

April 2026

Watershed

# Draft Buffalo River and Upper Red River of the North Watershed Restoration and Protection Strategy Report Update, 2026



**m** MINNESOTA POLLUTION  
CONTROL AGENCY



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## Key terms and abbreviations

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1W1P	One Watershed, One Plan
AQL	Aquatic life designated use
AQR	Aquatic recreation designated use
BMP	best management practice
BRLY	barely impaired
BRRW CWMP	Buffalo-Red River Watershed Comprehensive Watershed Management Plan
BRRWD	Buffalo-Red River Watershed District
BRW	Buffalo River Watershed
BWSR	Board of Water and Soil Resources
chl- <i>a</i>	Chlorophyll- <i>a</i>
DNR	Minnesota Department of Natural Resources
DO	dissolved oxygen
DO Flux	diel dissolved oxygen flux
DWSMA	Drinking Water Supply Management Area
<i>E. coli</i>	<i>Escherichia coli</i>
EPA	United States Environmental Protection Agency
EXS	water body exceeds the applicable water quality standard
F	Fahrenheit
F-IBI	fish-based index of biological integrity
FS	water body fully supports the designated use
FWMC	flow weighted mean concentration
GRAPS	Groundwater Restoration and Protection Strategies

HUC	Hydrologic Unit Code
IBI	index of biological integrity
IC	assessment results are inconclusive
IF	insufficient data to complete an assessment determination
IWM	intensive watershed monitoring
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
mg/L	milligrams per liter
M-IBI	macroinvertebrate-based index of biological integrity
MPCA	Minnesota Pollution Control Agency
MPN/100mL	most probable number per 100 milliliters
MS4	Municipal Separate Storm Sewer System
MTS	assessed water body meets the applicable water quality standard
NA	not assessed
NRCS	Natural Resources Conservation Service
NRLY	nearly impaired
NS	water body does not support the designated use
SID	stressor identification
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
URRW	Upper Red River of the North Watershed
USGS	United States Geological Survey
VUL	vulnerable to future impairment
WID	water body identification
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	watershed restoration and protection strategy
µg/L	microgram per liter

# Executive summary

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The State of Minnesota has adopted a Watershed approach for managing water quality for each of the 80 major watersheds in the state. On a 10-year rotation, each major watershed undergoes intensive watershed monitoring (IWM) and assessment and has the opportunity for the development of a Watershed Restoration and Protection Strategy (WRAPS) project. The first cycle of this process for the Buffalo River Watershed (BRW) and Upper Red River of the North Watershed (URRW) began in 2008, with the initial WRAPS reports completed for the BRW and URRW in 2016 and 2017, respectively. The BRW and URRW were reevaluated and assessed for the second time in 2021 as part of the watershed approach process, leading to the development of this WRAPS Report Update. This WRAPS Report Update addresses the two watersheds in one report, instead of separately, and is an update to the original WRAPS reports mentioned above. Some of the goals of this WRAPS Report Update are to highlight watershed conditions and trends over time, to share updated assessment results, water quality resources, information, and tools, and to provide updated recommendations for prioritizing, targeting, and planning future water quality improvement efforts.

An overview of the evaluation process and assessment results for streams and lakes in these watersheds is provided in Section 3. Overall, the assessment results for water quality and biological conditions in the BRW and URRW are generally similar between the first round of assessments, completed in 2010 and 2011, and the second round of assessments completed in 2021. While three aquatic life (AQL) use impairments were removed from Minnesota’s 303(d) Impaired Waters List as a result of the 2021 assessments, approximately 17 new impairments were added to the 2022 version of the list. However, biological and water quality conditions are improving in some stream systems in the watersheds, warranting future monitoring efforts in the subwatersheds of these water bodies to track continued improvements and potentially pursue additional impairment delistings (Section 10). Some of these water bodies include the “upper” Buffalo River (Section 5.2), the Buffalo River, South Branch (Section 5.4 and Section 5.5), Wolverton Creek (Section 5.7), and Whiskey Creek (Section 5.8). Additional restoration efforts for some of these water bodies and more are either underway or are in development and in search of funding (Section 5 and Section 8).

Additional information regarding conditions in the BRW and URRW are provided in Section 4, including for impaired waters, additional evaluation of biologically impaired or vulnerable streams and lakes, prioritization considerations, water quality and stream flow trends, climate and weather trends, and priority issues, pollutants, and stressors. Section 5 of this report is broken down by planning regions (Figure 5), providing additional information on assessment results, large-scale restoration and protection efforts, suggested water quality goals, and additional notes for individual streams and lakes within each respective region. Maps of impaired waters, priority streams and lakes, and monitoring locations are also provided for each planning region. Following Section 5 are an overview of environmental justice areas in the BRW and URRW (Section 6), current and suggested goals (Section 7), previous restoration and protection efforts and future prioritization considerations (Section 8), and strategies and programs to achieve current and future goals (Section 9).

It is important to note that this WRAPS Report Update does not directly address the Red River of the North mainstem, which makes up the western border of the watersheds. A separate TMDL report for the mainstem was developed and public noticed concurrently with this report.

# 1. Watershed approach

Minnesota has adopted a watershed approach (MPCA 2025a) to address the state’s 80 major watersheds. The Minnesota watershed approach incorporates **water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results** into a 10-year cycle that addresses both restoration and protection.

Along with the watershed approach, the Minnesota Pollution Control Agency (MPCA) developed a process to identify and address threats to water quality in each of these major watersheds.

**Figure 1. Minnesota’s watershed approach.**



This process is called WRAPS development. The WRAPS reports have two parts: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired, and total maximum daily load (TMDL) studies are developed for them. The TMDLs are incorporated into the WRAPS reports. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and use watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, the WRAPS report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. The WRAPS report also serves as a building block for addressing the U.S. Environmental Protection Agency’s (EPA) Nine Minimum Elements of watershed plans, to help qualify applicants for eligibility for Clean Water Act Section 319 implementation funds.

Initial WRAPS and TMDL reports for the BRW and URRW were completed in 2016 and 2017, respectively, as part of the first cycle (Cycle 1) of the Watershed Approach process. Comprehensive water quality and biological monitoring was initially completed in the BRW in 2009 and 2010 and in the URRW in 2008 and 2009, with assessments of the collected data completed in 2011. Watershed Monitoring and Assessment Reports, Biotic Stressor Identification (SID) Reports, and the aforementioned WRAPS and TMDL reports were then completed for each watershed. These reports and information were then available for the development of the *Buffalo-Red River Comprehensive*

*Watershed Management Plan* (BRRW CWMP, HEI 2020) beginning in 2018 and completed in 2020 as part of the One Watershed, One Plan (1W1P) program.

The MPCA and partners returned to the BRW and URRW for Cycle 2 of the watershed approach with a second round of IWM in 2019 and 2020, with watershed assessments then completed in early 2021. The MPCA and partners then prepared a *Watershed Assessment and Trends Update Report*, a SID Update report for streams, a *Buffalo River Watershed Stressor Identification Report – Lakes*, a TMDL report, and this WRAPS Report Update. These reports and more information can be found on the MPCA’s respective webpages for the BRW and URRW (MPCA 2025b and MPCA 2025c).

The purpose of this WRAPS Update is to summarize the work done by MPCA and watershed partners in Cycle 2 of the watershed approach, compare water quality and biological data and results over time, assess changes and progress towards Cycle 1 goals, and update strategies that might be necessary to restore or protect water quality and biological communities within the watersheds.

## 2. Watershed description

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The BRW, eight-digit hydrologic unit code (HUC-8) 09020106, and the URRW, HUC-8 09020104, are located in west-central Minnesota, comprising a total of approximately 1,615 square miles of land located within the counties of Clay, Becker, Otter Tail, and Wilkin. The watersheds are located in the Red River of the North Basin, with the majority of the land within the Red River Valley (or Lake Agassiz Plain) ecoregion and portions of the watersheds located in the North Central Hardwood Forests and the Northern Lakes and Forests ecoregions. The entirety of the watersheds fall within the political boundaries of the Buffalo-Red River Watershed District (BRRWD; Figure 2). Land use in the watersheds is predominantly agricultural, especially in the western portions of the watersheds, while the eastern portion of the BRW features more forests, lakes, and wetlands (Figure 3). Municipalities in the watersheds include those located along the U.S. Highway 10 corridor, from east to west: Audubon, Lake Park, Hawley, Glyndon, Dilworth, and Moorhead, as well as Callaway, Barnesville, Georgetown, Sabin, Comstock, Wolverton, Rothsay, Kent, and Breckenridge.

While the URRW includes land in North Dakota on the west side of the Red River of the North, MPCA’s watershed approach and this WRAPS Update includes land and waters only on the Minnesota side of the watershed. Additionally, the Red River of the North mainstem, which makes up the western border of the watersheds, is not included in these efforts and instead is monitored, assessed, and reported on separately.

The BRW and URRW are located on the traditional tribal homelands of the Anishinaabe and Dakota, while a small headwater portion of the “upper” Buffalo River Subwatershed is located within the White Earth Reservation (Figure 2). While water quality and biological data from this area are included in watershed assessments and this WRAPS Report Update, impaired waters located wholly within reservation boundaries are not included on Minnesota’s 303(d) Impaired Waters List and MPCA does not complete TMDLs for the impaired waters located within tribal boundaries.

Land use and surface waters in the BRW and URRW play an important role for the domestic water sources to the cities of Moorhead, Minnesota, Fargo, North Dakota, and others downstream. The domestic water supply for Moorhead is extracted from the Red River of the North and blended with water from the Moorhead and Buffalo Aquifers, the latter of which is identified as highly vulnerable to

contamination (MDH 2025). Fargo, meanwhile, gets its domestic water exclusively from the Red River of the North. Concerns for these drinking water sources include the transport of sediment, nutrients, and other pollutants into the Red River of the North upstream of the surface water intakes, as well as groundwater contamination through leaching. Additional concerns for the suppliers include increasing trends in noncarbonate hardness within the Red River of the North, potentially from ditching and altered hydrology within the URRW and other upstream watersheds in the Red River Basin, as well as the potential for an increased frequency and magnitude of harmful algal blooms (MDH 2023). Additional information regarding drinking water is provided in Section 5.6 and in *the Buffalo Red River Watershed (BRRW) Groundwater Restoration and Protection Strategies (GRAPS) Report* (MDH 2019).

**Figure 2. The BRW and the URRW.**

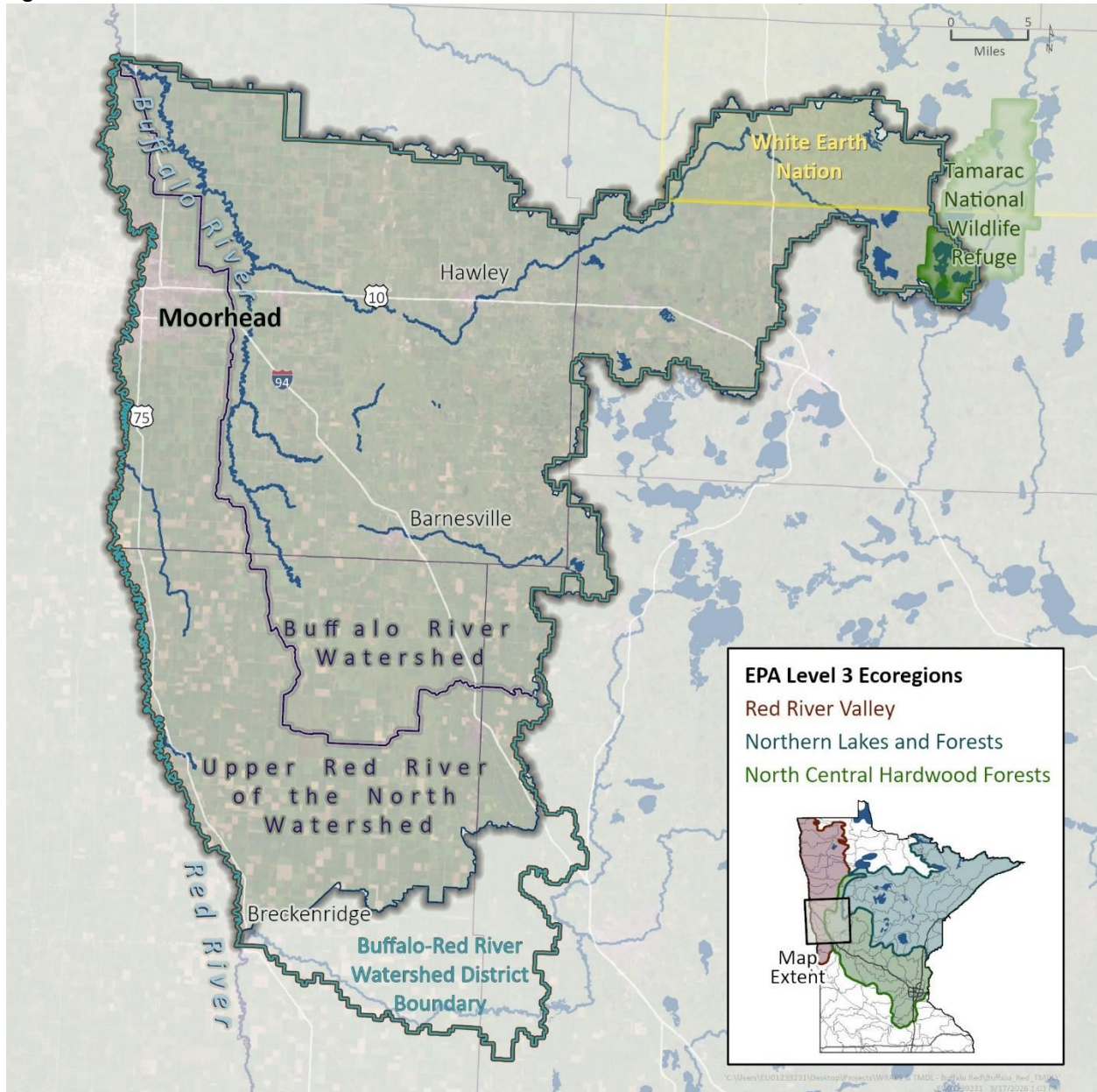
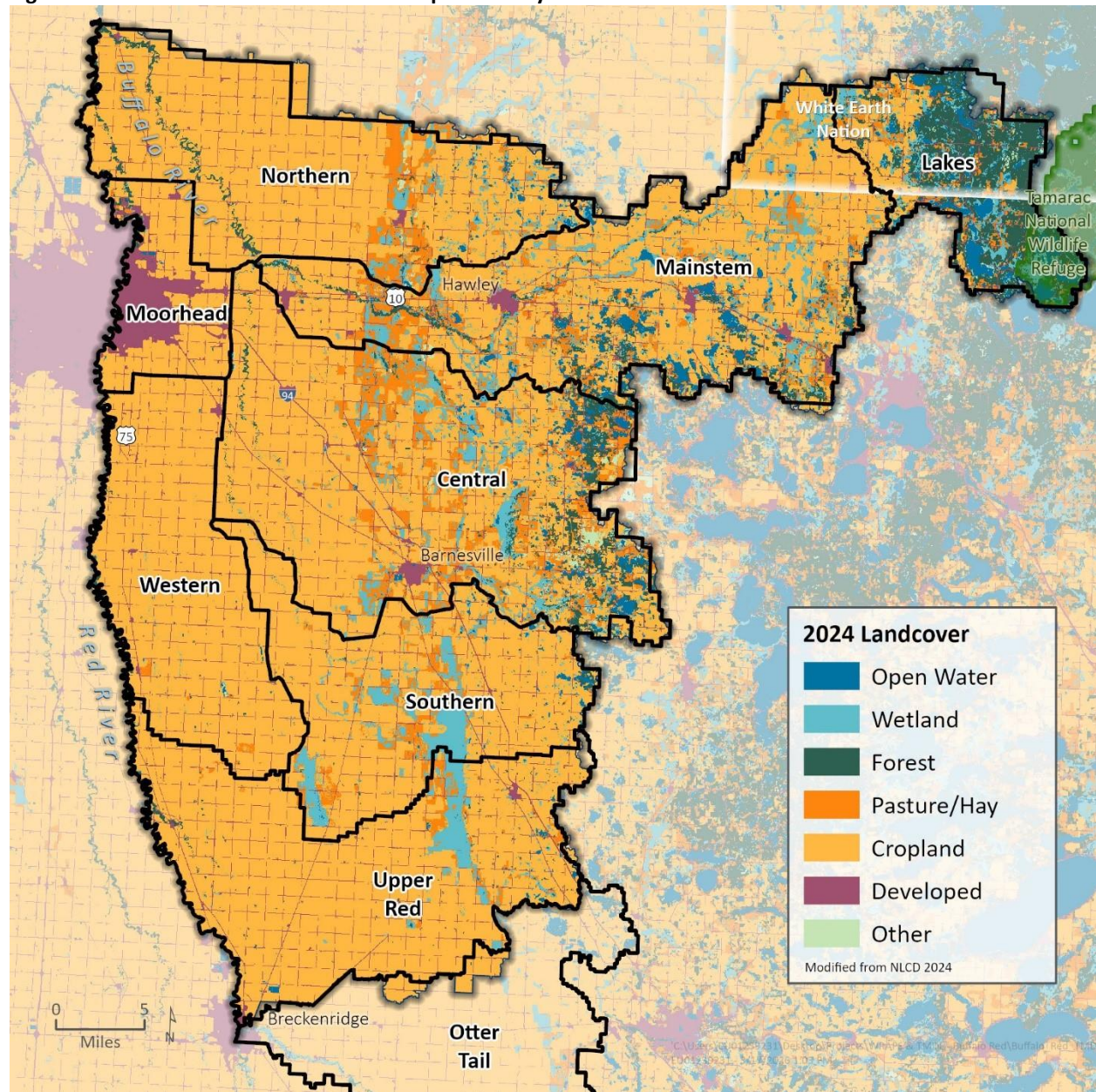
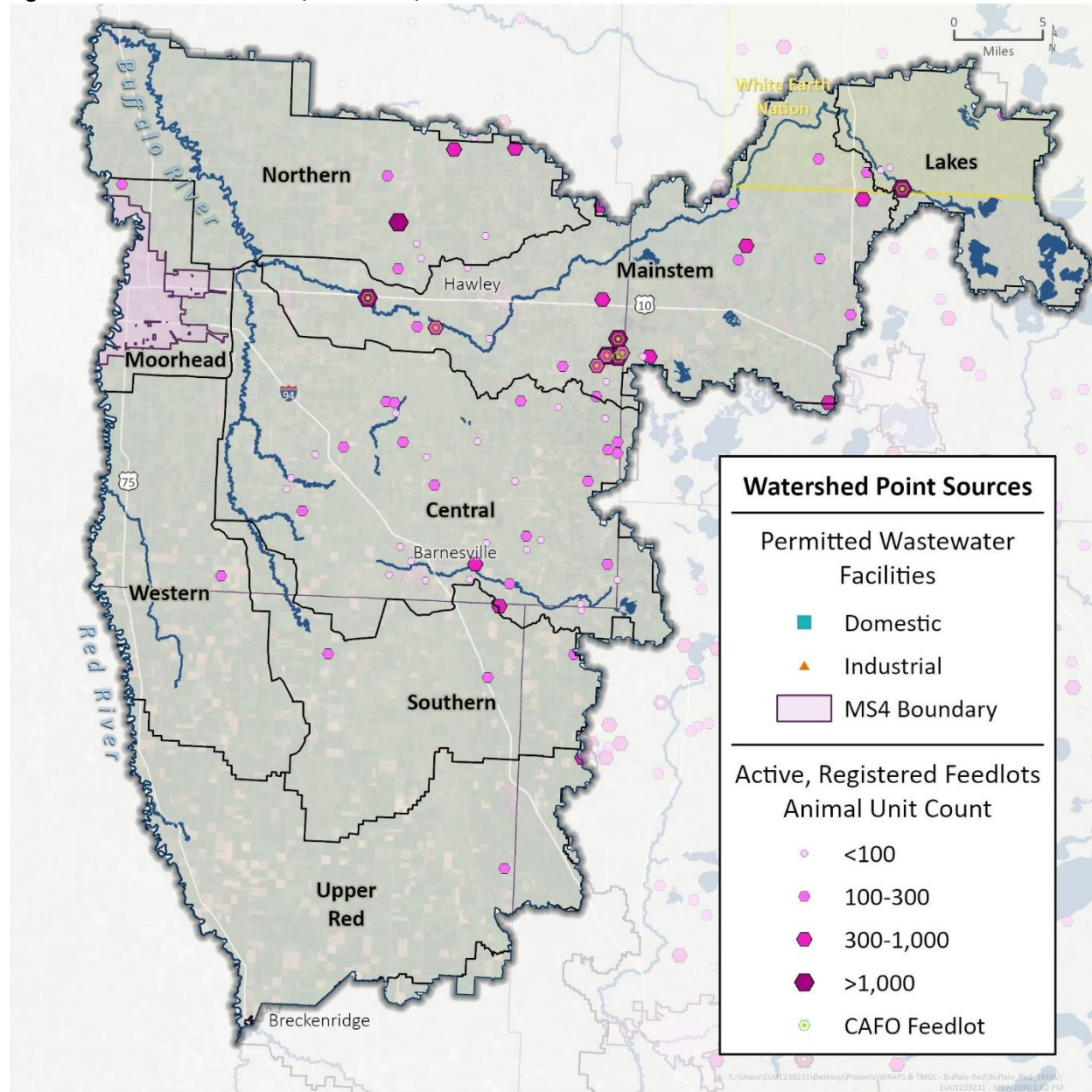


Figure 3. Land cover in the BRW and URRW provided by NLCD 2024.



As of 2024, the BRW and URRW featured approximately 200 registered animal feedlots, including 9 concentrated animal feeding operations. The watersheds also contain at least 14 municipal or domestic wastewater treatment facilities that discharge to surface waters and several permitted industrial wastewater or stormwater facilities. Municipal Separate Storm Sewer System (MS4) permitted communities are located within the cities of Moorhead and Glyndon (Figure 4). This WRAPS Report Update does not directly address each of these potential pollutant sources. Instead, information for these items can be found in other various reports, models, tools, and applications, including the *Buffalo River Watershed Total Maximum Daily Load* (MPCA 2016a), the *Upper Red River of the North Watershed Total Maximum Daily Load Report* (MPCA 2017a), and the *Buffalo River and Upper Red River of the North Watersheds Total Maximum Daily Load Report* (MPCA 2025h), the last of those being developed concurrently with this report.

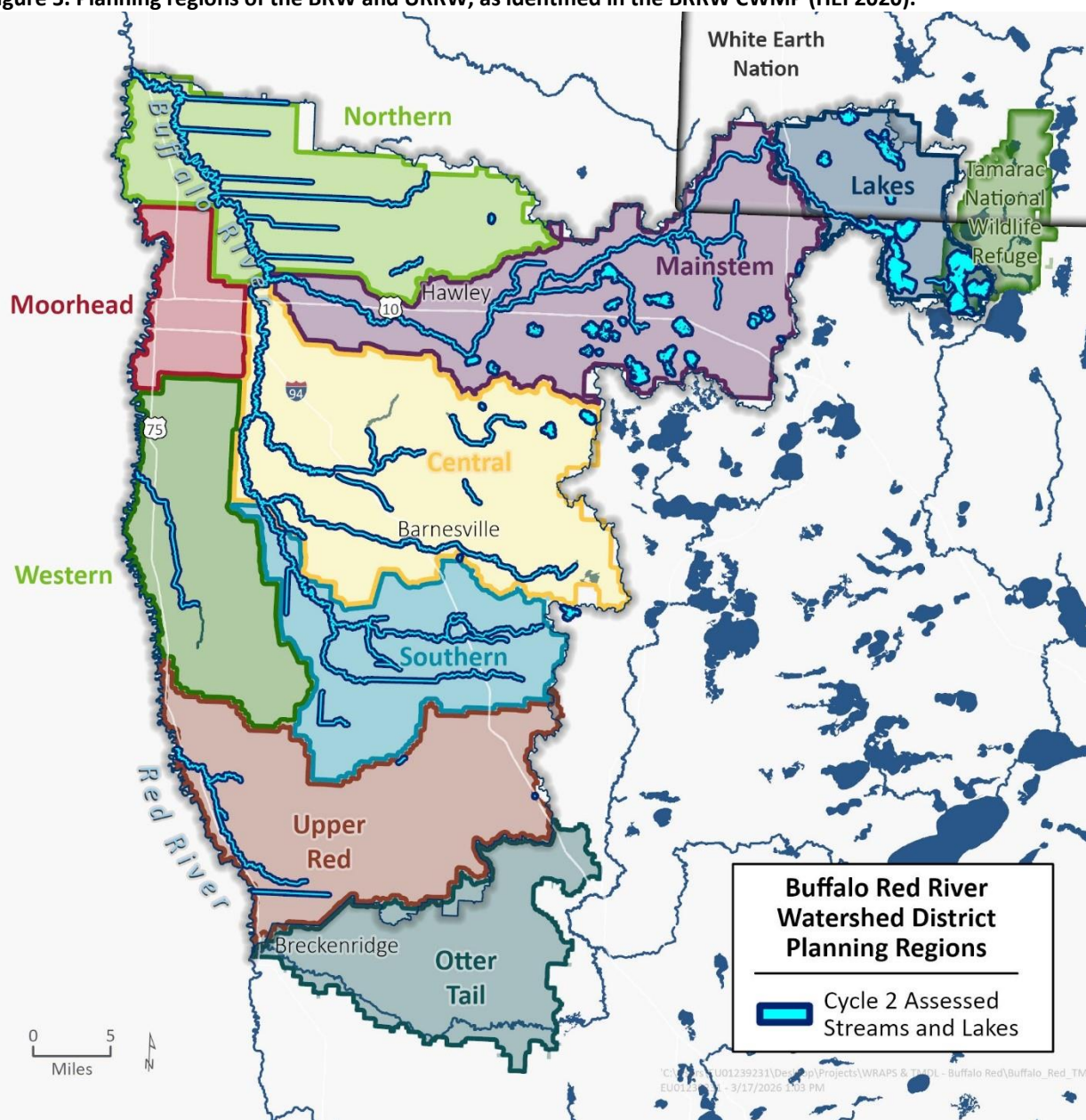
Figure 4. Wastewater facilities, MS4 areas, and feedlots within the BRW and URRW.



For the purposes of local water resource planning, the BRW and URRW are divided into planning regions that are based on physical similarities in ecoregions, hydrology, and land use (Figure 5). The planning regions account for regional variation within the watersheds and allow for watershed partners to work together on prioritizing and managing water resources within those planning regions at a more refined scale. This WRAPS Update is organized in part by the planning regions to aid future planning efforts including future updates to the BRRW CWMP.

For more information on the planning regions and on the land cover and other physical characteristics of the BRW and URRW, refer to Section 1 and Appendix A of the BRRW CWMP (HEI 2020), or to the original WRAPS, TMDL, SID, and Watershed Monitoring and Assessment Reports found on the MPCA’s BRW and URRW webpages (MPCA 2025b and MPCA 2025c).

Figure 5. Planning regions of the BRW and URRW, as identified in the BRRW CWMP (HEI 2020).



*\*Note: while the Otter Tail planning region is within the political boundary of the BRRWD, it is not within the BRW or URRW and instead is the most downstream portion of the Otter Tail River Watershed.*

### 3. Assessing water quality

This section summarizes the findings of the efforts that were undertaken by state and federal agencies, local government units, and other watershed partners to monitor, assess, and understand the biological and water quality conditions of the BRW and URRW. The goal is to provide a high-level overview of the efforts and results; more detailed information is provided in other reports and documents.

#### 3.1 Assessment overview

Water quality and biological monitoring are essential to determining whether lakes and streams meet applicable water quality standards designed to ensure that waters are fishable and swimmable. While

state and federal agencies and local government units monitor some water bodies on an ongoing basis, the MPCA conducts an intensive exam of select lakes and streams in each of the state's 80 major watersheds every 10 years to detect any changes in water quality. This IWM process looks at fish and macroinvertebrate communities as well as water chemistry to gauge water quality in those lakes and streams. Watershed partners then use the data to see which waters are healthy and can be prioritized for protection and which are impaired and need restoration. Additional information regarding water quality and monitoring can be found on the [MPCA water quality webpage](#) (MPCA 2025d).

After monitoring, assessments are made for individual water bodies to evaluate if they support the AQL and/or Aquatic Recreation (AQR) designated uses. The water body unit used for individual stream reaches and lakes is referred to as a water body identification (WID). Waters assessed as not supporting their designated uses are listed as "impaired" and should be considered for restoration efforts. Waters that are assessed as fully supporting their designated uses can be considered for protection efforts. The assessment process combines data analysis, expert review, and internal and external partner input, and ensures that all available data and information are used to make appropriate assessment decisions, depending on which unique beneficial uses are considered. Detailed information about the assessment process is provided in MPCA's *Guidance Manual for Assessing the Quality of Minnesota's Surface Waters* (MPCA 2024).

Cycle 1 IWM was completed in the BRW and URRW in 2008 through 2010, with watershed assessments for evaluating data from 2001 through 2010 completed in early 2011. Cycle 2 IWM was then completed in the watersheds in 2019 and 2020 with assessments of available data from 2011 through 2020 completed in early 2021. Additional data collection was conducted by MPCA in 2022 and 2023, as well as by other agencies and watershed partners since 2021. Summaries of the assessment results for the BRW and URRW are provided in the following sections, while some of the additional data collected in the watersheds since 2021 are provided in Section 5. Monitoring locations are also mapped by planning region in Section 5. All publicly available water quality data for each water body can be accessed by searching for the WID unit or navigating the map on [MPCA's surface water data webtool](#) (MPCA 2025e). A summary of water quality assessment results and additional information for assessed water bodies in the BRW and URRW can be found at [MPCA's Water Quality Assessment Results Data Viewer](#) (MPCA 2025f). Additional information can be found in the reports and documents referenced in this WRAPS Update or available at the MPCA's BRW and URRW Watershed webpages (MPCA 2025b, MPCA 2025c).

## 3.2 Streams

Cycle 2 assessment results for streams and rivers in the BRW and URRW are provided below in Table 1. Provided in the table for each stream reach is a result for each assessed parameter (i.e., total suspended solids [TSS], total phosphorus [TP], etc.), showing if the stream reach is found to meet ("MTS") or exceed/fail to meet ("EXS") the applicable water quality standards. An overall assessment result is also provided for both the AQL and AQR designated uses. Water bodies found to meet standards for all assessed parameters are fully supporting ("FS") the AQL and/or AQR designated uses while water bodies found to exceed or fail to meet any of the applicable standards are not supporting ("NS") and, therefore, are impaired. Assessment results may also be insufficient ("IF"), meaning not enough data were available to make an assessment finding, inconclusive ("IC"), meaning assessed data were ambiguous or not convincing either way, or not assessed ("NA"), meaning there were no or very little data available for assessments.

Overall, assessment results for streams and rivers in the BRW and URRW are comparable between Cycle 1 and Cycle 2. While biological and water quality conditions may have improved or declined in individual stream reaches between 2008 and 2020, the overall health of fish and macroinvertebrate communities across both watersheds showed little change between cycles. Individual tests were conducted in the BRW and URRW at 25 sites for macroinvertebrates and 28 sites for fish. The average macroinvertebrate-based index of biological integrity (M-IBI) score watershed-wide increased by 4.4 points between cycles, with 17 of the 25 sites showing slight improvements. However, the increased scores are not considered to be a statistically significant change. Meanwhile, the average fish-based index of biological integrity (F-IBI) score watershed-wide increased by 2.1 points between cycles, with scores at 16 of 28 sites showing minor declines. Again, these changes were not considered to be statistically significant (MPCA 2022). Additionally, although more stream reaches in the watersheds were assessed for AQL in Cycle 2 than in Cycle 1 and fewer were assessed for AQR, the overall proportion of assessed stream reaches found to be NS and impaired remained relatively similar between cycles (Figure 6).

While two macroinvertebrate bioassessment impairments and one turbidity impairment in the watersheds were removed from the 2022 impaired waters list as a result of the 2021 assessments, many new impairments were added to the 2020 and 2022 versions of the list. In the BRW, three new AQR use impairments were added to the 2022 list as a result of the 2021 assessments due to elevated levels of *Escherichia coli* (*E. coli*) bacteria. New AQL use impairments in the BRW added to the 2022 list include four due to low dissolved oxygen (DO), one for high TSS, and six new fish or macroinvertebrate bioassessment impairments. Additionally, a special assessment conducted in 2018 of deferred data from Cycle 1 resulted in 1 TSS impairment and 23 additional fish or macroinvertebrate impairments being added to the 2020 list for the BRW. In the URRW, new AQL impairments include one fish bioassessment impairment added in 2022 and an additional three previously deferred impairments that were added in 2020 due to low DO, high TSS, and fish bioassessments in two segments of Wolverton Creek, while two new fish and macroinvertebrate impairments were added in 2022 and two more in 2020 for three different unnamed streams (MPCA 2022). Additionally, two stream reaches in the BRW that were found to be supporting fish and macroinvertebrates were identified as vulnerable to future impairment (VUL) for those communities and those stream reaches are identified for additional protection considerations. Additional information for the bioassessment impairments is provided below in Section 4.2 while more specific details for individual assessed stream reaches are provided by planning region in Section 5.

Table 1. Cycle 2 assessment results for streams (2011-2020).

Planning region	WID	Water body name	Aquatic life													Aquatic recreation	
			Overall AQL assessment	Fish index of biological integrity (F-IBI)	Macroinvertebrate index of biological integrity (M-IBI)	Total suspended solids (TSS)	Transparency tube	Dissolved oxygen (DO)	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	pH	Diel dissolved oxygen flux (DO flux)	Ammonia nitrogen	Chloride	Overall AQR assessment	<i>Escherichia coli</i> ( <i>E. coli</i> )	
Northern	09020106-501	Buffalo River	NS	MTS	MTS	EXS	EXS	MTS	EXS	MTS	MTS	IF	MTS	MTS	NS	EXS	
	09020106-538	County Ditch 65	NS*	EXS*	EXS*	IF	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020106-556	County Ditch 2	NS	NA	EXS	IF	IF	IF	IF	IF	NA	IF	NA	IF	NA	NA	NA
	09020106-563	County Ditch 5 (County Ditch 8)	NS	EXS	EXS	IF	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020106-615	County Ditch 3	NS*	EXS*	EXS*	IF	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020106-617	County Ditch 39	NS	EXS	EXS	IF	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020106-619	County Ditch 10	NS	MTS	EXS	MTS	IC	EXS	EXS	IF	EXS	EXS	IF	IF	IF	IF	IF
	09020106-624	Unnamed creek	NS**	EXS**	EXS**	IF	NA	IC	IF	IF	NA	MTS	NA	NA	NA	NA	NA
Mainstem	09020106-513	Hay Creek	FS	MTS	MTS	MTS	MTS	IC	EXS	IC	MTS	NA	MTS	MTS	NS	EXS	
	09020106-518	Unnamed stream (Becker Co Ditch 15 Br 7)	NS	MTS	EXS	IF	IF	NA	IF	NA	IF	NA	IF	NA	NA	NA	NA
	09020106-576	Unnamed creek	NS	EXS	NA	IF	IF	IF	IF	NA	IF	NA	IF	NA	NA	NA	NA
	09020106-577	Unnamed ditch (Becker County Ditch 15)***	IF	NA	NA	IF	MTS	NA	IF	IF	NA	NA	NA	NA	IF	IF	IF
	09020106-578	Unnamed ditch (Becker Co Ditch 15 Branch 4)	NS**	MTS**	EXS**	IF	NA	IF	IF	IF	NA	IF	NA	NA	NA	NA	NA
	09020106-580	Unnamed creek (Becker County Ditch 9)	NS**	EXS**	EXS**	IF	NA	IF	IF	IF	NA	IF	NA	NA	NA	NA	NA
	09020106-581	County Ditch 16	NS**	EXS**	MTS**	IF	NA	IF	IF	IF	NA	IF	NA	NA	NA	NA	NA

Planning region	WID	Water body name	Aquatic life												Aquatic recreation	
			Overall AQL assessment	Fish index of biological integrity (F-IBI)	Macroinvertebrate index of biological integrity (M-IBI)	Total suspended solids (TSS)	Transparency tube	Dissolved oxygen (DO)	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	pH	Diel dissolved oxygen flux (DO flux)	Ammonia nitrogen	Chloride	Overall AQR assessment	<i>Escherichia coli</i> ( <i>E. coli</i> )
Mainstem	09020106-593	Buffalo River***	NS	EXS	MTS	EXS	EXS	IF	MTS	IF	MTS	NA	MTS	MTS	NS	EXS
	09020106-594	Buffalo River	NS	MTS	MTS	EXS	EXS	MTS	IC	MTS	MTS	NA	MTS	MTS	NS	EXS
	09020106-595	Buffalo River	NS	MTS	MTS	EXS	EXS	MTS	EXS	NA	MTS	NA	MTS	MTS	NS	EXS
	09020106-606	Unnamed ditch (Becker County Ditch 15)	IF	NA	NA	IF	MTS	NA	IF	IF	NA	NA	NA	NA	IF	IF
	09020106-607	Unnamed ditch (Becker County Ditch 15)	FS	MTS-VUL	MTS-VUL	EXS	IC	IF	IC	MTS	MTS	NA	IF	IF	NS	EXS
	09020106-621	Hay Creek	NS**	EXS**	NA	IF	NA	IF	IF	IF	NA	MTS	NA	NA	NA	NA
	09020106-622	Hay Creek	NS	NA	NA	EXS	EXS	IF	EXS	IF	MTS	NA	MTS	NA	NS	EXS
Central	09020106-502	Stony Creek	NS	MTS	MTS	EXS	EXS	EXS	EXS	NA	MTS	NA	MTS	MTS	NS	EXS
	09020106-503	Buffalo River, South Branch	NS	NA	MTS	IC	IC	EXS	EXS	NA	IF	NA	MTS	MTS	NS	EXS
	09020106-504	Buffalo River, South Branch	NS	NA	NA	EXS	EXS	IF	EXS	NA	MTS	NA	MTS	MTS	NS	EXS
	09020106-509	Whisky Creek	NS*	EXS*	EXS*	EXS	EXS	EXS	EXS	MTS	MTS	IF	MTS	MTS	NS	EXS
	09020106-510	Stony Creek	NS**	MTS**	EXS**	IF	NA	IF	IF	IF	NA	MTS	NA	NA	NA	NA
	09020106-534	Spring Creek	IF	NA	NA	NA	NA	IF	NA	NA	IF	NA	NA	NA	NA	NA
	09020106-585	Unnamed creek	IC	NA	NA	MTS	MTS	EXS	EXS	NA	MTS	NA	MTS	IF	NS	EXS
	09020106-589	Hay Creek	FS	NA	MTS	IF	NA	NA	IF	NA	NA	NA	NA	NA	NA	NA
	09020106-609	Hay Creek	NS**	EXS**	EXS**	MTS	IF	IF	EXS	IF	IF	MTS	IF	IF	NS	EXS
	09020106-610	Whisky Creek	FS	MTS	MTS-VUL	MTS	MTS	IF	MTS	MTS	MTS	NA	MTS	MTS	NS	EXS

Planning region	WID	Water body name	Aquatic life												Aquatic recreation	
			Overall AQL assessment	Fish index of biological integrity (F-IBI)	Macroinvertebrate index of biological integrity (M-IBI)	Total suspended solids (TSS)	Transparency tube	Dissolved oxygen (DO)	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	pH	Diel dissolved oxygen flux (DO flux)	Ammonia nitrogen	Chloride	Overall AQR assessment	<i>Escherichia coli</i> ( <i>E. coli</i> )
Central	09020106-611	Whisky Creek (Clay County Ditch 34)	IF	NA	NA	NA	NA	IF	NA	NA	IF	NA	NA	NA	NA	NA
	09020106-613	Stony Creek (Clay County Ditch 31)	NS	EXS	MTS	IF	IF	IF	IF	NA	IF	NA	IF	IF	IF	IF
	09020106-630	Hay Creek (Clay Co Ditch 17)	FS	MTS	MTS	IF	IF	IF	IF	NA	IF	NA	IF	NA	IF	NA
Southern	09020106-505	Buffalo River, South Branch	NS	MTS	EXS	MTS	IC	EXS	IC	NA	MTS	NA	MTS	MTS	NS	EXS
	09020106-507	Deerhorn Creek	NS	EXS	EXS	MTS	IC	IF	MTS	NA	MTS	NA	MTS	MTS	NS	EXS
	09020106-530	Wilkin Co. Ditch 40 (Lawndale Cr)	NS*	EXS*	IF**	EXS	IF**	IF	IF	IF	IF	NA	NA	NA	NA	NA
	09020106-531	State Ditch 14 (Lawndale Cr)	IC	IC	IC	IF	IF	IF	IF	NA	IF	NA	IF	IF	IF	IF
	09020106-535	State Ditch 15	IF	NA	NA	MTS	MTS	EXS	EXS	NA	MTS	NA	MTS	MTS	IF	IF
	09020106-544	Unnamed creek (Wilkin County Ditch 13)	NS	MTS	EXS	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020106-603	Buffalo River, South Branch	NS	NA	NA	MTS	IF	EXS	EXS	NA	MTS	NA	MTS	MTS	FS	MTS
	09020106-604	Buffalo River, South Branch (Wilkin Co Ditch 44 Lateral A)	IF	NA	NA	MTS	MTS	IF	MTS	NA	MTS	NA	MTS	MTS	IF	IF
	09020106-605	Buffalo River, South Branch	NS	EXS**	EXS	MTS	MTS	EXS	IC	IF	MTS	IF	MTS	MTS	NS	EXS

Planning region	WID	Water body name	Aquatic life												Aquatic recreation	
			Overall AQL assessment	Fish index of biological integrity (F-IBI)	Macroinvertebrate index of biological integrity (M-IBI)	Total suspended solids (TSS)	Transparency tube	Dissolved oxygen (DO)	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	pH	Diel dissolved oxygen flux (DO flux)	Ammonia nitrogen	Chloride	Overall AQR assessment	<i>Escherichia coli</i> ( <i>E. coli</i> )
Western	09020104-549	Wolverton Creek	NS*	EXS	MTS	IF	IF	EXS**	IF	NA	IF	NA	IF	NA	NS**	EXS**
	09020104-550	Wolverton Creek	NS*	EXS*	MTS	EXS*	EXS*	IF	EXS*	MTS	MTS*	MTS*	MTS*	MTS*	NS*	EXS*
Upper Red	09020104-516	Unnamed creek	NS*	EXS*	EXS	IF	IF	IF	IF	IF	IF	IF	IF	NA	NA	NA
	09020104-520	Whiskey Creek	NS	MTS	MTS	EXS	IC	EXS	EXS	MTS	MTS	IF	MTS	MTS	NS	EXS
	09020104-523	Unnamed ditch (County Ditch 6A)	FS	MTS	MTS	IF	IF	NA	IF	NA	IF	NA	IF	NA	NA	NA
	09020104-533	Unnamed creek	NS	EXS	MTS	IF	IF	NA	IF	NA	IF	NA	IF	NA	NA	NA
	09020104-537	Wilkin County Ditch 31	NS*	EXS*	MTS	MTS	MTS	IC	EXS	IF	MTS	IF	MTS	MTS	IC	IC

FS (fully supporting): all assessed parameters meet the applicable water quality standards.

MTS: the collected data meet the applicable water quality standard.

NS (not supporting): at least one or more parameter exceeds or fails to meet the applicable water quality standard and the WID is therefore impaired.

EXS: the collected data exceeds or fails to meet the applicable water quality standard(s).

VUL: the biological community is vulnerable to future impairment.

IF: the collected data were insufficient to make an assessment.

IC: the collected data were inconclusive.

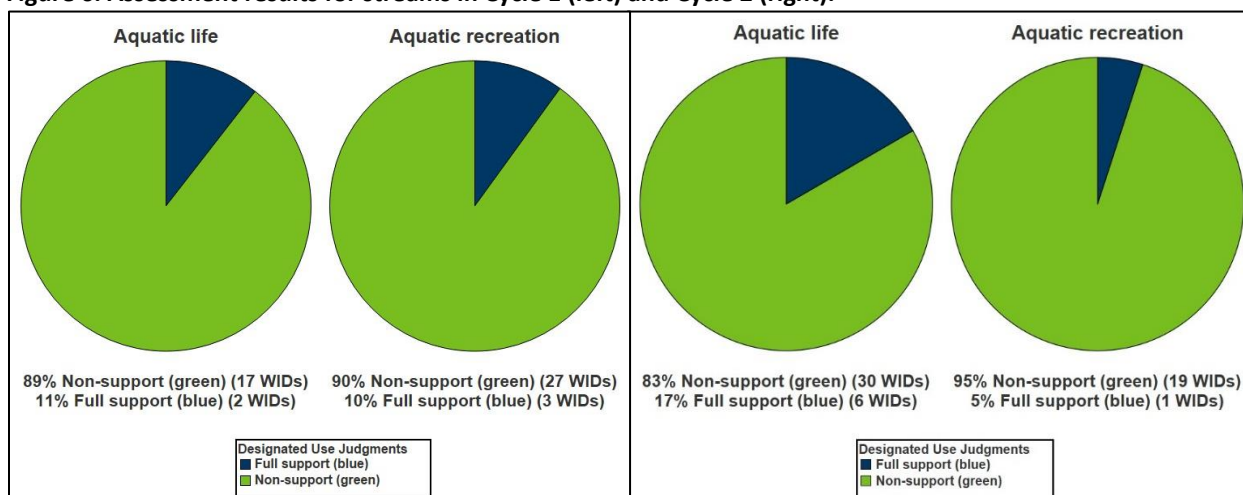
NA: Not assessed (no data).

\*2018 assessment of Cycle 1 data for 2020 impaired waters list, assessed again and confirmed in 2021 for Cycle 2.

\*\*2018 assessment of Cycle 1 data for 2020 impaired waters list, not assessed again in 2021 for Cycle 2.

\*\*\*Stream WID is partially within the White Earth Reservation boundary and crosses both the Lakes and Mainstem planning regions.

**Figure 6. Assessment results for streams in Cycle 1 (left) and Cycle 2 (right).**



### 3.3 Lakes

Cycle 2 assessment results for lakes in the BRW are provided below in Table 2. There were no lakes assessed during Cycle 2 in the URRW. Provided in the table for each lake is an overall assessment result for the AQR and AQL designated uses as well as a result for each assessed parameter (i.e., TP, F-IBI). Once again, results indicate if each lake is found to meet (“MTS”) or exceed/fail to meet (“EXS”) the applicable water quality standards for each assessed parameter, and lakes found to meet standards for all assessed parameters are fully supporting (“FS”) the AQR and/or AQL designated uses while lakes found to exceed or fail to meet any of the applicable standards are not supporting (“NS”) and, therefore, are impaired. Assessment results may also be insufficient (“IF”), meaning not enough data were available to make an assessment finding, inconclusive (“IC”), meaning assessed data were ambiguous or not convincing either way, or not assessed (“NA”), meaning there were no or very little data available for assessments.

Many fewer lakes were fully assessed for AQR during Cycle 2 than in Cycle 1. Due to the COVID-19 pandemic, many of the evaluated lakes were not sampled during the second year of IWM (2020) and as such, those lakes did not have a minimum of two years of data and are assessed as IF. Nonetheless, the overall proportion of lakes assessed as fully supporting versus those assessed as not supporting and impaired was very similar between Cycle 1 and Cycle 2 (Figure 7). No new AQR use impairments were added to the 2022 impaired waters list as a result of Cycle 2 assessments, while North Tamarac and Boyer Lakes were found to be “barely impaired,” and Sand Lake was found to be “nearly impaired.” These lakes should be considered for implementation efforts to attempt to restore the barely impaired lakes or protect Sand Lake from future impairment.

New for lakes in Cycle 2 are assessment results for the F-IBI AQL designated use. No lakes were assessed for F-IBI during Cycle 1 as the F-IBI evaluation process was not yet established. Chloride concentrations in certain lakes were also evaluated. Overall, 13 lakes were found to be fully supporting the AQL designated use based on F-IBI, with 2 of those found to be VUL. No new AQL use impairments were identified.

Additional information for individual lakes is provided by planning region in Section 5.

Table 2. Cycle 2 assessment results for lakes (2011-2020).

Planning region	WID	Water body name	Aquatic recreation				Aquatic life		
			Overall AQR assessment	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	Secchi depth	Overall AQL assessment	Fish index of biological integrity (F-IBI)	Chloride
Northern	14-0103-00	Cromwell	IF	IF	IF	IF	IF	NA	IF
	03-0393-00	Unnamed	IF	IF	IF	IF	IF	NA	IF
Mainstem	03-0414-00	Gandrud	IF	IF	IF	IF	IF	NA	IF
	03-0507-00	Unnamed	IF	IF	NA	NA	NA	NA	NA
	03-0508-00	Unnamed	IF	IF	NA	NA	NA	NA	NA
	03-0509-00	Unnamed	IF	IF	NA	NA	NA	NA	NA
	03-0510-00	Homestead	IF	IF	IF	IF	NA	NA	NA
	03-0526-00	Marshall	NS	EXS	EXS	EXS	FS	MTS	NA
	03-0579-00	Boyer	IC-BRLY	EXS	IF	MTS	FS	MTS	NA
	03-0618-00	Sand	IF-NRLY	IF	IF	IF	NA	NA	NA
	03-0619-00	Talac	NS	EXS	EXS	MTS	NA	NA	NA
	03-0621-00	Lund Brothers Marsh	IF	IF	IF	IF	NA	NA	NA
	03-0624-00	Forget-Me-Not	IF	IF	IF	NA	NA	NA	NA
	03-0625-00	Sorenson	NS	EXS	EXS	IC	NA	NA	NA
	03-0627-00	Unnamed	IF	IF	IF	IF	IF	NA	IF
	03-0631-00	Stakke	NS	EXS	EXS	MTS	NA	NA	NA
	03-0634-00	Orange	IF	IF	IF	NA	NA	NA	NA
	03-0645-00	West LaBelle	IF	IF	IF	NA	NA	NA	NA
	03-0646-00	Lime	NS	EXS	EXS	EXS	NA	NA	NA
	03-0647-00	Stinking	NS	EXS	EXS	IF	NA	NA	NA
	03-0648-00	East LaBelle	IF	IF	IF	NA	FS	MTS	NA
	03-0659-00	Sand	IF	IF	IF	IF	FS	MTS	NA
	03-0660-01	Axberg(Main Basin)	IF	IF	IF	IF	NA	NA	NA
	03-0660-02	Axberg(West Basin)	NA	IF	IF	IF	NA	NA	NA
	03-0924-00	Unnamed	IF	IF	NA	NA	NA	NA	NA
	03-1281-00	Hesby	NA	IF	IF	IF	NA	NA	NA
	14-0049-00	Lee	IF	IF	IF	IF	FS	MTS-VUL	MTS
	14-0089-00	Doran	IF	IF	IF	IF	NA	NA	NA
	14-0100-00	Silver	IF	IF	IF	IF	FS	MTS-VUL	IF
	14-0214-00	Chicken Drop Marsh	NA	IF	IF	IF	NA	NA	NA
	14-0302-00	Pine	FS	MTS	MTS	MTS	NA	NA	NA

Planning region	WID	Water body name	Aquatic recreation				Aquatic life		
			Overall AQR assessment	Total phosphorus (TP)	Chlorophyll- <i>a</i> (Chl- <i>a</i> )	Secchi depth	Overall AQL assessment	Fish index of biological integrity (F-IBI)	Chloride
Planning region	03-0203-00	Mud	IF	IF	IF	IF	NA	NA	NA
	03-0241-01	South Tamarack	FS	MTS	MTS	IC	NA	NA	NA
	03-0241-02	North Tamarack	NS-BRLY	EXS	EXS	EXS	FS	MTS	NA
	03-0291-00	Rice	IF	NA	NA	MTS	NA	NA	NA
	03-0293-00	Rock	FS	MTS	MTS	MTS	FS	MTS	IF
	03-0302-00	Little Round*	IF	IF	NA	IF	IF	NA	IF
	03-0303-00	Bear**	IF	IF	IF	IF	IF	NA	IF
	03-0304-00	Big Sugar Bush**	FS	MTS	MTS	MTS	FS	MTS	NA
	03-0313-00	Little Sugar Bush**	IF	IF	IF	IF	FS	MTS	NA
	03-0350-00	Buffalo*	NA	NA	NA	NA	FS	MTS	NA
	03-0428-00	O-Me-Mee**	IF	IF	IF	NA	NA	NA	NA
	03-0471-00	Mission**	IF	IF	IF	NA	NA	NA	NA
	Central	03-0657-00	Turtle	FS	MTS	MTS	MTS	FS	MTS
14-0030-00		Fifteen	NA	NA	NA	NA	FS	MTS	NA
14-0093-00		Barnesville	FS	MTS	MTS	NA	IF	NA	MTS
Southern	14-0389-00	Unnamed	IF	IF	IF	IF	IF	NA	IF
	56-0950-01	West Olaf***	FS	MTS	MTS	MTS	IF	NA	IF

FS (fully supporting): all assessed parameters meet the applicable water quality standards.

MTS: the collected data meet the applicable water quality standard.

EXS: the collected data exceeds or fails to meet the applicable water quality standard(s).

VUL: the biological community is vulnerable to future impairment.

BRLY: the lake narrowly exceeds the applicable water quality standards and is "barely" impaired.

NRLY: the lake is close to exceeding the applicable water quality standards and is "nearly" impaired.

IF: the collected data were insufficient to make an assessment.

IC: the collected data were inconclusive.

NA: Not assessed (no data).

\*Lake is partially within the White Earth Reservation boundary.

\*\*Lake is wholly within the White Earth Reservation boundary.

\*\*\*West Olaf Lake (56-0950-01) and some neighboring lakes are technically located within the Otter Tail River Watershed, HUC-8 09020103. See Section 5.5 for additional information.

Figure 7. Assessment results for lakes in Cycle 1 (left) and Cycle 2 (right).

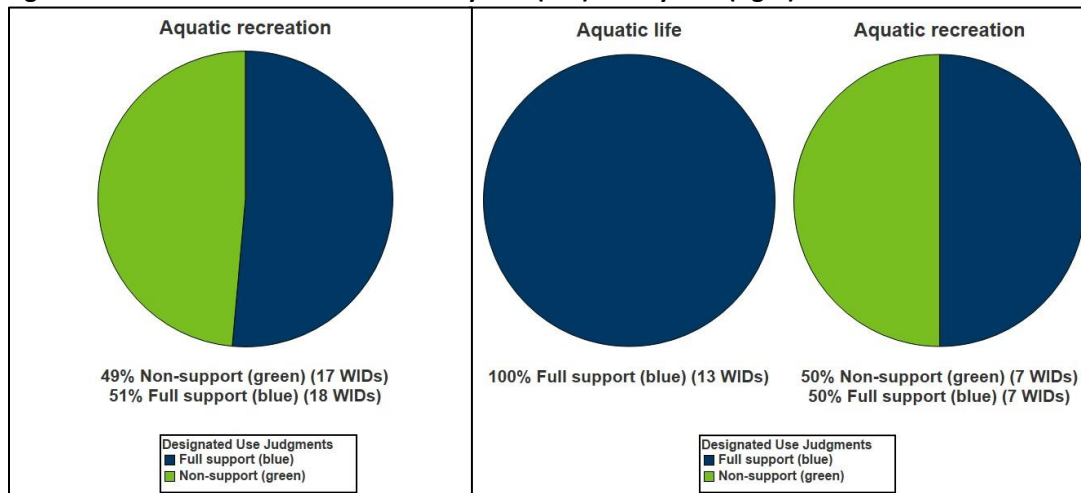


Figure 8. Overall Cycle 2 AQL assessment results for streams and lakes in the BRW and URRW (Table 1, Table 2).

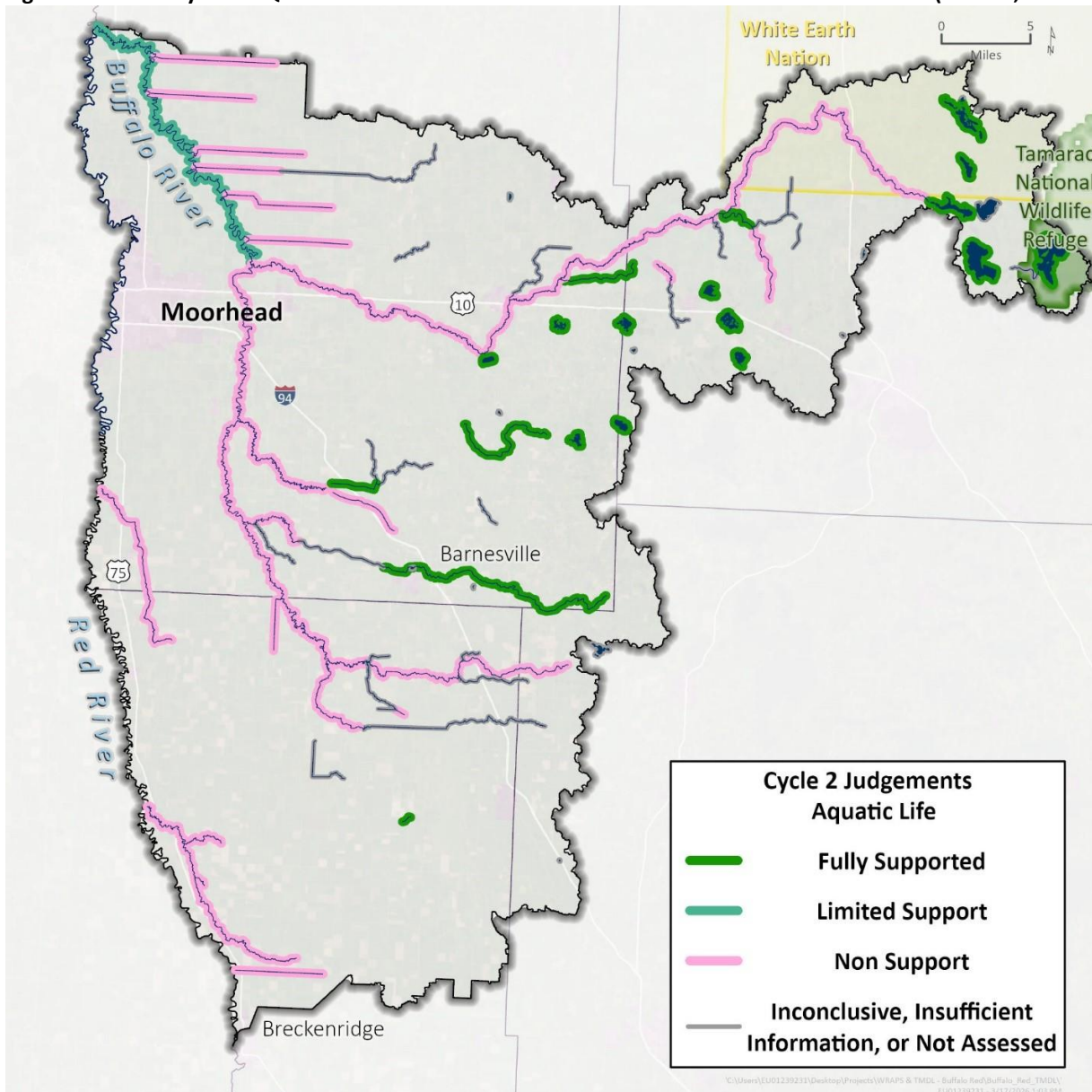
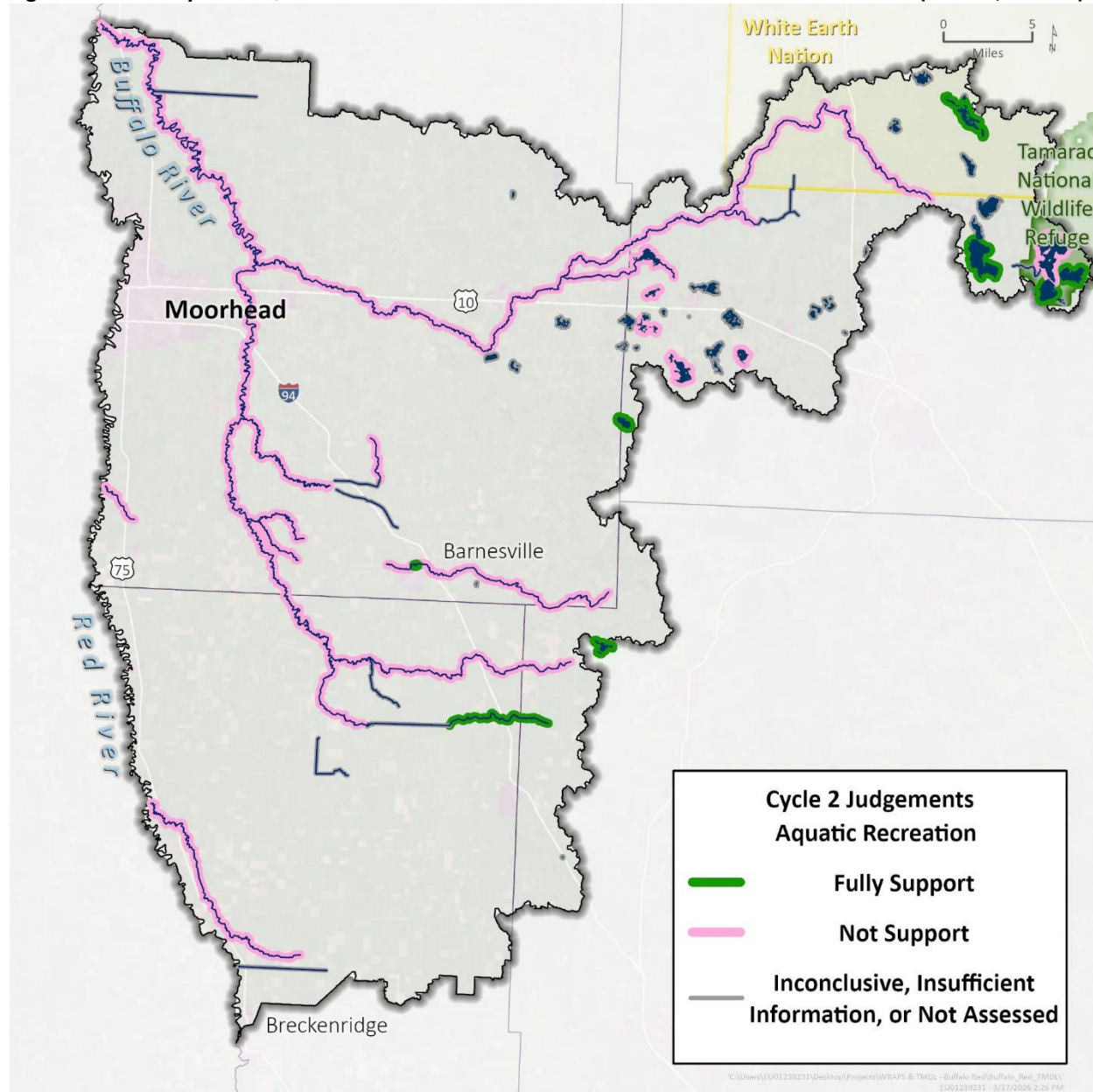


Figure 9. Overall Cycle 2 AQR assessment results for streams and lakes in the BRW and URRW (Table 1, Table 2).



## 4. Watershed condition status

The following sections provide a high-level overview of additional efforts to evaluate the water quality, biological, hydrologic, and other conditions within the BRW and URRW. Additional information is provided in the referenced reports, documents, and webpages.

### 4.1 Impaired waters and TMDL summary

As introduced in Section 3, water bodies that are found to not support (“NS”) their AQL and/or AQR designated uses are impaired and are added to Minnesota’s 303(d) Impaired Waters List (MPCA 2025g). The MPCA updates the impaired waters list every two years. Water bodies in the BRW and URRW, newly assessed as impaired in 2021 for Cycle 2, were added to Minnesota’s 2022 impaired waters list, while

impairments resulting from Cycle 1 assessments were added to the 2012 or 2020 impaired waters lists. Additional impairments in the watersheds from prior to Cycle 1 assessments date back to the 1996 list, while new impairments have been added to the 2024 list and may be added in the future. For a complete list of impaired waters in the BRW and URRW, refer to the latest version of the impaired waters list (MPCA 2025g). More information and maps for the impaired waters in the BRW and URRW are also provided by planning region in Section 5.

The federal Clean Water Act requires that TMDL studies are developed for water bodies that do not meet their applicable water quality standards and support their designated uses. A TMDL identifies the pollutants that are causing the impairments and how much of a pollutant a water body can receive and still meet water quality standards. The TMDL studies also identify what may be needed to restore and maintain impaired waters so that they meet their applicable standards. Impaired waters determined to be caused by conventional pollutants, such as sediment (TSS) or nutrients (TP), are addressed with TMDLs, while water bodies impaired by nonpollutant stressors, such as loss of connectivity, flow regime instability, and insufficient habitat, are not subject to load quantification and are not addressed with TMDLs. Completed TMDL studies within the BRW and URRW are summarized below.

- The *Buffalo River Watershed Total Maximum Daily Load* (MPCA 2016a) addressed 53 impairment listings for 37 water bodies, including 22 *E. coli* bacteria impairments, 13 turbidity impairments and 3 biological (F-IBI and M-IBI) impairments (addressed with TSS TMDLs), and 15 lakes with excess nutrient impairments. However, the TMDLs for two of those impaired water bodies were not approved by the EPA due to the water bodies being partially or wholly located within White Earth Reservation boundaries. The TMDL provided maximum load reductions for the bacteria-impaired streams ranging from 47% to 94% depending on the stream, and for the impairments addressed with TSS TMDLs ranging from 13% to 85% depending on the stream. The TMDL reductions for the nutrient-impaired lakes ranged from nearly 0% to 93%.
- The *Upper Red River of the North Watershed Total Maximum Daily Load Report* (MPCA 2017a) addressed three impairments, including one stream reach impaired due to *E. coli* bacteria and one stream reach impaired due to *E. coli* and turbidity (addressed with a TSS TMDL). Maximum load reductions provided for the bacteria-impaired streams were 49% and 64%, respectively, while a maximum load reduction of 29% was provided for the TSS TMDL.
- The *Buffalo River and Upper Red River of the North Watersheds Total Maximum Daily Load Report* (MPCA 2025h), developed concurrently with this WRAPS Report Update, includes TSS and TP TMDLs to address 14 impairments in 9 water bodies in the BRW and URRW, including 1 nutrient-impaired lake, 2 TSS-impaired and 2 DO-impaired stream reaches, and 9 stream reaches with biological (F-IBI and M-IBI) impairments.
- The Revision of the 2017 *Buffalo River Watershed Total Maximum Daily Load* (MPCA 2025i), also developed concurrently with this WRAPS Update, revising eight TMDLs previously approved as part of the *Buffalo River Watershed Total Maximum Daily Load* (MPCA 2016a) due to TMDL allocations for certain wastewater treatment facilities being incorrectly included in the TMDL tables.

A complete list of TMDLs and associated TMDL reductions is provided in Appendix A: Completed BRW and URRW TMDLs. A summary of all AQL and AQR impairments in the BRW and URRW and their TMDL

status as of this WRAPS project is also provided in Appendix A of the *Buffalo River and Upper Red River of the North Watersheds TMDL Report* (MPCA 2025h), or this information can be obtained in the impaired waters list (MPCA 2025g). The 2024 impaired waters list also includes one stream in the BRW with impaired wild rice production due to sulfate, and a number of water bodies with impaired aquatic consumption due to mercury in fish tissue. The aquatic consumption use impairments are not addressed as part of this WRAPS project and instead are addressed as part of the Minnesota Statewide Mercury TMDL (MPCA 2025g).

## 4.2 Stressor identification – streams

The MPCA uses the fish- and macroinvertebrate-based indices of biological integrity (F-IBI, M-IBI) to assess the status of fish and macroinvertebrate communities present in streams throughout a major watershed and to identify and further evaluate biological impairments in streams. Both the F-IBI and M-IBI for streams utilize actual fish and macroinvertebrate samples collected from the streams, water quality samples, assessments of in-stream habitat, and an assessment of other potential stressors that may be causing harmful conditions. From this data, F-IBI and M-IBI scores can be calculated for each stream reach to provide accurate measures of the condition of the biological communities in each stream (MPCA 2025j). Streams with scores that indicate that their fish and/or macroinvertebrate communities are impaired or vulnerable to impairment are then further evaluated through the SID process to identify the major factors causing harm to those communities, including both pollutant factors (e.g., TSS, nitrogen) and nonpollutant factors (e.g., altered hydrology, flow regime instability, insufficient habitat) (MPCA 2014, MPCA 2016b, MPCA 2023).

Five biologically impaired streams were evaluated through the SID process in Cycle 1, with the primary stressor for each impaired reach being altered hydrology/flow regime alteration (Table 3, MPCA 2014, MPCA 2016b, MPCA 2023). Additional stressors were present and evaluated but were seen as secondary stressors, including loss of connectivity, insufficient in-stream habitat, and excess sediment (TSS). Excess nutrients (TP and nitrogen) were not found to be direct stressors or contributing to other stressors.

**Table 3. Summary of the primary (X) and secondary (\*) stressors affecting the fish and macroinvertebrate bioassessments impaired reaches evaluated in the BRW Biotic SID (MPCA 2014) and the URRW Biotic SID Report (MPCA 2016b).<sup>1</sup>**

WID	Water body name	Biological impairment(s)	Low dissolved oxygen (DO)	Excess sediment/turbidity	Loss of connectivity	Altered hydrology/flow regime alteration	Lack of in-stream habitat
09020104-520	Whiskey Creek	M-IBI	*	*	NA	X	*
09020106-593	Buffalo River	F-IBI & M-IBI		*	X	*	*
09020106-505	Buffalo River, South Branch	M-IBI	*	X	NA	X	X
09020106-507	Deerhorn Creek	F-IBI & M-IBI	*	X	X	X	*
09020106-534	Spring Creek	F-IBI & M-IBI			X	X	

1. NA: loss of connectivity is not applicable as a stressor for M-IBI impairments. Blank cells were determined to not be supported as stressors.

As part of Cycle 2 assessments, two of the biological impairments evaluated in Cycle 1 were removed from the 2022 impaired waters list. The M-IBI impairment for Whiskey Creek (09020104-520) was corrected and removed as the original listing data were reviewed and declared unassessable due to being outside base flow conditions at the time of sampling. Extensive stream channel restoration and sediment reduction efforts have also been conducted along and upstream of Whiskey Creek since then. Additionally, the M-IBI impairment for the Buffalo River (09020106-593) was delisted and removed due to substantially improved M-IBI scores measured during Cycle 2. Significant sediment reduction efforts have been conducted in the Buffalo River Subwatershed likely contributing to this delisting. However, while TSS concentrations have improved in the Buffalo River, as well as in the Buffalo River, South Branch (09020106-505), TSS levels remain close to or above the impairment threshold for both of those stream reaches, therefore, sediment may remain as a stressor to those biological communities.

Aside from the examples above, the overall health of fish and macroinvertebrate communities evaluated across the BRW and URRW showed little change between cycles other than for some individual improvements (MPCA 2022). However, the number of biologically impaired streams evaluated as part of the *Cycle 2 Buffalo River and Upper Red River of the North Watersheds Stressor Identification Update* (MPCA 2023) substantially increased. First, 26 “deferred” biological impairments in 19 stream reaches that were not assessable in 2011 were assessed in 2018 and added to the 2020 impaired waters list. Next, nine new biological impairments in nine stream reaches from Cycle 2 assessments were evaluated. Finally, the six remaining biological impairments from the Cycle 1 SID process were re-evaluated. In total, 41 biological impairments in 29 stream reaches in the BRW and URRW were evaluated as part of the Cycle 2 SID Update.

The set of stressors evaluated in the Cycle 2 SID Update were similar to those stressors evaluated in the Cycle 1 reports. A summary of the proportion of stressors impacting the impaired fish and macroinvertebrate communities is provided below by planning region (Table 4). No biological impairments were identified in the Moorhead planning region, while one impaired reach of the Buffalo River (09020106-593) crosses both the Lakes and Mainstem planning regions and was included in the summary for the Mainstem planning region. Once again, flow regime instability was found to be the most predominant stressor across the watersheds, impacting biological communities in 97% of the impaired stream reaches due to the prevalence of high and fast peak stream flows and/or prolonged periods of slow or no flow. Loss of longitudinal connectivity due to dams, grade control structures, perched culverts, and other impediments was also common for almost all of the impaired fish communities (91%); the Ganz Dam remains noted as a substantial barrier to fish passage in the upper subwatersheds of the Buffalo River, South Branch. Insufficient physical habitat was found to impact the impaired fish and macroinvertebrate communities in 90% of the evaluated streams, often caused by bank erosion, absence of riffles and coarse substrate, limited cover and velocity types, and poor channel stability. About half of the biological impairments are stressed by high TSS (52%) and low DO (55%). Of those stressed by low DO, many (81%) of them are adversely impacted by eutrophication due to high levels of TP and high DO flux, a new development since Cycle 1. However, similar to Cycle 1, none of the biologically impaired communities evaluated in the Cycle 2 SID Update are impacted by high nitrate-nitrogen. One impaired stream reach, Lawndale Creek (09020106-530), has a high temperature stressor due to its designation as a cold-water trout stream.

Additional details on specific stressors and each impaired stream reach can be found in the Cycle 1 Biotic SID reports (MPCA 2014, MPCA 2016b) and the *Buffalo River and Upper Red River of the North Watersheds Stressor Identification Update* (MPCA 2023). Strength of evidence tables from these reports that summarize the stressors for each biological impairment are also provided in Appendix B: Stressor identification summaries.

**Table 4. Summary of the proportion of fish and macroinvertebrate bioassessments impaired reaches affected by each stressor evaluated in the Buffalo River and URRWs SID Update (MPCA 2023).<sup>1</sup>**

Evaluated Stressor	Planning region					
	Northern	Mainstem	Central	Southern	Upper Red	Western
Loss of longitudinal connectivity	4 / 5	5 / 5	4 / 4	3 / 3	2 / 3	2 / 2
Flow regime instability	7 / 7	6 / 7	5 / 5	5 / 5	3 / 3	2 / 2
Insufficient physical habitat	7 / 7	6 / 7	4 / 5	4 / 5	3 / 3	2 / 2
High TSS	1 / 7	4 / 7	1 / 5	3 / 5	2 / 3	1 / 2
Low dissolved oxygen (DO)	6 / 7	2 / 7	2 / 5	4 / 5	0 / 3	1 / 2
High nitrate-nitrogen	0 / 7	0 / 7	0 / 5	0 / 5	0 / 3	0 / 2
High temperature	0 / 7	0 / 7	0 / 5	1 / 5	0 / 3	0 / 2

1. Proportion of impaired reaches affected by each stressor are provided as the number of impaired reaches affected by that stressor / the number of bioassessment impaired reaches in that planning region.

### 4.3 Stressor identification – lakes

The Minnesota Department of Natural Resources (DNR) uses the F-IBI to assess the status of fish communities present in lakes throughout major watersheds and to identify and further evaluate biological impairments in lakes. The F-IBI utilizes fish community data collected from a combination of trap nets, gill nets, beach seines, and backpack electrofishing. From this data, an F-IBI score can be calculated for each lake that provides a measure of overall fish community health based on species diversity and composition. Lakes with F-IBI scores that indicate that their fish communities are impaired or vulnerable to impairment are then further evaluated through the SID process to identify the major factors causing harm to those communities (DNR 2023a).

Between 2016 and 2021, 13 lakes in the BRW were sampled and assessed using the F-IBI to evaluate biological health in those lakes. As mentioned in Section 3.3, all 13 lakes were found to be fully supporting the AQL use based on F-IBI scores that were at or above the impairment threshold for similar lakes. The F-IBI score from 2017 for Little Sugar Bush Lake (03-0313-00) was determined to be “exceptional,” while the F-IBI scores from 2017 and 2019 for both Lee (14-0049-00) and Silver (14-0100-00) Lakes indicate that fish communities in those lakes are VUL. One additional lake, West Olaf (56-0951-01), was evaluated and found to have a F-IBI score from 2007 that was below the impairment threshold. However, this lake was assessed as IF as these data are not recent enough for assessment in Cycle 2 and were not assessed in Cycle 1. Additional information including F-IBI scores for each evaluated lake can be found throughout the *Buffalo River Watershed Stressor Identification Report – Lakes*, especially Table 4 of that document (DNR 2023a).

Potential candidate causes for the vulnerable fish communities in Lee and Silver Lake were further evaluated. Eutrophication (excess nutrients) is supported as a stressor to the fish communities in both lakes. Both lakes have measured TP concentrations that are relatively high and both are located in subwatersheds with high land use disturbance. Lee Lake was assessed as not supporting the AQR use in Cycle 1 and added to the 2012 impaired waters list due to excess nutrients; Silver Lake may also have been found to be not supporting the AQR use if it had sufficient data for an assessment in either cycle. Physical habitat alterations, such as shoreline development and loss of riparian and near-shore vegetation, are inconclusive as stressors but are likely adversely affecting the fish communities in both lakes. Altered interspecific competition and pesticide application were evaluated as either inconclusive or refuted as stressors. Decreased DO, temperature regime changes, increased ionic strength, and metal and toxic chemical contamination were also inconclusive or eliminated as potential stressors and were not further evaluated.

**Table 5. Summary of the stressors associated with the biologically vulnerable lakes in the BRW (DNR 2023a).**

WID	Lake name	Candidate causes <sup>1</sup>			
		Eutrophication (excess nutrients)	Physical habitat alteration	Altered interspecific competition	Pesticide application
14-0049-00	Lee	+	0	-	0
14-0100-00	Silver	+	0	0	0

1. "+" supports the case for the candidate cause as a stressor, "0" indicates that evidence is inconclusive as to whether the candidate cause is a stressor, "-" refutes the case for the candidate cause as a stressor.

## 4.4 Stream and lake prioritization considerations

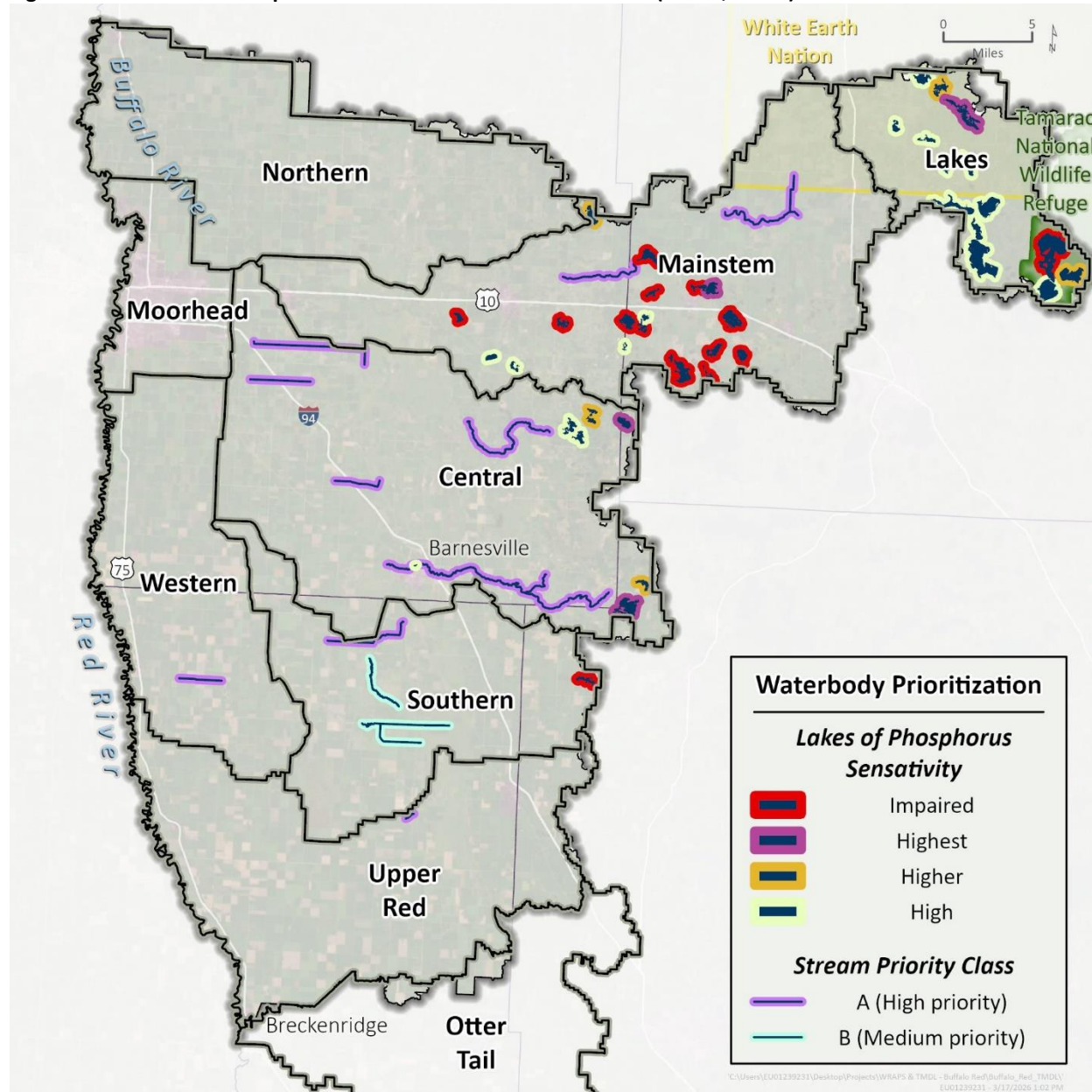
The MPCA provides updated statewide stream and lake prioritization considerations each year after watershed assessments have been completed for the previous year (Figure 10, MPCA 2025f). The prioritization rankings for streams are based on water quality assessments, the level of risk posed to the water bodies from near shore areas and contributing watersheds, and the level of protection already in place in the watershed. An overall score or rank is given and the stream rankings are displayed by priority class (high, medium, low). The prioritization rankings for lakes are based on water quality assessments, the amount of water clarity lost if phosphorus is added to the lake, the amount of land use disturbance, lake size, and current water quality trends. Additional considerations are given if the lake is assessed as being "nearly" or "barely" impaired or has vulnerable fish communities. The lake rankings are displayed by phosphorus sensitivity risk (highest, higher, high, impaired).

It is important to note that these prioritization considerations are a starting point; local knowledge and input of these water bodies are key in any further water planning efforts including the implementation of restoration or protection strategies.

Priority streams and lakes are also identified in the BRRW CWMP as resource priorities, both for each planning region in Section 2 of the CWMP and in Section 3 of the CWMP for Measurable Goals. The BRRW CWMP focuses on watershed issues (Section 4.7), such as sediment (TSS) or nutrient (TP) loading, with the understanding that addressing priority issues through implementation actions will yield benefits for multiple resource concerns (i.e., multiple water bodies) (HEI 2020, Section 2.0).

Additional considerations and maps for both the MPCA-provided priority waters and the BRRW CWMP priority resources are provided by planning region in Section 5.

Figure 10. Stream and lake prioritization considerations as of 2025 (MPCA, 2025f).



## 4.5 Water quality trends

### 4.5.1 Streams

The MPCA conducts river nutrient and sediment trend analyses at watershed outlets over long periods of time to provide an understanding of the combined outcomes of land use changes, management practices, and other key factors affecting water quality. Trends are determined for both flow-adjusted and nonflow-adjusted concentrations and loads using data, currently through 2022, from Minnesota’s Watershed Pollutant Load Monitoring Network (WPLMN, MPCA 2025k). Flow-corrected trends are the most common way of displaying trend data and can be interpreted as changes that would occur if stream flow had been the same year after year. Nonflow-corrected trends do not adjust for the influence of year-to-year flow variability, which may better reflect the long-term impacts of climate and weather patterns (MPCA 2025l).

River trend analyses are conducted for the outlet of the BRW at the Buffalo River near Georgetown (S002-125, WPLMN station H58033001) and for the outlet of the URRW at the Red River of the North near Kragnes (S002-097, WPLMN station H57026001) (Table 6). While Cycle 2 and more recently available water quality data may be showing improvements in individual stream reaches within the BRW and URRW (Section 5), the MPCA’s trend analyses show either no significant trend detected or a very small trend in river nutrient and TSS concentrations at the watershed outlets. Consideration for revisiting these analyses is warranted after more recent WPLMN data (2023-2024) becomes finalized.

**Table 6. Water quality trend analyses for streams at the outlets of the BRW and URRW (MPCA 2025I).<sup>1</sup>**

Parameter	Recent trend (2008-2022)				Historical trend (2003-2022)	
	Buffalo River near Georgetown (S002-125)		Red River near Kragnes (S002-097)		Red River near Kragnes (S002-097)	
	Flow-corrected	Nonflow-corrected	Flow-corrected	Nonflow-corrected	Flow-corrected	Nonflow-corrected
Sediment (TSS)	no trend	no trend	no trend	no trend	no trend	no trend
Nitrate (NO <sup>2</sup> +NO <sup>3</sup> )	no trend	+2.7%	no trend	no trend	+1.1%	no trend
Phosphorus (TP)	no trend	no trend	no trend	no trend	-1.2%	-1.3%

1. Green values indicate an improving trend in water quality for that parameter while red values indicate a degrading trend in water quality for that parameter.

## 4.5.2 Lakes

The MPCA conducts lake water clarity trend analyses statewide on an annual basis. The lake water clarity trend analyses use all available water clarity data in MPCA’s database for May through September from 1971 onwards. The majority of these data were collected by citizens or volunteers. The lake trend analyses are performed with a seasonal Mann Kendall test. Lake water clarity must change by more than half a foot per decade to be considered a detectable trend. The BRW and URRW include 60 lakes with at least some water clarity data (only one of which is located in the URRW). Of those 60 lakes, 50 had insufficient data for a trend analysis, 9 had no change or no trend, and none had a degrading trend. Just one lake, Turtle (03-057-00), had an improving trend; from 1975 to 2024 there is evidence of improving water clarity in Turtle Lake of approximately 1.3 feet per decade.

## 4.5.3 Stream flow

It is documented that stream flows have increased in the BRW and URRW, yet many of the smaller tributary streams are “flashy” with peak flows occurring quickly after rainfall or spring melt and prolonged stretches of low- or no-flow during dry periods (MPCA 2022, MPCA 2023, HEI 2020). Trend analysis has revealed that average annual flows in the Buffalo River near Hawley have increased by 125% from 1946 to 2020 (Figure 11), and average annual flows in the Red River of the North near Kragnes have increased by a substantial 400% from 1940 to 2020 (Figure 12), with many of the highest measured flows at those sites documented in the last 20 to 30 years (MPCA 2022). It is important to note that since these analyses use flow data through 2020, further consideration is warranted using more recent (2021-2024) data as they become finalized and applied. Like much of Minnesota, the BRW and URRW experienced significant drought conditions from 2021 through 2024 (DNR 2025a), potentially impacting stream flows throughout the watersheds.

Figure 11. Annual mean flow (cubic feet per second) for the Buffalo River near Hawley from 1946-2020 (MPCA 2022).

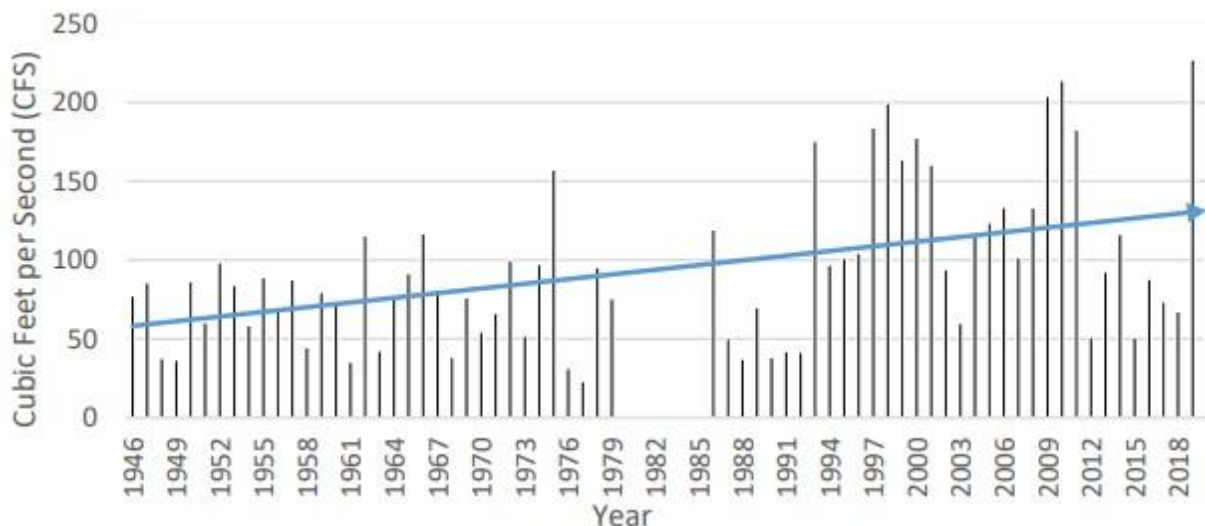
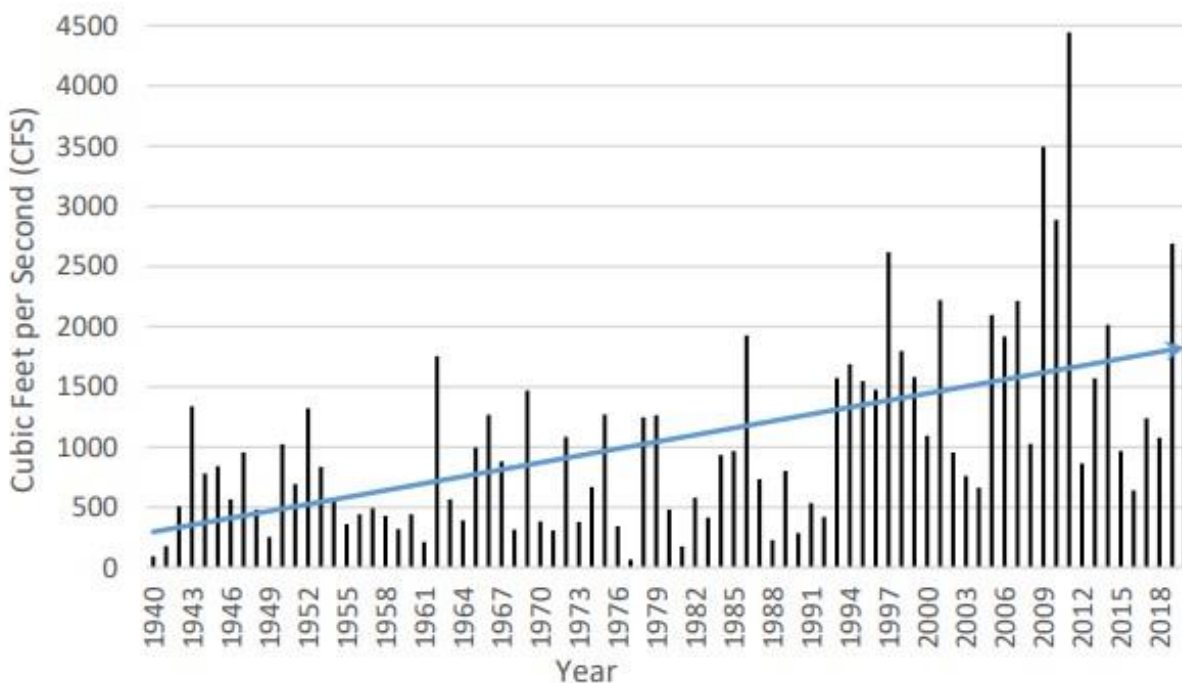


Figure 12. Annual mean flow (cubic feet per second) for the Red River near Kragens from 1940-2020 (MPCA 2022).



Additional information from the *Evaluation of Hydrologic Change Technical Summary* for the BRW (DNR 2023b) shows that essentially all flow conditions in the BRW have increased since the late 1990s. For example, increases documented in the Buffalo River near Dilworth include 152% for the largest, highest flood events that are exceeded 10% of the time or less, 286% for moderate flows that are exceeded at least 50% of the time, and 362% for low flows that are met or exceeded 90% of the time. All of the trends highlighted in this section are consistent throughout the Red River Basin (Galloway et al. 2024), with annual average and peak flows in the Red River of the North at Grand Forks, North Dakota, downstream of the BRW and URRW, increased by 300% over the last 10 years and by 350% over the last

20 years (MPCA 2025m). These increases in stream flow are attributed to the increasing precipitation and magnitude and frequency of intense storm events in the BRW and URRW (Section 4.6, DNR 2023b), and to land use activities and altered hydrology which have been focused on improved drainage for agricultural production and to alleviate recurring flooding issues in both rural and urban areas (Section 4.7.1, MPCA 2022, MPCA 2023, HEI 2020).

## 4.6 Climate and weather trends

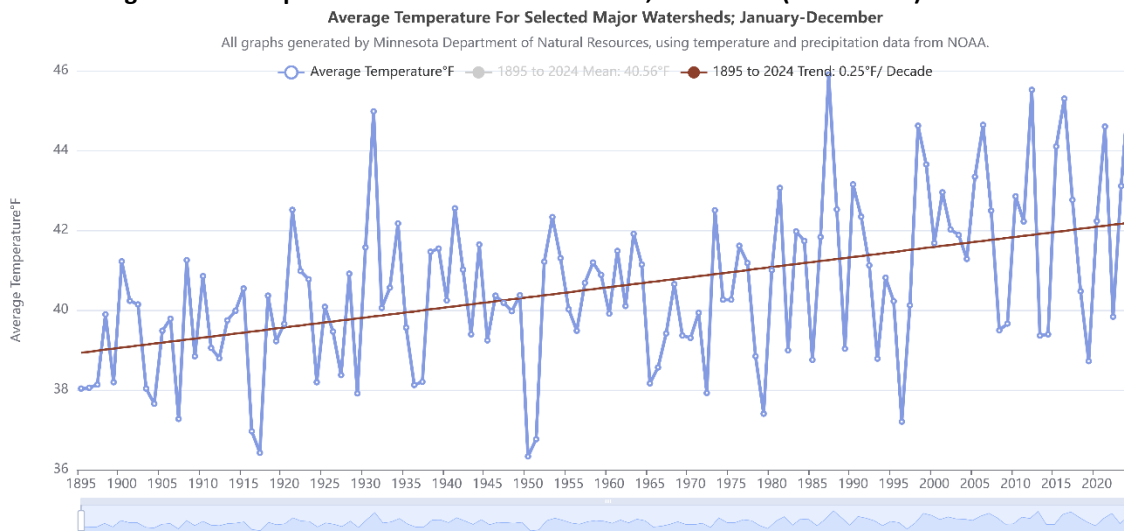
Similar for stream flow, it is well documented that climate and weather patterns in the BRW and URRW are changing, including changes in annual temperatures and annual precipitation (MPCA 2022, DNR 2023b, HEI 2020). Climate summary reports are provided for Minnesota's major HUC-8 watersheds by the DNR, which use observed data to deliver an overview of temperature and precipitation trends using 30-year averages, comparing the most recent 30-year average (1989-2018) to the entire climate record average (1985-2018). The summary reports for the BRW and URRW suggest that in these watersheds, annual minimum, maximum, and average temperatures slightly increased over the historical record, with more significant increases of approximately 1°F to 1.5°F over the most recent 30-year average (1989-2018). Precipitation in the watersheds, meanwhile, has been more variable when compared to the historical average, with an increase of approximately 1 inch over the most recent 30-year average (1989-2018) (DNR 2019a, DNR 2019b).

The DNR also provides historical climate data and future projections on the *Minnesota Climate Explorer* (DNR 2025b). Data through 2024 shows that average annual temperatures in the watersheds, combined (Figure 13), have increased by 0.25°F per decade and by almost 8°F total over the historical record (1895 – 2024) and by 0.5°F per decade and over 5°F over the last 30 years (1995 – 2024). Meanwhile, precipitation (Figure 14) has increased by 0.20 inches per decade or approximately 2.7 inches total over the historical record (1895 – 2024) but decreased by 0.99 inches per decade or approximately 1.3 inches total over the last 30 years (1995 – 2024).

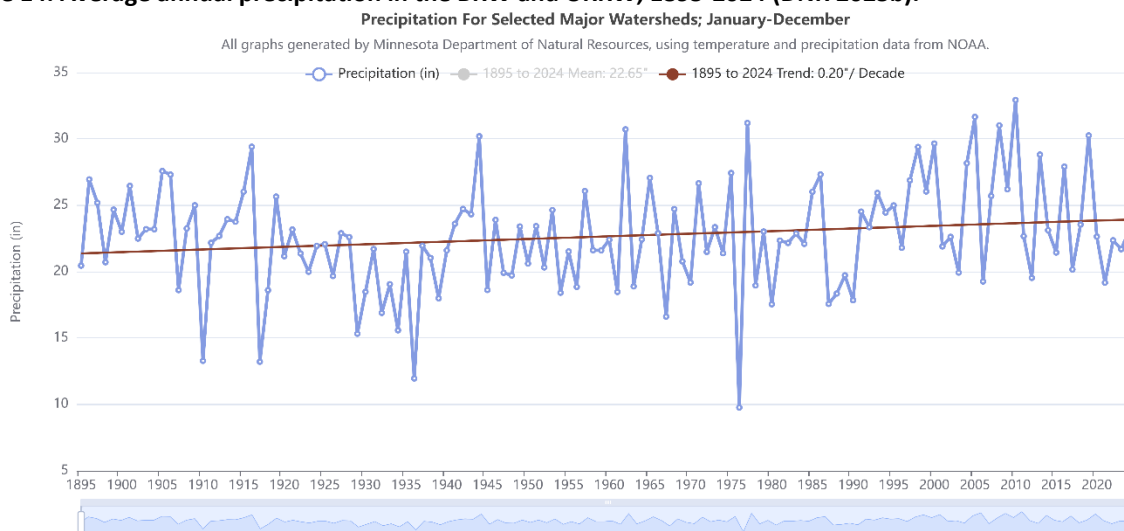
Future projections suggest that increasing trends will continue. Model mean projections show that annual average temperatures in the watersheds are projected to increase by 3.64°F above baseline by mid-century (years 2040-2059) and by 6°F to 10°F above baseline by late-century (2080-2099). Annual precipitation is projected to increase by 1.9 inches above baseline by mid-century and by 1.8 to 3.7 inches above baseline by late-century (DNR 2025b). Furthermore, the Minnesota Climate Mapping and Analysis Tool projects for the BRW and URRW that the number of days per year exceeding 90°F will increase by 17 days by mid-century (2040-2059) and by over 24 days by late century (2060-2079), and that the maximum 1-day through 7-day total precipitation will increase by approximately 0.3 to 0.5 inches by mid-century and by 0.5 to 0.7 inches by late-century, suggesting rainfall or storm events will increase in magnitude (Liess et al. 2025).

These weather and climate trends and projections should be considered in future planning efforts regarding hydrology and water quality in the BRW and URRW. (Section 9). The impacts of rising temperatures and more intense rain events can be significant, including continued increases in peak flood flows, increased sediment and nutrient loading, increased water temperatures and decreased winter lake ice duration, altered growing seasons for plants, trees, and crops, and more (MPCA 2025n).

**Figure 13. Average annual temperatures in the BRW and URRW, 1895-2024 (DNR 2025b).**



**Figure 14. Average annual precipitation in the BRW and URRW, 1895-2024 (DNR 2025b).**



## 4.7 Priority issues, pollutants, and stressors

The BRRW CWMP identifies “issues” as the factors, stressors, or difficulties resulting in an adverse consequence for the resource of concern (or select water bodies within the BRW and URRW). As mentioned in Section 4.4, the issues in the BRRW CWMP are prioritized with the intent that addressing priority issues through implementation actions will yield benefits for multiple water resources (HEI 2020). The following sections provide additional information for select BRRW CWMP priority issues in relation to watershed assessment results, more recently available water quality data, and watershed conditions for the BRW and URRW.

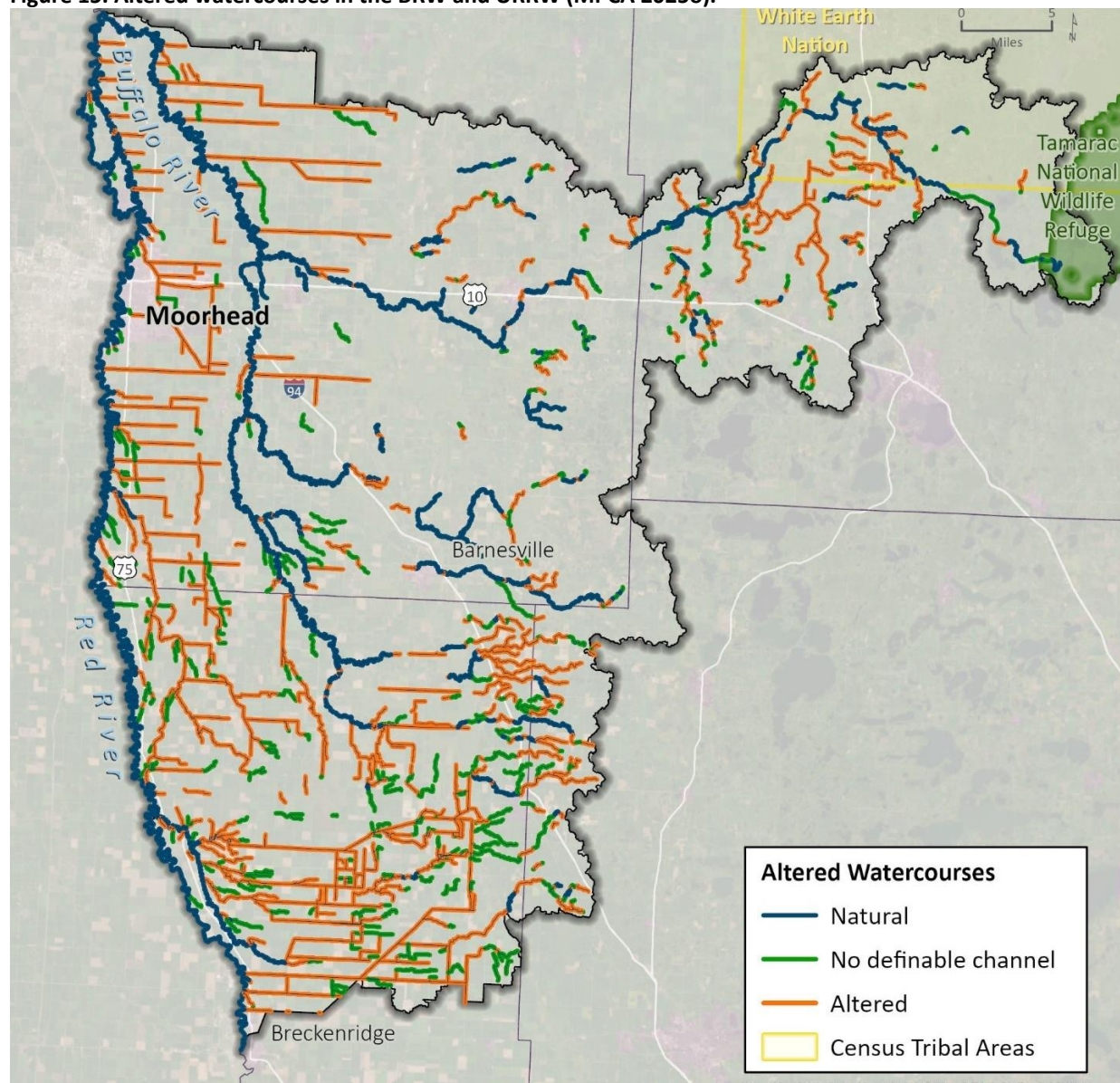
### 4.7.1 Altered hydrology

As discussed in Section 4.5.3, stream flows have increased substantially in the mainstem and the downstream portions of the BRW and URRW, partly attributed to increased precipitation and also attributed to land use activities and altered hydrology. In the BRW and URRW and other parts of Minnesota, channelizing, ditching, and damming projects have changed the natural course of streams

and their drainage areas to increase agricultural production and land value, reduce flooding in both rural and urban areas, and improve transportation. The resulting alterations can lead to increased stream flows, increased stream and ditch channel erosion and bank instability, increased sediment and nutrient loading, increased downstream flooding, degraded habitat, and more (HEI 2020, MPCA 2023, MPCA 2025o). In the BRW and URRW, excluding the Red River of the North mainstem, 54% of stream channels have been altered or impounded, while 28% remain natural and 18% have no definable channel (Figure 15, MPCA 2025o). Altered hydrology or flow regime instability are also identified as a primary stressor to the impaired fish or macroinvertebrate communities in all but one of the biologically impaired streams in the BRW and URRW, and often contribute to other stressors with extreme peak flows and lack of base flows leading to degraded habitat, excess sedimentation, and low DO (Section 4.2).

While many projects and practices have been implemented in the BRW and URRW to help combat the effects of altered hydrology (Section 5, Section 8), this issue should remain a top priority in future iterations of the BRRW CWMP and in the planning of future implementation efforts (Section 9).

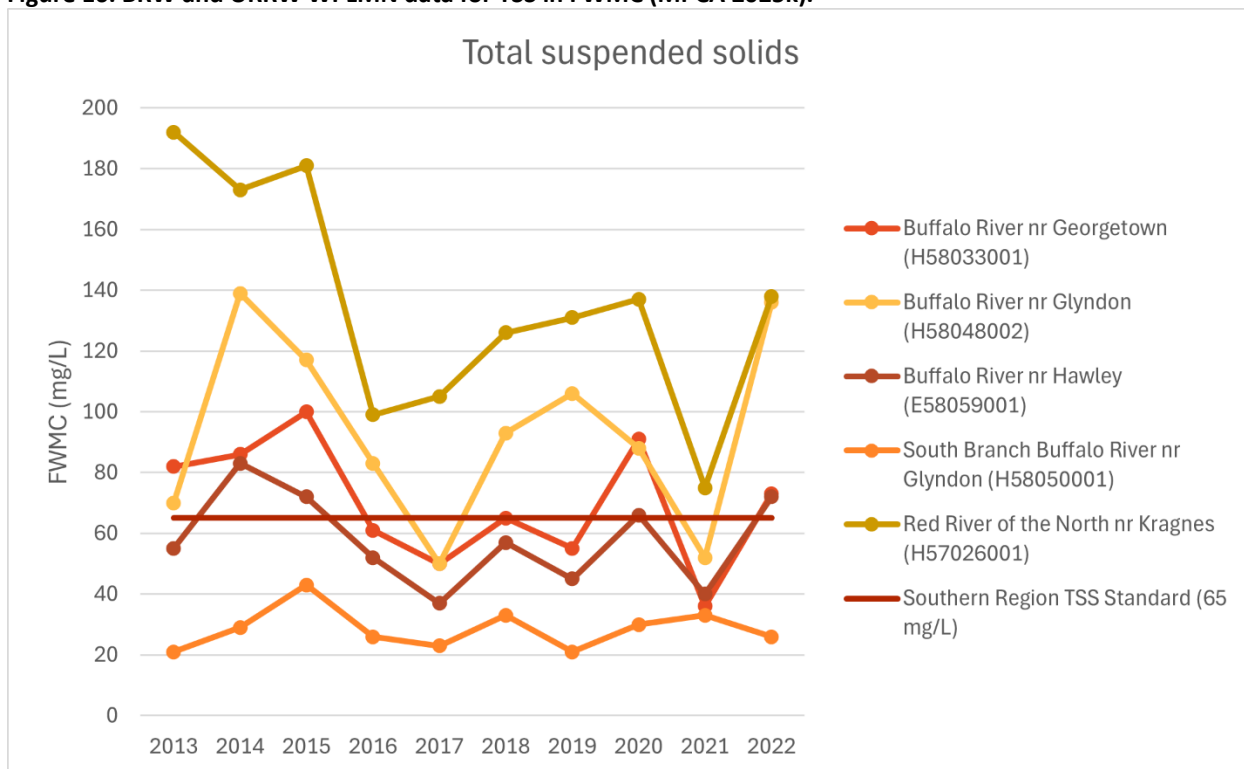
**Figure 15. Altered watercourses in the BRW and URRW (MPCA 2025o).**



## 4.7.2 Sediment loading

Recent data suggests that sediment concentrations, in the form of TSS, are improving in individual stream reaches including the “upper” Buffalo River, the Buffalo River, South Branch, Whiskey Creek, and more (Section 5). Furthermore, one turbidity impairment (Section 3.2) and one M-IBI impairment (Section 4.2) were delisted from the 2022 impaired waters list due to sediment reduction efforts. However, excess TSS and turbidity remain fairly prevalent in the BRW and URRW. Of the 24 stream reaches with sufficient data to make a Cycle 2 assessment determination for TSS, 12 (50%) were found to exceed their applicable TSS standard (Table 1). Just one of those 12 was a new addition to the 2022 impaired waters list due to TSS, while 10 were already listed as impaired due to TSS or turbidity. Excess sediment or TSS also remains a prevalent stressor in the biologically impaired stream reaches in the BRW and URRW (Section 4.2). Previous studies of WPLMN data suggested that TSS concentrations in the BRW and URRW have been higher than most of Minnesota (MPCA 2022). While trend analyses revealed no trend at the watershed outlets (Section 4.5.1), more recent WPLMN data through 2022 show some improvements, yet varied concentrations, at main locations throughout the watersheds (MPCA 2025k, Figure 16). Further evaluation is warranted after more recent WPLMN data (2023-2024) becomes finalized and available. Many sediment reduction projects and practices have been implemented in the BRW and URRW (Section 5, Section 8), and additional sediment reductions should remain a top priority in future planning efforts (Section 9).

**Figure 16. BRW and URRW WPLMN data for TSS in FWMC (MPCA 2025k).**



## 4.7.3 Nutrient loading

Elevated TP levels are widespread throughout the BRW and URRW. Of the 20 stream reaches with sufficient data to make a Cycle 2 assessment determination for TP, 16 (80%) were found to exceed their applicable TP standard (Table 1). However, there are no river eutrophication standard impairments

currently in the BRW and URRW due to the lack of response variables to assess the stream as impaired. Meanwhile, of the 15 lakes with sufficient data to make a Cycle 2 assessment determination for TP, 8 (54%) were found to exceed their applicable TP standard (Table 2). Additionally, high TP levels were commonly found amongst the biologically impaired stream reaches in the BRW and URRW (Section 4.2), with the effects of eutrophication impacting the DO regime for 81% of the impaired fish and/or macroinvertebrate communities stressed by low DO (MPCA 2023). Previous studies of WPLMN data again suggested that TP concentrations in the BRW and URRW have been higher than most of Minnesota (MPCA 2022), with WPLMN data at main locations throughout the watersheds showing TP concentrations consistently above the south region standard (MPCA 2025k, Figure 17).

Conversely, nitrate-nitrogen concentrations in BRW and URRW streams are generally low. While a select few of the biologically impaired stream reaches in the BRW and URRW had higher proportions of individual nitrate values above 8 milligrams per liter (mg/L), none of the biologically impaired communities were found to be stressed by high nitrate-nitrogen as of this evaluation (MPCA 2023, Section 4.2). Additionally, previous studies of WPLMN data suggested that nitrogen concentrations in the BRW and URRW have been lower than most of the state (MPCA 2022), and WPLMN data from 2013 through 2022 shows nitrate-nitrogen concentrations at main locations in the watersheds were consistently below 2 mg/L (Figure 18).

The 2025 Minnesota Nutrient Reduction Strategy assigns HUC-8 watershed outlet load reductions for TP and total nitrogen to achieve nutrient reduction goals at the state lines (MPCA 2025p, Section 2.9). The watershed nutrient reduction planning targets focus on reducible human caused nutrient loads and are intended to provide watershed planners with information on what each watershed can do to achieve the downstream goals, in this case for Lake Winnipeg. The watershed targets are one consideration, among many, that can inform land use decisions and best management practice (BMP) implementation efforts, but the targets should be viewed as approximate and should be supplemented with more localized data, information, modeling, and knowledge. The watershed targets are also intended to be considered along with local priorities, not to supersede them. While the preceding paragraph explains that nitrogen concentrations in BRW and URRW streams have generally been found to be low, the watershed outlet loads and therefore the load reduction targets for both TP and total nitrogen for the BRW and URRW are among the highest of all the Red River Basin watersheds (Table 7, Appendix C: Minnesota Nutrient Reduction Strategy watershed nutrient reduction planning targets). These targets and additional nutrient reduction efforts should remain a priority in future watershed planning efforts (Section 9).

**Table 7. Minnesota Nutrient Reduction Strategy watershed nutrient reduction planning targets for the BRW and URRW (MPCA 2025p).<sup>1</sup>**

Watershed	TP reduction (MT/yr) <sup>2</sup>	TP percent reduction	TN reduction (MT/yr) <sup>2</sup>	TN percent reduction
BRW	43	51%	432	56%
URRW	147	57%	638	60%

1. For additional information and a complete list of watershed nutrient reduction planning targets for the Red River Basin and statewide, see Appendix C: Minnesota Nutrient Reduction Strategy watershed nutrient reduction planning targets and the 2025 Minnesota Nutrient Reduction Strategy supporting document appendix 2-4 (MPCA 2025p).
2. TP: total phosphorus; TN: total nitrogen; MT/yr: metric tons per year.

Figure 17. BRW and URRW WPLMN data for TP in FWMC (MPCA 2025k).

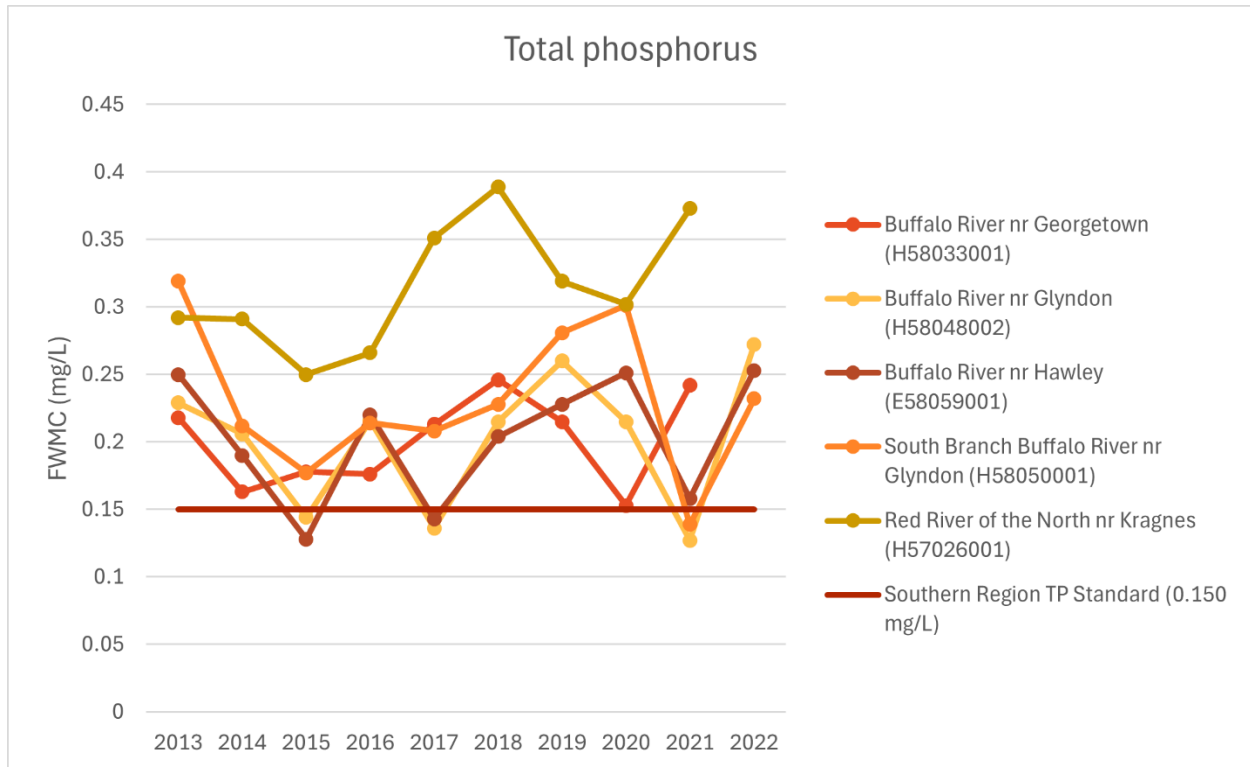
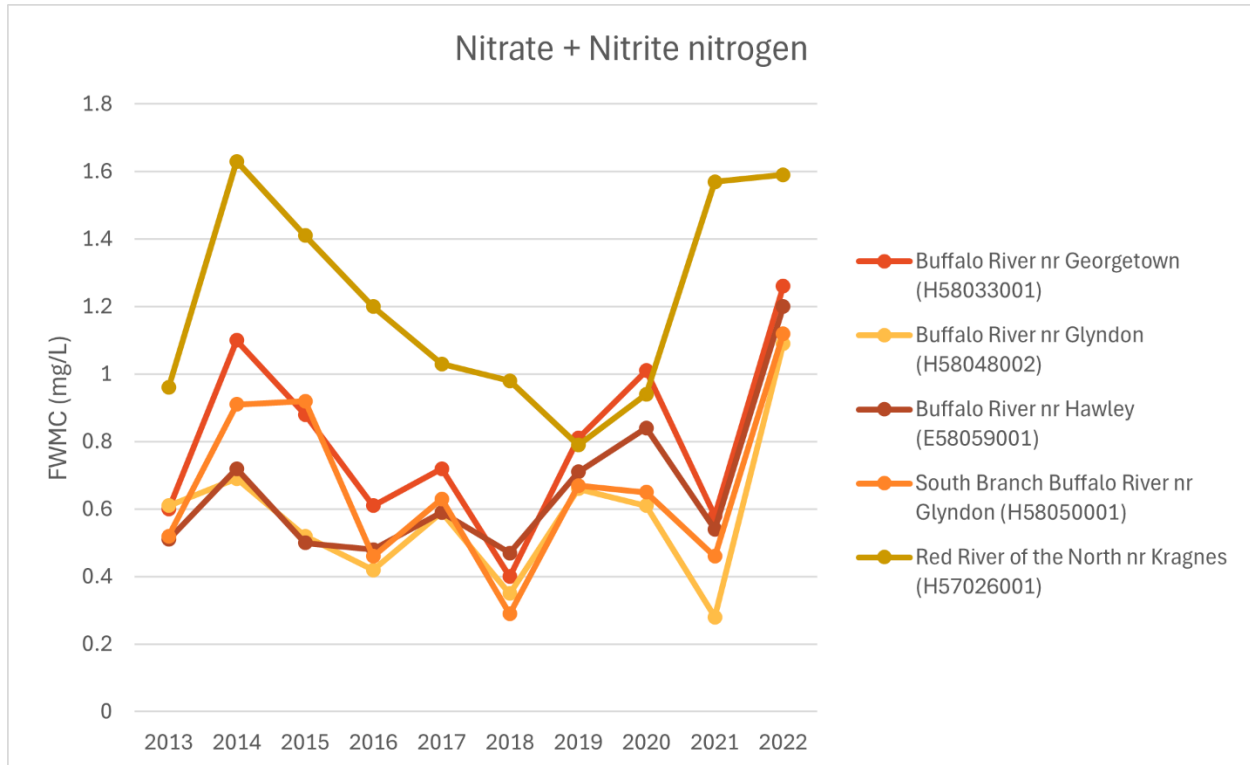


Figure 18. BRW and URRW WPLMN data for nitrate-nitrogen in FWMC (MPCA 2025k).



#### 4.7.4 Dissolved oxygen

Low DO is a common problem within streams in the BRW and URRW. Of the 14 stream reaches with sufficient data to make a Cycle 2 assessment determination for DO, 11 (79%) failed to meet the applicable standard (Table 1). Of those 11, 9 are included on the impaired waters list due to low DO, with 4 of those newly added to the 2022 list as a result of Cycle 2 assessments. Several other streams had concentrations failing to meet the standard, but insufficient data to make an assessment. Low DO was found to be a stressor in about half of the biologically impaired stream reaches in the watersheds (Section 4.2). As mentioned above, most of those are impacted by eutrophication, and at least two are noted as being impacted by wetland conditions at or upstream of the biological monitoring locations (MPCA 2023).

Prior to the development of the *Buffalo River and Upper Red River of the North Watersheds TMDL Report* (MPCA 2025h), MPCA staff determined that additional information would be needed to determine the drivers of the nine DO-impaired stream reaches in the BRW and URRW and address their impairment status. Additional information and MPCA staff's findings are provided in Appendix D: Dissolved oxygen driver analysis. In summary, eutrophication was found to be a primary driver for two of the impaired stream reaches; these reaches were addressed with TP TMDLs. Additionally, eutrophication was found to be a potential driver for one impaired stream and was found to not be a driver in four of the evaluated reaches. Three reaches were not further evaluated, while one of the evaluated streams, Deerhorn Creek (09020106-507), was found to be meeting the applicable eutrophication and DO standards and was suggested as an example for setting restoration targets for the other evaluated stream reaches.

Additional evaluation will need to be considered in the future for the DO-impaired stream reaches in the BRW and URRW. The sampling location for the uppermost reach of the Buffalo River, South Branch (09020106-603) should be re-evaluated and potentially moved upstream due to wetland conditions at the current sampling location observed by MPCA staff in 2023. Whiskey Creek (09020104-520) and Wolverton Creek (09020104-549) should be re-evaluated to assess how stream channel restoration work will impact DO concentrations in those reaches in the future. Finally, nonchemical drivers of low DO, especially hydrology, should be further investigated in all of the impaired stream reaches and their upstream tributaries.

#### 4.7.5 Bacteria

Elevated levels of *E. coli* bacteria are also prevalent throughout the BRW and URRW. There were 21 stream segments with sufficient data to make a Cycle 2 assessment determination for *E. coli*, 20 of which (95%) failed to meet the applicable standards (Table 1). The only stream reach with an *E. coli* assessment that met standards was the uppermost reach of the Buffalo River, South Branch (09020106-603). Of the 20 stream segments failing to meet the *E. coli* standards, 3 were added to the 2022 impaired waters list, bringing the total amount of bacteria-impaired stream segments in the watersheds to 28. Bacteria reduction efforts should remain a priority in future watershed planning (Section 9), especially when human-caused sources of bacteria can be addressed.

#### 4.7.6 Drinking water protection

Generally, all of the drinking water in the BRW and URRW comes from groundwater, other than within the city of Moorhead which uses a combination of groundwater and surface water from the Red River of the North (MDH 2019). The BRRW CWMP identifies the protection of both the quality and quantity of surface water and groundwater drinking water supplies as priority issues (HEI 2020). Groundwater sources in the middle portions of the watersheds may be at higher risk of contamination (MDH 2019), while surface water sources are subject to upstream land uses (MDH 2023). Additional information regarding surface water sources of drinking water for the city of Moorhead is provided in Section 5.6, while additional coverage of groundwater sources is provided in the BRRW GRAPS Report (MDH 2019).

## 5. Planning region summaries

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The following sections provide summaries for each BRRW CWMP planning region. Each summary includes a brief overview of the planning region's geography and land use, as well as a summary of water body assessment results. Priority water resources and information for some larger-scale restoration and protection efforts are also included for some planning regions. A map showing impaired waters, protection priority waters, and monitoring locations is also provided for each planning region.

Also included for each planning region is a table providing water quality data, assessment results, and other information for select water bodies (WIDs). Multiple water quality parameters, such as *E. coli* bacteria, TSS, or TP, are provided depending on available data for each water body. Applicable water quality standards (Appl WQS) are provided for certain parameters. These standards may vary between individual WIDs, including WIDs within the same planning region, as some of the standards (i.e., TSS and TP) are based on river regions, and the standards for F-IBI and M-IBI may vary based on each stream's use classification and based on which IBI tool was used, including between cycles.

Water quality data and assessment results are then provided for both Cycle 1 (2001-2010) and Cycle 2 (2011-2020). Water quality data are generally provided first in a numerical format and reflect either average pollutant concentrations or individual or averaged IBI scores. Concentrations are provided in most probable number per 100 milliliters (MPN/100mL, for *E. coli*), mg/L, or micrograms per liter ( $\mu\text{g/L}$ ). Water quality data are also provided where collected from 2021 through 2024; these data are provided for reference only from MPCA's publicly available data (MPCA 2025e) and should not be considered as officially assessed data.

Assessment results are provided for Cycle 1 and Cycle 2 for certain parameters similar to how they were provided in Section 3, showing if the stream reach is found to meet ("MTS") or exceed/fail to meet ("EXS") the applicable water quality standards. Assessment results may also be insufficient ("IF"), meaning not enough data were available to make an assessment finding, inconclusive ("IC"), meaning assessed data were ambiguous or not convincing either way, or not assessed ("NA"), meaning there were no or very little data available for assessments. It is important to note that pollutant concentrations for some parameters, such as TSS, may meet or be within the numeric water quality standard but still be noted with an assessment result of EXS and be listed as impaired. This is because that parameter may have a percentage of assessed samples that is above the allowed exceedance rate (i.e., >10%) for that parameter. Conversely, concentrations for some parameters may exceed or fail to meet the numeric standard but still be noted with an assessment result of MTS or IF; this is generally

because there may not be enough data to complete an assessment. Additionally, pollutant concentrations for some parameters, such as TP, may exceed or fail to meet the numeric standard, be noted with an assessment result of EXS, IF, or NA, but not be listed as impaired. This is typically because there is not enough data for supporting variables to list as impaired.

Some WIDs simply indicate “impaired – turbidity” for the TSS parameter. In 2015, the MPCA was approved to replace the historically used turbidity standards with standards for TSS. These WIDs are generally listed as impaired due to turbidity but had no or insufficient data for TSS from within or prior to Cycle 1.

Suggested water quality goals are provided for most parameters based on average pollutant concentrations or IBI scores in relation to applicable water quality standards. These suggested goals are a starting point and should be further evaluated, explored, and refined in local planning efforts, including in future versions of the BRRW CWMP. Goals are further discussed in Section 7.

Next, prioritization sources may be provided for certain parameters. These sources might include reports completed previously by MPCA, including WRAPS, TMDLs, SID reports for streams, and more. Additional indicators for these reports clarify if the source was completed as part of Cycle 1 (C1) or Cycle 2 (C2) watershed approach efforts. Other prioritization sources might include the BRRW CWMP (HEI 2020, “CWMP priority”), the Surface Water Intake Protection Plan for the Moorhead Public Service Public Water System (MDH 2023), the *Buffalo River Watershed Stressor Identification Report – Lakes* (DNR 2023a, “SID-Lakes”), and others.

Finally, notes for individual water bodies are generally provided. These notes may provide additional information for the water quality data, assessment results, or the prioritization source, identify capital improvement projects or other large-scale restoration or protection efforts for that WID, or provide additional recommendations such as the collection of additional water quality data.

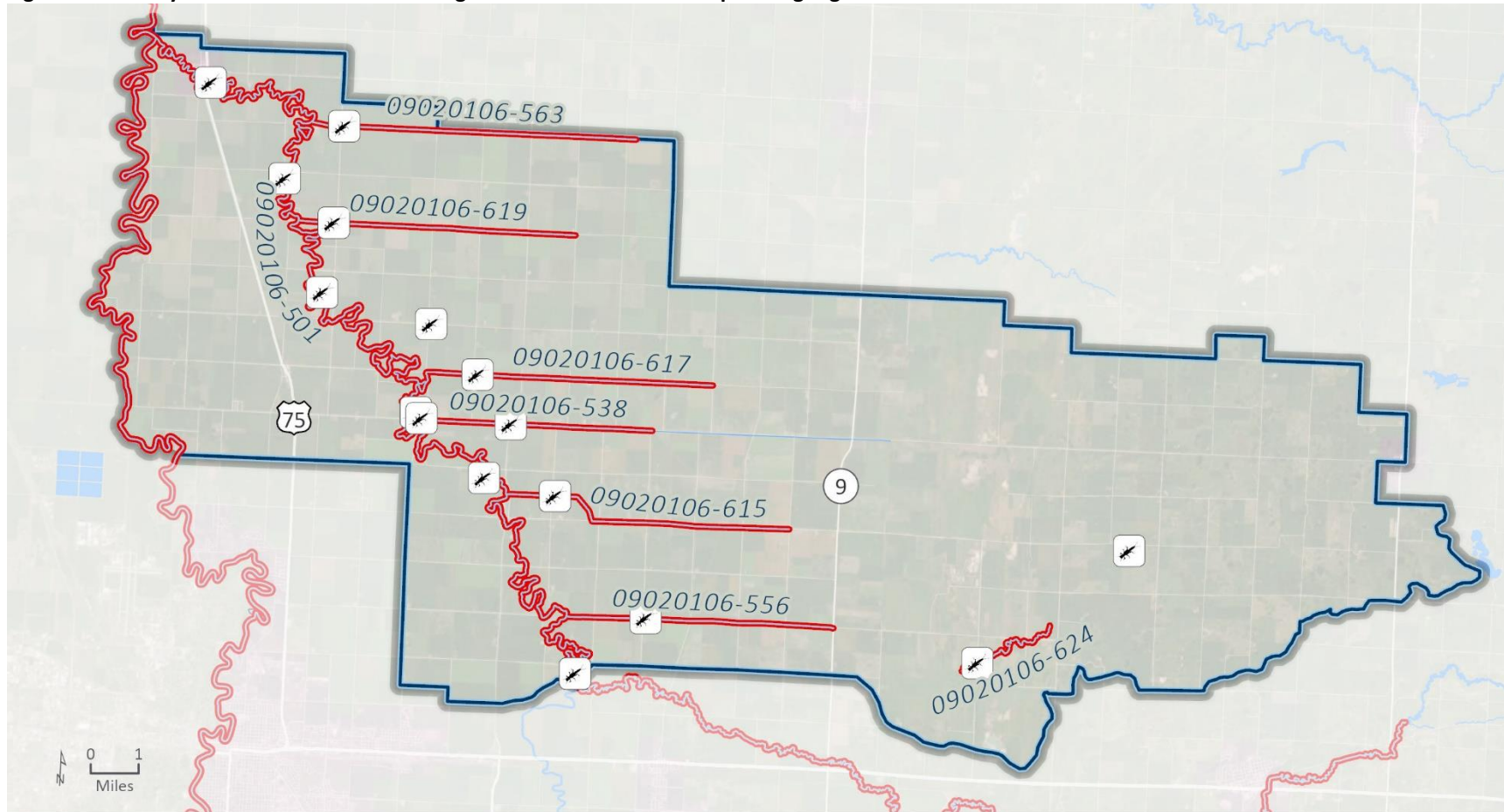
Blank cells indicate no available data or provided information for that parameter or field.

## 5.1 Northern planning region

The Northern planning region encompasses approximately 225 square miles, with the primary land use in the region being cultivated cropland and almost all the land being under private ownership (HEI 2020). The planning region includes the Buffalo River starting at the confluence of the “upper” Buffalo River and the Buffalo River, South Branch (WID 09020106-501), as well as several county ditches that drain into the Buffalo River from roughly Glyndon to Georgetown.

Of the eight assessed stream segments in the Northern planning region, all feature at least one parameter that was found in 2018 and/or 2021 to exceed or fail to meet the applicable AQL use standard (Table 1). For the AQR use, one stream segment was found to exceed or fail to meet the applicable *E. coli* bacteria standard, while one was assessed but had insufficient information to make a determination, and the rest were not assessed. While the Buffalo River (WID 09020106-501) was found to support healthy fish and macroinvertebrate communities, the stream segment failed to meet the standards for TSS, TP, and *E. coli* bacteria. The Northern planning region also has one lake that had insufficient information to complete an assessment (Table 2).

Figure 19. Priority water bodies and monitoring locations in the Northern planning region.



**Northern Planning Region**

*WRAPS Priority Waterbodies Labelled*

— 2024 Impaired Water

**Stream Priority Class**

— A (High priority)

— B (Medium priority)

- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensativity**

- Impaired
- Highest
- Higher
- High

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**Table 8. Water quality data and assessment results for select water bodies in the Northern planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-501	Buffalo River	<i>E. coli</i> (MPN / 100 mL)	126 1,260	202	EXS	185	EXS	119	Remove human sources	C1 TMDL	*Identified as a priority water resource in the BRRWD CWMP (HEI 2020).
		F-IBI	Varies	72	MTS	73	MTS	64	F-IBI 65+		
		M-IBI	Varies	37	MTS	40	MTS	40	M-IBI 40+		
		TSS (mg/L)	65	Impaired-Turbidity		96	EXS	53.6	<50 mg/L, <40% EXS rate		
		DO (mg/L)	5	7.2	MTS	7	MTS	8.4	>7 mg/L, <10% EXS rate		
		TP (µg/L)	150	234	EXS	242.7	EXS	178	<200 µg/L	CWMP priority	
09020106-538	County Ditch 25 (County Ditch 65)	F-IBI	Varies	0	EXS	0	EXS			C2 SID; C2 TMDL	*No fish sampled-biological monitoring suggests severe impairment.
		M-IBI	Varies	7	EXS	17	EXS		M-IBI 20+		
		DO (mg/L)	5	0.65	NA	2	IF		>2 mg/L, <80% EXS rate		
		TP (µg/L)	150	888	NA	264	IF		<250 µg/L		
09020106-556	County Ditch 2	F-IBI	Varies	49	MTS			18	F-IBI 40+		*Cycle 1 <i>E. coli</i> impairment with no new data. *New M-IBI impairment C2. *Identified as a priority water resource in the BRRWD CWMP (HEI 2020).
		M-IBI	Varies	24	MTS	13	EXS		M-IBI 20+	C2 SID	
		TSS (mg/L)	65	5.6	NA	5	IF	2.9	<10 mg/L, <10% EXS rate	CWMP priority	
		TP (µg/L)	150	78	NA	46	IF	48	< 50 µg/L		
09020106-563	County Ditch 5 (County Ditch 8)	F-IBI	Varies	34	MTS	16	EXS		F-IBI 20+	C2 SID	*New F-IBI and M-IBI impairments C2.
		M-IBI	Varies	0	EXS	21	EXS		M-IBI 20+	C2 SID	
		TSS (mg/L)	65	5.6	NA	12.9	IF		<15 mg/L, <10% EXS rate		
		DO (mg/L)	5	4.6	NA	3.7	IF		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	184	NA	671	IF		<250 µg/L		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-615	County Ditch 3	F-IBI	Varies	0	EXS	38	MTS		F-IBI 30+	C2 SID	*Deferred F-IBI and new M-IBI impairments C2.
		M-IBI	Varies	4	EXS	6	EXS		M-IBI 10+	C2 SID	
		TSS (mg/L)	65	11.8	NA	17	IF		<15 mg/L, <10% EXS rate		
		DO (mg/L)	5	10.8	NA	2.3	IF		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	575	NA	459	IF		<350 µg/L		
09020106-617	County Ditch 39	F-IBI	Varies	55	MTS	18	EXS		F-IBI 20+	C2 SID	*Cycle 1 <i>E. coli</i> impairment with no new data. *New F-IBI and M-IBI impairments C2.
		M-IBI	Varies	12	EXS	19	EXS		M-IBI 20+	C2 SID	
		TSS (mg/L)	65	39	IF	6.7	IF		<15 mg/L, <10% EXS rate		
		DO (mg/L)	5	7.8	NA	3	IF		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	140	NA	93	IF		<150 µg/L		
09020106-619	County Ditch 10	<i>E. coli</i> (MPN / 100 mL)	126 1,260	351	EXS	181	IF		Remove human sources	C1 TMDL	*Cycle 1 <i>E. coli</i> impairment with IF data C2. *New DO and M-IBI impairments C2 caused by eutrophication – see C2 TMDL Report.
		F-IBI	Varies	48	MTS	48	MTS		F-IBI 50+		
		M-IBI	Varies	9	EXS	15	EXS		M-IBI 20+	C2 SID; C2 TMDL	
		TSS (mg/L)	65	19.7	MTS	13.9	MTS		<15 mg/L, <10% EXS rate		
		DO (mg/L)	5	8.9	NA	5.8	EXS		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	223	NA	212	EXS		<150 µg/L	C2 TMDL	
09020106-624	Unnamed creek	F-IBI	Varies	12	EXS				F-IBI 15+	C2 SID	*Deferred F-IBI and M-IBI impairments.
		M-IBI	Varies	35	EXS				M-IBI 40+	C2 SID	
		DO (mg/L)	5	7.9	NA	6	IC		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	109	NA	251	IF		<200 µg/L		

## 5.2 Mainstem planning region

The Mainstem planning region covers roughly 304 square miles. The primary land use in the region is cultivated cropland, with hay and pasture, wetlands, and open water mixed in. While most of the land is under private ownership, the planning region features the municipalities of Glyndon, Hawley, Lake Park, and Audubon, as well as significant portions of public land including the Hamden Slough National Wildlife Refuge and the Buffalo River State Park (HEI 2020). A small portion of the planning region also lies within the White Earth Reservation (Figure 5). Primary water resources in the planning region include most of the “upper” Buffalo River (WIDs 09020106-593, -594, and -595) and several lakes.

There were 14 stream segments evaluated in 2018 and/or 2021 in the Mainstem planning region (Table 1). Of those, ten were found to have at least one parameter that failed to meet their applicable AQL use standard. Two stream segments were found to fully support for AQL, including Hay Creek (WID 09020106-513) and Unnamed ditch (Becker County Ditch 15) (WID 09020106-607), the latter of which had fish and macroinvertebrate communities found to be vulnerable to impairment suggesting that stream segment is worthy of protection considerations (Section 4.4). All six of the stream segments in the planning region that had sufficient data to assess for the AQR use failed to meet the applicable *E. coli* bacteria standards.

There were 29 lakes evaluated in the planning region, most of which had insufficient information to complete an assessment (Table 2). Of those, six were assessed as failing to meet the AQR use standards, all of which were previously listed as impaired due to excess nutrients and eutrophication. An additional six lakes in the planning region were assessed as impaired due to nutrients in Cycle 1 but had insufficient information for assessments in Cycle 2. Furthermore, Boyer Lake (03-0579-00) was found to be “barely” impaired, while Sand Lake (03-0618-00) was previously found to be “nearly” impaired. Of the six lakes assessed for AQL, all were found to be meeting their respective F-IBI standard. However, Lee (14-0049-00) and Silver (14-0100-00) lakes were found to have fish communities noted as VUL (Section 4.3, DNR 2023a). Boyer, Sand, Lee, Silver, and East LaBelle lakes are identified as candidates for restoration or protection considerations (Table 9).

While the “upper” Buffalo River (WIDs 09020106-593, -594, and -595) was assessed in 2021 as exceeding the applicable TSS and *E. coli* standards (Table 1), significant efforts have been made by the Becker Soil and Water Conservation District (SWCD), BRRWD, landowners, and other partners in these subwatersheds for the implementation of sediment reduction BMPs and other projects to improve water quality and stream habitat conditions. From 2004 through 2024, over 300 water and sediment control basin BMPs, 8 grade stabilization BMPs, over 2,000 feet of grassed waterways, more than 3,000 acres of cover crops, and thousands of acres of conservation tillage practices have been implemented in the subwatersheds contributing to WIDs 09020106-593 and 09020106-594, plus many other various projects and practices (MPCA 2025q, Figure 21). These two stream segments are also identified as part of the proposed Upper Buffalo River Restoration capital improvement project, aiming to restore and stabilize 3.5 miles of the river in Callaway and Riceville townships (BRRWD 2025a). Furthermore, in 2023 the BRRWD began construction on the Glyndon East Tributary project, which restored 9 miles of an unassessed tributary (09020106-532) to the Buffalo River near Glyndon (09020106-595) by cleaning out accumulated sediment, repairing the stream channel, installing 20 sediment BMPs, and restoring 130 acres of habitat (BRRWD 2025a).

Additional water quality monitoring should be conducted for these stream segments in the future. Available water quality data from 2021 through 2024 suggests that WID 09020106-593 may now be meeting the applicable TSS standard, while TSS concentrations are improving but still exceeding the applicable standards for WIDs 09020106-594 and 09020106-595 (MPCA 2025e). These data support the need for the Upper Buffalo River Restoration project and continued implementation efforts in the Mainstem planning region.

**Figure 20. Existing erosion on the “upper” Buffalo River (09020106-593) (BRRWD 2025a).**



Figure 21. BMPs implemented from 2004-2024 in the subwatersheds of the “upper” Buffalo River (WIDs 09020106-593 & 09020106-594, BWSR 2025a).

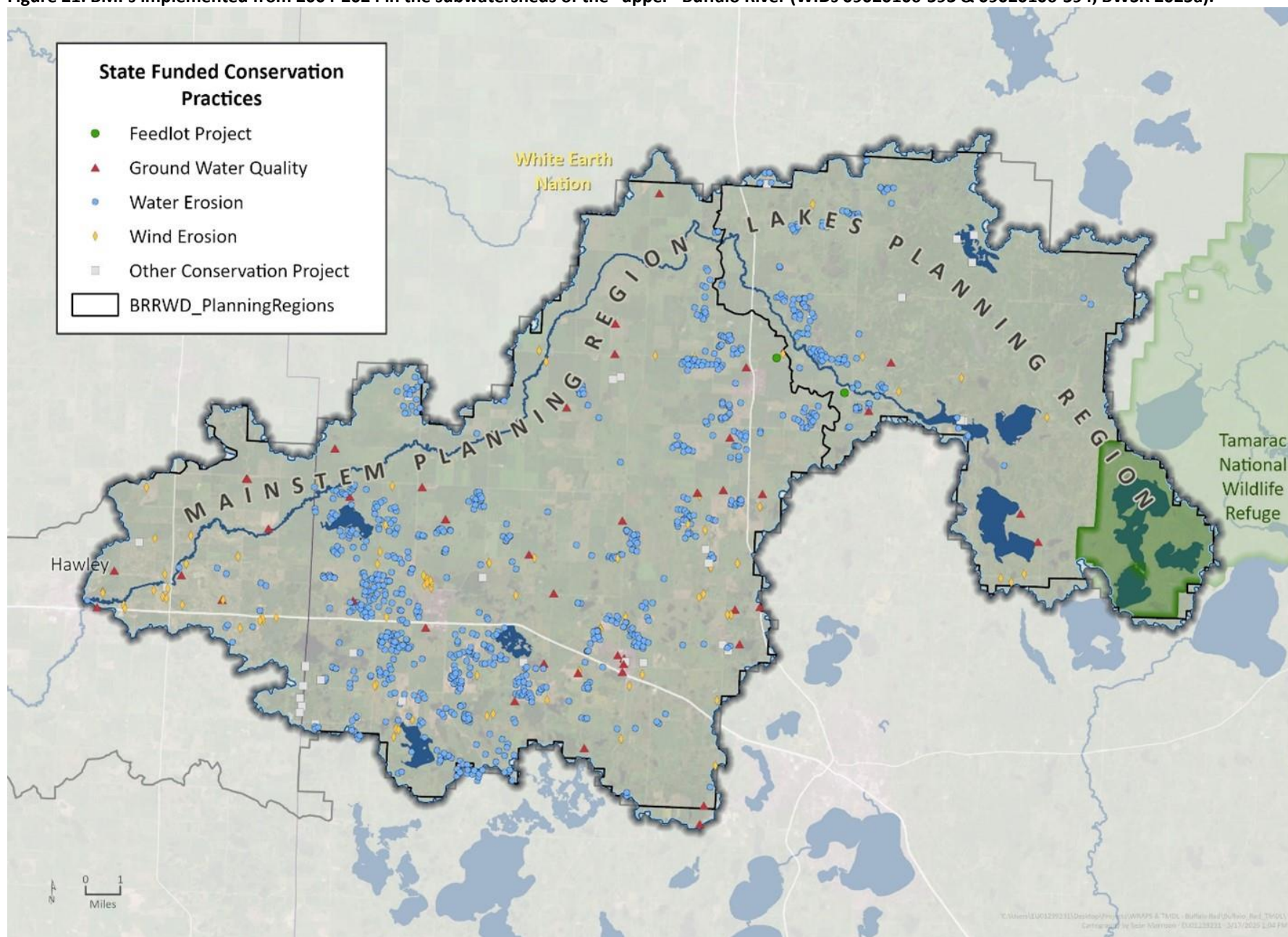
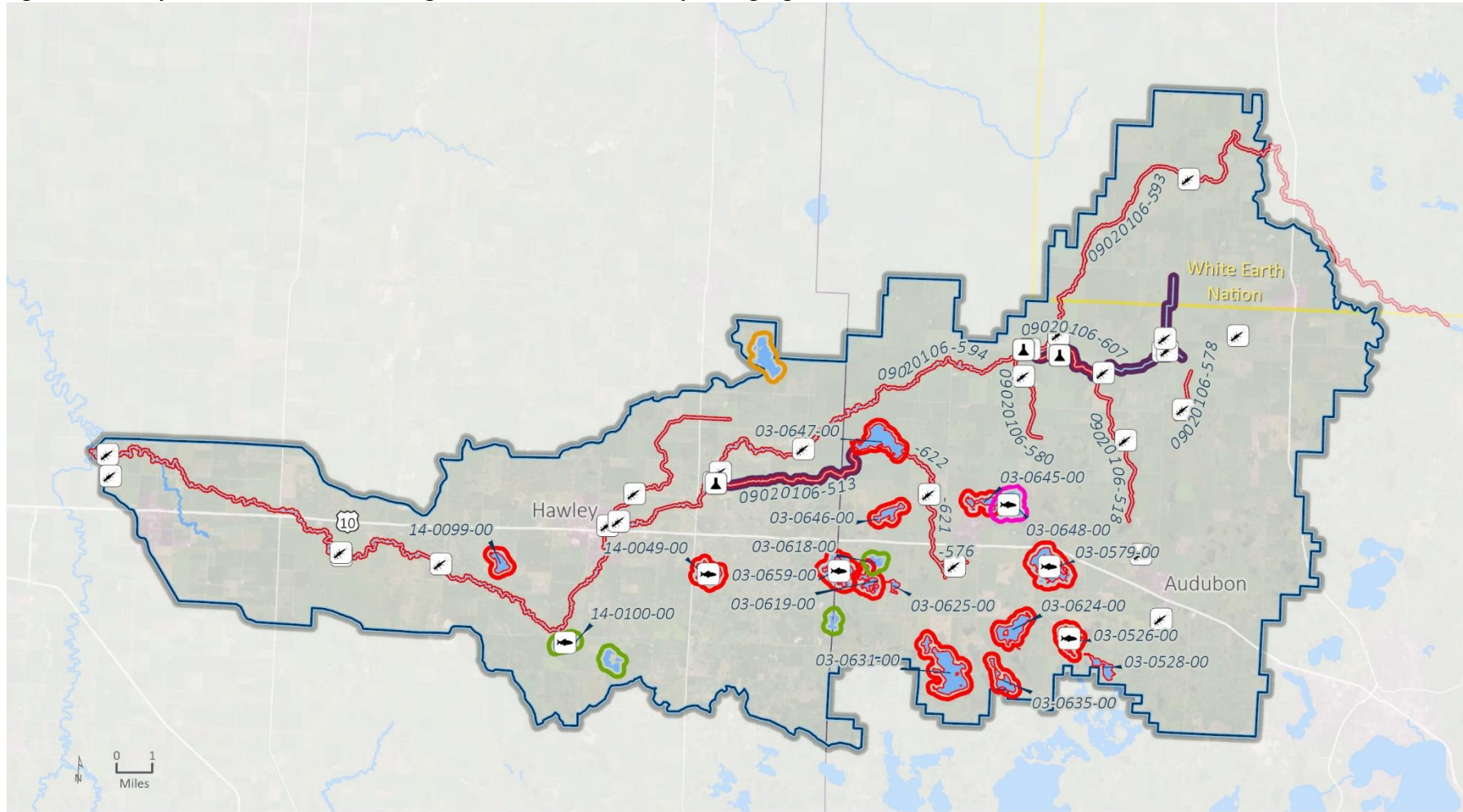


Figure 22. Priority water bodies and monitoring locations in the Mainstem planning region.



**Mainstem Planning Region**

WRAPS Priority Waterbodies Labelled

— 2024 Impaired Water

**Stream Priority Class**

— A (High priority)

— B (Medium priority)



Core Chemistry Monitoring Site



Biological Monitoring Site



Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensativity**



Impaired



Highest



Higher



High

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**Table 9. Water quality data and assessment results for select water bodies in the Mainstem planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-513	Hay Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260			369	EXS	295	Remove human sources	New C2 impairment	*New <i>E. coli</i> impairment C2. *M-IBI scores met standards but noted as vulnerable. *Identified as a priority water resource in the BRRWD CWMP (HEI 2020). *MPCA protection priority class A (Section 4.4).
		F-IBI	Varies	66	MTS	57	MTS		F-IBI 60+		
		M-IBI	Varies	34	MTS	37	MTS		M-IBI 35+		
		TSS (mg/L)	30			7.84	MTS	9	<10 mg/L, <10% EXS rate	CWMP priority	
		DO (mg/L)	5	8.04	IF	7.6	IC	7.9	>5 mg/L, <10% EXS rate		
		TP (µg/L)	100	242	EXS	289.0	EXS	288	<250 µg/L	CWMP priority	
09020106-518	Unnamed stream (Becker County Ditch 15 Br 7)	F-IBI	Varies	66	MTS	59	MTS		F-IBI >= 60		*New M-IBI impairment C2.
		M-IBI	Varies	30	MTS	12.0	EXS		M-IBI 20+	C2 SID	
		TSS (mg/L)	30	4	NA	3.8	IF	23.5	<20 mg/L, <10% EXS rate		
09020106-576	Unnamed creek	F-IBI	Varies			0	EXS		N/A	C2 SID	*No fish sampled-complete barriers to connectivity.
09020106-577	Unnamed ditch (Becker County Ditch 15)***	<i>E. coli</i> (MPN / 100 mL)	126 1,260			293	IF		Prevent impairment		*MPCA protection priority class A (Section 4.4).
		TSS (mg/L)	30	3.2	NA	1.8	NA		<5 mg/L, <10% EXS rate		
		TP (µg/L)	150	230	IF	336	IF		<250 µg/L		
09020106-593	Buffalo River***	<i>E. coli</i> (MPN / 100 mL)	126 1,260	904	EXS	323	EXS	140	Remove human sources	C1 TMDL	*Continue efforts for Upper Buffalo River Restoration project. *Collect additional data to pursue delisting of Turbidity/TSS impairment.
		F-IBI	Varies	40	EXS	50	EXS		Remove barriers to connectivity; F-IBI 60+	C1 & C2 SID	
		M-IBI	Varies	38	EXS	54	MTS		M-IBI 55+	C1 SID	

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-593	Buffalo River***	TSS (mg/L)	30	Impaired-Turbidity		20	EXS	10.3	<20 mg/L, <10% EXS - impairment delisted	CWMP priority	*Partially within White Earth tribal boundaries. *Noted as BRRW CWMP priority for hydrology and flooding, noted also as a Capital Improvement Project (HEI 2020).
		DO (mg/L)	5	8.5	IF	8	IF	10.1	>8 mg/L, <10% EXS rate		
		TP (µg/L)	150	72	MTS	63	MTS	25	<60 µg/L - continue reductions	CWMP priority	
09020106-594	Buffalo River	<i>E. coli</i> (MPN / 100 mL)	126 1,260	719	EXS	607	EXS	272	Remove human sources	C1 TMDL	*Identified as a priority water resource in the BRRWD CWMP (HEI 2020). *Noted as BRRW CWMP priority for hydrology and flooding (HEI 2020). *Continue efforts within the watershed and upstream to reduce pollutant loading.
		F-IBI	Varies	46	MTS	58	MTS		F-IBI 60+		
		M-IBI	Varies	57	MTS	63	MTS		M-IBI 60+		
		TSS (mg/L)	30	Impaired-Turbidity		38	EXS	26	<30 mg/L, <40% EXS rate	CWMP priority	
		DO (mg/L)	5	9.1	IF	8.3	MTS	9.3	>8 mg/L		
		TP (µg/L)	150	113	MTS	149	INC	127	<120 µg/L	CWMP priority	
09020106-595	Buffalo River	<i>E. coli</i> (MPN / 100 mL)	126 1,260	279	EXS	368	EXS	178	Remove human sources	C1 TMDL	*Identified as a priority water resource in the BRRWD CWMP (HEI 2020). *Noted as BRRW CWMP priority for hydrology and flooding (HEI 2020).
		F-IBI	Varies	56	MTS	66	MTS	77	F-IBI 65+		
		M-IBI	Varies	46	MTS	59	MTS	61	M-IBI 60+		
		TSS (mg/L)	65	Impaired-Turbidity		82	EXS	58	<50 mg/L, <40% EXS rate	CWMP priority	
		DO (mg/L)	5	9.1	IF	8.3	MTS	9.5	>8 mg/L		
		TP (µg/L)	150	163	EXS	210	EXS	145	<150 µg/L, prevent impairment	CWMP priority	
09020106-606	Unnamed ditch (Becker County Ditch 15)	<i>E. coli</i> (MPN / 100 mL)	126 1,260			1733	IF		Remove human sources		*MPCA protection priority class A (Section 4.4).
		TSS (mg/L)	30	17.8	NA	34	IF		<30 mg/L, <10% EXS rate		
		TP (µg/L)	150	190	NA	353	IF		<250 µg/L		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-607	Unnamed ditch (Becker County Ditch 15)	<i>E. coli</i> (MPN / 100 mL)	126 1,260			425	EXS	277	Remove human sources	C1 TMDL	*F-IBI scores met standards but noted as vulnerable. *M-IBI scores met standards but noted as vulnerable. *TSS identified as nearly impaired/vulnerable to impairment. *MPCA protection priority class A (Section 4.4).
		F-IBI	Varies	49	MTS	46	MTS		F-IBI 45+		
		M-IBI	Varies	39	MTS	36	MTS		M-IBI 40+		
		TSS (mg/L)	30	9.7	NA	13.8	EXS	17.6	<20 mg/L, <10% EXS rate		
		DO (mg/L)	5	10.6	NA	9.1	IF	10.8	>9 mg/L,		
		TP (µg/L)	150	164	NA	162	IC	164	<150 µg/L, prevent impairment		
09020106-621	Hay Creek	F-IBI	Varies	12	EXS				Address stressors	C2 SID; C2 TMDL	*Identified as a priority water resource in the BRRWD CWMP (HEI 2020). *Upstream of a nutrient-impaired lake.
		TSS (mg/L)	30			30.5	IF		<30 mg/L, <10% EXS rate		
		DO (mg/L)	5	3.9	NA	6.6	IF		>5 mg/L, <10% EXS rate		
		TP (µg/L)	100	184	NA	286	IF		<250 µg/L	CWMP priority	
09020106-622	Hay Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260			708	EXS	164	Remove human sources	C1 TMDL	*Identified as a priority water resource in the BRRWD CWMP (HEI 2020). *Upstream of a nutrient-impaired lake.
		TSS (mg/L)	30			17.3	EXS	11.6	<15 mg/L, <10% EXS rate	C2 TMDL	
		DO (mg/L)	5			8.5	IF	10.3	>9 mg/L, <10% EXS rate		
		TP (µg/L)	100			306	EXS	302	<250 µg/L	CWMP priority	
03-0526-00	Marshall	TP (µg/L)	40	42	EXS	49	EXS		<40 µg/L	C1 TMDL; CWMP priority	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020). *Additional degradation may impact F-IBI scores.
		Chl- <i>a</i> (µg/L)	14	21	EXS	29	EXS		<14 µg/L		
		Secchi (m)	1.4	1.9	MTS	1	EXS		>1.4 m		
		F-IBI	38			47	MTS		F-IBI 45+		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
03-0579-00	Boyer	TP (µg/L)	40	54	EXS	57	EXS		<40 µg/L	C1 TMDL; CWMP priority	*Mesotrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020). *Additional degradation may impact F-IBI scores.
		Chl- <i>a</i> (µg/L)	14	24	EXS	13	IF		<14 µg/L		
		Secchi (m)	1.4	2.4	MTS	3.2	MTS		>2.5 m		
		F-IBI	24			31	MTS		F-IBI 30+	SID-Lakes	
03-0618-00	Sand	TP (µg/L)	60	83	IF	72	IF		<60 µg/L		*Eutrophic lake. *Noted as nearly impaired; would be impaired with sufficient data for assessment. *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	20	9	IF	30	IF		<20 µg/L		
		Secchi (m)	1	1.1	IF	1.8	IF		>1 m		
03-0619-00	Talach	TP (µg/L)	60	93	EXS	73	EXS		<60 µg/L	C1 TMDL	*Mesotrophic lake.
		Chl- <i>a</i> (µg/L)	20	34	EXS	39	EXS		<20 µg/L		
		Secchi (m)	1	1.9	MTS	2.1	MTS		>1 m		
03-0624-00	Forget-Me-Not	TP (µg/L)	60	82	EXS	105	IF		<70 µg/L	C1 TMDL	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	20	27	EXS	52	IF		<30 µg/L		
		Secchi (m)	1	0.9	EXS				>1 m		
03-0625-00	Sorenson	TP (µg/L)	60	178	EXS	111	EXS		<100 µg/L	C1 TMDL	*Eutrophic lake.
		Chl- <i>a</i> (µg/L)	20	41	EXS	48	EXS		<30 µg/L		
		Secchi (m)	1	1.8	MTS	1.5	IC		>1 m		
03-0631-00	Stakke	TP (µg/L)	60	64	EXS	82	EXS		<70 µg/L	C1 TMDL	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	20	30	EXS	41	EXS		<30 µg/L		
		Secchi (m)	1	2	MTS	2.2	MTS		>2 m		
03-0645-00	West LaBelle	TP (µg/L)	60	89	EXS	52	IF		<60 µg/L	C1 TMDL	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	20	41	EXS	29	EXS		<20 µg/L		
		Secchi (m)	1	1.3	MTS				>1 m		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
03-0646-00	Lime	TP (µg/L)	60	138	EXS	190	EXS		<100 µg/L	C1 TMDL	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	20	63	EXS	113	EXS		<60 µg/L		
		Secchi (m)	1	0.84	EXS	0.4	EXS		>1 m		
03-0647-00	Stinking	TP (µg/L)	60	309	EXS	341	EXS		<250 µg/L	C1 TMDL	*Hypereutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	20	96	EXS	126	EXS		<100 µg/L		
		Secchi (m)	1	0.66	EXS	0.3	EXS		>1 m		
03-0648-00	East LaBelle	TP (µg/L)	60	38	IF	92	IF		<60 µg/L	CWMP priority	*Eutrophic lake. *Identified as a priority water resource in the BRRW CWMP (HEI 2020). *MPCA protection priority class A (Section 4.4).
		Chl- <i>a</i> (µg/L)	20	15	IF	48	IF		<20 µg/L		
		Secchi (m)	1	2.2	MTS				>1 m		
		F-IBI	24			52	MTS		F-IBI 50+	SID-Lakes	
03-0659-00	Sand	TP (µg/L)	40	125	EXS	66	IF		<60 µg/L	C1 TMDL	*Mesotrophic lake.
		Chl- <i>a</i> (µg/L)	14	32	EXS	17.5	IF		<15 µg/L		
		Secchi (m)	1.4	2.1	MTS	2.6	IF		>2 m		
		F-IBI	24			35, 53	MTS		F-IBI 40+	SID-Lakes	
14-0049-00	Lee	TP (µg/L)	40	52	EXS	61	IF		<50 µg/L	C2 TMDL	*Eutrophic lake. *F-IBI identified as vulnerable to impairment. *DNR SID-Lakes notes as a "top priority for restoration."
		Chl- <i>a</i> (µg/L)	14	21	EXS	24.6	IF		<20 µg/L		
		Secchi (m)	1.4	1.1	EXS	1.3	IF		>1.4 m		
		F-IBI	24			38, 29	MTS-VULN		F-IBI 35+	SID-Lakes	
14-0100-00	Silver	TP (µg/L)	40	49.5	IF	56	IF		<50 µg/L	SID-Lakes	*Mesotrophic lake. *F-IBI identified as vulnerable to impairment. *DNR SID-Lakes notes as a "top priority for restoration." *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	14	IF	10	IF		<14 µg/L		
		Secchi (m)	1.4	1.8	IF	2.6	IF		>1.4 m		
		F-IBI	38			44, 44	MTS-VULN		F-IBI 40+		

\*\*\*Stream WID is partially within the White Earth Reservation boundary and begins in the Lakes planning region.

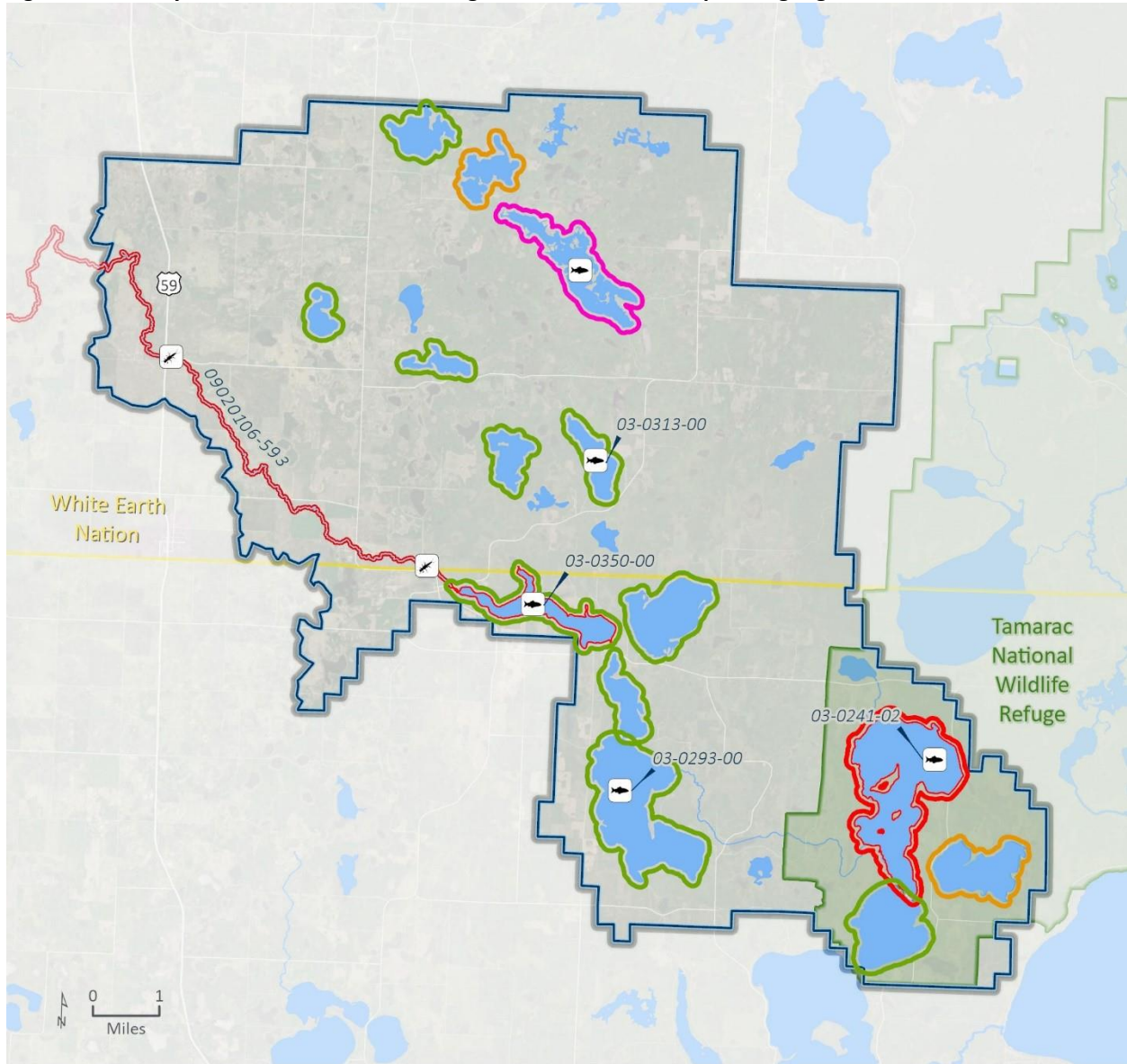
### 5.3 Lakes planning region

The Lakes planning region spans 106 square miles, a little over half of which is within the White Earth Reservation (Figure 5). Land cover within the planning region includes a mix of cultivated cropland, hay and pasture, forest, wetlands, and open water. Land ownership is also a mix of private and public, including parts of the Tamarac National Wildlife Refuge (HEI 2020). Rock (03-0293-00), Big Sugar Bush (03-0304-00), Little Sugar Bush (03-0313-00), and Buffalo (03-0350-00) lakes have been identified as priority lakes within the planning region (Section 4.4, Table 10).

The only stream segment in the Lakes planning region with sufficient data for an assessment in Cycle 2 is the headwaters reach of the “upper” Buffalo River (WID 09020106-593), which begins in the Lakes planning region but is covered in the previous section for the Mainstem planning region (Table 1). There were 13 lakes evaluated in the planning region, 5 of which had assessable data in Cycle 2 for the AQR use (Table 2). North Tamarack Lake (03-0241-02) was the only lake assessed as exceeding the AQR use standards; this lake has previously been listed as impaired due to excess nutrients and eutrophication. This lake has also been previously identified by MPCA as “barely” impaired as being due to natural background conditions, as the lake is well protected by natural shoreline vegetation, and the majority of its subwatershed is wetlands and forest lying primarily within the Tamarac National Wildlife Refuge. Pine (03-0200-00), South Tamarac (03-0241-01), and North Tamarac (03-0241-02) lakes, also within the Tamarac National Wildlife Refuge, were assessed in 2021 using data from 2010-2015. Since the assessments, data from 2016-2024 have been provided to the MPCA for these lakes; these data are included in the Cycle 2 and 2021-2024 data fields in Table 10.

Five lakes in the planning region were also assessed for AQL use, with all five found to be meeting their respective F-IBI standards (Table 2). The F-IBI score of 70 for Little Sugar Bush Lake (03-0313-00) was noted as “exceptional” and is over 30 points higher than the impairment threshold for that lake (Section 4.3, DNR 2023a).

Figure 23. Priority water bodies and monitoring locations in the Lakes planning region.



**Lakes Planning Region**

- WRAPS Priority Waterbodies Labelled*
- 2024 Impaired Water
- Stream Priority Class**
- A (High priority)
- B (Medium priority)

- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensitivity**

- Impaired
- Highest
- Higher
- High

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**Table 10. Water quality data and assessment results for select water bodies in the Lakes planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
03-0200-00	Pine	TP (µg/L)	30	24	MTS	19	MTS	16	<18 µg/L		*Mesotrophic lake. *MPCA protection priority class B (Section 4.4).
		Chl- <i>a</i> (µg/L)	9	8	MTS	5	MTS	5	<5 µg/L		
		Secchi (m)	2	2.1	MTS	2.5	MTS	2.6	>2.5 m		
03-0241-01	South Tamarack	TP (µg/L)	30	19.6	MTS	17	MTS	24	<18 µg/L		*Mesotrophic lake. *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	9	4	MTS	5	MTS	5	<5 µg/L		
		Secchi (m)	2	1.9	EXS	1.9	IC	1.8	>2 m		
03-0241-02	North Tamarack	TP (µg/L)	30	35.7	EXS	33	EXS	46	<35 µg/L		*Mesotrophic lake. *Natural background impairment.
		Chl- <i>a</i> (µg/L)	9	13	EXS	14	EXS	21	<14 µg/L		
		Secchi (m)	2	1.7	EXS	1.97	EXS	1.4	>2 m		
		F-IBI	36			62	MTS		F-IBI 60+	SID-Lakes	
03-0293-00	Rock	TP (µg/L)	60	27	MTS	33	MTS		<30 µg/L		*Mesotrophic lake. *Identified as a priority for improving shoreland stability and protection of wild rice in the BRRW CWMP (HEI 2020). *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	20	7	MTS	5.8	MTS		<6 µg/L	CWMP priority	
		Secchi (m)	1	1.8	MTS	2	MTS		>2 m		
		F-IBI	36			67	MTS		F-IBI 65+	SID-Lakes	
03-0302-00	Little Round*	TP (µg/L)	60	25	MTS	39	IF		<30 µg/L		*MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	20	3	MTS				<5 µg/L		
		Secchi (m)	1	0.8	EXS	0.2	IF		>1 m		
03-0304-00	Big Sugar Bush**	TP (µg/L)	40	13.2	MTS	11.4	MTS	10	<10 µg/L		*Oligotrophic lake. *MPCA protection priority class A (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	3	MTS	2.9	MTS	2	<3 µg/L		
		Secchi (m)	1.4	5.6	MTS	5.2	MTS	5.3	>5.5 m		
		F-IBI	45			54	MTS		F-IBI 55+	SID-Lakes	
03-0313-00	Little Sugar Bush**	TP (µg/L)	40	22.1	MTS	26	IF	25	<25 µg/L		*Mesotrophic lake. *Identified as a priority for improving shoreland stability and protection of wild rice in the BRRW CWMP (HEI 2020).
		Chl- <i>a</i> (µg/L)	14	11	MTS	20.6	IF	20	<14 µg/L		
		Secchi (m)	1.4	3	MTS	2.6	MTS	2.1	>2 m	CWMP priority	

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
03-0313-00	Little Sugar Bush**	F-IBI	38			70	MTS		F-IBI 70+	SID-Lakes	*F-IBI scores noted as exceptional.
03-0350-00	Buffalo*	TP (µg/L)	40	22.8	MTS				<25 µg/L	CWMP priority	*Mesotrophic lake. *Identified as a priority for improving shoreland stability and protection of wild rice in the BRRW CWMP (HEI 2020). *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	9	MTS				<10 µg/L		
		Secchi (m)	1.4	2.9	MTS		3.2		>3 m		
		F-IBI	45			55	MTS		F-IBI 55+	SID-Lakes	
03-0471-00	Mission**	TP (µg/L)	60	120	EXS	142	IF		<130 µg/L		Eutrophic lake. *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	20	76	EXS	107			<90 µg/L		
		Secchi (m)	1	0.6	EXS				>1 m		

\*Lake is partially within the White Earth Reservation boundary.

\*\*Lake is wholly within the White Earth Reservation boundary.

## 5.4 Central planning region

The Central planning region includes 326 square miles, most of which is privately owned with some public land mixed in. The primary land use is cultivated cropland, with hay and pasture, forest, and wetlands mixed in the middle and eastern portions of the planning region. The city of Barnesville is within the planning region, as well as a few smaller towns and communities (HEI 2020). The planning region includes the lower portion of the Buffalo River, South Branch (WIDs 09020106-503, 09020106-504), Stony Creek (09020106-502), Whisky Creek (09020106-509), and several upstream tributaries.

There were 13 stream segments evaluated in 2018 and/or 2021 in the Central planning region (Table 1). Of those, seven were found to have at least one parameter that failed to meet their applicable AQL use standard, and seven failed to meet the AQR use standard for *E. coli* bacteria. Three stream segments were found to be fully supporting for AQL, with Whisky Creek (09020106-610) found to have macroinvertebrate communities that are vulnerable to impairment. All three of these stream segments have been identified as worthy of protection considerations (Section 4.4) There were no stream segments found to be meeting the *E. coli* bacteria standard and fully supporting for AQR.

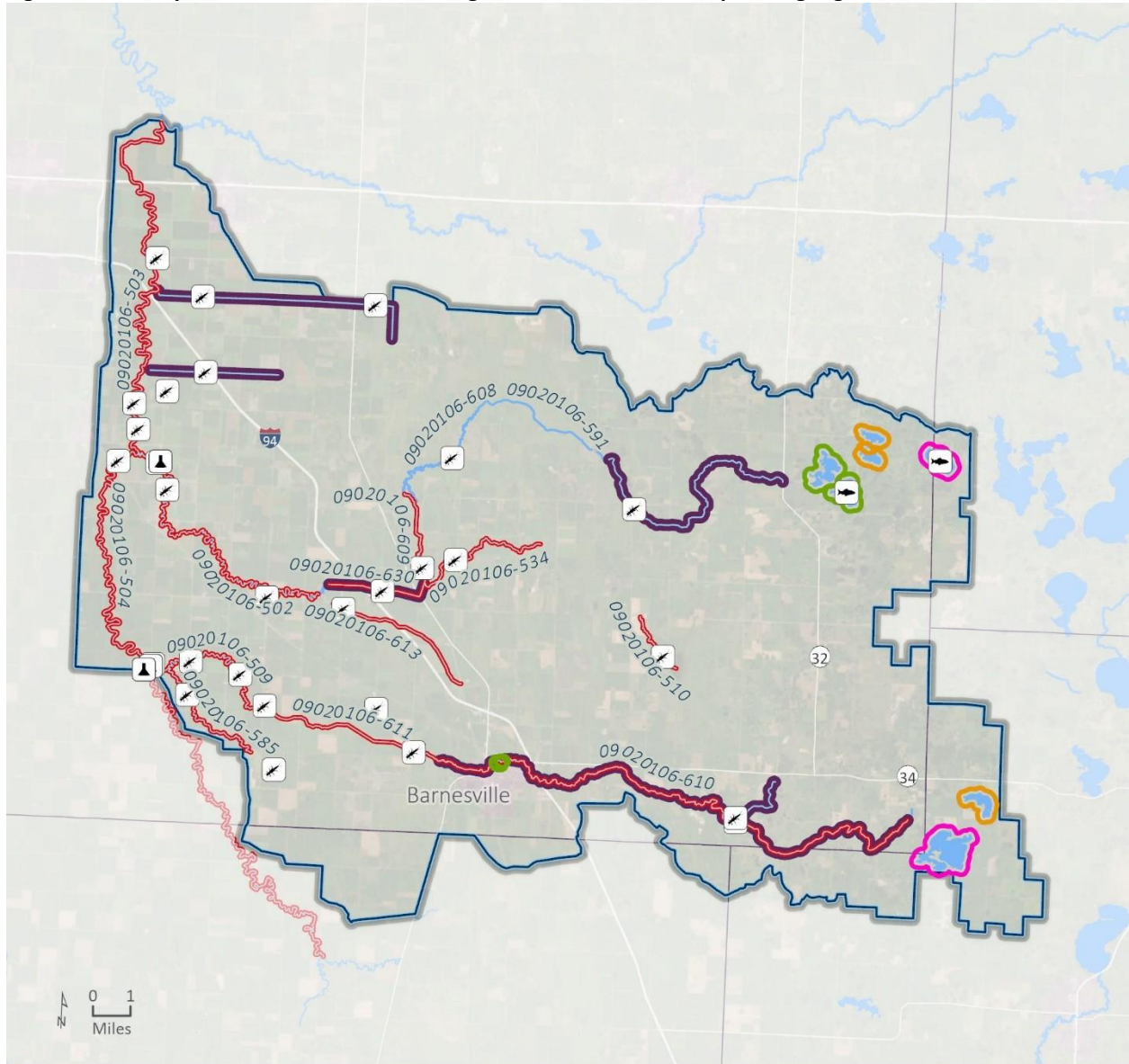
There were three lakes evaluated in the Central planning region in 2021 (Table 2). Turtle Lake (03-0657-00) was found to meet the applicable standards for both AQL and AQR and is identified as a priority for protection considerations (Section 4.4). Additionally, Turtle Lake is the only lake in the BRW found to have an improving water clarity trend, with a 1.3-foot improvement per decade over the last 40 years and a median water clarity that was 7 feet deeper than the watershed average in the latest evaluated year. Lake Fifteen (14-0300-00) was not assessed for AQR but was found to support AQL based on its F-IBI score meeting standards. Barnesville Lake (14-0093-00) was found to meet the applicable AQR standards but had insufficient data to assess for AQL. Barnesville Lake was also noted during 2021 assessments as having a public swimming area and also being connected to a bacteria-impaired stream.

The Buffalo River, South Branch (09020106-503 and 09020106-504), Stony Creek (09020106-502), and Whisky Creek (09020106-509) were all previously found to have elevated levels of TSS, TP, and *E. coli* bacteria, and frequent periods of low DO. However, TSS concentrations in these reaches are improving, with more recent water quality data from 2021 through 2024 suggesting that the Buffalo River, South Branch is either nearly meeting (09020106-504, 11% exceedance rate) or meeting (09020106-503, <5% exceedance rate) the applicable TSS standard. These stream segments and their tributaries are worthy of additional restoration efforts and additional water quality monitoring to re-evaluate these streams in the future. Examples of additional restoration efforts include the Stony Creek Restoration project (WID 09020106-613, completion in 2025, Figure 24) and the proposed Whisky Creek and South Tributary Channel Restoration project (WIDs 09020106-610, 09020106-611, and 09020106-585) (BRRWD 2025a).

Figure 24. Pre- (top) and post-project (bottom) photos of the Stony Creek Restoration project (BRRWD 2025a).



Figure 25. Priority water bodies and monitoring locations in the Central planning region.



### Central Planning Region

WRAPS Priority Waterbody

— 2024 Impaired Water

#### Stream Priority Class

— A (High priority)

— B (Medium priority)



Core Chemistry Monitoring Site



Biological Monitoring Site



Lakes with DNR IBI Fishery Score

#### Lakes of Phosphorus Sensativity

Impaired

Highest

Higher

High

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**Table 11. Water quality data and assessment results for select water bodies in the Central planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-502	Stony Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	560	EXS	416	EXS	262	Remove human sources	C1 TMDL	*TSS (17% EXS rate) and DO (14% EXS rate) are impaired due to >10% of assessable samples failing to meet standards. *Consider for restoration efforts and collect additional data to pursue delisting of impairments.
		F-IBI	Varies	62	MTS	58	MTS		F-IBI 60+		
		M-IBI	Varies			64	MTS		M-IBI 65+		
		TSS (mg/L)	65	Impaired-Turbidity		44	EXS	29.5	<30 mg/L, <10% EXS rate	C1 TMDL	
		DO (mg/L)	5	6.6	NA	6.2	EXS	7.9	>6.5 mg/L, <10% EXS rate		
		TP (µg/L)	150	185	EXS	216	EXS	212	<200 µg/L		
09020106-503	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 1,260	289	EXS	216	EXS	224	Remove human sources	C1 TMDL; CWMP priority	*New DO impairment C2. *TSS (13% EXS rate) is narrowly impaired due to >10% of discrete samples exceeding the standard. *Consider for restoration efforts and collect additional data to pursue Turbidity/TSS delisting. *Identified as a priority water resource in the BRRWD CWMP (HEI 2020).
		F-IBI	Varies	64	MTS			62	F-IBI 60+		
		M-IBI	Varies	34	MTS	46	MTS		M-IBI 45+		
		TSS (mg/L)	65	Impaired-Turbidity		46	IC	28	<30 mg/L, <10% EXS rate	C1 TMDL; CWMP priority	
		DO (mg/L)	5	6.1	IF	5.9	EXS	6.8	>6 mg/L, <20% EXS rate		
		TP (µg/L)	150	218	EXS	256	EXS	243	<200 µg/L		
09020106-504	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 1,260	281	EXS	198	EXS	211	Remove human sources	C1 TMDL	*New DO impairment C2. *TSS (12% EXS rate) is narrowly impaired due to >10% of discrete samples exceeding the standard. *Consider for restoration efforts and collect additional data to pursue Turbidity/TSS delisting.
		TSS (mg/L)	65	Impaired-Turbidity		36	EXS	28.8	<30 mg/L, <10% EXS rate	C1 TMDL;	
		DO (mg/L)	5	6.6	IF	6.2	EXS	6.4	>6 mg/L, <20% EXS rate		
		TP (µg/L)	150	196	EXS	230	EXS	193	<180 µg/L		
09020106-509	Whisky Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	350	EXS	519	EXS	520	Remove human sources	C1 TMDL	

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-509	Whisky Creek	F-IBI	Varies	56	EXS	52	EXS		F-IBI 55+	C2 SID	*DO is nearly impaired (~10% EXS rate). *TSS (19% EXS rate) is impaired due to >10% of discrete samples exceeding the standard. *Consider for restoration efforts.
		M-IBI	Varies	25	EXS	20	EXS		M-IBI 25+	C2 SID	
		TSS (mg/L)	65	Impaired-Turbidity		46.5	EXS	42.6	<40 mg/L, <15% EXS rate	C1 TMDL	
		DO (mg/L)	5	7	NA	6.7	IF	7.2	>6 mg/L, <15% EXS rate		
		TP (µg/L)	150	194	NA	243	EXS	211	<200 µg/L		
09020106-510	Stony Creek	M-IBI	Varies	12	EXS			24 (EXS)	M-IBI 25+		*Deferred M-IBI impairment. *Limited water quality data.
		TSS (mg/L)	65	4	NA	3.5	IF		<10 mg/L		
		DO (mg/L)	5	9.7	NA	6.5	IF		>6 mg/L		
		TP (µg/L)	150	42	NA	33	IF		< 40 µg/L		
09020106-534	Spring Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	471	EXS				Remove human sources.	C1 TMDL	*C1 impairments with no new data. *Noted as BRRW CWMP priority for hydrology and flooding (HEI 2020).
		F-IBI	Varies	43	EXS				F-IBI 45+	C1 SID; C2 SID	
		M-IBI	Varies	30	EXS				M-IBI 35+	C1 SID; C2 SID	
09020106-585	Unnamed creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260			269	EXS	100	Remove human sources	C1 TMDL	*New <i>E. coli</i> impairment. *Identified as part of a Capital Improvement Project (HEI 2020).
		TP (µg/L)	150	923	EXS	841	EXS	1,135	Reduce TP		
09020106-589	Hay Creek	F-IBI	Varies			6	NA	42	F-IBI 45+		*MPCA protection priority class A (Section 4.4).
		M-IBI	Varies			51	MTS		M-IBI 50+		
		TSS (mg/L)	65			4	IF		<10 mg/L		
		TP (µg/L)	100			134	IF		<130 µg/L		
09020106-609	Hay Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	Impaired		1,732	EXS		Remove human sources	C1 TMDL	*Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		F-IBI	Varies	0	EXS					C2 SID	
		M-IBI	Varies	18	EXS				M-IBI 20+	C2 SID	
		TSS (mg/L)	65	13.8	NA	22.3	MTS		<25 mg/L		
		DO (mg/L)	5	7.8	NA	7	IF		>7 mg/L		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-609	Hay Creek	TP (µg/L)	150	152	NA	173	EXS		<150 µg/L	CWMP priority	
09020106-610	Whisky Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260			691	EXS	656	Remove human sources	C1 TMDL	*New <i>E. coli</i> impairment C2. *Noted as BRRW CWMP priority for streambank instability, noted also as a Capital Improvement Project (HEI 2020). *MPCA protection priority class A (Section 4.4).
		F-IBI	Varies			61	MTS			CWMP	
		M-IBI	Varies			41	MTS			CWMP	
		TSS (mg/L)	65			12.4	MTS	9.4	<10 mg/L	CWMP	
		DO (mg/L)	5			7.8	IF	9.3	>8 mg/L		
		TP (µg/L)	150			82	MTS	99	<100 µg/L		
09020106-611	Whisky Creek (Clay Co. Ditch 34)	<i>E. coli</i> (MPN / 100 mL)	126 1,260	Impaired					Remove human sources	C1 TMDL	*C1 Turbidity and <i>E. coli</i> impairments. *Noted as BRRW CWMP priority for streambank instability, noted also as a Capital Improvement Project (HEI 2020).
		F-IBI	Varies	45	MTS					CWMP	
		M-IBI	Varies	28	MTS					CWMP	
		TSS (mg/L)	65	Impaired-Turbidity						C1 TMDL	
09020106-613	Stony Creek (Clay Co. Ditch 31)	<i>E. coli</i> (MPN / 100 mL)	126 1,260	609	EXS	522	IF	454	Remove human sources	C1 TMDL	*C1 Turbidity and <i>E. coli</i> impairments. *New F-IBI impairment C2. *Noted as BRRW CWMP priority for ditch bank and outlet instability, noted also as a Capital Improvement Project (HEI 2020). *Collect additional data to pursue Turbidity delisting.
		F-IBI	Varies	42	MTS	30	EXS		F-IBI 35+	C2 SID	
		M-IBI	Varies			46	MTS		M-IBI 48+		
		TSS (mg/L)	65	Impaired-Turbidity		36	IF	53.5	<50 mg/L, <10% EXS rate	C1 TMDL	
		DO (mg/L)	5	8.4	NA	9.5	IF	9.8	>9.5 mg/L		
		TP (µg/L)	150	108	NA	92	IF	106	<100 µg/L		
09020106-630	Hay Creek (Clay Co. Ditch 17)	<i>E. coli</i> (MPN / 100 mL)	126 1,260	Impaired					Remove human sources	C1 TMDL	*C1 <i>E. coli</i> and TSS impairments. *Collect additional data to further evaluate this reach. *MPCA protection priority class A (Section 4.4).
		F-IBI	Varies			38	MTS		F-IBI 40+		
		M-IBI	Varies			40	MTS		M-IBI 40+		
		TSS (mg/L)	65	Impaired		7.8	IF		<10% EXS rate		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
03-0657-00	Turtle	TP (µg/L)	40	12.3	MTS	10.4	MTS	8	<10 µg/L		*Oligotrophic lake. *MPCA protection priority class A (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	4	MTS	2.3	MTS	2	<2 µg/L		
		Secchi (m)	1.4	6.5	MTS	6.5	MTS	7.8	>7 m		
		F-IBI	45			53	MTS		F-IBI 55+	SID-Lakes	
14-0030-00	Fifteen	TP (µg/L)	40	33	MTS				<30 µg/L		*Mesotrophic lake. *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	14	IF				<14 µg/L		
		Secchi (m)	1.4	2.2	MTS				>2 m		
		F-IBI	24			85	MTS		F-IBI 80+	SID-Lakes	
14-0093-00	Barnesville	TP (µg/L)	60	21.7	INC	17	MTS		<20 µg/L		*Mesotrophic lake. *MPCA protection priority class C (Section 4.4).
		Chl- <i>a</i> (µg/L)	20			5.8	MTS		<6 µg/L		
		Secchi (m)	1						>1 m		

## 5.5 Southern planning region

The Southern planning region is comprised of 175 square miles, most of which again is privately owned with some public land mixed in. Land use in the planning region is primarily cultivated cropland, with some hay and pasture and wetlands in the central portion of the region (HEI 2020). Primary water resources in the planning region include Deerhorn Creek (09020106-507) and the upper and middle portions of the Buffalo River, South Branch.

There were nine stream segments in the Southern planning region evaluated in 2021 (Table 1). Of those, six were found to have at least one parameter that failed to meet their applicable AQL use standard and three were found to exceed the AQR use standard for *E. coli* bacteria. None of the evaluated streams were found to fully support AQL and just one was found to fully support for AQR; the rest had insufficient or inconclusive data to complete an assessment or were not assessed. One lake, West Olaf (56-0950-01) was assessed as part of the BRW in 2021 and met the AQR use standards (Table 2). However, degrading water quality in this lake has been reported to the MPCA by landowners in recent years. West Olaf Lake was not assessed in 2021 for the AQL use. Previous DNR monitoring conducted prior to Cycle 2 for West Olaf Lake suggested that the F-IBI scores would not have met the applicable standard (DNR 2023a, Section 4.3). Finally, while West Olaf, East Olaf, and other neighboring lakes were previously mapped within and assessed as part of the BRW, this series of lakes is now drained to the east to the Pelican River within the Otter Tail River Watershed (HUC-8 09020103). Consideration could be given to ensure these lakes are now included within and re-evaluated as part of the Otter Tail River Watershed.

The Southern planning region is home to the Upper South Branch Buffalo River Restoration project, aiming to restore and improve natural drainage capacity, reduce or eliminate breakout flooding, and improve water quality and habitat. Phase 1 (WID 09020106-604) of the project was completed in 2025 (Figure 26), and phase 2 (WIDs 09020106-605 and 09020106-505) was set to begin in 2025. Upon completion, both phases of the roughly \$9 million project are expected to include over 13 miles of restored stream channel, over 300 acres of enhanced buffers, over 100 sediment reduction BMPs (BRRWD 2025a).

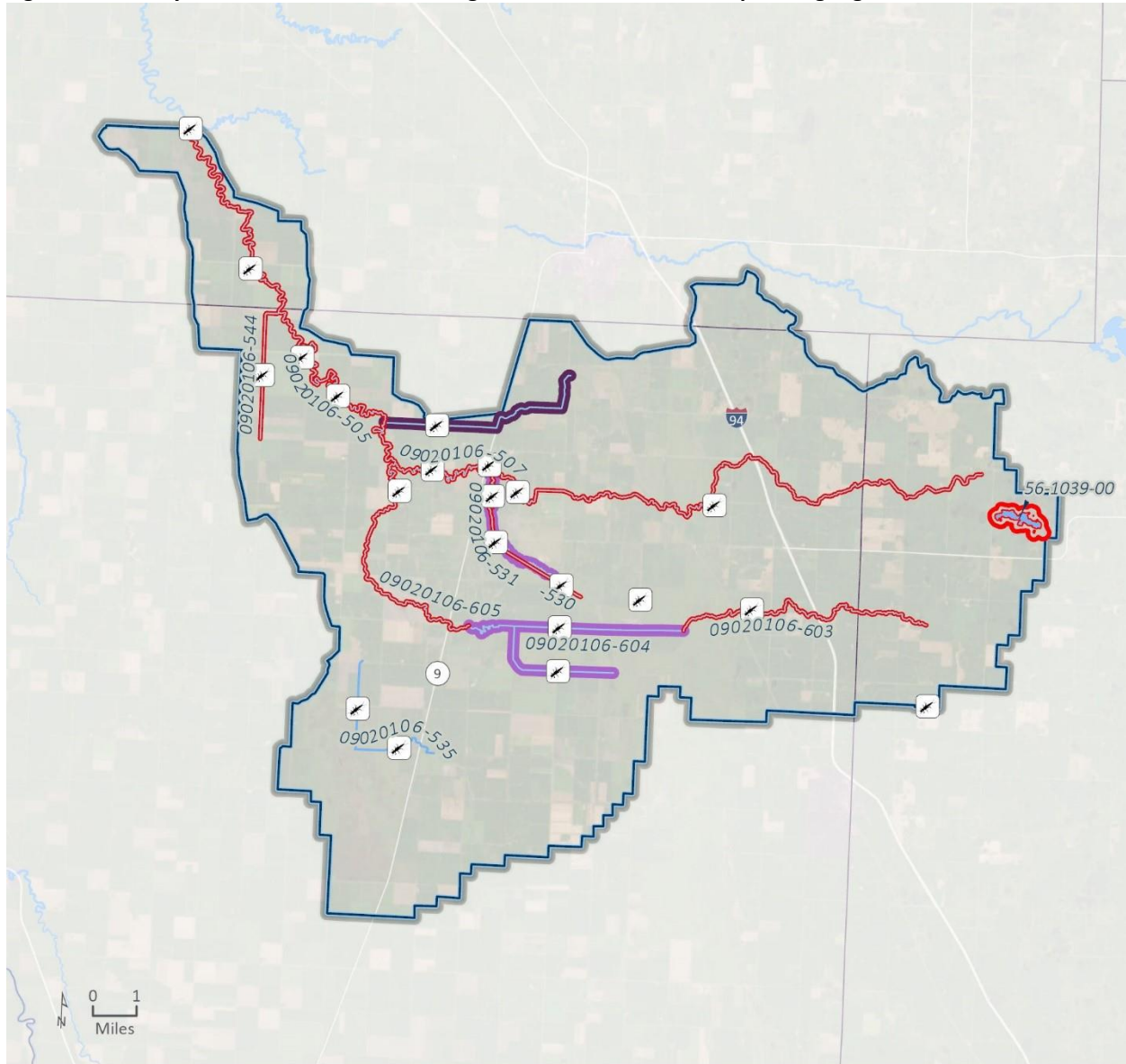
Deerhorn Creek (09020106-507) and the Buffalo River, South Branch (09020106-505) are listed as impaired due to turbidity. However, Cycle 2 and more recent (2021-2024) water quality data suggest that TSS concentrations are improving in these reaches and now are meeting the applicable TSS standards (MPCA 2025e), similar to the “upper” Buffalo River in the Mainstem planning region and to the South Branch and its tributaries in the Central planning region. One reach of the Buffalo River, South Branch (09020106-605) had its turbidity impairment delisted from the 2022 impaired waters list as a result of MPCA’s 2021 assessments, while the next downstream reach of the South Branch (09020106-505) and Deerhorn Creek did not have sufficient data to achieve a delisting. Additional data collection should be considered for these reaches after the completion of the Upper South Branch Buffalo River Restoration Phase 2 project to pursue impairment delistings for these stream reaches.

Previous capital improvement projects in the planning region include the Lawndale Creek re-meandering and restoration project (09020106-531, completed 2011) and the Manston Slough wetland restoration project (09020106-535, completed 2012). These areas could be considered for additional data collection and evaluation.

Figure 26. Pre- (top), during- (center), and post-project (bottom) photos of the Upper South Branch Buffalo River Restoration project phase 1 (BRRWD 2025a).



Figure 27. Priority water bodies and monitoring locations in the Southern planning region.



**Southern Planning Region**

*WRAPS Priority Waterbodies Labelled*

- 2024 Impaired Water
- Stream Priority Class**
- A (High priority)
- B (Medium priority)

- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensitivity**

- Impaired
- Highest
- Higher
- High

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**Table 12. Water quality data and assessment results for select water bodies in the Southern planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-505	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 1,260	259	EXS	316	EXS	194	Remove human sources	C1 TMDL	*New DO impairment C2. *Identified as part of the Upper South Branch Buffalo River Restoration project phase 2 (beginning 2025). *TSS is meeting the standard, however, not enough samples were collected at station S003-145. Consider collecting additional data to pursue Turbidity/TSS delisting. *Noted as BRRW CWMP priority for hydrology and flooding (HEI 2020).
		F-IBI	Varies	61.6	MTS	53	MTS		F-IBI 55+		
		M-IBI	Varies	24.8	EXS	18	EXS		M-IBI 20+	C1 SID	
		TSS (mg/L)	65	Impaired-Turbidity		24.4	MTS	25.8	<30 mg/L, <10% EXS rate	C1 TMDL	
		DO (mg/L)	5	7.7	IF	7.3	EXS	8.8	>7 mg/L, <10% EXS rate		
		TP (µg/L)	150	143	IF	155	IC	110	<150 µg/L		
09020106-507	Deerhorn Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	317	EXS	504	EXS	261	Remove human sources	C1 TMDL	*TSS is meeting the standard, however, data is insufficient to delist. Consider collecting additional data to pursue Turbidity/TSS delisting. *Noted as BRRW CWMP priority for hydrology and flooding (HEI 2020).
		F-IBI	Varies	1	EXS	45	EXS		F-IBI 45+	C1 SID	
		M-IBI	Varies	16.5	EXS	29.5	EXS		M-IBI 30+	C1 SID	
		TSS (mg/L)	65	Impaired-Turbidity		23.9	MTS	25.9	<30 mg/L, <10% EXS rate	C1 TMDL	
		DO (mg/L)	5	9.7	IF	8.2	IF	9.1	>8 mg/L, <10% EXS rate		
		TP (µg/L)	150	88.6	MTS	97.5	MTS	57	<100 µg/L		
09020106-530	Wilkin County Ditch 40-Lawndale Creek	F-IBI	Varies	32.5	EXS	35	EXS		F-IBI 40+	C2 SID, C2 TMDL	*TSS is exceeding the cold water TSS standard (7 of 9 samples EXS), however, additional data collection is suggested prior to listing TSS as impaired. *Consider collecting data to further evaluate this reach.
		M-IBI	Varies	69	IF						
		TSS (mg/L)	10	6.8	IF	14.3	EXS		<10 mg/L, <10% EXS rate		
		DO (mg/L)	7	9.9	NA	10.8	IF		>9 mg/L		
		TP (µg/L)	150	42.4	NA	83.5	IF		<100 µg/L		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-531	State Ditch 14-Lawndale Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	303	EXS	245	IF		Remove human sources	C1 TMDL	*Site of previous stream remeandering and restoration project (2011). *Limited WQ data. Consider collecting data to further evaluate designated use class for this reach. *MPCA protection priority class B (Section 4.4).
		F-IBI	Varies	73	NA	82	IC		F-IBI 85+		
		M-IBI	Varies	52.5	NA	40	IC		M-IBI 40+		
		TSS (mg/L)	65	5.35	NA	9.75	IF				
		DO (mg/L)	5								
		TP (µg/L)	150								
09020106-535	State Ditch 15	TSS (mg/L)	65	13	MTS	15.7	MTS		<15 mg/L, <10% EXS rate	CWMP priority	*Site of Manston Slough wetland restoration (2012). *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		DO (mg/L)	5	7	IF	4.5	EXS		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	277	IF	322	EXS		Reduce TP		
09020106-544	Unnamed creek (Wilkin County Ditch 13)	F-IBI	Varies	48	MTS	48	MTS		F-IBI 50+		*Deferred M-IBI impairment. *Limited WQ data. Consider collecting additional data to further evaluate this reach.
		M-IBI	Varies	16	EXS	5	EXS		M-IBI 15+	C2 SID	
		TSS (mg/L)	65	4	NA	5.2	IF		<10 mg/L		
		DO (mg/L)	5	7.9	NA	4.3	IF		>5 mg/L		
		TP (µg/L)	150	96.8	NA	164	IF		<150 µg/L		
09020106-603	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 1,260	68	NA	68	MTS				*Deferred DO impairment. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		TSS (mg/L)	65	15.6	NA	15.6	MTS		<15 mg/L, <10% EXS rate	CWMP priority	
		DO (mg/L)	5	4.4	EXS	4.4	EXS		>5 mg/L		
		TP (µg/L)	150			263	EXS		Reduce TP	CWMP priority	
09020106-604	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 1,260			347	IF		Reduce human sources		*Site of Upper South Branch Buffalo River Restoration phase 1 (completed 2025). *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		TSS (mg/L)	65	17.6	NA	17.6	MTS		<15 mg/L, <10% EXS rate	CWMP priority	
		DO (mg/L)	5	9.7	NA	9.8	IF		>9 mg/L, <10% EXS rate		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020106-604	Buffalo River, South Branch	TP (µg/L)	150	37.5	NA	37.8	MTS		<40 µg/L	CWMP priority	*Limited WQ data. Consider collecting additional data to further evaluate this reach. *MPCA protection priority class B (Section 4.4).
09020106-605	Buffalo River, South Branch	<i>E. coli</i> (MPN / 100 mL)	126 / 1,260	Impaired		321	EXS		Remove human sources	C1 TMDL	*TSS meeting standards, Turbidity DELISTED (2022). *Identified as part of the Upper South Branch Buffalo River Restoration project phase 2 (beginning 2025). *Noted as BRRW CWMP priority for hydrology and flooding. Also identified as a priority water resource in the BRRW CWMP (HEI 2020).
		F-IBI	Varies	25	EXS			62	F-IBI improved	C2 SID, C2 TMDL	
		M-IBI	Varies	30	EXS	23	EXS		MIBI 25+	CWMP priority	
		TSS (mg/L)	65	11.5	NA	12.2	MTS	16.3	>15 mg/L, <10% EXS rate	C2 TMDL	
		DO (mg/L)	5	6.1	NA	5	EXS	7	>5 mg/L, <10% EXS rate	CWMP priority, C2 TMDL	
		TP (µg/L)	150	164	NA	145	IC	183	<150 µg/L		
56-0950-01	West Olaf*	TP (µg/L)	40	31.5	MTS	33.7	MTS		<30 µg/L	SID-Lakes	*Mesotrophic lake. *Landowner reports of degrading water quality. *F-IBI sampled 2007 – would be impaired. *MPCA protection priority class B (Section 4.4).
		Chl- <i>a</i> (µg/L)	14	11	MTS	10.2	MTS		<10 µg/L		
		Secchi (m)	1.4	2.4	MTS	2.1	MTS		>2 m		
		F-IBI	45	12	IF						

\*West Olaf Lake (56-0950-01) and some neighboring lakes are now technically located within the Otter Tail River Watershed, HUC-8 09020103.

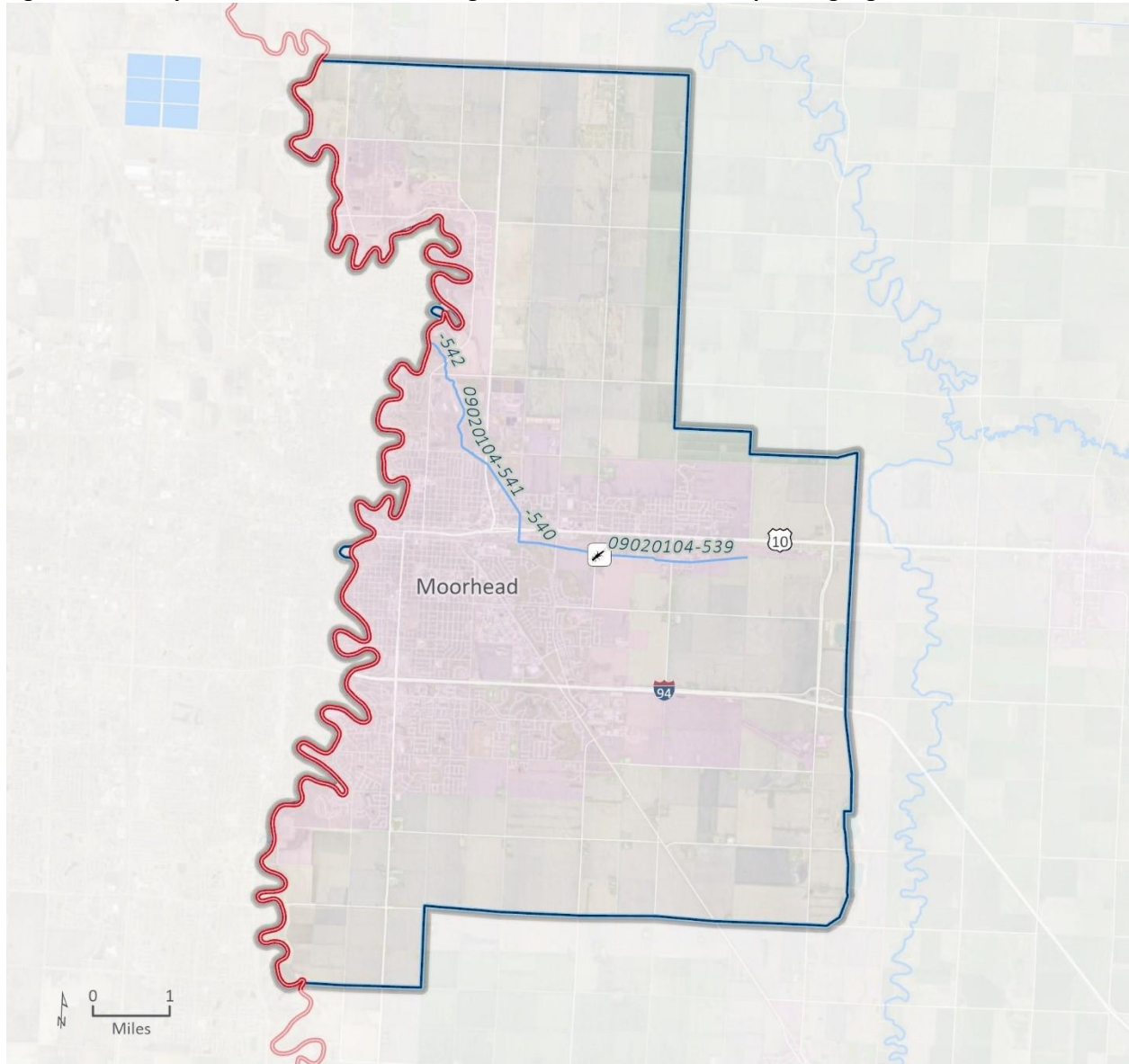
## 5.6 Moorhead planning region

The Moorhead planning region is made up of 63 square miles, a significant portion of which is the cities of Moorhead and Dilworth. These cities are the only municipal separate storm sewer (MS4) permitted areas in the watersheds, meaning these entities must develop a stormwater pollution prevention program and adopt BMPs to reduce the amount of sediment and other pollutants entering state waters from their stormwater systems (MPCA 2025r). The remainder of the planning region is primarily privately owned cultivated cropland (HEI 2020). There are no assessed water bodies in the Moorhead planning region (Table 1, Table 2). While it is not an assessed water body, Clay County Ditch 41 (“Snakey Creek,” WID 09020106-542) was noted in the BRRW CWMP as a priority for ditch bank and outlet instability and was the site of a restoration project completed in 2024. Consideration could be given for collecting data to further evaluate this stream system.

As the most populated area of the BRW and URRW, the priority resource concern in the Moorhead planning region is the protection of drinking water, from both groundwater and surface water derived sources. The drinking water supply management area (DWSMA) for the Moorhead Aquifer is located within Moorhead city limits. While technically located just outside of the planning region, the DWSMA for both the Buffalo Aquifer North and Buffalo Aquifer South are identified as highly vulnerable to contamination (Figure 29). These groundwater wellhead protection areas provide a significant portion of the domestic water to the cities of Moorhead, Dilworth, and the surrounding area, and are worthy of protection from contaminants leaching into the groundwater (MDH 2025).

The domestic water supply for the city of Moorhead is extracted from the Red River of the North and blended with water from the Moorhead and Buffalo Aquifers. The Minnesota Department of Health (MDH) and Moorhead Public Service, along with contributions from other agency and local partners, developed an updated Source Water Assessment in 2022 and a Surface Water Intake Protection Plan, completed in 2023 (MDH 2023). The purpose of these documents is to provide information for and expand upon activities to prevent or mitigate contamination of the Red River of the North. These documents are also intended to be used to guide Moorhead Public Service and watershed partners by documenting other complementary watershed-level activities to protect drinking water on a larger scale than can be accomplished by Moorhead Public Service alone. These documents indicate that some of the main concerns for Moorhead Public Service are sediment transport and increases in noncarbonate hardness, potentially from ditching and altered hydrology within the URRW and in the other upstream watersheds within the city’s DWSMA for surface water (DWSMA-SW, Figure 29). An additional concern includes the potential for an increased frequency and magnitude of harmful algal blooms, especially considering the region’s projected increases in temperatures and precipitation events (Section 4.6). Additionally, the documents suggest that water bodies within the designated “emergency response area” and “spill management area” upstream of the city’s surface water intake should be the focus for implementing projects and practices that address potential sources of contamination. These water resources might include stormwater management systems and ditches within the Moorhead planning region, as well as Wolverton Creek and several county or legal ditches that drain into Wolverton Creek or directly into the Red River of the North and that are located in the Western planning region.

Figure 28. Priority water bodies and monitoring locations in the Moorhead planning region.



**Moorhead Planning Region**

*WRAPS Priority Waterbodies Labelled*

- 2024 Impaired Water
- **Stream Priority Class**
- A (High priority)
- B (Medium priority)

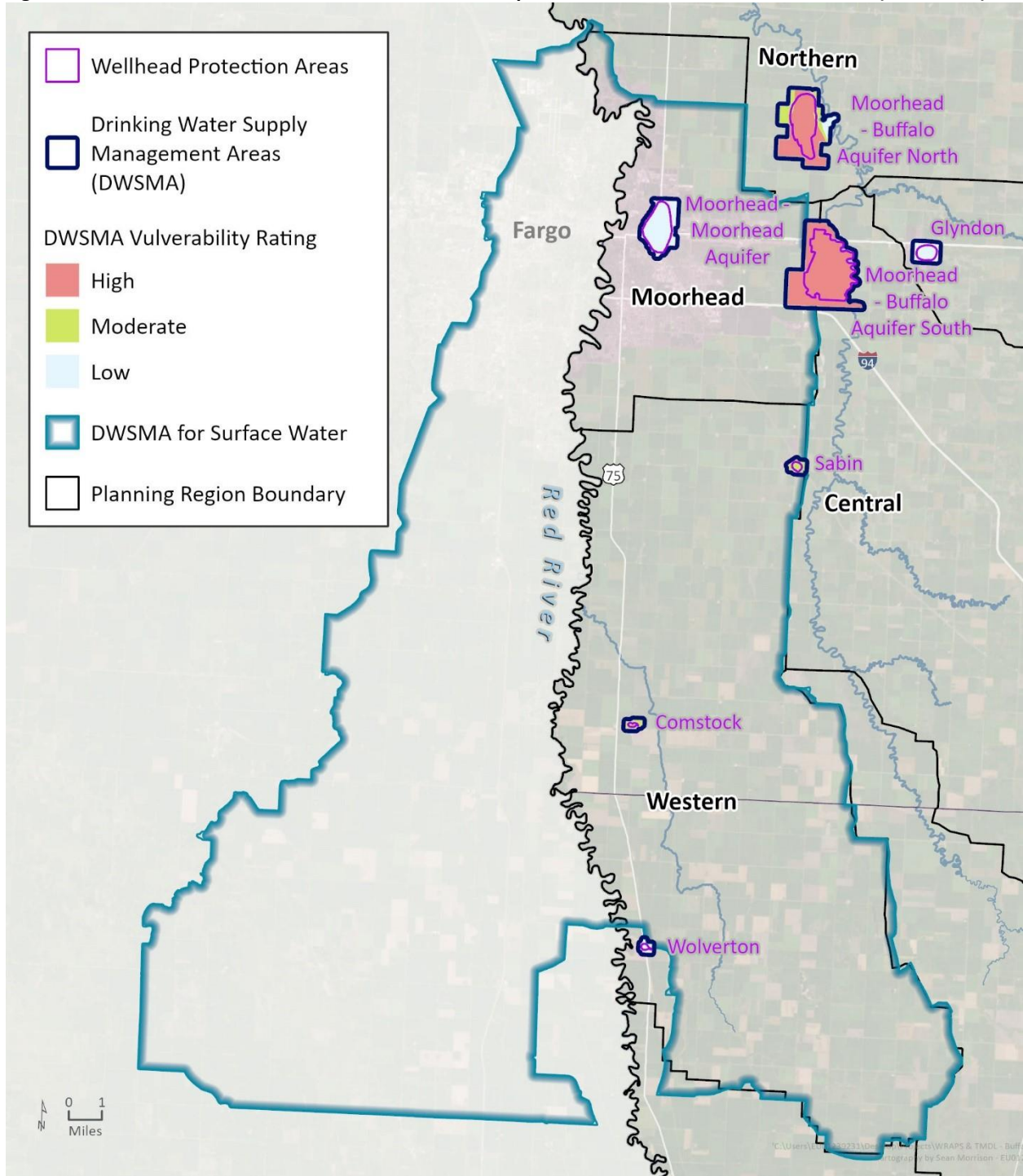
- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensativity**

- Impaired
- Highest
- Higher
- High

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Figure 29. Groundwater and surface water source water protection areas in the BRW and URRW (MDH 2025).



## 5.7 Western planning region

The Western planning region contains 165 square miles, most of which are privately owned. The planning region also includes the communities of Sabin, Comstock, and Wolverton. The primary land use in the planning region is cultivated cropland (HEI 2020). Wolverton Creek is the primary water resource in the planning region.

Two reaches of Wolverton Creek within the Western planning region were evaluated in 2018 and/or 2021 (Table 1). Both were found to have one or more parameters that failed to meet their applicable AQL use standard. Impairments include F-IBI and DO in the upper assessed reach of Wolverton Creek (09020104-549), and F-IBI and TSS in the lower reach (09020104-550). Both reaches also exceeded the AQR standard for *E. coli*, confirming that the previous bacteria impairments also remain in Wolverton Creek. There are no assessed lakes in the planning region (Table 2).

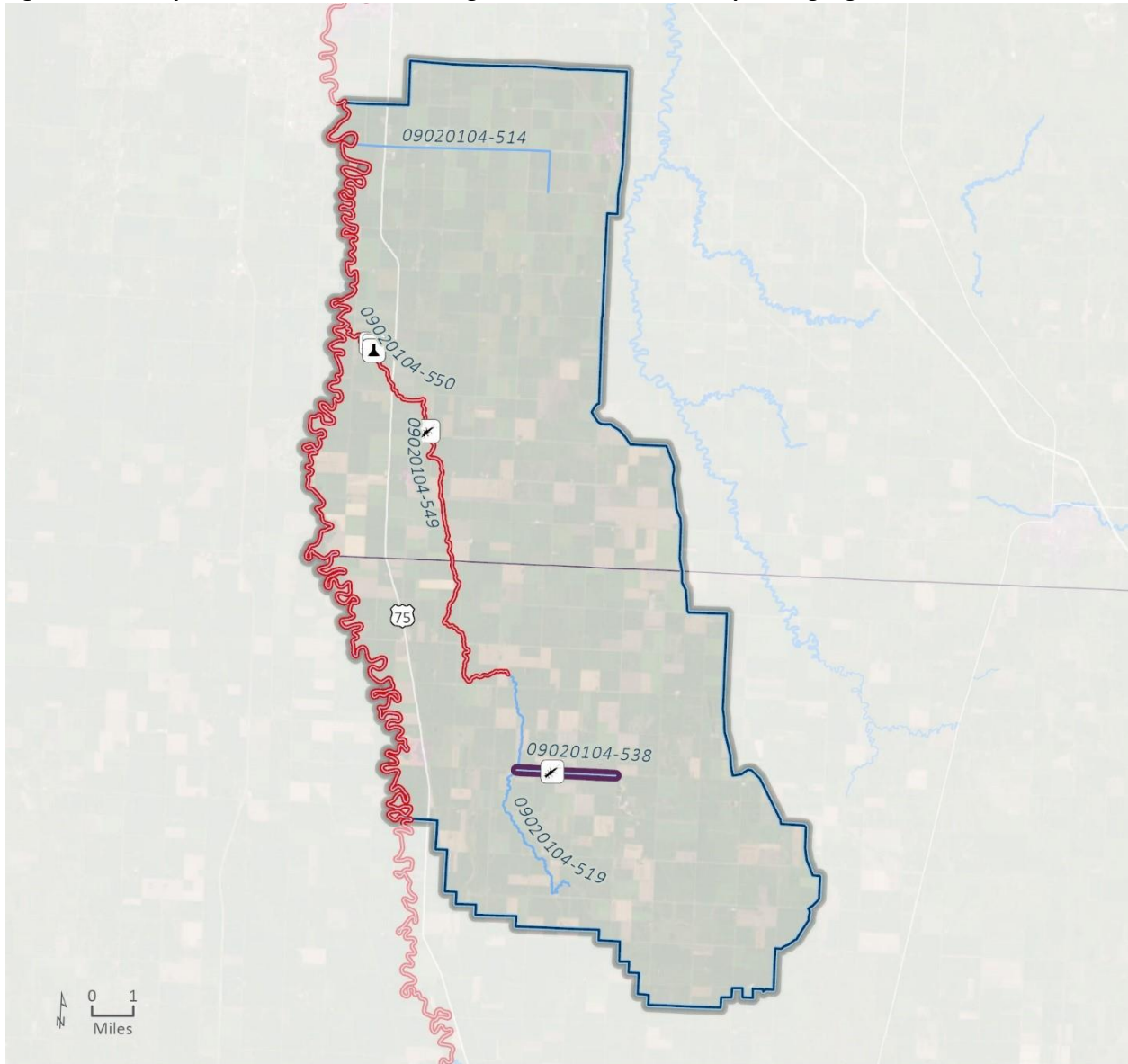
Wolverton Creek, Clay County Ditch 32 (09020104-514), Wilkin County Ditch 22 (09020104-538), and several other unassessed county and judicial ditches are also identified in the *Surface Water Intake Protection Plan for the Moorhead Public Service Public Water System* as streams within the city's DWSMA-SW (MDH 2023). This plan, discussed in more detail above for the Moorhead planning region, suggests that stream reaches within the city's DWSMA-SW should be the focus for implementing projects and practices that address potential sources of contamination to the city's surface water-derived source of drinking water, the Red River of the North.

The Wolverton Creek Restoration Project was completed between 2018 and 2020 in the upper (WID 09020104-519) and middle (09020104-549) reaches of Wolverton Creek. Goals of the project included removing large amounts of accumulated sediment from the stream channel, reducing flooding, improving water quality, and enhancing habitat. While Cycle 2 assessments revealed that pollutant concentrations were generally high in Wolverton Creek through 2020, more recent data from 2021 through 2024 suggest that TSS concentrations have shown some improvement. Additional data collection may be warranted to further evaluate this system. Additional restoration efforts could also be considered downstream of the previous efforts. The MPCA has noted significant bank erosion and water quality-related issues in the lower reach of Wolverton Creek (09020104-550, Figure 30).

**Figure 30. Bank erosion and instability documented in 2019 in Wolverton Creek (09020104-550) just downstream of 130<sup>th</sup> Avenue South (MPCA 2023).**



Figure 31. Priority water bodies and monitoring locations in the Western planning region.



**Western Planning Region**

*WRAPS Priority Waterbodies Labelled*

- 2024 Impaired Water
- A (High priority)
- B (Medium priority)

**Stream Priority Class**

- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensativity**

- Impaired
- Highest
- Higher
- High

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**Table 13. Water quality data and assessment results for select water bodies in the Western planning region.**

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020104-514	Clay County Ditch 32			*No data collected – also includes Clay County Ditches 9, 11, 32, 33, 36, 40, 53, 60; Clay-Wilkin Judicial Ditch 1; and Wilkin County Ditches 5A and 26 (no assigned WIDs)							
09020104-519	Wolverton Creek	NA	NA								
09020104-538	Wilkin County Ditch 22	F-IBI	Varies	9	MTS				F-IBI 10+		*Identified as a priority within the Moorhead Surface Water Intake Protection Plan (MDH 2023). *MPCA protection priority class A (Section 4.4). (WID - 538 only). *Consider collecting data to further evaluate these reaches.
		M-IBI	Varies	21	MTS				M-IBI 20+		
		TSS (mg/L)	65	30.5	NA				<30 mg/L		
		DO (mg/L)	5	9.9	NA				>5 mg/L		
		TP (µg/L)	150	138	NA				Reduce TP		
09020104-549	Wolverton Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	442	EXS				Remove human sources	C1 TMDL	*Identified as a priority within the Moorhead Surface Water Intake Protection Plan (MDH 2023). *Completed Capital Improvement Project (2020). *Collect additional data to further evaluate this reach.
		F-IBI	Varies			23	EXS		F-IBI 25+	C2 SID	
		M-IBI	Varies			42	MTS		M-IBI 45+		
		TSS (mg/L)	65	10.6	MTS	42.4	IF	25.6	<30 mg/L, <10% EXS rate		
		DO (mg/L)	5	5.3	EXS			5.3	>5 mg/L, <10% EXS rate		
TP (µg/L)	150	454	IF	464	IF	377	Reduce TP				
09020104-550	Wolverton Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	360	EXS	464	EXS	293	Remove human sources	C1 TMDL	*Identified as a priority within the Moorhead Surface Water Intake Protection Plan (MDH 2023). *Additional restoration efforts needed – see C2 TMDL Report. *Collect additional data to further evaluate this reach.
		F-IBI	Varies			22	EXS		F-IBI 25+	C2 SID	
		M-IBI	Varies			42	MTS		M-IBI 45+		
		TSS (mg/L)	65	56	EXS	76	EXS	28.5	<30 mg/L, <10% EXS rate	C2 TMDL	
		DO (mg/L)	5	7.4	MTS	7	IF	8.8	>7 mg/L, <10% EXS rate		
TP (µg/L)	150	688	EXS	552	EXS	518	Reduce TP				

## 5.8 Upper Red planning region

The Upper Red planning region consists of 244 square miles. Most of the land in the planning region is privately owned, with some small areas of public land in the eastern portion of the region. The city of Rothsay is also located in the far northeastern part of the planning region. Aside from some wetlands and hay and pasture in the eastern portion of the planning region, the most prevalent land use in the region is cultivated cropland (HEI 2020). Whiskey Creek (09020106-520) and its tributaries are the primary water resources in the Upper Red planning region.

Five stream segments were evaluated in the Upper Red planning region in 2021 (Table 1). Of those, an upstream segment of County Ditch 6A (09020104-523) was assessed as supporting the AQL use based on F-IBI and M-IBI scores meeting standards. The four remaining assessed streams were found to have at least one parameter that failed to meet their applicable AQL use standard. While Whiskey Creek (09020104-520) was found to meet its F-IBI and M-IBI standards, TSS, DO, and TP were all found to be exceeding their respective standards, confirming the previous turbidity and DO impairments remain. The outlet reach of County Ditch 6A (09020104-516) failed to meet its M-IBI standard, while that reach, the outlet reach of County Ditch 1A (09020104-533), and an Unnamed creek located to the south of Whiskey Creek (09020104-537) all failed to meet their respective F-IBI scores. Whiskey Creek was the only stream with sufficient data to assess for AQR; it was found to be exceeding the *E. coli* standard confirming that the previous bacteria impairment also remains for Whiskey Creek. There were no lakes in the planning region with assessable data (Table 2).

The BRRWD, in partnership with the Wilkin SWCD, West Otter Tail SWCD, and the Wilkin County Natural Resources Conservation Service (NRCS) office, have undertaken the Whiskey Creek Enhancement Project. This nearly \$10 million project aimed to restore over 9 miles of stream channel, improve drainage and channel conveyance, reduce sediment loading and improve water quality, and implement over 200 sediment reduction BMPs and 700 acres of enhanced buffers (Figure 32, BRRWD 2025a). In addition to other federal and state grants, local BRRWD funding, and other sources, a portion of the project's funding is provided as part of "group A" of the MPCA's Clean Water Act Section 319 Small Watersheds Focus Program, providing four, four-year grants to be awarded in the autumns of 2020, 2024, 2028, and 2032 (MPCA 2025s). The program requires the development of an EPA-approved nine key element plan to restore and protect waters within the entire Whiskey Creek HUC-10 Watershed (Section 1). Project work completed from 2021 through 2024 has been focused on the upper reaches of Whiskey Creek (WID 09020104-520), which has previously approved TMDLs for bacteria and turbidity impairments, and Unnamed Creek (WID 09020104-533, the outlet of County Ditch 1). Future project work through 2028 aims to continue implementation of sediment reduction BMPs within the upper portions of the Whiskey Creek watershed and potentially explore additional stream channel restoration or stabilization efforts for Unnamed Creek (WID 09020104-516, the outlet of County Ditch 6) and the adjacent portion of Whiskey Creek (09020104-520) upstream of Kent.

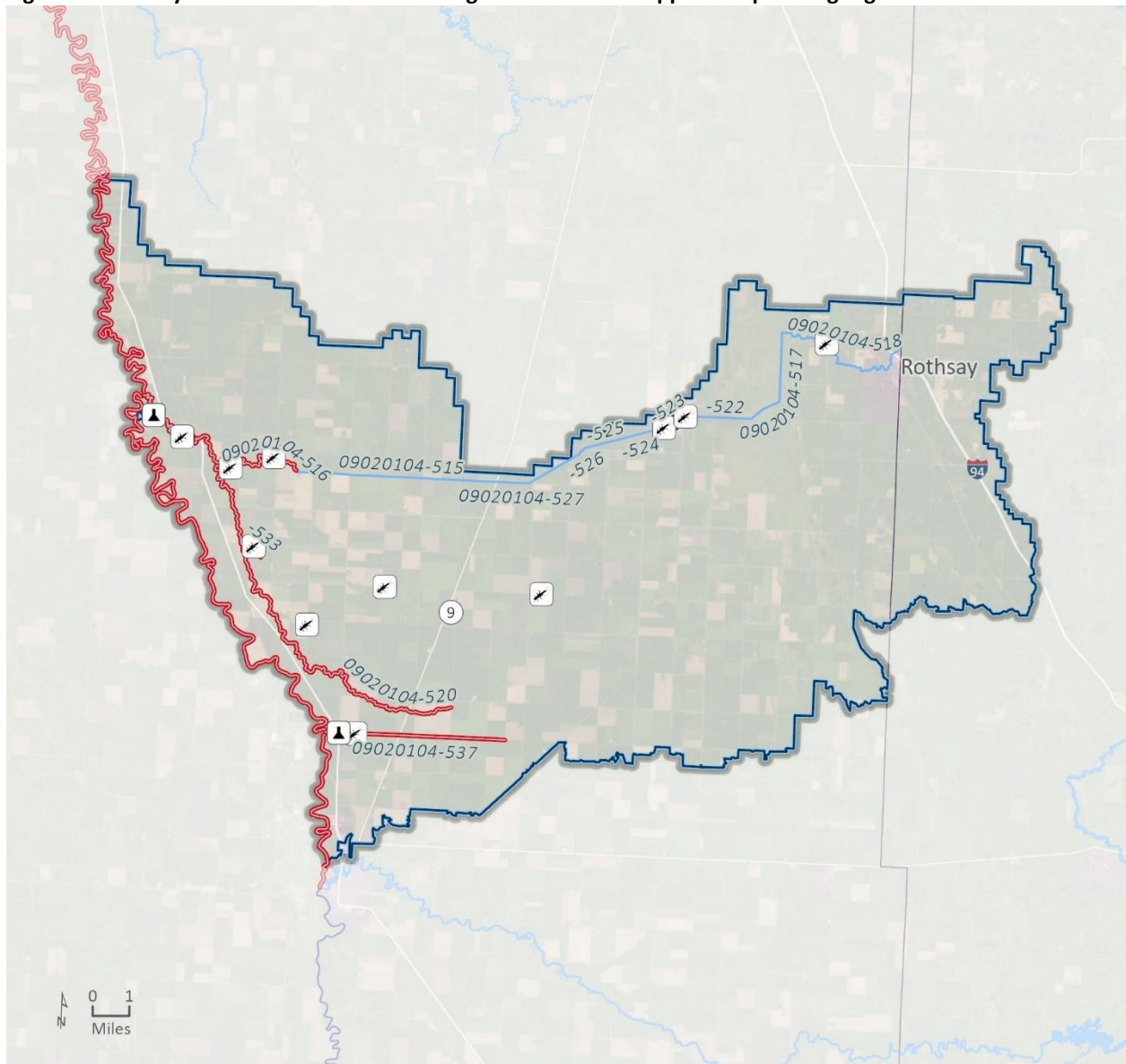
Additional water quality monitoring should be conducted for Whiskey Creek (09020104-520) and its tributaries in the future. Cycle 2 assessments of data through 2020, prior to the beginning of restoration efforts, showed that Whiskey Creek continued to exceed the applicable TSS standard. However, more recent data collected by the BRRWD from 2021 through 2024 at the outlet of Whiskey Creek suggests

that Whiskey Creek may now be meeting the TSS standard (MPCA 2025e). The MPCA is exploring effectiveness monitoring opportunities for Whiskey Creek, beginning as early as the 2026 field season.

**Figure 32. Photos of the Whiskey Creek Enhancement Project including pre-project (top), and post restoration looking upstream (center) and downstream (bottom) (BRRWD 2025a).**



Figure 33. Priority water bodies and monitoring locations in the Upper Red planning region.



**Upper Red Planning Region**

*WRAPS Priority Waterbodies Labelled*

- 2024 Impaired Water
- **Stream Priority Class**
- A (High priority)
- B (Medium priority)

- Core Chemistry Monitoring Site
- Biological Monitoring Site
- Lakes with DNR IBI Fishery Score

**Lakes of Phosphorus Sensativity**

- Impaired
- Highest
- Higher
- High

\\Users\EU01239231\Desktop\Projects\Buffalo\_Red\_TMDL\Buffalo\_Red\_TMDL\Cartography by Sean Morrison - EU01239231 - 10/30/2025 9:46 AM

**Table 14. Water quality data and assessment results for select water bodies in the Upper Red planning region.**

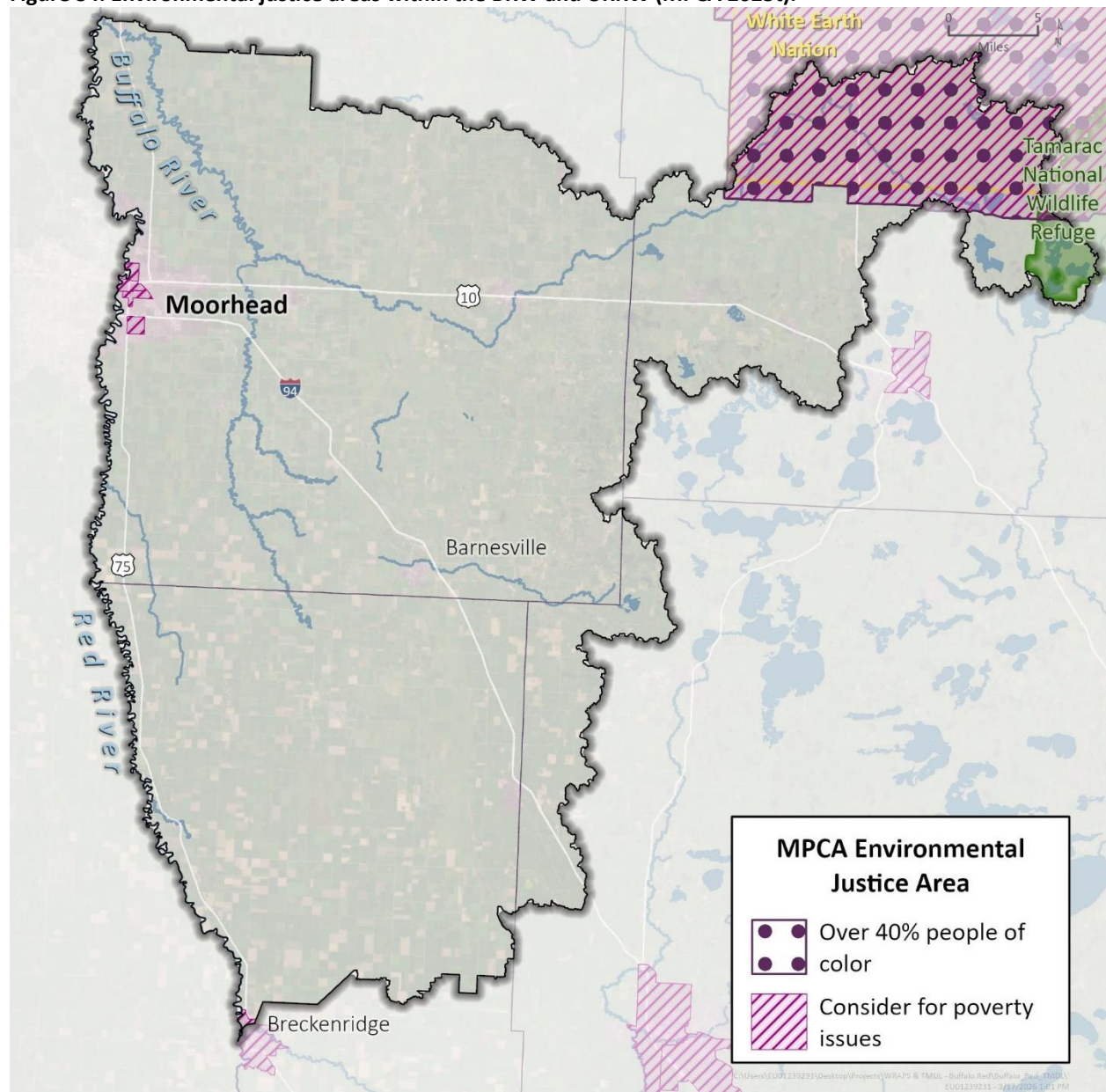
WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020104-516	Unnamed Creek	F-IBI	Varies	47	EXS	48	EXS		F-IBI 50+	C2 SID	*New M-IBI impairment C2. *Deferred F-IBI impairment. *Noted as BRRW CWMP priority for ditch bank and outlet instability. *Included in planning area for Whiskey Creek Restoration project.
		M-IBI	Varies	8.5	IF	23	EXS		M-IBI 25+	C2 TMDL	
		TSS (mg/L)	65	65.7	NA	15.9	IF		<30 mg/L, <10% EXS rate	CWMP	
		DO (mg/L)	5	7.4	NA	7.1	NA		>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	96.3	NA	85.6	IF		Reduce TP		
09020104-520	Whiskey Creek	<i>E. coli</i> (MPN / 100 mL)	126 1,260	361	EXS	375	EXS		Remove human sources	C1 TMDL	*Continue efforts for Whiskey Creek Restoration project. *Collect additional data to pursue delisting of Turbidity/TSS impairment. *Noted in BRRW CWMP as Capital Improvement Project (HEI 2020).
		F-IBI	Varies	53	MTS	57	MTS		F-IBI 60+		
		M-IBI	Varies	9	EXS	60	MTS		M-IBI 60+		
		TSS (mg/L)	65	Impaired-Turbidity		36	EXS	19.3	<30 mg/L, <10% EXS rate	C1 TMDL	
		DO (mg/L)	5	7.2	IF	5.2	EXS	8.9	>5 mg/L, <10% EXS rate		
		TP (µg/L)	150	284	IF	271	EXS	200	Reduce TP		
09020104-523	Unnamed Ditch (County Ditch 6A)	F-IBI	Varies	70	MTS	76	MTS		F-IBI 75+		*Noted as BRRW CWMP priority for ditch bank and outlet instability. *Included in planning area for Whiskey Creek Restoration project. *MPCA protection priority class A (Section 4.4).
		M-IBI	Varies	37	MTS	55	MTS		M-IBI 50+		
		TSS (mg/L)	65	52	NA	5.8	IF		<30 mg/L		
		TP (µg/L)	150	83	NA	34	IF		Reduce TP		
09020104-533	Unnamed Creek	F-IBI	Varies	41	MTS	30	EXS		F-IBI 35+	C2 SID	*New F-IBI impairment.
		M-IBI	Varies	6	NA	27	MTS		M-IBI 30+		
		TSS (mg/L)	65	22	NA	6.4	IF	27.5	<30 mg/L		
		DO (mg/L)	5	6.9	NA				>5 mg/L		
		TP (µg/L)	150	138	NA	292	IF	195	Reduce TP		

WID	Water body name	Parameter (units)	Appl WQS	Cycle 1 data – assessment		Cycle 2 data – assessment		2021-2024 data	Suggested water quality goals	Prioritization source	Notes
09020104-537	Wilkin County Ditch 31	<i>E. coli</i> (MPN / 100 mL)	126 1,260			190	IC	55	Remove human sources		*Deferred F-IBI impairment. *Identified as a priority water resource in the BRRW CWMP (HEI 2020).
		F-IBI	Varies	9	EXS	1	EXS		F-IBI 10+	C2 SID	
		M-IBI	Varies			26	MTS		M-IBI 30+		
		TSS (mg/L)	65	16	NA	22	MTS	8	<30 mg/L		
		DO (mg/L)	5	7.8	NA	7.6	IC	9.4	>5 mg/L		
		TP (µg/L)	150	142	NA	169	EXS	154	<150 µg/L	CWMP priority	

## 6. Environmental justice

The MPCA is committed to ensure that all people – regardless of income, race, ethnicity, color, or national origin – have the right to healthy air, sustainable lands, clean water, and a better climate. This means that all people benefit from equal levels of environmental protection or restoration and have opportunities to participate in decisions that may affect their environment or health. The MPCA considers tribal areas and census tracts with higher concentrations of low-income residents and people of color as areas of increased concern for environmental justice. The MPCA focuses on developing strategies to reduce pollution and health disparities in these areas. Current environmental justice areas in the BRW and URRW are provided in Figure 34 and include the portion of the BRW within the White Earth Reservation tribal area in the Mainstem (Section 5.2) and Lakes (Section 5.3) planning regions, as well as individual census tracts within the cities of Moorhead and Breckenridge (MPCA 2025t).

Figure 34. Environmental justice areas within the BRW and URRW (MPCA 2025t).



It is important that environmental justice considerations are included in MPCA’s watershed approach work, and consideration of these areas should be given during local water resource planning and for future iterations of the BRRW CWMP (HEI 2020). Examples of current efforts in the BRW and URRW in these environmental justice areas include the substantial sediment reduction efforts in the subwatersheds of the “upper” Buffalo River and the planned Upper Buffalo River Restoration project (Section 5.2), as well as efforts to protect both the surface water and groundwater sources of drinking water for the City of Moorhead (Section 5.6).

## 7. Current and suggested goals

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The BRRW CWMP (HEI 2020) provides a set of 11 measurable goals to address the plan’s priority issues. The measurable goals were developed from existing management plans, studies, reports, data, and other information, which includes previous WRAPS and TMDL reports. Due to the large and variable extent of the watersheds, goals are provided at the planning region scale and are prioritized or weighted by impact and urgency in each planning region. The goals for each planning region are to be considered a guide and starting point for the planning of implementation actions (Section 9). Goals are provided for TSS and TP reduction in loads per year, for hydrology and flooding in acre-feet of water storage, for stream channel and ditch stability in miles of projects, for bacteria in progress towards improving or preventing impairments, and more.

To supplement the BRRW CWMP measurable goals, suggested water quality goals were provided for individual parameters in the tables in Section 5 of this report. In general, the suggested water quality goals are to improve or at least maintain the current pollutant concentrations or IBI scores in those water bodies. Suggested goals for impaired waters may include improving those impaired parameters so that the pollutant concentration (i.e., TSS) meets or is within the numeric water quality standard (<65 mg/L), and to have a percentage of assessed samples that is below the allowed exceedance rate (i.e., <10%). For nonimpaired waters, in addition to improving or maintaining current conditions, goals may be to prevent future impairment. The suggested water quality goals are intended to support tracking progress towards the current BRRW CWMP goals and either updating these or developing new goals in future versions of the BRRW CWMP.

As discussed in Section 4.7.3, the watershed outlet load reduction goals for TP and total nitrogen from the Minnesota Nutrient Reduction Strategy (MPCA 2025p) should be considered in local planning efforts in the BRW and URRW. Again, these goals are not intended to supersede local priorities but should be considered alongside them and be supplemented with local knowledge and information.

## 8. Restoration and protection

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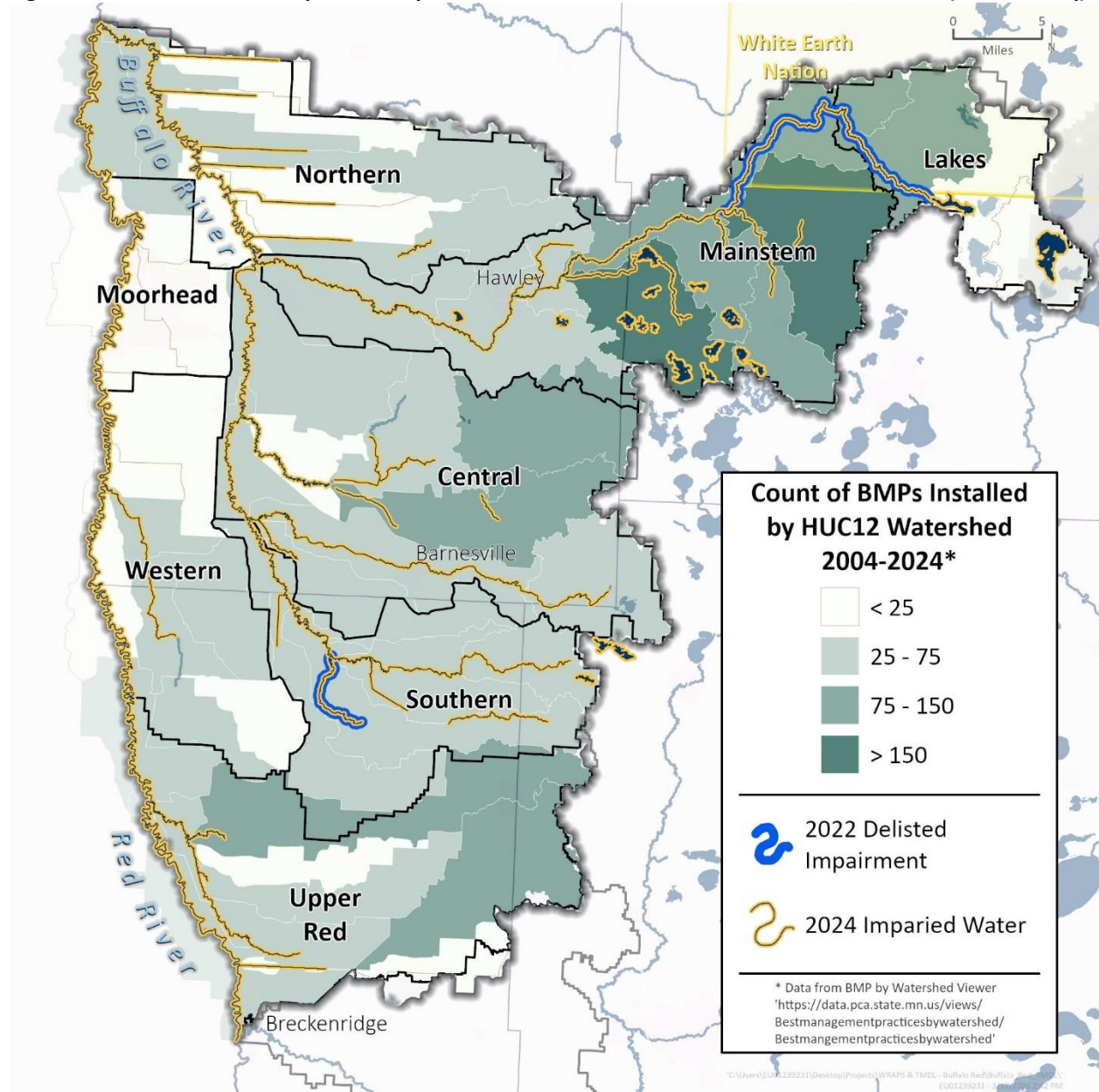
Efforts to achieve the goals in the BRRW CWMP and in the original WRAPS and TMDL reports for the BRW and URRW have been underway since the completion of those documents. The BRRWD and the Clay, Becker, West Otter Tail, and Wilkin SWCDs and NRCS offices are active in the BRW and URRW, providing technical and financial assistance through existing programs to reduce the impacts to water quality from agricultural and developed sources. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or dedicated

funding. Focus areas include nutrient management, conservation tillage, and soil health practices to reduce sediment and nutrient loading, water storage and infiltration practices to reduce runoff, and stream bank and lakeshore habitat preservation to protect aquatic ecosystems. Many practices recommended to landowners are designed to provide multiple water quality benefits, including diversifying crop rotations, expanding opportunities for buffers and natural riparian habitats, improving manure storage and application practices and grazing practices, and mitigating impacts of ditching and tile drainage. An overview of the number of BMPs that have been implemented per subwatershed in the BRW and URRW from 2004 through 2024 is provided below (Figure 35), as tracked via the BMPs Implemented by Watershed tool on the MPCA's Healthier Watersheds webpage (MPCA 2025q). In the BRW, many of the BMPs implemented are located in the subwatersheds of Hay Creek (WIDs 09020106-621 & 09020106-622) and the upstream reaches of the Buffalo River (WIDs 09020106-593 & 09020106-594, Section 5.2), while in the URRW, many of the BMPs are located in the contributing subwatersheds of Wolverton Creek (WIDs 09020104-549 & 09020104-550, Section 5.7) and Whiskey Creek (09020104-520, Section 5.8).

Efforts to improve hydrology and water quality in the BRW and URRW also include large scale capital improvement projects, many of which were originally identified in the BRRW CWMP (HEI 2020) and several of which were highlighted in Section 5. Examples of completed projects include the Wolverton Creek Restoration (2018) and Stony Creek Restoration (2025). Other examples of projects that are underway or in planning include the Whiskey Creek Enhancement, Upper South Branch Buffalo River Restoration phase 2, Upper Buffalo River Restoration, and more (BRRWD 2025a). All of these projects, in general, are targeted to reduce sediment and nutrient loading, restore natural stream channels and hydrology, reconnect floodplains, improve in-stream and adjacent habitat, and improve conditions both locally and downstream, all while working towards achieving the pollutant reduction goals and recommendations set forth in WRAPS and TMDL reports, the BRRW CWMP (HEI 2020), the Minnesota Nutrient Reduction Strategy (MPCA 2025p), and more. These projects can result in significant improvements locally and downstream, and their status should be tracked with future monitoring efforts (Section 10).

It is important to take the information gathered during Cycle 2 of the watershed approach process and adaptively manage to develop and enhance priority areas to continue focusing implementation efforts. The timing of this WRAPS Update is approximately mid-way through the 10-year timeframe of the BRRW CWMP, allowing new data to inform implementation efforts, as well as a mid-point plan review or for future iterations of the BRRW CWMP.

Figure 35. Number of BMPs implemented per subwatershed in the BRW and URRW, 2004 – 2024 (MPCA 2025q).



## 8.1 Restoration and protection priorities

As discussed in this report, priority streams and lakes have previously been identified in the BRRW CWMP, and other potential priority water bodies have been identified throughout this WRAPS Update, especially in Section 4.4 and Section 5. The following is a summary of existing priorities, as well as some recommendations to consider for continued or new prioritization. Once again, it is important to note that these prioritization considerations are a starting point; local knowledge and input of these water bodies are key in any further water planning efforts, including the implementation of restoration or protection strategies.

### 8.1.1 Streams

There are several individual stream reaches or larger stream systems that are identified as priorities in Section 4.4 and Section 5 of this WRAPS Update, and as priority resources in the BRRW CWMP (HEI 2020). While TP (Section 4.7.3) and bacteria (Section 4.7.5) concentrations remain high in many stream systems throughout the watersheds, TSS concentrations are improving in some select stream systems (Section 5). Furthermore, three AQL impairments were removed for streams from the 2022 impaired waters list. Additional prioritization for future planning efforts could be considered for the following stream systems:

- Wolverton Creek (09020104-550) and its tributaries, and other tributary streams and ditches to the Red River of the North that are located within the DWSMA and upstream of the Moorhead Public Service surface water intake (Section 5.6): to protect and prevent contamination of the city's surface water source of drinking water.
- Whiskey Creek (09020104-520) and its tributaries (Section 5.8): for continued progress for the Whiskey Creek Enhancement Project and for tracking a potential future delisting of Whiskey Creek's historical turbidity impairment.
- Buffalo River, South Branch, "lower" reaches (09020103-503 and -504, Section 5.4): Improving TSS concentrations in these reaches, as well as in Stony Creek (09020106-502) and Whiskey Creek (09020106-509) suggest that these stream segments are worthy of the capital improvement projects being undertaken upstream of them as described in Section 5.4.
- "Upper" Buffalo River (09020106-593, Section 5.2): improving TSS concentrations suggest this reach may now be meeting TSS standards. However, TSS concentrations downstream (09020106-594 & -595) are improving but still exceeding standards, supporting the need for the proposed capital improvement project.
- "Upper" Buffalo River, South Branch (09020106-605 and -505, Section 5.5): improving TSS concentrations suggest these reaches may be meeting TSS standards; however, additional restoration efforts are needed locally and downstream.
- Unnamed ditch (Becker County Ditch 15) (09020106-607): noted as "nearly impaired" for TSS (Section 5.2).
- County Ditch 22 (09020104-538, Section 5.1), Hay Creek (09020106-513, Section 5.2), Unnamed ditch (Becker County Ditch 15) (09020106-606 and -607, Section 5.2), and Whiskey Creek (09020106-610, Section 5.4): noted as having fish and/or macroinvertebrate communities that are VUL (Section 4.4).

### 8.1.2 Lakes

There are many lakes suggested for prioritization considerations in Section 4.4 and Section 5 in this WRAPS Update, as well as in the BRRW CWMP. These considerations may need to be narrowed down with local input for future planning efforts and for future iterations of the BRRW CWMP. As discussed in Section 3.3, many of the evaluated lakes in the BRW were not sampled during the second year of IWM (2020) and as such, those lakes did not have sufficient data to make an assessment determination for AQR and they are worthy of additional data collection (Section 10). However, the data that is available

for lakes in the Lakes planning region (Section 5.3) suggests that some of those lakes have improving or stable TP concentrations, while the opposite can be said for some lakes in the Mainstem planning region (Section 5.2). Unfortunately, no impaired lakes in the BRW have been removed or delisted from the impaired waters list. Additional prioritization could be considered for the following:

- Boyer (03-0579-00, Section 5.2) and North Tamarack (03-0241-02, Section 5.3) lakes: noted as “barely” impaired (Section 3.3).
- Sand Lake (03-0618-00, Section 5.2): noted as “nearly” impaired (Section 3.3) and in need of protection to prevent impairment or further degradation.
- Turtle Lake (03-0657-00, Section 5.4): noted as the only BRW lake with an improving water clarity trend (Section 4.5.2).
- Lee (14-0049-00) and Silver (14-0100-00) lakes (Section 5.2): noted as having fish communities VUL (Section 4.3) and suggested as “top priorities for restoration” (DNR 2023a).
- Little Sugar Bush Lake (03-0313-00, Section 5.3): noted as having exceptional F-IBI scores (Section 4.3) worthy of protection.

## 9. Strategies

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This section summarizes implementation strategies that could be used to help achieve the suggested water quality goals in this WRAPS Update and the measurable goals in the current and future versions of the BRRW CWMP (HEI 2020). For many of the strategies discussed below, BMPs and projects will need to be selected, designed, operated, and maintained to account for the projected increases in yearly temperatures and in the intensity of future precipitation events (Section 4.6) and the resulting impact on both average and especially peak stream flows (Section 4.5.3). Current and future land use activities and the effects of altered hydrology (Section 4.7.1) should also be considered. The consideration of future BMPs and projects should focus on the detention and retention of water in a variety of ways, both within the soil and on the landscape. Additional practices and projects should continue to focus on sediment, nutrient, and bacteria reductions, restoring or improving unstable stream channels, and protecting or restoring natural lake shorelines. The strategies discussed in this section are supported by the strategies and recommendations identified in the other reports referenced in this document and in Sections 4.1 and 4.2 of the current BRRW CWMP (HEI 2020).

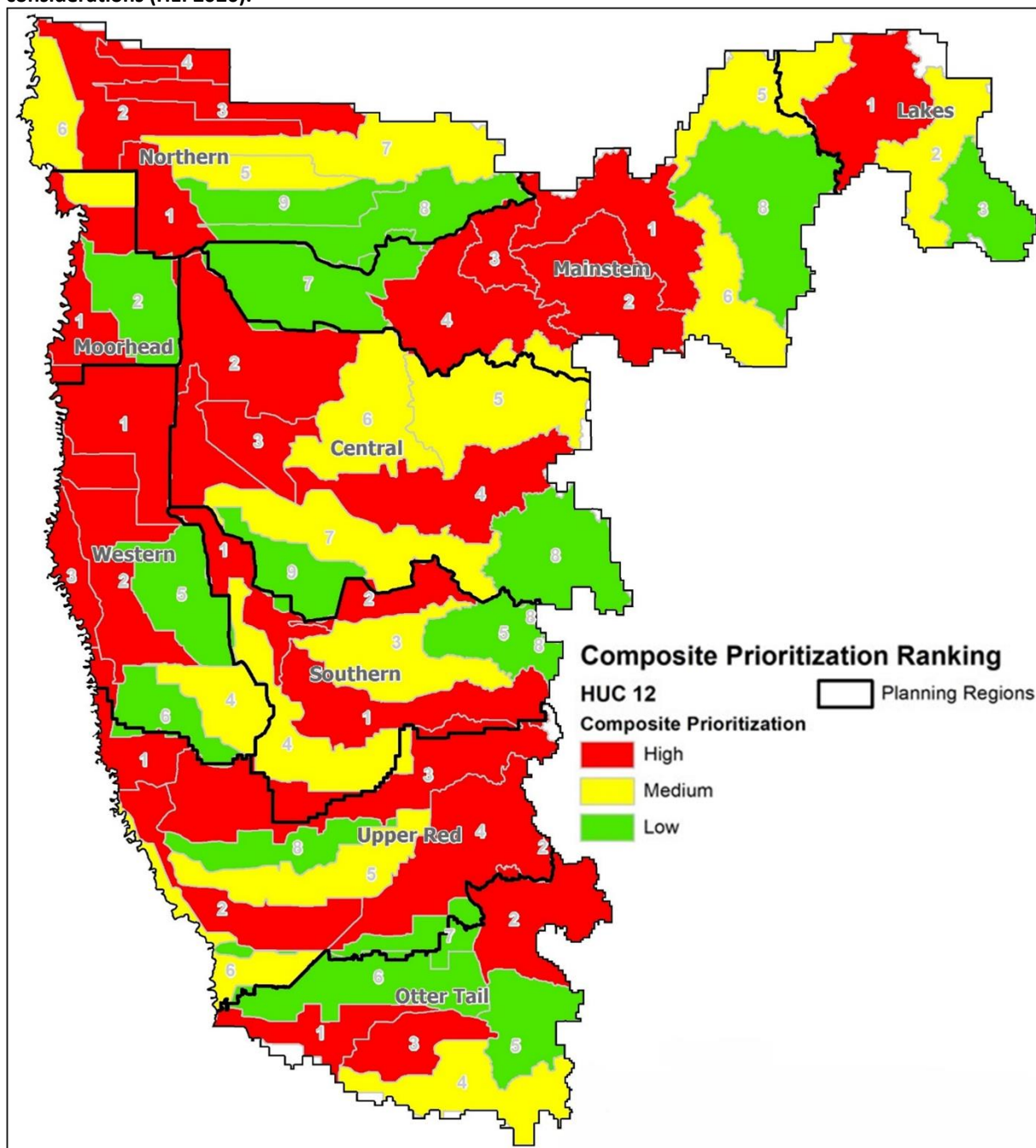
Primarily, the suggested implementation strategies for the BRW and URRW will focus on projects and BMPs that address nonpoint or nonpermitted sources of TSS and TP, especially runoff from cropland and developed areas as well as channel erosion and bank instability in streams and ditches. The following table provides an overview of example BMPs that may be considered or prioritized; the examples in Table 15 are not exhaustive. All of these examples generally target TSS and/or TP while some also address hydrology, DO, and bacteria.

**Table 15. Example BMPs for nonpoint or nonpermitted sources of pollution in the BRW and URRW (MPCA 2023a, DNR 2023a, HEI 2020).**

<b>Strategy</b>	<b>BMP examples</b>
Cropland, feedlot, pasture, manure, and nutrient runoff and management	Promote conservation tillage, crop rotations, cover crops, grassed waterways, filter strips, field borders, wind breaks, buffers, and other agricultural BMPs
	Implement in-field structural practices such as water and sediment control basins, side water inlets, grade stabilizations, and drainage water management
	Implement livestock waste management systems and runoff control measures
	Promote rotational grazing, livestock exclusion practices, and manure and nutrient management plans
	Promote proper use and incorporation of manure, fertilizers, pesticides, and herbicides
Water storage and hydrology	Maintain existing and implement new flood storage practices, retention/detention projects, wetland creations and restorations, or impoundments
	Implement in-field practices such as water and sediment control basins, side water inlets, and drainage water management
	Mitigate activities that will further alter the hydrology such as the promotion of multi-purpose drainage practices
	Address insufficient or perched culverts and other barriers to longitudinal connectivity
Stream restoration	Stabilize or restore degraded sections of natural stream reaches and unstable ditch banks and outlets using natural channel design
	Protect or re-connect the natural meandering of streams and promote the restoration of straightened streams
	Protect or re-connect naturally vegetated riparian corridors and natural floodplains for water storage, sediment deposition, and enhanced habitat
Lakeshore runoff and shoreline protection	Promote restoration of developed shorelines with natural vegetation and aesthetic lakescaping techniques
	Promote restoration of native floating-leaf and emergent aquatic vegetation
	Protect natural, undeveloped shorelines and protect existing stands of aquatic vegetation
	Promote green infrastructure practices that increase filtration
	Promote strategies to prevent the spread of aquatic invasive species
Residential and urban areas	Properly maintain compliant and repair or replace noncompliant septic systems
	Promote proper use of lawn and garden fertilizers, and promote other residential and urban stormwater practices such as rain gardens, infiltration areas, and more
Permanent land protection	Pursue permanent protective land easements and/or large wetland restorations through local, state, and federal programs
Capital improvements	Continue pursuing large-scale capital improvement projects including those mentioned throughout this WRAPS Report Update and more.

The BRRW CWMP (HEI 2020) prioritized subwatersheds at a HUC-12 scale to identify where to focus implementation efforts first. The resulting composite ranking map (Figure 36) encompassed the most pertinent factors used when prioritizing issues and setting goals for the CWMP and considers the wide variety of issues that vary in importance between the planning regions. The HUC-12 subwatersheds are ranked within each planning region and the prioritization is meant to be used to guide implementation efforts. However, this prioritization was not meant to be the only factor considered and implementation actions still may be pursued in lower ranking subwatersheds. Many of the recommended priority streams and lakes in this WRAPS Update (Section 4.4, Section 5, Section 8.1) are located in “high” ranking subwatersheds within their respective planning regions.

Figure 36. BRRW CWMP composite rank of subwatersheds by planning region for implementation considerations (HEI 2020).



## 9.1 Example pollution reduction programs

As introduced in Section 8, a number of programs exist or are being utilized in the BRW and URRW to support the implementation of pollution reduction projects and practices. The following are some recent or potential future examples.

### 9.1.1 Red River Basin Commission Soil Health Partnership

The Red River Basin Commission's *Supply Chain Soil Health Partnership* (RRBC 2025) is a collaborative initiative that offers financial incentives to agriculture producers adopting sustainable land management

practices to enhance soil health and resilience. The program targets key resource concerns like water management and soil quality, helping to mitigate flooding and drought impacts on farmland within the Red River Basin. The program provides producers with a flexible, accessible approach to cropland conservation and allows for a variety of land management practices including reduced tillage, cover crops, nutrient management, and alternative crop rotations. The partnership is funded primarily through a NRCS Regional Conservation Partnership Program grant as well as significant matching funds from corporate sponsors including General Mills, Cargill, and more. The partnership began with a projected year 1 enrollment of 35,000 acres within the Red River Basin, with projections increasing for year 2 to 90,000 acres and projections exploding to 675,000 acres for year 5. This partnership is currently available to producers within the BRW and URRW in Wilkin, Clay, and Otter Tail counties, as well as producers in Grant and Traverse counties in Minnesota and through other partnerships in North Dakota.

### **9.1.2 Red River Valley Drainage Water Management**

The goal of the Red River Valley Drainage Water Management project (MDA 2025a), led by the Minnesota Department of Agriculture (MDA) in partnership with other federal and local government agencies, agricultural businesses and interest groups, the University of Minnesota, and local landowners, is to improve agricultural production and reduce flooding losses while minimizing the unwanted environmental impacts of subsurface drainage. The project is evaluating drainage water management practices, currently controlled drainage and a saturated buffer, on an operating farm located in the URRW. The project aims to demonstrate the benefits and increase the adoption of these drainage water management practices in the Red River of the North basin due to the increase of subsurface tile drainage throughout the Red River Valley. Data collected through this on-farm research through 2023 shows that controlled drainage practices resulted in a decrease in nitrate-nitrogen and slight decreases in total Kjeldahl nitrogen and TSS when compared to conventional drainage. Additionally, initial data for the saturated buffer suggests that 76% of the nitrate-nitrogen load from the studied field was removed by the saturated buffer during that study period. This research shows promising potential for reducing the potential impacts of subsurface drainage through drainage water management and multi-purpose drainage practices (Table 15).

### **9.1.3 Water quality trading and phosphorus management plans**

Water quality trading (MPCA 2025u) is a market-based tool for achieving improved water quality and enhancing pollution reduction efforts while offering flexibility and potential cost savings. Water quality trading reduces pollutants (e.g., TP, TSS, and potentially others) in rivers and lakes by allowing a point source discharger, such as a wastewater treatment facility, to enter into agreements under which the point source “offsets” its pollutant load by obtaining reductions in a pollutant load discharged by another point source operation or by a nonpoint source or sources in the same watershed. As such, trading can help a point source operation achieve compliance with specific permit limits or other regulations instead of making significant facility upgrades and increasing operational costs. As the permitting and regulatory authority for most point source discharge operations in Minnesota, the MPCA must establish specific conditions governing trading in the point source discharger’s applicable permit.

The Red River Basin Commission is leading the development of a basin-wide management and trading plan to reduce TP in the Red River of the North using goal setting and collaboration among regulated and unregulated stakeholders, and at less cost and with broader-based involvement (MPCA 2021). The

*Red River Basin Water Quality Offset Plan*, currently in development for release in 2026, is intended to satisfy portions of the permitting requirements of multiple municipalities in the Minnesota portion of the Red River Basin, including the wastewater treatment facilities for the cities of Moorhead and Breckenridge, and to serve as a means for implementing water quality trades through the MPCA. While this draft plan is currently focused on TP, implementation of offset projects and practices will also likely have secondary benefits for increased flood resilience and water storage, habitat enhancements, and water quality improvements. Upon its completion, this plan could be considered for establishing trading opportunities for other permitted dischargers within the BRW and URRW.

Most of the wastewater treatment facilities in the BRW and URRW do not have specific permit discharge limits for TP. All BRW and URRW wastewater treatment facilities currently not having TP effluent limits or not currently participating in the Red River Basin Commission phosphorus reduction planning efforts mentioned above are required to have phosphorus management plans, which are intended to ensure the optimization of TP removal primarily through the management and reduction of upstream sources (MPCA 2017b and MPCA 2020). These phosphorus management plans may result in the cities implementing innovative approaches for reducing TP, perhaps through future water quality trading.

#### **9.1.4 Other program examples:**

Other local, state, federal, and other programs available in the BRW and URRW include but are not limited to the following:

- Local and state regulatory and assistance programs for septic systems (MPCA 2025v) and the MPCA's programs for animal feedlots (MPCA 2025w), wastewater (MPCA 2025x), and stormwater (MPCA 2025y).
- The Minnesota Buffer Law (BWSR 2025b) and state conservation easement programs such as Reinvest in Minnesota (RIM) (BWSR 2025c).
- The Minnesota Board of Water and Soil Resources' (BWSR) programs for Water Storage & Climate Resilience (BWSR 2025d), Groundwater Protection (BWSR 2025e), and Urban Stormwater Management (BWSR 2025f).
- The MDA's Minnesota Agricultural Water Quality Certification Program (MDA 2025b) and Agriculture BMP Loan Program (MDA 2025c).
- The Minnesota Nitrogen Fertilizer Management Plan (MDA 2025d) and Groundwater Protection Rule (MDA 2025e).
- Various NRCS programs such as the Environmental Quality Incentives Program and Regional Conservation Partnership Program (USDA 2025).

## **10. Additional monitoring considerations**

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An overview of water quality and biological monitoring efforts led by MPCA and partners is provided in Section 1 and Section 3.1 of this WRAPS Report Update. Monitoring locations in the BRW and URRW are mapped in Section 5. The MPCA will continue monitoring through the watershed approach process, including IWM (MPCA 2025a), and will continue monitoring efforts throughout the state through the

WPLMN (MPCA 2025k) and other programs (MPCA 2025d). The MPCA and partners would be set to return to the BRW and URRW for a third round of IWM in 2029 and 2030 under the current watershed approach methods (MPCA 2025a).

The BRRWD monitors and tracks changes of water quality with the implementation of their projects, practices, and programs through their Regional Assessment Location system. This system features over 30 monitoring locations within the BRRWD's boundaries and is a partnership between the BRRWD, International Water Institute, and the Red River Basin River Watch program (BRRW CWMP Section 5.3, HEI 2020). Monitoring locations are generally sampled monthly from April through October for nitrogen, TP, TSS, and *E. coli* bacteria. Water quality reports from previous years can be found on the BRRWD Programs webpage (BRRWD 2025b).

The *Surface Water Intake Protection Plan for the Moorhead Public Service Public Water System* (MDH 2023) calls for continued and additional monitoring of surface water quality to determine the best approaches to address the current and potentially worsening water quality in the watersheds upstream of the city. The plan suggests monitoring of total dissolved solids and/or major ion chemistry should be a priority as some analytes are regularly above drinking water limits and pose concerns at the city's intake. Additional recommendations are monitoring and tracing the increasing levels of sulfate and noncarbonate-based hardness in the Red River of the North upstream of the city of Moorhead, as well as tracking the frequency and intensity of harmful algal blooms that could impact the surface water supply.

In cooperation with the U.S. Army Corps of Engineers, the United States Geological Survey (USGS) initiated a water-quality monitoring study in 2019 related to the preconstruction phase of the Fargo-Moorhead Flood Risk Management Project (Galloway et al. 2024). Several water quality parameters were sampled from October 2019 through October 2022 from the Red River of the North and from three tributary streams in North Dakota. Sampling locations include three sites contributing upstream of the Fargo-Moorhead metropolitan area, including one on the Red River of the North just upstream of Wolverton Creek (09020104-550), one within the Fargo-Moorhead area, and six sites that contribute downstream of the Fargo-Moorhead area, including one located just downstream of the outlet of the Buffalo River (09020106-501). The study found, in general, that pollutant loads for most of the sampled parameters correlated closely to stream flows and increased, or worsened, from upstream to downstream. These parameters include but are not limited to suspended sediment, phosphorus, nitrogen, *E. coli* bacteria, total dissolved solids, and other major ions. The study attributes the increased loads from upstream to downstream to increased nonpoint runoff from both rural and urban areas during runoff events and periods of higher stream flow, as well as from point sources such as wastewater treatment facility discharges during periods of low flows. This monitoring study is expected to be continued during the construction phase of the Flood Risk Management Project, expected to be completed by early 2027, as well as during a post-construction phase (Galloway et al. 2024).

As opportunities arise and as resources allow, additional monitoring efforts could be explored to further refine pollutant source assessments, evaluate effectiveness of implemented BMPs and capital improvement projects, and track changes in water quality. Some potential monitoring opportunities to explore include:

- Additional monitoring for potential impairment delistings: Local, state, and federal watershed partners have completed, are currently implementing, or are currently planning several large-scale water quality improvement projects and efforts within the BRW and URRW. Additional chemical and biological data should be collected in the future, in partnership with local watershed partners, from within and downstream of these project areas to monitor for improvements and to assess the success of these efforts, including for potential delistings from future impaired waters lists. Examples provided throughout this report, especially in Section 5 and Section 8.1.1, include the “upper” Buffalo River (Section 5.2), the “lower” reaches of the Buffalo River, South Branch, Stony Creek, and Whiskey Creek (Section 5.4), the “upper” Buffalo River, South Branch (Section 5.5), Wolverton Creek (Section 5.7), and Whiskey Creek and its tributaries (Section 5.8). The MPCA is currently exploring additional monitoring opportunities to document the effectiveness of the Whiskey Creek Enhancement Project, potentially beginning in 2026 in partnership with the BRRWD, DNR, and others.
- Additional monitoring for biological impairments: Some of the biologically impaired stream reaches (F-IBI and M-IBI) in the BRW and URRW have limited TSS, DO, or eutrophication related data to determine the severity of how these parameters impact the biological communities within those stream reaches. Additionally, some of these impaired reaches are stressed by those parameters based on field observations (MPCA 2023), but biological response data are inconclusive or there are not enough discrete chemical data at this time to develop a TMDL for those parameters. Future condition and problem investigation monitoring in these reaches will be needed to collect the data to confirm the stressor determinations, complete TMDLs, and support recategorizations as necessary.
- BRW lakes: Due to the COVID-19 pandemic, most or all lakes in the BRW were not sampled in 2020 for eutrophication measures. As a result, there were many lakes in the BRW with some chemistry data but not enough to assess against the eutrophication standards. Additional condition monitoring could be considered for BRW lakes that did not have enough recent data to assess, have “nearly” or “barely” impairment threshold designations, have vulnerable fish communities as identified by the DNR (2023a), and have been identified as priority lakes in this WRAPS Update or in the current or future versions of the BRRW CWMP (HEI 2020).
- Lawndale Creek/State Ditch 14: The upper reaches of Lawndale Creek (WIDs 09020106-529 & 09020106-530) are designated as a general cold water habitat stream (use class 1B, 2Ag), while State Ditch 14 (09020106-531) is designated as a general warm water habitat stream (use class 2Bg). Since the different use classes feature different water quality and biological standards, additional problem investigation or special study water quality and biological monitoring may be warranted to determine how the entire system works together and to determine if the system should be classified as a cold- or warm-water stream.
- Additional monitoring, as needed, to further evaluate the DO (Section 4.7.4, Appendix D) or bacteria (Section 4.7.5) impairments in streams, or to further evaluate other conditions in the BRW and URRW. Additional monitoring for bacteria could potentially consider Microbial Source Tracking to further investigate and identify potential sources of the *E. coli* impairments, which could then be used to aid and focus restoration and implementation efforts.

# 11. Public participation/public notice

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Efforts were made during the development of this WRAPS Report Update and the *Buffalo River and Upper Red River of the North Watersheds TMDL Report* (MPCA 2025h) to include local officials and the public. The BRRWD, county SWCDs, the White Earth Band of Ojibwe and other potentially interested Tribal Organizations, and other local, state, and federal watershed partners were invited to participate in the development of the reports. A number of virtual, hybrid, and in-person meetings and other informal communication took place with these organizations and other stakeholders. Often these efforts were made in combination with other BRRW CWMP meetings or other watershed partner activities within the BRW and URRW. Opportunities were given to review and provide feedback for draft versions of this WRAPS Update and the TMDL report. Any input, comments, and suggestions from these efforts were taken into consideration in developing the reports. Less emphasis was put on public outreach beyond these efforts than what was done for the first cycle of the watershed approach process in the BRW and URRW.

## 11.1 Public notice for comments

An opportunity for public comment on the draft WRAPS Report Update was provided via a public notice in the *State Register* from April 6, 2026, through May 21, 2026. There were [xx] comments received and responded to as a result of the public comment period.

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# Appendix A: Completed BRW and URRW TMDLs

**Table 16. Maximum TMDL bacteria and TSS load reductions for streams from the BRW TMDL (MPCA 2016a, excerpted from report Table 4-39).**

WID	Bacteria		TSS	
	Max % load reduction	Critical flow regime	Max % load reduction	Critical flow regime
09020106-501	55%	High	52%	High
09020106-502	69%	High/moist	36%	Average
09020106-503	57%	High	13%	Moist
09020106-504	47%	Average	NR	NA
09020106-505	64%	High	72%	High
09020106-507	77%	High	60%	High
09020106-508*	61%	Average	NR	NA
09020106-509	62%	Average	34%	Average
09020106-511*	75%	Dry	---	---
09020106-515*	71%	Average	---	---
09020106-519*	94%	Average	---	---
09020106-520*	93%	High	---	---
09020106-521	83%	Dry	43%	High
09020106-523	90%	High	43%	Moist
09020106-534	79%	High	---	---
09020106-556	67%	High	---	---
09020106-559*	72%	Dry	---	---
09020106-562*	64%	Dry	---	---
09020106-593**	88%	Average	NR	NA
09020106-594	62%	Average	61%	High
09020106-595	57%	Dry	85%	High

“\*” – This WID has since been “split” into two or more separate stream WIDs. Contact MPCA for more information.

“\*\*” – TMDLs for this WID were not approved by EPA due to the WID’s location within the White Earth Reservation boundaries.

“NR” – No reduction required.

“NA” – Not applicable.

“---” – Not impaired/no TMDL.

**Table 17. TMDL phosphorus percent reductions for lakes from the BRW TMDL (MPCA 2016a, excerpted from report Table 5-3).**

Lake name	WID	TP % reduction	Lake name	WID	TP % reduction
Boyer	03-0579-00	40%	Marshall	03-0526-00	0%
Forget-Me-Not	03-0624-00	42%	Sand	03-0659-00	93%
Gottenberg	03-0528-00	15%	Sorenson	03-0625-00	73%
Gourd	03-0635-00	68%	Stakke	03-0631-00	3%
Jacobs	56-1039-00	78%	Stinking	03-0647-00	84%
Lime	03-0646-00	80%	Talac	03-0619-00	52%
Maria	14-0099-00	72%	West LaBelle	03-0645-00	45%

A TMDL was also completed for Mission Lake (03-1471-00) with a 60% reduction. That TMDL was not approved by EPA, however, due to the lake’s location within the White Earth Reservation boundaries.

**Table 18. Maximum TMDL bacteria and TSS load reductions for streams from the URRW TMDL Report (MPCA 2017a).**

WID	Bacteria		TSS	
	Max % load reduction	Critical flow regime	Max % load reduction	Critical flow regime
09020104-512*	49%	Very low	---	---
09020104-520	64%	Very high	29%	High

“\*” – This WID (Wolverton Creek) has since been “split” into two separate stream WIDs. Contact MPCA for more information.

“---” – Not impaired/no TMDL.

**Table 19. TMDL reductions from the BRW and URRWs TMDL Report (MPCA 2025h).**

WID	Water body name	TMDL pollutant	Overall % reduction
09020104-516	Unnamed Creek	TSS	24%
09020104-550	Wolverton Creek	TSS	41%
09020106-530	Unnamed Creek (Lawndale Creek)	TSS	62%
09020106-621 and -622	Hay Creek	TSS	21%
09020106-538	County Ditch 25 (County Ditch 65)	TP	53%
09020106-605	Buffalo River, South Branch	TP	22%
09020106-519	County Ditch 10	TP	1%
14-0049-00	Lee Lake	TP	40%

# Appendix B: Stressor identification summaries

Figure 37. Strength of Evidence summary from the BRW Biotic SID (MPCA 2014).

Reach (last three digits of AUID)	Buffalo River Stressor ID - Candidate Causes							
	Low DO	High TP	High Nitrate	High Sediment /Turbidity	Poor Habitat	Altered Hydrology	Lack of Physical Connectivity	Pesticides
Upper Buffalo River (593)	-	--	-	+	0	++	++	0
Deer Horn Creek (507)	+	-	-	+	+	++	++	0
S Branch Buffalo River (505)	++	--	-	++	++	++	++	0
Spring Creek (534)	-	--	-	-	0	+	++	0

KEY: The preliminary review of evidence _____ the case for this stressor being a candidate
++ strongly supports
+ weakly supports
0 neither supports or refutes
- weakly refutes
-- strongly refutes

Figure 38. Strength of Evidence summary for Whiskey Creek (09020104-520) from the URRW Biotic SID Report (MPCA 2016b).

Stressors	Multiple Lines of Evidence (Consistency of Evidence) SOE Scores for M-IBI Impaired Whiskey Creek <sup>1</sup>
Flow Regime Alteration	+++
Lack of In-stream Habitat	++
Excess Suspended Sediment	+
Low DO	+++
Pesticide Toxicity	0

<sup>1</sup> **Score Key:** +++ *convincingly supports* the case for the candidate cause, ++ *strongly supports* the case for the candidate cause, + *somewhat supports* the case for the candidate cause, 0 *neither supports nor weakens* the case for the candidate cause, - *somewhat weakens* the case for the candidate cause, -- *strongly weakens* the case for the candidate cause, --- *convincingly weakens* the candidate cause, R *refutes* the case for the candidate cause, and NE *no evidence available*.

**Table 20. Weight of evidence summary for stressors associated with bioassessments impairments in the BRW (MPCA 2023).**

Reach Name (WID)	Planning region	Bioassessments Impairment <sup>1</sup>	Candidate Cause <sup>2</sup>						
			Loss of Longitudinal Connectivity	Flow Regime Instability	Insufficient Physical Habitat	High Total Suspended Solids	Low Dissolved Oxygen	High Nitrate-Nitrogen	High Temperature
Whisky Creek (09020106-509)	Central	F-IBI	+	+	++	+++	+	-	NA
		M-IBI	NA	++	+	+	0	0	NA
Stony Creek (09020106-510)	Central	M-IBI	NA	+	0	-	0	-	NA
Spring Creek (09020106-534)	Central	F-IBI	+	++	++	-	+	-	NA
		M-IBI	NA	++	++	-	+	0	NA
Hay Creek (09020106-609)	Central	F-IBI	+	++	+	-	0	0	NA
		M-IBI	NA	++	+	0	0	-	NA
Stony Creek (09020106-613)	Central	F-IBI	+	++	+	0	-	0	NA
Unnamed Stream (09020106-518)	Mainstem	M-IBI	NA	++	+	0	INSUF	-	NA
Unnamed Creek (09020106-576)	Mainstem	F-IBI	+++	INSUF	INSUF	INSUF	INSUF	INSUF	NA
Unnamed Ditch (09020106-578)	Mainstem	M-IBI	NA	+	+	-	++	-	NA
Unnamed Creek (09020106-580)	Mainstem	F-IBI	+	++	++	++	0	0	NA
		M-IBI	NA	++	++	+	0	0	NA
County Ditch 16 (09020106-581)	Mainstem	F-IBI	+	+++	++	++	+	0	NA
Buffalo River (09020106-593)	Mainstem <sup>3</sup>	F-IBI	++	++	++	+++	0	-	NA
Hay Creek (09020106-621)	Mainstem	F-IBI	+	++	+	++	-	0	NA
County Ditch 25 (09020106-538)	Northern	F-IBI	INSUF	INSUF	INSUF	INSUF	INSUF	INSUF	NA
		M-IBI	NA	+++	+	++	++	-	NA
County Ditch 2 (09020106-556)	Northern	M-IBI	NA	+++	+	0	0	-	NA
County Ditch 5 (09020106-563)	Northern	F-IBI	++	+++	++	0	++	-	NA
		M-IBI	NA	+++	++	0	++	0	NA
County Ditch 3 (09020106-615)	Northern	F-IBI	++	++	++	0	++	0	NA
		M-IBI	NA	++	++	-	++	0	NA
County Ditch 39 (09020106-617)	Northern	F-IBI	+	++	++	0	++	-	NA
		M-IBI	NA	++	+	0	+	-	NA

Reach Name (WID)	Planning region	Bioassessments Impairment <sup>1</sup>	Candidate Cause <sup>2</sup>						
			Loss of Longitudinal Connectivity	Flow Regime Instability	Insufficient Physical Habitat	High Total Suspended Solids	Low Dissolved Oxygen	High Nitrate-Nitrogen	High Temperature
County Ditch 10 (09020106-619)	Northern	M-IBI	NA	+++	+	0	++	-	NA
Unnamed Creek (09020106-624)	Northern	F-IBI	+	+++	+	0	++	0	NA
		M-IBI	NA	++	+	-	++	0	NA
Buffalo R., S. Branch (09020106-505)	Southern	M-IBI	NA	+	+	++	+	-	NA
Deerhorn Creek (09020106-507)	Southern	F-IBI	++	++	++	0	0	-	NA
		M-IBI	NA	+++	++	+	0	0	NA
Lawndale Creek (09020106-530)	Southern	F-IBI	++	+	0	++	+	-	++
Unnamed Creek (09020106-544)	Southern	M-IBI	NA	++	+	-	++	-	NA
Buffalo R., S. Branch (09020106-605)	Southern	F-IBI	+	+++	0	0	+	-	NA
		M-IBI	NA	+++	+	0	++	-	NA

<sup>1</sup> Aquatic life impairment for fish bioassessments (F-IBI) and/or benthic macroinvertebrate bioassessments (M-IBI).

<sup>2</sup> Key: +++ the multiple lines of evidence **convincingly support** the case for the candidate cause as a stressor; ++ the multiple lines of evidence **strongly support** the case for the candidate cause as a stressor; + the multiple lines of evidence **somewhat support** the case for the candidate cause as a stressor; 0 the multiple lines of evidence **neither support nor refute** the case for the candidate cause as a stressor; - the multiple lines of evidence **refute** the case for the candidate cause as a stressor; INSUF there is **insufficient information** to evaluate the candidate cause as a stressor; and NA the candidate cause is **not applicable** as a stressor due to type of bioassessments impairment or the use classification of the reach.

<sup>3</sup> The upstream portion of the Buffalo River (WID 09020106-593) is located in the Lakes Planning Region.

**Table 21. Weight of evidence summary for stressors associated with bioassessments impairments in the URRW (MPCA 2023).**

Reach Name (WID)	Planning region	Bioassessments Impairment <sup>1</sup>	Candidate Cause <sup>2</sup>						
			Loss of Longitudinal Connectivity	Flow Regime Instability	Insufficient Physical Habitat	High Total Suspended Solids	Low Dissolved Oxygen	High Nitrate-Nitrogen	High Temperature
Unnamed Creek (09020104-516)	Upper Red	F-IBI	+	++	++	0	-	-	NA
		M-IBI	NA	0	+	+++	-	0	NA
Unnamed Creek (09020104-533)	Upper Red	F-IBI	0	++	++	INSUF	INSUF	INSUF	NA
Unnamed Ditch (09020104-537)	Upper Red	F-IBI	++	++	++	+	0	0	NA
Wolverton Creek (09020104-549)	Western	F-IBI	++	+++	+++	0	+	0	NA
Wolverton Creek (09020104-550)	Western	F-IBI	+	++	+++	+++	0	0	NA

<sup>1</sup> Aquatic life impairment for fish bioassessments (F-IBI) and/or benthic macroinvertebrate bioassessments (M-IBI).

<sup>2</sup> **Key:** +++ the multiple lines of evidence *convincingly support* the case for the candidate cause as a stressor; ++ the multiple lines of evidence *strongly support* the case for the candidate cause as a stressor; + the multiple lines of evidence *somewhat support* the case for the candidate cause as a stressor; 0 the multiple lines of evidence *neither support nor refute* the case for the candidate cause as a stressor; – the multiple lines of evidence *refute* the case for the candidate cause as a stressor; **INSUF** there is *insufficient information* to evaluate the candidate cause as a stressor; and **NA** the candidate cause is *not applicable* as a stressor due to type of bioassessments impairment or the use classification of the reach.

# Appendix C: Minnesota Nutrient Reduction Strategy watershed nutrient reduction planning targets

Figure 39. Statewide watershed phosphorus load reduction (left) and percent reduction (right) goals.

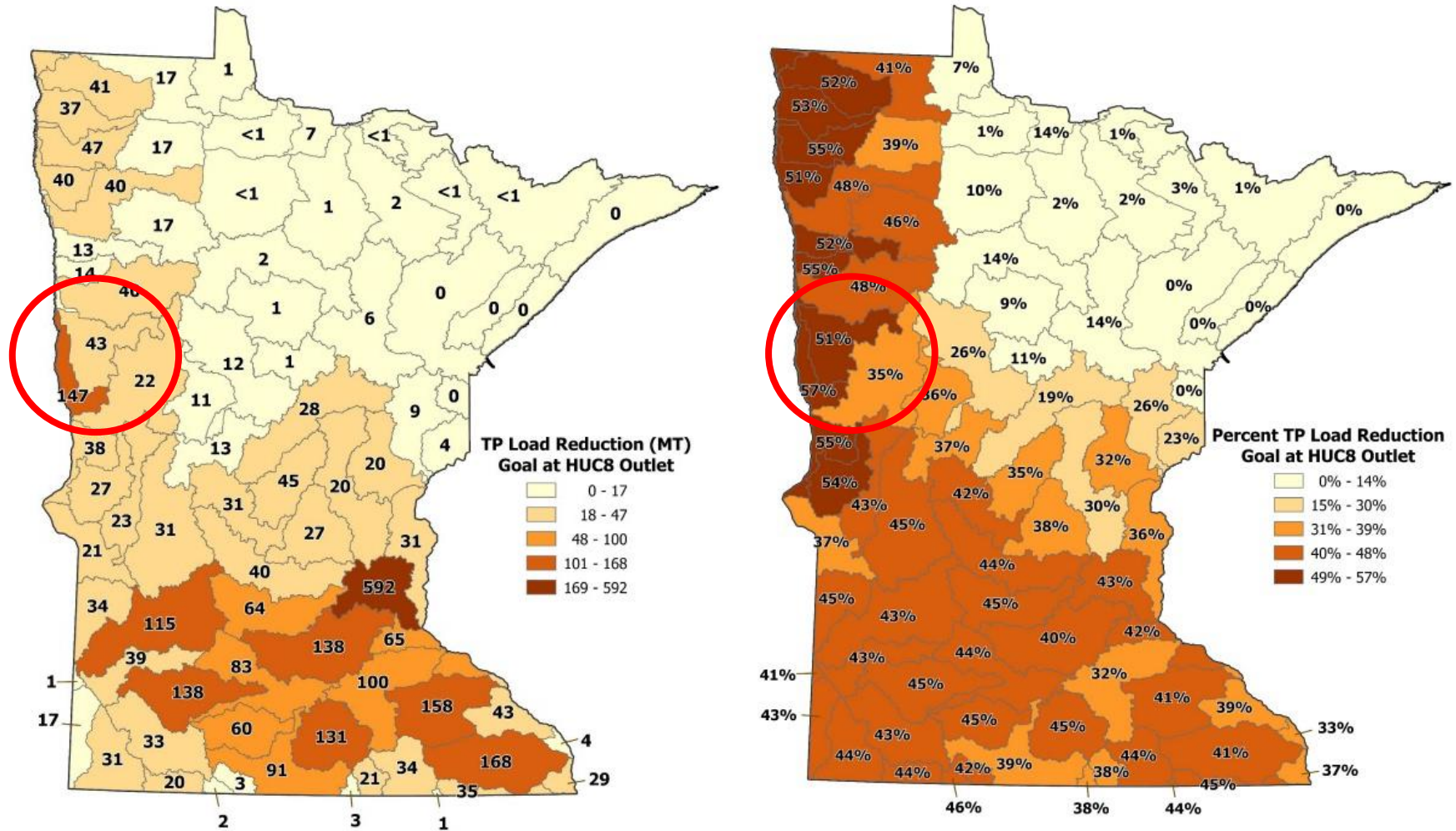
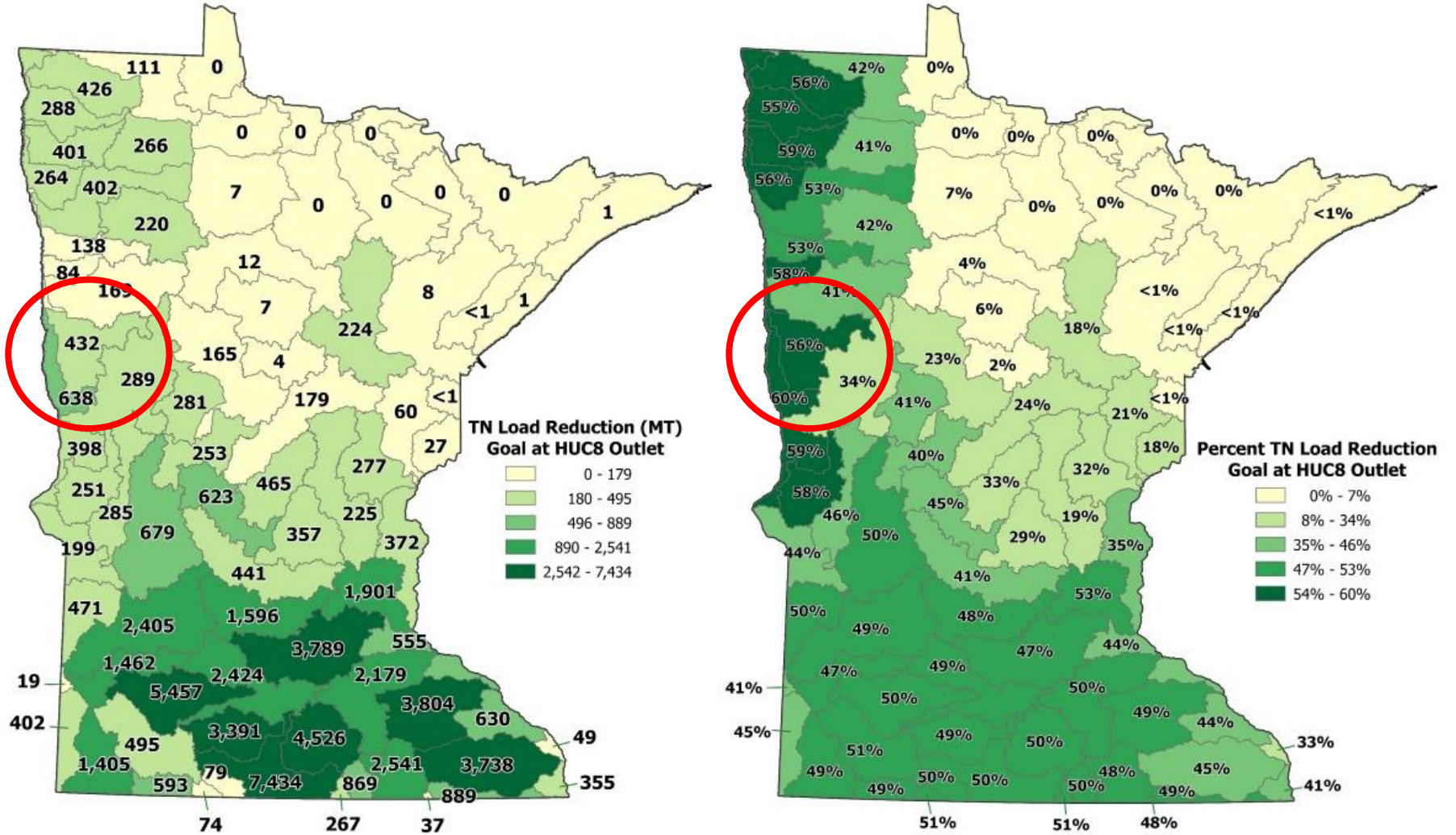


Figure 40. Statewide watershed nitrogen load reduction (left) and percent reduction (right) goals.



\*Figures are excerpted from the 2025 Minnesota Nutrient Reduction Strategy supporting document appendix 2-4 (MPCA 2025p).

## Appendix D: Dissolved oxygen driver analysis

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This appendix provides information and data for the MPCA's investigation of the nine stream reaches located within the BRW and the URRW that are listed as impaired due to low DO as of Minnesota's 2024 303(d) Impaired Waters List. Of the nine impaired reaches, seven are located in the BRW and two are located in the URRW. Prior to the development of the *Buffalo River and Upper Red River of the North Watersheds TMDL Report* (MPCA 2025h), MPCA staff determined that additional information would be needed to address the impairment status of each of these stream reaches. It was anticipated that at least some of the impaired reaches would have sufficient data to be addressed with phosphorus TMDLs in that report. It was also anticipated that the low DO in all of the impaired reaches may be driven at least partially by nonchemical factors such as stream channel geomorphology and hydrology.

The MPCA staff determined that additional information would be collected from six of the seven DO-impaired stream reaches within the BRW, provided below in Table 22 from upstream to downstream. Two additional stream reaches that are not currently listed as impaired due to low DO were also evaluated as they are tributaries to the Buffalo River, South Branch: Deerhorn Creek (WID 09020106-507) and Whiskey Creek (09020106-520). MPCA staff determined that additional information from one of the BRW DO-impaired stream reaches and the two DO-impaired reaches within the URRW should not be collected and those impairments would be deferred for this investigation and TMDL development. The uppermost reach of the Buffalo River, South Branch (09020106-603) was not evaluated due to wetland conditions and no flow at the sampling location observed by MPCA staff in 2023. Whiskey Creek (09020104-520) was not evaluated due to significant stream channel restoration work being conducted within the sampling area during the summer of 2023. Wolverton Creek (09020104-549) was not evaluated due to stream channel restoration work completed in recent years (2018-2021) as well as impounded streamflow from multiple beaver dams within the sampling area.

Additional data collection was conducted by MPCA staff over a roughly two-week period during the summer of 2023, from late June through early July. This time period was selected based on available staff time and resources, and to target the potential for critical conditions for low DO when water temperature is high, stream flow is low, and the effects of eutrophication are increased. The MPCA staff deployed sondes in late June in seven of the eight evaluated stream reaches primarily to track continuous DO and fluctuations in DO concentrations (diel DO flux), as well as additional parameters. A sonde was not deployed in County Ditch 10 (09020106-619) as two previous sonde deployments in 2019 and 2020 provided data that was determined to be sufficient for this evaluation. Sondes were recovered two weeks later, and their data was downloaded for analyzing by MPCA staff. Additionally, MPCA staff conducted discrete water quality sampling and field observations three times over the two-week period: at sonde deployment, at the midpoint of the two-week period, and at sonde retrieval. Lab parameters collected include TP, ortho-phosphorus, chlorophyll-*a* (chl-*a*), biochemical oxygen demand (BOD), and TSS. Field parameters collected with the sondes include discrete DO, temperature, specific conductance, and more. The MPCA staff also conducted flow estimates, transparency tube measurements, and other stream channel observations. Stream flow data was also downloaded from the MPCA-DNR Cooperative Stream Gaging network<sup>1</sup> and the USGS National Water Dashboard<sup>2</sup>.

The MPCA staff then analyzed all of the data collected over the two-week period in the summer of 2023, as well as all other historical data for each stream reach, in order to evaluate the potential drivers, or causes, of the low DO and diel DO flux in each reach. MPCA staff's findings are summarized below in Table 22. Eutrophication was found to be a driver for two of the DO-impaired stream reaches due to TP and diel DO flux exceeding the applicable river eutrophication standards (RES) (TMDL report Section 2.4.2): Buffalo River, South Branch (WID 09020106-605) and County Ditch 10 (09020106-619). As such, TP TMDLs were developed for these two stream reaches.

Eutrophication was found to be a potential driver for the low DO in Stony Creek (09020106-502) due to TP exceeding the RES and occasional exceedances of the response variables; however, the response variable data was determined to be inconclusive. Eutrophication was not found to be a driver in the remaining evaluated stream reaches with low DO as TP was found to be exceeding the RES or inconclusive, but the response variables including diel DO flux were found to be meeting standards. These include the three remaining reaches of the Buffalo River, South Branch (09020106-505, 09020106-504, 09020106-503) as well as Whiskey Creek (09020106-509), which has historical exceedances of the DO standard but is not currently listed as impaired due to low DO. The DO impairments for Stony Creek and the Buffalo River, South Branch will also be deferred for TMDL development and their status on the IWL will remain unchanged at this time.

Deerhorn Creek (09020106-507) was found to be meeting the applicable RES and DO standards and is suggested as an example for setting restoration targets for the other evaluated stream reaches.

Additional data collection will need to be considered in the future for re-evaluation of the deferred DO-impaired stream reaches in the BRW and URRW, potentially including additional TMDLs or recategorization to 4C due to nonpollutant causes. The sampling location for the uppermost reach of the Buffalo River, South Branch (09020106-603) should be re-evaluated and potentially moved upstream due to the wetland conditions at the current sampling location observed by MPCA staff in 2023. Whiskey Creek (09020104-520) and Wolverton Creek (09020104-549) should be re-evaluated to assess how the significant stream channel restoration work impacted DO concentrations in those reaches. Finally, nonchemical drivers of low DO, especially hydrology, should be further investigated in all of the DO-impaired stream reaches and their upstream tributaries.

1. MPCA-DNR Cooperative Stream Gaging network: available at <https://www.dnr.state.mn.us/waters/csg/index.html>.
2. USGS National Water Dashboard: available at: <https://dashboard.waterdata.usgs.gov/app/nwd/en/?aoi=default>.

**Table 22. Summary of DO driver analysis.<sup>1</sup>**

WID	Water body name	Water body description	Data supports impairment determination?						Potential low DO driver(s)?	Next Steps
			TP	Chl- <i>a</i>	Diel DO flux	BOD	pH	Minimum daily DO		
09020106-605	Buffalo River, South Branch	Unnamed cr to Deerhorn Cr	Yes	No	Yes	No	No	Yes	Eutrophication	TP TMDL
09020106-507	Deerhorn Creek	Headwaters to S Br Buffalo R	No	No	No	No	No	No	Not evaluated	NA – not impaired
09020106-505	Buffalo River, South Branch	Deerhorn Cr to Whisky Cr	No	No	No	No	No	Inc	Nonchemical	Defer
09020106-509	Whisky Creek	T137 R47W S13, east line to S Br Buffalo R	Yes	No	No	No	No	Yes	Nonchemical	NA – not impaired
09020106-504	Buffalo River, South Branch	Whisky Cr to Stony Cr	Yes	No	No	No	No	Yes	Nonchemical	Defer
09020106-502	Stony Creek	Hay Cr to S Br Buffalo R	Yes	Inc	Inc	Inc	No	Yes	Inconclusive	Defer
09020106-503	Buffalo River, South Branch	Stony Cr to Buffalo R	Yes	No	No	No	No	Yes	Nonchemical	Defer
09020106-619	County Ditch 10	80th St N to Buffalo R	Yes	No	Yes	No	No	Inc	Eutrophication	TP TMDL

1. Buffalo River, South Branch (09020106-603) was not evaluated due to wetland conditions and no flow at the sampling location. Whiskey Creek (WID 09020104-520) was not evaluated due to ongoing stream channel restoration work within the sampling area during the summer of 2023. Wolverton Creek (09020104-549) was not evaluated due to stream channel restoration work completed in recent years as well as impoundments from beaver dams within the sampling area. The DO impairments in these stream reaches will be deferred.