceeded water quality standards for shallow lakes. These findings indicate **nonsupport for AQR use**.				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
Sunburg	**34-0359-00**	122.9 (n=8)	64.6 (n=7)	1.5 (n=8)
Reviewing historical assessment data and comments, this lake was likely intended to be opted in and listed as impaired in 2012, as only one year of data was available in 2010—and that data exceeded water quality standards. Additional eutrophication data collected in 2011 also exceeded the criteria. More recent sampling in 2019 shows continued exceedances for TP and chl-*a*. Secchi depth in 2019 technically meets the standard, but exceedances were observed. Notably, the July 2019 Secchi reading was 2.1 meters; however, sampling notes indicate an Aphanizomenon bloom at the time. These blooms can result in artificially high clarity readings, as Aphanizomenon are visually easy to see through in the water column. Clarity declined sharply in August and September, with readings dropping to 0.8 meters. Based on these findings, the lake is recommended as **nonsupporting for AQR use**.				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
Goose	**61-0043-00**	248.3 (n=7)	108.9 (n=8)	2.8 (n=7)
Eutrophication data were collected in 2019 and 2020. TP and chl-*a* levels significantly exceed water quality criteria for shallow lakes, while Secchi depth meets the standard. June 2020 samples showed exceptionally high TP and chl-*a* concentrations. Even when these outliers are excluded and new averages are calculated, both parameters still exceed the standards. Given the consistently elevated nutrient levels, the lake is recommended as **nonsupporting for AQR use**.				
North Central Hardwood Forest - Shallow Lake Standard		<60	<20	>1.0
Steenerson	**61-0095-00**	320.1 (n=12)	62 (n=12)	1.37 (n=12)
This lake was assessed in 2011; however, no TMDL was developed. Eutrophication data collected in 2009 and 2010 show that TP and chl-*a* exceed water quality criteria for shallow lakes. Based on this assessment, the lake was determined to be in **nonsupport of AQR use**.				

Lakes with AQR Nutrient Impairment	**Lake ID**	**TP** (µg/L)	**Chl-*a*** (µg/L)	**Secchi** (m)
Western Corn Belt Plains - Shallow Lake Standard		<90	<30	>0.7
Shakopee	**12-0030-00**	285 (n=10)	95.6 (n=10)	0.4 (n=18)
Shakopee Lake will not be formally assessed as a lake. Eutrophication data collected between 2019 and 2024 show that TP, chl-*a*, and Secchi depth all exceed water quality criteria for shallow lakes. However, Shakopee Lake is a reservoir with a residence time of less than 14 days. Per EPA guidance (EPA, 200a; Kennedy, 2001), reservoirs with residence times under 14 days are not assessed as lakes. Since both the upstream and downstream ditches are listed as impaired, Shakopee Lake will be addressed through adjacent stream TMDLs and will be a recipient of restoration activities associated with those efforts.				

Lake aquatic life assessment

DNR fisheries sampled 37 lakes and determined that 8 lakes were impaired for AQL use. Details about these fish impairments and recommendations to address them can be found in the Chippewa River Watershed SID Report - Lakes (DNR 2025) stored in the https://wrl.mnpals.net/, and Table 3 identifies the lakes assessed and their impairment status.

A review of the AQL impaired lakes found some similarities. Many of these lakes are struggling to support healthy fish populations. The biggest challenges include stressors from nutrient pollution, degraded shorelines, and invasive species. Excess nutrients, often from agricultural runoff, residential development, and livestock manure, lead to algae growth and poor water quality (DNR 2025).

Shoreline conditions are also a concern. High dock densities, erosion, and the loss of emergent vegetation reduce habitat quality for fish and other AQL. Invasive species such as Common Carp, Zebra Mussels, and Eurasian Watermilfoil are common in many of these lakes, disrupting native habitat and food webs (DNR 2025).

While low oxygen levels were generally not a problem, altered species competition and a lack of pesticide monitoring data remain issues (DNR 2025).

The DNR Lakes Report (DNR 2025) recommends actions such as following TMDL and watershed plans, expanding agricultural BMPs, restoring and protecting shorelines with native vegetation, preventing the spread of invasive species, and improving fish passage to reconnect habitats.

Figure 7. Chippewa River Watershed lakes surveyed for AQL, Lake Index of Biological Integrity

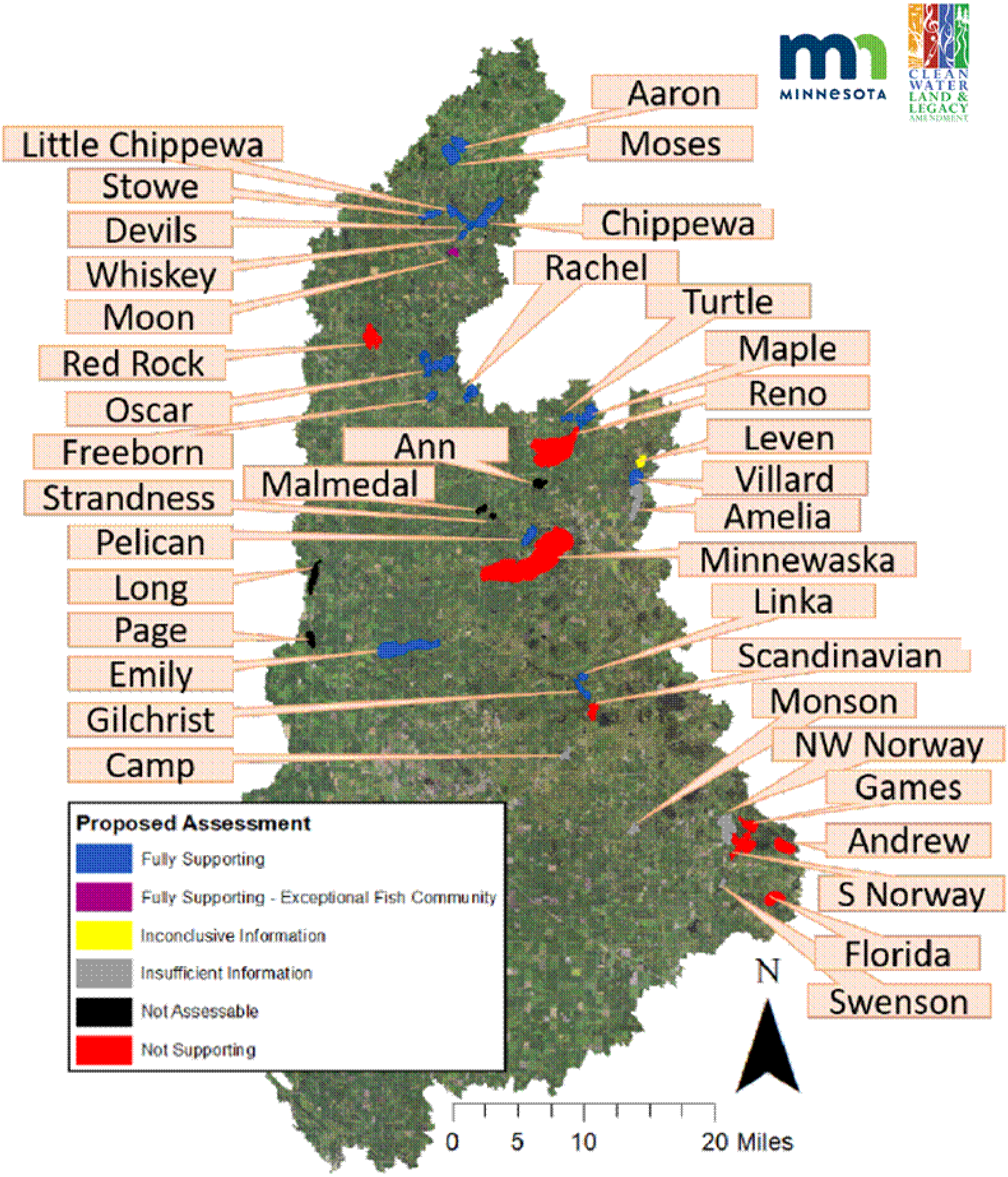


Table 3. Lake AQL results (2016 – 2019), Lake Index of Biological Integrity.

Lake ID	Lake Name	Assessable FIBI Scores (Year)	Assessment Recommendation	FIBI Tool	Impairment Threshold
21-0079-00	**Maple**	55 (2019)	**Fully Supporting**	2	45
21-0145-00	**Chippewa**	50 (2017)	**Fully Supporting**	2	45
21-0160-00	**Rachel**	56 (2018)	**Fully Supporting**	2	45
21-0212-00	**Little Chippewa**	65 (2019)	**Fully Supporting**	2	45
21-0216-00	**Whiskey**	51 (2019), 46 (2016)	**Fully Supporting**	2	45
21-0245-00	**Moses**	50 (2019), 44 (2016)	**Fully Supporting**	2	45
34-0206-00	**Andrew**	32 (2019), 28 (2018)	**Not Supporting**	2	45
34-0217-00	**Florida**	35 (2019)	**Not Supporting**	2	45
34-0224-00	**Games**	39 (2018)	**Not Supporting**	2	45
61-0041-00	**Scandinavian**	21 (2018)	**Not Supporting**	2	45
61-0064-00	**Amelia**	34 (2019)	**Insufficient Information**	2	45
61-0078-00	**Reno**	37 (2019), 44 (2018)	**Not Supporting**	2	45
61-0130-00	**Minnewaska**	24 (2018)	**Not Supporting**	2	45
21-0226-00	**Moon**	66 (2017)	**Fully Supporting**	4	38
61-0037-00	**Linka**	52 (2017)	**Fully Supporting**	4	38
61-0066-00	**Leven**	46 (2020), 37 (2019)	**Inconclusive Information**	4	38
75-0019-00	**Page**	NA	**Not Assessable**	4	38
21-0162-00	**Freeborn**	30 (2016)	**Fully Supporting**	5	24
21-0213-00	**Devils**	37 (2016)	**Fully Supporting**	5	24
21-0242-00	**Aaron**	57 (2016)	**Fully Supporting**	5	24
21-0257-00	**Oscar**	78 (2018)	**Fully Supporting**	5	24
21-0291-00	**Red Rock**	12 (2019)	**Not Supporting**	5	24
34-0251-02	**South Norway**	23 (2019), 16 (2019)	**Not Supporting**	5	24
61-0072-00	**Gilchrist**	33 (2017)	**Fully Supporting**	5	24
76-0072-00	**Camp**		**Insufficient Information**	5	24
21-0090-00	**Turtle**	54 (2016), 45 (2016)	**Fully Supporting**	7	36
21-0264-00	**Stowe**	43 (2019)	**Fully Supporting**	7	36

Lake ID	Lake Name	Assessable FIBI Scores (Year)	Assessment Recommendation	FIBI Tool	Impairment Threshold
34-0251-01	**Northwest Norway**	45 (2019), 48 (2019)	**Insufficient Information**	7	36
34-0321-00	**Swenson**		**Insufficient Information**	7	36
61-0067-00	**Villard**	66 (2019)	**Fully Supporting**	7	36
61-0111-00	**Pelican**	51 (2016)	**Fully Supporting**	7	36
61-0122-00	**Ann**	NA	**Not Assessable**	7	36
61-0128-00	**Strandness**	NA	**Not Assessable**	7	36
61-0162-00	**Malmedal**	NA	**Not Assessable**	7	36
61-0180-00	**Emily**	49 (2016)	**Fully Supporting**	7	36
75-0024-00	**Long**	NA	**Not Assessable**	7	36
76-0033-00	**Monson**		**Insufficient Information**	7	36

4.1.2 Lake trends

Long-term lake water quality trends in the CRW were evaluated using two key eutrophication indicators: TP and Secchi disk transparency. The Secchi analysis, completed by MPCA staff, drew on volunteer-collected data from the MPCA's Volunteer Water Monitoring Program (VWMP) and assessed trends in 42 lakes (MPCA 2022a, Surface Water). The TP analysis, completed as a part of this report, used state monitoring records to compare paired Cycle 1 and Cycle 2 data for 66 lakes, applying statistical tests to determine the significance of observed changes. Together, these efforts provide a clear picture of nutrient conditions and water clarity across the watershed, highlighting both improvements and lakes showing signs of decline.

Secchi depth/Transparency

In the CRW, for Cycle 2, 42 lakes had sufficient data (at least 50 Secchi readings over 8 years) to evaluate long-term water clarity trends. Much of the data were contributed by volunteers through the MPCA's VWMP.

Consistent with statewide patterns, most lakes did not show a statistically significant trend (Table 4). Four lakes had a decreasing clarity trend: Hoff, Red Rock, Rachel, and Villard. Thirteen lakes had improving clarity, including Venus Lake, which is currently impaired (MPCA 2022a, Water Clarity Trends - Lakes).

Table 4. CRW lake water clarity trends paired with MPCA VLMP data. Lake water quality trend analysis was performed with a seasonal Mann Kendall test.

Lake Name	WID	County	Trend
Red Rock	21-0291-00	Douglas	Degrading
Rachel	21-0160-00	Douglas	Degrading
Norway (West)	34-0251-01	Kandiyohi	Degrading
Hoff	61-0092-00	Pope	Degrading
Chippewa	21-0145-00	Douglas	Improving
Maple	21-0079-00	Douglas	Improving
Whiskey	21-0216-00	Douglas	Improving
Turtle	21-0090-00	Douglas	Improving
Little Chippewa	21-0212-00	Douglas	Improving
South Oscar	21-0257-02	Douglas	Improving
Devils	21-0213-00	Douglas	Improving
Moses	21-0245-00	Douglas	Improving
Venus	21-0305-00	Douglas	Improving
Moon	21-0226-00	Douglas	Improving
Andrew	34-0206-00	Kandiyohi	Improving
Minnewaska	61-0130-00	Pope	Improving
Camp	76-0072-00	Swift	Improving
Aaron	21-0242-00	Douglas	No trend
Mary	34-0249-00	Kandiyohi	No trend
Villard	61-0067-00	Pope	No trend
Strandness	61-0128-00	Pope	No trend
Emily	61-0180-00	Pope	No trend
Stowe	21-0264-00	Douglas	No trend
Freeborn	21-0162-00	Douglas	No trend
Private	21-0125-00	Douglas	No trend
Norway (South)	34-0251-02	Kandiyohi	No trend
Florida	34-0217-00	Kandiyohi	No trend
Games	34-0224-00	Kandiyohi	No trend
Amelia	61-0064-00	Pope	No trend
Gilchrist	61-0072-00	Pope	No trend
Scandinavian#	61-0041-00	Pope	No trend
Linka	61-0037-00	Pope	No trend
Pelican	61-0111-00	Pope	No trend
Signalness	61-0149-00	Pope	No trend
Reno	61-0078-00	Pope	No trend
Leven	61-0066-00	Pope	No trend
Ann	61-0122-00	Pope	No trend
Marlu	61-0060-00	Pope	No trend
Malmedal	61-0162-00	Pope	No trend
Simon	61-0034-00	Pope	No trend
Johanna	61-0006-00	Pope	No trend
Long	75-0024-00	Stevens	No trend

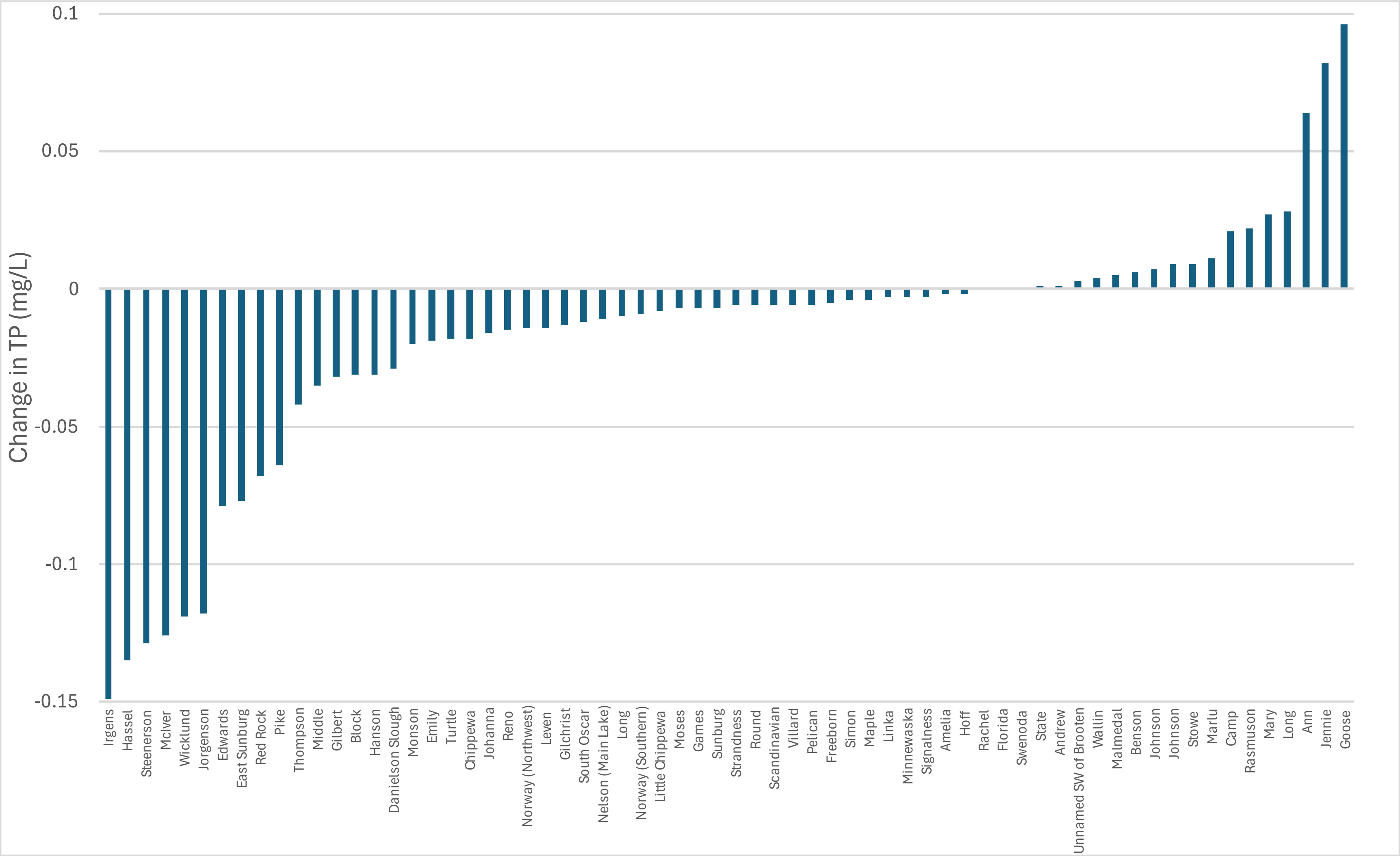
The lake water clarity must change more than half a foot per decade to be considered a detectable change or trend.

Phosphorus

Excessive nutrient loads, in particular TP, lead to increased algae blooms and reduced transparency, both of which may significantly impair or prohibit the use of lakes for AQR. The eutrophication standards are specific to ecoregion and lake depth. The ecoregion-based eutrophication standards are the primary basis for AQR beneficial use assessments in lakes (MPCA 2024b).

For this report, 66 lakes with paired TP data from Cycle 1 and Cycle 2 were compared. Average TP concentrations decreased by 0.017 mg/L. This reduction is statistically significant with results at the 95% and 99% confidence levels, supported by both a paired t-test ($p = 0.003$) and a Wilcoxon signed-rank test ($p = 0.00034$). These results suggest a modest but meaningful improvement in P conditions across the watershed during the past two decades. Figure 8 shows the change in average lake TP from Cycle 1 to Cycle 2.

Figure 8. Change in average TP by lake from Cycle 1 to Cycle 2 in the Chippewa River Watershed.



An average decrease of 0.017 mg/L in TP concentration is a substantive improvement when viewed relative to the standards, not just a statistical outcome, but one with potential ecological significance.

However, several lakes now approach or exceed the TP standard, and some lakes that previously met the standard may be drifting closer to exceeding the standard (see Figure 9). Even modest increases in P can:

- Trigger algal blooms
- Decrease water clarity
- Shift lake trophic status (e.g., mesotrophic to eutrophic)

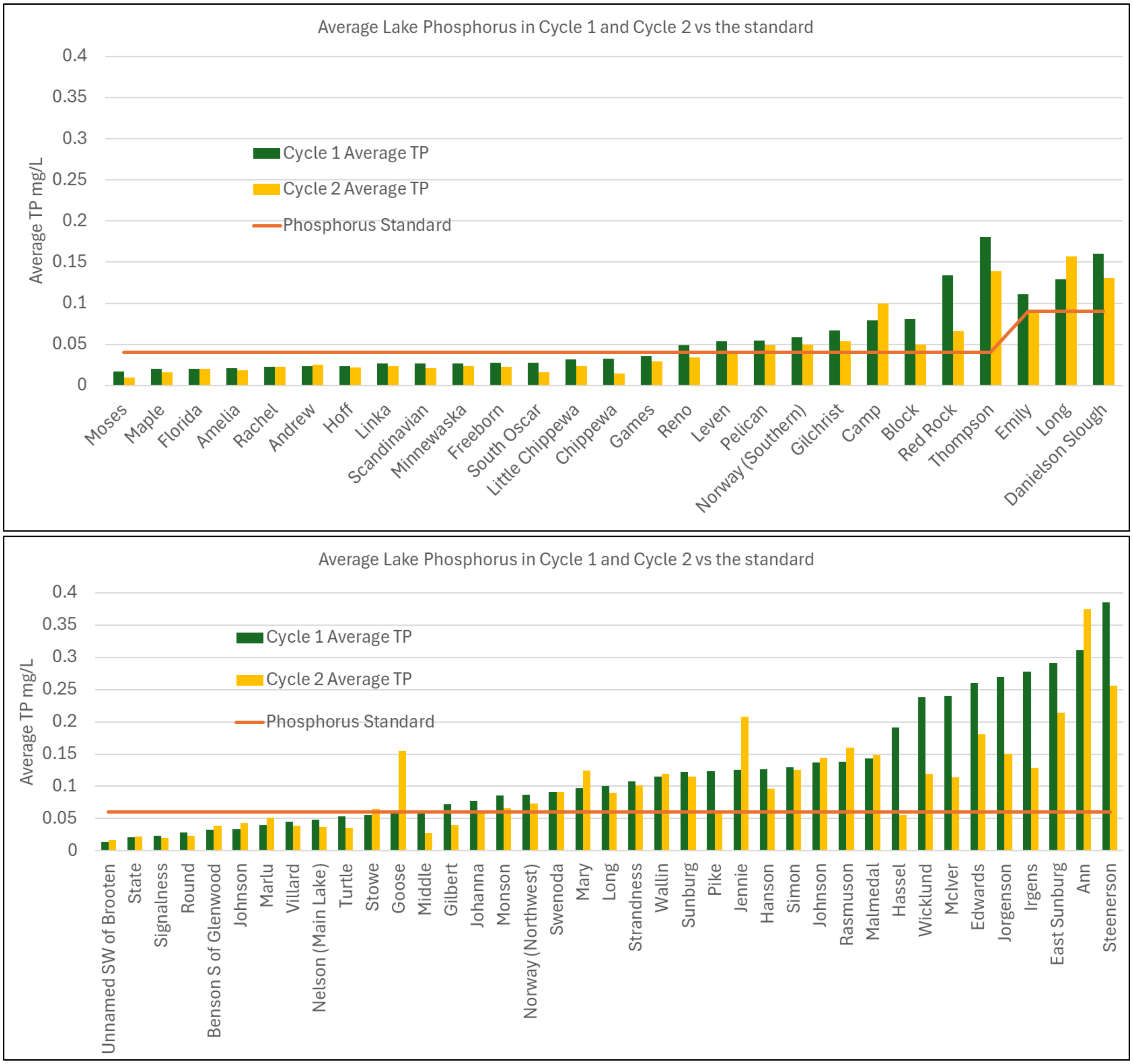
While the overall trend across the watershed shows a statistically significant decrease in average lake TP concentrations between 2000 through 2009 and 2010 through 2020, not all lakes followed this pattern. Several lakes experienced notable increases in TP over the past two decades, suggesting localized or lake-specific issues may be contributing to worsening nutrient conditions.

The following lakes saw an increase in their average TP concentrations in excess of +0.02 mg/L:

- Goose Lake: +0.096 mg/L,
- Jennie Lake: +0.082 mg/L,
- Ann Lake: +0.064 mg/L,
- Long Lake: +0.028 mg/L,
- Mary Lake: +0.027 mg/L,
- Rasmuson Lake: +0.022 mg/L,
- Camp Lake: +0.021 mg/L.

The absence of a shared geographic or hydrologic linkage among these lakes suggests that TP increases stem from localized sources or site-specific factors. These changes are substantially opposite of the average trend observed across the watershed and may indicate emerging localized P loading concerns, such as increased watershed runoff, failing septic systems, internal nutrient cycling, or other sources.

Figure 9. Average lake phosphorus in Cycle 1 and Cycle 2 vs the different lake standards

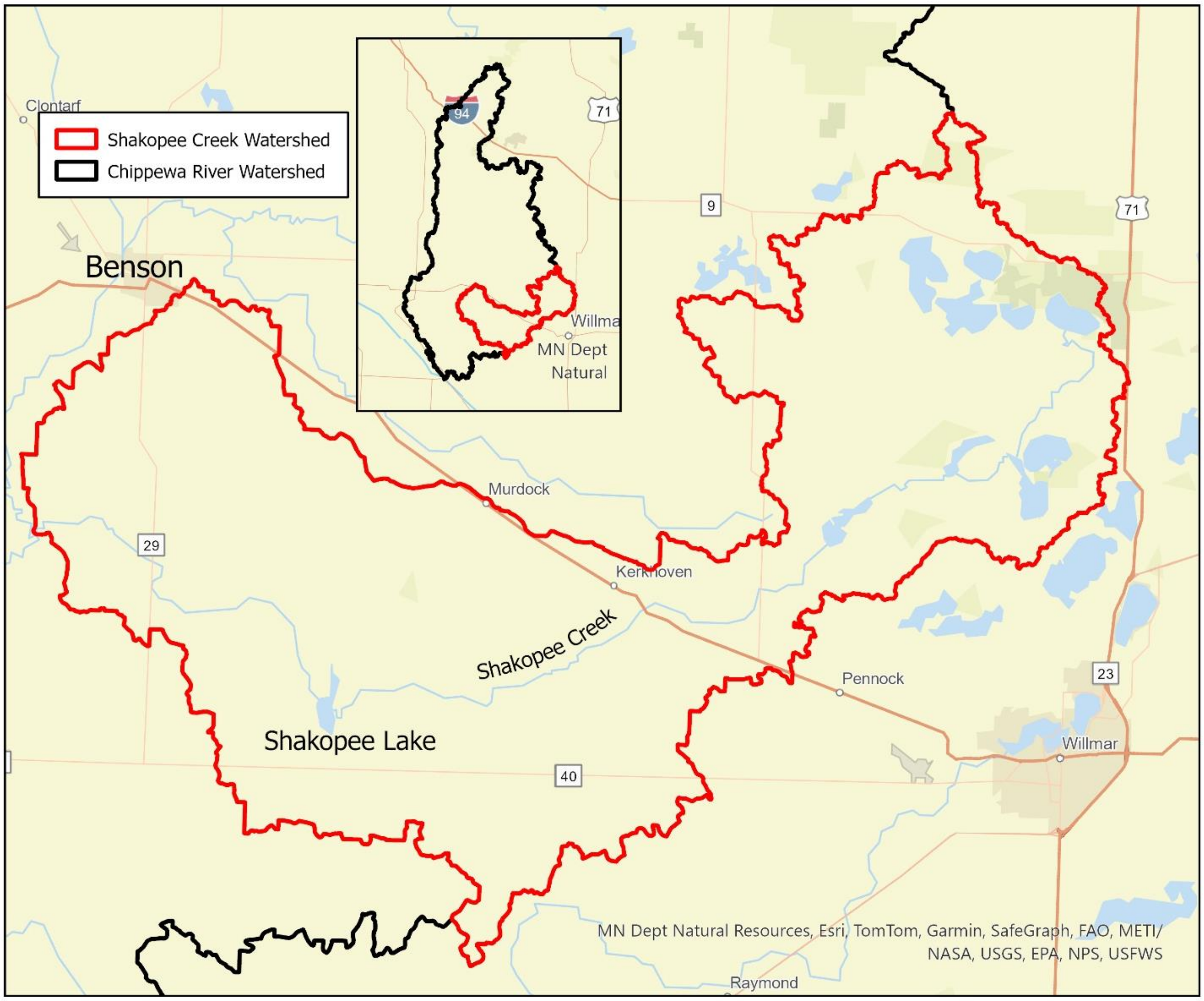


4.1.3 Shakopee Lake Reservoir

Shakopee Lake (261 acres), (Figure 10), is singled out in this report in part because it will not be addressed in a TMDL report. Located in the lower end of the Shakopee Creek Subwatershed, which consistently reports the highest concentrations of TSS, TP and NO_2-NO_3, Shakopee Lake has some of the highest TP and chl-*a* concentrations and is one of the most polluted water bodies in the CRW. Technically a reservoir with a short residence time (11 to 14 days under low flow) and therefore not formally assessed as a lake under EPA guidance, Shakopee Lake was formally requested for assessment-level monitoring in Cycle 2. The decision to monitor and evaluate Shakopee Lake reflects its outsized role in shaping downstream water quality and its importance as a recreational resource to the adjacent Chippewa County Park 1.

Results show that all three eutrophication parameters (chl-*a*, Secchi transparency, and TP) consistently and significantly exceed regional shallow lake standards, confirming Shakopee Lake has degraded water quality despite recent structural and land management improvements.

Figure 10. Shakopee Lake and the Shakopee Creek Subwatershed.



MN Dept Natural Resources, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS

Water Quality Conditions

Monitoring of Shakopee Lake water quality between 2019 and 2023 has demonstrated that all three eutrophication parameters greatly and consistently exceeded regional standards for shallow lakes and have not improved since Cycle 1 (CRWP 2010, Surface Water). The lake is nutrient- and sediment-rich, with severe algal blooms and widespread carp disturbance. A large stock of legacy P and sediment, built up from decades of upstream erosion, remains in the lakebed. Shakopee Creek has the highest concentrations of TSS, TP, and N in the CRW (see Section 4.2.3). The TSS and P are readily resuspended, driving turbidity and elevated TP concentrations downstream even when inflows are relatively clean.

- **TSS and TP:** Shakopee Lake may be a net contributor of sediment and P to downstream waters on a day-to-day basis, with outlet conditions consistently worse than inlet conditions (CRWP 2010).

- **Nitrogen (NO_2–NO_3):** Unlike P, nitrogen levels tend to decline as water passes through the lake (CRWP 2010).
- **Aquatic Plants:** Sparse vegetation (<20% coverage) and low plant diversity have been documented, limiting the lake's capacity to stabilize sediments or improve clarity (DNR 2021).
- **Algal Growth:** Eutrophication indicators from Cycle 2 monitoring are far above state thresholds (e.g., TP ~365 µg/L, chl-*a* ~61 µg/L).

Contributing Factors

The Shakopee Creek Watershed is characterized by heavy soils, extensive ditching, and numerous open tile intakes, all of which historically funneled sediment and nutrients directly into the lake. Agricultural practices such as fall fertilizer and manure application amplify P losses during spring snowmelt.

Watershed improvements since Cycle 1

Buffer requirements have now been implemented watershed-wide (16.5 ft on ditches and up to 50 ft on lakes, rivers, and streams (Minnesota Buffer Law), reducing direct sediment and nutrient delivery to Shakopee Creek and Shakopee Lake. Also, between 2010 and 2024, the Shakopee Creek Watershed has successfully implemented 103,500 acres of water related BMPs with nutrient management, tillage/residue management, and cover crops being the top three based on acreage (Workbook: Best management practices by watershed).

Recent Structural and Planning Improvements

Two major advances have been made to the reservoir since the first WRAPS cycle:

- **Dam Replacement with Drawdown Capability:** The failing spillway was replaced in 2022 with a low-hazard dam equipped with sluice gates, allowing for controlled **temporary drawdowns** that mimic natural droughts, consolidate sediments, promote vegetation recovery, and reduce carp impacts.
- **Shakopee Lake Management Plan:** With the dam rebuild, a formal management plan was developed for the first time. This plan provides a clear framework for coordinated drawdowns, vegetation restoration, wildlife habitat enhancement, and long-term monitoring - a level of management capacity that did not exist prior to the dam project Shakopee Lake Management Plan (DNR 2021).

Habitat and Wildlife

Although water quality is degraded, Shakopee Lake remains an important stopover for migratory waterfowl and other wildlife in a landscape with few shallow lakes. It provides habitat for ducks, geese, pelicans, herons, and various furbearers. Habitat quality, however, fluctuates widely with water level, vegetation cover, and water clarity.

Management Goals and Strategies

The Shakopee Lake Management Plan (DNR 2021) outlines actions to improve water quality and habitat:

- **Drawdowns:** Periodic water level reductions to consolidate sediments, stimulate vegetation growth, and reduce carp impacts.
- **Vegetation Restoration:** Increase aquatic plant diversity and coverage (>75%) to stabilize sediments and improve clarity.
- **Water Quality Targets:** Achieve Secchi depth >2.3 ft and reduce TP and chl-*a* to meet MPCA shallow lake standards.
- **Upstream Load Reduction (Bathtub Model):** The MPCA modeling indicates that upstream P inputs must be reduced by ~70% (~14,375 lbs/year) before Shakopee Lake could meet the shallow lake TP standard (0.090 mg/L). See appendix Bathtub model.
- **Regulatory Context (DO TMDL):** The upstream reach of Shakopee Creek (07020005-732) is listed as impaired by dissolved oxygen (DO). The CRW DO TMDL called for a 27% reduction (~2,180 lbs/year) in TP to help address oxygen demand and improve water quality conditions feeding into Shakopee Lake.

Ongoing Challenges

Despite improved buffers, dam management, and the new management plan, Shakopee Lake continues to export P and sediment due to its large watershed (202 sq. miles), row-crop dominance, and legacy P pool. Meeting long-term water quality goals will require progress on both:

1. **In-lake management** (drawdowns, vegetation recovery, sediment stabilization); and
2. **Upstream reductions** (nutrient timing, alternative tile intakes, perennial cover, and other BMP adoption to achieve both the 70% P reduction identified by the Bathtub model and the 27% reduction identified in the DO TMDL).

4.2 Water quality conditions - streams

4.2.1 New stream impairments and delistings

In 2020, the TALU framework was applied to the deferred Cycle 1 monitoring data for the CRW. This assessment of 48 WIDs resulted in 29 new AQL impairments.

In 2021 and 2022, the Cycle 2 assessment identified 21 new stream impairments in the watershed (MPCA 2022a). These new impairments consist of two new TSS impairments, one river eutrophication (nutrients) impairment, one bacteria (*E. coli*) impairment, five DO impairments, five new macroinvertebrate impairments and seven new fish impairments. The fish and macroinvertebrate impairments are further detailed in the *Chippewa River Watershed Stressor Identification Report Update 2024* (MPCA 2024c). One TSS impairment, the RES impairment, and one DO impairment were addressed in the *Chippewa River Watershed TMDL Report 2025* (MPCA 2025).

The Cycle 2 assessment also identified eight stream WIDs that are no longer impaired and will be "delisted". Two WIDs originally listed as impaired for AQL fish bioassessments and six WIDs listed as impaired for AQL macroinvertebrate bioassessments will be removed from Minnesota's impaired waters list. Aquatic communities are influenced by a complex combination of water quality, habitat, and hydrologic conditions, making it difficult to attribute improvements to any single factor. However, local implementation projects, such as streambank and riparian buffer restoration, improved nutrient and sediment management, and wastewater treatment system upgrades, have collectively reduced stressors on aquatic life. Additional details on the type and scale of these projects are provided in Sections 4.3 and 4.5.

Details on lakes previously listed as impaired for AQR can be found in the *Chippewa River Watershed TMDL Report* (MPCA 2017a), and the *Chippewa River WRAPS 2017 Report* (MPCA 2017b).

4.2.2 Stressor identification

The MPCA assesses the biological condition of rivers and streams by examining fish and aquatic macroinvertebrate communities. Aquatic communities reflect the impacts of human activities over time, making them valuable indicators of water quality.

If impairments are identified, the SID process is used to determine the factors causing harm to AQL, essential to restoration and protection efforts. The SID process utilizes EPA's CADDIS approach, involving data review, strength of evidence analysis, and additional data collection when necessary. Biological metrics and tolerance values help assess ecological integrity.

In the CRW, 28 stream reaches with biological impairments were analyzed in the *Chippewa River Watershed SID Report Update 2024* (MPCA 2024c; Figure 11), identifying key stressors including:

- Hydrologic Alteration: Changes in water movement due to channel alteration, drainage, and other activities, leading to habitat disruption, increased sedimentation, and altered flow regimes.
- Connectivity Issues: Barriers like dams and improperly installed culverts that hinder fish migration and disrupt ecosystem connectivity.
- Insufficient Physical Habitat: Loss or degradation of habitat due to sediment deposition, channelization, and landscape alterations, impacting species that rely on specific habitats.
- DO Depletion: Low DO levels or fluctuations, often due to nutrient enrichment and plant overgrowth, causing stress or mortality in aquatic species.
- Eutrophication: Excess nutrient levels, particularly P, leading to overgrowth of algae and plants, altering habitat, food resources, and DO levels.
- Suspended Solids: Increased sediment and turbidity from land use activities, leading to habitat degradation and impaired AQL.
- Nitrate-Nitrogen Pollution: Elevated nitrate levels from agricultural runoff, posing toxic effects on sensitive aquatic organisms.

These stressors interact within the watershed's landscape, affecting water quality and biological integrity. The C*hippewa River Watershed SID Report* highlights the importance of understanding these dynamics for effective watershed management and restoration.

Figure 11. Map of biological stream reach impairments identified in the CRW (MPCA 2024c). Impaired reaches are shown in red.

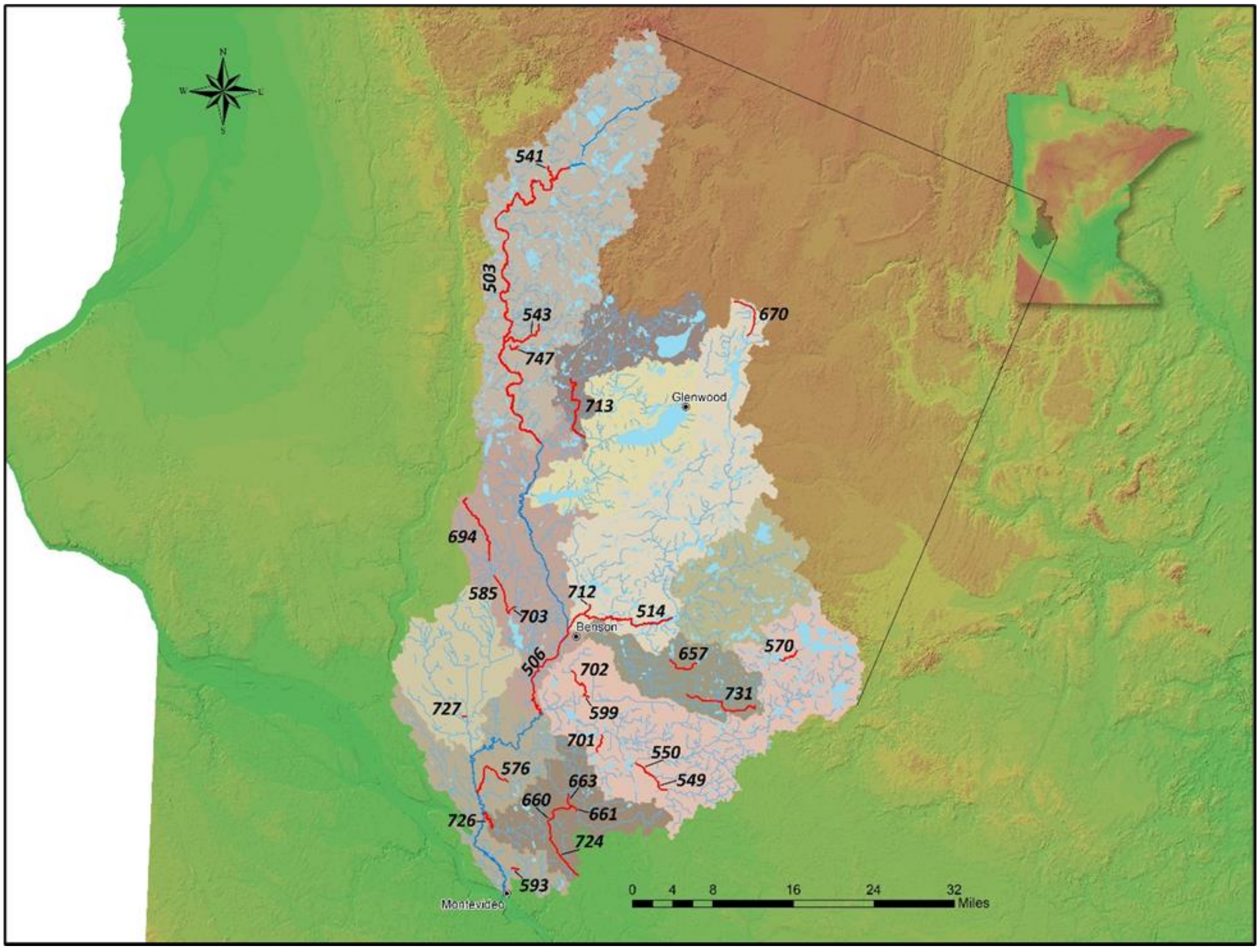
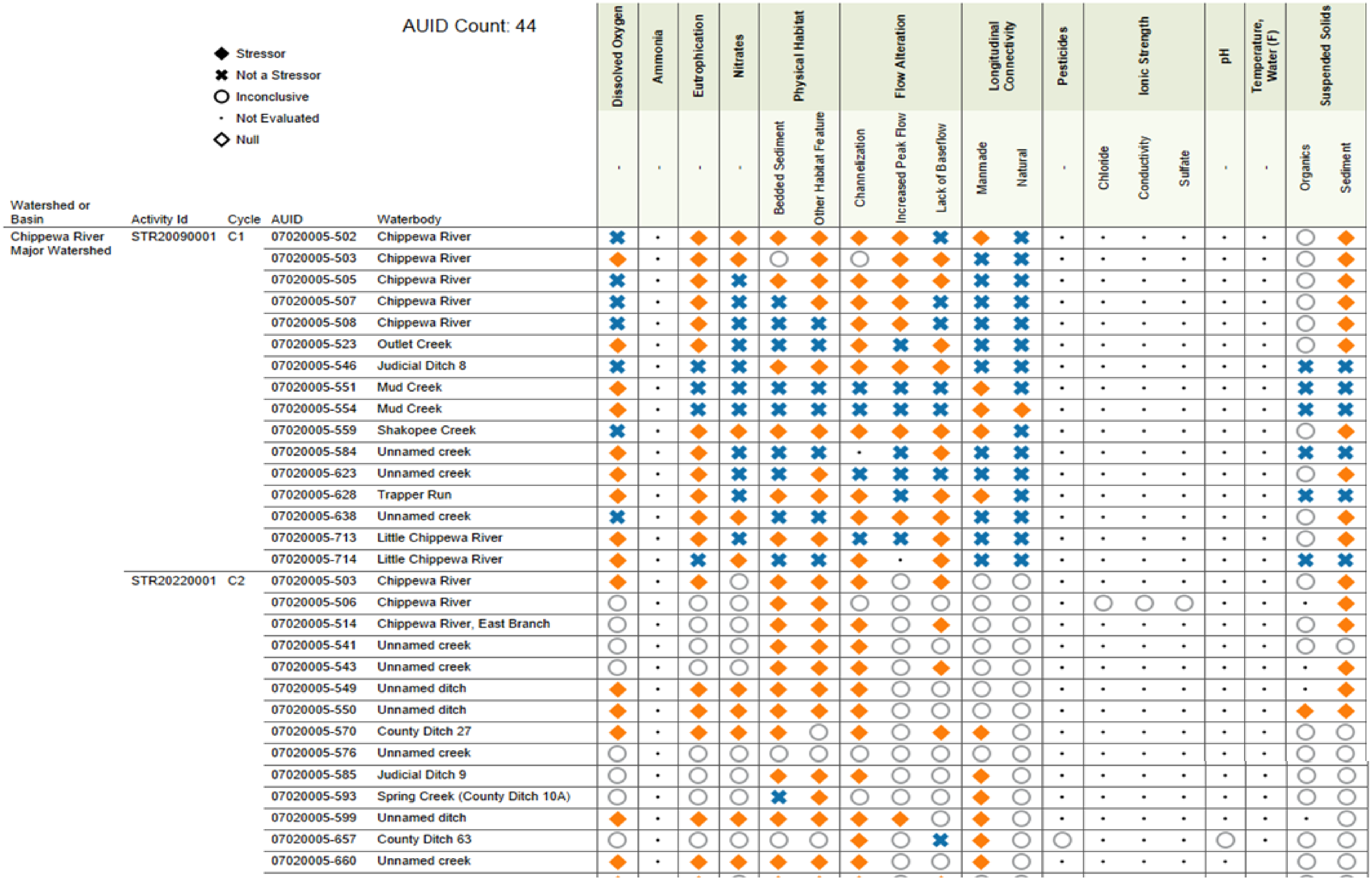


Table 5 is a summary of the biologically impaired reaches and stressors identified in [Chippewa River Watershed SID Report Update 2024 (MPCA 2024c)](). The primary stressors identified were hydrologic alteration, habitat loss, connectivity barriers, nutrient enrichment, and sedimentation.

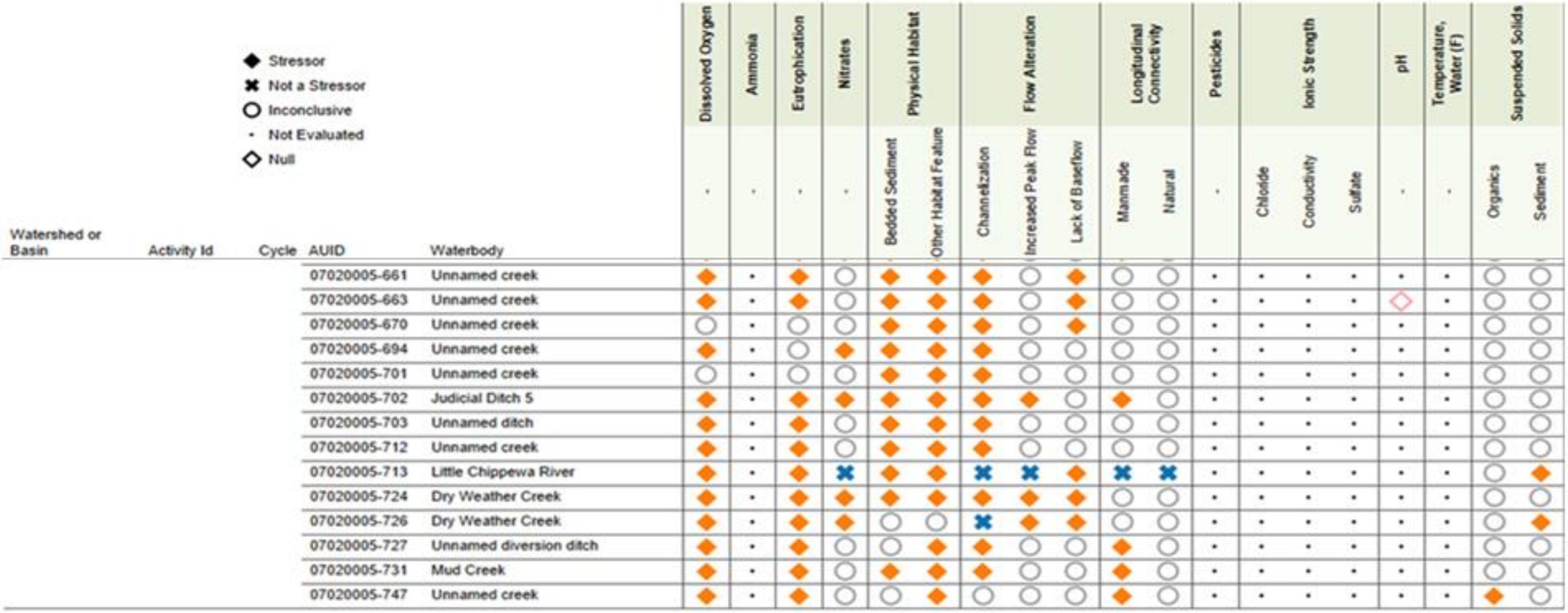
Table 5. All Stressors: Chippewa River Watershed SID Report 2015 and Report Update 2024.



AUID Count: 44

◆ Stressor
✖ Not a Stressor
○ Inconclusive
· Not Evaluated
◇ Null

Watershed or Basin	Activity Id	Cycle	AUID	Waterbody	Dissolved Oxygen	Ammonia	Eutrophication	Nitrates	Physical Habitat		Flow Alteration			Longitudinal Connectivity		Pesticides	Ionic Strength			pH	Temperature, Water (F)	Suspended Solids	
					-	-	-	-	Bedded Sediment	Other Habitat Feature	Channelization	Increased Peak Flow	Lack of Baseflow	Manmade	Natural	-	Chloride	Conductivity	Sulfate	-	-	Organics	Sediment
Chippewa River Major Watershed	STR20090001	C1	07020005-502	Chippewa River	✖	·	◆	◆	◆	◆	◆	◆	✖	◆	✖	·	·	·	·	·	·	○	◆
			07020005-503	Chippewa River	◆	·	◆	◆	○	◆	○	◆	◆	✖	✖	·	·	·	·	·	·	○	◆
			07020005-505	Chippewa River	✖	·	◆	✖	◆	◆	◆	◆	◆	✖	✖	·	·	·	·	·	·	○	◆
			07020005-507	Chippewa River	✖	·	◆	✖	✖	◆	◆	◆	✖	✖	✖	·	·	·	·	·	·	○	◆
			07020005-508	Chippewa River	✖	·	◆	✖	✖	✖	◆	◆	✖	✖	✖	·	·	·	·	·	·	○	◆
			07020005-523	Outlet Creek	◆	·	◆	✖	✖	✖	◆	✖	◆	✖	✖	·	·	·	·	·	·	○	◆
			07020005-546	Judicial Ditch 8	✖	·	✖	✖	◆	◆	◆	◆	◆	✖	✖	·	·	·	·	·	·	✖	✖
			07020005-551	Mud Creek	◆	·	✖	✖	✖	✖	✖	✖	✖	◆	✖	·	·	·	·	·	·	✖	✖
			07020005-554	Mud Creek	◆	·	✖	✖	✖	✖	✖	✖	✖	◆	◆	·	·	·	·	·	·	✖	✖
			07020005-559	Shakopee Creek	✖	·	◆	◆	◆	◆	◆	◆	◆	◆	✖	·	·	·	·	·	·	○	◆
			07020005-584	Unnamed creek	◆	·	◆	✖	✖	✖	·	✖	◆	✖	✖	·	·	·	·	·	·	✖	✖
			07020005-623	Unnamed creek	◆	·	◆	✖	✖	◆	✖	✖	✖	✖	✖	·	·	·	·	·	·	○	◆
			07020005-628	Trapper Run	◆	·	◆	✖	◆	◆	◆	✖	◆	◆	✖	·	·	·	·	·	·	✖	✖
			07020005-638	Unnamed creek	✖	·	◆	◆	✖	✖	◆	◆	◆	✖	✖	·	·	·	·	·	·	○	◆
			07020005-713	Little Chippewa River	◆	·	◆	✖	◆	◆	✖	✖	◆	✖	✖	·	·	·	·	·	·	○	◆
			07020005-714	Little Chippewa River	◆	·	✖	◆	✖	✖	◆	·	◆	✖	✖	·	·	·	·	·	·	✖	✖
	STR20220001	C2	07020005-503	Chippewa River	◆	·	◆	○	◆	◆	◆	○	◆	○	○	·	·	·	·	·	·	○	◆
			07020005-506	Chippewa River	○	·	○	○	◆	◆	○	○	○	○	○	·	○	○	○	·	·	·	◆
			07020005-514	Chippewa River, East Branch	○	·	○	○	◆	◆	◆	○	◆	○	○	·	·	·	·	·	·	○	◆
			07020005-541	Unnamed creek	○	·	○	○	◆	◆	◆	○	○	○	○	·	·	·	·	·	·	○	○
			07020005-543	Unnamed creek	○	·	○	○	◆	◆	◆	○	◆	○	○	·	·	·	·	·	·	·	◆
			07020005-549	Unnamed ditch	◆	·	◆	◆	◆	◆	◆	○	○	○	○	·	·	·	·	·	·	·	◆
			07020005-550	Unnamed ditch	◆	·	◆	◆	◆	◆	◆	○	○	○	○	·	·	·	·	·	·	◆	◆
			07020005-570	County Ditch 27	◆	·	◆	◆	◆	○	◆	○	◆	◆	○	·	·	·	·	·	·	○	○
			07020005-576	Unnamed creek	○	·	○	○	○	○	○	○	○	○	○	·	·	·	·	·	·	○	○
			07020005-585	Judicial Ditch 9	○	·	○	○	◆	◆	◆	○	○	◆	○	·	·	·	·	·	·	○	○
			07020005-593	Spring Creek (County Ditch 10A)	○	·	○	○	✖	◆	○	○	○	◆	○	·	·	·	·	·	·	○	○
			07020005-599	Unnamed ditch	◆	·	◆	◆	◆	◆	◆	◆	○	◆	○	·	·	·	·	·	·	·	○
			07020005-657	County Ditch 63	○	·	○	○	○	○	◆	○	✖	◆	○	○	·	·	·	○	·	○	○
			07020005-660	Unnamed creek	◆	·	◆	◆	◆	◆	◆	○	○	◆	○	·	·	·	·	·		○	○



- ◆ Stressor
- ✖ Not a Stressor
- ○ Inconclusive
- • Not Evaluated
- ◇ Null

Watershed or Basin	Activity Id	Cycle	AUID	Waterbody	Dissolved Oxygen	Ammonia	Eutrophication	Nitrates	Physical Habitat		Flow Alteration			Longitudinal Connectivity		Pesticides	Ionic Strength			pH	Temperature, Water (F)	Suspended Solids	
					-	-	-	-	Bedded Sediment	Other Habitat Feature	Channelization	Increased Peak Flow	Lack of Baseflow	Manmade	Natural	-	Chloride	Conductivity	Sulfate	-	-	Organics	Sediment
			07020005-661	Unnamed creek	◆	•	◆	○	◆	◆	◆	○	◆	○	○	•	•	•	•	•	•	○	○
			07020005-663	Unnamed creek	◆	•	◆	○	◆	◆	◆	○	◆	○	○	•	•	•	•	◇	•	○	○
			07020005-670	Unnamed creek	○	•	○	○	◆	◆	◆	○	◆	○	○	•	•	•	•	•	•	○	○
			07020005-694	Unnamed creek	◆	•	○	◆	◆	◆	◆	○	○	○	○	•	•	•	•	•	•	○	○
			07020005-701	Unnamed creek	○	•	○	○	◆	◆	◆	○	○	○	○	•	•	•	•	•	•	○	○
			07020005-702	Judicial Ditch 5	◆	•	◆	◆	◆	◆	◆	◆	○	◆	○	•	•	•	•	•	•	○	○
			07020005-703	Unnamed ditch	◆	•	◆	○	◆	◆	◆	○	○	○	○	•	•	•	•	•	•	○	○
			07020005-712	Unnamed creek	◆	•	◆	○	◆	◆	◆	○	○	○	○	•	•	•	•	•	•	○	○
			07020005-713	Little Chippewa River	◆	•	◆	✖	◆	◆	✖	✖	◆	✖	✖	•	•	•	•	•	•	○	◆
			07020005-724	Dry Weather Creek	◆	•	◆	◆	◆	◆	◆	◆	◆	○	○	•	•	•	•	•	•	○	○
			07020005-726	Dry Weather Creek	◆	•	◆	◆	○	○	✖	◆	◆	○	○	•	•	•	•	•	•	○	◆
			07020005-727	Unnamed diversion ditch	◆	•	◆	○	○	◆	◆	○	○	◆	○	•	•	•	•	•	•	○	○
			07020005-731	Mud Creek	◆	•	◆	○	◆	◆	◆	○	○	◆	○	•	•	•	•	•	•	○	○
			07020005-747	Unnamed creek	◆	•	◆	○	○	◆	○	○	○	◆	○	•	•	•	•	•	•	◆	○

Biological Condition Trends in the Watershed

To evaluate whether biological conditions in the watershed's rivers and streams have changed over time, statistical comparisons were conducted on paired FIBI and MIBI scores at monitoring sites sampled during Cycle 1 and Cycle 2 of IWM (Table 6). Paired t-tests and Wilcoxon signed-rank tests of FIBI and MIBI scores were used to evaluate if biological conditions of the watershed’s rivers and streams have changed between time periods. Figure 12 shows changes in impairment status and trends for several stream reaches and lakes in the CRW between Cycle 1 and Cycle 2.

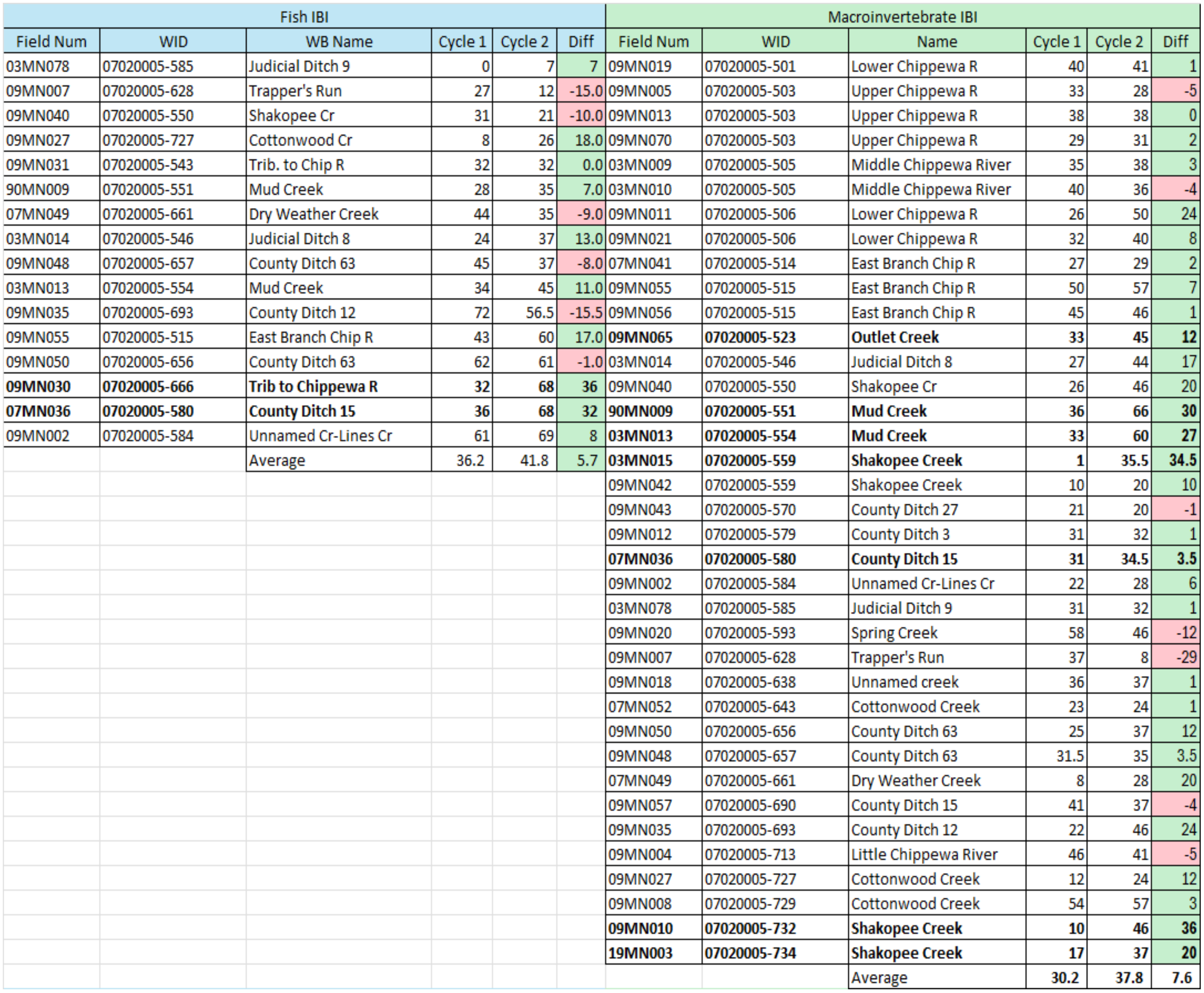
Macroinvertebrates (MIBI)

A total of 37 paired sites were analyzed. The average MIBI score increased by 7.6 points from Cycle 1 to Cycle 2. This improvement was found to be statistically significant using both the paired t-test ($p = 0.0024$) and the Wilcoxon signed-rank test ($p = 0.0015$). These consistent results provide strong evidence of a meaningful improvement in macroinvertebrate community condition across the watershed.

Fish (FIBI)

For fish communities, 16 paired sites were evaluated. The average FIBI score increased by 5.7 points between sampling periods. However, this change was not statistically significant based on either the paired t-test ($p = 0.1639$) or the Wilcoxon signed-rank test ($p = 0.2441$), suggesting that observed differences may reflect natural variability rather than a consistent directional trend.

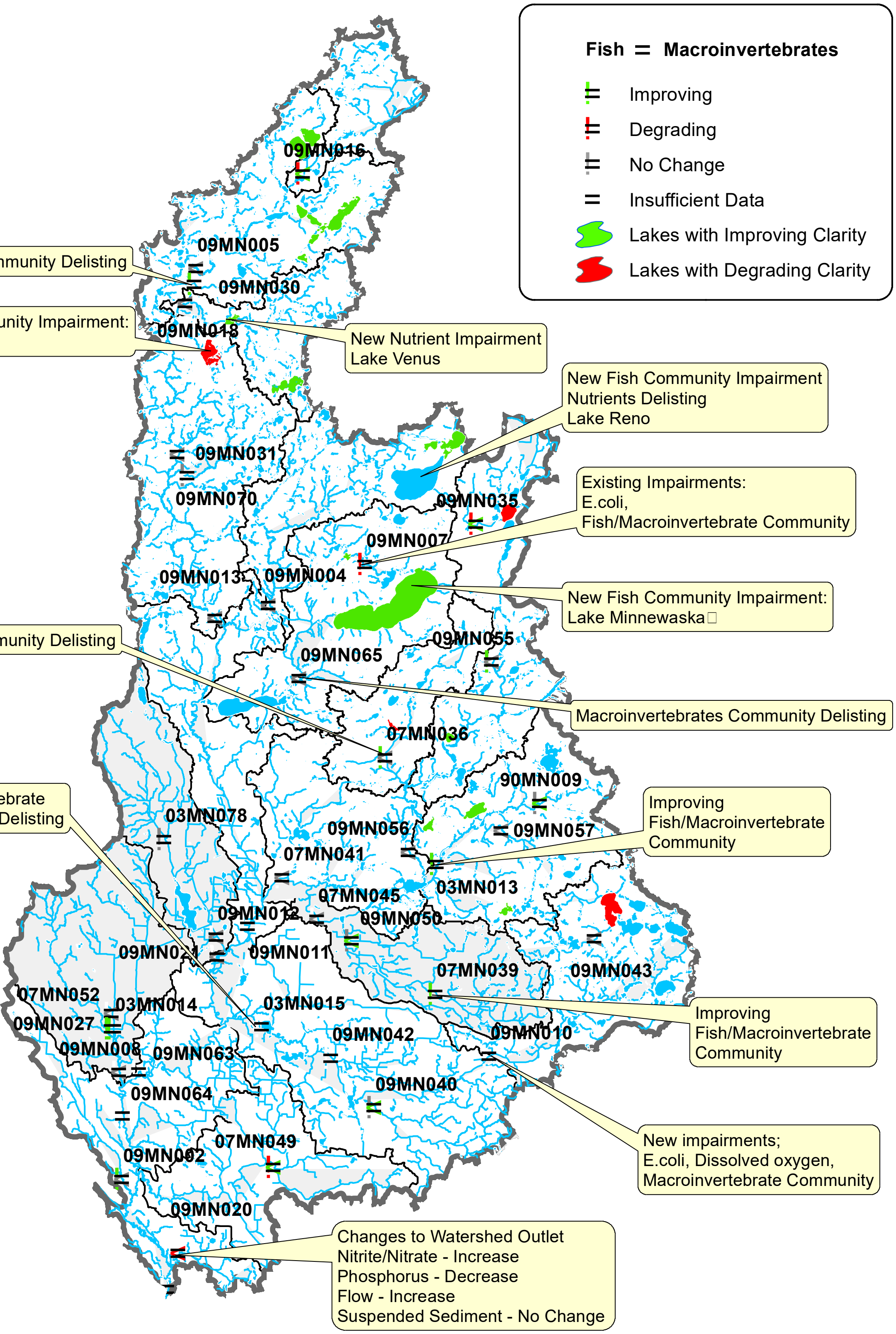
Table 6. Fish and macroinvertebrate IBI score analysis between Cycle 1 and Cycle 2 assessments for the CRW.



Fish IBI						Macroinvertebrate IBI					
Field Num	WID	WB Name	Cycle 1	Cycle 2	Diff	Field Num	WID	Name	Cycle 1	Cycle 2	Diff
03MN078	07020005-585	Judicial Ditch 9	0	7	7	09MN019	07020005-501	Lower Chippewa R	40	41	1
09MN007	07020005-628	Trapper's Run	27	12	-15.0	09MN005	07020005-503	Upper Chippewa R	33	28	-5
09MN040	07020005-550	Shakopee Cr	31	21	-10.0	09MN013	07020005-503	Upper Chippewa R	38	38	0
09MN027	07020005-727	Cottonwood Cr	8	26	18.0	09MN070	07020005-503	Upper Chippewa R	29	31	2
09MN031	07020005-543	Trib. to Chip R	32	32	0.0	03MN009	07020005-505	Middle Chippewa River	35	38	3
90MN009	07020005-551	Mud Creek	28	35	7.0	03MN010	07020005-505	Middle Chippewa River	40	36	-4
07MN049	07020005-661	Dry Weather Creek	44	35	-9.0	09MN011	07020005-506	Lower Chippewa R	26	50	24
03MN014	07020005-546	Judicial Ditch 8	24	37	13.0	09MN021	07020005-506	Lower Chippewa R	32	40	8
09MN048	07020005-657	County Ditch 63	45	37	-8.0	07MN041	07020005-514	East Branch Chip R	27	29	2
03MN013	07020005-554	Mud Creek	34	45	11.0	09MN055	07020005-515	East Branch Chip R	50	57	7
09MN035	07020005-693	County Ditch 12	72	56.5	-15.5	09MN056	07020005-515	East Branch Chip R	45	46	1
09MN055	07020005-515	East Branch Chip R	43	60	17.0	**09MN065**	**07020005-523**	**Outlet Creek**	**33**	**45**	**12**
09MN050	07020005-656	County Ditch 63	62	61	-1.0	03MN014	07020005-546	Judicial Ditch 8	27	44	17
09MN030	**07020005-666**	**Trib to Chippewa R**	**32**	**68**	**36**	09MN040	07020005-550	Shakopee Cr	26	46	20
07MN036	**07020005-580**	**County Ditch 15**	**36**	**68**	**32**	**90MN009**	**07020005-551**	**Mud Creek**	**36**	**66**	**30**
09MN002	07020005-584	Unnamed Cr-Lines Cr	61	69	8	**03MN013**	**07020005-554**	**Mud Creek**	**33**	**60**	**27**
		Average	36.2	41.8	5.7	**03MN015**	**07020005-559**	**Shakopee Creek**	**1**	**35.5**	**34.5**
						09MN042	07020005-559	Shakopee Creek	10	20	10
						09MN043	07020005-570	County Ditch 27	21	20	-1
						09MN012	07020005-579	County Ditch 3	31	32	1
						07MN036	**07020005-580**	**County Ditch 15**	**31**	**34.5**	**3.5**
						09MN002	07020005-584	Unnamed Cr-Lines Cr	22	28	6
						03MN078	07020005-585	Judicial Ditch 9	31	32	1
						09MN020	07020005-593	Spring Creek	58	46	-12
						09MN007	07020005-628	Trapper's Run	37	8	-29
						09MN018	07020005-638	Unnamed creek	36	37	1
						07MN052	07020005-643	Cottonwood Creek	23	24	1
						09MN050	07020005-656	County Ditch 63	25	37	12
						09MN048	07020005-657	County Ditch 63	31.5	35	3.5
						07MN049	07020005-661	Dry Weather Creek	8	28	20
						09MN057	07020005-690	County Ditch 15	41	37	-4
						09MN035	07020005-693	County Ditch 12	22	46	24
						09MN004	07020005-713	Little Chippewa River	46	41	-5
						09MN027	07020005-727	Cottonwood Creek	12	24	12
						09MN008	07020005-729	Cottonwood Creek	54	57	3
						09MN010	**07020005-732**	**Shakopee Creek**	**10**	**46**	**36**
						19MN003	**07020005-734**	**Shakopee Creek**	**17**	**37**	**20**
								Average	**30.2**	**37.8**	**7.6**

Bold entries denote delisted WIDs, **green shows increase in score, red shows decrease in score (MPCA 2024c).**

Figure 12. Change in water quality in the CRW (MPCA 2022a). Alpha numeric codes (e.g. 09MN016) indicate discrete monitoring locations in the CRW.



Fish Community Delisting

New Fish Community Impairment:
Red Rock Lake

New Nutrient Impairment
Lake Venus

New Fish Community Impairment
Nutrients Delisting
Lake Reno

Existing Impairments:
E.coli,
Fish/Macroinvertebrate Community

New Fish Community Impairment:
Lake Minnewaska

Fish Community Delisting

Macroinvertebrates Community Delisting

Macroinvertebrate
Community Delisting

Improving
Fish/Macroinvertebrate
Community

Improving
Fish/Macroinvertebrate
Community

New impairments;
E.coli, Dissolved oxygen,
Macroinvertebrate Community

Changes to Watershed Outlet
Nitrite/Nitrate - Increase
Phosphorus - Decrease
Flow - Increase
Suspended Sediment - No Change

4.2.3 Stream Water Quality and Flow Trends WPLMN

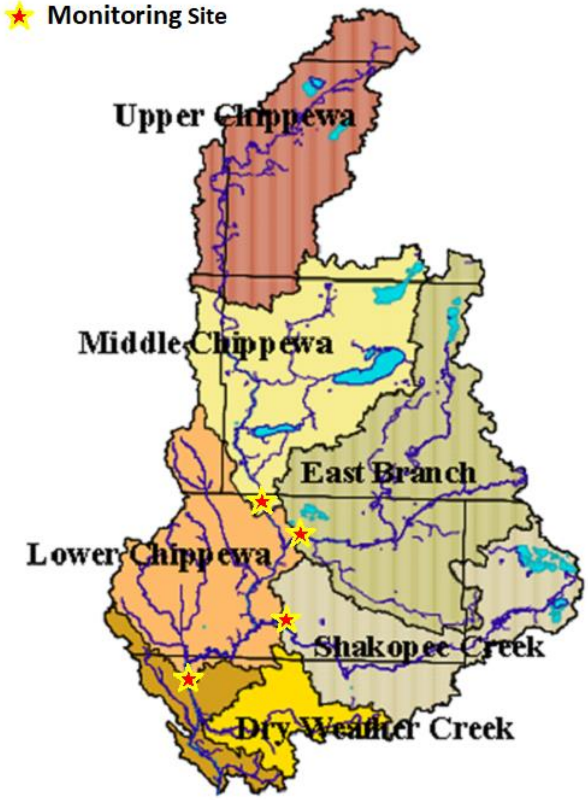
The WPLMN is a statewide partnership that includes state and federal agencies, the Metropolitan Council, universities, and local organizations. Since 2007, this network has worked together to collect water quality data and track long-term trends across Minnesota.

In the CRW, in addition to continuous flow data, the WPLMN partnership usually collects 18 to 25 water samples per season from three upstream locations on the Chippewa River, and 25 to 35 samples from a downstream site near Milan on Highway 40. This WRAPS Update focuses on flow-weighted mean concentrations (FWMC) of three key pollutants: TP, TSS, and nitrate-nitrite (NO_2+NO_3) (Figure 13).

Before 2007, these same sites were monitored by the Chippewa River Watershed Project (now the Chippewa River Watershed Association (CRWA)) with support from the MPCA. The monitoring protocols were essentially the same to WPLMN protocols. For more details, visit: Watershed pollutant load monitoring.

FWMC provides a flow-adjusted annual average that accounts for how much water moves through a river, offering a more accurate measure of pollutant loading than a simple concentration average. Analysis of FWMC data from 1999 to 2021 at the Chippewa River Hwy 40 monitoring site shows differing long-term trends for TP, NO_2+NO_3, and TSS. Additional analysis of FWMC data from the four WPLMN/CRWA monitoring sites highlights geographic differences in both the range and variability of concentrations. At the time of this report's analysis the latest WPLMN FWMC data set available was 2021 data.

Figure 13. CRWA management zones. WPLMN monitoring sites are located at the outlet of four of these zones.

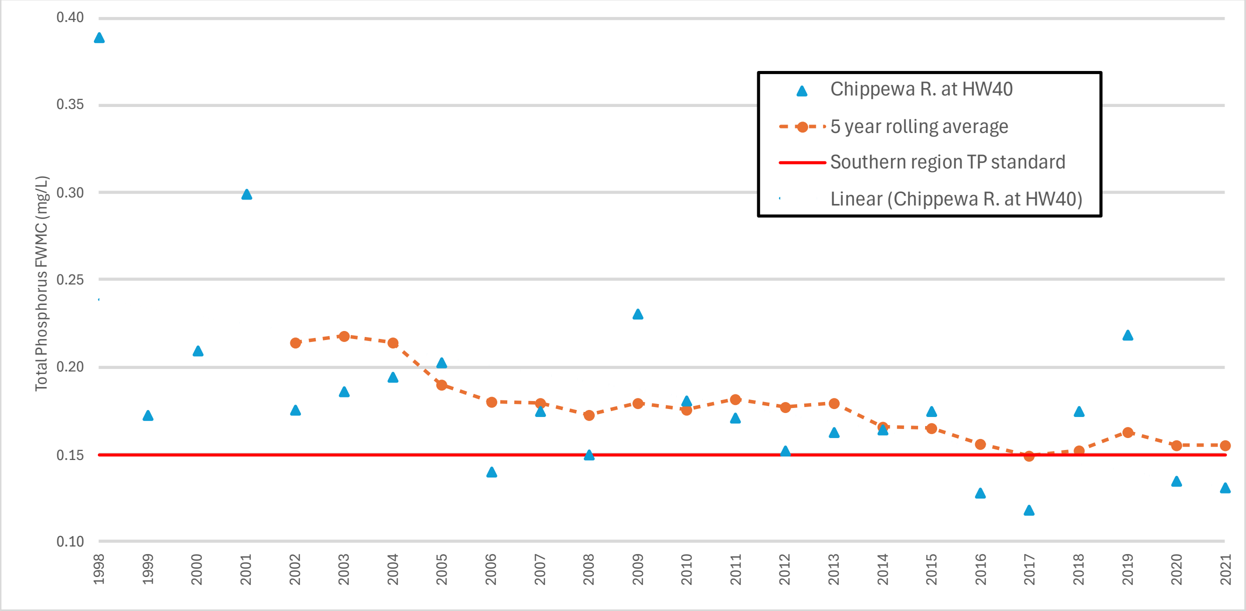


Phosphorus

Across the four WPLMN monitoring sites (Figure 16), many of the annual TP FWMCs (1998-2021) exceed the applicable water quality standard of 0.15 mg/L. This threshold is used as a benchmark for identifying nutrient impairment in the southern nutrient region in Minnesota. While some years and sites fall below this value, particularly at the East Branch and Clontarf locations, the majority of observations at Shakopee Creek and HW40 exceed the standard, indicating persistent P loading concerns. These exceedances highlight the ongoing need for P reduction strategies across the watershed, especially in subwatersheds where elevated and variable TP levels suggest active sources of nutrient runoff.

Statistical Analysis of Phosphorus Trends at HW40 (1999-2004 vs. 2016-2021):
A comparison of TP FWMCs at the Chippewa River near Milan (HW40) shows a decline from an average of 0.239 mg/L during 1998-2004 to 0.151 mg/L during 2016-2021 (Figure 14). This represents a 37% reduction from 1998 to 2021. A Welch's t-test was used to assess the statistical significance of this change, resulting in a p-value of 0.052. While this result does not meet the conventional 95% confidence threshold ($p < 0.05$), it does meet the 90% confidence threshold ($p < 0.10$), suggesting that the decline in TP concentrations is statistically significant at that level and likely reflects a real improvement over time. A Welch's t-test was applied to compare mean TP concentrations between Cycle 1 and Cycle 2 because it accommodates unequal variances and sample sizes, which are common in long-term water-quality datasets. A review of BMP trends in Section 4.5 indicates that upgrades to wastewater treatment facilities, increasing landowner engagement and a rise in the acres of BMPs may account for this reduction in TP FWMC. In particular, there has been a big increase in nutrient management, cover crops utilization and tillage/residue management.

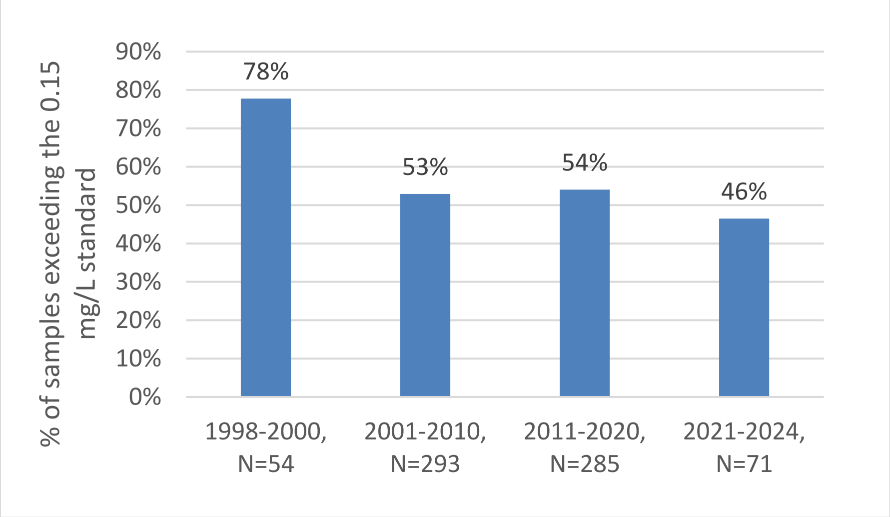
Figure 14. Trend in annual FWMC TP at Chippewa River Hwy 40 monitoring site (1998-2021).



Exceedances of the TP standard

Individual TP sample results at the HW40 monitoring site from 1998 to 2024 were reviewed through the lens of four time periods (1998-2000, 2001-2010, 2011-2020 and 2021-2024). TP concentrations exceeding the 0.150 mg/L threshold were most prevalent in the 1998 through 2000 period, with 78% of samples above the standard. The 2001 through 2010 period showed a notable improvement, with exceedances dropping to 53%. This progress remained unchanged between 2011 through 2020, where 54% of samples exceeded the threshold. Preliminary data from 2021 through 2024 suggest a slight improvement to 46% exceedance, although the smaller sample size warrants caution in interpretation (Figure 15). These fluctuations highlight the need for continued monitoring and adaptive management to sustain and build upon water quality improvements.

Figure 15. Percent of TP samples exceeding the standard by period at Chippewa R. Hwy 40 near Milan.



Although the majority of TP samples at HW40 continue to exceed the 0.150 mg/L threshold with exceedance rates ranging from 58% to 83% depending on the time period, the overall P load reaching downstream waters appears to be declining. This is reflected in the decreasing FWMC observed over the same period. This suggests that while concentration-based standards are frequently exceeded, the volume of P delivered to the system during runoff events has been reduced. Management efforts may be helping to limit P export during higher flow periods, even as challenges remain in meeting concentration thresholds consistently (see Section 4.5).

Subwatershed Comparisons

TP FWMCs across the four monitoring sites in the CRW are seen in Figure 16 and Figure 17. Among the sites, Shakopee Creek near Benson exhibits the highest median TP FWMC and the widest range of values, including several high outliers, indicating both elevated and variable P loading, likely from more intense land use or runoff conditions.

In contrast, the East Branch Chippewa River near Benson shows the lowest and most consistent TP FWMC levels, with a tightly clustered distribution and minimal outliers, suggesting a more stable P regime. The Chippewa River near Clontarf displays a similar median to the East Branch but with slightly greater variability.

The Chippewa River near Milan occupies a middle ground, with moderate TP concentrations and one high outlier, reflecting a cumulative influence of upstream conditions. Since this site receives the combined contributions of the other sites it serves as a useful indicator of upstream land management effectiveness.

Figure 16. TP FWMC 1998 – 2021 in the CRW (Source [MPCA-WPLMN]() and [CRWA]()).

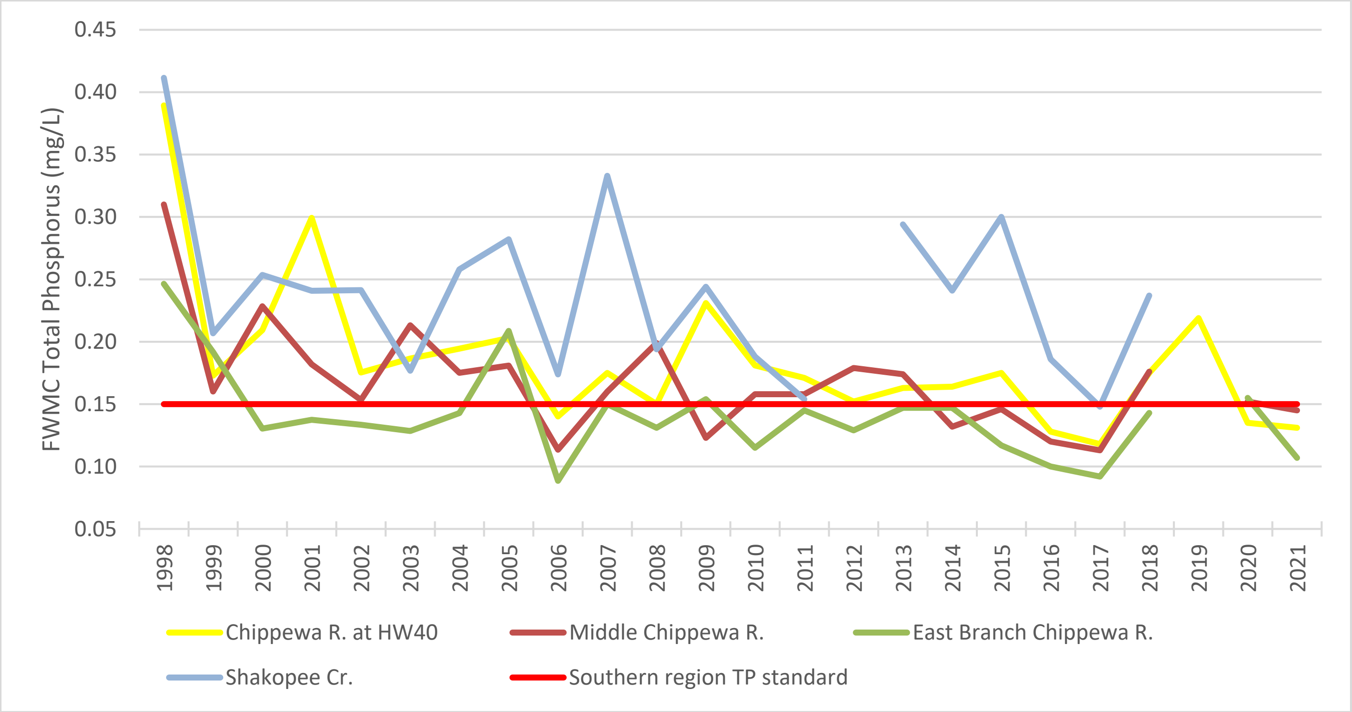
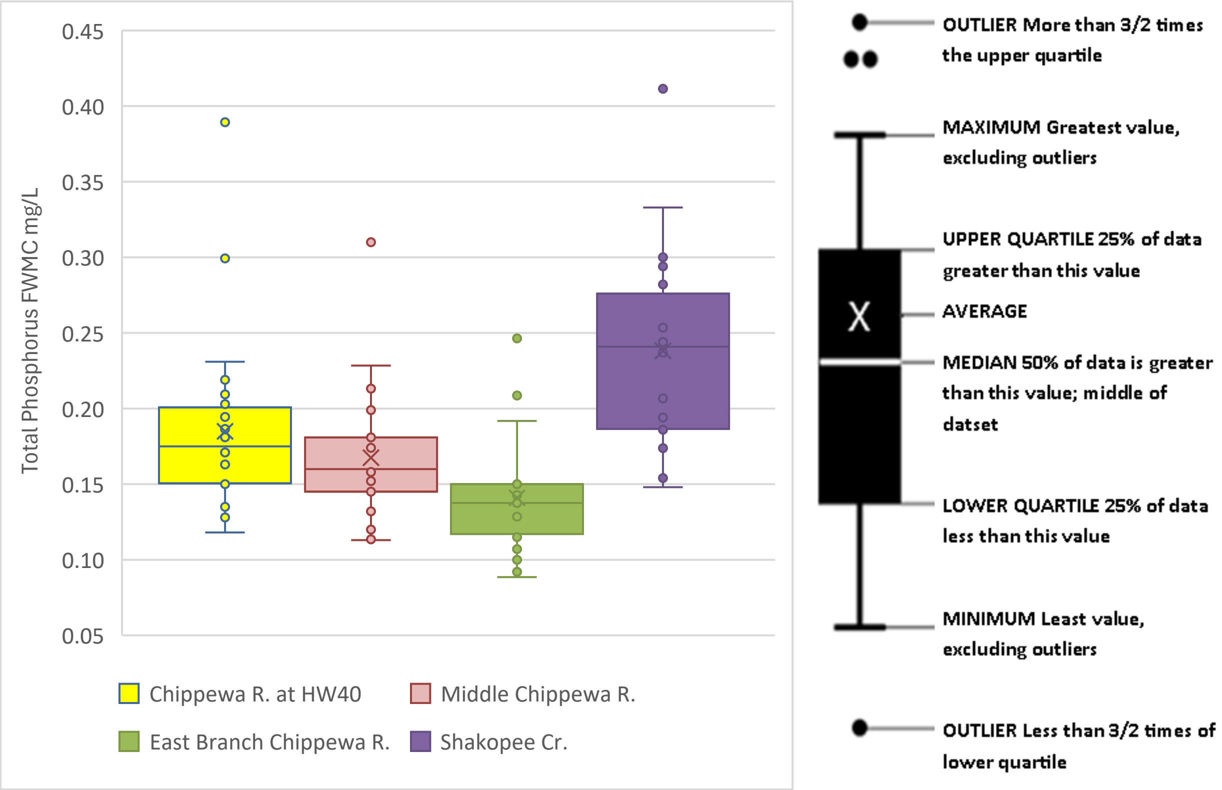


Figure 17. Boxplot of Chippewa TP FWMC (1999-2021) at four WPLMN monitoring sites.



TP FWMC data summary by subwatershed (1998-2021)

1. Lower Chippewa River (HW40)

- **Average FWMC:** 0.18 mg/L, **Range:** 0.12 - 0.39 mg/L
- **Trend:** TP FWMC concentrations have decreased from 0.39 mg/L in 1998 to around 0.13 mg/L by 2021, with some variability. This site shows **a clear long-term decline** in TP FWMC.
- **Interpretation:** Despite frequent exceedances of the 0.150 mg/L TP water quality standard in individual samples, the **rate of samples exceeding the standard appears to be trending downward** (Figure 15), consistent with observed reductions in the watershed's FWMC (Figure 14).

2. Middle Chippewa River at Clontarf

- **Average FWMC:** 0.17 mg/L, **Range:** 0.11 - 0.31 mg/L
- **Trend:** After early highs in 1998-2000 (e.g., 0.31 mg/L), TP FWMC generally declined, with values stabilizing in the 0.11-0.18 range in the 2010s.
- **Interpretation:** This subwatershed shows **moderate improvement**, with TP water quality concentration levels now more frequently near or below the 0.150 mg/L standard.

3. East Branch Chippewa River at Benson

- **Average FWMC:** 0.14 mg/L, **Range:** 0.09 - 0.25 mg/L
- **Trend:** This subwatershed maintained relatively low TP FWMC throughout the entire period, with consistent values near or below the 0.150 mg/L target.
- **Interpretation:** The East Branch consistently meets the TP water quality concentration threshold and can be considered a **strong performer** for P management, possibly due to lower P inputs or more effective land use practices.

4. Shakopee Creek

- **Average FWMC:** 0.24 mg/L, **Range:** 0.15 - 0.41 mg/L
- **Trend:** TP FWMC concentrations have remained **persistently high**, often exceeding 0.250 mg/L, with only occasional years below the 0.150 mg/L water quality standard threshold.
- **Interpretation:** Shakopee Creek stands out as the **most consistently over the standard** of the four CRW subwatersheds for P. Continued or enhanced management efforts are warranted to address persistent exceedances and high P loads.

Phosphorus Summary

P levels are still high and, in many years, exceed the 0.150 mg/L standard. Nonetheless, three of the four subwatersheds (HW40, Clontarf, East Branch) have seen **stable or declining TP FWMC trends**, indicating progress in P load reduction.

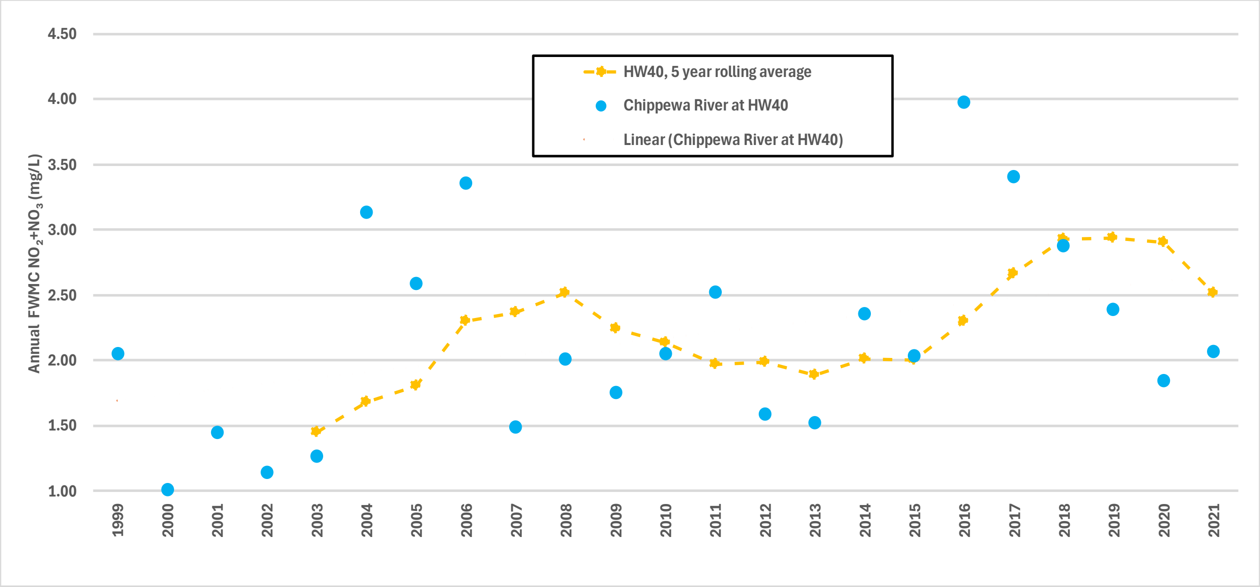
Shakopee Creek remains an outlier, consistently contributing high P concentrations, likely driving impairment downstream.

These trends suggest that **targeted management in the Shakopee Creek Subwatershed** could yield significant benefits for the CRW as a whole. Section 5.0 of this report considers some of these strategies.

Nitrogen

Annual FWMCs of nitrate + nitrite (NO_2+NO_3) at the HW40 monitoring site increased significantly over time. Comparing the first six years of monitoring (1999-2004) to the most recent six-year period (2016-2021), average FWMC rose from 1.675 mg/L to 2.762 mg/L, representing a 65% increase. This change is statistically significant (t = -2.315, p = 0.008), suggesting a meaningful upward trend in nitrogen concentrations over the monitoring record (see Figure 18). It is important to note that while the concentration is rising, this is still well below the proposed draft aquatic life nitrogen standard of 8 mg/L.

Figure 18. Trend in annual FWMC NO_2+NO_3 at Chippewa River Hwy 40 monitoring site (1999-2021).



Cross-Site Comparisons

Differences in FWMC NO_2+NO_3 across the four monitoring sites during the time period of 1999 through 2021 in the CRW are seen in Figure 19. Shakopee Creek, south of Benson, stands out with the highest NO_2+NO FWMC concentrations by far, having both the highest median and largest range, including several years extending above 9 mg/L. Thess values are above the draft 8 mg/L nitrogen standard, underscoring a significant nitrogen loading source, likely linked to intensive agriculture land use or drainage practices in that subwatershed.

Figure 20 illustrates strong spatial differences in nitrogen levels and variability at the four subwatershed sites.

Figure 19. Annual FWMC NO_2+NO_3 by year, 1999 –2021 in the CRW. Source MPCA-WPLMN and CRWA.

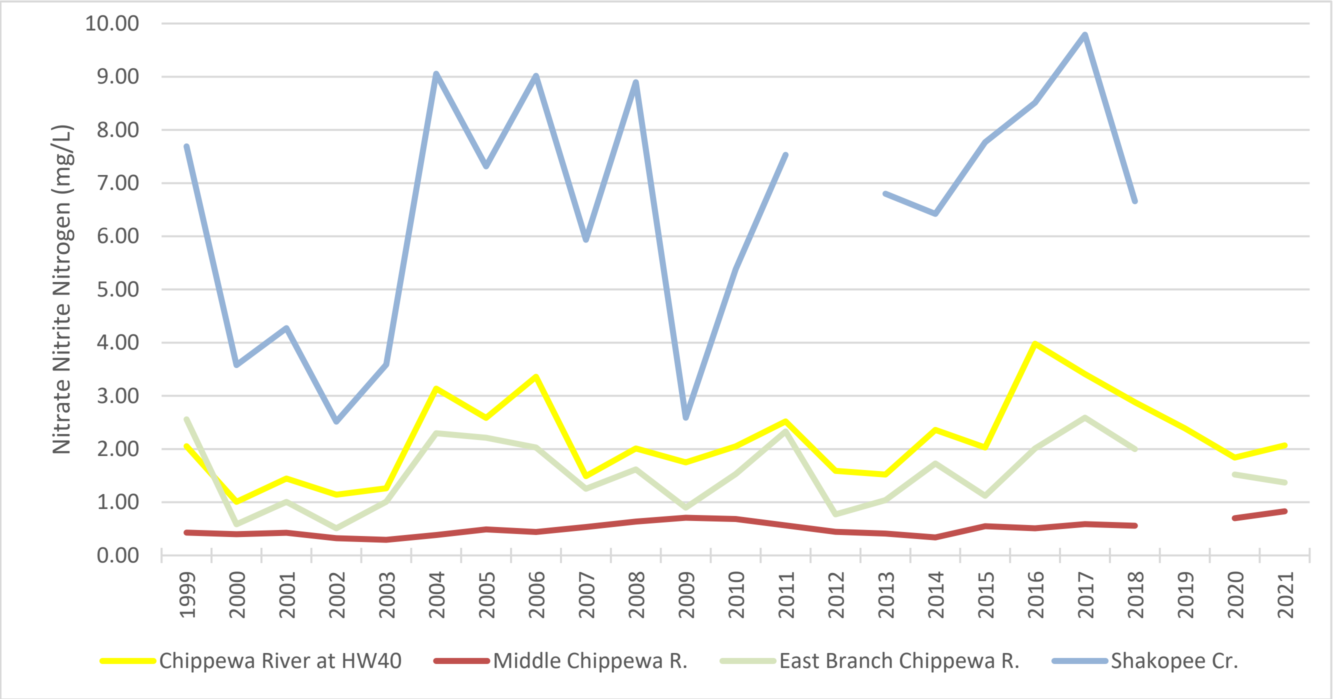
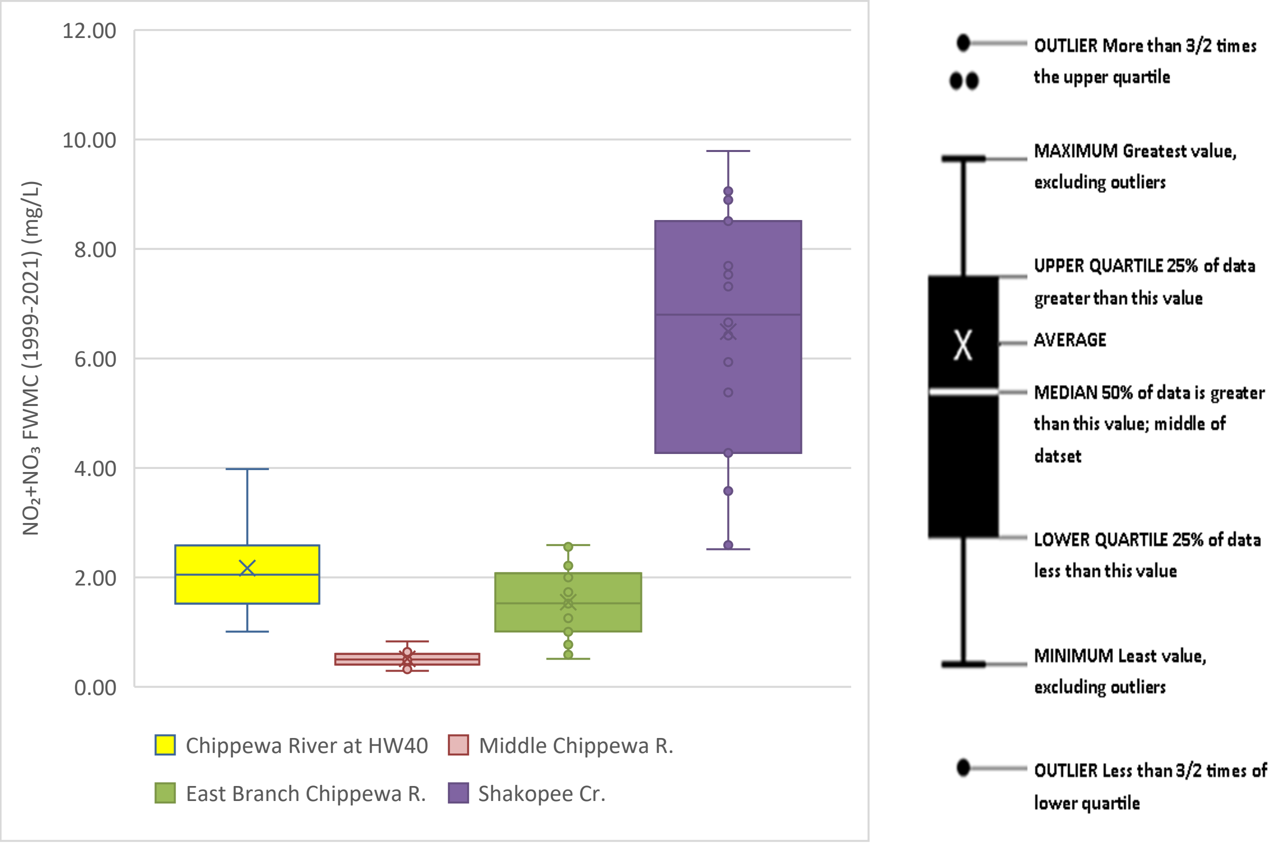


Figure 20. Boxplot of CRW annual NO_2+NO_3 FWMC (1999-2021) at four monitoring sites.



The Chippewa River near Clontarf exhibits the lowest nitrogen levels overall. It has a very tight distribution and a low median, suggesting minimal nitrogen loading and a relatively well-buffered upstream area.

The East Branch Chippewa River near Benson has slightly lower NO_2+NO_3 median FWMC than the Lower Chippewa site at HW40, with less variability, indicating more consistent and possibly lower upstream nitrogen contributions.

The Chippewa River at HW40 near Milan shows moderate FWMC, with a median around 2 mg/L and a moderate spread. This suggests that while nitrogen levels are lower than at Shakopee Creek, they still reflect cumulative contributions from upstream sources.

NO_2+NO_3 FWMC data summary by subwatershed (1998-2021)

1. Lower Chippewa River (HW40)

- **Average:** 2.15 mg/L, **Range:** 1.01 - 3.98 mg/L
- **Trend:** The average FWMC has increased significantly from the early 2000s to the most recent six-year period (**1999-2004 avg: 1.675 mg/L**, **2016-2021 avg: 2.762 mg/L**, **+65%**). A two-sample independent t-test showed a statistically significant increase in **NO_2+NO_3** FWMC from 1999–2004 to 2016–2021 ($t = -2.315$, $p = 0.008$).
- **Interpretation:** This trend suggests growing nutrient pressures across the CRW, potentially linked to increasing fertilizer use or declining crop nutrient-use efficiency and underscores the need for continued nutrient reduction efforts.

2. Middle Chippewa River at Clontarf

- **Average:** 0.51 mg/L, **Range:** 0.29 - 0.83 mg/L
- NO_2+NO_3 FWMC have remained **low and relatively stable** over the full monitoring period.
- This subwatershed consistently shows the **lowest nitrogen levels** in the CRW, indicating fewer nutrient contributions and possibly more effective retention or lower sources upstream.

3. East Branch Chippewa River at Benson

- **Average:** 1.50 mg/L, **Range:** 0.51 - 2.59 mg/L
- FWMCs in the East Branch are **moderate but variable**, with periodic increases in loading (notably in 2004 and 2017-2018).
- The data show some **fluctuations without a clear long-term trend**, though recent years appear slightly elevated compared to early values.
- Continued monitoring is warranted to determine whether recent increases represent a new trend or short-term variability.

4. Shakopee Creek

- **Average:** 6.29 mg/L, **Range:** 2.41 - 9.79 mg/L
- This subwatershed consistently has the **highest nitrate FWMC** in the watershed, **approximately 3 to 12 times higher** than the other stations.

- The elevated levels suggest significant nutrient sources, likely from intensive land use and drainage networks in the Shakopee Creek Watershed.
- While the FWMCs on average were below the proposed draft aquatic life standard of 8.0 and the 10 mg/L drinking water standard several years FWMC's approach or exceed them, indicating a need for focused nutrient reduction strategies.

Nitrogen Summary

While NO_2+NO_3 FWMC remain below Minnesota's drinking water standard (10 mg/L), the **upward trend is concerning**. Additionally, elevated nitrate was identified as a stressor to aquatic biology in several impaired reaches in the CRW (MPCA 2024c). The data suggest that **nutrient inputs from the upstream watershed, particularly Shakopee Creek**, are increasing pressure on downstream water quality. This underscores the need for a **watershed-scale nitrogen management strategy** that targets known high-contributing subwatersheds to prevent further water quality degradation in the mainstem Chippewa River.

Total Suspended Solids

In the Lower Mainstem at the Hwy 40 monitoring site, TSS FWMCs were evaluated over the available monitoring record (1999-2021) to assess long-term change. Comparing the early monitoring period (1999–2004) to the most recent six-year period (2016–2021) shows a notable decline in average TSS concentrations, from 86 mg/L to 51 mg/L, a **40.5% reduction**. Results of a Welch's t-test (unequal variances) indicate this reduction is statistically significant at the **95% confidence level** ($t = 3.30$, $p = 0.011$), demonstrating a clear downward trend in sediment concentrations at the Hwy 40 site. This suggests that, over the past two decades, sediment loads in the lower Chippewa River have decreased, likely reflecting both improved upland and channel conditions and the cumulative benefits of conservation practices implemented across the watershed.

These results suggest that, despite periodic high TSS years, overall sediment loads at this site have decreased, possibly due to improved land or watershed management practices upstream. These results warranted continued analysis to confirm this trend.

To further understand long-term changes in TSS, 26 years (1999-2024) of individual TSS sample data from the Chippewa River at HW40 near Milan were used. Instead of using the Cycle 1 and Cycle 2 10-year blocks, the two six-year end periods of the data (1999-2004 and 2019-2024) were compared. Looking at these data blocks a **statistically significant improving trend** over time was observed in the exceedances of the standard.

Two key signs of improvement were observed:

1. **Exceedance Rate** - the percent of samples each year that were higher than the state water quality limit of 65 mg/L for TSS was lower in the 2019 to 2024 time range (Figure 22; Surface water station S002-203).
2. **Flow-Weighted Mean Concentration** - Figure 23 shows the annual TSS FWMC in the Chippewa River near Milan from 1999-2021, along with a five-year rolling average to show the trend, has decreased. WPLMN Data Browser.

Data compared:

- The percent of individual TSS samples exceeding the standard between 1999 through 2004 (N=115) and 2019 through 2024 (N=73).
- The annual FWMCs between 1999 through 2004 and 2016 through 2021.

Results:

- In the early years (1999-2004), about 50% of the samples were above the TSS standard.
- In the recent years (2019-2024), this dropped to 33%.

This is a clear and meaningful improvement. An independent two-proportion z-test ($z = 2.37$, $p = 0.018$) confirmed that the decline in TSS exceedance rate between 1999 through 2004 and 2019 through 2024 is statistically significant meaning it's very unlikely to be due to chance.

The yearly average TSS levels (FWMC) showed the same story:

- Early years (1999-2004) averaged about 86 mg/L.
- Recent years (2016-2021) averaged closer to 51 mg/L.

A two-sample t-test confirmed this drop is statistically significant ($t = 3.30$, $p = 0.011$).

Interpretation:

Overall, even though the Chippewa River is still impaired at this monitoring station, there are improvements in water quality at this site. TSS levels in the Chippewa River near Milan have dropped steadily over time. Both the number of samples over the limit and the overall annual averages have gone down.

The fact that both key measures improved and that the differences are statistically significant tells us that changes upstream are having a positive effect. These results support continued investments in land and water practices that help protect and restore the river.

Figure 21. Trend in annual FWMC TSS at Chippewa River Hwy 40 monitoring site (1999-2021).

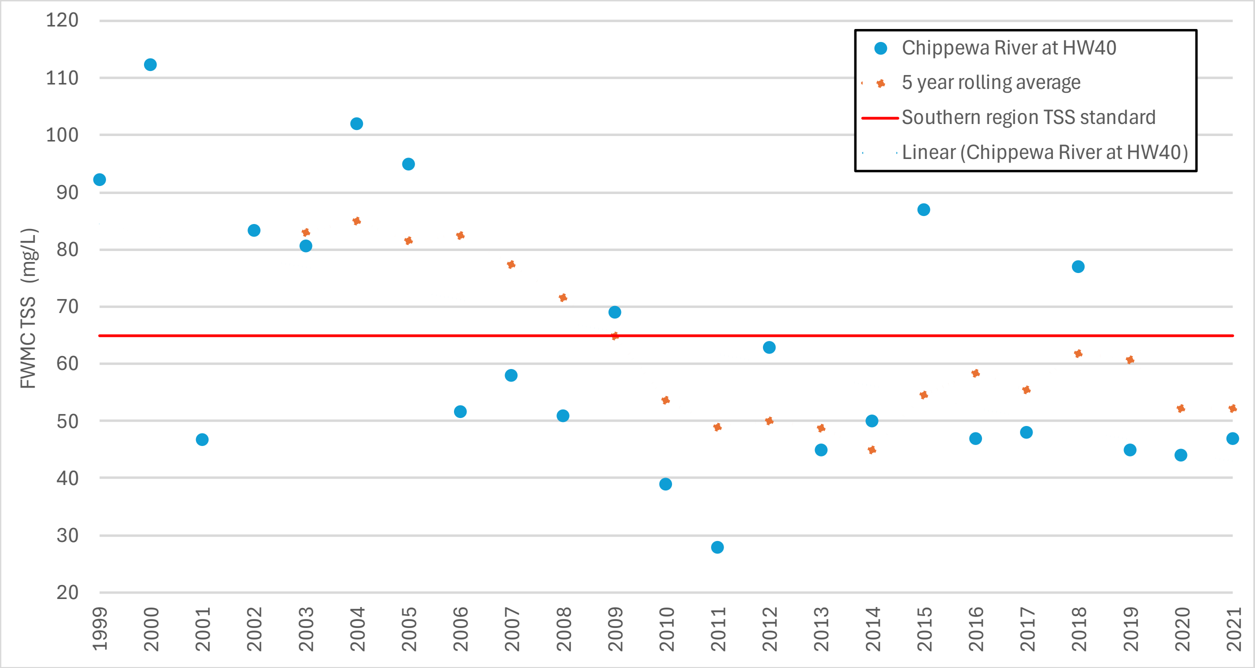
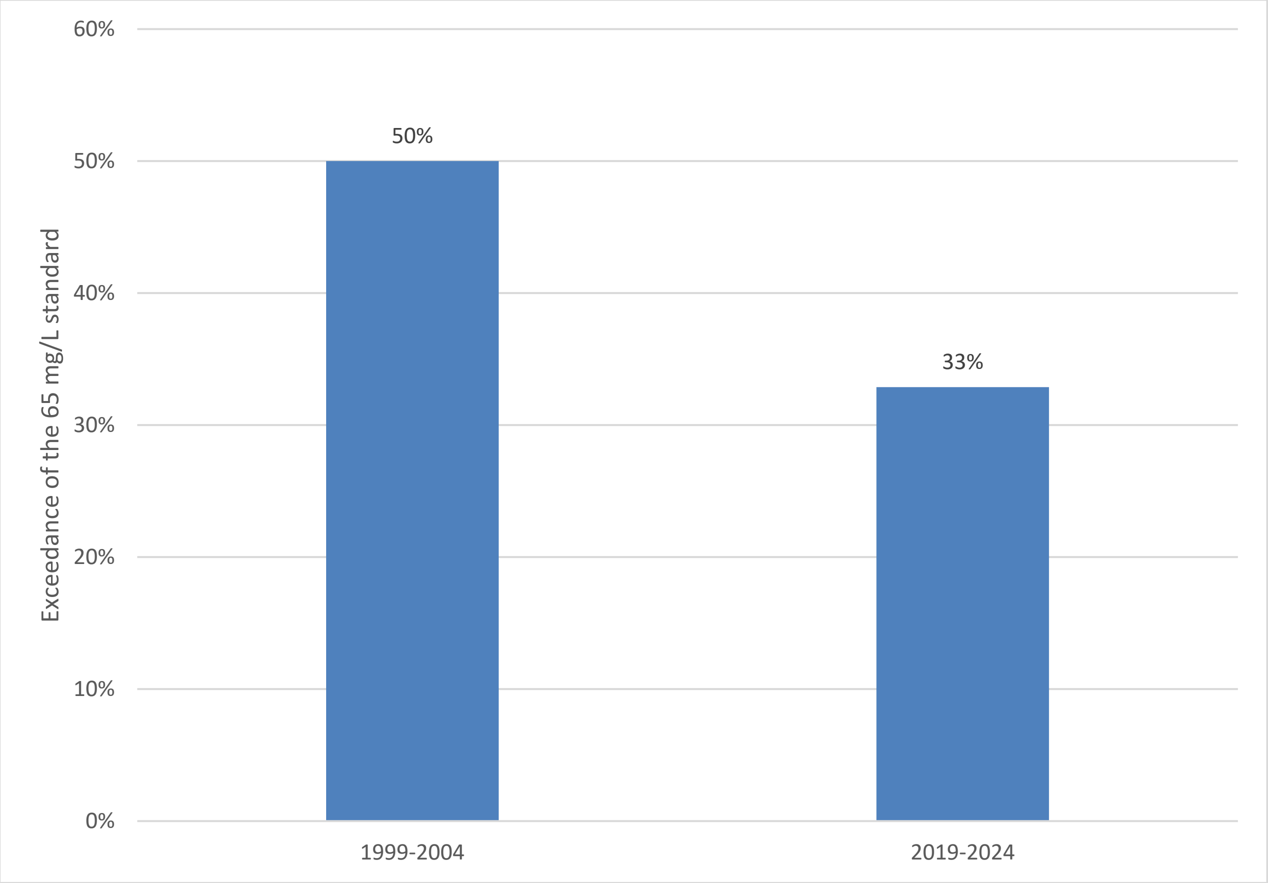


Figure 22. TSS sample percent exceedance of 65 mg/L standard at HW40 for two six-year periods, 1999 - 2004 and 2019 - 2024.



Key Patterns by Subwatershed

Figure 23 shows 23 years of annual TSS FWMC from four monitoring sites in the CRW and reveals both long-term trends and important differences in variability and magnitude between locations.

The Shakopee Creek near Benson (20th Ave SW) (blue) site consistently showed the highest annual TSS FWMCs, both in terms of annual peaks and overall variability. The Figure 24 boxplot highlights an elevated median and broad interquartile range, while the annual trend chart Figure 23 shows frequent spikes above 100 mg/L—especially in 2004 through 2006 and 2015. These patterns indicate episodic but intense sediment loading, likely tied to runoff-driven erosion from upstream cropland or tile-drained landscapes. Shakopee Creek stands out as a priority location for sediment reduction efforts.

The Chippewa River near Clontarf (CSAH22) (orange) shows moderate sediment annual FWMC concentrations with substantial variability from year to year. While not as extreme as Shakopee Creek, several years—particularly 2004, 2008, 2012, 2015, and 2018—record elevated TSS FWMCs, pointing to intermittent sediment surges. The boxplot confirms this, showing a widespread and moderate median. This site may benefit from targeted mitigation in high-contributing subwatersheds.

The Chippewa River near Milan (MN40) (yellow) displays moderate annual FWMC TSS levels overall, but importantly, the time series chart reveals a clear downward trend over the 20-year period. The site had relatively high annual FWMC TSS in the early 2000s, but values have steadily declined, with lower variability in recent years. This decline, also evident in the boxplot's more compressed upper range, suggests successful sediment management upstream, possibly through land use changes, conservation practices, or stabilized streambanks.

The East Branch Chippewa River near Benson (CR78) (green) maintains the lowest and most stable annual FWMC TSS concentrations across the dataset. Both charts reinforce this: the boxplot shows a tight, low interquartile range, and the trend is the most flat and consistent of the four. This suggests a well-buffered system with minimal sediment contributions, likely supported by perennial vegetation, fewer erosive land uses, or stable hydrology.

Figure 23. Annual TSS FWMC by year (1999-2021) in the CWR (Source MPCA-WPLMN and CRWA).

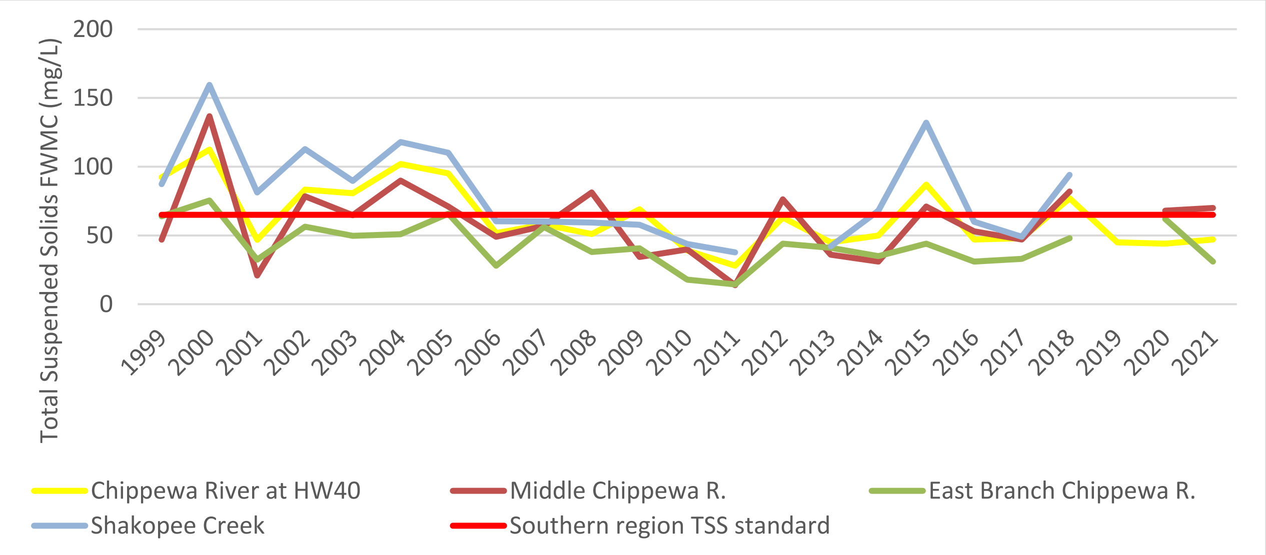
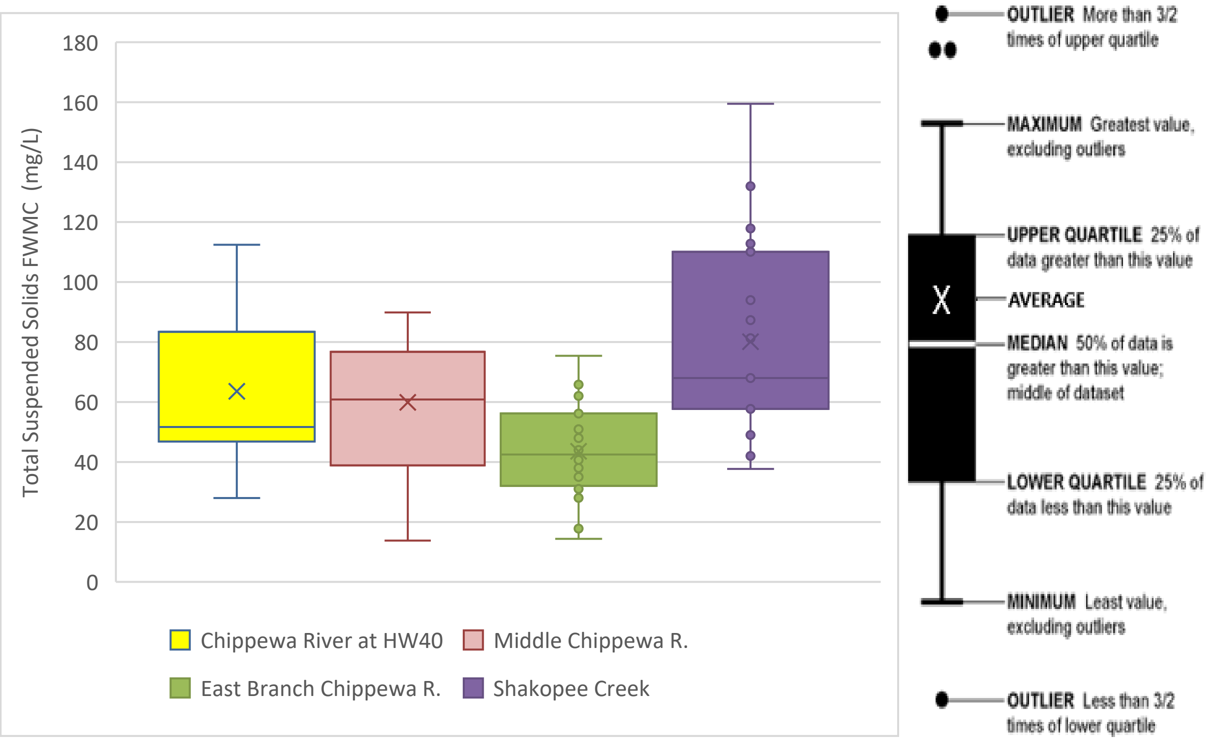


Figure 24. Boxplot of CRW annual TSS FWMC 1999-2021 at four monitoring sites.



Flow

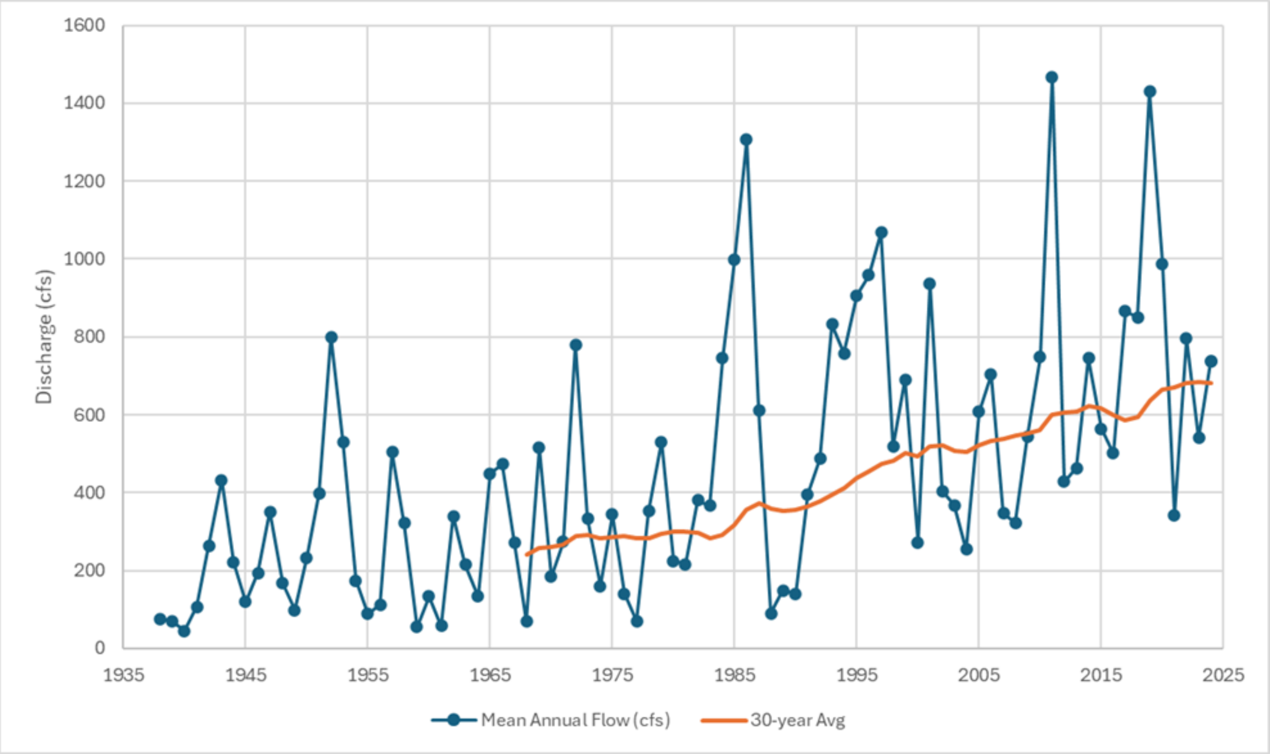
Evaluation of Hydrologic Change (EHC)

In the DNR's Evaluation of Hydrologic Change Technical Summary CRW (DNR 2023) the authors looked at river flow data from the USGS gage on the Chippewa River near Milan (05304500). DNR found, over the last two decades, the CRW has become markedly flashier, wetter, and hydrologically unstable. These changes are driven by a combination of more intense precipitation and substantial landscape alteration, especially from agriculture and drainage systems. Management strategies need to focus on restoring storage, slowing flows, and reconnecting floodplains to improve resilience and water quality (EHC Technical Summary Chippewa River Watershed).

The DNR identified 1983 as the primary hydrologic change point for the CRW, marking a shift toward wetter conditions and more variable streamflow (see Figure 24). While this change point helps define long-term trends, many of the most significant changes in flow behavior have become more pronounced over the last two decades. These more recent shifts are linked to both climate and land use dynamics, with serious implications for watershed health and management.

Precipitation across the watershed has increased by roughly 13% since 1983, averaging 2.2 inches more per year (DNR 2023). Indicators such as the Palmer Hydrologic Drought Index show a 176% increase in "extremely wet" years and a 51% reduction in "extremely dry" conditions. This increase in precipitation is matched by a dramatic rise in streamflow (Figure 25). Average annual discharge at the Milan stream gauge increased by 145%, while peak flows, those most likely to cause flooding, rose by 73% (DNR 2023).

Figure 25. Annual mean discharge for the Chippewa River near Milan (05304500) (1938 –2024) (USGS 2025).



Hydrologic changes since 1983 are not limited to high-flow events. The full flow regime has also shifted. Flows exceeded 90% of the time (baseflow conditions) increased by 558%, while flows exceeded 50% of the time (median flows) jumped by 341%. Even the lowest 7-day flows of each year are now 866% higher than they were prior to the change point. These increases indicate a fundamental alteration in how water moves through the landscape, with stream systems now experiencing higher volumes of water more often, and with greater variability (Table 7, DNR 2023).

Channel stability is another growing concern. The “bankfull” flow, the flow that most often shapes a stream’s channel, has increased by 110%. This suggests higher erosion potential, more sediment movement, and an elevated risk to infrastructure and riparian habitats. Additional indicators of hydrologic flashiness, such as the rate of rise and frequency of flow pulses, also point to quicker, more intense runoff during storms (DNR 2023).

Land use change has amplified these trends. Since the 1930s, the share of the watershed in corn and soybean production has increased by over 300%, replacing perennial vegetation like small grains and hay. These row crops draw less water early in the season and leave soil bare for longer periods, contributing to increased surface runoff. The result is a 124% increase in the watershed’s runoff ratio, the proportion of precipitation that becomes streamflow, signaling reduced infiltration and landscape storage (DNR 2023).

While the formal hydrologic change point occurred in 1983, the effects have accelerated in the last 20 years (Table 7). Intensifying rainfall, continued drainage development, and the expansion of row cropping have created conditions that promote frequent flooding, streambank erosion, and downstream water quality problems. Baseflows are higher, but not necessarily due to improved groundwater recharge, instead, they likely reflect increased subsurface drainage delivering water more efficiently to streams (DNR 2023).

In summary, the CRW has become flashier, wetter, and less stable. These shifts are consistent with regional patterns observed in other southern and western Minnesota watersheds but are particularly pronounced here. The EHC applied the critical concepts described to produce a summary table (Table 7) showing the percent increase or decrease for each of the 21 key metrics, the range of variability, and associated levels of concern about watershed impacts. The findings point to a need for renewed investment in landscape-based solutions that restore storage, slow water down, and rebuild watershed resilience. Strategies such as wetland restoration, floodplain reconnection, perennial cover, soil health practices, and improved drainage management will be key to mitigating the impacts of these long-term hydrologic changes.

Table 7. EHC summary table and metrics in the CRW (DNR 2023).

Hydrologic Group	Metric	Magnitude Change (%)	Magnitude Impact	RVA Change (%)	RVA Impact
Annual Values	Annual Precipitation	13	Moderate	-11	Moderate
	Annual Discharge	145	Extreme	-66	Extreme
	Annual Peak Discharge	73	Extreme	5	Neutral
	Annual Runoff Ratios	124	Extreme	-65	Extreme
Low Flows	7-Day Minimum	866	Extreme	-84	Extreme
	August Median Base Flow	276	Extreme	-46	Major
	90% Flow Duration	558	Extreme	-95	Extreme
Moderate Flows	May Median Flow	129	Extreme	-24	Major
	50% Flow Duration	341	Extreme	n/a	n/a
	1.5 Year Return Interval Flows	110	Extreme	n/a	n/a
	Annual Baseflow	149	Extreme	-66	Extreme
High Flows	10% Flow Duration	105	Extreme	188	Extreme
	5 Year Return Interval Flows	73	Extreme	n/a	n/a
	10 Year Return Interval Flows	61	Extreme	n/a	n/a
	3-Day Maximum	102	Extreme	-8	Neutral
Flow Timing	Julian Day Max Flow	62	Extreme	-62	Extreme
	Julian Day Min Flow	76	Extreme	-3	Neutral
Flashiness	High Pulse Count	50	Major	-3	Neutral
	Low Pulse Count	-100	Extreme	-62	Extreme
	Number of Reversals	10	Moderate	3	Neutral
	Rise Rate	122	Extreme	-46	Major

Impact Concern Legend						
>50 Extreme	**20 to 50 Major**	**10 to 20 Moderate**	**10 to -10 Neutral**	**-10 to -20 Moderate**	**-20 to -50 Major**	**< -50 Extreme**

The Range of Variability Approach (RVA) (Table 7, DNR 2023) shows how much a river's flow pattern has shifted from what used to be normal. Instead of only measuring bigger or smaller flows, it looks at how often certain flow conditions occur compared to the past. In short, RVA reveals how the "normal rhythm" of the river has changed, which matters for both water quality and AQL.

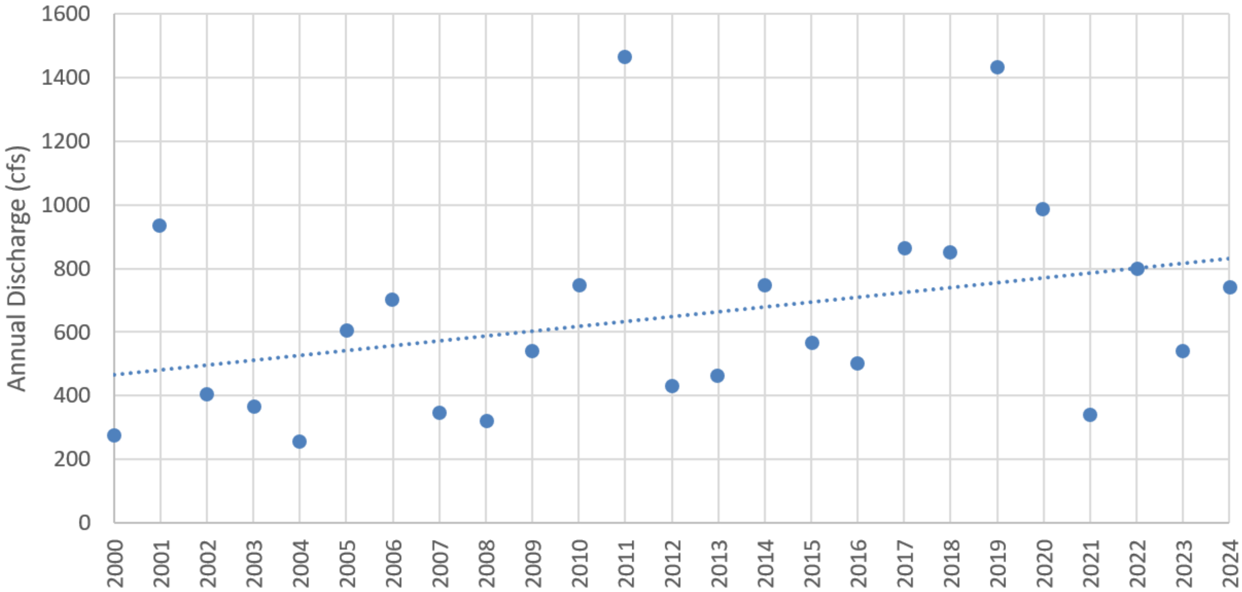
Hydrologic Change at the HW40 Monitoring Site (2001-2024)

Analysis of annual mean discharge at the HW40 monitoring site reveals a statistically significant increase in streamflow between the years preceding Cycle 1 monitoring (2001-2010) and Cycle 2 monitoring (2011-2021) (Figure 26). Average discharge rose from 523 cfs to 786 cfs, representing a 50% increase (one-tailed t-test, p = 0.035). This change aligns with observed hydrologic trends in the CRW, where streamflow conditions have become flashier and more variable. The increase in flow volume is likely driven by a combination of intensified precipitation, widespread artificial drainage, and expanded row crop agriculture, all of which reduce landscape storage and increase runoff efficiency.

This upward trend in discharge is not only statistically significant but ecologically meaningful. Higher flow volumes, especially during storm events, can increase streambank erosion, degrade habitat, and worsen downstream water quality. These findings reinforce the need for watershed-scale strategies that restore hydrologic balance, such as wetland restoration, floodplain reconnection, and increased perennial vegetation cover.

While the decade-based trend is clear, data from the most recent four years (2021-2024) offer additional context (Figure 26). The year 2021 marked the lowest discharge on record since 2008, consistent with statewide drought conditions. However, streamflow rebounded sharply in 2022, 2023, and 2024, returning to or near the post-2010 average. This rebound, despite continued dry weather, suggests a highly responsive and efficient drainage system that moves water off the land quickly, often before it can be stored or infiltrated. These observations support the broader conclusion that the watershed's hydrology has become more volatile, with streamflow increasingly shaped by land use and storm intensity rather than seasonal water balance alone.

Figure 26. Annual mean discharge at HW40 monitoring site (2000-2024) (USGS).



4.2.4 HSPF Model

HSPF is a continuous simulation model used by the MPCA to evaluate hydrology and water quality at the watershed scale. It integrates land use, climate, and management practice data to simulate runoff, sediment, and nutrient loading to rivers and lakes. In Minnesota watershed work, HSPF supports source assessment, scenario testing, TMDL development, and WRAPS Update planning.

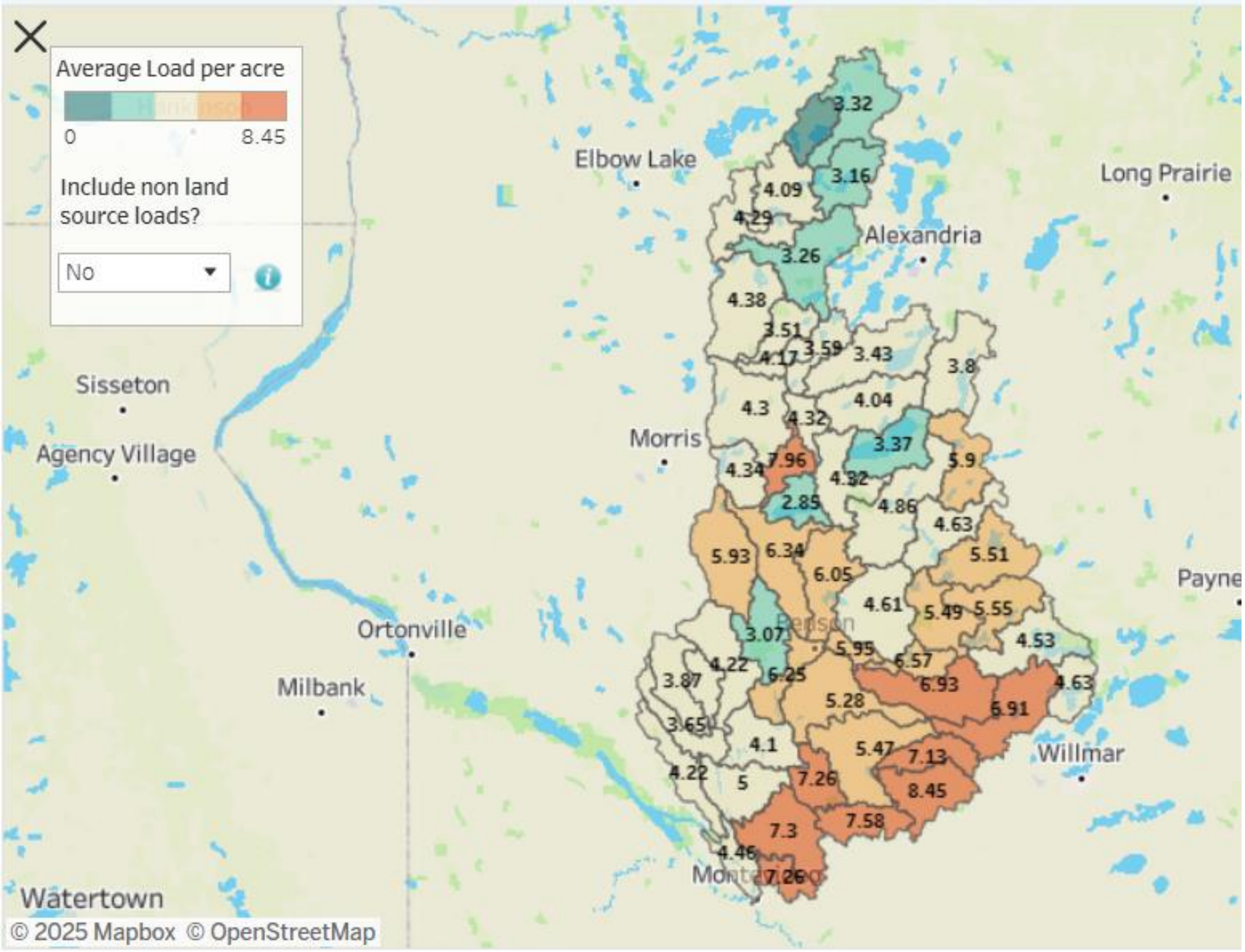
HSPF-SAM

Hydrologic Simulation Program-Fortran Scenario Application Manager (HSPF-SAM) is the MPCA's interface and workflow manager for running, organizing, and exploring HSPF model scenarios. It streamlines set-up, executes alternative management and climate/land use runs, and produces decision-ready outputs (tables, timeseries, and mapped summaries) that planners and partners can use directly.

Using HSPF with HSPF-SAM, the watershed can be subdivided into modeled catchments and compute per-acre yields for nitrogen, P, and TSS. Scenario runs (e.g., baseline vs. BMP portfolios) are summarized as color-coded source assessment maps that highlight load "hotspots" and low-yield areas. These maps, along with sortable catchment tables, let the user prioritize where reductions will be most cost-effective, diagnose why certain catchments are high or low (e.g., moraine slopes vs. perennial cover), and track projected benefits of targeted practices over time.

Figure 27 uses color-coding to display average nitrogen load per acre by modeled catchment in the CRW. Darker orange and red areas (especially in the southern and southeastern portions of the watershed**,** Shakopee Creek and Dry Weather Creek) indicate the highest nitrogen yields, reaching up to ~8.45 lbs/acre. Lighter orange and yellow areas represent moderate loads, while green/blue areas in the north and northwest show the lowest nitrogen contributions.

Figure 27. HSPF-SAM source assessment, nitrogen in lbs/ac/year in the CRW.



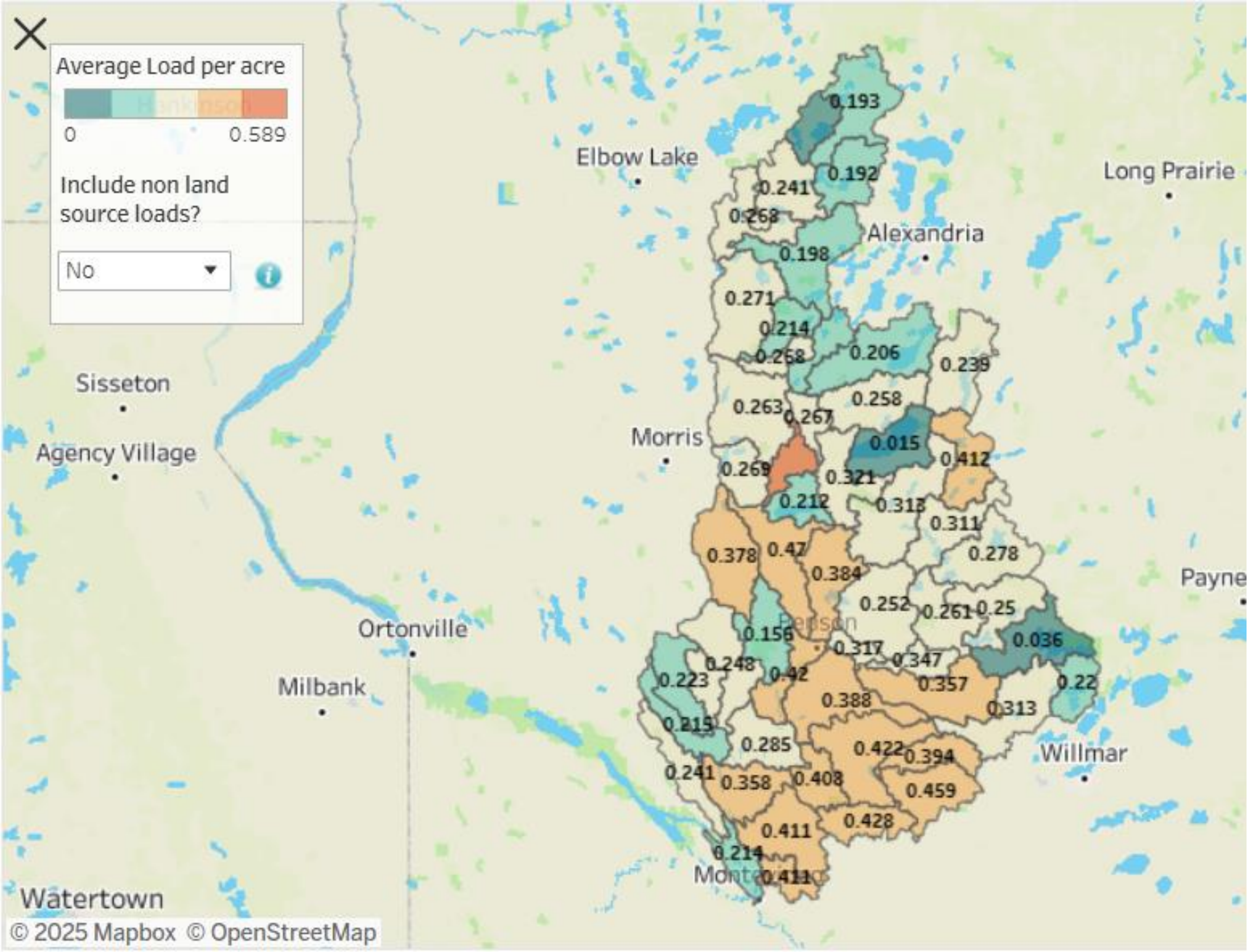
Include non land source loads?

No

The HSPF-SAM source assessment map for P (Figure 28) shows modeled average P load per acre (yield) across the CRW. The highest yields appear in a broad band across the southern part of the watershed (Shakopee Creek, Dry Weather Creek and the Lower Mainstem), where many catchments have modeled yields between about 0.38 and 0.47 lbs per acre. These high-load areas are contiguous, suggesting an opportunity for coordinated P reduction efforts that could deliver significant benefits downstream.

The northern third of the watershed generally produces the lowest modeled TP yields, with most catchments between 0.19 and 0.27 lbs per acre, and an especially low outlier of 0.015 in the Minnewaska Lake area.

Figure 28. HSPF-SAM source assessment, phosphorus lbs/ac/year in the CRW

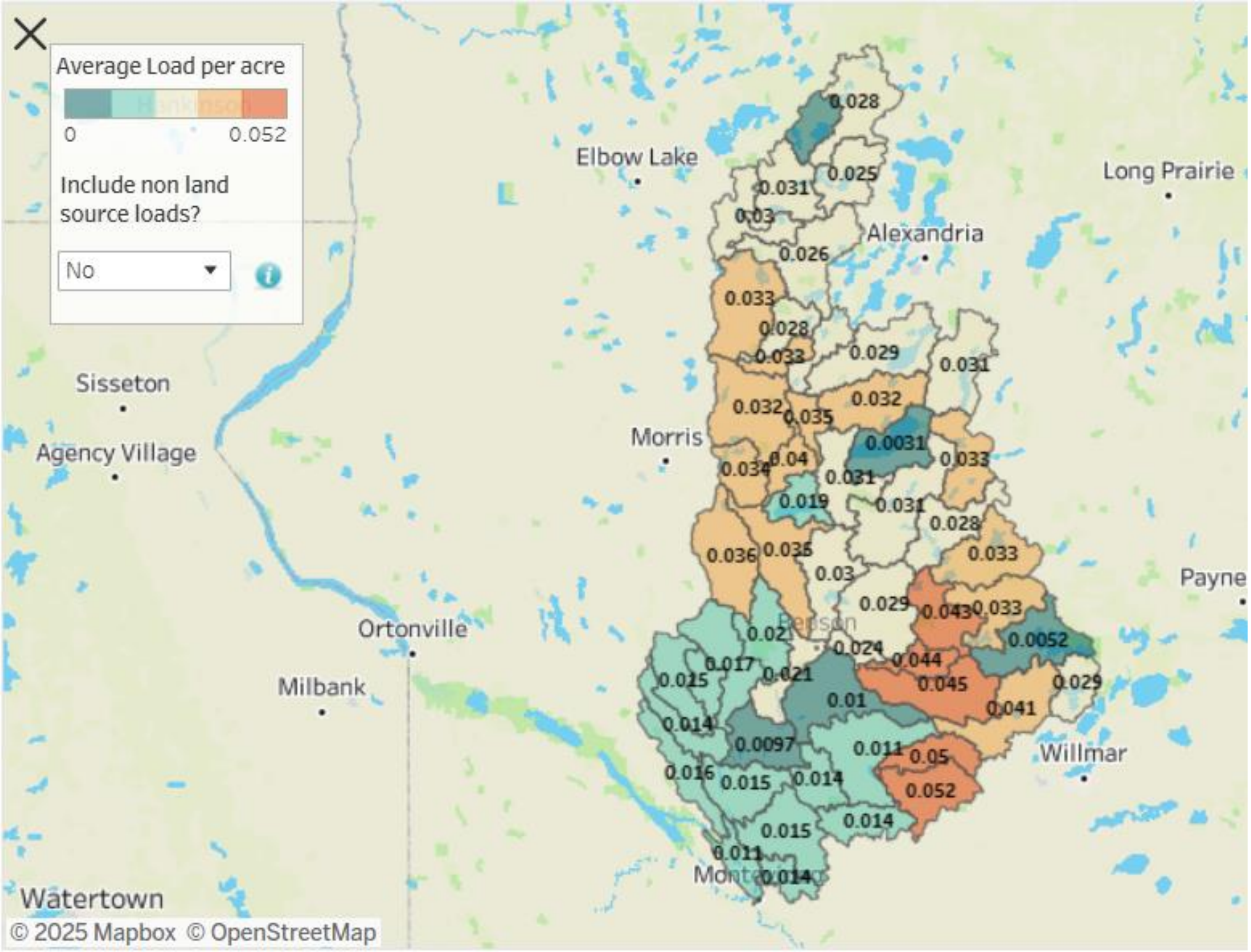


The TSS HSPF output map shows modeled average TSS load per acre across the CRW (Figure 29), ranging from 0 to 0.052 tons per acre. The highest modeled loads yields concentrated in the southeastern part of the watershed, where several connected catchments produce between 0.043 and 0.052 tons per acre. This band of elevated TSS aligns closely with the glacial moraine region, an area of steeper slopes and more erodible soils that naturally generate higher sediment yields.

Within this high-load zone, some catchments stand out with notably lower yields despite being surrounded by higher-load areas. These lighter-yielding pockets often correspond to areas with more perennial vegetation, which stabilizes soils, reduces surface runoff, and limits sediment delivery to streams. Moderate TSS yields, typically 0.032 to 0.040 tons per acre, appear in parts of the central and north-central watershed, creating a transition between the moraine high-load zone and the lower-yield regions.

The lowest modeled yields are found in the far southwest and far north, where many catchments produce less than 0.020 tons per acre, and several fall below 0.012 tons per acre. These stable areas may reflect flatter terrain, cohesive soils, or effective sediment control practices. Overall, the map highlights both the erosive influence of the glacial moraine and the protective role of perennial vegetation, suggesting that targeted sediment reduction efforts in high-load moraine areas—paired with strategic expansion of perennial cover—could substantially reduce TSS delivery downstream.

Figure 29. HSPF-SAM source assessment TSS in tons/ac/year in the CRW.



Include non land source loads? No

4.2.5 Bacteria

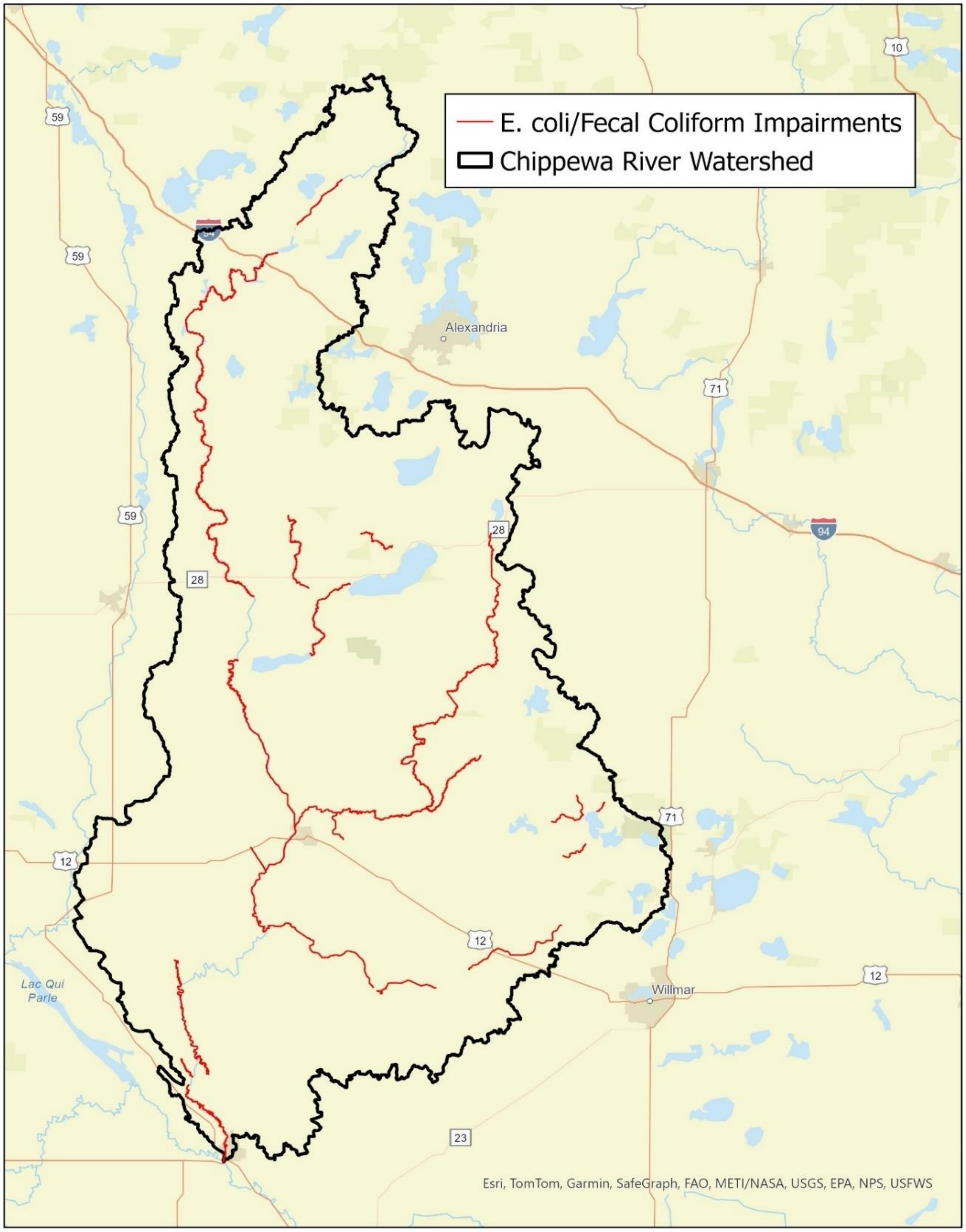
All 24 stream WIDs assessed for bacteria in the CRW during the Cycle 2 monitoring period were found to be impaired by bacteria (Figure 30). This includes one new bacteria impairment listing on the class 7 ditch (County Ditch 60/Chippewa River: 07020005-539) reach that flows into Stowe Lake (MPCA 2022a).

Some bacteria and pathogens will always be present in surface waters. While most of the bacteria and pathogens from fecal waste in the water will die off over time, some may survive. Pathogens from fecal waste generally die off in the environment much faster than bacteria. While there is not a way to rid water bodies of all pathogens, actions can be taken to reduce bacteria in surface waters Bacteria | Minnesota Pollution Control Agency. Effective methods include:

- Controlling runoff on feedlot properties and where manure is spread on farmland
- Repairing or replacing failing septic systems
- Improving wastewater treatment processes at some facilities
- Controlling erosion with practices such as conservation tillage and riparian buffers
- Rotational livestock grazing, which reduces both sedimentation and fecal coliform concentrations

- Urban stormwater management - runoff detention, infiltration, and street sweeping
- Restricting livestock access to surface waters

Figure 30. Chippewa River Watershed *E. coli*/fecal coliform impairments on Minnesota's 2024 303(d) impaired waters list.



4.3 Sources, risks, and natural conditions

SSTS

Each county is responsible for enforcing rules for Subsurface Sewage Treatment Systems (SSTS) to protect public health, groundwater, and natural resources. These rules follow state law and require systems to meet specific technical standards. Septic systems must be inspected and updated if they fail or when properties are sold or expanded (e.g., adding a bedroom or bathroom), although as of publication, Stevens and Chippewa Counties do not require inspections at property transfer.

Counties and Soil and Water Conservation Districts (SWCDs) often offer low-interest loans to help residents fix or replace septic systems. State programs like the MPCA's Clean Water Partnership the Small Community Wastewater Program and the Agriculture BMP Loan Program also provide funding to support upgrades, replacements, or new community systems.

Since 2002, it is estimated that the counties within the CRW (excluding Otter Tail County) have, on average, replaced 317 systems per year. Table 8 shows annual SSTS replacements per county from 2017 - 2023.

Table 8. Number of estimated SSTS replacements in seven counties in the CRW (2017-2023)*.

Year	Chippewa	Douglas	Grant	Kandiyohi	Pope	Stevens	Swift
2017	0	101	0	45	51	12	17
2018	24	73	16	84	48	13	24
2019	22	62	18	80	45	12	15
2020	22	76	23	105	62	9	22
2021	21	97	14	108	49	14	21
2022	22	73	15	80	36	0	27
2023	22	129	10	88	44	7	23

*The numbers presented in this table are county estimates provided to MPCA for reporting purposes and are not intended to be exact values.

The MPCA, through the Clean Water Partnership Loan Program, has awarded over $17M to counties within the CRW to provide low interest loans for SSTS upgrades since 2010. More information on SSTS financial assistance can be found at SSTS financial assistance.

Wastewater treatment facilities

Municipal and industrial wastewater point sources have discharge and monitoring requirements specified in the facility permits to ensure pollutant levels in their discharge support water quality goals. Because these systems often require monitoring, their total contributions can be calculated.

Annual loading data from wastewater treatment facilities (WWTFs) located in the CRW were compiled from Discharge Monitoring Reports (DMRs) reported to the MPCA from 2000 through 2024 for TP, TSS, and TN values . As shown in Figure 31 and Figure 32 below, TP and TSS loads from WWTFs have been decreasing over time. The TN data (Figure 33) were estimated during the first round of WRAPS reporting but since 2012, the majority of the estimated loading is based on facility specific sampling. When compared to total loading to the Chippewa River, WWTFs contributed approximately 2.1% of the TP, 2.2% of TN and 0.1% of TSS loading when compared to the three year combined (2019-2021) watershed load estimates from the WPLMN at the Chippewa River near Milan, Hwy 40 monitoring site.

There are 15 municipal and one industrial WWTFs in the CRW. Four WWTFs are small or very small facilities with design flows of less than 0.1 million gallons per day (mgd). Ten are mid-sized facilities with design flows ranging from 0.2 to 0.6 mgd. Two are large facilities with design flows of over 1.0 mgd day. WWTF pollutant loads are calculated as a function of effluent flows and concentrations. TP, TSS, and TN loads discharged by the Montevideo WWTF are large relative to the loads discharged by other WWTFs because it is the largest facility and discharges more water than the small facilities in the watershed.

TP loading from 2000 to 2024 shows a clear trend toward lower annual loading. The highest annual total loading from all wastewater permitted sources was 15,544 kg in 2000. Most of the permitted P loading between 2005 and 2021 was from the two largest facilities, Montevideo and Benson WWTPs. The average TP loading from permitted sources between 2021 and 2024 indicates permitted P loads have decreased 73% since 2000 through 2003. It is likely that future P loading from WWTPs will remain low based on implementation of permitting requirements.

Figure 31. CRW WWTF TP loads 2000-2024.

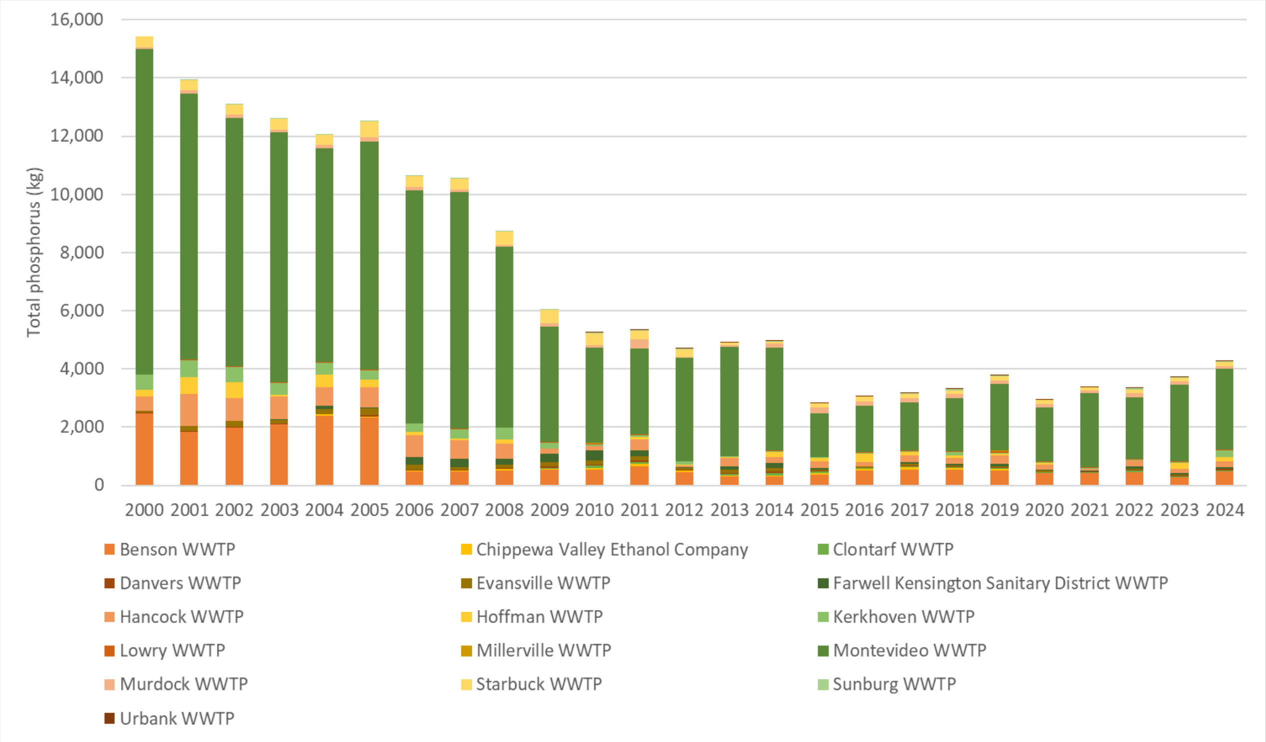


Figure 32. CRW WWTF TSS loads 2000-2024.

Figure 33. CRW WWTF total nitrogen loads 2000-2024.

Urban, construction, and industrial stormwater

Stormwater systems in some communities, dependent on size and location, are regulated under the Municipal Separate Storm Sewer System (MS4) program, which requires the use of BMPs to reduce pollutants. The municipal stormwater permit holds permittees responsible for stormwater discharging from the conveyance system they own and/or operate. The conveyance system includes ditches, roads, storm sewers, stormwater ponds, etc. In the CRW, only Montevideo (MS400261) is regulated under MS4 rules. A map of the MS4 regulated areas can be found at the link above. Under the National Pollutant Discharge Elimination System (NPDES) stormwater program, permitted MS4 entities are required to obtain a permit, then develop and implement an MS4 Stormwater Pollution Prevention Program (SWPPP), which outlines a plan to reduce pollutant discharges, protect water quality, and satisfy water quality requirements in the Clean Water Act. An annual report is submitted to the MPCA each year by the permittee documenting progress on implementation of the SWPPP.

Construction stormwater is regulated by NPDES General Permit (MNR100001) for any construction activity disturbing a) one acre or more of soil, b) less than one acre of soil if that activity is part of a “larger common plan of development or sale” that is greater than one acre, or c) less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources. Industrial stormwater is regulated by NPDES General Permit (MNR050000) or Nonmetallic Mining and Associated Activities General Permit (MNG490000) if the industrial activity has the potential for significant materials and activities to be exposed to stormwater discharges. The amount of land under Construction and Industrial Stormwater Permits in the CRW (858 acres) was divided by the total area of the watershed to determine the percent of permitted land. Results of this analysis show that approximately 0.066% of land in the CRW is currently under a Construction and Industrial Stormwater Permit suggesting these land uses are not a significant source of pollutants in the CRW.

Feedlots and livestock

Livestock are potential sources of bacteria and nutrients to streams in the CRW, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas.

Because most feedlots are regulated to have minimal runoff, the largest water quality risk associated with feedlots is from land-applied manure. Manure is a by-product of animal production, and large numbers of animals create large quantities of manure. This manure is usually stored onsite and then transported to spread over agricultural fields to help fertilize the soil. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition and helps build soil health. Manure, however, can pose water quality concerns when it is not applied properly or leaks or spills from nearby fields, storage pits, lagoons, or tanks.

A review of the MPCA internal feedlot database shows the number of active feedlots in the CRW has been decreasing from its high of 1,252 active permits in 2009 to 761 in 2025 (Figure 35). The number of animal units (AUs) in the CRW fluctuates from year to year. The number has been as low as 153,410 in 2006 and as high as 209,572 in 2017 (Figure 36).

In 2025, there were approximately 176,718 AU of various species reported managed under 761 permitted facilities in the CRW. Twenty-one permits had greater than 1,000 AUs and accounted for 75,511 AUs (43%). There were 740 permits with less than 1,000 AUs accounting for the remaining 101,207 AUs (57%).

Figure 34. Registered feedlots in the CRW (2006-2025).

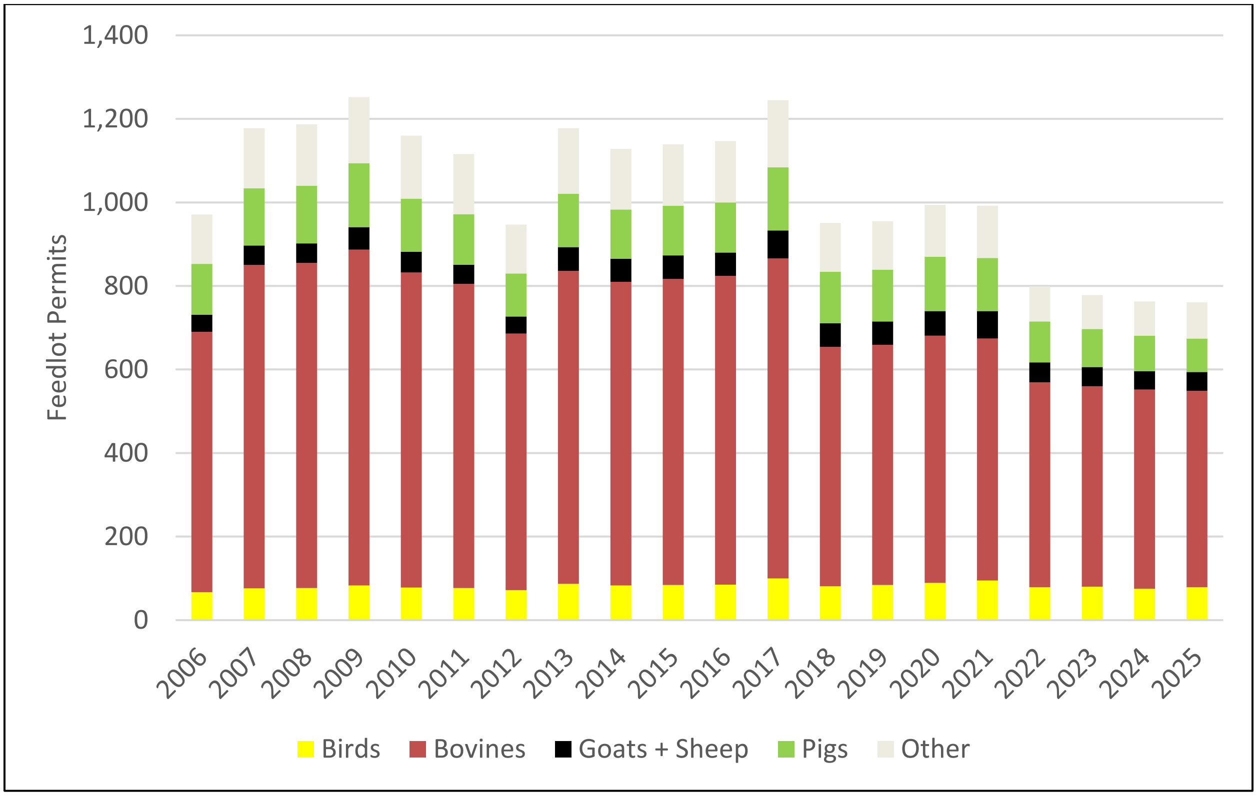
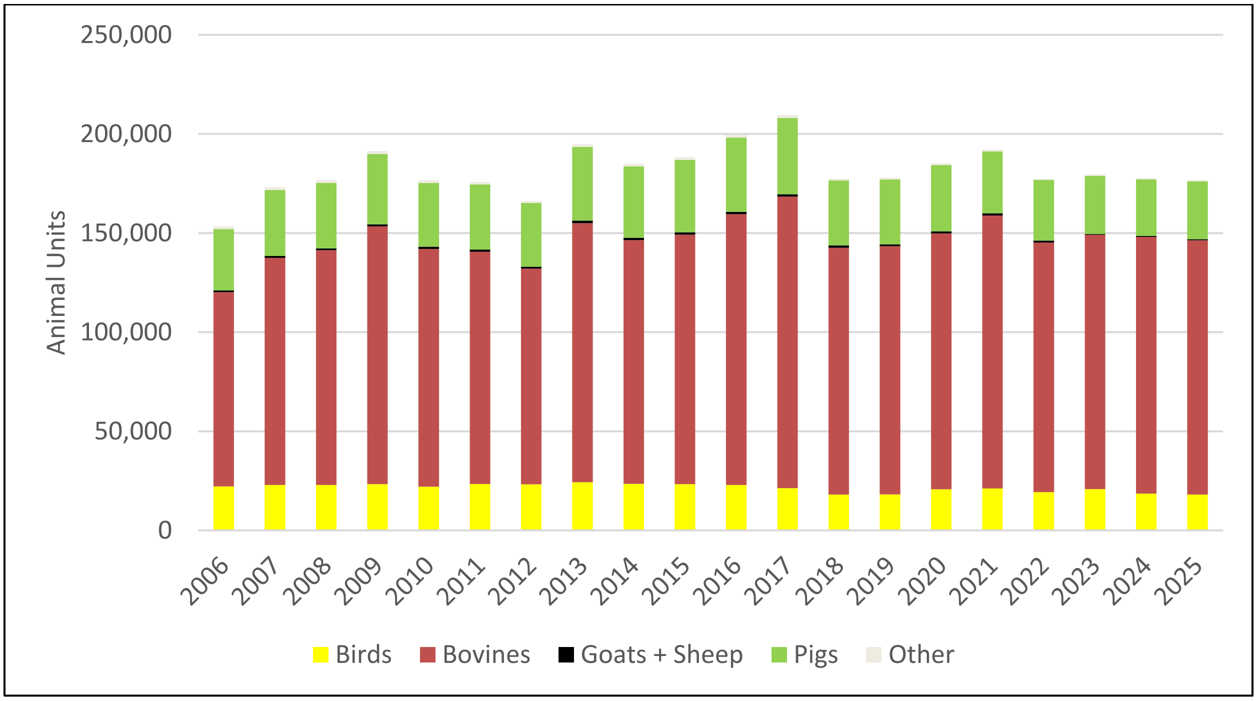


Figure 35. Registered AUs in the CRW (2006-2025).



4.4 Land use

Historically, the CRW has undergone extensive conversion from native prairie, wetlands, and forests to agriculture. By the late 20th century, over 85% of the watershed was in agricultural use, dominated by row crops such as corn and soybeans, with pasture and hayland in decline. This change was accompanied by widespread ditching, tile drainage, and wetland loss, which reduced landscape storage and increased runoff efficiency.

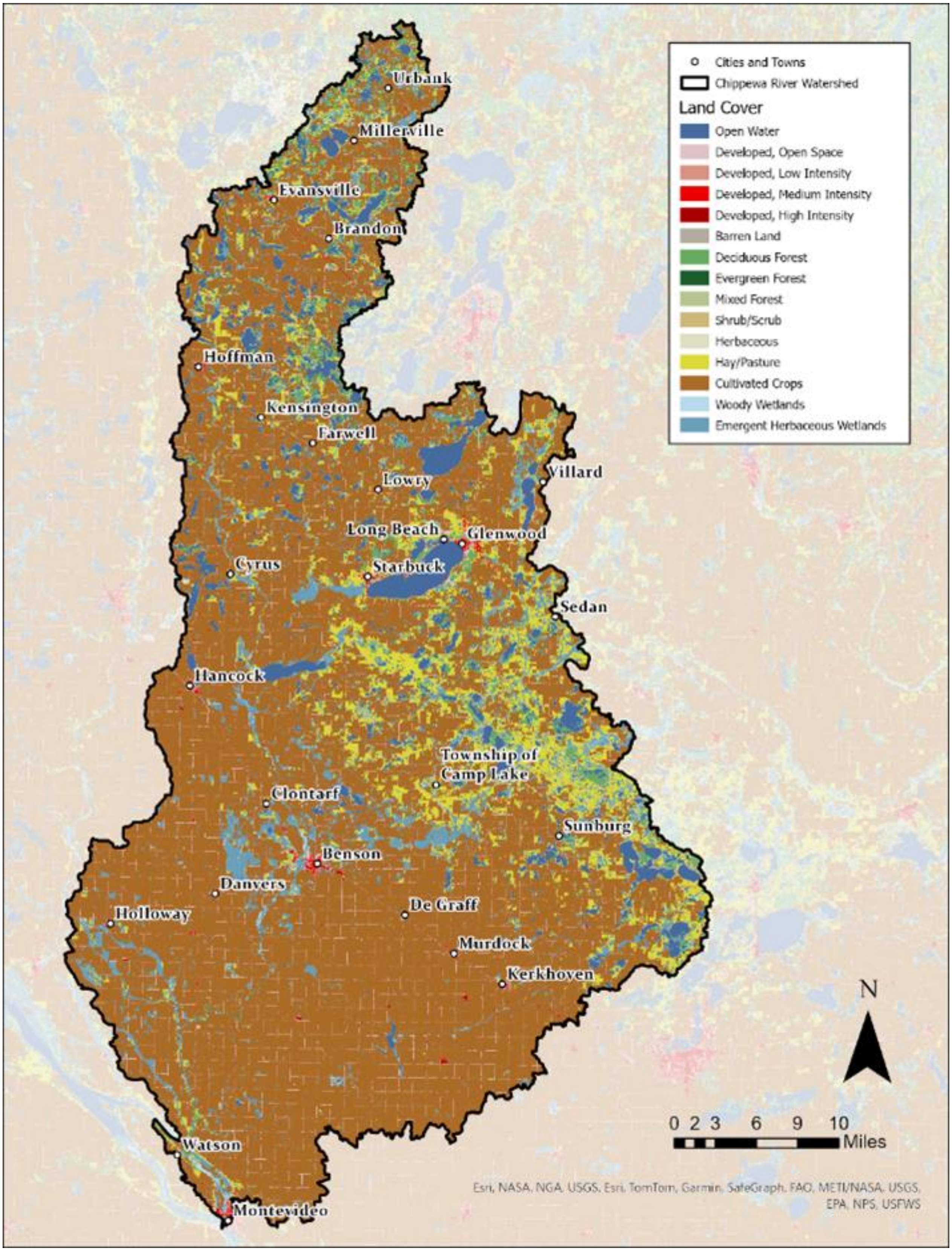
More recent decades have seen continued intensification, including a shift toward larger field sizes, fewer perennial cover areas, and consolidation of agricultural operations. However, there are also signs of localized diversification such as expansion of conservation practices, grasslands, and riparian buffer restoration.

At present, the watershed remains overwhelmingly agricultural, with less than 10% in forest, wetland, or native grassland (Table 9, Figure 37). Urban development is limited but increasing near some towns. The hydrologic impacts of land cover change, such as higher peak flows, flashier runoff, and reduced baseflows, remain a central concern, and these conditions continue to shape both water quality and aquatic habitat (DNR 2023).

Table 9. Land use and land cover in the CRW. Source: 2021 National Land Cover Database (Dewitz 2023).

Water body name	Cultivated crops	Developed	Forest	Hay and pasture	Water	Wetland
Chippewa River Watershed	69%	4%	4%	9%	6%	8%

Figure 36. CRW land use. Source: 2021 National Land Cover Database (Dewitz 2023).



Esri, NASA, NGA, USGS, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USFWS

DNR's Chippewa Watershed Context Report

The *Chippewa Watershed Context Report* for the Chippewa River, developed by the DNR, provides a landscape-level overview of the watershed's physical characteristics, land use patterns, and ecological stressors (DNR 2017). This report supports watershed planning by identifying key natural and human influences that shape water quality and habitat conditions.

The CRW has undergone significant land cover transformation. More than 78% of the landscape is now dominated by agricultural production, primarily row crops. This shift, along with widespread wetland drainage and more than half of the stream miles being ditched or impounded, has altered the watershed's hydrology. Natural water storage has been reduced, stream flows have become more variable, and sediment and nutrient delivery to lakes and streams has increased. These physical changes are key contributors to the water quality and habitat impairments observed in the watershed (DNR 2017).

Considering the findings of this DNR report, restoration and protection efforts should recognize that hydrologic alteration, nutrient runoff, and the loss of perennial vegetation are the primary stressors impacting aquatic systems. Large areas with hydric soils but limited remaining wetlands point to opportunities for wetland restoration and water storage improvements. Similarly, straightened stream segments and disconnected floodplains can be prioritized for habitat restoration and improved flow stability. Addressing these core drivers can support multiple goals, including pollutant reduction, AQL support, and climate resilience.

To achieve durable results, restoration and protection strategies should integrate conservation practices such as improved nutrient management, buffer restoration, streambank stabilization, and targeted wetland reestablishment. The DNR's watershed context report also highlights the importance of topography, soils, and ecological classification when evaluating site-specific actions. Aligning restoration and protection strategies with these underlying landscape features will help ensure long-term gains in water quality and overall watershed health.

4.5 Best management practices

Since 2010, and especially post-2016, the CRW has significantly increased BMP implementation, particularly in key areas recognized by Minnesota's Nutrient Reduction Strategy (NRS; MPCA 2026). The focus on living cover, nutrient management, erosion control, and drainage treatment not only aligns with NRS-recommended practices, but also meaningfully contributes to achieving state-level nutrient reduction milestones and improving downstream water health.

Scaling up implementation effort post-2010

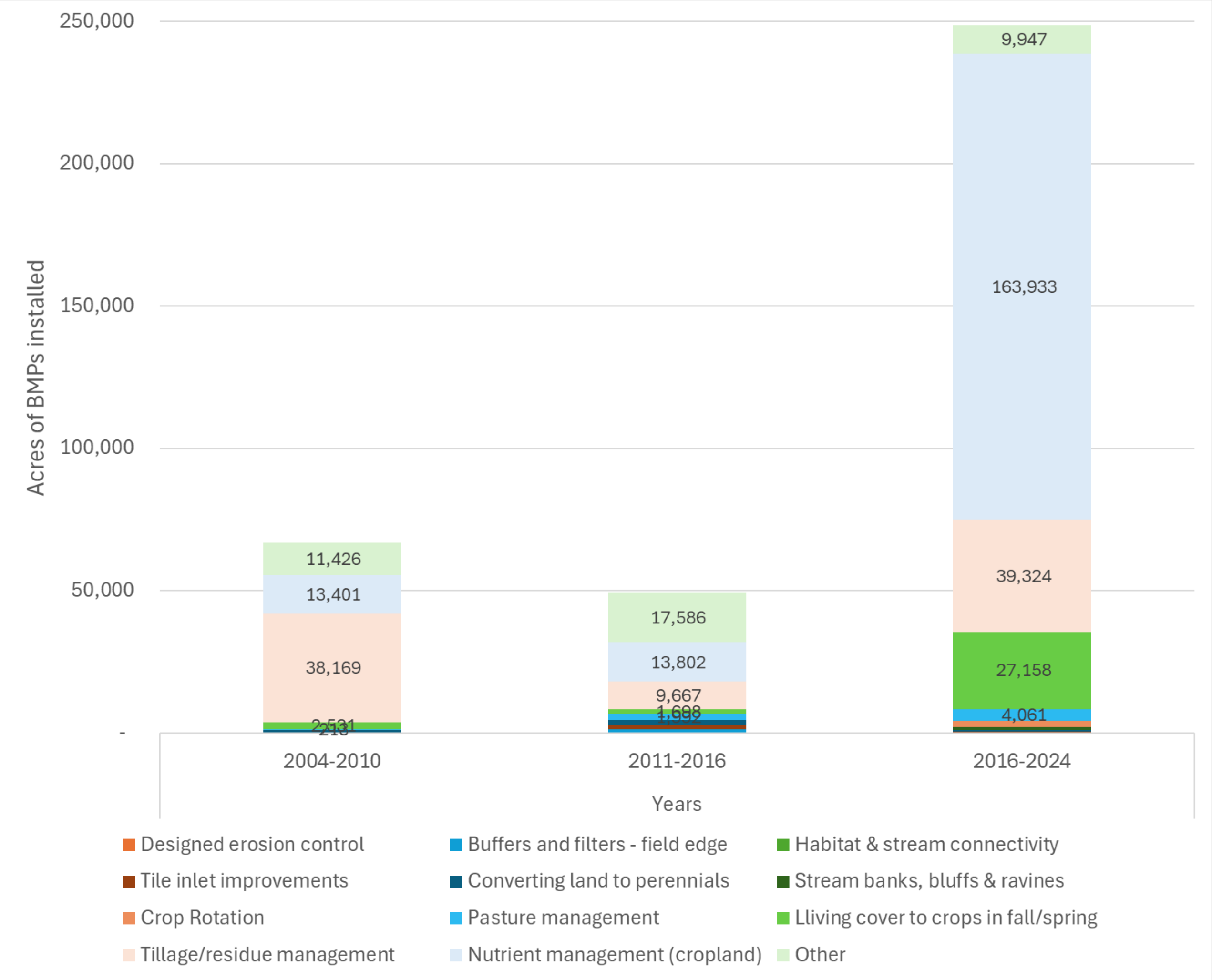
There has been a notable expansion in BMP activity (see Figure 37 and Figure 38):

- Total projects nearly tripled from earlier periods (close to 800 projects in both 2004-2010 and 2011-2016) to 2,371 projects in 2016-2024. This may be in part due to increased focus on soil health practices and new programs that more effectively meet farmer's needs among other factors. These data are taken from the Best management practices by watershed webtool (This resource summarizes nonpoint BMPs from the following sources: USDA-NRCS, BWSR MDA and MPCA. It does not include private BMPs installed solely through private funding).

- The most dramatic increases occurred in living cover, nutrient management, and pasture management—all key to reducing nutrient runoff.

This scaling underscores increased local commitment to watershed and downstream water quality, including major basins and ultimately the Mississippi River, Lake Pepin, and beyond.

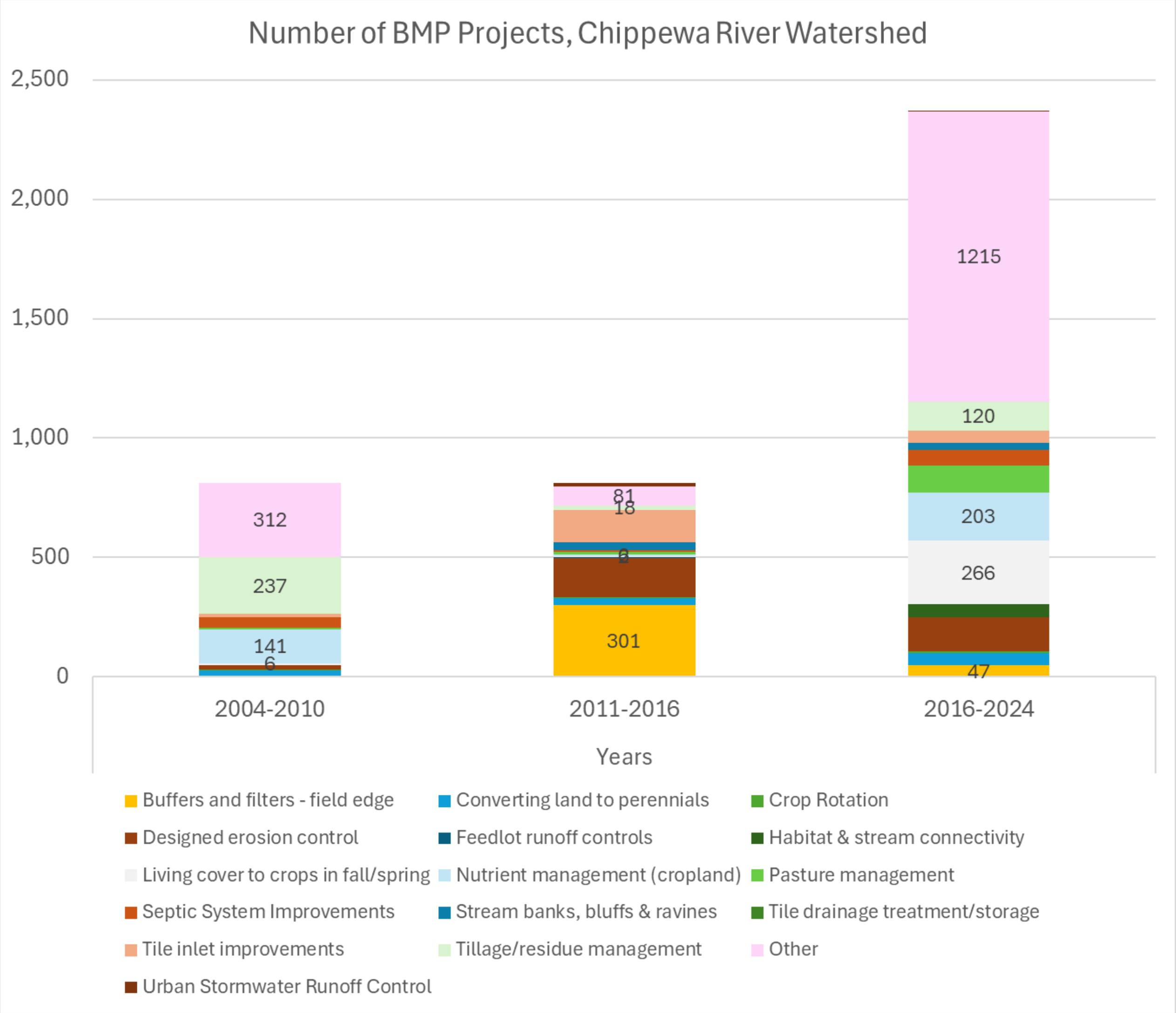
Figure 37. Acres of BMPs in the Chippewa River Watershed installed over three time periods.



The sharp increase in the number of BMP projects since 2016 also reflects a highly engaged public, with more landowners taking advantage of available programs and demonstrating interest in conservation (see Figure 40). This growth suggests that outreach, technical assistance, and funding opportunities are resonating with producers and land managers, leading to broader adoption of practices that protect soil, reduce nutrient losses, and improve water quality. The willingness of landowners to participate at this scale is a critical driver of progress toward watershed and downstream nutrient reduction goals.

The “Other” BMP category saw a dramatic increase, from 312 projects in 2004-2010 and 81 in 2011-2016 to 1,215 projects in 2016-2024, indicating a major expansion beyond traditional row-crop conservation. This growth likely reflects both improved reporting and the adoption of a wider range of practices, including urban stormwater management, livestock-related BMPs, and innovative or locally tailored solutions not previously tracked in standard categories. The diversification of practices shows that conservation efforts are broadening to address nutrient and sediment sources across the full landscape, from agricultural fields to feedlots and developed areas, enhancing the watershed's capacity to meet water quality goals.

Figure 38. Number of BMP projects across three time periods in the CRW.



Alignment with NRS Priority Practices

The BMPs implemented in the CRW strongly align with the Minnesota NRS's recommended practices (MPCA 2026):

- **Living cover practices** (e.g., cover crops, riparian buffers) have surged—266 projects since 2016—addressing both P and N reductions.
- **Nutrient management on cropland** also saw a strong resurgence (203 projects), advancing fertilizer use efficiency, a key strategy for reducing N losses (MPCA 2026).
- **Field erosion control** via practices like tillage/residue management remained substantial through 2016-2024, helping curb TP runoff (MPCA 2026).
- **Drainage water treatment and storage** seen in tile inlet improvements, echoes the NRS's emphasis on treating subsurface flows that convey N losses (MPCA 2026).

Contribution Toward Statewide Nutrient Load Milestones

Minnesota's NRS calls for 10% to 20% nutrient load reductions by 2025, escalating to 45% to 50% reductions by 2040 (Watershed Nutrient Loads to Accomplish Minnesota's Nutrient Reduction Strategy Goals; MPCA 2022b). The BMPs being implemented in the CRW, particularly around nutrient management, living cover, and erosion control, directly support these targets:

- **Reduction of phosphorus** through erosion control and cover practices.
- **Mitigation of nitrogen** via nutrient use efficiency and drainage treatment strategies.
- **Enhancing downstream water quality** toward cumulative goals for major receiving waters like Lake Pepin and the Mississippi River.

The future of BMP growth in the CRW is positive

With the CRW Comprehensive Watershed Management Plan (CWMP) now fully adopted as of August 2024, the next decade is poised for even greater progress in BMP implementation (CRWA 2024). The plan brings new funding including non-competitively awarded Watershed Based Implementation Funding, coordinated planning, and stronger partnerships, building on an already accelerating rate of adoption. If current trends from 2021 through 2024 continue, HSPF modeled projections suggest the watershed could achieve a 6% reduction in P, 10% reduction in sediment, and 3% reduction in nitrogen by 2030, surpassing sediment goals and coming close to P targets, though additional effort will be needed to meet nitrogen goals (Table 10). The expanded resources and strategic focus provided by the CWMP create an opportunity to close those gaps, diversify practices, and target critical source areas, positioning the watershed to deliver substantial water quality benefits locally and downstream over the next 10 years.

Table 10. HSPF modeled rates of reduction based on past BMP implementation rates of adoption.

HSPF modeled	2011-2020 reduction	2021-2024 reduction	2021-2030 projected reduction based on 2021-2024 rate of adoption	CWMP 10-year goals
Phosphorus	2.64%	1.85%	6%	7%
Sediment	4.14%	3.05%	10%	7%
Nitrogen	1.62%	0.85%	3%	5%

Watershed pollutant load reduction calculator, Best management practices by watershed, Comprehensive Watershed Management Plan - Chippewa River Watershed Association

4.6 Groundwater

Additional protection concerns in the watershed relate to groundwater and drinking water supplies. Most residents and businesses in the Chippewa River Watershed (CRW) rely on groundwater drawn from private or community wells. Several communities have elevated vulnerability to contamination. Montevideo's drinking water system is considered highly vulnerable, indicating a strong connection between surface water and the aquifers that supply the community. Benson, Cyrus, Glenwood, Hoffman, Starbuck, and Watson have moderately vulnerable systems, where contaminants on the land surface can reach groundwater more quickly and may affect both drinking water and connected surface waters. In contrast, the communities of Brandon, DeGraff, Evansville, Hancock, Holloway, Kerkhoven, Lowry, and Murdock have low vulnerability because their deeper aquifers are better protected. However, unused or abandoned wells present an ongoing risk by providing direct pathways for contaminants to reach groundwater. Protecting abundant, high-quality groundwater resources remains essential, particularly given changing hydrology and its potential to reduce groundwater recharge. (MDH 2022)

5.0 Goals and recommendations

5.1 Restoration priorities

The CRW's restoration priorities focus on addressing high-priority issues that impair or threaten AQL and AQR. Efforts should concentrate on:

- **Reducing sediment and nutrient loading** through targeted erosion control, soil cover practices, upland and ravine stabilization, and soil health improvement.
- **Restoring hydrologic function** by increasing upland water storage, reconnecting floodplains, and reversing wetland loss to reduce peak flows and downstream flooding.
- **Improving habitat quality** in streams, lakes, and riparian corridors, with emphasis on restoring degraded lake shoreland and enhancing habitat connectivity.
- **Addressing bacteria sources** in areas where water quality is most affected by addressing potential noncompliant feedlots, pastures with uncontrolled cattle access to waterways, promoting manure management improvements, and upgrading failing septic systems.

Subwatershed restoration should focus targeting on where pollutant loads and EHC indicate the largest returns on investment, while addressing the numerous lake and stream impairments.

- **Upper Chippewa River.** Likely influenced by nonpoint sources, shoreline inputs, and legacy sources. Priorities: shoreline BMPs, targeted nutrient interception, riparian stabilization, and where feasible, in-lake and near-lake measures paired with watershed P controls.
- **Shakopee Creek and Dry Weather Creek.** The highest priority subwatersheds due to the highest combined TSS, N and P pressure with extensive artificial drainage and low perennial cover. Priorities: nutrient management planning, timing and rate control, cover crops, alternative tile intakes, saturated buffers, bioreactors, and wetland storage.
- **East Branch Chippewa River.** Chronic TSS exceedance with bank, ravine, and gully contributions. Priorities: side-inlet controls, water and sediment control basins (WASCOBs), grassed waterways, bank stabilization, and floodplain reconnection.
- **Lower mainstem Chippewa River.** Amplified peaks and channel stress from cumulative drainage and upstream loads. Priorities: distributed storage in headwaters, WASCOBs and grassed waterways, bank stabilization, riparian and floodplain reconnection.

- **EHC-flagged areas (flashy hydrographs, storage deficits).** Use EHC to set storage targets and pick hydrology-first practices: wetland restoration, controlled drainage, and water storage basins.

These restoration priorities align with *Chippewa Comprehensive Watershed Management Plan* (CRWA 2024) high-priority issues such as upland erosion, hydrology change, nutrient loading, and soil health degradation, while building on the pollutant and stressor reductions outlined in the *2017 Chippewa River WRAPS Report* (MPCA 2017b).

5.2 Protection priorities

Protection strategies should focus on safeguarding high-quality waters, stable habitats, and intact natural systems before they become degraded. Priority protection actions include:

- **Maintain high-quality headwaters streams and** lakes by enhancing perennial cover in sensitive areas, especially in the Upper Chippewa and other subwatersheds with strong existing water quality.
- **Protect riparian buffers and lake shorelands** through voluntary conservation, easements, and zoning enforcement.
- **Secure and manage critical habitat corridors** to preserve aquatic connectivity and wildlife movement.
- **Sustain groundwater quality** by sealing unused wells, managing pesticide and nutrient application in high-vulnerability areas, and promoting wise water use.

These protection measures reflect both *Chippewa Comprehensive Watershed Management Plan* goals for habitat and groundwater protection and the *2017 Chippewa River WRAPS Report* emphasis on preventing future impairments through proactive land use management.

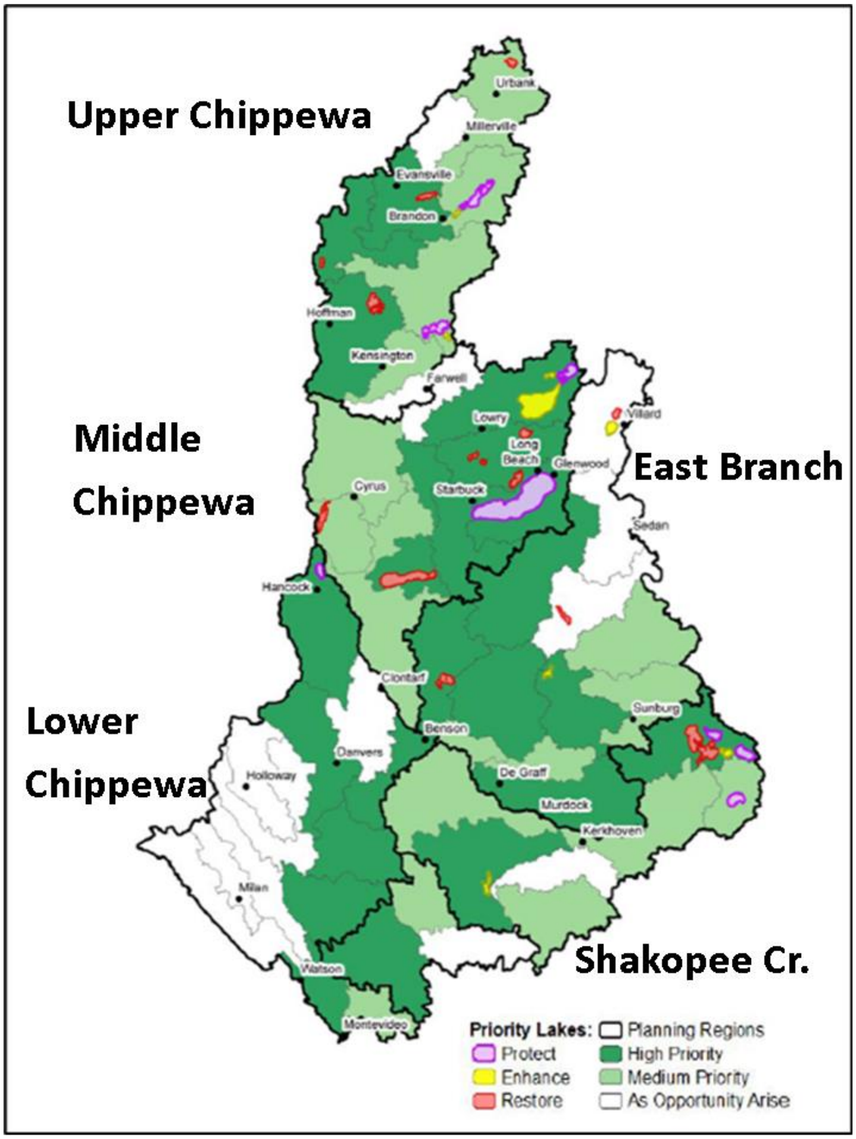
5.3 Implementation approach

Implementation will follow a **targeted, phased strategy** that integrates pollutant reduction modeling, EHC, and active community participation as outlined in the *Chippewa River Watershed Association Public Participation Plan* (CRWA 2020).

Targeting and Phasing

- **Data-driven targeting** - Use Prioritize, Target, and Measure Application (PTMApp), HSPF modeling, WRAPS Update monitoring results and other conservation targeting tools to locate high-load regions, unstable banks, hydrologically altered areas, and lake shoreline “hot spots.”
- **Prioritization sequence** - Focus early-phase investments in:
    1. *Shakopee Creek* and *Dry Weather Creek* for nutrient load reduction.
    2. *East Branch Chippewa River* for sediment stabilization.
    3. Upper Chippewa River eutrophication impaired reach for P impairment mitigation.
    4. Lakes with active impairments for P and clarity.

Figure 39. Priority zones and lakes from the Comprehensive Watershed Management Plan.



- **Lake integration** - Treat lakes and their “lake-sheds” as distinct “subwatersheds,” pairing upstream source controls with near-shore restoration and in-lake management where feasible. Use TMDL load reduction targets to direct conservation efforts required.

Best Management Practices

- **Agricultural BMPs** - Build off previous success installing cover crops, conservation tillage, rotational grazing, alternative tile intakes, and wetland restorations.
- **Shoreline and lake BMPs** - Stabilize eroding shorelines, restore aquatic vegetation, install stormwater retrofits, and manage internal loading where needed.
- **Hydrologic storage practices** - Wetland creation, controlled drainage, water storage basins, and floodplain reconnection in EHC-flagged areas.
- **Urban and developed land practices** - Rain gardens, infiltration basins, and riparian stormwater treatment in lakeside and river corridor communities.

Community Engagement and Partnerships

Drawing from the Public Participation Plan's (CRWA 2020) **inform-consult-involve-collaborate** framework:

- **Inform** - Use clear, visual materials on pollutant trends, EHC changes, and lake conditions in newsletters, meetings, and online updates.
- **Consult** - Gather feedback from local landowners, farmers, lake associations, tribal partners, resource users and municipalities before setting project scopes.
- **Involve** - Host watershed tours, lake days, and shoreline walks to connect residents directly to project sites and monitoring results.
- **Collaborate** - Build partnerships with SWCDs, counties, state agencies, NGOs, and civic groups for joint funding and implementation.

Funding and Capacity

- Leverage watershed-based implementation funding (WBIF), CWF, Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP), and other cost-share programs.
- Use grant proposals to support lake-specific projects and multi-practice subwatershed packages.
- Invest in staff capacity for both technical BMP design and community facilitation.

Monitoring and Adaptive Management

- Monitor progress toward 10-year WRAPS Update and CWMP targets using CRWA, WPLMN, IWM, and lake-specific trend data.
- Reassess EHC indicators and lake clarity data every several years to adjust hydrologic storage goals and nutrient reduction strategies.
- Report progress annually to stakeholders and the public, highlighting both pollutant reductions and cultural benefits (fishing, recreation, tourism).

This implementation framework continues the adaptive management approach from the 2017 *Chippewa River Watershed Restoration and Protection Strategy Report* and the *Chippewa Comprehensive Watershed Management Plan*, ensuring that protection and restoration work is both strategically located, and community supported.

6.0 Climate

6.1 Climate trends

6.1.1 Climate data vs. weather data

Understanding the distinction between climate data and weather data is pivotal for grasping the implications of climate change. Climate data encapsulates long-term averages of weather conditions over decades, providing insight into enduring patterns like average temperatures, humidity levels, and precipitation. In contrast, weather describes daily fluctuations. For instance, while Minnesota's typically cold February is a reflection of climate, an unexpected April snowstorm represents weather variability. Recognizing these differences helps in understanding that individual weather incidents do not contradict the broader trends of climate change, which include increasing instances of extreme weather due to long-term shifts in climate patterns.

6.1.2 Climate impacts in the CRW

Minnesota's climate is changing. Warmer temperatures and heavier or more frequent rainstorms are starting to affect the land, water, and wildlife in the CRW. These changes are already influencing how we manage flooding, drinking water, wildlife habitat, and local infrastructure (*Climate Summary for Watersheds, Chippewa River*).

Rainfall and temperature have a big impact on water quality. More rain means more runoff—carrying nutrients, dirt, and bacteria into rivers and lakes. This pollution makes water less safe for swimming, boating, and fishing. At the same time, warmer temperatures help algae grow faster and more often. Some of these algae, like blue-green algae, can be harmful to people and pets. As algae die and break down, they use up oxygen in the water, which can lead to fish kills and other problems for AQL. Blue-green algae and harmful algal blooms | Minnesota Pollution Control Agency, Minimizing fish kills in Minnesota | Minnesota Pollution Control Agency

These trends are especially concerning in the CRW, where:

- 32 lakes are polluted by excess nutrients that make them unsuitable for recreation,
- 1 stream reach is too polluted for healthy AQL due to nutrients,
- 7 stream reaches have low oxygen levels caused by nutrient overload, harming fish and other wildlife,
- And, the MPCA studies have found 29 more stream sections stressed by too many nutrients and 27 with excessively low oxygen levels *Chippewa River Watershed SID Report Update 2024.*

To protect our lakes, rivers, and the communities that rely on them, it is essential to understand how climate change is intensifying existing challenges. Warmer temperatures, shifting precipitation patterns, and changing seasonal cycles are likely to result in more frequent and severe algae blooms, warmer water that limits swimming opportunities, shorter ice fishing seasons, and increased spread of invasive species. Rivers may experience higher flows and greater bank instability, while AQL faces growing stress from these combined pressures.

6.1.3 Present and future climate trends in the CRW

Annual average temperatures in the CRW increased over the last century and most years during the past two decades were warmer than average (DNR 2019). The 30-year rolling average temperature (red line in Figure 40) generally increased from the mid-1920s through late-1940s and again from the 1980s through the 2010s; the 30-year average temperatures were generally stable or slightly decreasing in the 1950s through 1970s (Figure 40). Annual average temperatures (blue line in Figure 40) have varied considerably over time but higher annual average temperatures have been more frequent in the late-1990s through 2010s. The projected increase in average annual temperature between 2040 and 2059 in

West Central Minnesota ranges from 3.8° to 4.5° Fahrenheit (F), depending on the extent to which renewable energy adoption replaces fossil fuel consumption in future emission scenarios (Coffman et al. 2024).

In the CRW, monthly average temperatures peak in July (Figure 41). Winter temperatures have increased over time (by about 3.0° F), along with spring and fall temperatures (about 1.4° F) and summer temperatures (about 1.2° F; DNR 2019).

Regardless of which emissions scenarios are adopted, temperatures are expected to continue to rise from the middle to the end of the century (Figure 42). Furthermore, by mid-century, annual daily average maximum temperature in West Central Minnesota is projected to increase between 3.6°F and 4.3°F. These changes are projected to increase the number of days that exceed 90°F by 17 to 24 days and decrease the number of days below 32°F by 21 to 25 days (Coffman et al. 2024).

Figure 40. Annual average temperature in the CRW 1899 -2018 (DNR 2019)

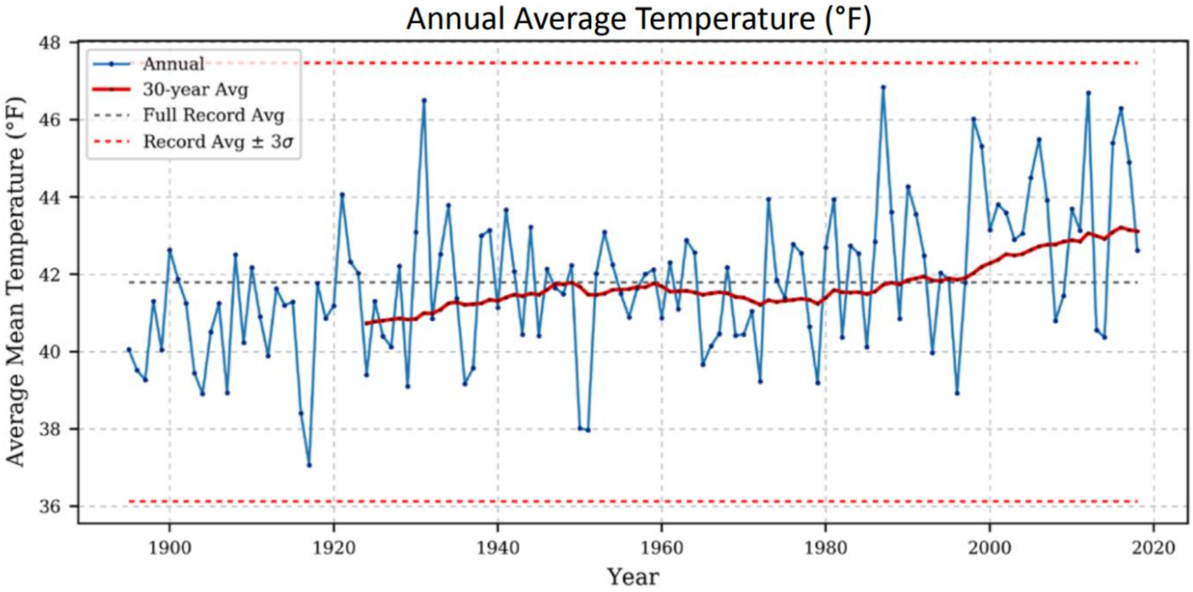
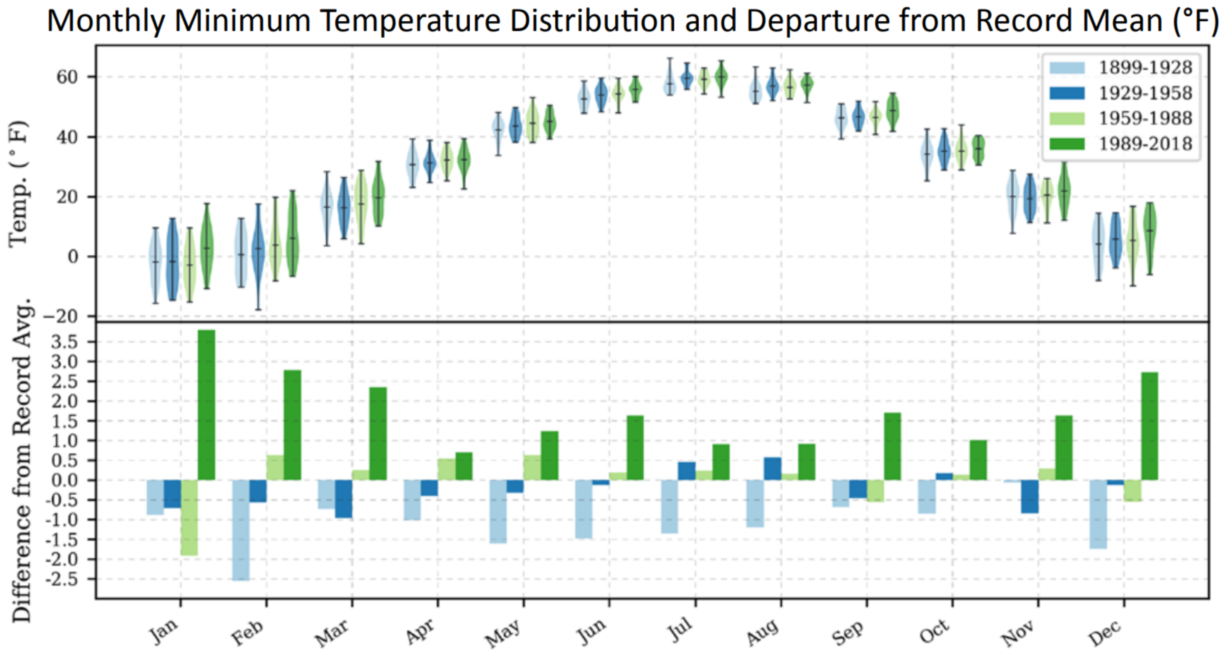
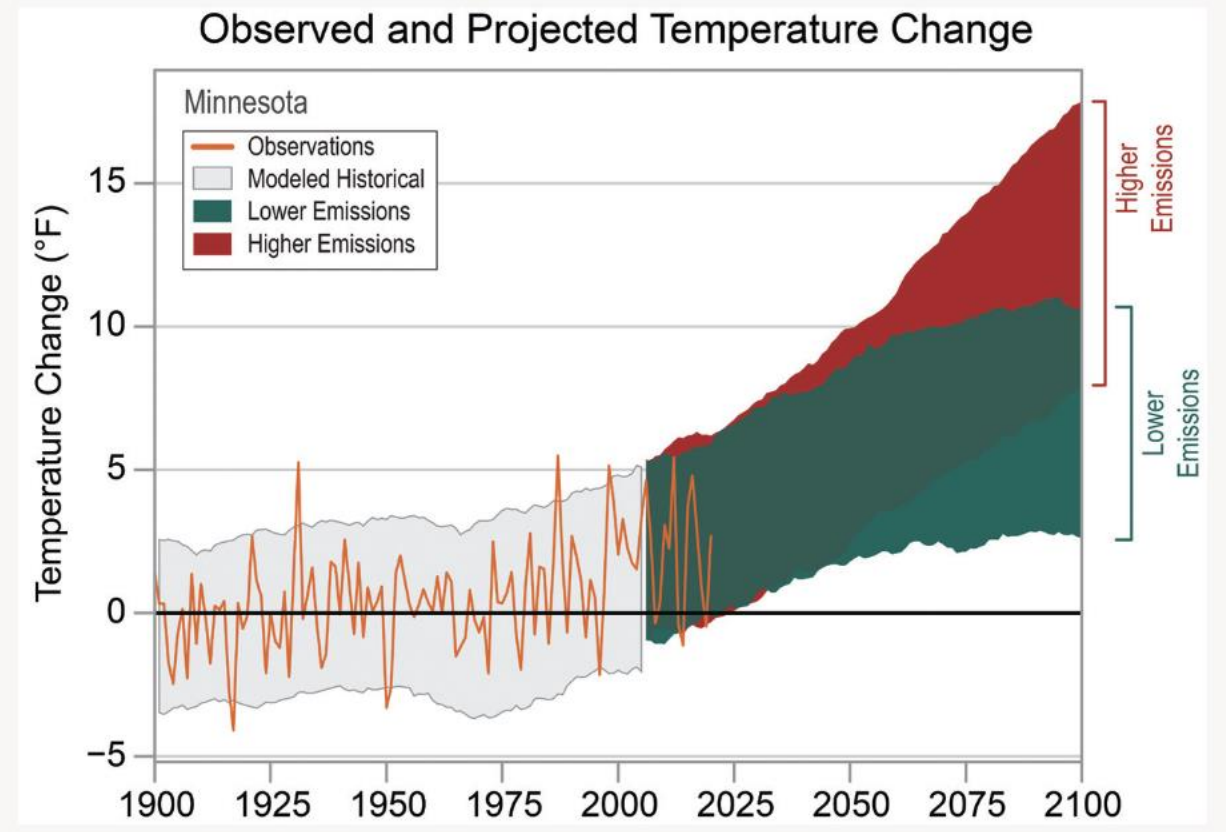


Figure 41. Monthly average temperatures and departures from record means in the CRW.



Source: DNR 2019, p. 6

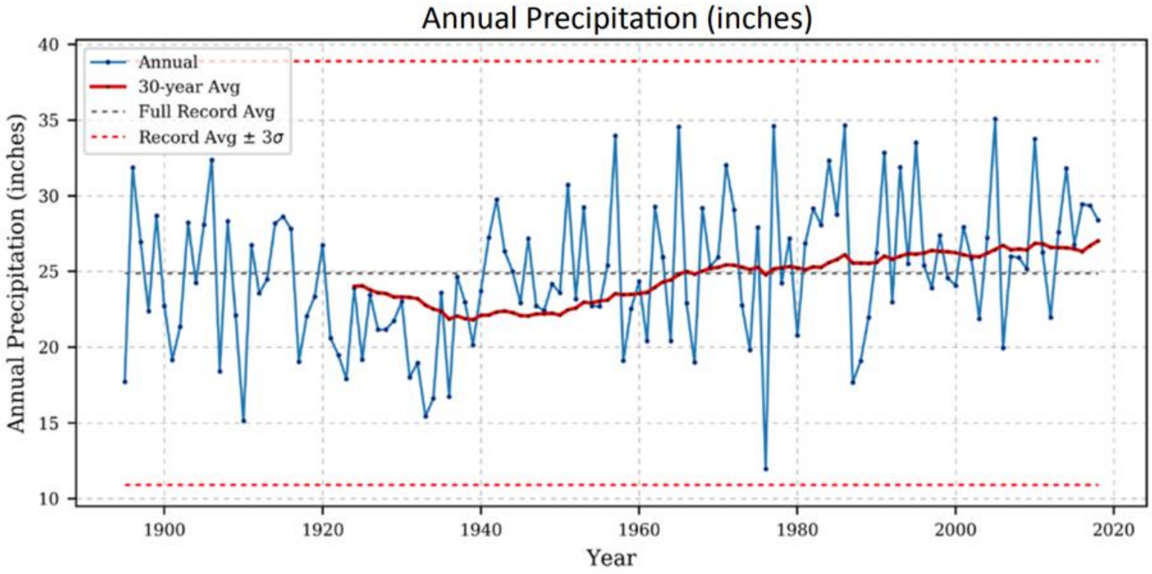
Figure 42. Observed and projected temperature changes in Minnesota.



Source: Runkle et al. 2022.

Annual precipitation in the CRW has been increasing since the mid-20th century (Figure 42). Monthly precipitation is typically highest in May and June and increases in precipitation in recent years were most pronounced in April through July (DNR 2019). In general, the frequency of 1-inch and 3-inch rain events has increased in Minnesota, along with the size of the heaviest rainfall of the year (DNR 2022). In the west central region of Minnesota, annual precipitation has increased an average of 3.3 inches from 1895 through 2023 (Coffman et al. 2024). In the CRW, annual average precipitation has increased 2.1 inches, with a 1.1-inch increase in the summer season average (DNR 2019). Minnesota has experienced an increase in devastating, large-area extreme rainstorms and climate projections indicate these big rains will continue increasing into the future (DNR 2022).

Figure 43. Annual precipitation in the CRW.



Source: DNR 2019, p. 11

In-lake and in-stream temperatures directly impact DO concentration and nutrient eutrophication. In Minnesota, lake surface temperatures have warmed throughout all seasons (MPCA 2025b). During the summer growing season (June through September), lakes in southern Minnesota are, on average, approximately 2.7° to 4.4° F warmer now than they were 50 years ago. In-stream temperatures in the Chippewa River (-503) have generally increased over time in August and September (MPCA 2025b). Average lake ice duration has decreased 10 to 14 days over the last 50 years (MPCA 2025b). Warmer winters have resulted in about nine fewer days of ice coverage on average for lakes in central Minnesota since the mid-1970s (MPCA 2025b).

6.2 Building climate resilience in the Chippewa River Watershed

The CRW is already experiencing the effects of climate change—warmer temperatures, heavier rainfall, and more extreme weather. These changes are impacting farms, towns, lakes, and infrastructure. To address this, communities can adopt two key approaches: **mitigation** (reducing greenhouse gas emissions) and **adaptation** (preparing for climate impacts).

Mitigation strategies aim to limit the severity of future climate change by addressing its root causes. For farmers, businesses, and communities, mitigation not only helps the environment but can also lead to financial savings and improved efficiency.

- Reducing energy use with efficient technologies

- Switching to renewable energy sources like solar or wind
- Using sustainable land practices such as crop rotation, cover crops, and agroforestry
- Improving fertilizer efficiency to reduce runoff and emissions

Nitrous oxide (N_2O), a greenhouse gas 300 times more potent than CO_2, can be reduced through practices like precise fertilizer application, cover cropping, and improved soil management. Nitrous oxide emissions grew 40% from 1980 to 2020, accelerating climate change - NOAA Research.

Adaptation strategies involve preparing for and managing the impacts of climate change that are already occurring or are expected in the future. These strategies not only protect communities and businesses from climate risks but also offer practical benefits to those who implement them.

- Improving water management with practices such as rain gardens, wetlands and buffers
- Enhancing soil health to boost crop resilience
- Planting drought-resistant crops and deep-rooted perennials
- Establishing natural shoreline buffers to prevent erosion and protect water quality

Strategies for CRW's surface waters: the lakes and streams of the CRW are changing; ice cover is decreasing, water is warming, and runoff is fueling algal blooms and DO issues. Protecting Minnesota's lakes requires both mitigation and adaptation. Key strategies include:

- Soil and Water Management: Practices like cover cropping, no-till farming, wetlands, and rain gardens reduce runoff and pollution.
- Shoreline Buffers: Vegetated buffers trap sediment, protect against erosion, and support wildlife.
- Aquatic Species Management: Restore habitats and adjust fish stocking to respond to changing lake conditions.
- Community and Policy Action: Engage the public through education and implement policies that support long-term lake health.

Resilient communities focus on updating policies, community engagement, and sustainable action. With support from partners like the MPCA, communities across the watershed can prepare for climate change while protecting the land, water, and livelihoods that define the region {Climate-resilient communities | Minnesota Pollution Control Agency}.

7.0 Environmental justice

Every Minnesotan - regardless of income, race, ethnicity, color, or national origin - has the right to healthy air, sustainable lands, clean water, and a better climate. Yet, too many people, especially low-income communities, communities of color, and Indigenous people, bear a disproportionate share of environmental burdens and climate-related impacts. The MPCA and the Board of Water and Soil Resources (BWSR) both emphasize environmental justice (EJ) as a core value in planning and implementation work: Understanding environmental justice in Minnesota BWSR 2025 Nonpoint Priority Funding Plan.

Why Environmental Justice Matters in the CRW

EJ is a critical component of watershed work in the CRW, where many residents face economic hardship, and some communities of color have been historically underserved. Equitable access to clean water, safe environments, and meaningful participation in decisions affecting local lands and waters is essential for building trust, protecting public health, and creating long-lasting, community-centered solutions.

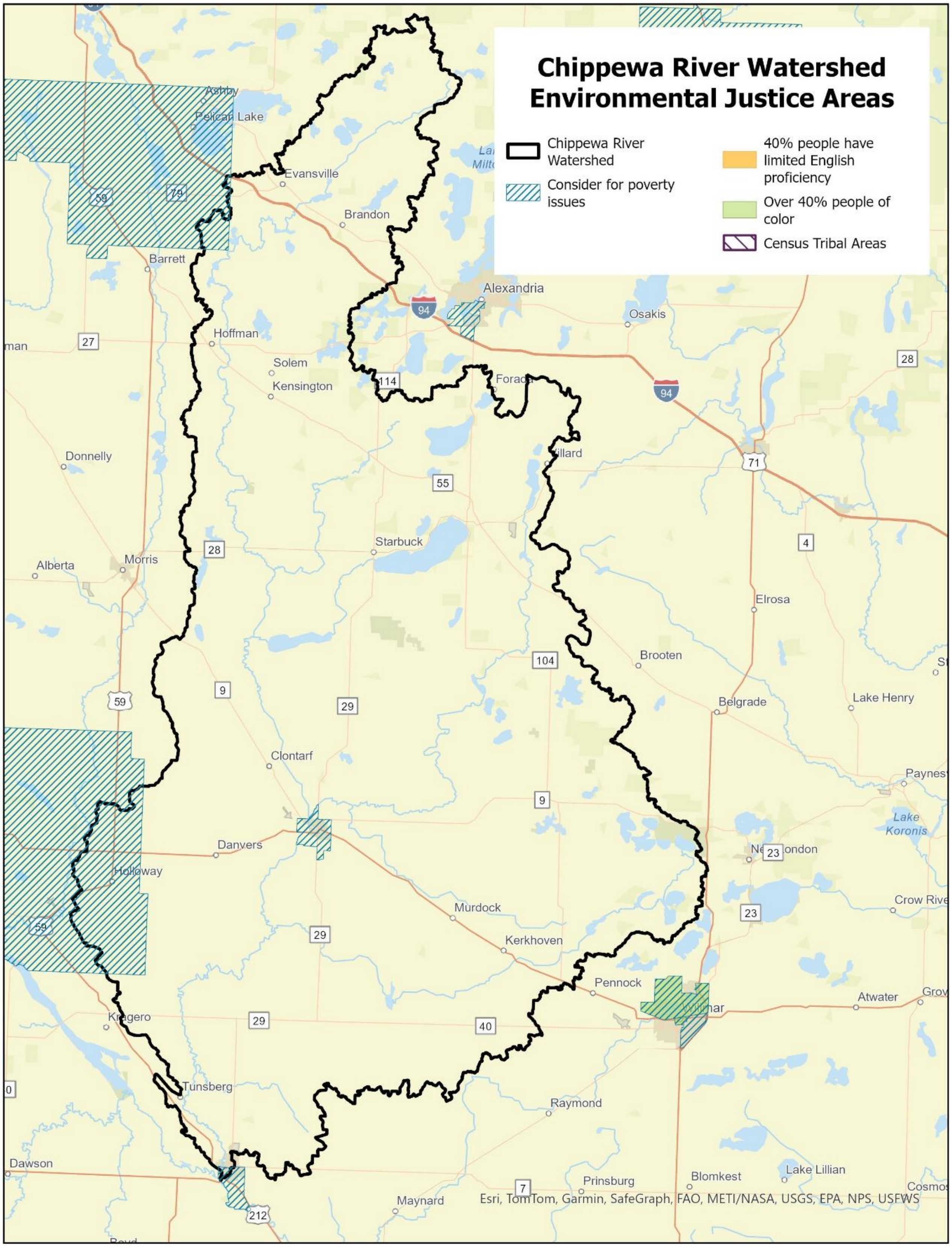
Income-Based Environmental Justice Considerations

In the CRW, the primary EJ consideration is income. According to Minnesota statute, a census tract is identified as an EJ area if at least 35% of the population has an income below 200% of the federal poverty level. In the CRW, four census tracts meet this criterion (Figure 44) Understanding Environmental Justice in Minnesota.

Supporting these findings, data from the National Center for Education Statistics (NCES) show that in the 2023 to 2024 school year, 42% of students across the 5 CRW school districts were classified as qualifying for free or reduced-price lunch, reflecting the broader economic challenges many families face.

While these designated EJ zones highlight priority areas for engagement and investment, low-income individuals and households live throughout the watershed. Watershed programs should be designed to reduce financial barriers, ensure access to cost-share opportunities, and engage residents through clear communication and practical support.

Figure 44. Chippewa River Watershed Environmental Justice areas.



Race and Ethnicity in the Watershed

Minnesota statute defines an EJ concern for race if a census tract has at least 40% residents identifying as people of color. In the CRW, census tract data show a range from 1.2% to 17.5% people of color, meaning no tracts currently meet the racial EJ threshold.

However, local school demographics offer a more nuanced view. According to National Center for Education Statistics data, nonwhite students now make up between 6% and 30% of the student population depending on the school district, suggesting demographic shifts and the importance of proactively considering communities of color in future watershed planning.

While no census tract meets the statutory threshold, people of color live in communities across the watershed. Watershed efforts should actively seek to understand and respond to their needs through targeted engagement, responsive program design, and ongoing collaboration with trusted community partners.

Centering Environmental Justice in Watershed Planning

To ensure the CRW's CWMP and implementation efforts are inclusive and equitable, deliberate action is needed. The following strategies are aligned with MPCA and BWSR guidance and support meaningful engagement and investment in historically underserved communities.

1. Community Engagement and Empowerment

- Host listening sessions and community forums in low-income areas and emerging communities of color.
- Outreach may include in-person meetings at local schools or libraries, materials distributed through food shelves or churches, and announcements via community-specific social media, local radio, or multilingual newsletters.
- Partner with trusted local organizations, churches, and schools to co-develop outreach.
- Reduce barriers to participation by offering stipends, meals, childcare, or transportation. *Environmental Justice Framework Report*, *Promising Practices for EJ Methodologies in NEPA Reviews*

2. Equitable Access to Resources

- Prioritize funding, BMP cost-share, and technical assistance for landowners and neighborhoods in EJ-identified areas.
- Translate materials into locally spoken languages; ensure plain-language content is available.
- Offer simplified applications and one-on-one assistance for under-resourced applicants. Environmental justice | Minnesota Pollution Control Agency, BWSR Nonpoint Priority Funding Plan

3. Data Transparency and Targeted Monitoring

- Use EJ screening tools to map pollution burdens, water access, and infrastructure gaps by demographic and income data.

- Following MPCA's Environmental Justice Framework Report, monitoring should focus on filling gaps in or near EJ-designated areas, especially where local residents have raised concerns about pollution or other environmental risks.
- Make water data tools user-friendly and publicly accessible through dashboards or maps. Environmental justice | Minnesota Pollution Control Agency

4. Inclusive Decision-Making

- Include community representatives on local planning teams, advisory committees, or watershed boards.
- Ensure timelines and public review processes allow for early and meaningful input.
- Encourage co-leadership with grassroots or cultural organizations when designing solutions. One Watershed, One Plan Operating Procedures, Environmental justice | Minnesota Pollution Control Agency

5. Long-Term Investment and Accountability

- Embed equity goals and benchmarks within WBIF strategies.
- Report regularly on outreach, funding, and improvements tied to underserved communities.
- Focus climate resilience investments, like stormwater retrofits, tree planting, or flood mitigation, on the people and places most at risk Nonpoint Priority Funding Plan, Environmental justice | Minnesota Pollution Control Agency.

8.0 Tribal statement

No part of the CRW in Minnesota is located within the boundary of a Native American Reservation (USCB 2018). However, portions of counties that make up the CRW are of interest to six Tribal Governments that have expressed an interest in the land and waters of the CRW (MPCA 2024c). They are:

- Upper Sioux Community, Pezihutazizi Oyate
- Lower Sioux Indian Community of Minnesota, Caŋsayapi
- Leech Lake Band of Ojibwe, Gaa-Zagaskwaabiganikaag
- Mille Lacs Band of Ojibwe, Mis-Qua-Mi-Saga-Eh-Ganing
- Sisseton-Wahpeton Oyate
- White Earth Band of Ojibwe, Gaa-waabaabiganikaag

While no areas within the watershed were specifically identified, the MPCA will continue to work with tribes interested in the watershed.

9.0 Public participation/Public notice

Public Outreach and Participation

Public outreach is a cornerstone of the CRW approach to restoration and protection. It encompasses education, training, marketing, technical assistance, and community events designed to connect local stakeholders with water resource goals. In this second cycle of the Watershed Approach, emphasis was placed on supporting and documenting the outreach work of the CRWA, SWCDs, counties, and local partners.

Building Partnerships and Trust

The CRWA and its local government unit (LGU) partners recognize that long-term water quality improvement depends on strong community relationships. Early outreach efforts focused on building trust with local governments, agencies, and residents, listening to concerns, gathering ideas, and coordinating activities. These efforts culminated in the 2020 Chippewa River Watershed Restoration and Protection Strategies Public Participation Plan, developed with support from a MPCA grant. The plan outlined strategies for community education, youth engagement, and landowner involvement across the watershed (CRWA 2020).

Cycle 2 Engagement Strategies

During Cycle 2, coordination was organized around a local work group of counties, agencies, and CRWA partners. Together, they consistently met and prioritized, developed strategies to direct implementation projects that leveraged resources and accelerated adoption of BMPs. Outreach activities were designed to:

- Focus in LGU partner priority areas in the CRW.
- Increase public understanding of watershed science and current water quality conditions.
- Develop relationships, strengthen partnerships and build networks that support accelerated implementation.
- Listen to and learn from community perspectives to shape strategies for restoration and protection.
- Connect landowners directly with conservation opportunities through direct staff contact.

Although the COVID-19 pandemic limited in-person meetings between 2019–2022, partners adapted by expanding online outreach, individual landowner contacts, and alternative outreach formats.

Examples of Outreach Activities

The CRW partners have built a diverse outreach portfolio:

- Youth education: SWCD staff lead programs in schools, 4-H, and scout groups; organize outdoor field days; and support the Envirothon competition to develop conservation awareness among students (CRWA 2020).

- Community events: County fairs, tours, nitrate testing clinics, soil health field days, and women's field days connect residents directly with conservation practices and water quality issues (CRWA 2020).
- CRWA signature events: Annual meetings, canoe paddles, and "Pollinators, Pies, and Pints" gatherings create opportunities for watershed residents to learn in informal, community-oriented setting (CRWA 2020).
- Communication tools: Partners maintain newsletters, social media platforms, story maps, and public service announcements to share progress and opportunities for involvement.

Linking WRAPS and CWMP

Public participation remains central to watershed planning. One clear example of this collaborative approach is the CWMP, which was developed alongside the WRAPS Update. The two efforts were deliberately interwoven: WRAPS Updates provided scientific analysis, monitoring data, and pollutant reduction targets, while the CWMP process brought in local priorities, on-the-ground knowledge, and broader community perspectives. Together, they created a feedback loop where technical findings informed local planning, and local input strengthened the trends and analysis focus of the WRAPS.

This collaborative alignment broadened opportunities for shared engagement, allowing residents and partners to see how their voices were shaping both state-led and locally led planning. It also ensured that outreach not only supported WRAPS goals but also directly influenced county and SWCD implementation strategies through the CWMP. In this way, the two plans reinforced one another, laying a stronger foundation for coordinated action to protect and restore the CRW.

Public notice for comments

An opportunity for public comment on this draft WRAPS Update report was provided via a public notice in the *State Register* from December 8, 2025, through January 7, 2026. There were two comments received and responded to as a result of the public comment period.

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Appendix

Table 11. Comparison of lake chemistry summer averages.

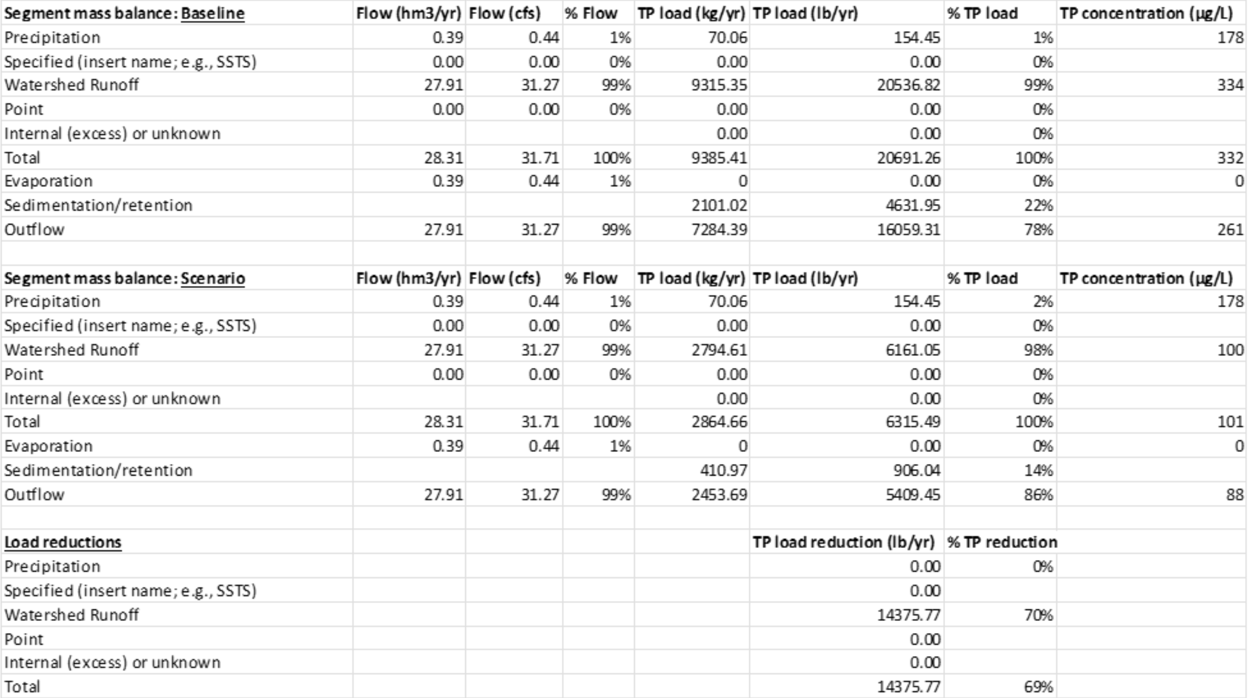
Water body Name	Lake ID (WID)	Summer Mean							
		Secchi meters			Phosphorus, μg/L			Chl-*a* μg/L	
		2000-2009	2010-2020		2000-2009	2010-2020		2000-2009	2010-2020
Shakopee	12-0030-00		0.4			197			85.1
Unnamed	12-0067-00				231				
Maple	21-0079-00	2.96	4.1		18.1	17.1		5	3.2
Turtle	21-0090-00	1.55	2.2		41.3			18	
Private	21-0125-00	1.93	2.7						
Indian	21-0136-00	2.6			24.2			10	
Chippewa	21-0145-00	3.54	3.9		17.1	15.6		4	5.2
LITTLE OSCAR (MAIN)	21-0156-01	1.53			47.3			20	
Rachel	21-0160-00	3.29	2.9		19.7	20.6		7	4.5
Freeborn	21-0162-00	1.93			27.3			10	
Mattson	21-0171-00	0.53			119				
West Olaf	21-0177-00	0.91			48				
Olaf	21-0178-00	0.91			38				
Gilbert	21-0189-00	0.56	2.6		72.2	40.1		36	10.5
Little Chippewa	21-0212-00	3.02	2.9		32	23.3		8	8.1
Devils	21-0213-00	2.37	3.4			17			5.3
Whiskey	21-0216-00	2.43	2.8		37.1			11	
Moon	21-0226-00	4.13	5.7			11.1			2
Aaron	21-0242-00	2.04	2.1		24.5	8.8		8	1.5
Moses	21-0245-00	4.62	5.4		16.6			8	
Stockhaven	21-0246-00	0.91	1.1		40				
South Oscar	21-0257-02	2.47	5.4		28.3	16.3		9	3.3
Stowe	21-0264-00	1.5	1.4		56.1	68.4		36	41
Stockhousen	21-0265-00	1.37			40				
Eng (main basin)	21-0274-01					97			39.1
Red Rock	21-0291-00	1.56	1.4		123	64.1		35	34
Venus	21-0305-00	0.6	0.7			88.1			59.1
Jennie	21-0323-00	0.4	0.6		162	159		76	62.1
Fanny	21-0336-00	0.5							
Long	21-0343-00	0.59			99.1			45	
Thompson	26-0020-00	1.42			136			39	
Lower Elk	26-0046-00	1.71	1.6		116	107		32	31.7
Florida Slough	34-0204-00	0.63			81.8			25	
Andrew	34-0206-00	2.58	2.9		21.3	25		6	5
Henchien	34-0207-00	1.67			10				

Water body Name	**Lake ID (WID)**	**Summer Mean**							
		Secchi meters			**Phosphorus, *μ*g/L**			**Chl-*a* *μ*g/L**	
		2000-2009	**2010-2020**		**2000-2009**	**2010-2020**		**2000-2009**	**2010-2020**
Middle	34-0208-00	0.5	2.8		61.8	21.5		38	5.6
Florida	34-0217-00	2.5	3.2		20.1	17.7		6	4.3
Crook	34-0218-00	1.5			22				
Swan	34-0223-00	2.29	0.9		24	10			
Games	34-0224-00	2.31	1.9		27.2	29.5		10	10.2
Unnamed	34-0236-00	1.5			31				
Mary	34-0249-00	0.4	0.4						
Norway (Northwest)	34-0251-00	0.98	0.5		60.6	67.6		27	37.2
Norway (Southern)	34-0251-02		1.3			47.3			22
Swan	34-0285-00	0.6			181				
Church	34-0292-00	0.31	0.3		277	221			98.8
Unnamed	34-0307-00		1.1			114			14
Henjum	34-0316-00	0.46			126				
Swenson	34-0321-00	0.56	0.8		95.4	136		57	47.7
Unnamed	34-0327-00	0.14	0.2		555	526		381	223
East Sunburg	34-0336-00	1.21	1.2		237	193		110	86.4
Deer	34-0344-00	2.89			24				
Blaamyhre	34-0345-00		1.1			25.5			3.6
Hefta	34-0347-00	0.28							
Unnamed	34-0348-00	0.29			122				
Glesne	34-0352-00					27			4.5
Unnamed	34-0353-00		0.5			53			
Sunburg	34-0359-00		1.5			123			64.6
Block	56-0079-00	1.9	1.8		81	52.8		33	29.8
East Johanna	61-0002-00	0.53			56				
Round	61-0003-00	0.68			57				
Johanna	61-0006-00	1.58	2		68	70.4		40	17.5
Johnson	61-0010-00	1.86			38.4			21	
Unnamed	61-0013-00	1.3			15.4			4	
Simon	61-0034-00	0.45	0.7		126	125		72	50.1
Linka	61-0037-00	3.87	4.5		26.7	23.1		6	3.9
Scandinavian	61-0041-00	2.62	2.7		25.2	20.7		8	6
Goose	61-0043-00	0.81	2.8		59	248		56	109
Round	61-0048-00	1.92	3		25.9			10	
Swenoda	61-0051-00	0.56			90.7			57	
Marlu	61-0060-00	1.53	1.7		45.1			23	
State	61-0062-00	1.43			21.6			4	
Amelia	61-0064-00	3.98	3.6		20.4	18.6		8	6.9

Water body Name	Lake ID (WID)	Summer Mean							
		Secchi meters			Phosphorus, µg/L			Chl-*a* µg/L	
		2000-2009	2010-2020		2000-2009	2010-2020		2000-2009	2010-2020
Leven	61-0066-00	1.58	1.7		48.5	43.2		25	16.7
Villard	61-0067-00	1.76	1.4		40.9	38.6		19	15.6
Gilchrist	61-0072-00	1.28	1.4		66	54.9		44	33.1
Reno	61-0078-00	2.39	2.2		47.1	33.1		17	10.5
Hanson	61-0080-00	0.69			111			41	
Rasmuson	61-0086-00	0.65			149			85	
Unnamed	61-0091-00	0.5	0.5		121				
Hoff	61-0092-00	2.72	2.3		22.8			7	
Steenerson	61-0095-00	1.37			320			62	
Benson	61-0097-00	1.92			35.7			14	
Mary	61-0099-00	0.6			110			82	
Celia	61-0100-00	2.12			47				
Nelson (Main Lake)	61-0101-01	1.12	2.6		42.5	40.5		20	12.8
Edwards	61-0106-00	0.96			220			106	
White Star	61-0108-00	2.29			16				
Pelican	61-0111-00	1.36	1.5		54.1	50.2		23	25.9
Ann	61-0122-00	1.35	1.9		273	345		78	35.9
John	61-0123-00	0.6			141			81	
Strandness	61-0128-00	0.72	1.2		123	97.2		40	25.7
Minnewaska	61-0130-00	2.52	3.2		26.7	23.6		8	5.2
Signalness	61-0149-00	3.14	3.1		20.7	21.5		4	5.6
Wallin	61-0156-00	0.89			117			22	
Malmedal	61-0162-00	0.52	0.8		151	151		82	54.9
Jorgenson	61-0164-00	0.48			210			124	
Larson	61-0170-00	1.07			80				
Emily	61-0180-00	0.41	0.8		110	99.1		48	32
Pike	61-0183-00	0.68			96.5			49	
Unnamed	61-0189-00	0.2	0.2		159	227		522	364
Danielson Slough	61-0194-00	0.72			147			70	
McIver	61-0199-00	0.57			177			104	
Wicklund	61-0204-00	0.81			178			41	
Irgens	61-0211-00	0.46			203			91	
Unnamed	61-0274-00	0.53			123				
Unnamed	61-0287-00	1.5			24				
Page	75-0019-00		1.7			243			16.9
Long	75-0024-00	1.04	1.1		150			32	
Bjork	75-0034-00		1.5			56			22.6
Charlotte	75-0046-00		0.5			242			130

Water body Name	Lake ID (WID)	Summer Mean							
		Secchi meters			Phosphorus, µg/L			Chl-*a* µg/L	
		2000-2009	2010-2020		2000-2009	2010-2020		2000-2009	2010-2020
West Sunberg	76-0032-00	3.2			381				
Monson	76-0033-00	1.27	2.4		84.1	47.2		40	33.6
Frank	76-0034-00	1.37			18				
Hollerberg	76-0057-00	0.77			76.1			34	
Camp	76-0072-00	1.86	2.2		35.1	25		18	11.5
Hassel	76-0086-00	0.17	0.8		209	60.8		73	14.1
Frovold	76-0092-00	0.29			190				
Johnson	76-0094-00	0.14			169				
Hoffs Slough	76-0103-00		0.7			24			

Shakopee Lake BATHTUB Model Output – Modeled to Observed In-Lake Phosphorus



Segment mass balance: Baseline	Flow (hm3/yr)	Flow (cfs)	% Flow	TP load (kg/yr)	TP load (lb/yr)	% TP load	TP concentration (µg/L)
Precipitation	0.39	0.44	1%	70.06	154.45	1%	178
Specified (insert name; e.g., SSTS)	0.00	0.00	0%	0.00	0.00	0%	
Watershed Runoff	27.91	31.27	99%	9315.35	20536.82	99%	334
Point	0.00	0.00	0%	0.00	0.00	0%	
Internal (excess) or unknown				0.00	0.00	0%	
Total	28.31	31.71	100%	9385.41	20691.26	100%	332
Evaporation	0.39	0.44	1%	0	0.00	0%	0
Sedimentation/retention				2101.02	4631.95	22%	
Outflow	27.91	31.27	99%	7284.39	16059.31	78%	261
Segment mass balance: Scenario	**Flow (hm3/yr)**	**Flow (cfs)**	**% Flow**	**TP load (kg/yr)**	**TP load (lb/yr)**	**% TP load**	**TP concentration (µg/L)**
Precipitation	0.39	0.44	1%	70.06	154.45	2%	178
Specified (insert name; e.g., SSTS)	0.00	0.00	0%	0.00	0.00	0%	
Watershed Runoff	27.91	31.27	99%	2794.61	6161.05	98%	100
Point	0.00	0.00	0%	0.00	0.00	0%	
Internal (excess) or unknown				0.00	0.00	0%	
Total	28.31	31.71	100%	2864.66	6315.49	100%	101
Evaporation	0.39	0.44	1%	0	0.00	0%	0
Sedimentation/retention				410.97	906.04	14%	
Outflow	27.91	31.27	99%	2453.69	5409.45	86%	88
Load reductions					**TP load reduction (lb/yr)**	**% TP reduction**	
Precipitation					0.00	0%	
Specified (insert name; e.g., SSTS)					0.00		
Watershed Runoff					14375.77	70%	
Point					0.00		
Internal (excess) or unknown					0.00		
Total					14375.77	69%	