Watershed health

June 2018

Mississippi River-Grand Rapids Watershed Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

Authors

MPCA Mississippi River – Grand Rapids Watershed Report Team:
Benjamin Lundeen, Isaac Martin, Nathan Mielke, Jonathon Newkirk, Scott Niemela, Kevin Stroom, Bruce Monson, Shawn Nelson, Kris Parson, Sophia Vaughan, Anthony J. Dingmann, Paul Schreiber, Mark Evenson

Contributors/acknowledgements

Citizen Stream Monitoring Program Volunteers
Citizen Lake Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture
Itasca Soil and Water Conservation District
Carlton Soil and Water Conservation District
Aitkin Soil and Water Conservation District
Headwaters Science Center

Project dollars provided by the Clean Water Fund (from the Clean Water, Land and Legacy Amendment).

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

Document number: wq-ws3-07010103b

Contents

Figures

Tables

List of acronyms

AUID Assessment Unit Identification Determination

Chl-a Chlorophyll-a

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

DTW Depth to Water

EPA U.S. Environmental Protection Agency

EQuIS Environmental Quality Information System

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

FS Full Support

FWMC Flow Weighted Mean Concentration

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

IWM Intensive Watershed Monitoring

LRVW Limited Resource Value Water

MCL maximum contaminant level

MDH Minnesota Department of Health

DNR Minnesota Department of Natural Resources

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NWI National Wetland Inventory

NH3 Ammonia

NS Not Supporting

OP Orthophosphate

PCB Poly Chlorinated Biphenyls

PFC perfluorochemicals

PFOS perfluorooctane sulfonate

RAA Risk Assessment Advice

SMCL secondary maximum contaminant level

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

UAA Use Attainability Analysis

USGS United States Geological Survey

WIMN “What’s in My Neighborhood?”

WPLMN Water Pollutant Load Monitoring Network

Executive summary

The Mississippi River-Grand Rapids Watershed (8-HUC 07010103), located in the Upper Mississippi River Basin, drains 2,056 square miles in north central Minnesota. Much of the Mississippi River-Grand Rapids Watershed consists of dense forest and wetlands. Wetlands (and those created by beaver dams in particular) can have profound effects on the chemical and biological characteristics of rivers and streams.

This watershed is bordered by seven other major watersheds, and spans parts of Aitkin, Cass, Carlton, Itasca, and St. Louis counties. There are many lakes in the watershed that offer exceptional fishing, boating, swimming, and other recreational opportunities. Some of Minnesota's most well-known fisheries reside within this watershed, most notably Big Sandy Lake. The Mississippi River flows roughly 100-miles through this watershed; however, this report focuses primarily on the major tributaries to the Mississippi River, which include the Prairie, Swan, Sandy, Tamarack, Hill, Moose, Split Hand Creek, and Willow River, as well as numerous smaller named and unnamed tributaries.

In 2015, the Minnesota Pollution Control Agency (MPCA) and local partners began an intensive watershed monitoring (IWM) effort of rivers, streams and lakes within the Mississippi River-Grand Rapids Watershed. Then in 2017, all waterbodies with sufficient data (i.e. 73 streams and 216 lakes) were assessed for aquatic life, aquatic recreation, and/or aquatic consumption use support.

Lakes in this watershed are generally in good condition. Nearly all lakes assessed for aquatic life met standards, with 20% of those lakes identified as having exceptional fish communities. Aquatic recreation use – swimming, wading, etc. was supported in many lakes in the watershed. Many of the lakes are deep and often without considerable development. Shallower lakes, or those with heavy development, are at higher risk for increased nutrients and algae blooms. Impairments were identified primarily in the southern portion of the watershed (Big Sandy Lake (outlet) and Tamarack River subwatersheds).

Similar to lakes, fish and macroinvertebrate communities in streams throughout the watershed are in good condition. The Prairie River (from Day Brook to Balsam Creek), West Fork Prairie River (Hartley Lake to Prairie River), Tamarack River (from Little Tamarack River to Prairie River), and Willow River Ditch (from Willow River Flowage to Moose River) are designated as Exceptional Use streams based on good habitat and excellent fish and macroinvertebrate communities. These reaches should be protected to preserve the integrity of their diverse biological communities. Several streams are impaired for aquatic life based on poor fish and/or macroinvertebrate communities. These impairments are likely a result of non-point source pollution, habitat fragmentation due to alterations of streams, low dissolved oxygen (DO) and elevated nutrients, and/or loss of connectivity with upstream resources. A detailed discussion of biological community stressors within the Mississippi River-Grand Rapids Watershed may be found in the Stressor Identification Report (MPCA, *In prep*).

Introduction

Water is one of Minnesota's most abundant and precious resources. The MPCA is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA), which requires states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption, and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of waterbodies that do not meet established standards. Such waters are referred to as "impaired waters" and the state must make appropriate plans to restore these waters, including the development of Total Maximum Daily Loads (TMDLs). A TMDL is a comprehensive study determining the assimilative capacity of a waterbody, identifying all pollution sources causing or contributing to impairment, and an estimation of the reductions needed to restore a waterbody so that it can once again support its designated use.

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment. To successfully prevent and address problems, decision makers need good information regarding the status of the resources, potential and actual threats, options for addressing the threats, and data on the effectiveness of management actions. The MPCA's monitoring efforts are focused on providing that critical information. Overall, the MPCA is striving to provide information to assess, and ultimately, to restore or protect the integrity of Minnesota's waters.

The passage of Minnesota's Clean Water Legacy Act in 2006 provided a policy framework and the initial resources for state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. This work is implemented on an on-going basis with funding from the Clean Water Fund created by the passage of the Clean Water Land, and Legacy Amendment to the state constitution. To facilitate the best use of agency and local resources, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of agency and local water monitoring programs to assess the condition of Minnesota's surface waters, and to allow for coordinated development and implementation of water quality restoration and improvement projects.

The strategy behind the watershed monitoring approach is to intensively monitor streams and lakes within a major watershed to determine the overall health of water resources, identify impaired waters, and to identify waters in need of additional protection. The benefit of the approach is the opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. The watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and non-point sources of pollution and further the CWA goal of protecting and restoring the quality of Minnesota's water resources.

This watershed-wide monitoring approach was implemented in the Mississippi River-Grand Rapids Watershed beginning in the summer of 2015. This report provides a summary of all water quality assessment results in the Mississippi River-Grand Rapids Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units. The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring, and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA, 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Intensive watershed monitoring

The IWM strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale (Figure 1). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for waterbodies within a similar geographic and hydrologic extent. The foundation of this approach is the 80 major watersheds (8-HUC) within Minnesota. Using this approach, many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least 1 year within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, 8-HUC, aggregated 12-HUC and 14-HUC (Figure 1). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the 8-HUC scale. The outlet of the major 8-HUC watershed (purple dot in Figure 2) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The aggregated 12-HUC is the next smaller subwatershed scale, which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated 12-HUC outlet (green dots in Figure 2) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each aggregated 12-HUC, smaller watersheds (14 HUCs, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated 12-HUC tributaries. Each of these minor subwatershed outlets are sampled for biology to assess aquatic life use support (red dots in Figure 2).

Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported and where applicable, where fish community health can be determined. Lakes are prioritized by size, accessibility (can the public access the lakes), and presence of recreational use.

Specific locations for sites sampled as part of the intensive monitoring effort in the Mississippi River-Grand Rapids Watershed are shown in Figure 2 and are listed in Appendices 2.1 and 2.2.

Figure 1. The IWM design.

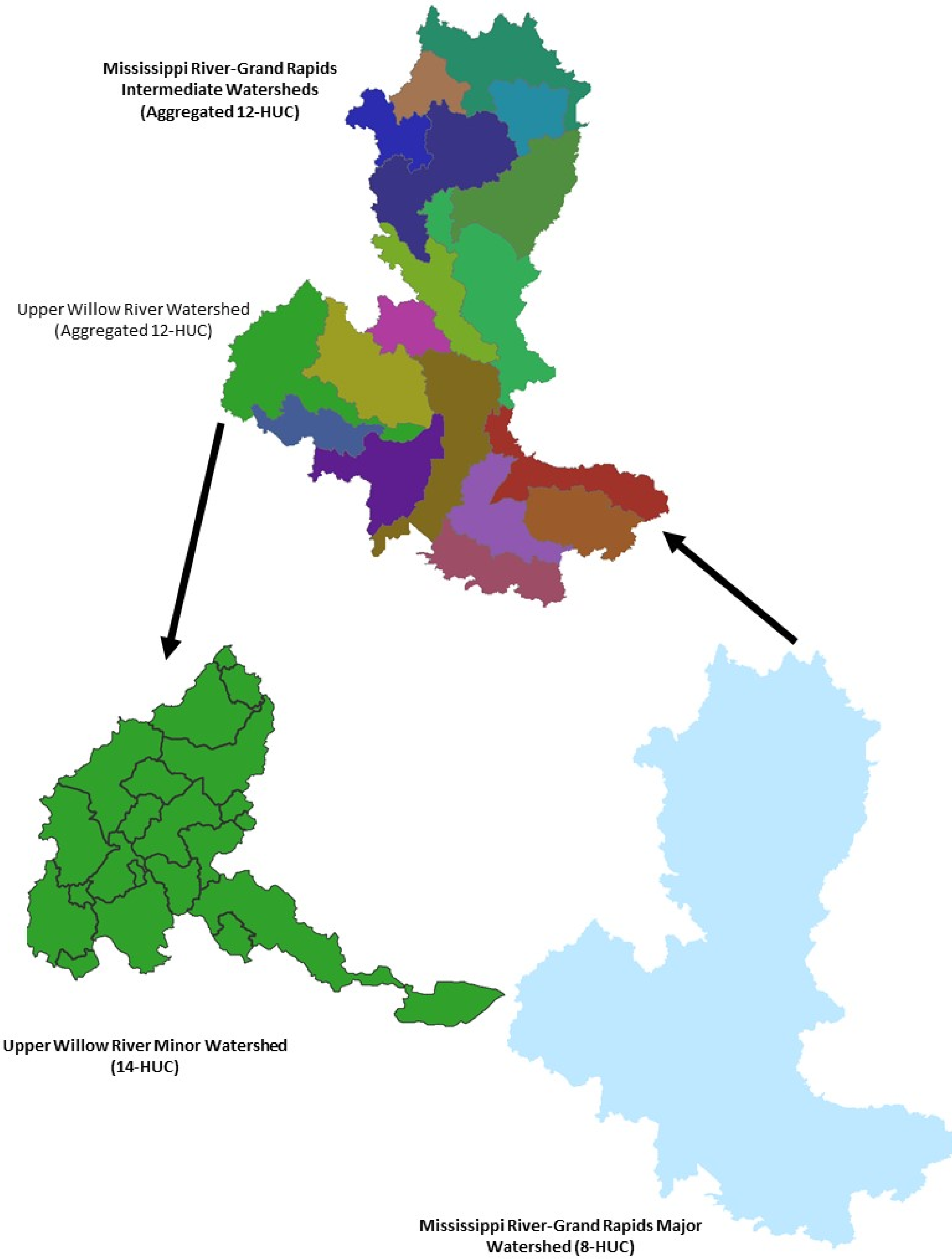
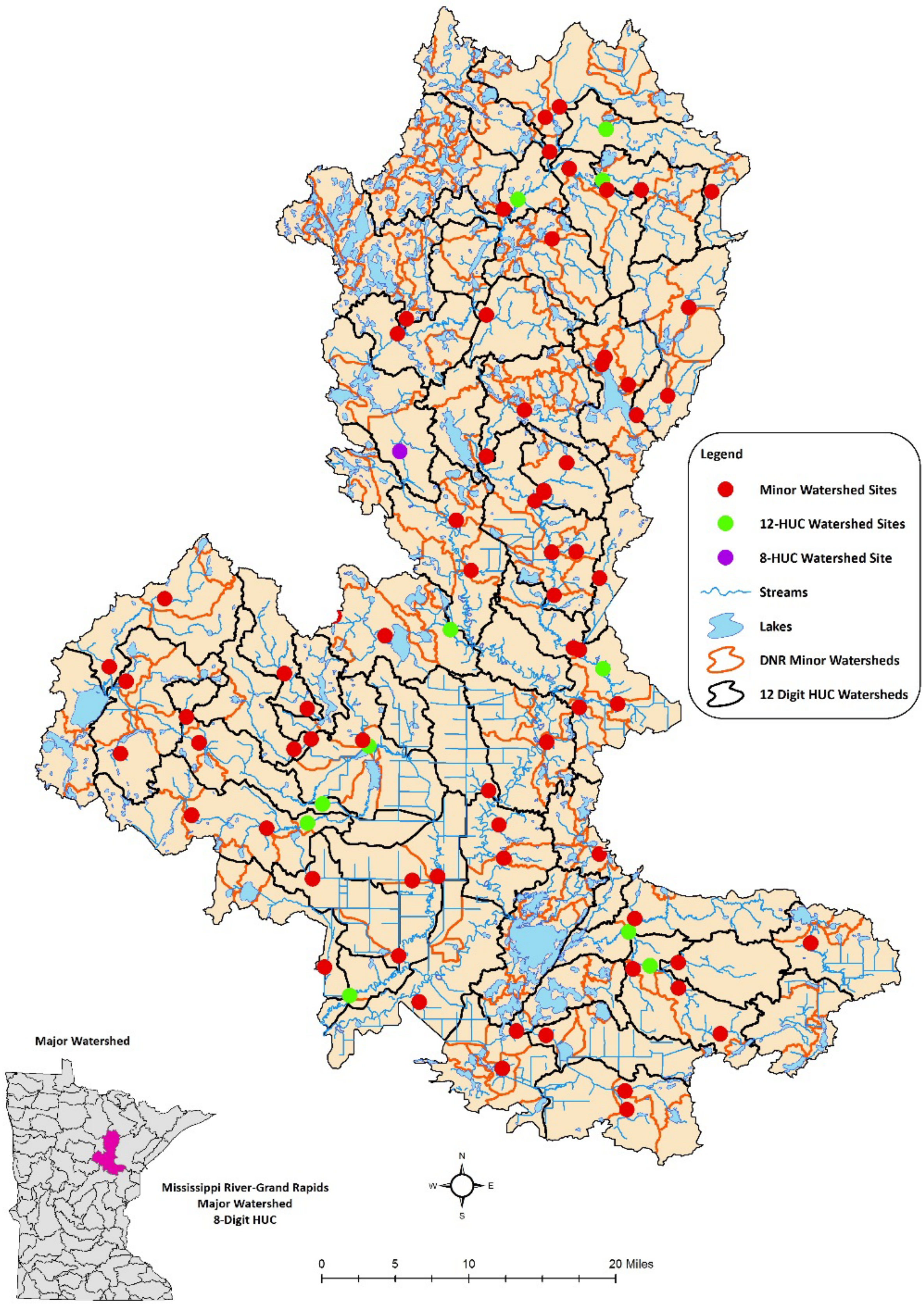


Figure 2. IWM sites for streams in the Mississippi River-Grand Rapids Watershed.

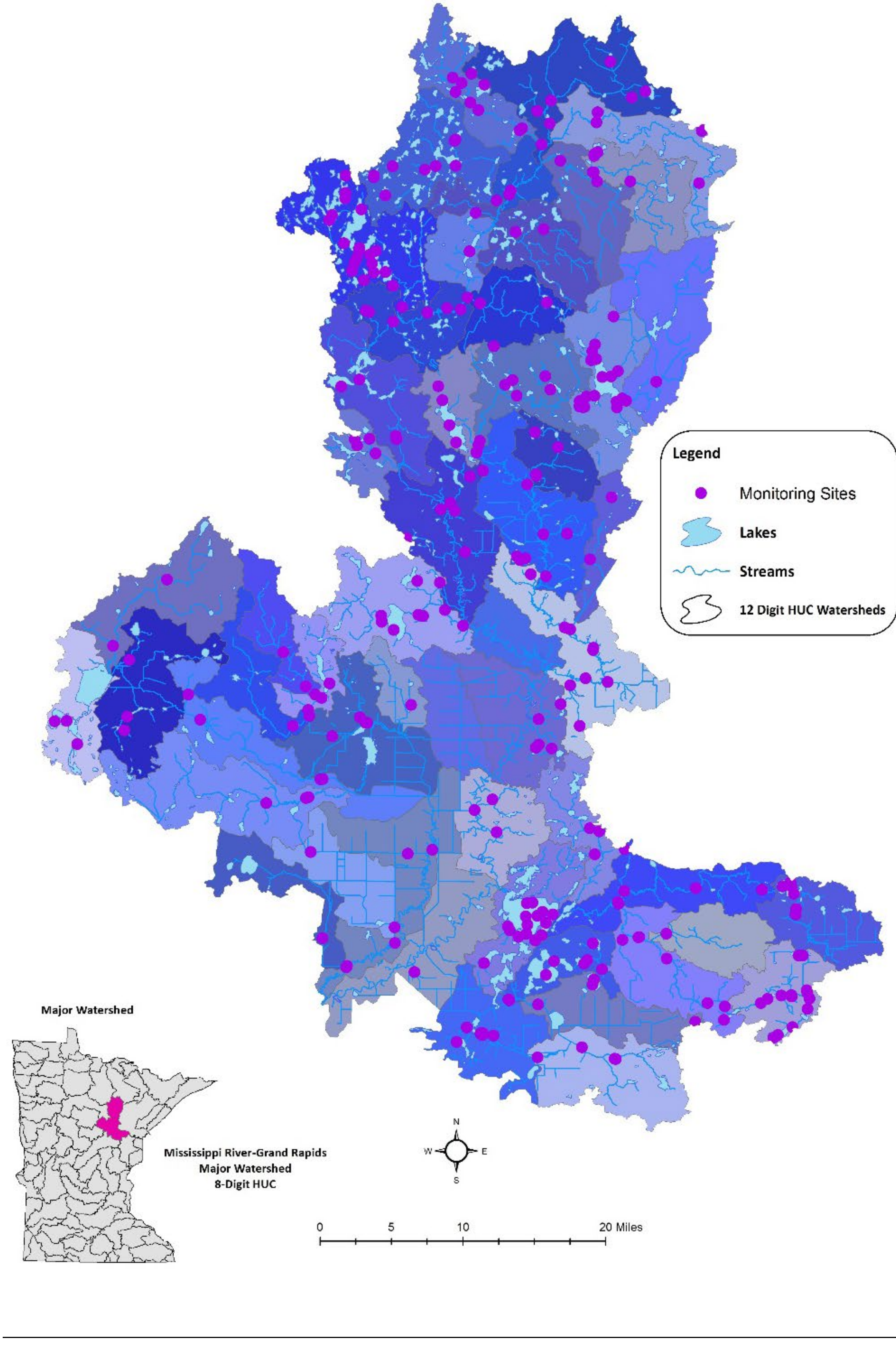


Citizen and local monitoring

Citizen and local monitoring is an important component of the watershed approach. The MPCA and its local partners jointly select the stream sites and lakes to be included in the IWM process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments the ability to see how their efforts are used to inform water quality decisions and track how management efforts affect change. Many SWAG grantees invite citizen participation in their monitoring projects and their combined participation greatly expand our overall capacity to conduct sampling.

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 3 provides an illustration of the locations where citizen-monitoring data were used for assessment in the Mississippi River-Grand Rapids Watershed.

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Mississippi River-Grand Rapids Watershed.



Assessment methodology

The Clean Water Act (CWA) requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA, 2016)*. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation), or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams, and wetlands are protected for aquatic life and recreation where these uses are attainable. Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses.

Protection of aquatic recreation means the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of *E. coli* bacteria in the water. To determine if a lake supports aquatic recreational activities, its trophic status is evaluated, using total phosphorus, Secchi depth and chlorophyll-a (Chl-a) as indicators. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this beneficial use. The concentrations of mercury and polychlorinated biphenyls (PCBs) in fish tissue are used to evaluate whether or not fish are safe to eat in a lake or stream and to issue recommendations regarding the frequency that fish from a particular waterbody can be safely consumed. For lakes, rivers, and streams that are protected as a source of drinking water, the MPCA primarily measures the concentration of nitrate in the water column to assess this designated use.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates and plants. Biological monitoring, the sampling of aquatic organisms, is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI). This index is a scientifically validated combination of measurements of the biological community (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a site. The MPCA has developed stream IBIs for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. The MPCA also uses a lake fish IBI developed by the Minnesota Department of Natural Resources (DNR) to determine if lakes are meeting aquatic life use. Because the lakes, rivers, and streams in Minnesota are physically, chemically, and biologically diverse, IBIs are developed separately for different stream classes and lake class groups to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life. For streams, these include pH, DO, un-ionized ammonia nitrogen, chloride, total suspended solids, pesticides, and river eutrophication. For lakes, pesticides and chlorides contribute to the overall aquatic life use assessment.

Protection for aquatic life uses in streams and rivers are divided into three tiers: Exceptional, General, and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that can be characterized as having an overall balanced distribution of the assemblages and with the ecosystem functions largely maintained through redundant attributes. Modified Use waters have been extensively altered through legacy physical modifications that limit the ability of the biological communities to attain the General Use. Currently the Modified Use is only applied to streams with channels that have been directly altered by humans (e.g., maintained for drainage, riprapped). These tiered uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat. For additional information, see: http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/tiered-aquatic-life-use-talu-framework.html).

Table 1. Proposed tiered aquatic life use standards.

Proposed Tiered Aquatic Life Use	**Acronym**	**Proposed Use Class Code**	**Description**
Warm water General	WWg	2Bg	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the General Use biological criteria.
Warm water Modified	WWm	2Bm	Warm water Stream protected for aquatic life and recreation, physically altered watercourses (e.g., channelized streams) capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Modified Use biological criteria, but are incapable of meeting the General Use biological criteria as determined by a Use Attainability Analysis
Warm water Exceptional	WWe	2Be	Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the Exceptional Use biological criteria.
Coldwater General	CWg	2Ag	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of cold water aquatic organisms that meet or exceed the General Use biological criteria.
Coldwater Exceptional	CWe	2Ae	Coldwater Stream protected for aquatic life and recreation, capable of supporting and maintaining an exceptional and balanced, integrated, adaptive community of cold water aquatic organisms that meet or exceed the Exceptional Use biological criteria.

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, DO and toxic pollutants.

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R. ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its AUID), comprised of the U.S. Geological Survey (USGS) eight-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the DNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the AUID and are composed of an eight-digit number indicating county, lake, and bay for each basin.

It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). Over the course of time it takes fish, particularly game fish, to grow to "catchable" size and accumulate unacceptable levels of pollutants, there is a good chance they have traveled a considerable distance. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach and thus often includes several assessment units.

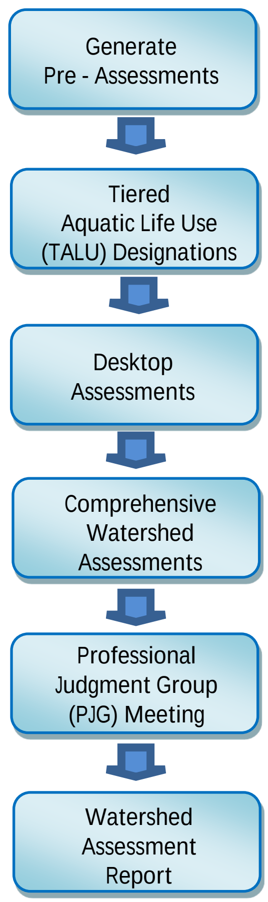
Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 4.

The first step in the aquatic life assessment process is largely an automated process performed by logic programmed into a database application where all data from the 10 year assessment window is gathered; the results are referred to as 'Pre-Assessments'. Data filtered into the "Pre-Assessment" process is then reviewed to insure that data is valid and appropriate for assessment purposes. Tiered use designations are determined before data is assessed based on the attainment of the applicable biological criteria and/or an assessment of the habitat. Stream reaches are assigned the highest aquatic life use attained by both biological assemblages on or after November 28, 1975. Streams that do not attain the Exceptional or General Use for both assemblages undergo a Use Attainability Analysis (UAA) to determine if a lower use is appropriate. A Modified Use can be proposed if the UAA demonstrates that the General Use is not attainable as a result of legal human activities (e.g., drainage maintenance, channel stabilization) which are limiting the biological assemblages through altered habitat. Decisions to propose a new use are made through UAA workgroups which include watershed project managers and biology leads. The final approval to change a designated use is through formal rulemaking.

The next step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. Pre-assessments are then reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are conducted at the workstation of each reviewer (i.e., desktop) using computer applications to analyze the data for potential temporal or spatial trends as well as gain a better understanding of any extenuating circumstances that should be considered (e.g., flow, time/date of data collection, or habitat).

Figure 4. Flowchart of aquatic life use assessment process.



The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface*

Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA, 2016) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04i.pdf for guidelines and factors considered when making such determinations.

The last step in the assessment process is the Professional Judgment Group meeting. At this meeting results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling events that may have been uncharacteristic due to annual climate or flow variation, local factors such as impoundments that do not represent the majority of conditions on the AUID). Waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are also included in watershed monitoring and assessment reports.

Watershed overview

Located within the northcentral portion of Minnesota, the Mississippi River-Grand Rapids Watershed is comprised of lakes, wetlands, and rich soils. The Mississippi River-Grand Rapids has a total drainage of 2,056 square miles (NRCS 2008), spanning across five counties: Aitkin, Carlton, Cass, Itasca, and St. Louis.

This watershed lies completely within the Northern Lakes and Forest Omernick level III Ecogregion (Omernik & Gallant, 1988) (Figure 5). This watershed is largely forested, with many wetlands scattered throughout. The expanse of wetland and forest habitats are tied to the watersheds rich history of glaciation (Figure 6). The northern and western portions have soils that are characteristic of retreating and wasting of ice sheets (Agriculture department), while the central and southern portions contain soils left over from Glacial Lake Aitkin.

Figure 5. The Mississippi River-Grand Rapids Watershed within the Northern Lakes and Forest ecoregion of Northern Minnesota.

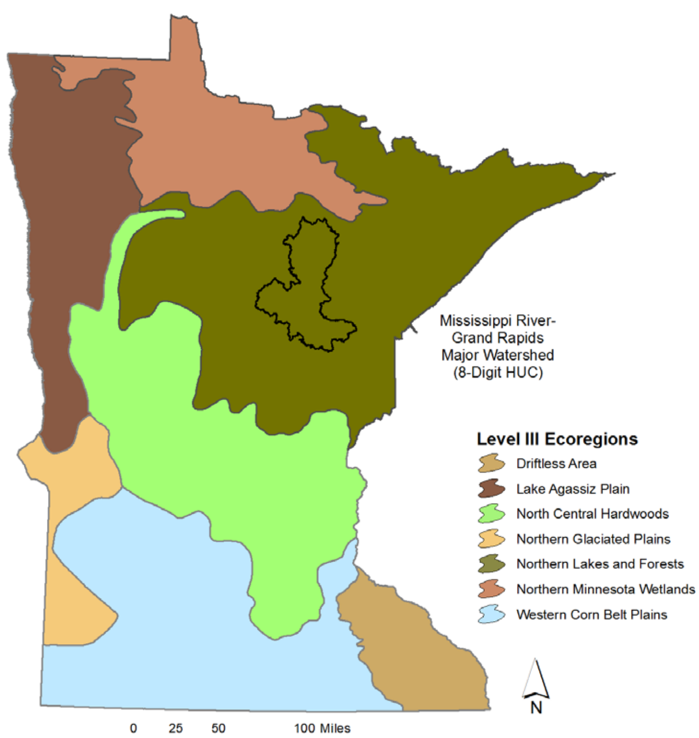
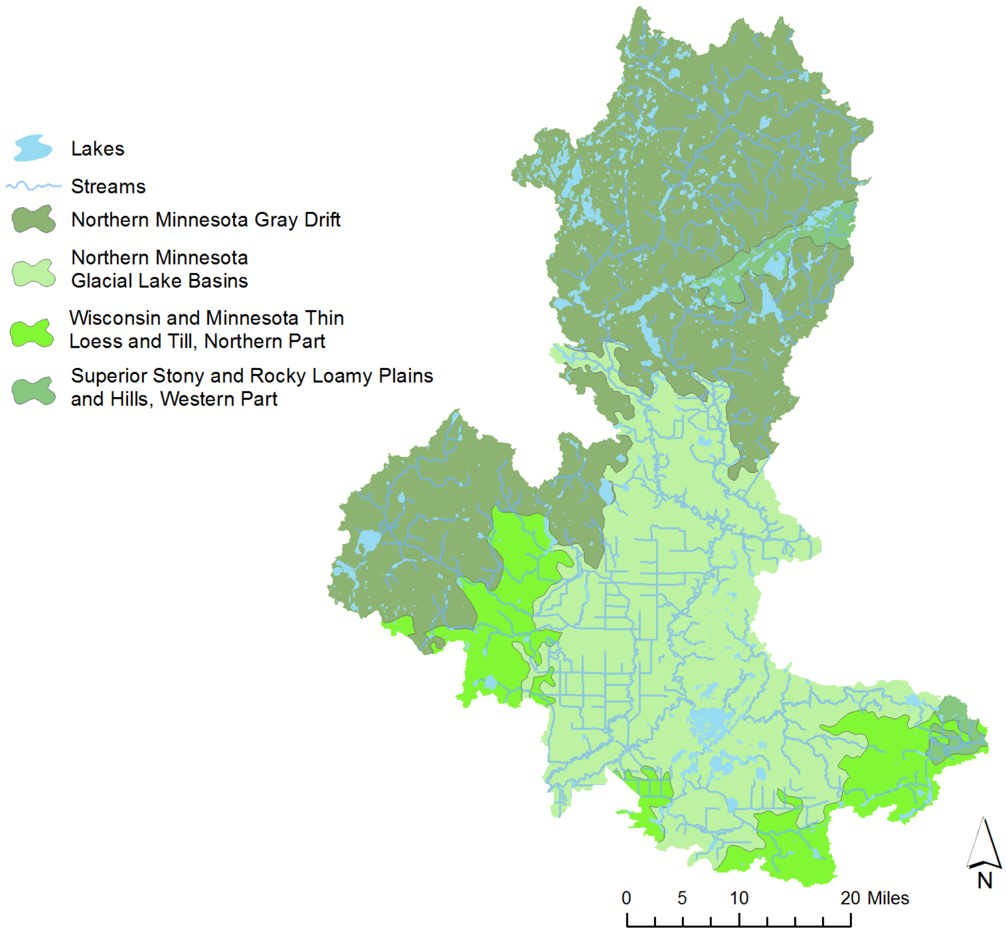


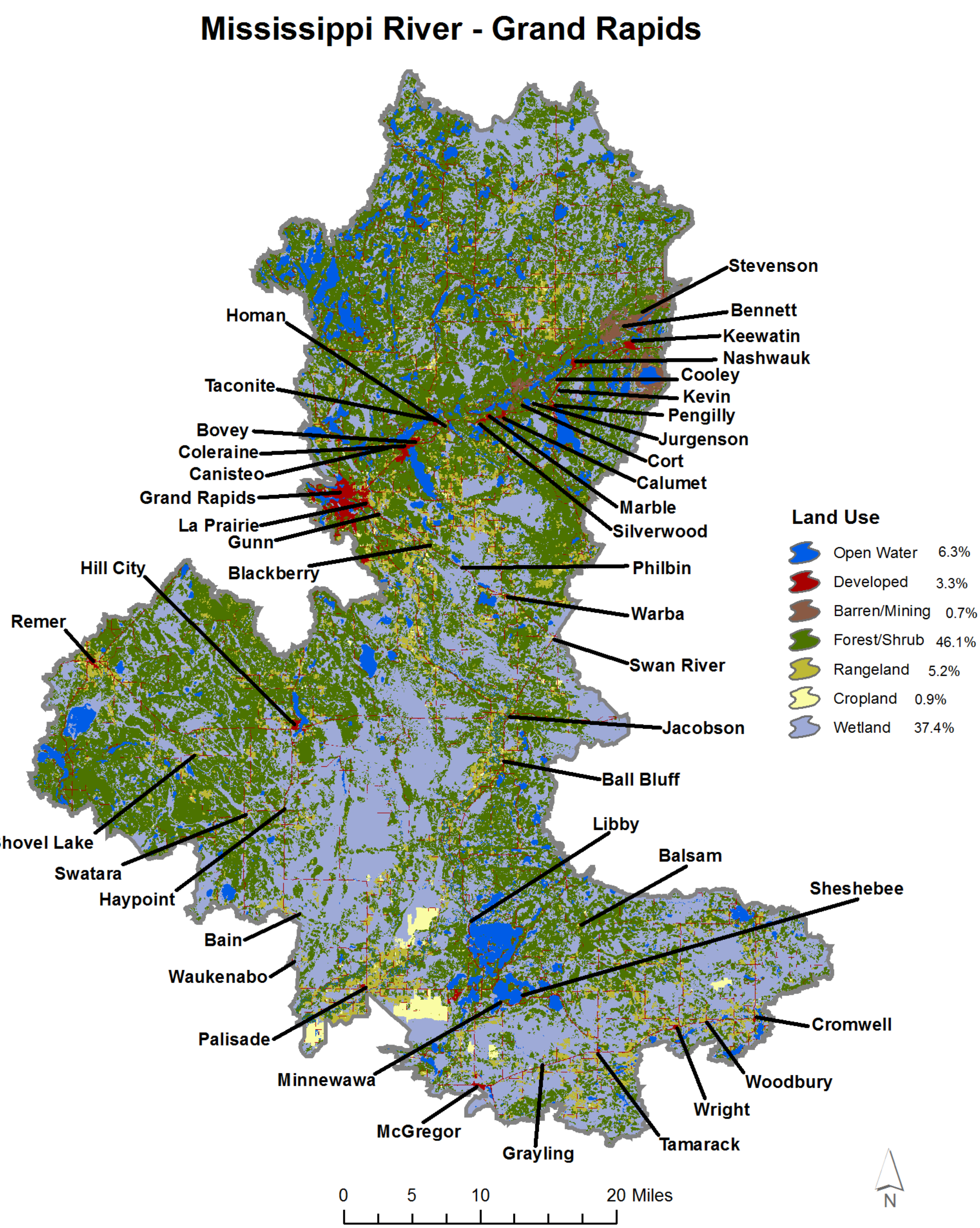
Figure 6. Major Land Resource Areas (MLRA) and springs in the Mississippi River-Grand Rapids Watershed.



Land use summary

Approximately 70% of the lands in Mississippi River-Grand Rapids Watershed are privately owned, with the remaining lands in tribal, state/federal ownership, or open water (NRCS, 2008). Forests (46%) and wetlands (37%) are the most common land cover types in this watershed (Figure 7). Many of the forested areas of this watershed are working forests; Blandin Paper Company occupies significant holdings within this watershed (12.3%; NRCS, 2008).

Figure 7. Land use in the Mississippi River-Grand Rapids Watershed.



Surface water hydrology

The northern extent of the Mississippi River-Grand Rapids Watershed originates from Stingy Lake (31-0051-00) which empties into the Prairie River near Nashwauk, Minnesota. The Prairie River flows nearly 58-miles southwesterly, through Lawrence (31-0231-00) and Prairie (31-0384-00) lakes before emptying into the Mississippi River a few miles downstream of the Blandin Paper Company in Grand Rapids, Minnesota. The Swan River (71 miles long) is the largest tributary to the Mississippi River in the central portion of this watershed. There are three major tributaries to the Mississippi River in the southeastern portion of the watershed; the Prairie (38 miles long), Sandy (26.5 miles long), and the Tamarack (26 miles long) rivers. In the western portion of the watershed, the Moose (25 miles long) and Willow (87.5 miles long) rivers are two major tributaries.

Many of these tributaries are rich in logging history. This area was once dominated by the white pine (*Pinus strobus*), which were cut for use in lumber and the development of Minnesota (Larson, 2007). Much of the work to move the large quantities of felled trees to the Mississippi River was done using steam powered floating rigs. As a result of the logging movement, a number of stream channels were altered or physically cut through the landscape. One example of this is the Willow-River ditch, near the Swatara, Minnesota, which was created in late 1880s. This channel diverted much of the north flowing section of the Willow to a new easterly route, and severed the natural connection of the Moose River with it northern route; much of which is now located in the Moose-Willow Wildlife Management Area.

Many of the Mississippi River tributaries and wetlands in the southcentral portion of the Mississippi River-Grand Rapids Watershed have been altered. This is likely a result of the historical belief that flooded lands or swamps were common enemies, providing breeding areas for diseases, hindering transportation, and restricting human progress and development (King, 1980). However, in comparison to other Minnesota watersheds, the Mississippi River-Grand Rapids Watershed is minimally altered (31%; Figure 8 and Figure 9).

Figure 8. Map of percent modified streams by major watershed (8-HUC).

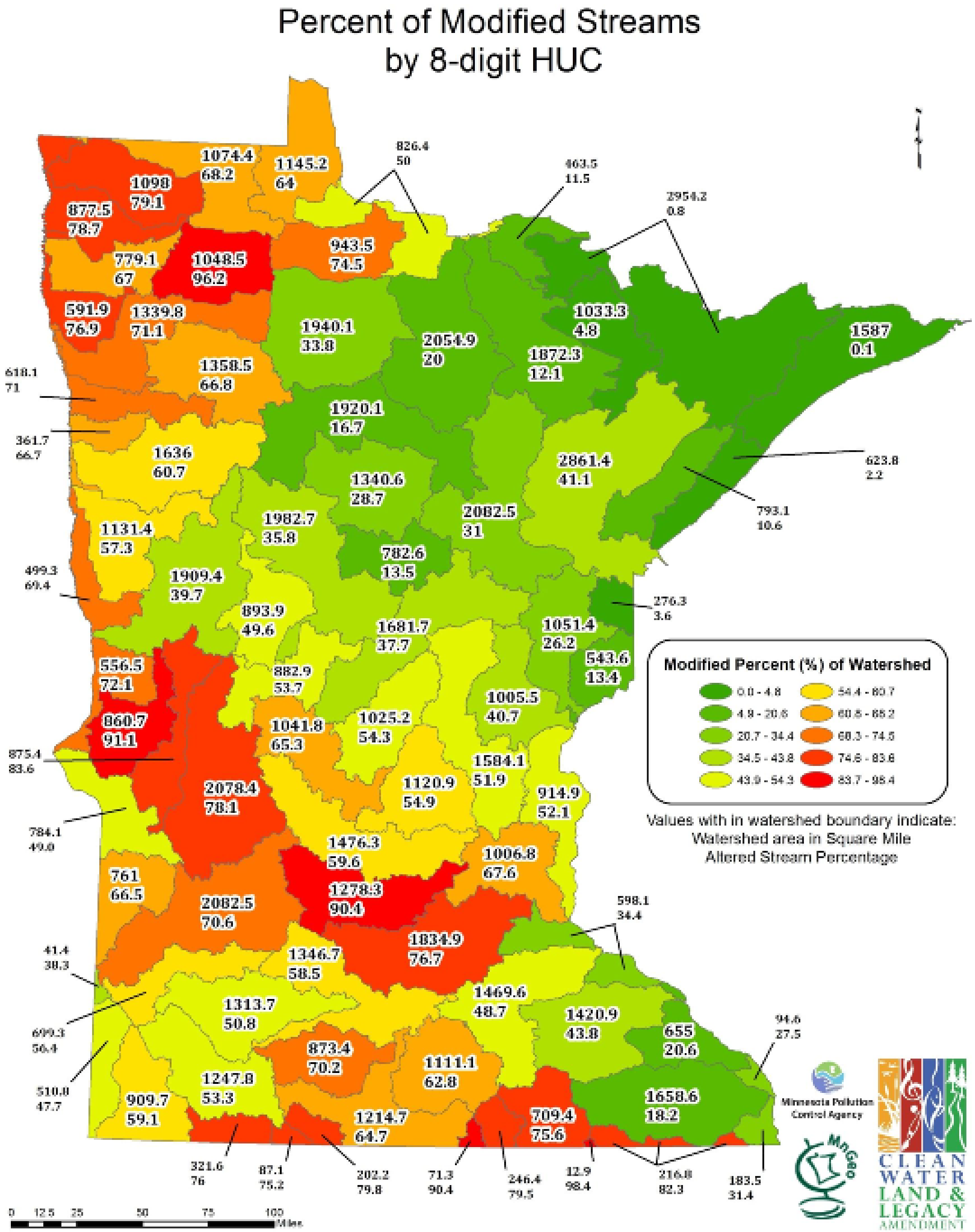
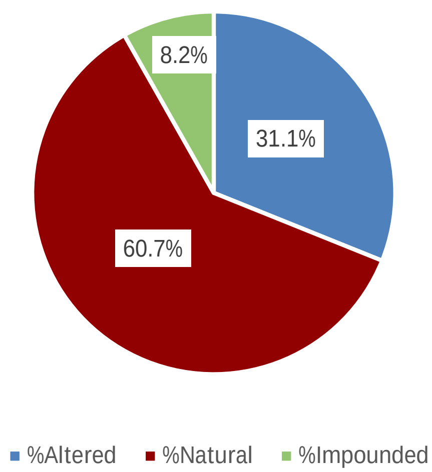


Figure 9. Comparison of natural to altered streams in the Mississippi River-Grand Rapids Watershed percentages derived from the Statewide Altered Water Course project).

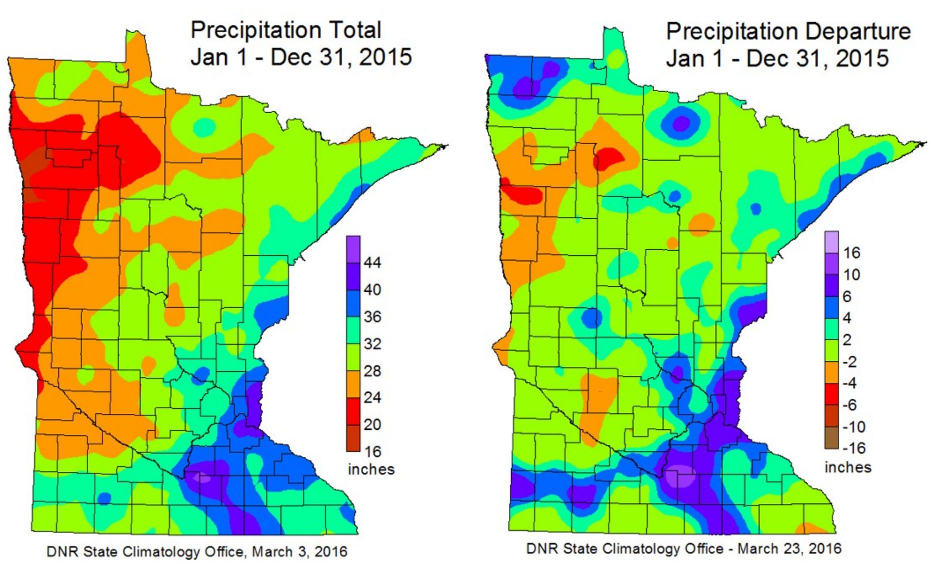


Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.6˚C (NOAA, 2016); the mean summer (June-August) temperature for the Mississippi River-Grand Rapids Watershed is 18.1˚C and the mean winter (December-February) temperature is -11.4˚ C (DNR: Minnesota State Climatology Office, 2017).

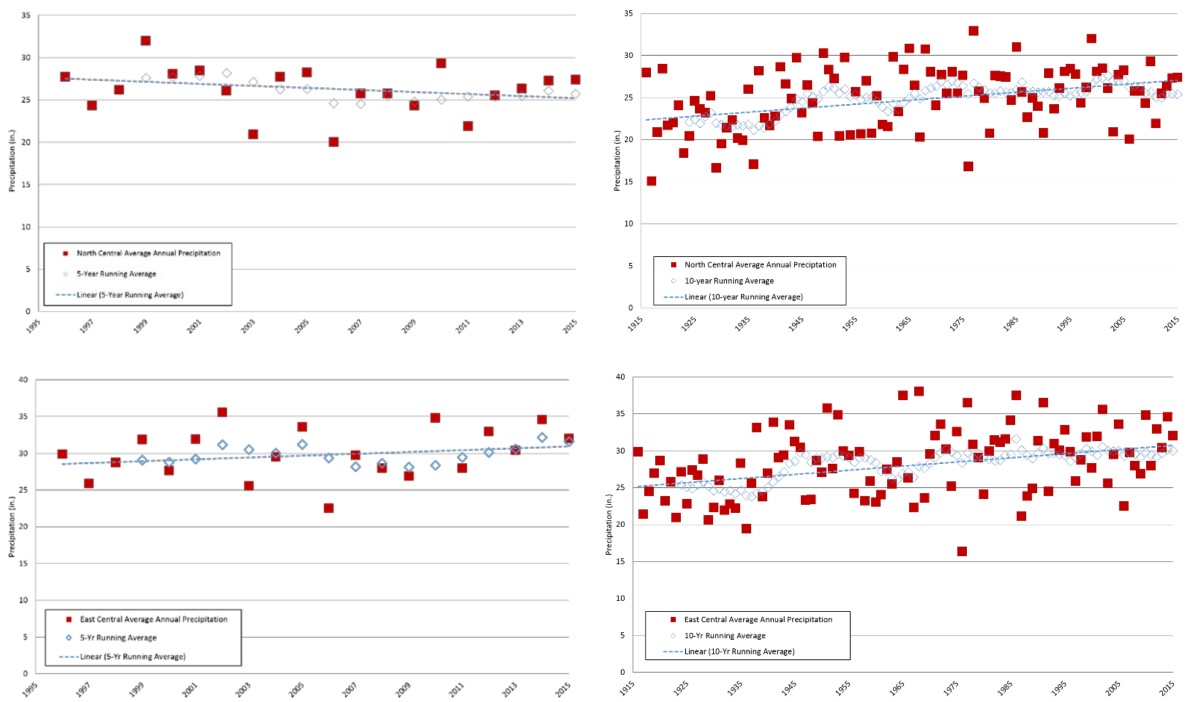
Precipitation is an important source of water input to a watershed. Figure 10 displays two representations of precipitation for calendar year 2015. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this figure, the Mississippi River-Grand Rapids Watershed area received 24 to 28 inches of precipitation in 2015. The display on the right shows the amount that precipitation levels departed from normal. The watershed area experienced precipitation that ranged from two to four inches below normal in 2015.

Figure 10. Statewide precipitation total (left) and precipitation departure (right) during 2015. (Source: DNR State Climatology Office, 2016)



The upper half of the Mississippi River-Grand Rapids Watershed is located in the North Central and the lower half is located in the East Central precipitation region. Figure 11 displays the areal average representation of precipitation in north central Minnesota for 20 and 100 years, *left and right respectively*, while Figure 12 represents East Central precipitation region. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. Though rainfall can vary in intensity and time of year, rainfall totals in the North and East Central regions display no significant trends over the last 20 years. However, precipitation in both regions exhibit a significant rising trend over the past 100 years ($p<0.001$). This is a strong trend and matches similar trends throughout Minnesota.

Figure 11. Precipitation trends in east Central Minnesota from 1996-2015 (left) and 1916-2015 (right). (Source: WRCC, 2017)



Hydrogeology and groundwater quality and quantity

Hydrogeology

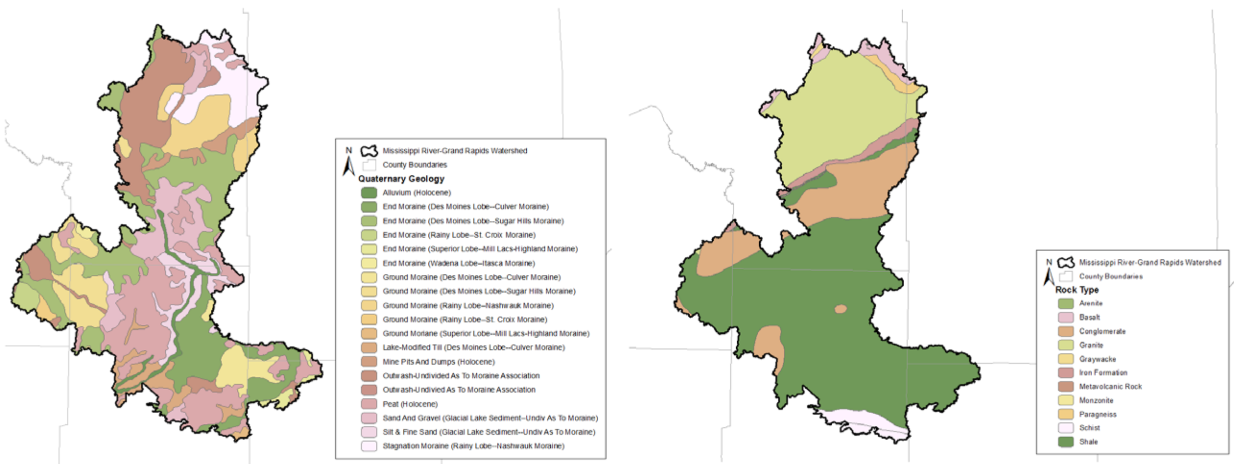
Hydrogeology is the study of the interaction, distribution, and movement of groundwater through the rocks and soil of the earth. The geology of a region strongly influences the quantity of groundwater available, the quality of the water, the sensitivity of the water to pollution, and how quickly the water will be able to recharge and replenish the source aquifer. This branch of geology is important to understand as it indicates how to manage groundwater withdrawal and land use and can determine if mitigation is necessary.

Surficial and bedrock geology

Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface in much of the Mississippi River-Grand Rapids Watershed and is the parent material for the soils that have developed since glaciation. The depth to bedrock ranges from exposed at the surface to nearly 590 feet and is buried by deposits of the various ice lobes that reached this watershed during the last glacial period, as well as during previous glaciations in the last 2.58 million years. The deposits at the surface are associated with three ice lobes: the Des Moines, Rainy, and Superior lobes, and post-glacial alterations to that sediment, including soil formation and peat accumulation. The geomorphology includes glacial lake sediment, lake modified till, ground, end and stagnation moraines, mine pits and dumps, peat, outwash and alluvium (Figure 13, *left*) (Hobbs and Goebel, 1982).

Bedrock is the main mass of rocks that form the Earth, located underneath the surficial geology and can be seen in only a few places where weathering has exposed the bedrock. Precambrian bedrock lies under the extent of the Mississippi River-Grand Rapids Watershed, displaying evidence of volcanic activity. The main terrane groups include the Animikie Group and the Wawa Subprovince (Jirsa et al., 2011). Additionally, the Coleraine Formation, a Cretaceous bedrock associated with the Mesozioc era, is found within this watershed, overlying the Precambrian bedrock. This formation includes conglomerate, sandstone, shale and lignite. The rock types that are found in the uppermost bedrock include arenite, basalt, conglomerate, granite, greywacke, iron formation, metavolcanic rock, monzonite, paragneiss, schist, and shale (Figure 13, *right*) (Morey and Meints, 2000).

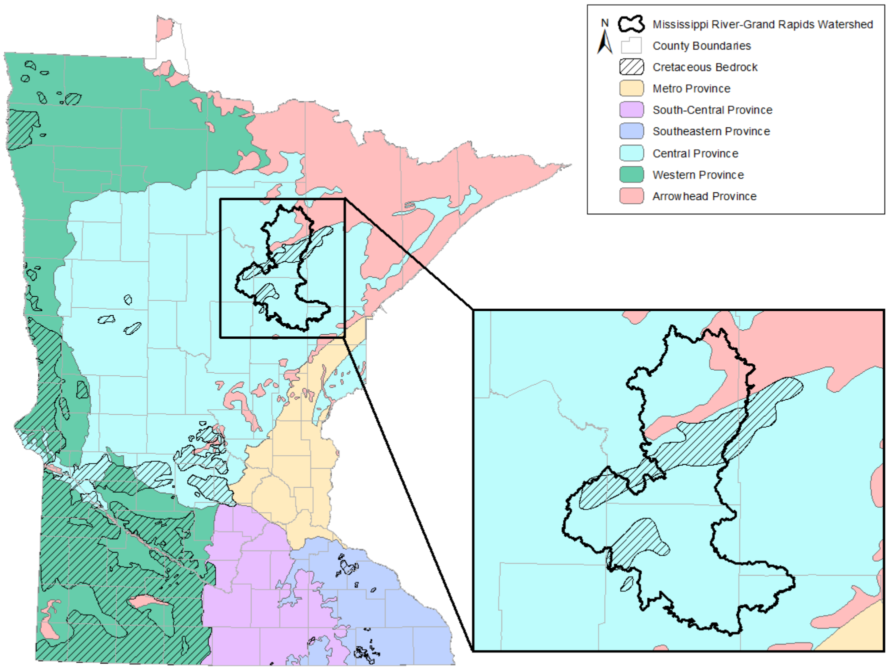
Figure 12. Quaternary geology (left) and bedrock geology rock types (right) within the Mississippi River-Grand Rapids Watershed. (GIS Source: Hobbs & Goebel, 1982; Morey & Meints, 2000)



Aquifers

Groundwater aquifers are layers of water-bearing units that readily transmit water to wells and springs (USGS, 2016). As precipitation hits the surface, it infiltrates through the soil zone and into the void spaces within the geologic materials underneath the surface, saturating the material and becoming groundwater (Zhang, 1998). The water table is the uppermost portion of the saturated zone, where the pore-water pressure is equal to local atmospheric pressure. The geologic material determines the permeability and availability of water within the aquifer. Minnesota's groundwater system is comprised of three types of aquifers: 1) igneous and metamorphic bedrock aquifers, 2) sedimentary rock aquifers, and 3) glacial sand and gravel aquifers (MPCA, 2005). The Mississippi River-Grand Rapids Watershed has portions of the watershed within the Arrowhead and Central Groundwater Provinces, as well as areas with Cretaceous bedrock present (Figure 14). The Arrowhead Province contains mostly exposed fractured igneous and metamorphic bedrock with a limited thin layer of glacial drift, while the Central Province has sand aquifers in thick sandy and clayey glacial drift (DNR, 2001). The Cretaceous bedrock are layers of sandstone that are interbedded with thick layers of shale, located between older bedrock and glacial drift, and are often utilized as local water sources (DNR, 2001). The general availability of groundwater for areas that are within the Arrowhead Province are very limited due to the hard fractured bedrock, while areas associated with the Central Province have good groundwater availability in the surficial sands, moderate availability in the buried sands, and limited within the bedrock (DNR, 2001; DNR, 2018a).

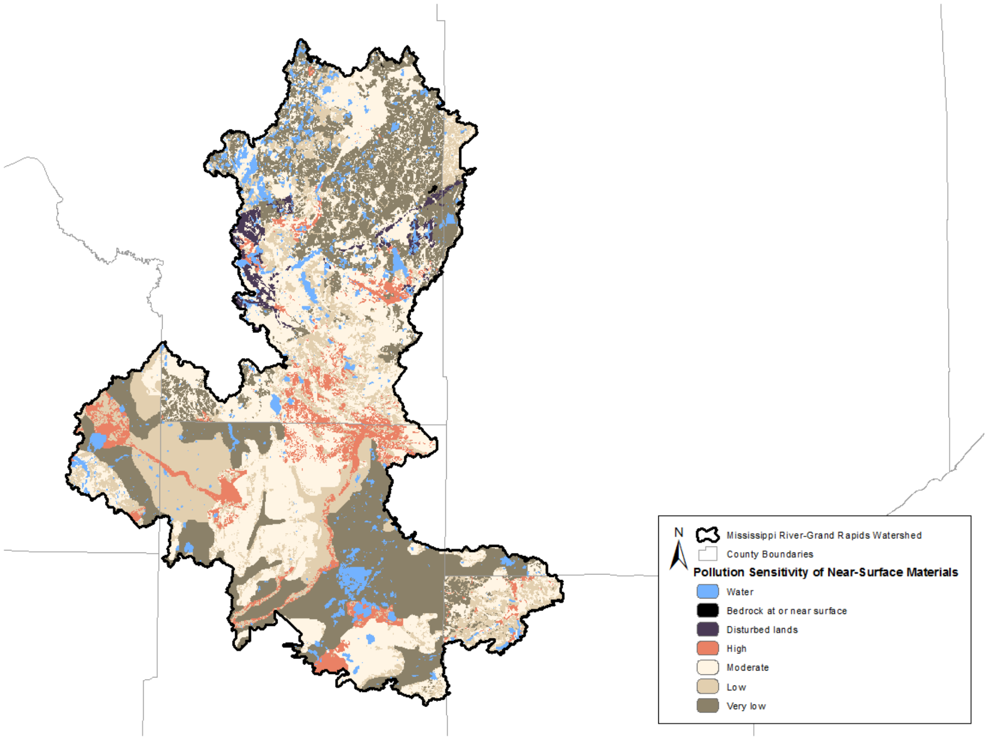
Figure 13. Groundwater provinces within the Mississippi River-Grand Rapids Watershed. (GIS Source: DNR, 2001)



Groundwater pollution sensitivity

Since bedrock aquifers are typically covered with thick till, they normally better protected from contaminant releases at the land surface. It is also less likely that withdrawals from these wells would have a direct and significant impact on local surface waterbodies. In contrast, surficial aquifers are typically more likely to 1) be vulnerable to contamination, 2) have direct hydrologic connections to local surface water, and 3) influence the quality and quantity of local surface water. The DNR is working on a hydrogeological atlas focused on the pollution sensitivity of the bedrock surface. It is being produced county-by-county, and awaiting completion for those counties within the Mississippi River-Grand Rapids Watershed. Until the hydrogeological atlas is finished, a 2016 statewide evaluation of pollution sensitivity of near-surface materials completed by the DNR is utilized to estimate pollution vulnerability up to 10 feet from the land surface. This display is not intended to be used on a local scale, but as a coarse-scale planning tool. According to this data, the Mississippi River-Grand Rapids Watershed is estimated to have primarily very low to moderate with some high pollution sensitivity areas scattered throughout the watershed, most likely due to the presence of sand and gravel Quaternary geology (Figure 15) (DNR, 2016).

Figure 14. Pollution sensitivity of near-surface materials for the Mississippi River-Grand Rapids Watershed. (GIS Source: DNR, 2016)



Groundwater potential recharge

Groundwater recharge is one of the most important parameters in the calculation of water budgets, which are used in general hydrologic assessments, aquifer recharge studies, groundwater models, and water quality protection. Recharge is a highly variable parameter, both spatially and temporally, making accurate estimates at a regional scale difficult to produce. The MPCA contracted the USGS to develop a statewide estimate of recharge using the SWB – Soil-Water-Balance Code. The result is a gridded data structure of spatially distributed recharge estimates that can be easily integrated into regional groundwater studies. The full report of the project as well as the gridded data files are available at: https://gisdata.mn.gov/dataset/geos-gw-recharge-1996-2010-mean.

Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock-surficial deposit interface (Figure 16). Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). For the Mississippi River-Grand Rapids Watershed, the average annual potential recharge rate to surficial materials ranges from 0.84 to 11.77 inches per year, with an average of 4.90 inches per year (Figure 17). The statewide average potential recharge is estimated to be 4 inches per year with 85% of all recharge ranging from 3 to 8 inches per year. When compared to the statewide average potential recharge, the Mississippi River-Grand Rapids Watershed receives approximately the same average potential recharge.

Figure 15. Average annual potential recharge rate to surficial materials in Mississippi River-Grand Rapids Watershed. (1996-2010) (GIS Source: USGS, 2015)

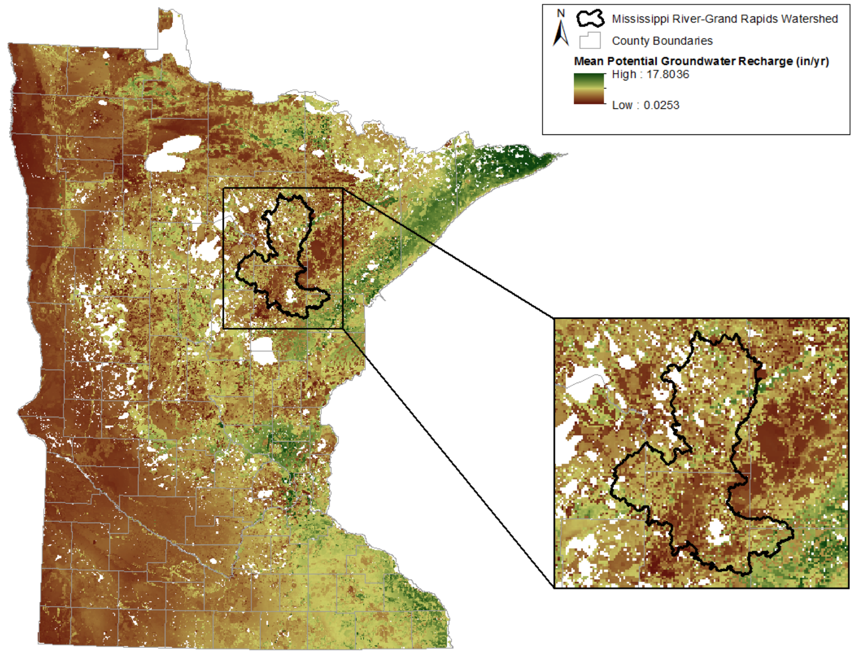
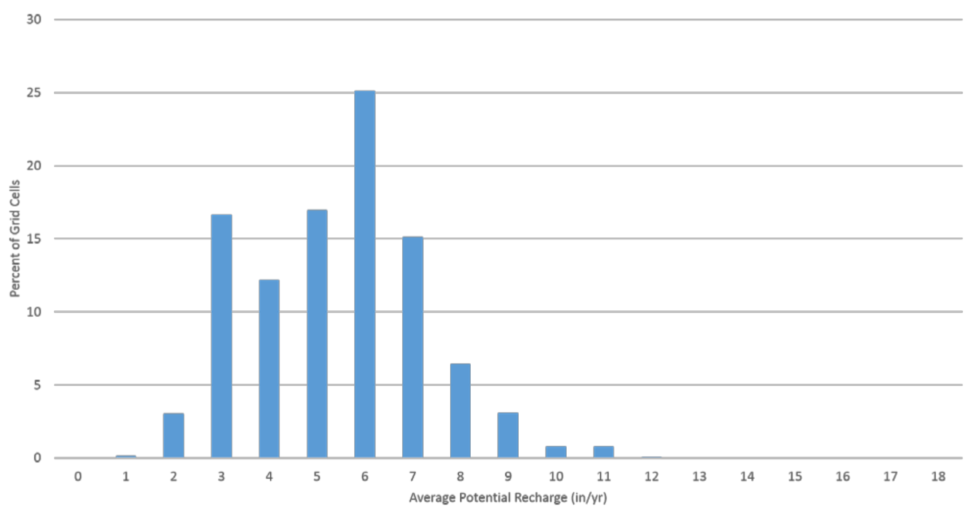


Figure 16. Average annual potential recharge rate percent of grid cells in the Mississippi River-Grand Rapids Watershed (1996-2010)



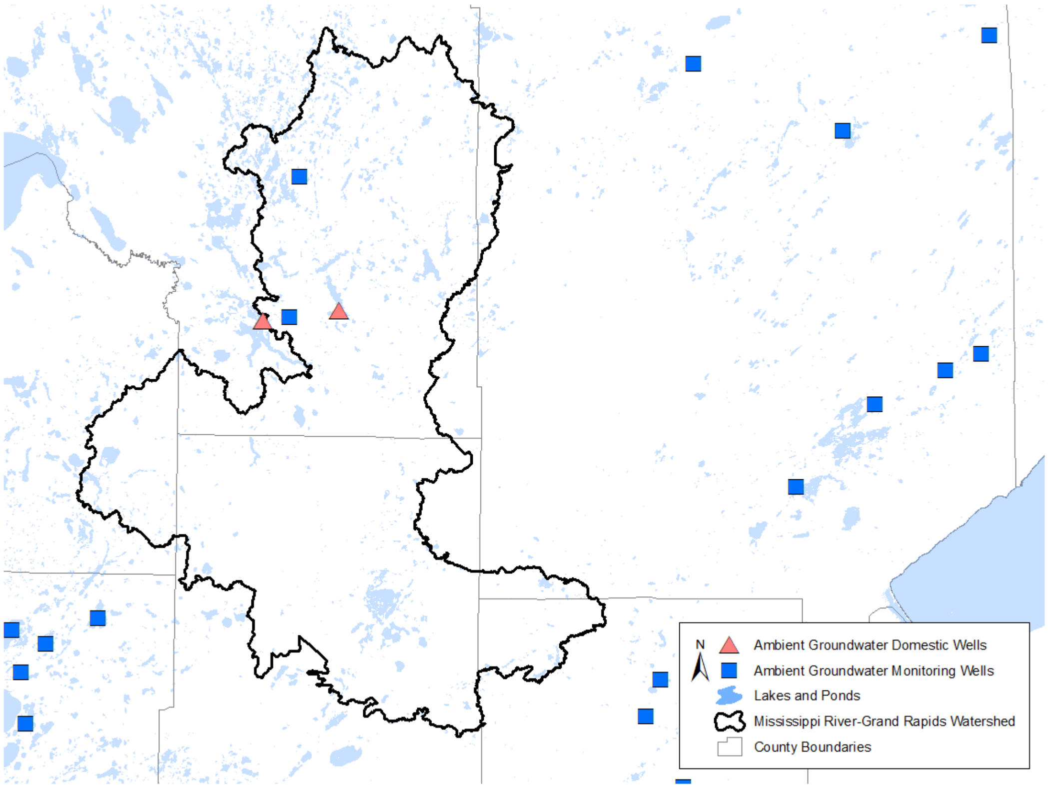
Groundwater quality

Approximately 75% of Minnesota's population receives their drinking water from groundwater, undoubtedly indicating that clean groundwater is essential to the health of its residents. The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These ambient groundwater wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

There are currently four MPCA Ambient Groundwater Monitoring wells (two monitoring, two domestic) within the Mississippi River-Grand Rapids Watershed (Figure 18). Data collection for the network ranges from 2004 to 2017; two of the wells have been sampled since 2004 (some years missing), one well since 2013 and one well since 2015.

Preliminary analysis was completed on these wells, indicating the most important groundwater quality issues in this watershed are chloride, iron, and manganese. The most commonly detected analyte within this watershed was chloride. Chloride has become an increasing concern in developed areas where salt is used as a deicing agent and high concentrations adversely affect the taste of drinking water (Kroening and Ferrey, 2013). Chloride concentrations in the watershed ranged from 1.6 to 208 milligrams per liter (mg/L) with a mean of 28.6 mg/L, which is under the 250 mg/L secondary maximum contaminant level (SMCL). SMCLs are set because of issues associated with aesthetic (tastes or odors), cosmetic (undesirable, but not damaging), or technical (damage to equipment or effectiveness of treatments) effects (EPA, 2017). The next two most commonly detected contaminants were sodium (no current standard) and sulfate (SMCL of 250 mg/L), but not at levels of concern. Other chemicals that were detected commonly (greater than 50% of the time) included potassium, magnesium, calcium, bromide, strontium, phosphorus, inorganic nitrogen (nitrate and nitrite), iron, manganese and barium. All detections were within water quality standards, with the exception of iron and manganese. Six exceedances of iron and manganese occurred in one of the domestic wells, which is a common occurrence for domestic well water. The SMCL for iron is 0.3 mg/L set by the U.S. Environmental Protection Agency (EPA) for drinking water while manganese has a Risk Assessment Advice (RAA) set by the Minnesota Department of Health (MDH) of 100 micrograms per liter (ug/L) for infants and 300 ug/L for children and adults (MDH, 2012a; EPA, 2017). Noticeable affects associated with iron in water include a rusty color, metallic taste, pipe clogging and staining clothes and appliances. Manganese is naturally occurring and commonly found in groundwater across the state. It may have a black to brown color, black staining, or a bitter metallic taste, and may be unsafe for human consumption when concentrations are over the RAA. At low levels, manganese is considered beneficial, but high exposures can cause harm to the nervous system and cause issues with memory, attention and motor skills (MDH, 2012a; MDH, 2012b). If drinking water exceeds the SMCL or RAA, individuals are advised by the MDH to utilize a carbon filter or bottled water, especially with infants and nursing mothers (MDH, 2012b).

Figure 17. MPCA ambient groundwater monitoring well locations within the Mississippi River-Grand Rapids Watershed.



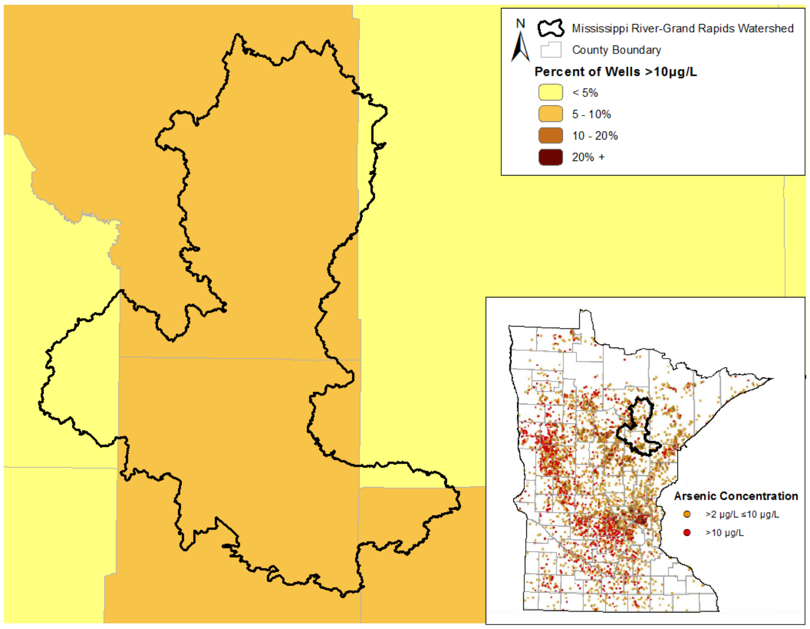
Regional groundwater quality

From 1992 to 1996, the MPCA conducted baseline water quality sampling and analysis of Minnesota's principal aquifers. The Mississippi River-Grand Rapids Watershed lies primarily within the Northeast Region with the west central edge located within the North Central Region. The Northeast Region has groundwater quality that is considered good when compared to other areas with similar aquifers, but with exceedances of drinking water criteria in arsenic, beryllium, boron, manganese and selenium (MPCA, 1999). Concentrations of chemicals within the Precambrian aquifers were comparable to similar aquifers throughout the state and concentrations of major cations and anions were lower in the surficial and buried drift aquifers when compared to similar aquifers statewide (MPCA, 1999). Many of the exceedances identified were attributed to geology, but some trace inorganic chemicals may be of concern locally. Volatile organic compounds were also detected in this region, with the most commonly detected compounds associated with well disinfection, atmospheric deposition and fuel oils (MPCA, 1999).

Another source of information on groundwater quality comes from the MDH. Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that 10.7% of all wells installed from 2008 to 2015 have arsenic levels above the maximum contaminant level (MCL) for drinking water of 10 ug/L (MDH, 2016a). In the Mississippi River-Grand Rapids Watershed, the majority of new wells are within the water quality standards for arsenic levels, but there are exceedances to the MCL. When observing concentrations of arsenic by percentage of wells that exceed the MCL of 10 micrograms/liter per county, the watershed lies within counties that range from 3.7 to 9.9% exceedances. By county, the percentages of wells identified with concentrations exceeding the MCL are as follows: Carlton (9.9%), Aitkin (5.8%), Itasca (5.4%), Cass (4.2%), and St. Louis

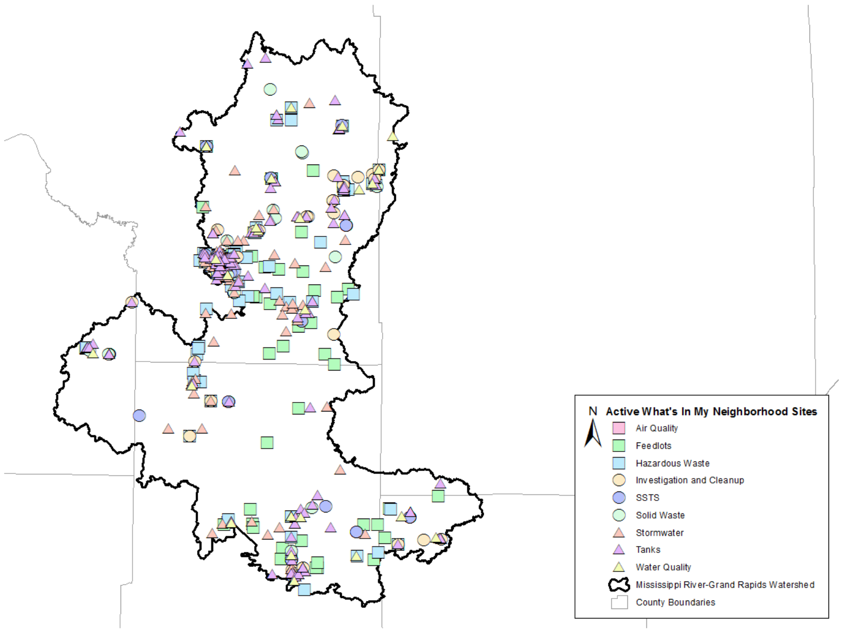
(3.7%) County (MDH, 2016b) (Figure 19). It is important to reiterate that the percentages of arsenic concentration exceedances are per county, not specifically for Mississippi River-Grand Rapids Watershed. For more information on arsenic in private wells, please refer to the MDH's website: https://apps.health.state.mn.us/mndata/arsenic_wells.

Figure 18. Percent wells with arsenic occurrence greater than the MCL for the Mississippi River-Grand Rapids Watershed (2008-2015). (Source: MDH, 2016b)



A statewide dataset of potentially contaminated sites and facilities with environmental permits and registrations is available at the MPCA's website, through a web-based application called, "What's In My Neighborhood" (WIMN). This MPCA resource provides the public with a method to access a wide variety of environmental information about communities across the state. The data is divided into two groups. The first is potentially contaminated sites, and includes contaminated properties, formerly contaminated sites, and those that are being investigated for suspicion of being contaminated. The second category is made up of businesses that have applied for and received different types of environmental permits and registrations from the MPCA. An example of an environmental permit would be for a business acquiring a permit for a stormwater or wastewater discharge, requiring it to operate within limits established by the MPCA. In the Mississippi River-Grand Rapids Watershed, there are currently 707 active sites identified by WIMN: 200 tanks (aboveground and underground), 143 stormwater sites (construction and industrial stormwater), 136 hazardous waste sites, 39 feedlots, 36 investigation and cleanup sites, 27 water quality sites (wastewater), 19 air quality sites, and 16 solid waste sites (Figure 20). For more information regarding WIMN, refer to the MPCA webpage at http://www.pca.state.mn.us/index.php/data/wimn-whats-in-my-neighborhood/whats-in-my-neighborhood.html.

Figure 19. Active "What's In My Neighborhood" site programs and locations for the Mississippi River-Grand Rapids Watershed. (Source: MPCA, 2018)



Groundwater quantity

The DNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or one million gallons per year. Permit holders are required to track water use and report to the DNR annually. The changes in withdrawal volume discussed in this report are a representation of water use and demand in the watershed and are taken into consideration when the DNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

The three largest permitted consumers of water in the state are (in order) power generation, public water supply (municipals), and irrigation (DNR, 2018b). According to the most recent DNR Permitting and Reporting System, in 2015 the withdrawals within the Mississippi River-Grand Rapids Watershed were primarily utilized for water level maintenance (52.8%), such as construction and mine dewatering. The remaining withdrawals include: power generation (24.2%), industrial processing (20.4%), agricultural irrigation (1.5%), special categories, to include construction non-dewatering, dust control, and pipeline and tank testing (0.5%), other temporary withdrawals (0.3%), and non-crop irrigation (golf courses) (0.2%). From 1996 to 2015, withdrawals associated with power generation, other temporary and water level maintenance have increased significantly ($p<0.001$, $p<0.01$, and $p<0.05$, respectively). Withdrawals associated with special categories and industrial processing have decreased ($p<0.001$ and $p<0.1$, respectively), while agricultural and non-crop irrigation has remained steady during this time period. Figure 21 displays total high capacity withdrawal locations within the watershed with active permit status in 2015. During 1996 to 2015, groundwater withdrawals within the Mississippi River-Grand Rapids Watershed exhibit a significant decreasing withdrawal trend ($p<0.001$) (Figure 22, *left*), while surface water withdrawals appear to be increasing, but not at a significant rate ($p<0.1$) (Figure 22, *right*).

Figure 20. Locations of active status permitted high capacity withdrawals in 2015 within the Mississippi River-Grand Rapids Watershed.

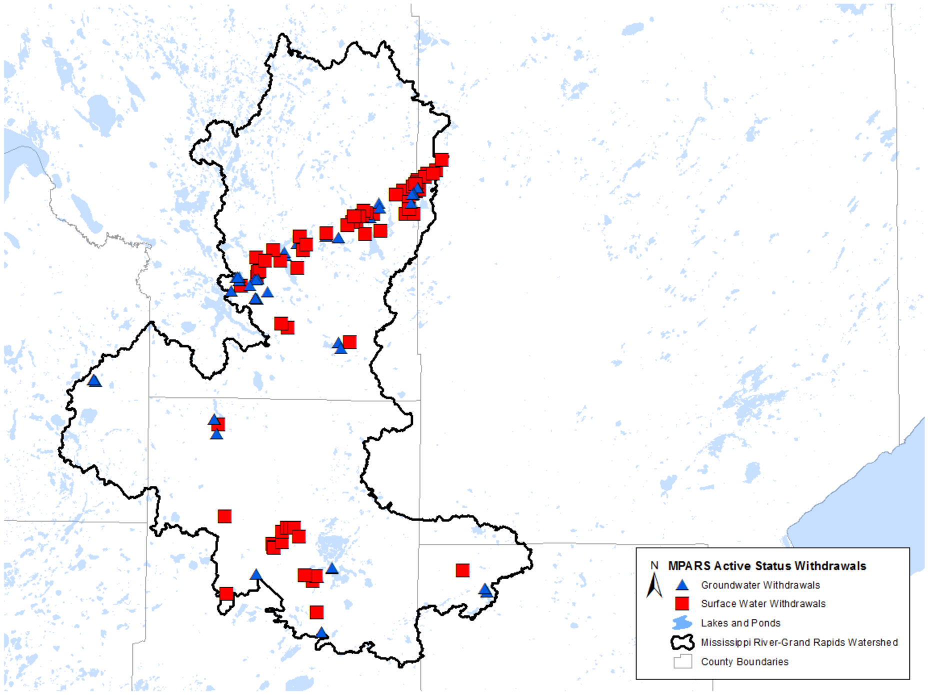
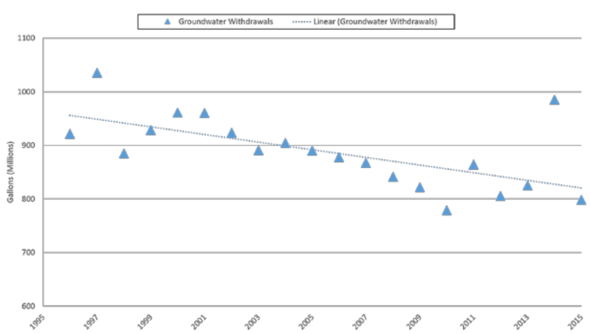
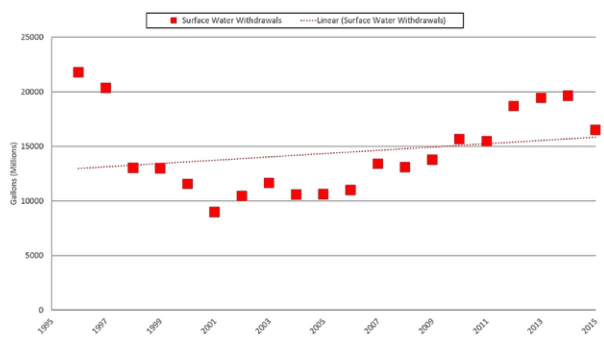


Figure 21. Total annual groundwater (left) and surface water (right) withdrawals in the Mississippi River-Grand Rapids Watershed (1996-2015).





Minnesota Department of Natural Resources observation wells

Monitoring wells from the DNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. To access the DNR Observation Well Network, please visit http://www.dnr.state.mn.us/waters/cgm/index.html.

Two of the 17 DNR Observation Wells (31000 and 31017) within the Mississippi River-Grand Rapids Watershed were chosen for analysis based on data availability and geologic location as representation of depth to groundwater throughout the watershed (Figure 23). Depth to Water (DTW) was collected on a monthly basis and the average annual DTW was calculated. For observation well 31000, located at Grand Rapids, DTW on an average annual basis from 1996 to 2015 has remained relatively constant

([Figure 24](#)), while observation well 31017 at Taconite exhibits a statistically significant decreasing trend in DTW on an average annual basis from 1999 to 2015 ($p<0.001$) ([Figure 25](#)). For both wells, DTW decreased from 1999 to 2012 and increased from 2013 to 2015.

Figure 22. DNR quaternary water table observation well locations within the Mississippi River-Grand Rapids Watershed.

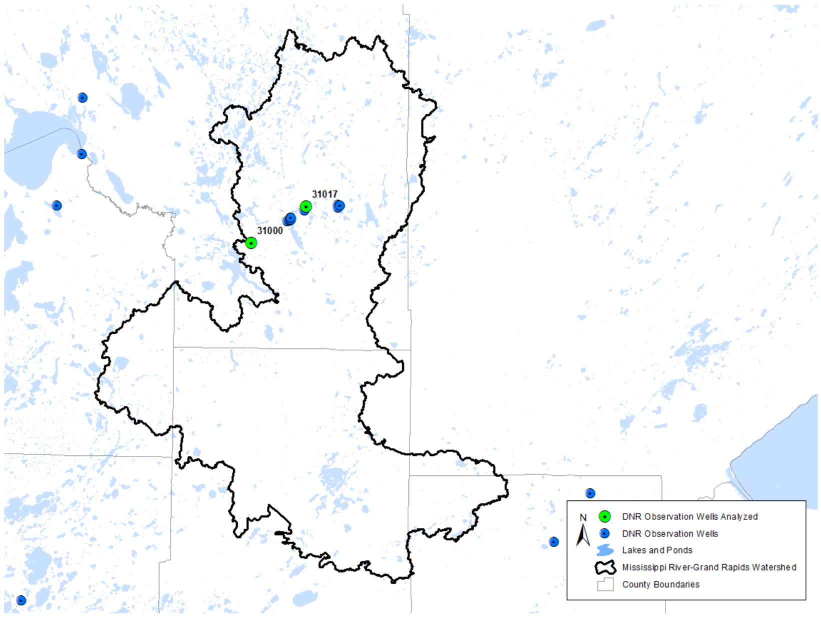


Figure 23. Depth to groundwater for observation well 31000 at Grand Rapids (1996-2015).

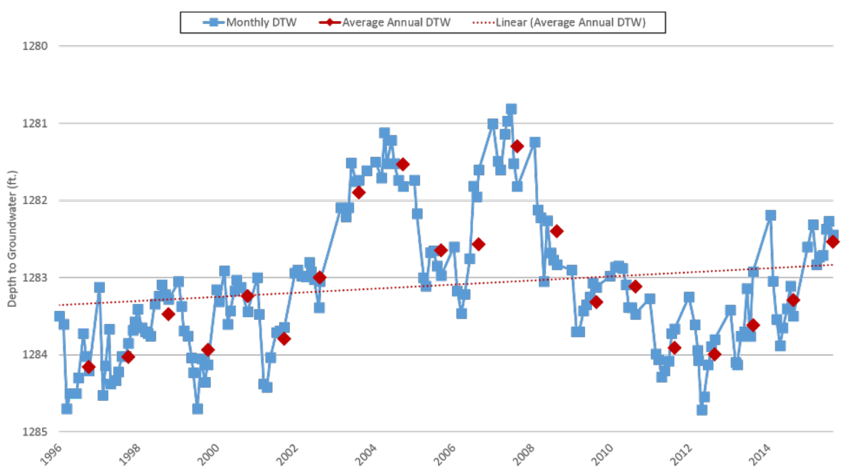
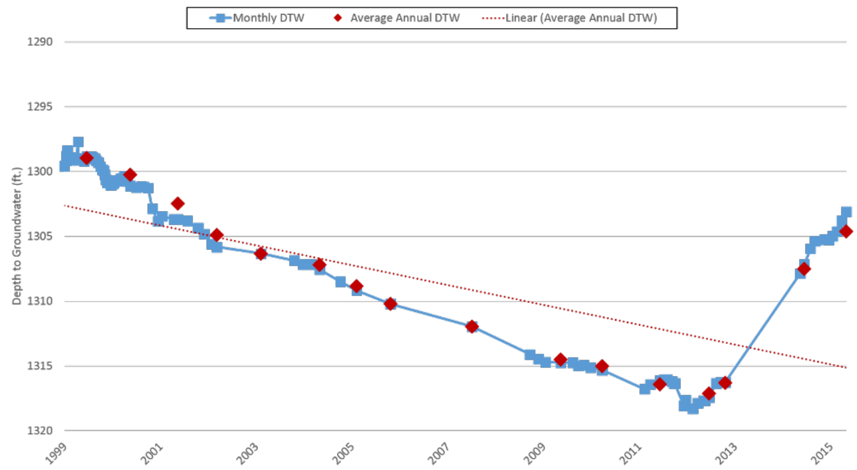


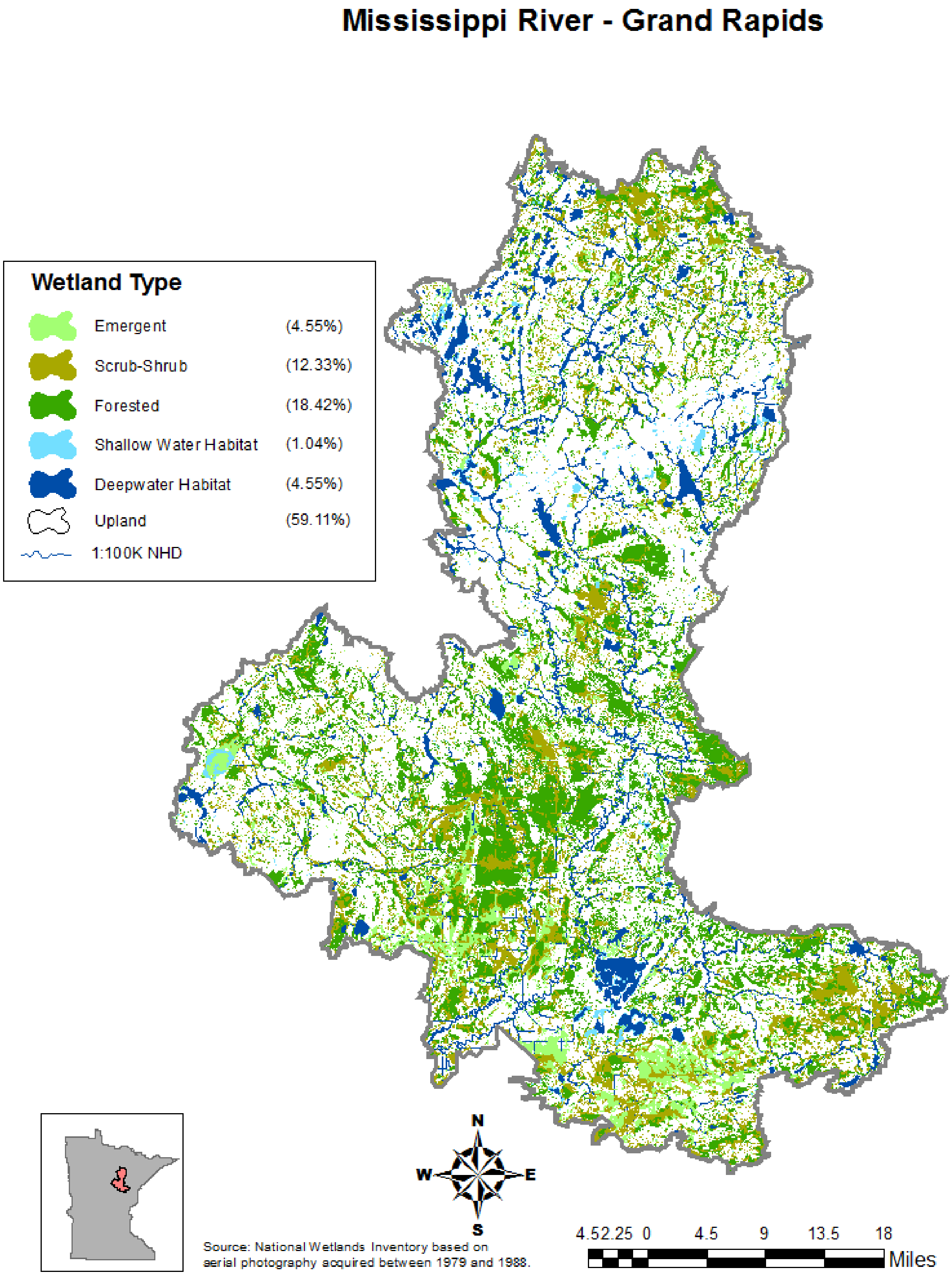
Figure 24. Depth to groundwater for observation well 31017 at Taconite (1999-2015).



Wetlands

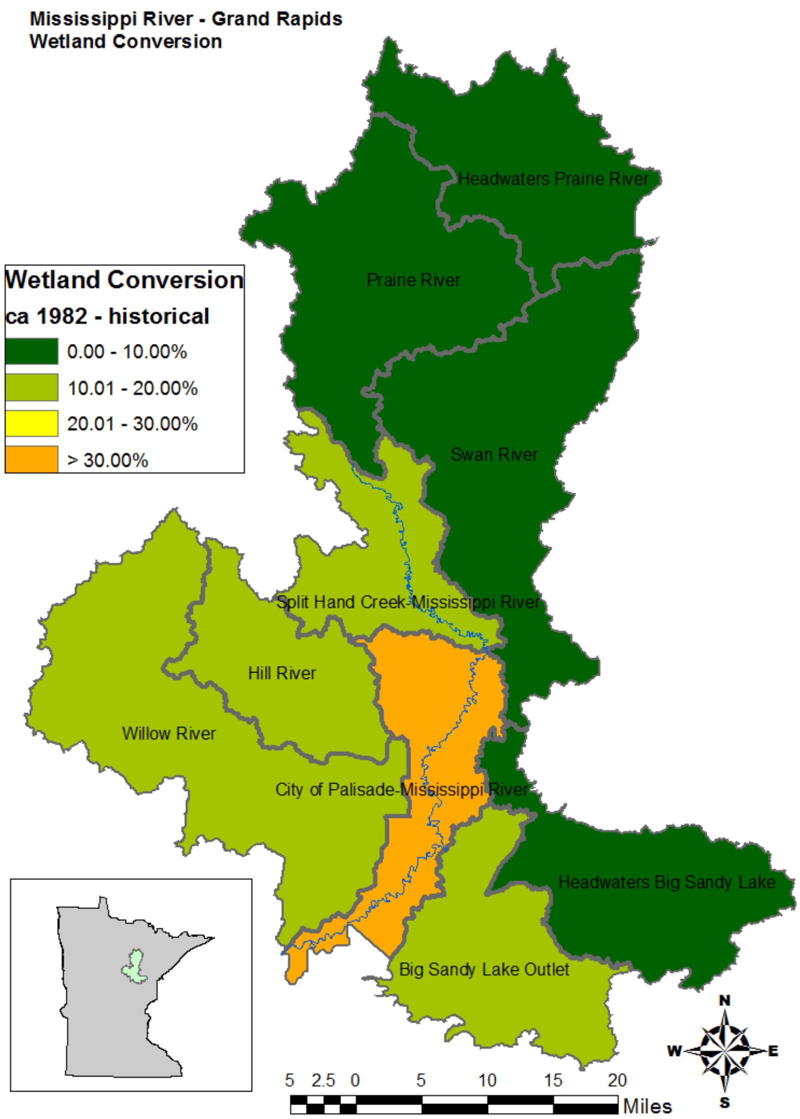
Excluding open water portions of lakes and rivers, the Mississippi River-Grand Rapids Watershed has approximately 484,240 acres of wetlands, which is equivalent to 36.3% of the watershed area. Forested wetlands comprise 18.4% of the watershed and are the most common wetland class in this watershed by a factor of over three to one (3:1) compared to the sum of Emergent and Shallow Open Water class wetlands (Figure 26). Scrub-shrub wetlands are the second most common wetland class comprising 12.33% of the watershed. Emergent and shallow water habitat wetlands combined total 5.59% of the wetland area in the Mississippi River-Grand Rapids Watershed. Peatlands comprise 22% of the wetland extent in the Mississippi River-Grand Rapids Watershed. Often called "bogs", peatlands are wetlands with thick deposits of partially decomposed plant material that accumulates as peat. Peatlands can occur as forested-shrub dominated or as open herbaceous emergent dominated wetland communities. These estimates of wetland characteristics and distribution observations are derived from the original Minnesota National Wetland Inventory (NWI) based primarily on circa 1982 spring leaf-off imagery. The wetland inventory for this watershed was updated in a small portion of the eastern edge of this watershed, essentially within the watershed portions extending into St. Louis and Carlton Counties; this updated portion was not used in wetland calculations. Updated NWI for remaining portions of this watershed and adjacent areas are expected to be published in mid-summer 2018. For more information and status of Minnesota's NWI update, visit: http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html.

Figure 25. Wetlands and surface water in the Mississippi River-Grand Rapids Watershed. Wetland data are from the original Minnesota National Wetlands Inventory.



The Mississippi River-Grand Rapids Watershed surface geology is fairly complex, but mostly a combination of glacial moraines, predominately including both end and ground moraines originating from three different glacial lobe advances; Des Moines, Superior, and Rainy Lobes. Several expansive peatland "flats" are scattered among the various moraine complexes. Each of these geologic features are either strongly conducive to formation of wetland characteristics or in the case of the peatland areas are inherently wetland. The entire Mississippi River-Grand Rapids Watershed occurs within the Mixed Wood Shield Ecoregion.

Figure 26. Estimated wetland conversion rates between original wetland coverage and ca. 1982. Presented at 10-HUC subwatershed scale.



Conversion or loss of wetlands has been limited in the Grand Rapids-Mississippi River Watershed compared to watersheds to the south and west. A geographic pattern of wetland change is apparent at the 10-HUC subwatershed scale (Figure 26). Estimates of historic wetland extent were derived using drainage classifications of soil SURRGO polygons classed as 'Poorly Drained' and 'Very-Poorly Drained' as proxies of historic and contemporary wetland extent. These results were compared to wetland extent estimates based on original NWI data to produce wetland loss estimates as a percentage at a 10-HUC subwatershed scale. Findings from this analysis shows the city of Palisade-Mississippi Subwatershed, compared to the other 10-HUC subwatersheds has lost the most (32.7%) of its historic wetlands. This subwatershed straddles the Mississippi River in the lower extent of the 8-HUC watershed. Also in the southern extent of the 8-HUC watershed, adjacent to the city of Palisade Subwatershed are the Willow River and Big Sandy Lake Outlet 10-HUC subwatersheds, each of which by the early 1980s had lost nearly 20% (19.6 and 18.9% respectively) of their historic wetlands. Progressing north Hill River and Split Hand Creek-Mississippi River subwatersheds each had lost an estimated 13% (13.3 and 12.9% respectively) of their historic wetlands by the early 1980s. In the northern and eastern portions of the Mississippi River-Grand Rapids Watershed Swan River, Prairie River, Headwaters Big Sandy Lake Subwatersheds lost less than 10% of their wetlands.

Historically the city of Palisade-Mississippi River Subwatershed supported an estimated 68.2% wetlands. Big Sandy Lake Outlet and Willow River subwatersheds each were originally over 50% wetland (57.4 and 51.8% respectively). In contrast, Prairie River, Headwaters Prairie River and Swan River subwatersheds each historically supported less than 1/3 wetland (22.2, 29.6 and 30.8% respectively). Split Hand Creek-Mississippi River, Headwaters Big Sandy Lake and Hill River subwatersheds each supported somewhat intermediate (33.6, 49.4 and 50.0% respectively) estimated wetland extent originally.

Special wetland features

The Mississippi River-Grand Rapids Watershed is in the heart of Minnesota's wild rice producing waters. Approximately 136 lakes, pond,s or wetland basins in the Mississippi River-Grand Rapids Watershed are reported as supporting wild rice. Lake or shallow lake classification would apply to 113 of these basins. The remaining 23 basins could be classified as wetlands. In addition, 11 stream segments are reported to support wild rice. These stream segments are widely distributed across the 8-HUC watershed and range in size from 1.23 to 26.49 mi. in length. These 11 stream segments total 176 miles.

Watershed-wide data collection methodology

Lake water sampling

The MPCA, citizen volunteers, and local partners (Itasca, Carlton and Aitkin Soil and Water Conservation Districts (SWCDs) collected chemistry data from over 200 lakes in the watershed within the 10-year assessment window. Historically, 56 volunteers have enrolled in the Citizen Lake Monitoring Program (CLMP) and conducted lake monitoring within the watershed on behalf of MPCA. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period (June to September) for phosphorus, Chl-a and Secchi depth to meet data minimums required for recreation assessments.

Stream water sampling

Fifteen water chemistry stations were sampled from May through September in 2015, and again June through August of 2016, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Water chemistry stations were placed at the outlet of each aggregated 12-HUC subwatershed greater than 40 mi^2 (purple and green circles in Figure 2). Sites were not placed on the main-stem Mississippi River. SWAGs were awarded to Itasca SWCD and the Headwaters Science Center to collect two years of stream chemistry data for aquatic life and recreation use assessments. (See Appendix 2.1 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study).

Three subwatersheds did not have a stream chemistry site established. The Balsam Creek Subwatershed does not have suitable road crossing far enough away from lake-water interference, and the other two subwatersheds are main stem Mississippi River drainages.

Stream flow methodology

The MPCA and the DNR joint stream water quantity and quality monitoring data for dozens of sites across the state on major rivers, at the mouths of most of the state's major watersheds, and at the mouths of some aggregated 12-HUC subwatersheds are available at the DNR/MPCA Cooperative Stream Gaging webpage at: http://www.dnr.state.mn.us/waters/csg/index.html.

Lake biological sampling

A total of 49 lakes were monitored for fish community health in the Mississippi River-Grand Rapids Watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2017 assessment was collected from 2012 through 2016. Assessments to determine aquatic life use support were completed for 45 of these lakes.

To measure the health of aquatic life at each lake, a fish index of biological integrity (IBI) was calculated based on monitoring data collected in the lake. A fish classification framework was developed to account for natural variation in community structure, which is attributed to area, maximum depth, alkalinity, shoreline complexity, and geographic location. As a result, an IBI is available for four different groups of lake classes (Schupp Lake Classification, DNR). Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs). IBI scores higher than the impairment threshold and upper CI indicate that the lake supports aquatic life. Scores below the impairment threshold and lower CI indicate that the lake does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, plant surveys, and observations of local land use activities).

Stream biological sampling

The biological monitoring component of the IWM in the Mississippi River-Grand Rapids Watershed was completed during the summer of 2015. A total of 76 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, seven existing biological monitoring stations within the watershed were revisited in 2015. These monitoring stations were initially established as part of a random Upper Mississippi River Basin wide survey in 2000 or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2017 assessment was collected in 2015. A total of 60 AUIDs were sampled for biology in the Mississippi River-Grand Rapids Watershed. Waterbody assessments to determine aquatic life use support were conducted for 81 AUIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, IBIs, specifically Fish and Invert IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into seven distinct warm water classes and two cold water classes, with each class having its own unique Fish IBI and Invert IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and CIs (for IBI classes, thresholds and CIs, see Appendix 3.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold and lower CI indicate that the stream reach does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, observations of local land use activities). For IBI results for each individual biological monitoring station, see Appendices 4.1 and 4.2.

Fish contaminants

Minnesota Department of Natural Resource (DNR) fisheries staff collect most of the fish for the fish contaminant monitoring program. In addition, MPCA's biomonitoring staff collect up to five piscivorous (top predator) fish and five forage fish near the 8-HUC pour point, as part of the IWM. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish of each species are analyzed for PCBs.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted, and ground to a homogenized tissue sample. Homogenized fillets were placed in 60 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture Laboratory analyzed the samples for mercury and PCBs. If fish were tested for perfluorochemicals (PFCs), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFCs. Of the measured PFCs, only perfluorooctane sulfonate (PFOS) is reported because it bioaccumulates in fish to levels that are potentially toxic and a reference dose has been developed.

From the fish contaminant analyses, MPCA determines which waters exceed impairment thresholds. The Impaired Waters List is prepared by the MPCA and submitted every even year to the EPA. MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs (and PFOS when tested) in fish tissue is based on the fish consumption advisories prepared by the MDH. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 mg/kg for PCBs (and 0.200 mg/kg for PFOS).

Monitoring of fish contaminants in the 1970s and 1980s showed high concentrations of PCBs were primarily a concern downstream of large urban areas in large rivers, such as the Mississippi River, and in Lake Superior. Therefore, PCBs are now tested where high concentrations in fish were measured in the past and the major watersheds are screened for PCBs in the watershed monitoring collections.

Before 2006, mercury in fish tissue was assessed for water quality impairment based on MDH's fish consumption advisory, the same as PCBs. With the adoption of a water quality standard for mercury in edible fish tissue, a waterbody has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90th percentile) exceed 0.2 mg/kg of mercury. At least five fish samples of the same species are required to make this assessment and only the last 10 years of data are used for the assessment. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

Load monitoring

Intensive water quality sampling occurs at all Water Pollutant Load Monitoring Network (WPLMN) sites. Thirty-five samples per year are allocated for basin and major watershed sites and 25 samples per season (ice out through October 31) for subwatershed sites. Because concentrations typically rise with streamflow for many of the monitored pollutants, and because of the added influence elevated flows have on pollutant load estimates, sampling frequency is greatest during periods of moderate to high flow. All major snowmelt and rainfall events are sampled. Low flow periods are also sampled although sampling frequency is reduced as pollutant concentrations are generally more stable when compared to periods of elevated flow.

Water sample results and daily average flow data are coupled in the $FLUX_{32}$ pollutant load model to estimate the transport (load) of nutrients and other water quality constituents past a sampling station over a given period of time. Loads and flow weighted mean concentrations (FWMCs) are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website https://www.pca.state.mn.us/wplmn/overview.

Groundwater monitoring

The MPCA maintains an Ambient Groundwater Monitoring Network that monitors the aquifers that are most likely to be polluted with non-agricultural chemicals. This network primarily targets the shallow aquifers that underlie the urban parts of the state, due to the higher tendency of vulnerability to pollution. The MPCA's Ambient Groundwater Monitoring Network as of 2018, when this report was produced, consisted of approximately 270 wells that are primarily located in the sand and gravel and Prairie du Chien - Jordan aquifers.

Some wells in the MPCA's network are used to discern the effect of urban land use on groundwater quality and comprise an early warning network. Most wells in this early warning network contain water that was recently recharged into the groundwater, some even less than one year old. The wells in the early warning network are distributed among several different settings to determine the effect land use has on groundwater quality. These assessed land use settings are: 1) sewered residential, 2) residential areas that use subsurface sewage treatment systems for wastewater disposal, and 3) commercial or industrial, and 4) undeveloped. The data collected from the wells in the undeveloped areas provide a baseline to assess the extent of any pollution from all other land use settings.

Water samples from the MPCA's Ambient Groundwater Monitoring Network wells generally are collected annually by MPCA staff. This sampling frequency provides sufficient information to determine trends in groundwater quality. The water samples are analyzed to determine the concentrations of over 100 chemicals, including nitrate, chloride, and volatile organic compounds.

Information on groundwater monitoring methodology is taken from Kroening and Ferrey's report: The Condition of Minnesota's Groundwater, 2007-2011 (2013). To download ambient groundwater monitoring data, please refer to: https://www.pca.state.mn.us/data/groundwater-data.

Wetland monitoring

The MPCA is actively developing methods and building capacity to conduct wetland quality monitoring and assessment. Our primary approach is biological monitoring—where changes in biological communities may be indicating a response to human-caused impacts. The MPCA has developed Indices of Biological Integrity (IBIs) to monitor the macroinvertebrate condition of depressional wetlands with open water and the Floristic Quality Assessment (FQA) to assess vegetation condition in all of Minnesota's wetland types. For more information about the wetland monitoring (including technical background reports and sampling procedures), please visit the MPCA Wetland monitoring and assessment webpage.

The MPCA currently does not monitor wetlands systematically by watershed. Rather, the MPCA is using probabilistic monitoring to assess status and trends of wetland quality in the state and by major ecoregion. Probabilistic monitoring refers to the process of randomly selecting sites to monitor; from which, an unbiased estimate of the resource can be made. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

Individual aggregated 12-HUC subwatershed results

Aggregated 12-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each aggregated 12-HUC subwatershed within the Mississippi River-Grand Rapids Watershed. The primary objective is to portray all the full support and impairment listings within an aggregated 12-HUC subwatershed resulting from the complex and multi-step assessment and listing process. This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated 12-HUC subwatersheds contain the assessment results from the 2017 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2015-2016 IWM effort, but also considers available data from the last 10 years.

The proceeding pages provide an account of each aggregated 12-HUC subwatershed. Each account includes a brief description of the aggregated 12-HUC subwatershed, and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, and b) lake aquatic life and recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the aggregated 12-HUC subwatershed. A brief description of each of the summary tables is provided below.

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the aggregated 12-HUC subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2017 assessment process (2018 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 4). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), DO, TSS, chloride, pH, TP, Chl-a, biochemical oxygen demand and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*Escherichia coli*) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated 12-HUC subwatershed, as well as in the Watershed-wide results and discussion section.

Lake assessments

A summary of lake water quality is provided in the aggregated 12-HUC subwatershed sections where available data exist. This includes aquatic recreation (phosphorus, Chl-a, and Secchi) and aquatic life, where available (*i.e.* chloride and fish IBI). Similar to streams, parameter level and over all use decisions are included in the tables.

Upper Prairie River Aggregated 12-HUC HUC 0701010301-01

The Upper Prairie River Subwatershed drains approximately 151 square miles of Itasca (89.1%) and St. Louis (10.9%) counties and is the fifth largest subwatershed within the Mississippi River – Grand Rapids Watershed. The headwaters of the Prairie River begin in a forested wetland and flow 15 miles to the southwest through Prairie (31-0053-00) and Wolf (31-0152-00) lakes before its confluence with Day Brook (-542). There are numerous unnamed streams within the drainage. From Day Brook, the Prairie River continues 11 miles and receives additional flow from the West Fork of the Prairie River and the East River before exiting this subwatershed at the confluence of Balsam Creek (-696). This subwatershed is a part of the larger Prairie River system (507.81 mi^2), which is the second largest river drainage in the Mississippi River – Grand Rapids Watershed. There are 53 lakes greater than 10 acres in size, the most prominent being Antler, Hartley, Stingy, Long, Wasson, and Round. The subwatershed is dominated by forest (49.1%), wetland (40.4%), and open water (5.3%). Only 2.4% is rangeland, 2.3% is developed, 0.5% is barren/mining, and there is no row-crop agriculture (<0.1%). A large portion (73.0%) of this subwatershed lies within the boundaries of George Washington State Forest. Itasca SWCD conducted intensive water chemistry sampling near the outlet of the subwatershed on the Prairie River. The outlet is represented by water chemistry station S008-480 and biological station 15UM053.

Table 2. Aquatic life and recreation assessments on stream reaches: Upper Prairie River Aggregated 12-HUC. (Reaches are organized upstream to downstream in the table).

AUID **Reach Name** *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07010103-717 ***Unnamed Creek*** *Unnamed Creek (Scooty Lake Outlet) to Prairie River*	15UM057	1.77	WWg	EXS	MTS	IF	IF	IF	- -	IF	IF	- -	- -	IMP	- -
07010103-711 ***Deer Creek*** *Kleffman Lake to Rock Lake Creek*	- -	0.52	WWg	- -	- -	- -	- -	MTS	- -	- -	- -	- -	IF	IF	- -
07010103-721 ***Deer Creek*** *Headwaters to Kleffman Lake*	15UM063	5.76	WWg	MTS	- -	IF	IF	IF	- -	IF	IF	- -	IF	SUP	- -
07010103-542 ***Day Brook*** *Headwaters (Day Lake (69-0906-00) to Prairie River*	00UM006	23.77	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF	- -	IF	SUP	- -
07010103-571 ***Prairie River, West Fork*** *Hartley Lake to Prairie River*	15UM050	2.31	WWe	MTS	MTS	IF	IF	IF	--	IF	IF	- -	- -	SUP	- -
07010103-543 ***Prairie River*** *Headwaters to Day Brook*	15UM058	14.55	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF	- -	IF	SUP	- -
07010103-759 ***Prairie River*** *Day Brook to Balsam Creek*	15UM053 S008-480	11.31	WWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	- -	IF	SUP	SUP
07010103-561 ***Unnamed Creek*** *Bartlett Lake outlet to Bluebill Lake*	--	2.38	WWg	--	--	--	--	--	--	--	--	--	--	IF	--

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
LRVW = limited resource value water *Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 3. Lake assessments: Upper Prairie River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators: Fish IBI	Aquatic Life Indicators: Chloride	Aquatic Life Indicators: Pesticides ***	Aquatic Recreation Indicators: Total Phosphorus	Aquatic Recreation Indicators: Chlorophyll-a	Aquatic Recreation Indicators: Secchi	Aquatic Life Use	Aquatic Recreation Use
West	31-0040-00	75	25	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Stingy	31-0051-00	360	25	Deep Lake	NLF	- -	- -	MTS	- -	MTS	IF	MTS	IF	FS
Bower	31-0052-00	93	30	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	EX	IF	FS
Prairie	31-0053-00	29	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Twenty Four	31-0054-00	85	35	Deep Lake	NLF	- -	- -	- -	- -	MTS	EX	EX	- -	IF
Unnamed	31-0055-00	19	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Washington	31-0056-00	25	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Sherry	31-0057-00	138	10	Deep Lake	NLF	- -	- -	MTS	- -	IF	IF	EX	IF	IF
O'Leary	31-0070-00	135	20	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Kennedy	31-0137-00	101	80	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Scooty	31-0150-00	168	75	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Wolf	31-0152-00	189	6	Deep Lake	NLF	- -	IF	MTS	- -	EX	MTS	EX	IF	IF
Hartley	31-0154-00	289	50	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
White Swan	31-0260-00	159	17	Deep Lake	NLF	I	- -	- -	- -	MTS	MTS	MTS	- -	FS
Bluebill	31-0265-00	144	14	Deep Lake	NLF	- -	- -	MTS	- -	IF	EX	EX	IF	IF

Long (Main Bay)	31-0266-01	342	34	Deep Lake	NLF	- -	MTS	IF	- -	MTS	MTS	MTS	FS	FS
Little Long	31-0266-02	27	29	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	EX	- -	IF
Gunny Sack	31-0267-00	82	13	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF
Round	31-0268-00	453	40	Deep Lake	NLF	D	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Stumple	31-0269-00	12	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Wasson	31-0281-00	414	65	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Unnamed	31-0293-00	7	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Ann	31-0305-00	95	20	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	- -	FS
Rat	31-0307-00	23	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Bartlet	31-0308-00	117	8	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF
Antler	31-0349-00	225	90	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Unnamed	31-0453-00	9	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Unnamed	31-0949-00	8	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Stuart	69-0920-00	28	40	Deep Lake	NLF	- -	- -	- -	IF	- -	- -	IF	IF	IF

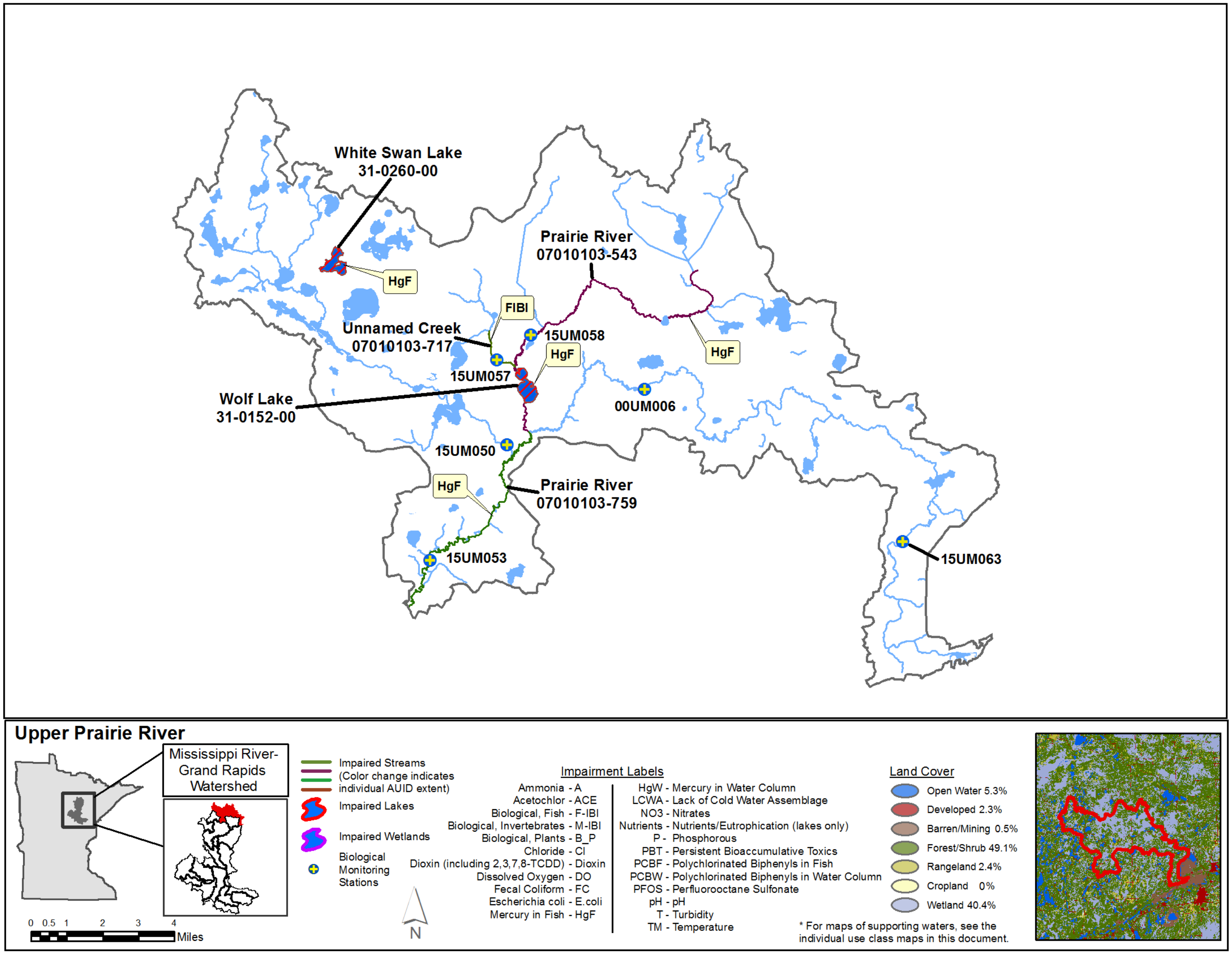
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data; D = decreasing/declining trend; I = increasing/improving trend
Abbreviations for Indicator Evaluations: -- = No Data; **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data; **IF** = Insufficient Information; **FS** = Full Support (Meets Criteria)
Key for Cell Shading: [green] = full support of designated use; [yellow] = insufficient information.

Summary

Aquatic life and recreation indicators for lakes, rivers and streams of the Upper Prairie River Subwatershed (0701010301-01) generally reflect good-to-excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high, and streams are characterized by low levels of sediment, nutrients, and bacteria. Two streams (West Fork Prairie River (-571) and Prairie River (-759)) meet exceptional use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for these and other outstanding stream resources found throughout the Upper Prairie River Subwatershed. An unnamed creek (Scooty Lake outlet to Prairie River (-717)) was determined to be impaired for FIBI. The undisturbed nature of this watershed allows this impairment to be reclassified as natural background and will require a site-specific standard for FIBI.

Lakes in the subwatershed are predominantly characterized by low levels of nutrients, algae and chloride, and healthy fish communities (DNR); however, two lakes exhibit signs of stress. Wolf Lake is vulnerable to a future recreation use impairment; the basin is shallow and has elevated phosphorus. Round Lake exhibits a declining trend in water clarity. Protection strategies developed in the subwatershed should include intentional efforts to reduce contributions of phosphorus to these two lakes.

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Upper Prairie River Aggregated 12-HUC.



East River Aggregated 12-HUC HUC 0701010301-02

The East River Subwatershed drains 67 square miles of Itasca (93.8%) and St. Louis (6.2%) counties and is the fifth smallest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of the East River begin in a forested wetland and continue 6 miles to the north through Shafer Lake (31-0049-00) before turning west at the confluence of unnamed creek. The East River continues an additional 16 miles while receiving additional contributions from numerous unnamed streams before exiting this subwatershed at the Prairie River. This subwatershed is a part of the larger Prairie River system (508 mi^2), which is the second largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 18 lakes greater than 10 acres, with the most prominent being Buck, Libby, and Moran. This subwatershed is dominated by forest (54.5%), wetland (34.7%), and rangeland (4.6%). Only 3.4% is open water, 2.5% is developed, 0.2% is row-crop agriculture and 0.1% is barren/mining. A small portion (0.2%) of this subwatershed lies within the George Washington State Forest. Water chemistry sampling was conducted on the East River downstream of Highway 65, 9.5-miles north of Nashwauk. The outlet is represented by water chemistry station S008-479 and biological station 15UM060.

Table 4. Aquatic life and recreation assessments on stream reaches: East River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-719 ***Unnamed Creek*** *Johnson Lake Outlet to East River*	15UM061 16UM169	3.24	WWg	MTS	EXS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-718 ***East River*** *Unnamed Creek to Little Buck Lake Outlet*	15UM064	7.62	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-712 ***East River*** *Little Buck Lake Outlet to Unnamed Creek*	15UM060 S008-479	1.62	WWg	MTS	MTS	NA	MTS	MTS	MTS	MTS	MTS		IF	SUP	SUP
07010103-714 ***East River*** *South Fork Lake Outlet to Pickerel Lake Outlet*	15UM062 16UM168	1.97	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 5. Lake water aquatic recreation assessments: East River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Long	31-0043-00	97	45	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	- -	FS
Unnamed	31-0044-00	20	35	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	IF	- -	FS
Libby	31-0048-00	106	15	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	EX	- -	IF
Buck	31-0069-00	493	30	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
South Fork	31-0135-00	19	22	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	- -	FS

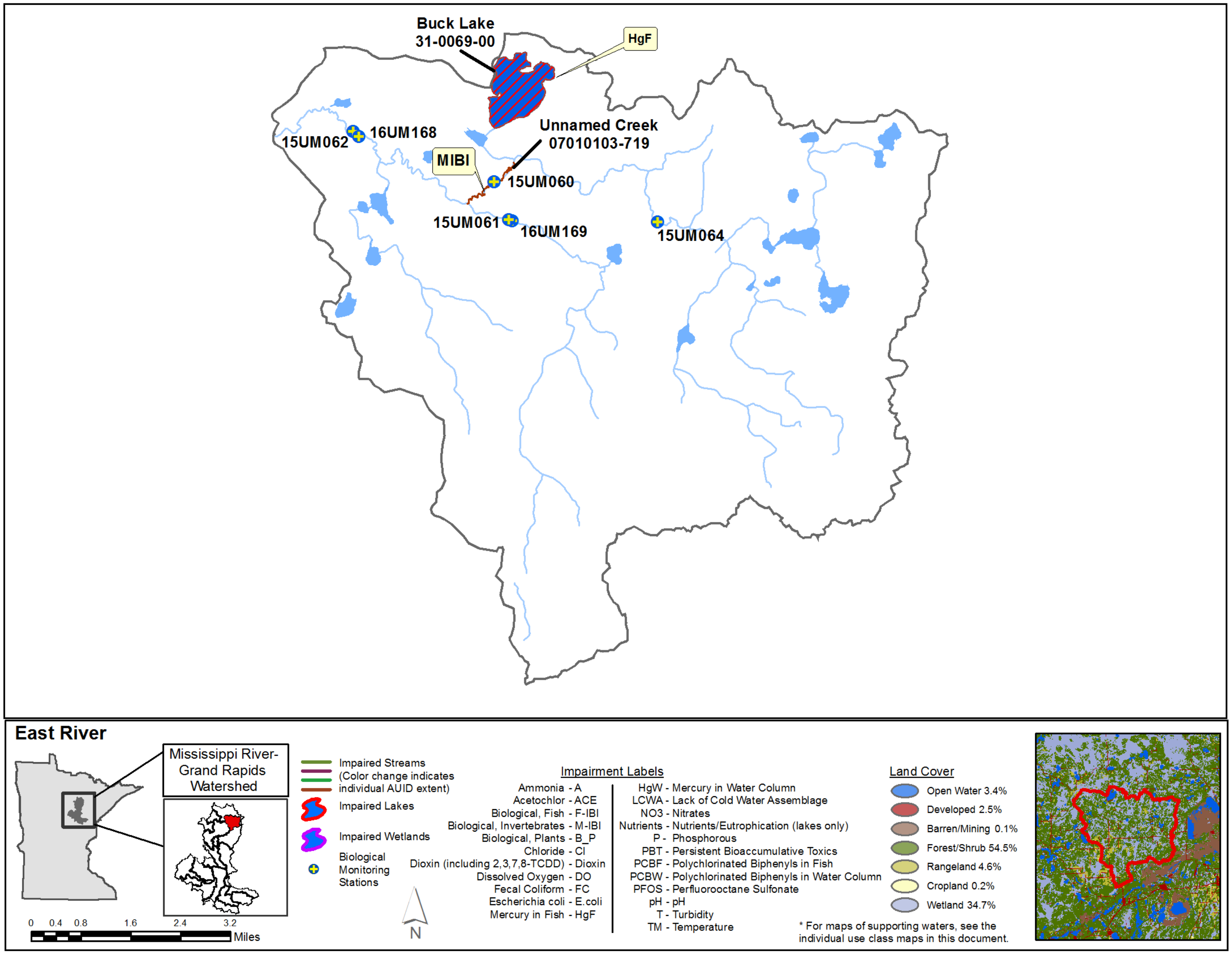
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data; I = increasing/improving trend
Abbreviations for Indicator Evaluations: -- = No Data; **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading: = full support of designated use; = insufficient information.

Summary

Aquatic life and recreation indicators for lakes, rivers and streams of the East River Subwatershed (0701010301-02) generally reflect good water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are generally high. Water chemistry parameters for the East River (-712) all meet water quality standards with the exception of the DO (Table 4). This reach is low gradient, with a large, wetland and forest dominated watershed; the dissolved oxygen exceedances are considered to be naturally occurring. Nutrients are slightly elevated. Bacteria concentrations are low and the river supports aquatic recreation. An unnamed creek (Johnson Lake outlet to East River (-719)) was determined to be impaired for MIBI. The undisturbed nature, wetland influence, and numerous beaver dams allows this impairment to be reclassified as natural background and will require a site-specific standard for MIBI.

Lakes in this subwatershed are of good quality (Table 5). Libby Lake is shallow and more productive than other lakes in the watershed; while the watershed is relatively intact, protection strategies to reduce contributions of phosphorus will be important for this basin. The fish community in Buck Lake is of exceptional quality, with no pollution tolerant species present; Buck Lake also exhibits a trend of increasing clarity

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the East River Aggregated 12-HUC.



Lower Prairie River Aggregated 12-HUC HUC 0701010302-01

The Lower Prairie River Subwatershed drains 177 square miles of Itasca County and is the third largest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed consists of the lower reaches of the Prairie River and starts at the confluence of Balsam Creek and the Upper Prairie River subwatersheds. The Prairie River continues 36 miles, while flowing through Lawrence and Prairie lakes, before reaching the Mississippi River. Numerous named (Sucker Brook and Clear Creek) and unnamed streams contribute their waters to the Prairie River. This subwatershed is a part of the larger Prairie River drainage system (509 mi^2), which is the second largest river drainage in the Mississippi River-Grand Rapids Watershed. There are a total of 69 lakes greater than 10 acres, with the most prominent being Prairie, Shoal, Crooked, Lawrence, Big Sucker, O'Reilly and Bray. This subwatershed is dominated by forest (60.0%), wetland (22.8%), and open water (6.4%). Only 5.3% is rangeland, 4.5% is developed, 0.6% is row-crop agriculture, and 0.5% is barren/mining. This subwatershed encompasses the entire Prairie Lake Deer Yard Wildlife Management Area and a portion of the Botany Bog Scientific and Natural Area. Water chemistry sampling was conducted at the Clearwater Road crossing (S008-478) and at the outlet of the subwatershed upstream of Highway 169, 10 miles northeast of Grand Rapids on the Prairie River. The outlet is represented by water chemistry station S003-667 and biological station 15UM049. Two separate monitoring locations were needed due to the large geographical area and the long length of the Prairie River within this 12-HUC.

Table 6. Aquatic life and recreation assessments on stream reaches: Lower Prairie River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07010103-722 ***Unnamed Creek*** *Unnamed Creek to Bray lake*	15UM056	2.19	CWg	EXS	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-618 ***Sucker Brook*** *Unnamed Lake (31-0125-00) to Prairie River*	15UM055	5.32	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-760 ***Prairie River*** *Balsam Creek to Prairie Lake*	00UM003 15EM049 S008-478	24.23	WWg	MTS	- -	MTS	MTS	MTS	MTS	MTS	MTS		MTS	SUP	IMP
07010103-508 ***Prairie River*** *Prairie Lake to Mississippi River*	15UM049 S003-667	7.16	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS		MTS	SUP	SUP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 7. Lake assessments: Lower Prairie River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Big McCarthy	31-0120-00	110	43	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Moose	31-0121-00	105	6	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	IF	FS
Little McCarthy	31-0123-00	62	24	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Big Sucker	31-0124-00	253	36	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Trestle	31-0127-00	89	48	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	MTS	- -	IF
Shoal	31-0141-00	254	73	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Thirty	31-0145-00	123	14	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	IF	- -	FS
Bray	31-0147-00	177	44	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Nashwauk	31-0192-00	159	53	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Crooked	31-0193-00	475	68	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	EX	FS	FS
Island	31-0217-00	56	35	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Shamrock	31-0218-00	52	55	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
O'Reilly	31-0219-00	193	79	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Dunning	31-0221-00	68	Unknown	Deep Lake	NLF	I	- -	- -	- -	- -	- -	MTS	- -	IF
Hecemovich	31-0229-00	14	Unknown	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF

Bass	31-0230-00	128	43	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Lawrence	31-0231-00	432	32	Deep Lake	NLF	D	MTS	MTS	- -	MTS	MTS	EX	FS	FS
Lower Lawrence	31-0238-00	149	34	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	- -	FS
Snaptail	31-0255-00	166	68	Deep Lake	NLF	D	- -	- -	- -	MTS	MTS	MTS	IF	FS
Oliver	31-0368-00	16	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Unnamed	31-0381-00	43	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Prairie (main bay)	31-0384-02	732	31	Deep Lake	NLF	NT	MTS	MTS	- -	MTS	MTS	EX	FS	FS
Island	31-0406-00	59	43	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Hay	31-0407-00	53	41	Deep Lake	NLF	- -	- -	IF	IF	IF	IF	IF	IF	IF
Shoal	31-0534-00	659	9	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	MTS	IF	IF
Jessie Pit	31-1281-00	37	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data; D = decreasing/declining trend; I = increasing/improving trend; NT = no evidence of any trend
Abbreviations for Indicator Evaluations: -- = No Data; **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data; **IF** = Insufficient Information; **FS** = Full Support (Meets Criteria)
Key for Cell Shading: = full support of designated use; = insufficient information.

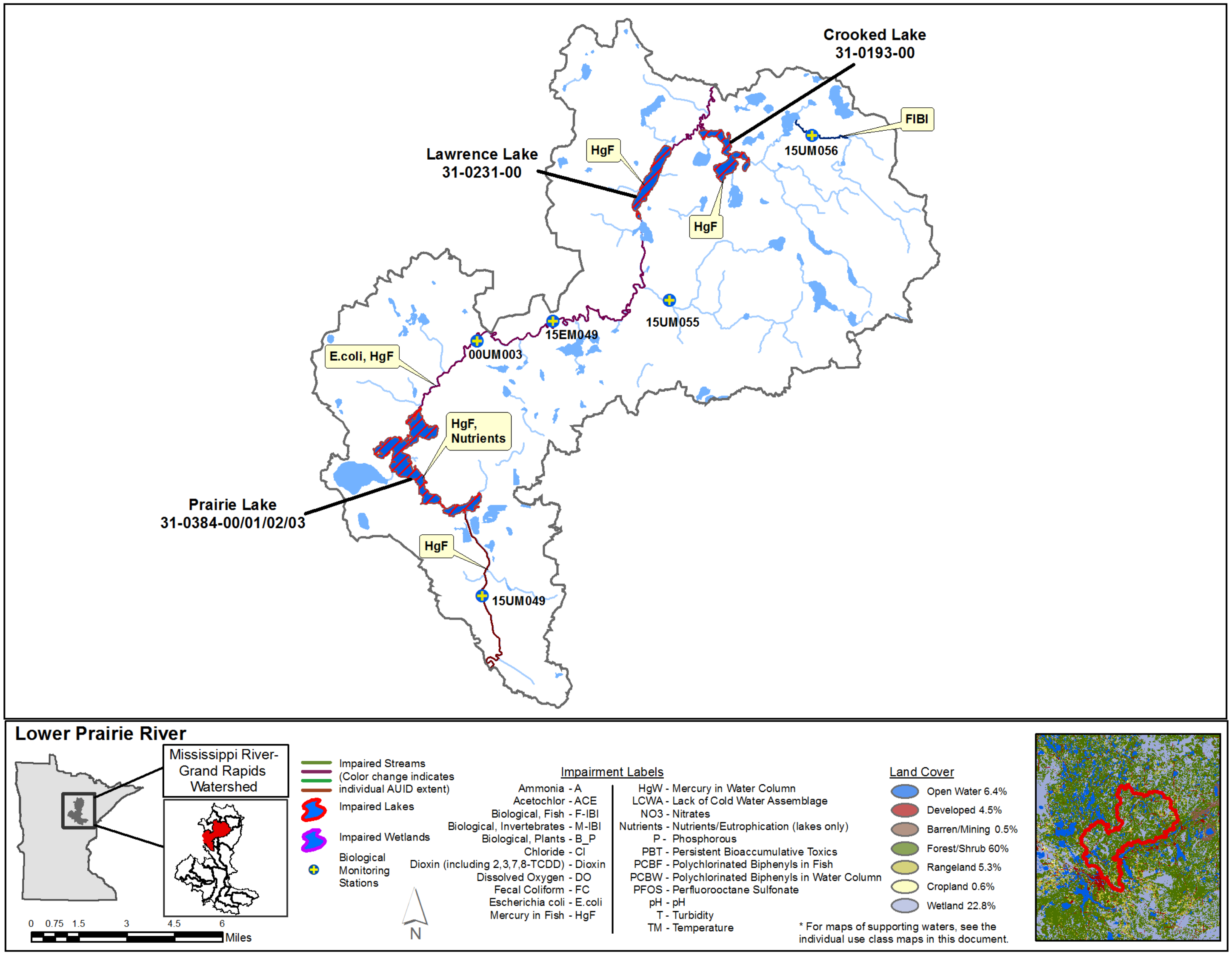
Summary

Aquatic life indicators for lakes, rivers and streams of the Lower Prairie River Subwatershed (0701010302-01) generally reflect good-to-excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high, and streams are characterized by low levels of sediment, and nutrients. Upstream of Prairie Lake, the Prairie River has elevated bacteria levels, which resulted in an impairment for aquatic recreation. Bacteria levels on the Prairie River downstream of Prairie Lake are lower and support aquatic recreation.

An unnamed creek (unnamed creek to Bray Lake) was identified as having a FIBI impairment. This stream was previously a DNR designated trout stream, however this designation was removed in 1980 because the stream showed little potential to support a trout population. No coldwater fish were observed in either the 2015 or 2016 collections, however nearly 11% of the macroinvertebrate community was comprised of coldwater taxa and water temperatures are consistent with other trout streams in the region; suggesting this stream is more appropriately classified as coldwater. A rare and pollution sensitive caddisfly (*Goera*) known to inhabit rocky coldwater streams was observed in this reach. Habitat along this reach is very good, consisting of good riffle, run, pool morphology and abundant coarse substrates. Fluctuations in water levels, likely a result of historic ditching and beaver activity may limit the reproductive ability of brook trout in this stream. Strategies to improve water level fluctuations and coldwater fish management are needed for this stream.

Eighteen lakes meet water quality standards and fully support aquatic recreation (Table 7). Lawrence and Snaptail lakes have decreasing transparency trends. These lakes should be considered high priority for protection to reduce inputs of phosphorus. Prairie Lake will be removed from the 303(d) Impaired Waters List based on new chemistry data that demonstrates that the lake meets standards. FIBI assessment comments provided by DNR indicate the fish communities generally perform well in this watershed; Bray Lake has an exceptional fish community.

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Lower Prairie River Aggregated 12-HUC.



Clearwater Creek Aggregated 12-HUC — HUC 0701010302-02

The Clearwater Creek Subwatershed drains 62 square miles of Itasca County and is the third smallest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed is a part of the larger Prairie River system (508 mi2), which is the second largest river drainage in the Mississippi River-Grand Rapids Watershed. Numerous large waterbodies connected and fed by various small tributary streams, including Clearwater and Wabana Creek make up this subwatershed. There are 65 lakes greater than 10 acres, with the most prominent being Wabana, Trout, Spider, Bluewater, Irma, Little Long, and Ruby. This subwatershed is dominated by forest (59.2%), open water (24.2%), and wetland (12.2%). Only 3.0% is developed, 1.1% is rangeland, 0.2% is row-crop agriculture, and 0.1% is barren/mining. A large portion (76.6%) of this subwatershed lies within the Chippewa National Forest and the Bowstring State Forest. As a result of the proximity to Clearwater Lake; there was no intensive water chemistry sampling conducted on rivers and streams within this subwatershed.

Table 8. Aquatic life and recreation assessments on stream reaches: Clearwater Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry Station ID**	**Reach Length (miles)**	**Use Class**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-587 ***Clearwater Creek*** *Clearwater Lake to Prairie River*	15UM094	2.13	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 9. Lake assessments: Clearwater Creek Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Inkey	31-0240-00	68	68	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Hanson	31-0344-00	68	66	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Upper Hanson	31-0346-00	120	53	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Murphy	31-0389-00	133	20	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF
Wabana	31-0392-00	2198	115	Deep Lake	NLF	I	MTS	MTS	- -	MTS	IF	MTS	FS	FS
Little Trout	31-0394-00	85	80	Deep Lake	NLF	I	- -	- -	- -	- -	- -	MTS	- -	IF
Bluewater	31-0395-00	362	100	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Middle Hanson	31-0396-00	64	32	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF
Little Wabana	31-0399-00	114	57	Deep Lake	NLF	I	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Rainbarrel	31-0400-00	12	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Clearwater	31-0402-00	71	38	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Big Rainbarrel	31-0408-00	20	44	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Trout	31-0410-00	1745	160	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Upper Spring	31-0411-00	14	20	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Lower Spring	31-0446-00	13	15	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF

Spider	31-0538-00	1343	35	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Little Long	31-0613-00	275	61	Deep Lake	NLF	D	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Unnamed	31-0628-00	23	42	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Shelly	31-0630-00	117	77	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Irma	31-0634-00	347	56	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Little Wolf	31-0635-00	15	46	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	IF	IF
Wolf	31-0636-00	237	41	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Beaver	31-0638-00	18	30	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Adele	31-0642-00	21	15	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Doctor	31-0643-00	23	5	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Surprise	31-0646-00	10	31	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Circle	31-0647-00	19	14	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Bluebill Pond	31-0972-00	8	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Pothole	31-0991-00	11	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Unnamed	31-1152-00	6	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF

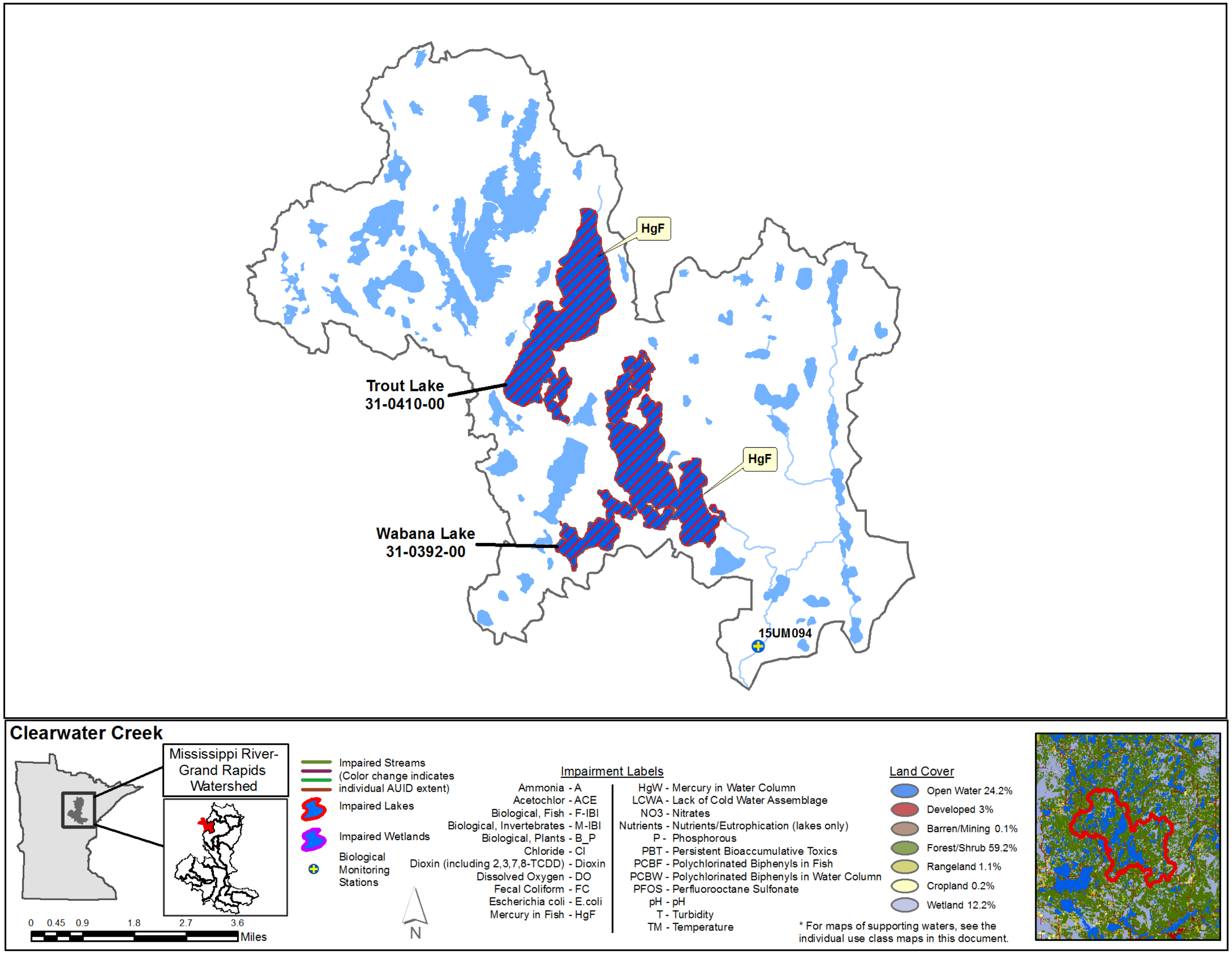
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data; D = decreasing/declining trend; I = increasing/improving trend
Abbreviations for Indicator Evaluations: -- = No Data; **MTS** = Meets Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data; **IF** = Insufficient Information; **FS** = Full Support (Meets Criteria)
Key for Cell Shading: = full support of designated use; = insufficient information

Summary

Aquatic life indicators for lakes and streams of the Clearwater Creek Subwatershed (0701010302-02) reflect excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) from the one monitored location on Clearwater Creek are high. This subwatershed has some of the clearest water (i.e. deepest observed transparency) in the entire Mississippi River-Grand Rapids Watershed.

Trout, Little Trout, Wabana and Bluewater lakes all meet the most stringent recreation use standards, which are protective of known populations of lake trout, a pollution intolerant species. These four lakes have a particularly high recreational quality and benefit specifically from low levels of land development and relatively small watersheds. The western portion of the subwatershed is lake-rich with large, deep lakes comprising a majority of the land-cover. Each of these interconnected basins acts as a sink for pollutants that may arrive via surface drainage before they flow to the next 'downstream' lake. FIBI assessments indicate that the fish communities generally perform well in this watershed; Wabana, Bluewater and Little Wabana lakes have exceptional fish communities and all would benefit from future efforts to help sustain the valuable resources.

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Clearwater Creek Aggregated 12-HUC.



Balsam Creek Aggregated 12-HUC HUC 0701010302-03

The Balsam Creek Subwatershed drains 51 square miles of Itasca County and is the smallest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed is a part of the larger Prairie River system (508 mi^2), which is the second largest river drainage in the Mississippi River-Grand Rapids Watershed. Numerous lakes are found within the headwaters of this subwatershed and are connected through various unnamed streams before contributing their waters to Balsam Lake (31-0259-00). Balsam Creek begins at the outlet of Balsam Lake and continues 7 miles before exiting this subwatershed at the Prairie River. There are a total of 51 lakes greater than 10 acres, with the most prominent being Balsam, King, Cutaway, Burrows, Lower Balsam, and Buckman. This subwatershed is dominated by forest (58.0%), wetland (21.4%), and open water (14.6%). Only 3.6% is developed, 2.0% is rangeland, 0.3% is row-crop agriculture and there is no barren/mining (<0.1%). A large portion (64.1%) of this subwatershed lies within the Balsam Island Wildlife Management Area, George Washington State Forest, and the Chippewa National Forest. Due to the lack of a suitable road crossing near the pour point of this subwatershed, established water chemistry station was not established. The outlet is represented by biological station (15UM051).

Table 10. Aquatic life and recreation assessments on stream reaches: Balsam Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-690 ***Unnamed Creek*** *Scrapper Lake to Balsam Lake*	- -	0.44	WWg	- -	- -	- -	- -	MTS	- -	- -	- -		- -	IF	- -
07010103-696 ***Balsam Creek*** *Lower Balsam Lake to Prairie River*	15UM051	1.42	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 11. Lake assessments: Balsam Creek Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators: Fish IBI	Aquatic Life Indicators: Chloride	Aquatic Life Indicators: Pesticides ***	Aquatic Recreation Indicators: Total Phosphorus	Aquatic Recreation Indicators: Chlorophyll-a	Aquatic Recreation Indicators: Secchi	Aquatic Life Use	Aquatic Recreation Use
Moose	31-0242-00	68	11	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Lower Balsam	31-0247-00	258	29	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
King	31-0258-00	317	25	Deep Lake	NLF	I	- -	- -	- -	EX	EX	EX	- -	NS
Balsam	31-0259-00	711	40	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Marble	31-0271-00	147	10	Deep Lake	NLF	- -	- -	- -	- -	IF	EX	EX	- -	IF
Buckman	31-0272-00	228	10	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	IF	FS
Scrapper	31-0345-00	170	28	Deep Lake	NLF	- -	MTS	- -	- -	- -	- -	MTS	FS	IF
Sawyer	31-0348-00	133	15	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	- -	FS
Burrows	31-0413-00	301	36	Deep Lake	NLF	D	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Burnt Shanty	31-0424-00	194	30	Deep Lake	NLF	I	- -	- -	- -	MTS	MTS	MTS	IF	FS
Cutaway	31-0429-00	305	55	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Lost Moose	31-0432-00	108	10	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Sand	31-0438-00	193	50	Deep Lake	NLF	I	- -	- -	- -	MTS	MTS	MTS	IF	FS
Blandin	31-0484-00	104	20	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF
Haskell	31-0945-00	96	57	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = new impairment; = full support of designated use; = insufficient information.

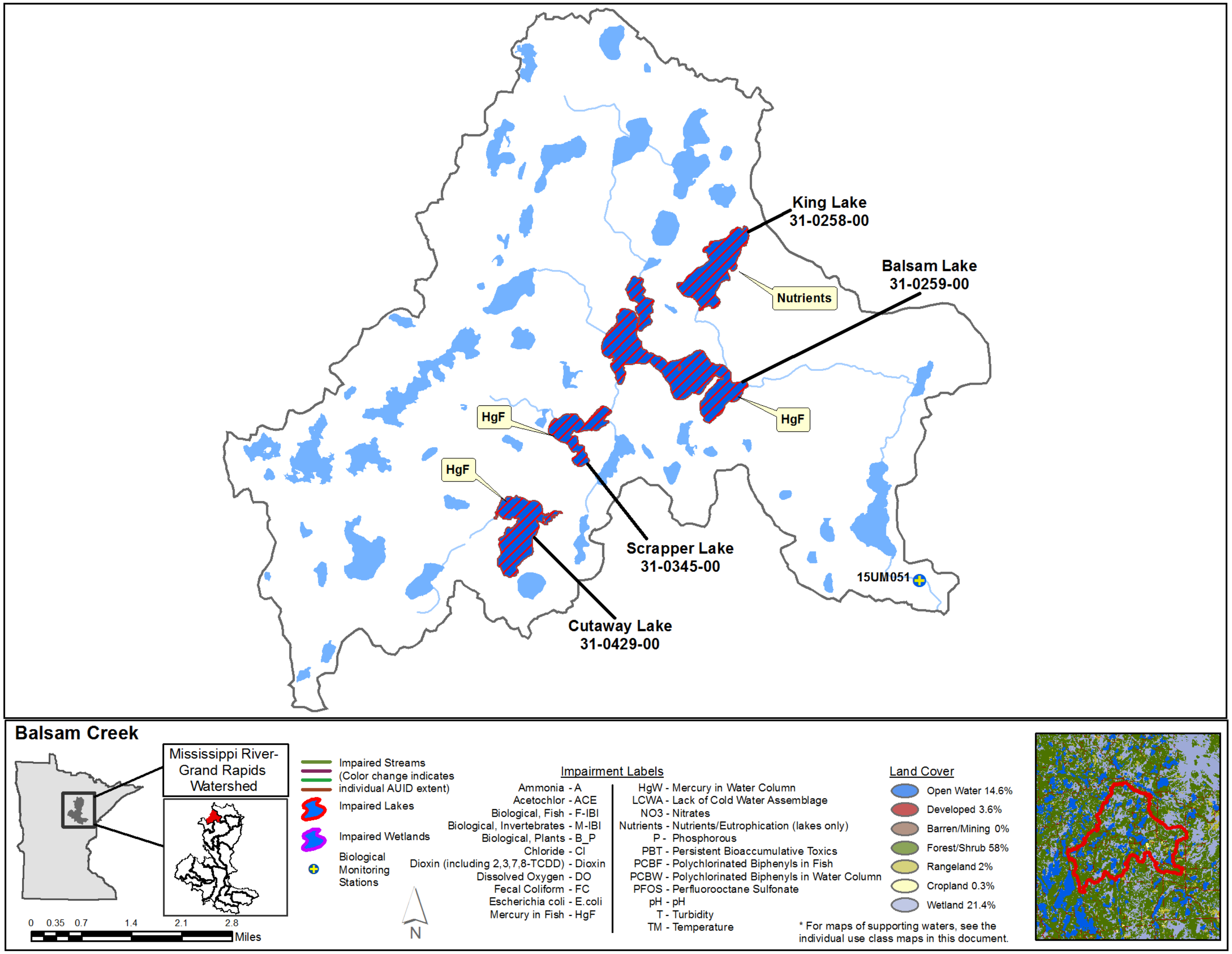
Summary

Aquatic life indicators for lakes and streams of the Balsam Creek Subwatershed (0701010302-02) generally reflect excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) and habitat scores (MSHA) are high (Table 10 and Appendix 5). The FIBI score exceeds the exceptional use threshold for Northern Streams, likely due to the high numbers of sensitive taxa (Logperch, Hornyhead Chub, and Burbot). A unique and sensitive dragonfly species (*Macromia illinoiensis*) was collected from Balsam Creek. While the MIBI score does not meet Exceptional Use for Northern Forest Streams in the riffle-run class, the presence of this and other sensitive taxa indicate good water quality and that protection of this subwatershed is imperative to maintaining these communities.

A volunteer with the CSMP submitted four-seasons of Secchi-tube transparency data from an unnamed creek (07010103-690). This creek is a short connector stream between Balsam and Scrapper lakes and had high clarity on all dates.

Lakes in the subwatershed are characterized by low levels of nutrients, algae, and chloride; long-term Secchi transparency data show improving trends in transparency on King, Burnt Shanty, and Sand lakes. King Lake exhibited elevated phosphorus and algae concentrations and was added to the 303(d) Impaired Waters List. Protection and restoration strategies developed in the subwatershed should include intentional efforts to reduce contributions of phosphorous to King and other lakes. FIBI assessments indicate that the fish communities generally perform well in this watershed; Balsam and Lower Balsam lakes have exceptional fish communities and should be protected.

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Balsam Creek Aggregated 12-HUC.



Split Hand-Mississippi River Aggregated 12-HUC HUC 0701010303-01

The Split Hand-Mississippi River Subwatershed drains 97 square miles of Itasca (95.4%) and Aitkin (4.6%) counties and is the seventh smallest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed is made of many small drainages that contribute their waters directly to the Mississippi River. A portion of the city of Grand Rapids lies within the boundaries of this subwatershed. There are a total of 24 lakes greater than 10 acres, with the most prominent being Blandin Reserve, Mud, and Blackberry. This subwatershed is dominated by forest (44.4%), wetland (29.8%), and developed (10.1%). Only 9.8% is rangeland, 4.7% is open water, 1.0% is row-crop agriculture, and 0.2% is barren/mining. A portion of Bass Brook Wildlife Management Area, Golden Anniversary State Forest, and Savanna State Forest lie within the boundaries of this subwatershed. The main drainage route of this subwatershed is the Mississippi River, as a result there was no intensive water chemistry sampling conducted on rivers and streams within this subwatershed. However, sampling occurred on Mississippi River AUID 07010103-708 as a part of the 2013-2104 large river monitoring effort. Results and discussion regarding the mainstem Mississippi River in this subwatershed may be found in Appendix 8.

Table 12. Aquatic life and recreation assessments on stream reaches: Split Hand – Mississippi River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-726 ***Unnamed Creek*** *Blackberry Lake to Mississippi River*	15UM048	2.54	WWg	EXS	EXS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-727 ***Unnamed Creek*** *Unnamed Creek to Mississippi River*	15UM088	1.79	WWg	EXS	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 13. Lake assessments: Split Hand – Mississippi River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Mud	31-0206-00	270	5	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	IF	- -	FS
Round	31-0209-00	100	16	Deep Lake	NLF	D	- -	MTS	- -	IF	EX	EX	IF	IF
Blackberry	31-0210-00	143	20	Deep Lake	NLF	- -	- -	- -	- -	MTS	EX	IF	- -	IF
Becker	31-0211-00	18	Unknown	Deep Lake	NLF	- -	- -	IF	IF	IF	IF	IF	IF	IF
Clearwater	31-0214-00	127	16	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Unnamed	31-0342-00	11	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Hale	31-0361-00	125	59	Deep Lake	NLF	I	- -	- -	- -	- -	- -	MTS	IF	IF
McKinney	31-0370-00	108	34	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Ice	31-0372-00	39	53	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Hale	31-0373-00	127	57	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Forest	31-0374-00	38	29	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Horseshoe	31-0376-00	139	11	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading: [green] = full support of designated use; [yellow] = insufficient information.

Summary

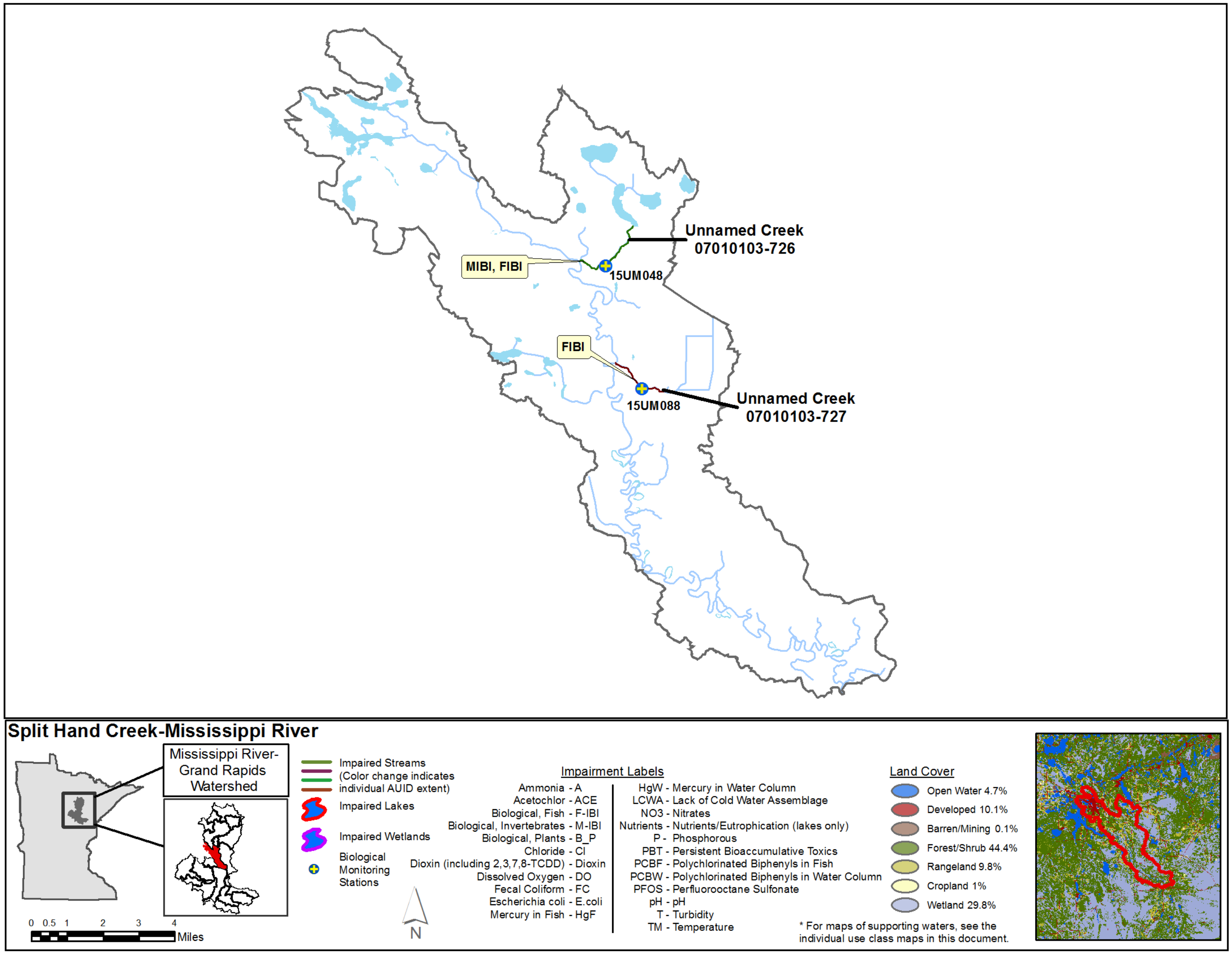
Aquatic life indicators for streams of the Split Hand-Mississippi River Subwatershed (0701010303-01) generally reflect poor water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) and habitat scores (MSHA) are poor (Table 12 and Appendix 5). Two unnamed tributaries to the Mississippi River were monitored for biology several times over the summers of 2015 and 2016 in this subwatershed. Resulting FIBI and/or MIBI are below standards for northern streams, and both streams were impaired for aquatic life. Stream alterations coupled with poor habitat, numerous road crossings, and bank instability are likely stressors of the biological communities.

The primary receiving waterbody in this subwatershed is the main-stem Mississippi River (07010103-707). MPCA collected chemistry data on the Mississippi River in 2013-14; those data indicate that this segment of the Mississippi River meets standards for aquatic life and recreation. Two previous impairment listings from 1998 (DO and turbidity) were removed from Minnesota's impaired waters inventory.

Lake water quality is good in this watershed. Seven lakes met standards for aquatic recreation. Round Lake and Blackberry Lake are both close to the impairment threshold, with phosphorus approaching the standard and algal production higher than expected. Both are shallow lakes susceptible to wind mixing of nutrients, which can drive algal blooms in mid-late summer.

McKinney and Hale lakes were assessed for aquatic life (Table 13). Both lakes are located on the northern fringe of the city of Grand Rapids, and have moderately developed watersheds (Hale more so than McKinney). McKinney Lake had a low overall proportion of pollution tolerant species. Hale Lake has an exceptional fish community and is a lake of biological significance in the watershed. An exceptional Fish IBI score in a near-urban setting is a significant achievement, and future development plans from the city would be wise to incorporate protection strategies to maintain the integrity of this valuable resource.

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Split Hand – Mississippi River Aggregated 12-HUC.



Split Hand Creek Aggregated 12-HUC — HUC 0701010303-02

The Split Hand Creek Subwatershed drains 56 square miles of Itasca (97.6%) and Aitkin (2.4%) counties and is the second smallest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed is a direct drainage to the Mississippi River and consists of Split Hand Creek and numerous unnamed streams. Split Hand Creek begins at the outlet of Split Hand Lake (31-0353-00) and flows east for 8.5 miles, then through Little Split Hand Lake (31-0341-00) before reaching the Mississippi River. There are 13 lakes greater than 10 acres, with the most prominent being Split Hand and Little Split Hand Lake. This subwatershed is dominated by forest (49.1%), wetland (34.9%), and open water (7.2%). Only 6.2% is rangeland, 2.1% is developed, 0.5% is row-crop agriculture, and there is no barren/mining (<0.1%). A portion of Golden Anniversary, Hill River, and Savanna State Forest lie within the boundaries of this subwatershed. Intensive water chemistry sampling was conducted at the outlet of the subwatershed at River Road (Cr 3), 1 mile S of Splithand on Split Hand Creek. The outlet is represented by water chemistry station S008-477 and biological station 15UM047 (upstream of CR 68, 7 mi. SW of Warba).

Table 14. Aquatic life and recreation assessments on stream reaches: Split Hand Creek Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry Station ID**	**Reach Length (miles)**	**Use Class**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-732 ***Unnamed Creek*** *Unnamed Creek to Split Hand Lake*	15UM046 16UM165	2.4	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-574 ***Split Hand Creek*** *T53 R24W S18, west line to Mississippi River*	15UM047 S008-477	6.34	WWg	- -	MTS	MTS	MTS	MTS	MTS	MTS	MTS		IF	SUP	IMP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 15. Lake assessments: Split Hand Creek Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Little Cowhorn	31-0198-00	115	12	Deep Lake	NLF	- -	- -	MTS	- -	EX	EX	EX	IF	NS
Little Split Hand	31-0341-00	244	23	Deep Lake	NLF	I	- -	MTS	- -	MTS	EX	MTS	IF	FS
Split Hand	31-0353-00	1370	34	Deep Lake	NLF	- -	- -	MTS	- -	EX	EX	EX	IF	NS
Mud	31-0355-00	46	4	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Cowhorn	31-0356-00	623	3	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Carlson	31-0366-00	178	7	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	IF	- -	FS

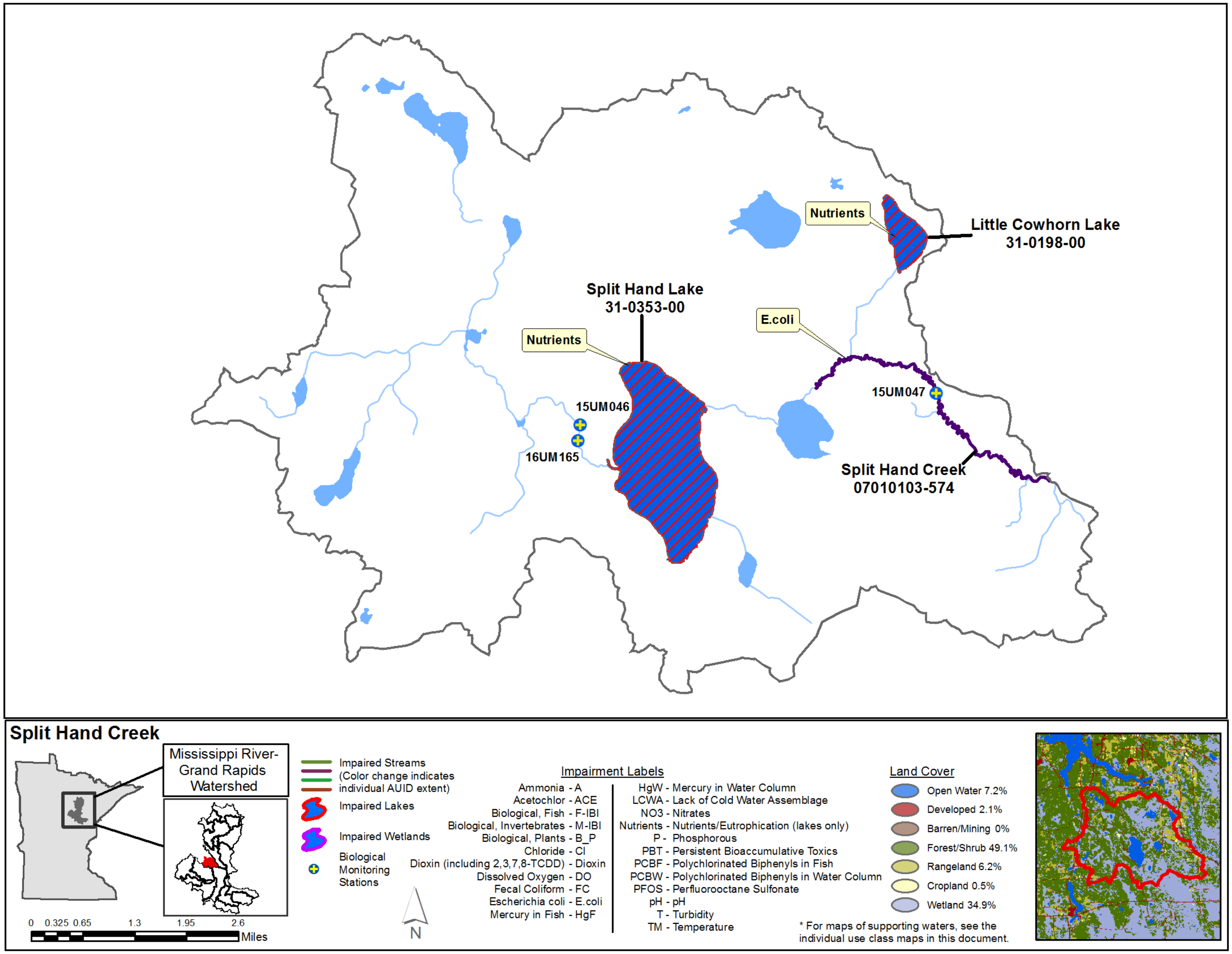
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: I = increasing/improving trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2018 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Summary

Aquatic life indicators for streams in the Split Hand Creek Subwatershed (0701010303-02) generally reflect good water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high (Table 14). The MIBI score from 15UM047 exceeds the exceptional use threshold for Northern-Glide Pool streams. The macroinvertebrate community at this site is diverse and includes a number of sensitive taxa. Habitat throughout this watershed range from good (15UM046, headwaters of Split Hand Creek) to poor (15UM047) (Appendix 5). The poor habitat observed at the lower portion of Split Hand Creek is likely due to localized bank instability resulting from cattle entering and exiting the stream; a common occurrence observed throughout the lower portions of Split Hand Creek. The lower portions of Split Hand Creek are impaired for aquatic recreation use due to chronically elevated levels of *E. coli* bacteria. Phosphorus meets the standard, but there is some evidence of large swings in oxygen concentrations, which occasionally fall below the standard. Bank erosion and livestock access noted during biological monitoring may contribute to the elevated phosphorus and TSS concentrations observed in 2015. Protection of this subwatershed is imperative to maintaining water quality. The lower reach of Split Hand Creek is vulnerable to future impairments due to the elevated concentrations of phosphorous and TSS. Strategies to limit cattle's direct access to stream habitats may stabilize stream banks and help to improve and/or maintain water quality in this subwatershed.

Lakes in this subwatershed are generally characterized by elevated nutrients (i.e. Little Cowhorn and Split Hand lakes have new and old impairments (2018 and 2010 respectively). Carlson and Little Split Hand sake support recreation. Little Split Hand Lake is vulnerable to future impairment; nuisance algal blooms do occur on the lake.

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Split Hand Creek Aggregated 12-HUC.



Lower Swan River Aggregated 12-HUC HUC 0701010304-01

The Lower Swan River Subwatershed drains 181 square miles of Itasca (81.9%) and Aitkin (18.1%) counties and is the second largest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed begins at the confluence of the Trout Creek (-539) and the Swan River (-753). The Swan River continues southeast for 52 miles before exiting this subwatershed and contributing its waters to the Mississippi River. Numerous small tributary streams, including some coldwater resources, contribute their waters directly to the Swan River. This subwatershed is a part of the larger Swan River drainage system (328 mi^2), which is the fourth largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 35 lakes greater than1 acres, with the most prominent being Canisteo Pit, Trout, Shallow, and Little Sand Lake. This subwatershed is dominated by forest (44.5%), wetland (39.5%), and rangeland (7.2%). Only 4.8% is open water, 3.5% is developed, 0.5% is row-crop agriculture, and there is no barren/mining (<0.1%). A portion of this subwatershed lies within the Savanna State Forest, Trout Lake Eagle and Swan River Deer Yard Wildlife Management Area. Water chemistry sampling was conducted at the outlet of the subwatershed upstream of CR 431, 3 miles S of Swan River on the Swan River. The outlet is represented by water chemistry station S001-922 and biological station 15UM084.

Table 16. Aquatic life and recreation assessments on stream reaches: Lower Swan River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry** **Station ID**	**Reach Length (miles)**	**Use Class**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-594 ***Sand Creek*** *Lammon Aid Lake to Swan River*	15UM074 15UM075 15UM106	8.66	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-595 ***Unnamed Creek (Warba Creek)*** *Headwaters to Swan River*	15UM082 15UM083	4.81	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-608 ***Bruce Creek*** *Headwaters (Unnamed Lake 31-0015-00) to T54 R23W S25, south line*	15UM081	3.53	WWg	MTS	- -	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-689 ***Bruce Creek*** *T53 R23W S26, north line to Swan River*	15UM080	0.23	CWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-728 ***Unnamed Creek*** *Unnamed Creek to Swan River*	15UM089	2.25	WWg	EXS	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-729 ***Unnamed Creek*** *Unnamed Creek to Swan River*	15UM090	0.86	WWg	- -	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-743 **Unnamed Ditch** *Headwaters to Unnamed Ditch*	09UM092	2.14	WWg	--	--	NA	NA	NA	--	NA	NA	--	NA	NA	--
07010103-754 ***Swan River*** *Trout Creek to Mississippi River*	10EM066 15UM073 15UM078 15UM079 15UM084 S001-922	51.73	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS		MTS	SUP	SUP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 17. Lake assessments: Lower Swan River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Hay	01-0059-00	127	32	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
New	31-0007-00	72	22	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Roothouse	31-0076-00	35	12	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
McGuire	31-0078-00	83	20	Deep Lake	NLF	I	- -	- -	- -	- -	- -	IF	IF	IF
Sand	31-0082-00	113	36	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Shallow	31-0084-00	541	85	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Foot	31-0090-00	16	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Little Sand	31-0093-00	199	44	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Unnamed	31-0102-00	10	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Bass	31-0207-00	95	16	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	- -	FS
Trout	31-0216-00	1811	135	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: I = increasing/improving trend; -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data; **IF** = Insufficient Information; **FS** = Full Support (Meets Criteria)
Key for Cell Shading: [green] = full support of designated use; [light yellow] = insufficient information.

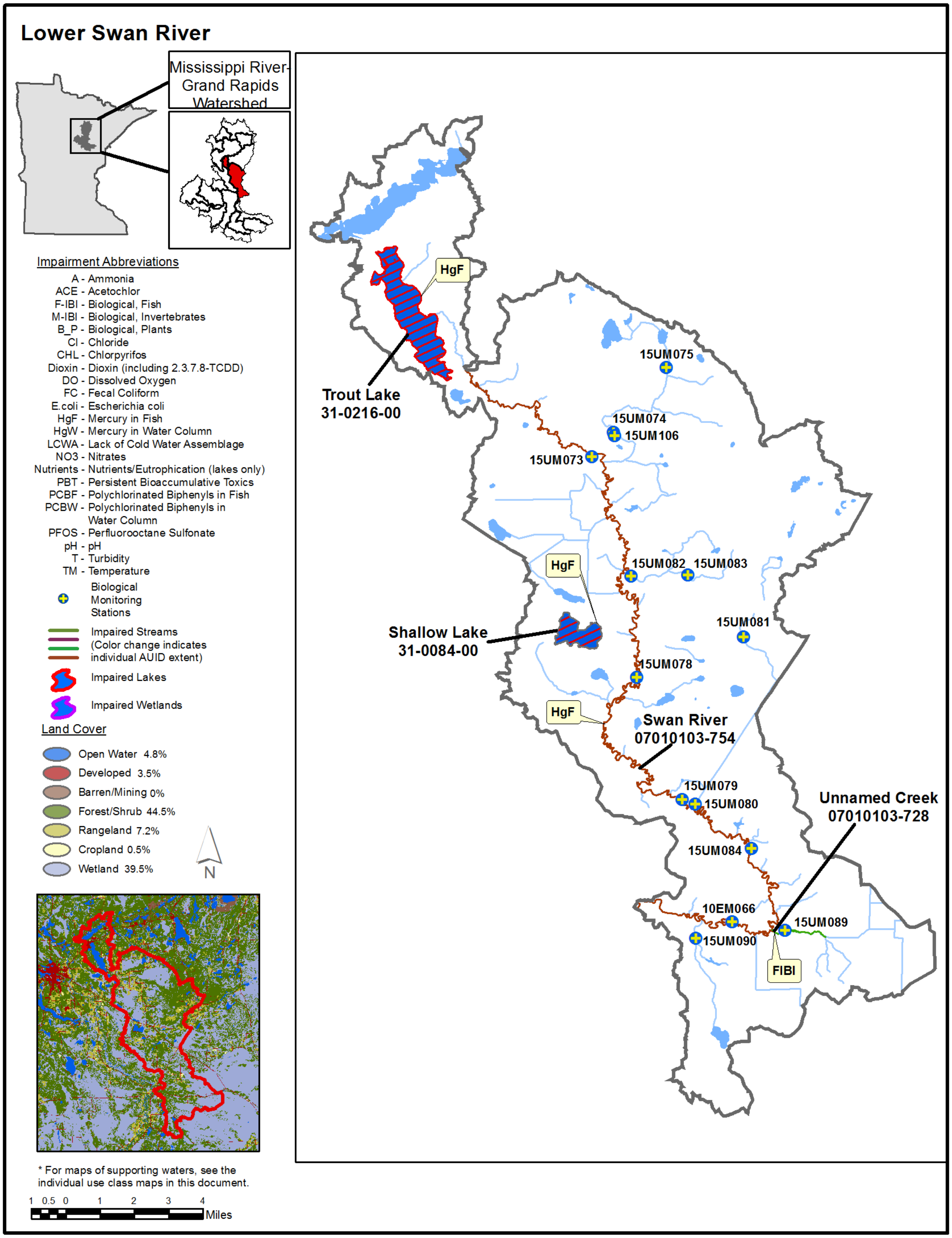
Summary

Aquatic life and recreation indicators for lakes, rivers and streams of the lower Swan River subwatershed (0701010304-01) generally reflect good-to-excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high (Table 16). The lower portions of the Swan River (-754; from Trout Creek to the Mississippi River) nearly meet all necessary Exceptional Use criteria for both fish and macroinvertebrate assemblages. Although this resource is not officially designated as Exceptional many sections of this river support some of the most diverse fish and macroinvertebrate communities within the entire Mississippi River-Grand Rapids Watershed. This subwatershed contains three tributaries to the Swan River (Bruce, Sand, and Warba creeks) that are designated trout streams by the DNR. The DNR is proposing to remove these streams from the designated trout waters inventory. The biological and water temperature data collected as part of this IWM effort corroborate these decisions. The one exception to this is the lower portion of Bruce Creek (-689), which still maintains cold water temperatures, and coldwater fish (mottled sculpin) and macroinvertebrate taxa. Although DNR is proposing to remove the trout stream designation on this stretch of Bruce Creek, the MPCA will maintain the more stringent coldwater standards to protect this resource.

An unnamed tributary (-728) to the Swan River was determined to be impaired for aquatic life based on low FIBI results. This stream receives water from a network of ditched wetlands near Jacobson, Minnesota. The watershed is largely forested wetlands with numerous beaver dams scattered throughout the upstream portions; it is plausible that the increased flow due to stream alteration is destructive to habitats in the lower portions of this unnamed tributary.

All lakes monitored met standards for aquatic recreation. Secchi transparency is improving on Trout and McGuire lakes. Trout Lake historically received wastewater from the cities of Bovey and Coleraine. The improving trend in transparency is the result of continued recovery since removing the direct point source from the lake. The fish communities perform well in this watershed. Shallow Lake was noted as having an exceptional fish community, which makes it a lake of biological significance (Table 17). Future lakeshore and watershed development plans should incorporate protection strategies to ensure the lake maintains integrity. Trout Lake benefits from lower than average levels of shoreline development.

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Lower Swan River Aggregated 12-HUC.



Upper Swan River Aggregated 12-HUC HUC 0701010304-02

The Upper Swan River Subwatershed drains 148 square miles of Itasca (87.6%) and St. Louis (12.4%) counties and is the sixth largest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of the Swan River (-753) begin at the outlet of Swan Lake (31-0067-00) and continues 19 miles to the southwest before exiting this subwatershed. Several tributary streams, including Pickerel, O'Brien (Welcome), Hay, and many unnamed creeks, contribute their waters directly to Swan Lake. Pickerel Creek (-590) is the only coldwater resource within this drainage and is managed by DNR for Brook Trout. This subwatershed is a part of the larger Swan River drainage system (328 mi^2), which is the fourth largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 59 lakes greater than 10 acres, with the most prominent being National Steel Pit, Butler Tac #5 Pit, Hill-Annex Pit, O'Brien, Swan, and Pickerel lakes. This subwatershed is dominated by forest (55.6%), wetland (16.0%), and open water (11.6%). Only 8.6% is barren/mining, 4.9% is developed, 3.2% is rangeland, and 0.1% is row-crop agriculture. Several tailings basins and mining pits exist within this subwatershed. The Hill Annex Mine State Park lies within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed (upstream of CR 10), 7-miles east of Grand Rapids on the Swan River. The outlet is represented by water chemistry station S000-936 and biological station 15UM071.

Table 18. Aquatic life and recreation assessments on stream reaches: Upper Swan River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:										Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication		
07010103-545 ***Hay Creek*** *Headwaters to Swan Lake*	15UM070 99UM061	9.99	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-575 ***Welcome Creek*** *Carlz Pit (31-1239-00) to Reservoir 2N (31-1228-00)*	00UM004	1.63	WWg	--	--	NA	NA	NA	NA	NA	--		NA	NA	--
07010103-583 ***O'Brien Creek (Welcome Creek)*** *Little O'Brien Lake to Swan Lake*	15UM069	1.78	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-588 ***Unnamed Ditch*** *Headwaters to O'Brien Creek*	15UM065	2.01	WWg	--	--	IF	--	--	--	IF	IF		IF	--	--
07010103-590 ***Pickerel Creek*** *Headwaters to Swan Lake*	15UM066 15UM067	2.39	CWg	EXS	EXS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-753 ***Swan River*** *Swan Lake to Trout Creek*	10EM194 15UM071 S000-936	18.97	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS		IF	SUP	IMP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 19. Lake assessments: Upper Swan River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Unnamed	31-0018-00	12	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Nameless	31-0019-00	35	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Hart	31-0020-00	320	55	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Twin (East Bay)	31-0026-01	94	36	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Twin (West Bay)	31-0026-02	53	14	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
O'Brien (north portion)	31-0032-01	348	63	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	- -	IF	FS
Unnamed	31-0035-00	221	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Moose	31-0036-00	26	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Hay	31-0037-00	25	Unknown	Deep Lake	NLF	- -	- -	IF	- -	IF	- -	IF	IF	IF
Swan (West Bay)	31-0067-01	336	20	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Swan (Main Basin)	31-0067-02	2109	66	Deep Lake	NLF	I	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Unnamed	31-0087-00	28	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	IF	IF
Unnamed	31-0091-00	11	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Ox Hide	31-0106-00	118	35	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS

Snowball	31-0108-00	139	38	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Upper Panasa	31-0111-00	148	13	Deep Lake	NLF	- -	IF	MTS	- -	IF	EX	EX	IF	IF
Lower Panasa	31-0112-00	249	25	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Bass	31-0115-00	87	17	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
North Twin	31-0190-00	225	41	Deep Lake	NLF	I	- -	MTS	- -	MTS	MTS	MTS	IF	FS
South Twin	31-0191-00	149	40	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Big Diamond	31-0223-00	133	31	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF
Holman	31-0227-00	145	60	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: I = increasing/improving trend; -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data; **IF** = Insufficient Information; **FS** = Full Support (Meets Criteria)
Key for Cell Shading: (green) = full support of designated use; (yellow) = insufficient information.

Summary

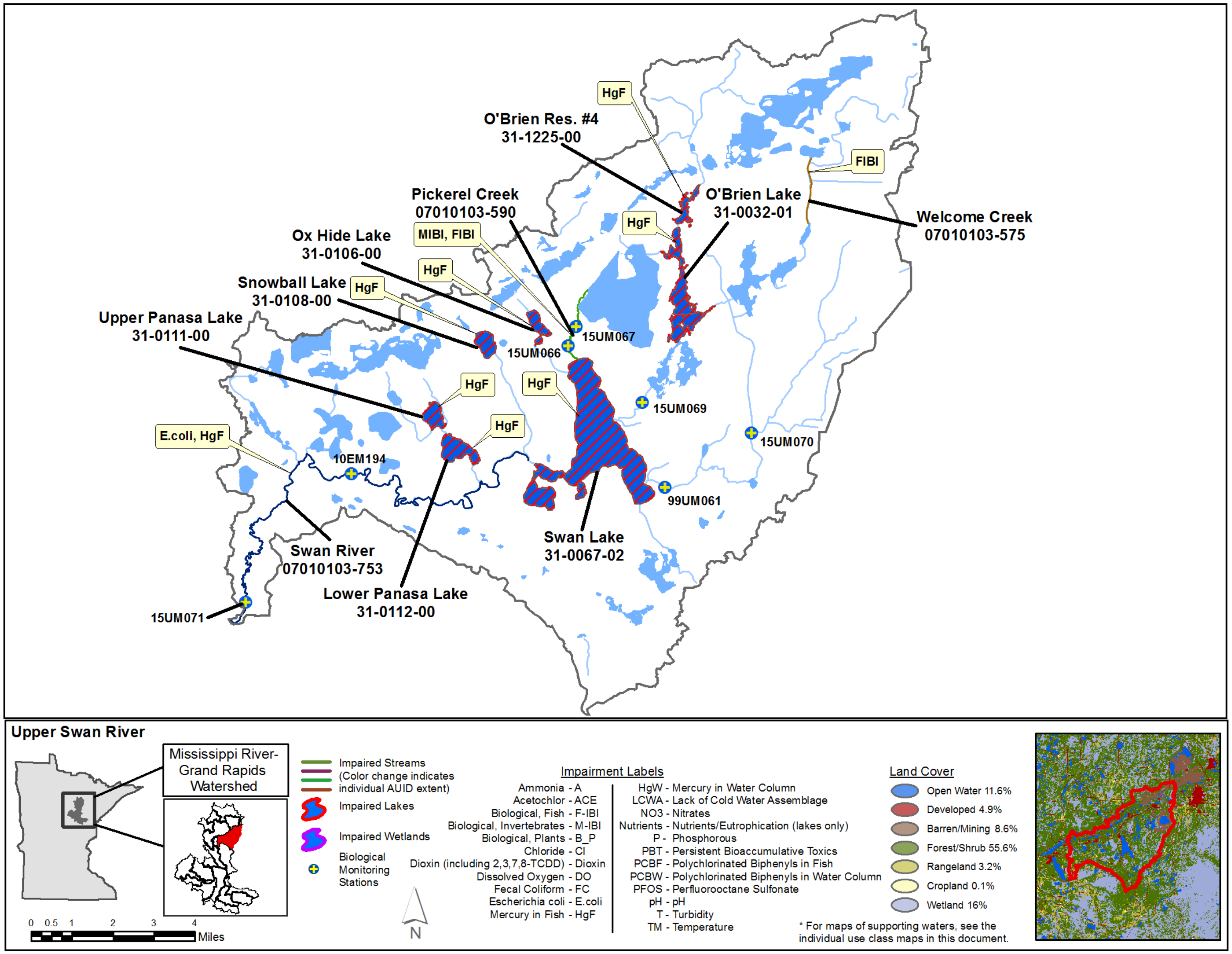
Aquatic life parameters for lakes and streams within the Upper Swan River Subwatershed generally reflect good water quality conditions (Table 18). The Swan River (outlet of Swan Lake to Trout Creek; -753) contains a diverse biological community, however occasional elevations in nutrients and sediment were observed over the course of this IWM effort. During July of 2015 and 2016, four bacteria samples exceeded the chronic standard (100 MPN/100mL), which suggests that even though bacteria are not likely problematic for occasional bodily contact, frequent interaction with the river potentially poses an elevated risk to human health. The Swan River (from the outlet of Swan Lake to the outlet of the subwatershed) does not support recreational uses, and was added to the 303(d) Impaired Waters List.

Pickerel Creek (-590) is a designated trout stream on the outskirts of Pengilly, and has been managed by the DNR since the initial brook trout stocking in 1948. Brook trout fingerlings were stocked 11 out of 13 years from 1948-1960, and have been regularly stocked since 1988. Habitat, FIBI, and MIBI scores were poor at two monitoring stations on Pickerel Creek and resulted in an impairment for aquatic life. This watershed drains the Essar Steel (taconite mine) tailings basin. Prior to the Butler taconite mine (now Essar steel) using this area, this was a natural stream flowing through a number of wetland habitats. On average, water temperatures at the upstream station are stressful to brook trout approximately 46% of the time during summer months, compared to 14% at the downstream location. It is difficult to rule out the potential effects of land use changes on water temperature in the upstream watershed of Pickerel Creek. The presence of springs below 15UM067 likely aid in lowering temperatures at 15UM066.

Eleven lakes fully support aquatic recreation (Table 19). Swan and Twin lakes both have improving trends in water clarity. Upper Panasa Lake meets the phosphorus standard, but algal blooms occur more frequently on the lake than expected. This lake is vulnerable to impairment from additional inputs of phosphorus and should be a priority for protection efforts.

The DNR conducted Fish IBI surveys on Twin, Swan, and Snowball lakes and all three fully support aquatic life. Swan Lake has an exceptional fish community, and DNR has identified the lake as a resource of biological significance. A Score the Shore survey of shoreline development (2016) determined that Swan Lake scores slightly below the statewide average, but still in the 'moderately' developed range. This shoreline score, combined with the exceptional rating for fish, suggests that any future development in or around the lake's watershed should incorporate protection strategies to maintain the high integrity of the fish community.

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Upper Swan River Aggregated 12-HUC.



Prairie River Aggregated 12-HUC HUC 0701010305-01

The Prairie River Subwatershed drains 111 square miles of Aitkin (49.2%), St. Louis (29.8%), and Carlton (21.0%) counties and is the ninth largest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters begin in a forested wetland and continues 17 miles to the northwest through Hasty Brook (-606 & -603) before contributing its waters to Prairie Lake (69-0848-00). The Prairie River (-516) begins at the outlet of Prairie Lake and continues 25 miles to the west before receiving additional flow from the Tamarack River Subwatershed. It continues for an additional 10.6 miles before exiting this subwatershed at Big Sandy Lake (01-0062-00). This subwatershed is a part of the larger Sandy River drainage system (409.1 mi^2), which is the third largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 25 lakes greater than 10 acres in size, with the most prominent being Prairie, Wakefield, and Cutaway. This subwatershed is dominated by wetland (47.1%), forest (42.7%), and open water (4.8%). Only 3.0% is rangeland, 2.3% is developed, 0.1% is row-crop agriculture, and there is a small amount of barren/mining (<0.1%). A large portion (70.8%) of this subwatershed lies within the Savanna Portage State Park, Savana State Forest, and the Fond Du Lac State Forest. Intensive water chemistry sampling was conducted at the outlet of the subwatershed upstream of 145th Place, in Balsam on the Prairie River. The outlet is represented by water chemistry station S002-446 and biological station 00UM020.

Table 20. Aquatic life and recreation assessments on stream reaches: Prairie River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07010103-514 ***West Savanna River*** *Headwaters (Little Red Horse Lake 01-0052-00) to Prairie River*	00UM021 15UM016	14.45	WWg	MTS	MTS	MTS	MTS	MTS	- -	MTS	MTS		MTS	SUP	- -
07010103-603 ***Hasty Brook*** *Unnamed Ditch to Prairie Lake*	09UM088	6.75	WWg	MTS	MTS	MTS	MTS	MTS	- -	MTS	MTS		IF	SUP	IMP
07010103-516 ***Prairie River*** *Prairie Lake Tamarack River*	15EM039 15UM014	25	WWg	MTS	MTS	MTS	MTS	MTS	- -	MTS	IF		MTS	SUP	SUP
07010103-515 ***Prairie River*** *Tamarack River to West Savanna River*	00UM020 S002-446	8.46	WWg	MTS	- -	MTS	MTS	MTS	MTS	MTS	MTS		IF	SUP	SUP
07010103-522 ***Prairie River*** *West Savanna River to Sandy Lake*	- -	2.1	WWg	- -	- -	IF	- -	IF	- -	IF	- -		IF	IF	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional,
LRVW = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 21. Lake assessments: Prairie River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Savanna	01-0014-00	92	23	Deep Lake	NLF	- -	- -	- -	- -	EX	EX	EX	IF	NS
Shumway	01-0015-00	70	23	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Rat House	01-0053-00	103	3	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	- -	- -	IF
Prairie	69-0848-00	795	45	Deep Lake	NLF	I	- -	MTS	- -	IF	EX	EX	IF	IF

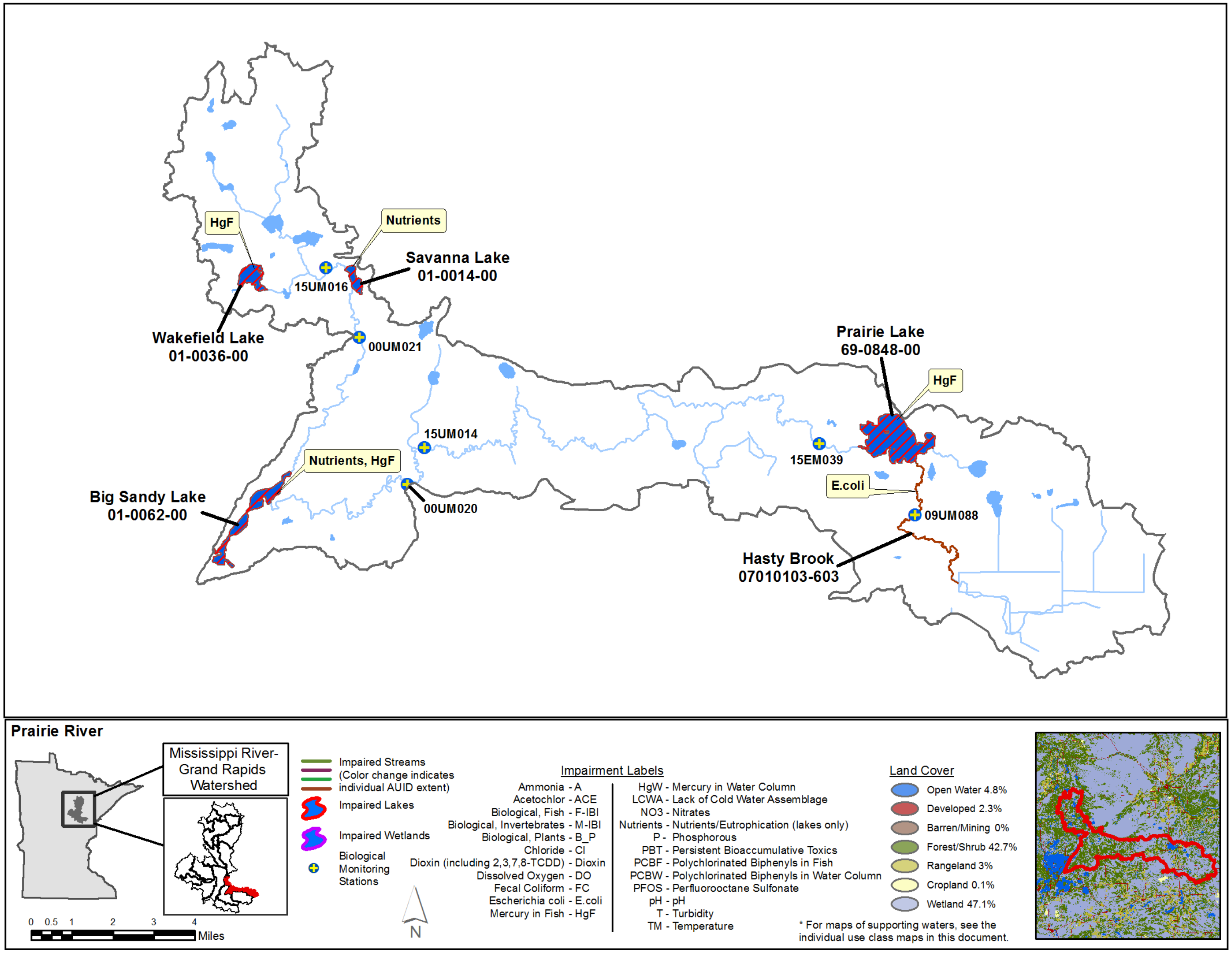
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: I = increasing/improving trend; -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = new impairment; = full support of designated use; = insufficient information.

Summary

Aquatic life for streams in the Prairie River Subwatershed (0701010305-01) generally reflect good water quality (Table 20). Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are good and sediment concentrations are low. Elevated nutrients concentration were observed throughout the subwatershed, however, excess nutrients do not appear to be stressing the aquatic communities at this time. Hasty Brook was classified as a designated trout stream by the DNR in 1961, when brook trout were stocked for the first time. Since then, brook trout (yearlings) were stocked one other time, in 1963. The DNR is proposing to remove Hasty Brook from the designated trout waters inventory. MPCA data (water temperature and biological communities) collected as part of this IWM effort corroborate that decision. Bacteria concentrations in Hasty Brook (-603) are persistently elevated, indicating risk of illness from bodily contact; as such this stream does not support aquatic recreation. The two main sections of the Prairie River fully support aquatic recreation. Strategies to reduce bacteria levels in the upstream portions of the Tamarack River will help protect the downstream portion of the Prairie River.

Shumway Lake easily supports recreational activities (Table 21). Prairie Lake, a prominent lake in the watershed, has elevated levels of algae; however, phosphorus meets the standard and there is an improving trend in water clarity on the lake. This lake is vulnerable to future impairment. Work to reduce inputs of phosphorus to the lake will be key to protecting the resource. Savanna Lake does not support aquatic recreation based on low clarity and the presence of excess algae; however, Savanna Lake is considered to be impaired due to natural causes and will require a site specific standard.

Figure 36. Currently listed impaired waters by parameter and land use characteristics in the Prairie River Aggregated 12-HUC.



Tamarack River Aggregated 12-HUC HUC 0701010305-02

The Tamarack River Subwatershed drains 103 square miles of Aitkin (30.6%), St. Louis (1.1%), and Carlton (68.3%) counties and is the ninth smallest subwatershed within the Mississippi River-Grand Rapids Watershed. Various named (e.g. Little Tamarack River) and unnamed streams exist within this subwatershed that connect and feed the numerous streams and lakes. The most significant tributary within this subwatershed is the Tamarack River, which starts at the outlet of Flower Lake (09-0064-00) and flows 26 miles northwesterly before entering the Prairie River (-515). This subwatershed is a part of the larger Sandy River drainage system (409 mi^2), which is the third largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 9 lakes greater than 10 acres in size (most in the Cromwell area), with the most prominent being Island, Eagle, and Tamarack lakes. This subwatershed is dominated by wetland (53.5%), forest (31.0%), and rangeland (8.9%). Only 3.1% is developed, 2.6% is open water, 0.8% is row-crop agriculture, and 0.1% is barren/mining. A portion (30.0%) of this subwatershed lies within the Savanna State Forest Water chemistry sampling was conducted at the outlet of the subwatershed (upstream of CR 64), 5.5 miles north of Tamarack on the Tamarack River. The outlet is represented by water chemistry station S008-441 and biological station 15UM012.

Table 22. Aquatic life and recreation assessments on stream reaches: Tamarack River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:										**Aquatic Life**	**Aquatic Rec. (Bacteria)**
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication		
07010103-699 ***Unnamed Creek*** *Eagle Lake (09-0057-00) to Island Lake (09-0060-02)*	--	1.25	WWg	--	--	IF	--	IF	--	IF	--	--	IF	IF	--
07010103-701 ***Unnamed Creek*** *Lower Island Lake (09-0060-02) to Upper Island Lake (09-0060-01)*	--	0.04	WWg	--	--	NA	--	NA	--	NA	--	--	NA	NA	--
07010103-703 ***Unnamed Ditch*** *Cross Lake (09-0062-00) to Upper Island Lake (09-0060-01)*	--	2.95	WWg	--	--	NA	--	NA	--	NA	--	--	NA	NA	--
07010103-734 ***Little Tamarack River*** *Unnamed Creek to Tamarack River*	15UM009	4.03	WWg	MTS	MTS	IF	IF	IF	- -	IF	- -	MTS	IF	SUP	- -
07010103-735 ***Unnamed Creek*** *Unnamed Creek to Tamarack River*	15UM010	3.5	WWg	IF	MTS	IF	IF	IF	- -	IF	IF	IF	IF	SUP	- -
07010103-757 ***Tamarack River*** *Headwaters (Flower Lake 09-0064-00) to Little Tamarack River*	15UM007 15UM008	18.3	WWg	MTS	MTS	NA	IF	IF	- -	MTS	MTS	MTS	MTS	SUP	- -
07010103-758 ***Tamarack River*** *Little Tamarack River to Prairie River*	15UM012 S008-441	7.52	WWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	SUP	IMP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 23. Lake assessments: Tamarack River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Eagle	09-0057-00	379	42	Deep Lake	NLF	- -	- -	- -	- -	IF	EX	MTS	IF	NS
Upper (North) Island	09-0060-01	105	25	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	EX	IF	NS
Lower (South) Island	09-0060-02	290	22	Deep Lake	NLF	D	EX	- -	- -	IF	IF	EX	NS	NS
Cross	09-0062-00	105	23	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	EX	IF	IF
Woodbury	09-0063-00	64	24	Deep Lake	NLF	D	- -	- -	- -	IF	IF	EX	IF	IF
Long	09-0066-00	17	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	EX	IF	IF
Tamarack	09-0067-00	234	48	Deep Lake	NLF	I	- -	- -	- -	IF	IF	EX	IF	NS

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle ☐ = new impairment ☐ = insufficient information.

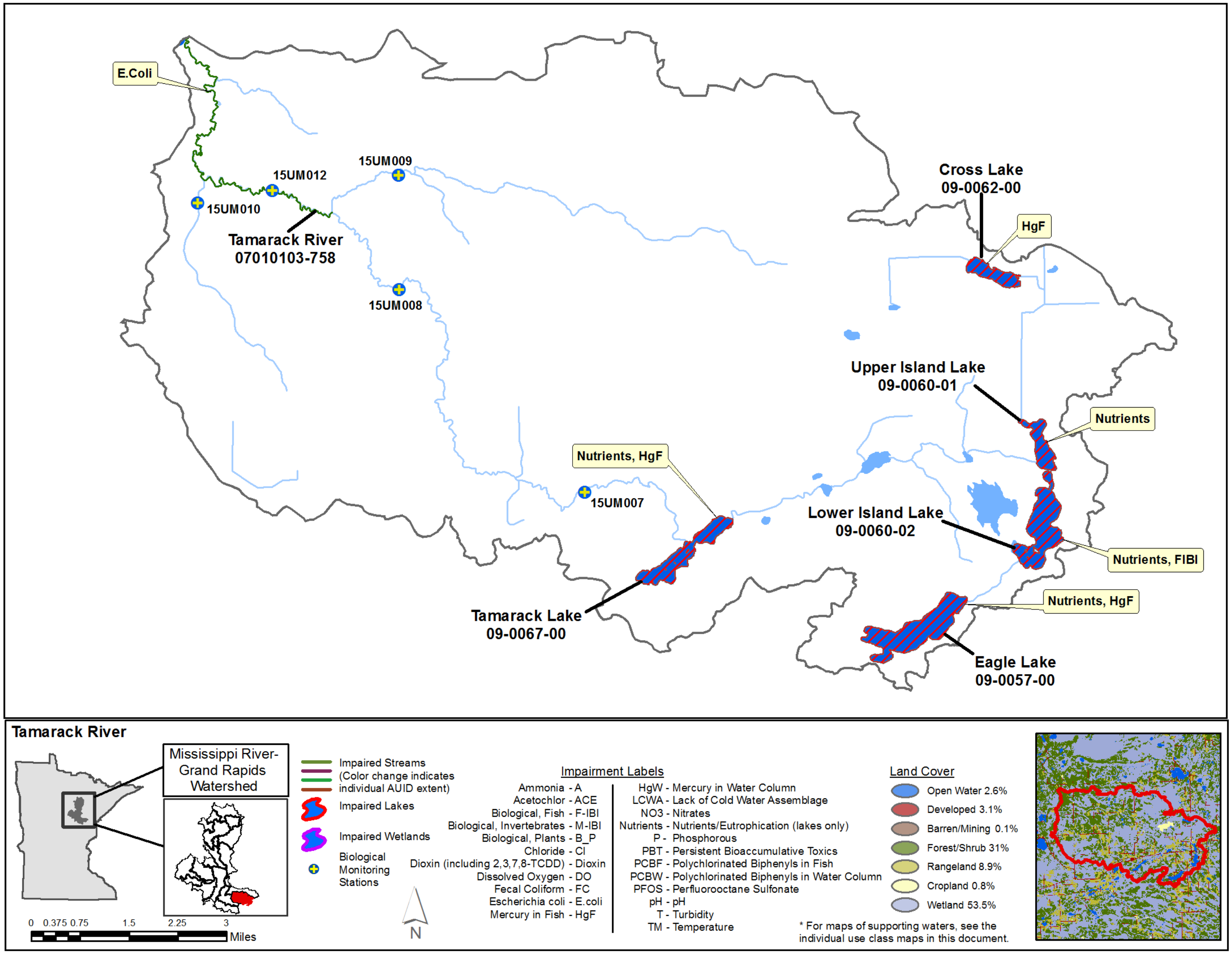
Summary

Aquatic life indicators for streams and rivers of the Tamarack River subwatershed (0701010305-02) generally reflect excellent water quality. FIBI and MIBI scores are high, and streams are characterized by low levels of sediment. One stream (Tamarack River; from the Little Tamarack River to Prairie River) meets Exceptional Use biocriteria based on FIBI and MIBI scores. Although the biology is Exceptional, nutrients concentrations are slightly elevated, and high bacteria concentrations warrant an aquatic recreation impairment. Elevated levels of nutrients and bacteria appear to be localized to the lower portions of the Tamarack River, as conditions greatly improve below the confluence with the Prairie River. Strategies to reduce anthropogenic inputs of nutrients and bacteria should be developed for this stretch of the Tamarack River.

Lakes in this watershed are of moderate size and generally shallow. Eagle, North and South Island, and Tamarack lakes all have existing impairments for elevated phosphorus and algae concentrations. These lakes continue to have phosphorus concentrations at or near the standard and algae concentrations just above the standard. Carlton County officials noted that Eagle Lake still turns very green during the later summer months. Shoreline-development permit violations are known to occur on the lake. Lower (South) Island Lake is downstream of Eagle Lake and has a declining trend in Secchi transparency. Tamarack Lake has an improving trend in water clarity; work to reduce inputs of phosphorus here and in the upstream lakes will lead to improved conditions.

The DNR conducted a Fish IBI survey on Lower (South) Island Lake near Cromwell, Minnesota. The lake scored poorly for overall species richness, but gill netting did capture a pollution intolerant species, Rock Bass. A Score the Shore survey (2016) indicated that shoreline development is moderate and better than the statewide average. Based on the low fish IBI score, DNR determined this lake does not support aquatic life and is now a part of the 303(d) Impaired Waters List (Table 23).

Figure 37. Currently listed impaired waters by parameter and land use characteristics in the Tamarack River Aggregated 12-HUC.



Big Sandy Lake Outlet Aggregated 12-HUC HUC 0701010306-01

The Big Sandy Lake Outlet Subwatershed drains 101 square miles of Aitkin (98.7%) and Carlton (1.3%) counties and is the eighth smallest subwatershed within the Mississippi River-Grand Rapids Watershed. Various unnamed streams exist within the drainage that connect and feed the many lakes. Two major inlets (Sandy River and Prairie River) enter this subwatershed and eventually contribute their waters to Big Sandy Lake (01-0062-00). The largest tributary stream within this subwatershed is Minnewawa Creek. This subwatershed is a part of the larger Sandy River drainage system (409 mi^2), which is the third largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 34 lakes greater than 10 acres in size, with the most prominent being Big Sandy, Minnewawa, Rat, and Aitkin lakes. This subwatershed is dominated by wetland (39.9%), forest (31.7%), and open water (20.4%). Only 4.0% is rangeland, 3.9% is developed, 0.1% is row-crop agriculture, and there is very little barren/mining (<0.1%). Portions of Savanna Portage State Park, Savanna State Forest, Grayling Marsh WMA, and the Sandy Lake Reservoir Wildlife Management Area (WMA) lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed at the Highway 65 crossing, 5 miles north of McGregor, Minnesota on Minnewawa Creek. The outlet is represented by water chemistry station S002-442 and biological station 07UM082.

Table 24. Aquatic life and recreation assessments on stream reaches: Big Sandy Lake Outlet Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-518 ***Minnewawa Creek*** *Unnamed Ditch to Lake Minnewawa Outlet Creek*	15UM004	3.82	WWm	EXS	EXS	IF	IF	IF	- -	IF	MTS		IF	IMP	- -
07010103-519 ***Minnewawa Creek*** *Lake Minnewawa Outlet Creek to Sandy River (Flowage Lake)*	07UM082 S002-442	2.38	WWg	EXS	MTS	EXS	MTS	MTS	MTS	IF	MTS		IF	IMP	SUP
07010103-520 ***Unnamed Creek*** *Lake Minnewawa Outlet to Minnewawa Creek*	--	0.51	WWg	--	--	NA	NA	NA	--	NA	--	--	NA	NA	--
07010103-556 ***Unnamed Ditch*** *Unnamed Ditch to Unnamed Ditch*	--	1	WWg	--	--	--	--	--	--	--	--	--	--	IF	--
07010103-613 ***Unnamed Creek*** *Headwaters to Horseshoe Lake*	--	2.48	WWg	--	--	NA	NA	NA	--	NA	--	--	NA	NA	--

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 25. Lake assessments: Big Sandy Lake Outlet Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators: Fish IBI	Aquatic Life Indicators: Chloride	Aquatic Life Indicators: Pesticides ***	Aquatic Recreation Indicators: Total Phosphorus	Aquatic Recreation Indicators: Chlorophyll-a	Aquatic Recreation Indicators: Secchi	Aquatic Life Use	Aquatic Recreation Use
Island	01-0022-00	254	25	Deep Lake	NLF	D	- -	- -	- -	MTS	MTS	EX	IF	FS
Round	01-0023-00	548	27	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Loon	01-0024-00	33	21	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	IF	FS
Minnewawa	01-0033-00	2306	21	Deep Lake	NLF	I	MTS	MTS	- -	EX	EX	EX	FS	NS
Horseshoe	01-0034-00	232	12	Deep Lake	NLF	D	MTS	MTS	- -	EX	EX	EX	FS	NS
Mud	01-0035-00	52	Unknown	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF
Remote	01-0038-00	124	24	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Aitkin	01-0040-00	734	15	Deep Lake	NLF	- -	MTS	- -	- -	- -	- -	- -	FS	- -
Glacier	01-0042-00	127	60	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	MTS	IF	FS
Sandy River	01-0060-00	332	7	Deep Lake	NLF	- -	- -	- -	- -	NA	NA	NA	IF	NA
Big Sandy	01-0062-00	6336	84	Deep Lake	NLF	D	MTS	MTS	- -	EX	EX	EX	FS	NS
Bass	01-0063-00	90	42	Deep Lake	NLF	- -	- -	- -	- -	MTS	EX	EX	- -	IF
Rat	01-0077-00	422	21	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	EX	EX	FS	IF
Cole	09-0068-00	140	24	Deep Lake	NLF	D	- -	- -	- -	MTS	MTS	MTS	IF	FS

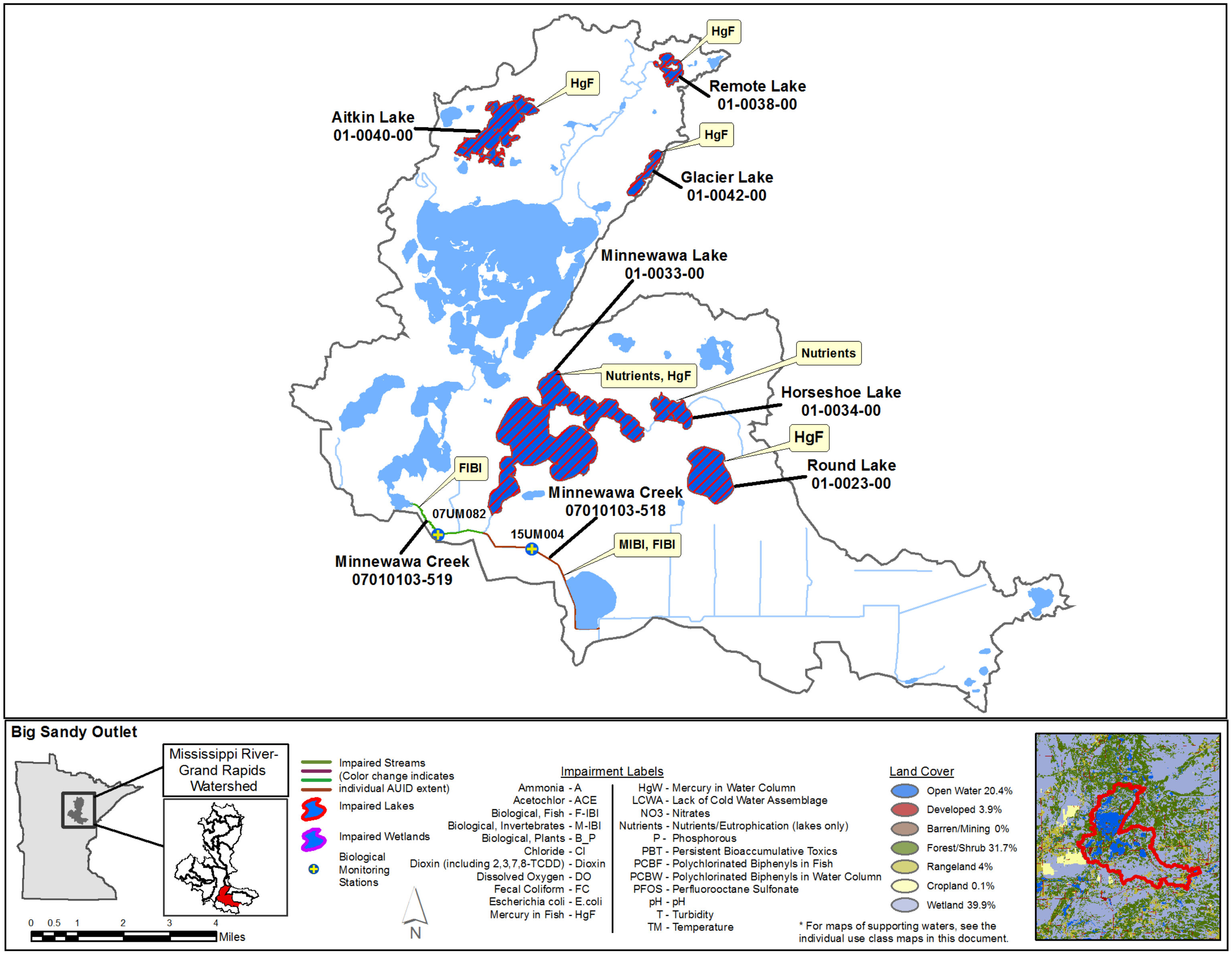
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: D = decreasing/declining trend; I = increasing/improving trend; -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data; **NA** = Not Assessed; **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria); **NS** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: [pink] = existing impairment, listed prior to 2014 reporting cycle; [green] = full support of designated use; [yellow] = insufficient information.

Summary

Aquatic life indicators for streams of the Big Sandy Lake Outlet Subwatershed (0701010306-01) are generally poor (Table 24). Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are low, both communities are dominated by taxa tolerant of low dissolved oxygen. Two stretches of Minnewawa Creek were monitored during the IWM effort; both represent highly altered (i.e. channelized) streams with limited instream habitats, low dissolved oxygen and soft sediments. The upstream portion of Minnewawa Creek is designated as Modified Use based on poor biology and habitat quality. Water levels throughout Minnewawa Creek appear to influence the amount of emergent vegetation growth within the stream channel. Extensive aquatic vegetation may inhibit dissolved oxygen conditions during the peak of summer, which may result in poor fish and macroinvertebrate communities. Shutting off flow from some of the upstream reaches (e.g. Grayling WMA) may help maintain water levels and result in improved dissolved oxygen and biological communities.

Lakes in this subwatershed exhibit mixed results; new data from Big Sandy, Minnewawa, and Horseshoe lakes confirm existing impairments. TMDL strategies have been developed for Minnewawa and Big Sandy lakes. Efforts to address excessive nutrients in Horseshoe Lake will help to improve conditions downstream in Minnewawa Lake, which happens to have an improving transparency trend. Rat and Bass lakes are close to becoming impaired for nutrients as phosphorous and Chl-a concentrations are near standards. Declining transparency trends were noted in a number of lakes in this subwatershed, and strategies to reduce additional inputs of phosphorous will benefit recreational uses on the lakes. The fish communities generally perform well in this subwatershed.

Figure 38. Currently listed impaired waters by parameter and land use characteristics in the Big Sandy Lake Outlet Aggregated 12-HUC.



Sandy River Aggregated 12-HUC HUC 0701010306-02

The Sandy River Subwatershed drains 95 square miles of Aitkin (99.8%) and Carlton (0.2%) counties and is the sixth smallest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of the Sandy River begin in a forested wetland and flow 23 miles to the west before exiting this subwatershed. Several unnamed tributary streams contribute their flow to the Sandy River. This subwatershed is a part of the larger Sandy River drainage system (409 mi2), which is the third largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 18 lakes greater than 10 acres in size, with the most prominent being Rock, Rice, and Round lakes. This subwatershed is dominated by wetland (54.4%), forest (28.1%), and rangeland (7.7%). Only 4.1% is row-crop agriculture, 2.9% is open water, 2.8% is developed, and there is little barren/mining (<0.1%). Portions of the Savanna State Forest, Kimberly Marsh WMA, Grayling Marsh WMA, McGregor WMA, Lawler WMA, Salo Marsh WMA, and McGregor Marsh SNA lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed (upstream of CR 62), 3-miles northeast of McGregor, on the Sandy River. The outlet is represented by water chemistry station S003-306 and biological station 15UM022.

Table 26. Aquatic life and recreation assessments on stream reaches: Sandy River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07010103-604 ***County Ditch 42*** *Headwaters to Sandy River*	- -	3.76	LRVW	- --	- -	MTS	- -	- -	- -	MTS	- -		NA	- -	- -
07010103-512 ***Sandy River*** *Headwaters to Big Sandy Lake*	15UM001 15UM022 16UM064 S003-306	27.81	WWg	EXS	EXS	EXS	MTS	EXS	MTS	MTS	MTS		IF	IMP	SUP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 27. Lake assessments: Sandy River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators: Fish IBI	Aquatic Life Indicators: Chloride	Aquatic Life Indicators: Pesticides ***	Aquatic Recreation Indicators: Total Phosphorus	Aquatic Recreation Indicators: Chlorophyll-a	Aquatic Recreation Indicators: Secchi	Aquatic Life Use	Aquatic Recreation Use
Rice	01-0005-00	78	Unknown	Wetland	NLF	- -	- -	- -	- -	NA	NA	- -	- -	NA
Douglas	01-0009-00	73	39	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF
Round	01-0070-00	179	52	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Davis (Main Bay)	01-0071-01	79	32	Deep Lake	NLF	- -	- -	- -	- -	NA	NA	NA	IF	NA
Steamboat	01-0071-02	51	21	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF
Rock	01-0072-00	334	13	Deep Lake	NLF	- -	- -	MTS	- -	MTS	EX	EX	IF	IF
Townline	01-0083-00	66	40	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	IF	IF

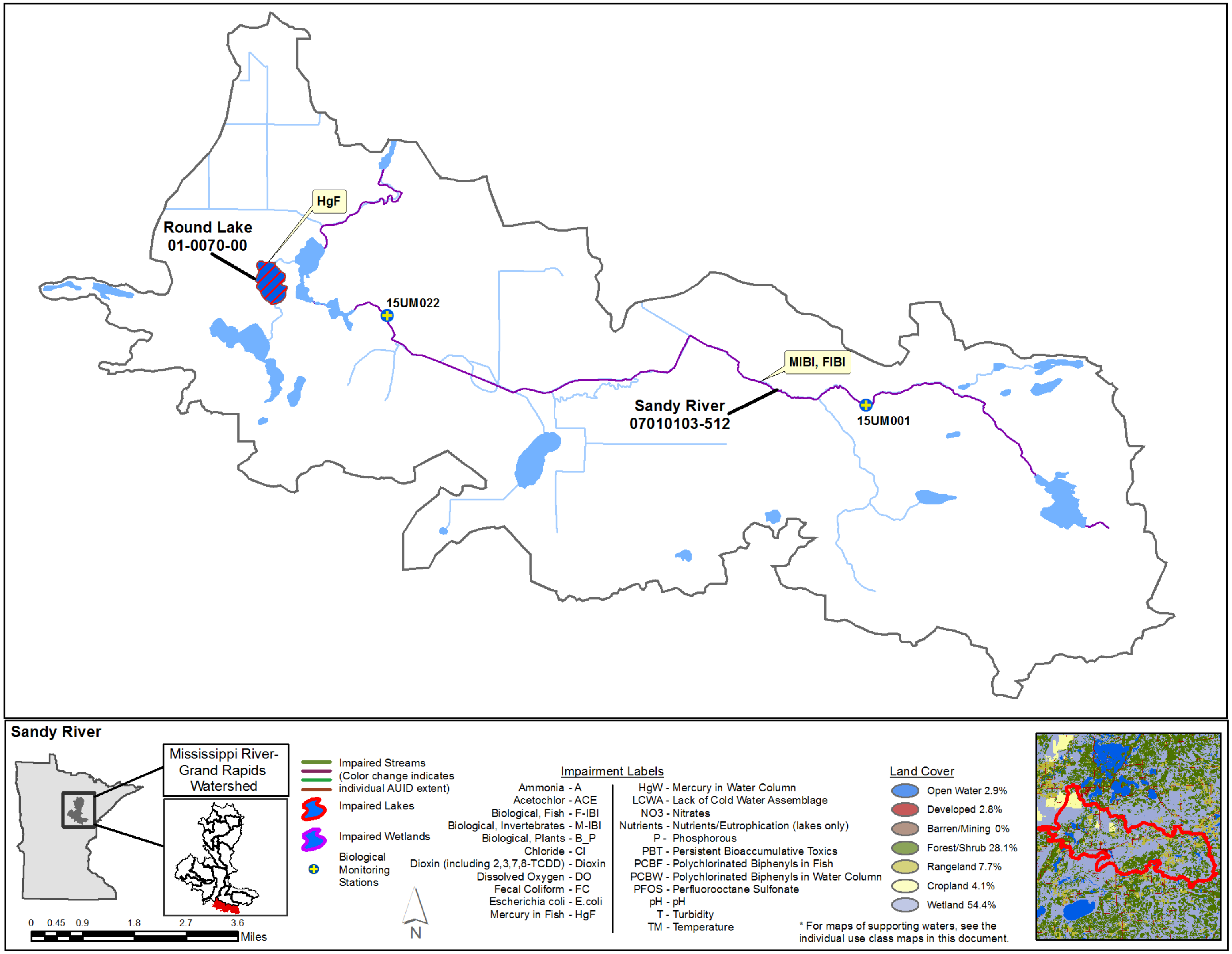
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading: ▭ = full support of designated use; ▭ = insufficient information.

Summary

Aquatic life indicators from the Sandy River in the Sandy River Subwatershed (070101306-02) indicate poor water quality conditions. FIBI and MIBI scores are low. Biological communities are characterized by species tolerant of low dissolved oxygen and homogenous habitats. Habitat conditions along the Sandy River are poor, representative of the highly altered nature of this stream. Dissolved oxygen data at multiple stations show numerous exceedances of the aquatic life standard; however, these data were not assessed because of the potential for wetland influence. Elevated phosphorus concentrations are present in the stream, and may be affecting the aquatic communities.

The MPCA collected water quality samples from Round Lake in 2015 and 2016. The data meet recreation standards for the Northern Lakes and Forests Ecoregion; however, both chl-a and Secchi are very near their respective standards. Work to protect Round Lake from additional inputs of phosphorus is important. Davis and Steamboat lakes are showing elevated phosphorus and algae concentrations. Rock Lake is considered vulnerable to future impairment; phosphorus concentrations are approaching the standard, which promotes excess algae growth and reduced clarity in the lake.

Figure 39. Currently listed impaired waters by parameter and land use characteristics in the Sandy River Aggregated 12-HUC.



Hill River Aggregated 12-HUC HUC 0701010307-01

The Hill River Subwatershed drains 146 square miles of Aitkin (77.1%), Cass (0.3%), and Itasca (22.6%) counties and is the seventh largest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of this subwatershed begins in a forested wetland and flows 13 miles to the southeast (through Morrison Brook) before entering Hill Lake (01-0142-00). The Hill River begins at Hill Lake and flows 16 miles before exiting this subwatershed. Several unnamed tributaries, the Little Hill River, and the two abandoned channels of the Willow and Moose Rivers contribute their waters to the Hill River. Numerous tributary streams and the majority of the Hill River have been channelized. This subwatershed is a part of the larger Willow River drainage system (516 mi^2), which is the largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 21 lakes greater than 10 acres in size, with the most prominent being Hill, Moose River Pool, and Washburn. This subwatershed is dominated by forest (48.8%), wetland (43.2%), and rangeland (3.8%). Only 2.4% is developed, 1.7% is open water, 0.1% is row-crop agriculture, and there is no barren/mining (<0.1%). Portions of the Chippewa National Forest, Hill River State Forest, Savanna State Forest, Moose-Willow WMA, Hill Lake WMA, and Little Hill River WMA lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed (adjacent to 640th Lane) on the Hill River. The outlet is represented by water chemistry station S008-440 and biological station 15UM041.

Table 28. Aquatic life and recreation assessments on stream reaches: Hill River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry** **Station ID**	**Reach Length (miles)**	**Use Class**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-761 ***Morrison Brook*** *Unnamed Creek to Unnamed Creek*	15UM045 16UM170	3.59	CWg	MTS	MTS	IF	IF	MTS	- -	IF	IF		IF	FS	- -
07010103-762 ***Morrison Brook*** *Unnamed Creek to T52 R26W S14, south line*	09UM087	2.80	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	FS	- -
07010103-586 ***Morrison Brook*** *T52 R26W S23, north line to Hill Lake*	- -	0.84	WWg	- -	- -	- -	- -	MTS	- -	- -	- -		- -	IF	- -
07010103-738 ***Little Hill River*** *Unnamed Creek to Hill River*	15UM040	9.22	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	FS	- -
07010103-739 ***Unnamed Ditch*** *Headwaters to Hill River*	15UM044	3.85	WWg	EXS	MTS	IF	IF	IF	- -	IF	IF		IF	NS	- -
07010103-526 ***Hill River*** *Headwaters (Hill Lk 01-0142-02) to Willow R Flowage*	15UM041 15UM042 15UM105 16UM150 S008-440	8.64	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS		IF	FS	FS

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 29. Lake assessments: Hill River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Langs	01-0108-00	29	Unknown	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	IF	IF
Washburn	01-0111-00	62	22	Deep Lake	NLF	- -	- -	- -	- -	MTS	MTS	EX	IF	FS
Hill (North Basin)	01-0142-01	673	48	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Hill (South Basin)	01-0142-02	107	15	Deep Lake	NLF	- -	- -	IF	IF	EX	IF	MTS	IF	IF

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading: = full support of designated use; = insufficient information.

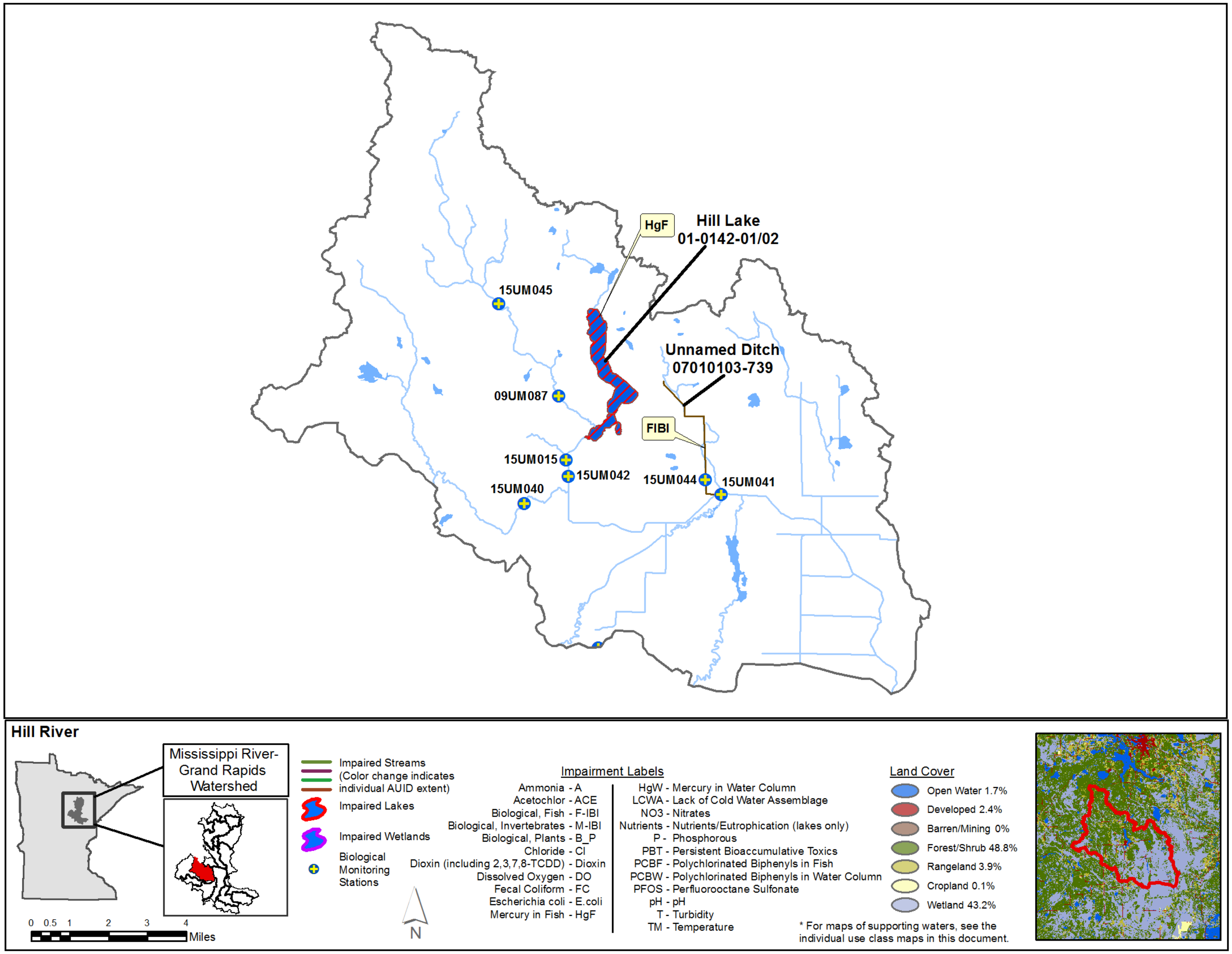
Summary

Aquatic life and recreation parameters for lakes, streams, and rivers within the Hill River Subwatershed (0701010307-01) generally reflect good-to-excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are generally high. DNR notes that Morrison Brook is one of the most productive trout streams in the Grand Rapids area; however, the lower portions (-762) of this stream were assessed using warmwater criteria based on water temperature information and biological communities collected over several years. Surveys conducted by the MPCA (2009, 2015, and 2016) and DNR (2009) within this lower section have yielded very few coldwater taxa, and water temperatures measured continuously over the course of three summers (2014-2016) indicated temperatures are stressful to brook trout. However, the DNR will maintain the coldwater designation on the lower portion (western boundary of T52 R26W S10 to Hill Lake) to protect wintering areas for brook trout. An unnamed ditch to the Hill River (-739; headwaters to Hill River) was determined to be impaired for aquatic life based on FIBI results. This highly altered reach has numerous beaver dams, poor instream habitat (dominant substrate is highly mobile sand) and is likely a residual channel created to move timber to the Mississippi River given the connections with the Hill and Willow river channels.

The Hill River has elevated nutrients, occasional exceedances of the dissolved oxygen standard and low concentrations of sediment. Wetlands are present in the lower reaches of the stream and likely contribute to the low oxygen and elevated nutrient concentrations, especially for samples collected during flooding in July 2016. Low levels of bacteria on the Hill River indicate support for aquatic recreation.

Washburn Lake and both basins of Hill Lake were assessed for aquatic recreation. Washburn Lake and the north-basin of Hill Lake both fully support aquatic recreation. The south basin of Hill Lake has elevated phosphorus and algae, but good clarity (Table 29). The south basin is smaller and shallower than the north basin; as a result it also has a lower capacity to process and store nutrients. Hill Lake is a Sentinel Lake, which has a long record of data collected by MPCA, DNR, and volunteers. More information can be found at https://www.pca.state.mn.us/water/sentinel-lakes.

Figure 40. Currently listed impaired waters by parameter and land use characteristics in the Hill River Aggregated 12-HUC.



Lower Willow River Aggregated 12-HUC HUC 0701010308-01

The Lower Willow River Subwatershed drains 120 square miles of Aitkin County and is the eighth largest subwatershed within the Mississippi River-Grand Rapids Watershed. This subwatershed begins at the confluence of the Moose-Willow River Ditch and the Hill River Ditch (Willow River). The Willow River continues to flow 38 miles southwest to the Mississippi River. Several unnamed ditches and White Elk Creek contribute water to the Willow River. This subwatershed is a part of the larger Willow River drainage system (516 mi^2), which is the largest river drainage in the Mississippi River-Grand Rapids Watershed. There are five lakes greater than 10 acres in size, with the most noticeable being White Elk, Mud, and Red lakes. This subwatershed is dominated by wetland (63.4%), forest (27.4%), and rangeland (5.3%). Only 1.7 % is open water, 1.7% is developed, 0.4% is row-crop agriculture, and there is little barren/mining (<0.1%). Portions of the Hill River State Forest, Waukenabo State Forest, Roberts-Wickstrom WMA, and Willowsippi WMA lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed upstream of CR 3 (480th Street), 3 miles W of Palisade on the Willow River. The outlet is represented by water chemistry station S008-442 and biological station 10EM200.

Table 30. Aquatic life and recreation assessments on stream reaches: Lower Willow River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry** **Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-572 ***Unnamed Ditch*** *Unnamed Ditch to Unnamed Ditch*	15UM029	4.26	WWg	- -	- -	IF	IF	IF	- -	IF	IF		IF	IF	- -
07010103-742 ***Unnamed Ditch*** *Unnamed Ditch to Willow River*	15UM028	5.68	WWg	- -	- -	IF	IF	IF	- -	IF	IF		IF	IF	- -
07010103-697 ***Unnamed Ditch*** *Unnamed Ditch to Unnamed Ditch*	10EM189	1.28	WWg	- -	- -	IF	IF	IF	- -	IF	IF	MTS	IF	IF	- -
07010103-627 ***Unnamed Ditch*** *Unnamed Ditch to Willow River*	15UM023	1.35	WWg	- -	- -	IF	IF	IF	- -	IF	IF		IF	IF	- -
07010103-741 ***White Elk Creek*** *Unnamed Ditch to Willow River*	15UM026	8.39	WWg	EXS	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-748 ***Willow River*** *Moose-Willow River Ditch to Mississippi River*	10EM200 15UM025	37.88	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	IF	SUP	SUP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 31. Lake assessments: Lower Willow River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
White Elk	01-0148-00	655	4	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	IF	IF

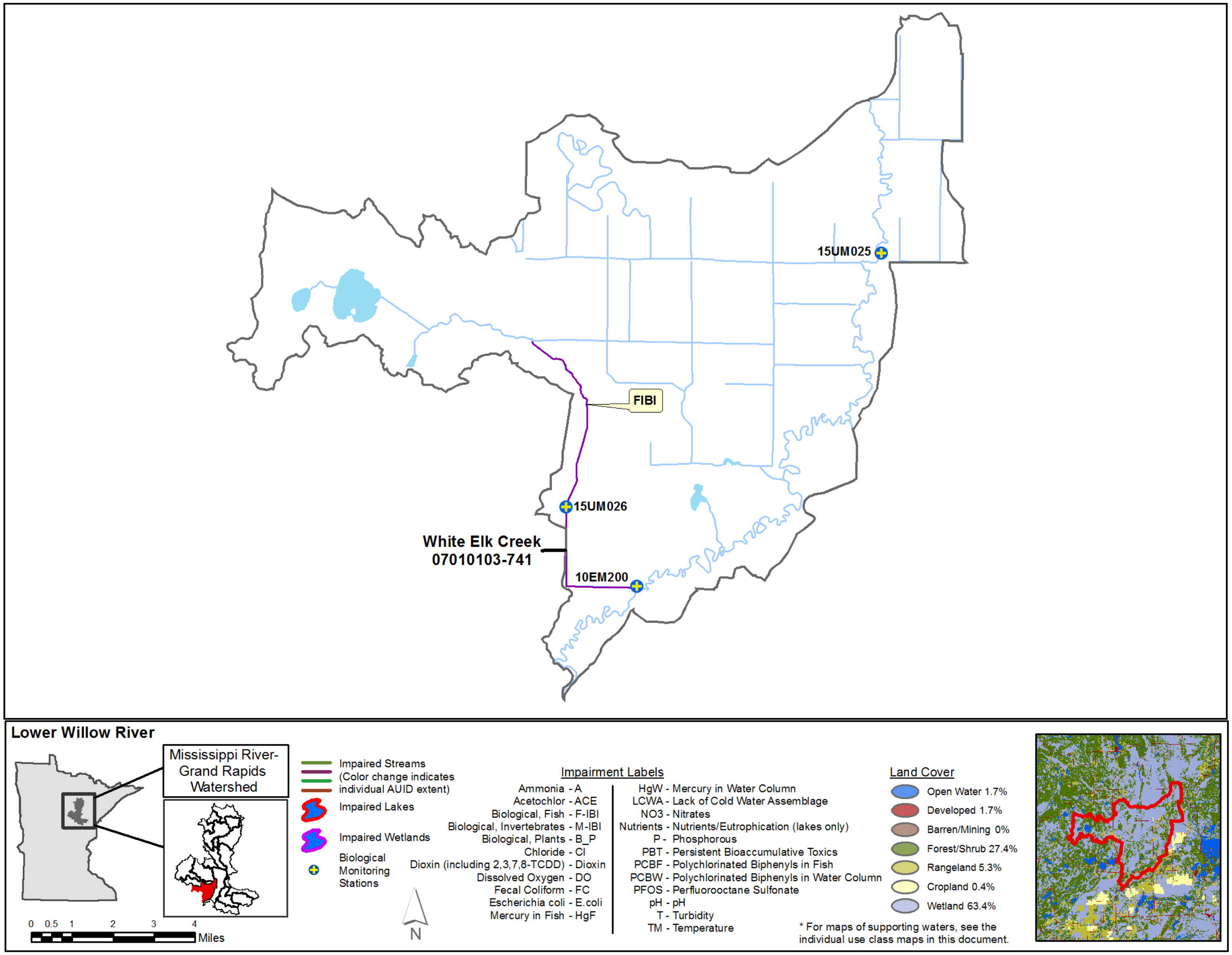
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **IF** = Insufficient Information
Key for Cell Shading: ☐ = insufficient information.

Summary

Aquatic life and recreation indicators for streams in the Lower Willow River Subwatershed (0701010308-01) vary. The lower portions of the Willow River (-748; Moose-Willow River Ditch to the Mississippi River) are characterized by low levels of sediment, bacteria, and good biological communities. Phosphorus concentrations within the lower portion of the Willow River are elevated, however a corresponding increase in productivity (i.e. Chl-a) was not observed. White Elk Creek, a tributary to the lower portions of the Willow, was impaired based on poor FIBI. This is a highly altered stream, which was once a direct tributary to the Mississippi River and solely contained within the Mississippi River-Brainerd 8-HUC (07010104). A lateral ditch was created to connect this stream with the Willow River. Restoring connectivity with its original flow path may help to improve biological conditions within this stream.

White Elk Lake is a designated wildlife lake sampled by DNR in 2009 and 2014. While the datasets are too small for assessment, water quality is generally good, with low phosphorus and algae present on sampling dates.

Figure 41. Currently listed impaired waters by parameter and land use characteristics in the Lower Willow River Aggregated 12-HUC.



Upper Willow River Aggregated 12-HUC HUC 0701010308-02

The Upper Willow River Subwatershed drains 185 square miles of Cass (68.5%), Aitkin (21.4%), and Itasca (10.1%) counties and is the largest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of this subwatershed originate from No-ta-she-bun Lake and flow 8 miles to the confluence with the Willow River near Remer, Minnesota. From here, the Willow River flows 31 miles southeast to the confluence with the Willow River Ditch. Historically, the Willow River turned north (near Haypoint, Minnesota) and connected with the Hill and Moose rivers; however, the Willow River Ditch now connects the Willow to the Moose-Willow River Ditch. Several small tributaries contribute their water throughout this subwatershed. This subwatershed is a part of the larger Willow River drainage system (516 mi^2), which is the largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 43 lakes greater than 10 acres in size, with the most prominent being Big Rice, Thunder, Birch, and Little Thunder lakes. This subwatershed is dominated by forest (57.1%), wetland (30.9%), and open water (5.4%). Only 4.0% is rangeland, 2.3% is developed, 0.2% is row-crop agriculture, and there is little barren/mining (<0.1%). Portions of the Chippewa National Forest, Hill River State Forest, Remer State Forest, Land O'Lakes State Forest, Moose-Willow WMA, Big Rice WMA and Willow Lake Deer Yard WMA lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed (adjacent to unnamed road off of Jack Pine Drive), 2-miles east of Haypoint on the Willow River. The outlet is represented by water chemistry station S008-443 and biological station 15UM019.

Table 32. Aquatic life and recreation assessments on stream reaches: Upper Willow River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-525 ***Willow River, North Fork*** *Headwaters (Willow Lake 31-0775-00) to South Fork Willow River*	15UM035	7.92	WWg	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	--
07010103-554 ***Unnamed Creek*** *Headwaters to Willow River*	00UM014	3.42	WWg	MTS	MTS	IF	IF	IF	--	IF	IF		IF	SUP	--
07010103-599 ***Unnamed Creek (Michaud Brook)*** *Headwaters to Michaud Lake*	15UM031	1.02	WWg	NA	NA	IF	IF	IF	--	IF	IF		IF	NA	--
07010103-605 ***Birch Branch (Birch Brook)*** *Little Birch Lake to Willow River*	15UM034	2.60	WWg	--	--	NA	NA	NA	--	NA	NA		NA	NA	--
07010103-716 ***Willow River Ditch*** *Willow River Flowage to Moose River*	15UM019 S008-443	3.30	WWe	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS		IF	SUP	SUP
07010103-751 ***Willow River*** *South Fork Willow River to Willow River Ditch*	10EM125 15UM032 15UM039	31.34	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS		MTS	SUP	IMP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 33. Lake assessments: Upper Willow River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Shovel	01-0200-00	133	4	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	IF	IF
Little Thunder (West Bay)	11-0009-01	222	72	Deep Lake	NLF	D	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Little Thunder (East Bay)	11-0009-02	28	57	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Thunder	11-0062-00	1251	80	Deep Lake	NLF	I	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Kidney	11-0068-00	54	59	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	MTS	- -	IF
Bass	11-0069-00	193	55	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS
Big Rice	11-0073-00	2170	5	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	NA	IF	FS
Muskeg	31-0728-00	22	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Shingle Mill	31-0729-00	63	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
Shorty	31-0730-00	25	Unknown	Deep Lake	NLF	- -	- -	- -	- -	- -	- -	IF	- -	IF
No-ta-she-bun	31-0775-00	235	40	Deep Lake	NLF	- -	MTS	- -	- -	MTS	MTS	MTS	FS	FS

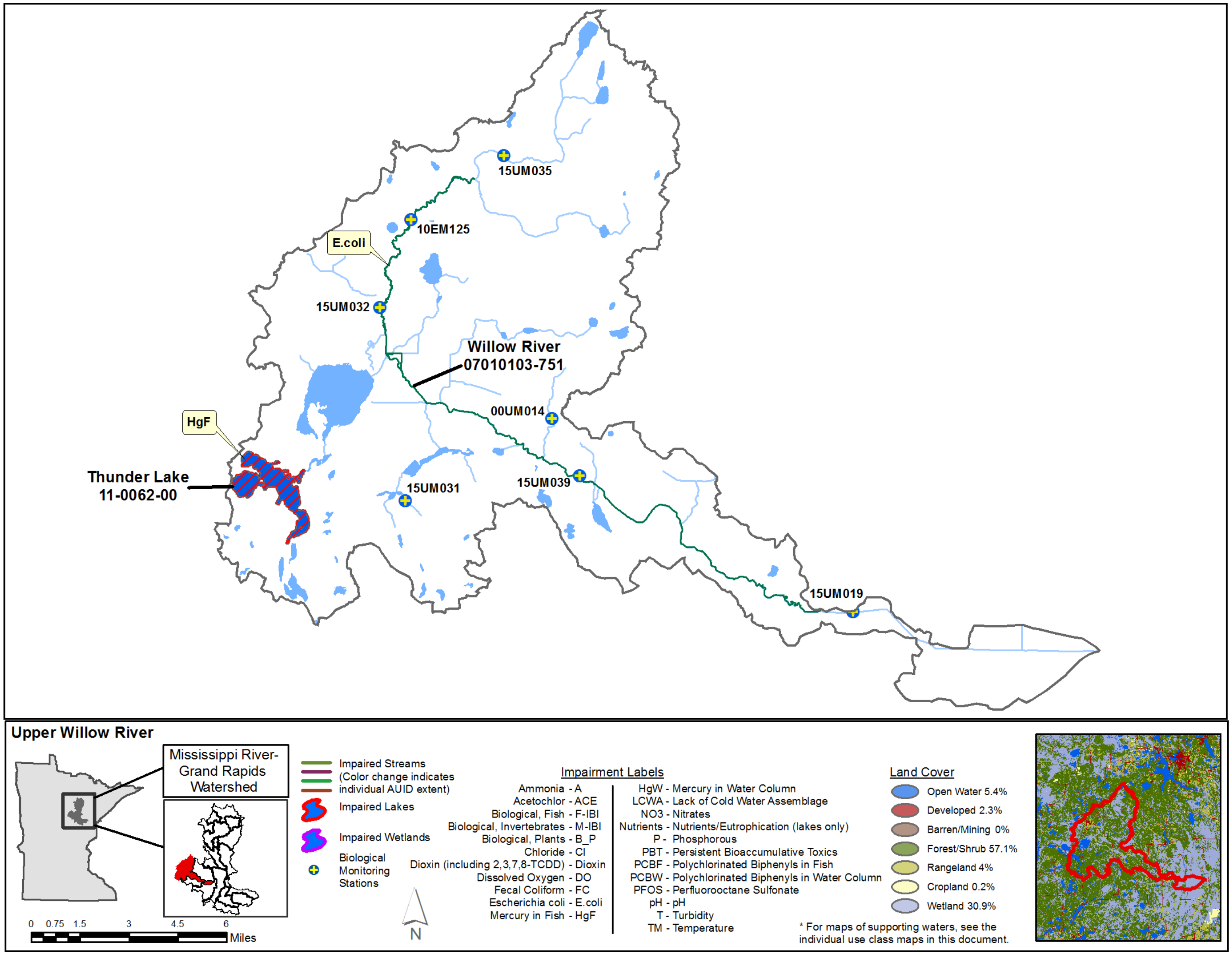
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EX** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading: [green] = full support of designated use; [yellow] = insufficient information.

Summary

Aquatic life indicators for lakes, rivers and streams of the Upper Willow River subwatershed (0701010308-02) generally reflect good-to-excellent water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high, and streams are characterized by low levels of sediment and nutrients. The Willow River Ditch (-716), meets Exceptional Use biocriteria based on FIBI and MIBI scores; protection strategies should be developed for this stream and other outstanding stream resources found throughout the Upper Willow River Subwatershed. The upstream section of the Willow River (-751) does not support aquatic recreation due to elevated bacteria levels during the month of July. Therefore, this reach was added to the 2018 303(d) Impaired Waters List. Downstream of the flowage, bacteria concentrations are lower and aquatic recreation is supported.

Lakes in this subwatershed are some of the best performing of the entire Mississippi River-Grand Rapids Watershed; they were predominately characterized by low levels of nutrients, algae, and chloride. Many of these lakes reside in the headwaters portions of the subwatershed and are mostly undisturbed, which makes them valuable recreational resources. Future development plans should incorporate best management practices to preserve the integrity of these resources. The fish communities generally perform well in this watershed; Thunder and No-ta-she-bun lakes contain exceptional fish communities, and are both lakes of biological significance in the watershed.

Figure 42. Currently listed impaired waters by parameter and land use characteristics in the Upper Willow River Aggregated 12-HUC.



Moose River Aggregated 12-HUC HUC 0701010308-03

The Moose River Subwatershed drains 65 square miles of Aitkin (57.7%) and Cass (42.3%) counties and is the fourth smallest subwatershed within the Mississippi River-Grand Rapids Watershed. The headwaters of this subwatershed begin in a forested wetland area, much of which is within the Land O'Lakes State Forest, and continues 35 miles east to the confluence with the Willow River Ditch, 4 miles southeast of Haypoint, Minnesota. Several small tributaries connect small, shallow lakes to the Moose River along this route. This subwatershed is a part of the larger Willow River drainage system (516 mi^2), which is the largest river drainage in the Mississippi River-Grand Rapids Watershed. There are 23 lakes greater than 10 acres in size, with the most prominent being Moose, Otter, Bass, and White Oak lakes. This subwatershed is dominated by forest (61.7%), wetland (30.1%), and rangeland (3.6%). Only 2.9% is open water, 1.6% is developed, 0.1% is row-crop agriculture, and there is little barren/mining (<0.1%). Portions of the Hill River State Forest, Land O'Lakes State Forest, and Hay Point WMA lie within the boundaries of this subwatershed. Water chemistry sampling was conducted at the outlet of the subwatershed (upstream of Hwy 169), 1-mile south of Haypoint on the Moose River. The outlet is represented by water chemistry station S004-408 and biological station 15UM021.

Table 34. Aquatic life and recreation assessments on stream reaches: Moose River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID Reach Name *Reach Description*	Biological Chemistry Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
07010103-749 ***Moose River*** *Headwaters to Moose-Willow River Ditch*	15UM021 15UM115 S004-408	24.64	WWg	MTS	MTS	EXS	MTS	MTS	MTS	MTS	MTS		MTS	IMP	SUP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 35. Lake assessments: Moose River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Moose	01-0140-00	147	Unknown	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	- -	IF
Otter	01-0196-00	113	10	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	- -	IF
Little McKinney	01-0197-00	27	9	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	IF	- -	IF

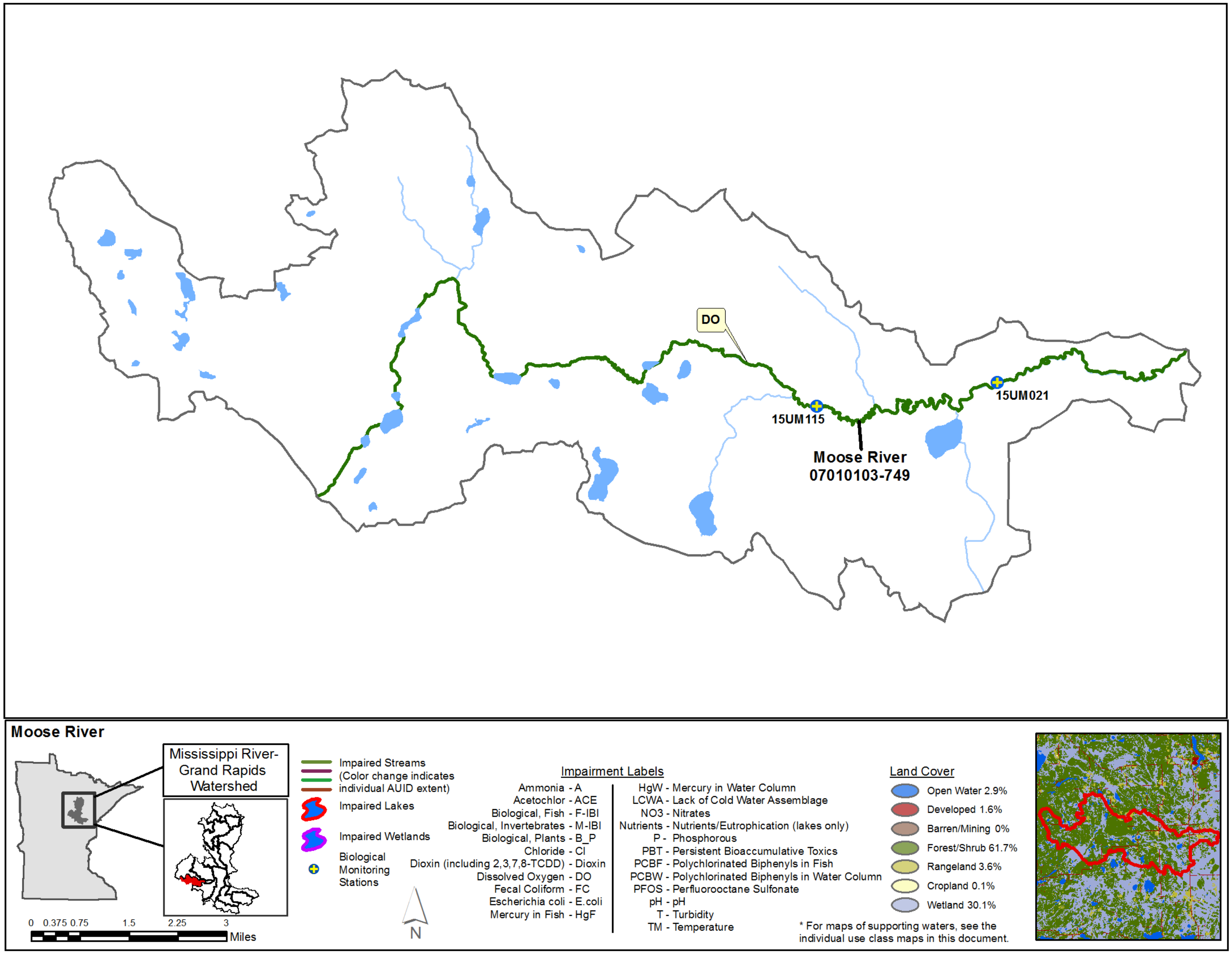
Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **IF** = Insufficient Information
Key for Cell Shading: ☐ = insufficient information.

Summary

Aquatic life and recreation parameters for the Moose River in the Moose River Subwatershed (0701010308-03) generally reflect good water quality. Fish and macroinvertebrate index of biological integrity (FIBI and MIBI) scores are high, and the Moose River is characterized by low levels of sediment, nutrients and bacteria. The Moose River was listed as impaired for aquatic life in 2012, based on low dissolved oxygen data collected at one station. Longitudinal dissolved oxygen measurements made in 2015 and 2016 along the Moose River indicate that the chronically low concentrations of dissolved oxygen are a result of natural background conditions (i.e. low gradient stream with a heavily vegetated channel, and flow contributions from numerous shallow, wild rice lakes). The impairment for dissolved oxygen is considered to be naturally occurring; it will require a site-specific dissolved oxygen standard.

Limited data are available for the shallow lake basins in the Moose River subwatershed (Table 35). Phosphorus concentrations are close to or exceeding the standard; it is likely that occasional algal blooms do occur on these lakes.

Figure 43. Currently listed impaired waters by parameter and land use characteristics in the Moose River Aggregated 12-HUC.



City of Palisade-Mississippi River Aggregated 12-HUC HUC 0701010309-01

The city of Palisade-Mississippi River Subwatershed drains 169 square miles of Aitkin (99.5%), and Itasca (0.5%) counties and is the fourth largest subwatershed within the Mississippi River-Grand Rapids Watershed. This is a Mississippi River flow-through subwatershed, which originates at the confluence of the Swan and Mississippi rivers (northern extent) and continues 60 miles southwest to the confluence of the Mississippi and Willow Rivers (i.e. the pour point of the Mississippi River-Grand Rapids Watershed). Several small, highly altered ditches contribute water to this section of the Mississippi River. Libby Brook and Two River Springs are both small designated trout streams that flow into the Mississippi River near the town of Ball Bluff, Minnesota. This subwatershed is comprised of many small drainages that flow directly to the Mississippi River. There are 19 lakes greater than 10 acres in size, with the most prominent being Vanduse, Blackface, and Ball Bluff Lake. The land cover in the subwatershed is dominated by wetland (46.8%), forest (34.0%), and rangeland (8.6%). Only 5.3% is row-crop agriculture, 2.7% is developed, 2.6% is open water, and there is no barren/mining (<0.1%). Portions of the Hill River State Forest, Savanna State Forest, Waukenabo State Forest, Wold WMA and Roberts-Wickstrom WMA lie within the boundaries of this subwatershed. A chemistry monitoring station was not established in this subwatershed because the main-stem of the Mississippi River is the primary drainage channel. However, sampling occurred on Mississippi River AUID 07010103-708 as a part of the 2013-2104 large river monitoring effort. Results and discussion may be found in Appendix 8.

Table 36. Aquatic life and recreation assessments on stream reaches: City of Palisade-Mississippi River Aggregated 12-HUC. Reaches are organized upstream to downstream in the table.

AUID **Reach Name** *Reach Description*	**Biological Chemistry** **Station ID**	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
07010103-602 ***Unnamed Creek (Libby Brook)*** *Unnamed Lake (01-0037-00) to Mississippi River*	15UM017	2.72	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-623 ***Unnamed Creek (Two Rivers Springs)*** *Unnamed Creek to T51 R24W S26, west line*	15UM020	1.34	WWg	MTS	MTS	IF	IF	IF	- -	IF	IF		IF	SUP	- -
07010103-730 ***Unnamed Creek*** *Unnamed Creek to Mississippi River*	16UM151	0.50	WWg	EXP	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-731 ***Unnamed Creek*** *Unnamed Creek to Unnamed Creek*	15UM091	1.45	WWg	EXP	MTS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-733 ***Pokegama Creek*** *Unnamed Ditch to Mississippi River*	15UM087 16UM167	1.21	WWg	EXS	EXS	IF	IF	IF	- -	IF	IF		IF	IMP	- -
07010103-737 ***Unnamed Creek*** *Unnamed Creek to Mississippi River*	15UM018	1.21	WWg	--	--	IF	IF	IF	--	IF	IF	--	IF	IF	--
07010103-756 ***Unnamed Ditch*** *Unnamed Ditch to Mississippi River*	16UM152	3	WWg	EXS	EXS	IF	IF	IF	- -	IF	IF		IF	IMP	- -

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 37. Lake assessments: City of Palisade-Mississippi River Aggregated 12-HUC.

Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Aquatic Life Indicators:			Aquatic Recreation Indicators:			Aquatic Life Use	Aquatic Recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Blackface	01-0045-00	186	18	Deep Lake	NLF	- -	- -	- -	- -	IF	IF	MTS	NA	IF
Ball Bluff	01-0046-00	167	78	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Little Ball Bluff	01-0057-00	39	49	Deep Lake	NLF	- -	- -	MTS	- -	MTS	MTS	MTS	IF	FS
Vanduse	01-0058-00	233	27	Deep Lake	NLF	- -	MTS	MTS	- -	MTS	MTS	MTS	FS	FS
Sanders	01-0076-00	36	6	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	NA	IF
Libby	01-0080-00	72	Unknown	Deep Lake	NLF	- -	- -	- -	- -	IF	- -	- -	NA	IF

Abbreviations for Ecoregion: NLF = Northern Lakes and Forests
Abbreviations for Secchi Trend: -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **IF** = Insufficient Information, **FS** = Full Support (Meets Criteria)
Key for Cell Shading ▭ = full support of designated use; ▭ = insufficient information.

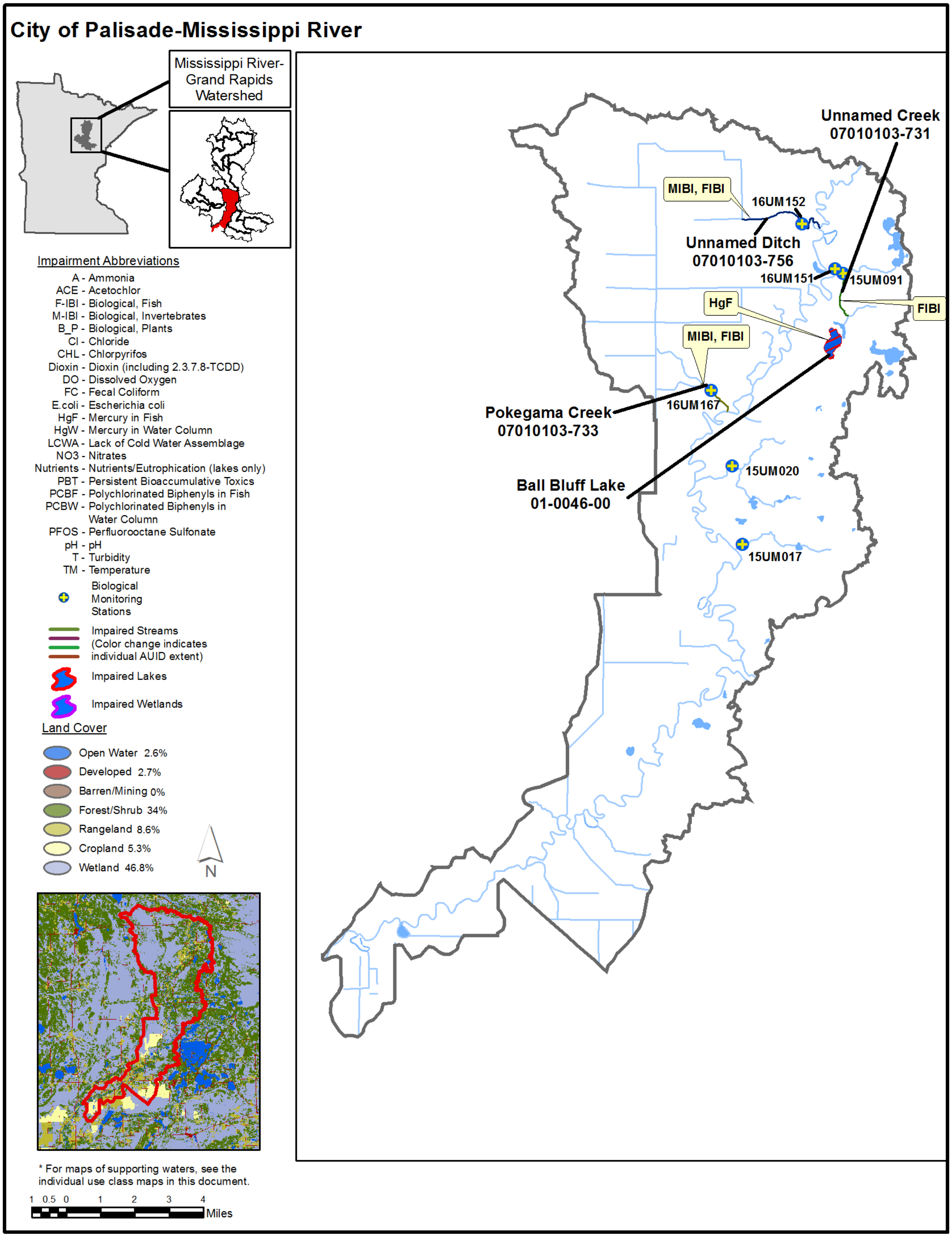
Summary

Aquatic life indicators for streams of the city of Palisade-Mississippi River subwatershed (0701010309-01) generally reflect poor water quality. Fish and macroinvertebrate index biological integrity (FIBI and MIBI) and instream habitat (MSHA) scores (Table 36 and Appendix 5) are generally poor. Four small tributaries (-730, -731, -733, and -756) are impaired for aquatic life based on poor FIBI and/or MIBI scores. These tributaries all contain extensive channelized sections, resulting in excess sediments, lack of instream habitat, bare roots, extensive bank erosion, and connectivity issues. Strategies to mitigate hydrologic and habitat stressors should be developed.

Two small DNR designated trout streams (Libby Brook and Two River Springs) were assessed using warm water biocriteria. Warm water temperatures, a lack of coldwater taxa, and the cessation of DNR efforts to stock and manage these streams were all factors that were instrumental in the decision to apply the warmwater criteria to these stream sections. DNR is proposing to remove Libby Brook from the designated trout inventory. The upper, unassessed segment of Two River Springs does have a naturally reproducing brook trout population and will therefore retain its coldwater designation.

Lakes in the subwatershed are largely characterized by low levels of nutrients, algae, and chloride. Blackface Lake has a small chemistry dataset but considerable transparency data; average transparency indicates that the lake likely supports recreation use. The fish communities in the lakes sampled by DNR are in good condition in this subwatershed; Vanduse Lake is noted as having a near exceptional fish community.

Figure 44. Currently listed impaired waters by parameter and land use characteristics in the City of Palisade-Mississippi River Aggregated 12-HUC.



Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Mississippi River-Grand Rapids, grouped by sample type. Summaries are provided for lakes, streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption results, load monitoring data results, transparency trends, and remote sensed lake transparency. Additionally, groundwater and wetland monitoring results are included where applicable.

Following the results are a series of graphics that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Mississippi River-Grand Rapids Watershed.

Stream water quality

Seventy-three of the 203 uniquely identified stream/river reaches in the watershed were assessed in 2017 (Table 37). Forty-four streams fully support aquatic life, and 12 streams fully support aquatic recreation. Eight stream assessments found individual stream reaches met standards for one intended use but not the other (e.g. fully supporting aquatic life and not supporting aquatic recreation; or vice versa).

Throughout the watershed, 22 streams do not support aquatic life and/or recreation. Of those, 16 do not support aquatic life and six do not support aquatic recreation. The streams that do not support recreation all show chronically elevated bacteria concentrations.

Table 38. Assessment summary for stream water quality in the Mississippi River-Grand Rapids Watershed.

				Supporting		Non-supporting		Insufficient Data			
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Limited Resource Value	# Corrections
07010103	**1,332,798**	**247**	**73**	**44**	**12**	**16**	**6**	**13**	**0**	**2**	
0701010301-01	96,256		8	5	1	1	0	2	0	0	
0701010301-02	43,088		4	3	1	1	0	0	0	0	
0701010302-01	113,219		4	3	1	1	1	0	0	0	
0701010302-02	39,665		1	1	0	0	0	0	0	0	
0701010302-03	32,772		2	1	0	0	0	1	0	0	
0701010303-01	62,088		2	0	0	2	0	0	0	0	
0701010303-02	35,526		2	2	0	0	1	0	0	0	
0701010304-01	115,610		8	6	1	1	0	1	0	0	
0701010304-02	94,543		4	3	0	1	1	0	0	1	
0701010305-01	71,108		5	4	2	0	1	1	0	0	
0701010305-02	65,878		5	4	0	0	1	1	0	0	
0701010306-01	64,328		3	0	1	2	0	1	0	0	
0701010306-02	60,534		1	0	1	1	0	0	0	1	
0701010307-01	93,371		6	4	1	1	0	1	0	0	
0701010308-01	77,009		6	1	1	1	0	4	0	0	
0701010308-02	118,622		4	4	1	0	1	0	0	0	
0701010308-03	41,352		1	1	1	0	0	0	0	0	1
0701010309-01	107,830		7	2	0	4	0	1	0	0	

Lake water quality

The Mississippi River-Grand Rapids Watershed has 625 lakes greater than 10 acres in size. All lakes were assessed against standards for aquatic recreation that are designed to protect lakes in the Northern Lakes and Forests Ecoregion; lakes with stream trout or lake trout populations were held to standards that are more stringent to protect those sensitive fish populations. Data from 216 lakes were reviewed during assessment process; 106 were found to meet NLF standards and fully support aquatic recreation. Only 11 lakes in the entire watershed do not support aquatic recreation. Ninety-nine lakes did not meet minimum data requirements to complete an assessment of aquatic recreation.

Staff at MPCA and DNR collaborated to assess aquatic life on 49 lakes. Forty-four of the lakes fully support aquatic life and only one does not. The IBIs and the biocriteria used to assess aquatic life in lakes are tailored to specific lake types.

Table 39. Assessment summary for lake water chemistry in the Mississippi River-Grand Rapids River Watershed.

			Supporting		Non-supporting				
Watershed	Area (acres)	Lakes >10 Acres	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data (aquatic life)	Insufficient Data (aquatic recreation)	#Delistings
07010103	**1,332,798**	**625**	**44**	**106**	**1**	**11**	**89**	**99**	0
0701010301-01	96,256	53	4	12	0	0	11	17	0
0701010301-02	43,088	20	1	4	0	0	0	1	0
0701010302-01	113,219	71	5	18	0	0	10	11	**1**
0701010302-02	39,665	62	5	13	0	0	4	17	0
0701010302-03	32,772	52	5	11	0	1	4	3	0
0701010303-01	62,088	24	2	7	0	0	6	5	0
0701010303-02	35,526	12	0	2	0	2	3	3	0
0701010304-01	115,610	36	3	7	0	0	5	6	0
0701010304-02	94,543	86	5	13	0	0	12	9	0
0701010305-01	71,108	24	1	1	0	1	3	2	0
0701010305-02	65,878	10	0	0	1	4	6	4	0
0701010306-01	64,328	33	6	6	0	3	6	3	0
0701010306-02	60,534	20	0	1	0	0	6	4	0
0701010307-01	93,371	23	0	2	0	0	4	2	0
0701010308-01	77,009	5	0	0	0	0	1	1	0
0701010308-02	118,622	48	5	6	0	0	2	5	0
0701010308-03	41,352	25	0	0	0	0	3	3	0
0701010309-01	107,830	21	2	3	0	0	3	3	0

Fish contaminant results

Mercury and PCBs have been analyzed in fish tissue samples collected from 45 lakes in the Mississippi River-Grand Rapids Watershed. DNR fisheries staff collected samples from 1982 to 2016. The fish collected in the Mississippi River are not included in this assessment. Perfluorochemicals were measured in representative fish from 4 lakes.

Thirty-three of the 45 tested lakes are on the 2018 Impaired Waters Inventory (IWI) for mercury in fish tissue (Appendix 6). Of the 33 lakes on the IWI, 19 qualified for inclusion in the Minnesota Statewide Mercury TMDL.

PCBs were tested in representative species from 20 lakes. PCB concentrations were mostly less than the reporting limits. The highest PCB concentration was 0.12 mg/kg in a Lake Trout from Trout Lake (31-0410), collected in 1990, and is below the threshold for impairment (0.2 mg/kg).

Perfluorochemicals were measured in four lakes: Shallow (31-0084), Hart (09-0067), Tamarack (31-0020), and Hill (01-0142). All results of perfluorooctane sulfonate (PFOS) were less than the reporting limits except for a Black Crappie from Tamarack Lake in 2007, which had a measured PFOS concentration of 1.95 µg/kg. In 2007, the US EPA analyzed the samples and had a reporting limit of 0.98 µg/kg. In 2009, the samples were analyzed by AXYS Analytical Ltd, which had a reporting limit around 5.0 µg/kg (0.005 mg/kg). Therefore, the PFOS in the Black crappie would have been below the reporting limit for AXYS.

Pollutant load monitoring

The WPLMN has four sites within the Mississippi River-Grand Rapids Watershed as shown in Table 41. The Mississippi River at Grand Rapids is a "basin" site that is monitored year round. The other three sites listed in the table are "subwatershed" sites that are monitored seasonally. This report will use the data collected from the Mississippi River at Grand Rapids site.

Statewide average annual FWMCs of TSS, TP, and NO_3+NO_2-N by major watershed are presented in Figure 46, with the Mississippi River-Grand Rapids Watershed highlighted. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that makes it to a river or stream and is expressed in inches.

As a general rule, elevated levels of TSS and NO_3+NO_2-N are regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess TP can be attributed to both non-point as well as point sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Table 40. WPLMN stream monitoring sites for the Mississippi River-Grand Rapids Watershed.

Site Type	Stream Name	USGS ID	DNR/MPCA ID	EQuIS ID
Basin	Mississippi River at Grand Rapids, MN	05211000	E09064001	S003-656
Subwatershed	Prairie River near Taconite	05212700	E09020001	S007-944
Subwatershed	Swan River near Jacobson, CR 431	N/A	H09065001	S001-922
Subwatershed	Willow River near Pallisade, CSAH 5	05221020	H09118001	S004-407

Excessive TSS, TP, and NO_3+NO_2-N in surface waters impacts fish and other aquatic life, as well as fishing, swimming and other recreational uses. High levels of NO_3+NO_2-N is a concern for drinking water which may be affected by surface water inputs throughout a watershed. The city of Grand Rapids does not receive its drinking water supply directly from the Mississippi River but rather five groundwater wells ranging from 140 to 572 feet in depth. Due to the topography of the watershed and location of the wells, the Mississippi River mainstem contributes very little (<15%) water to these groundwater wells (Jane De Lambert, MDH, Personal Communication, 2018). The abundance of other surface waters throughout the watershed such as lakes, small streams and ditches have a greater impact on NO_3+NO_2-N concentrations in the groundwater supply.

When compared with other major watersheds throughout the state, Figure 45 shows the average annual TSS, TP, and NO_3+NO_2-N FWMCs for the Mississippi River at Grand Rapids to be significantly lower than watersheds in the south and western portions of Minnesota, but in line with the lake, wetland, and forest rich watersheds found in the north-central and northeastern regions of the state. More information can be found at the WPLMN website.

Substantial year-to-year variability in water quality occurs for most rivers and streams, including the Mississippi River. Annual TSS, TP, and NO_3+NO_2-N FWMCs and loads for the Mississippi River at Grand Rapids are shown in Figure 45.

Figure 45. 2007-2015 Average annual TSS, TP, and NO3-NO2-N flow weighted mean concentrations, and runoff by major watershed.

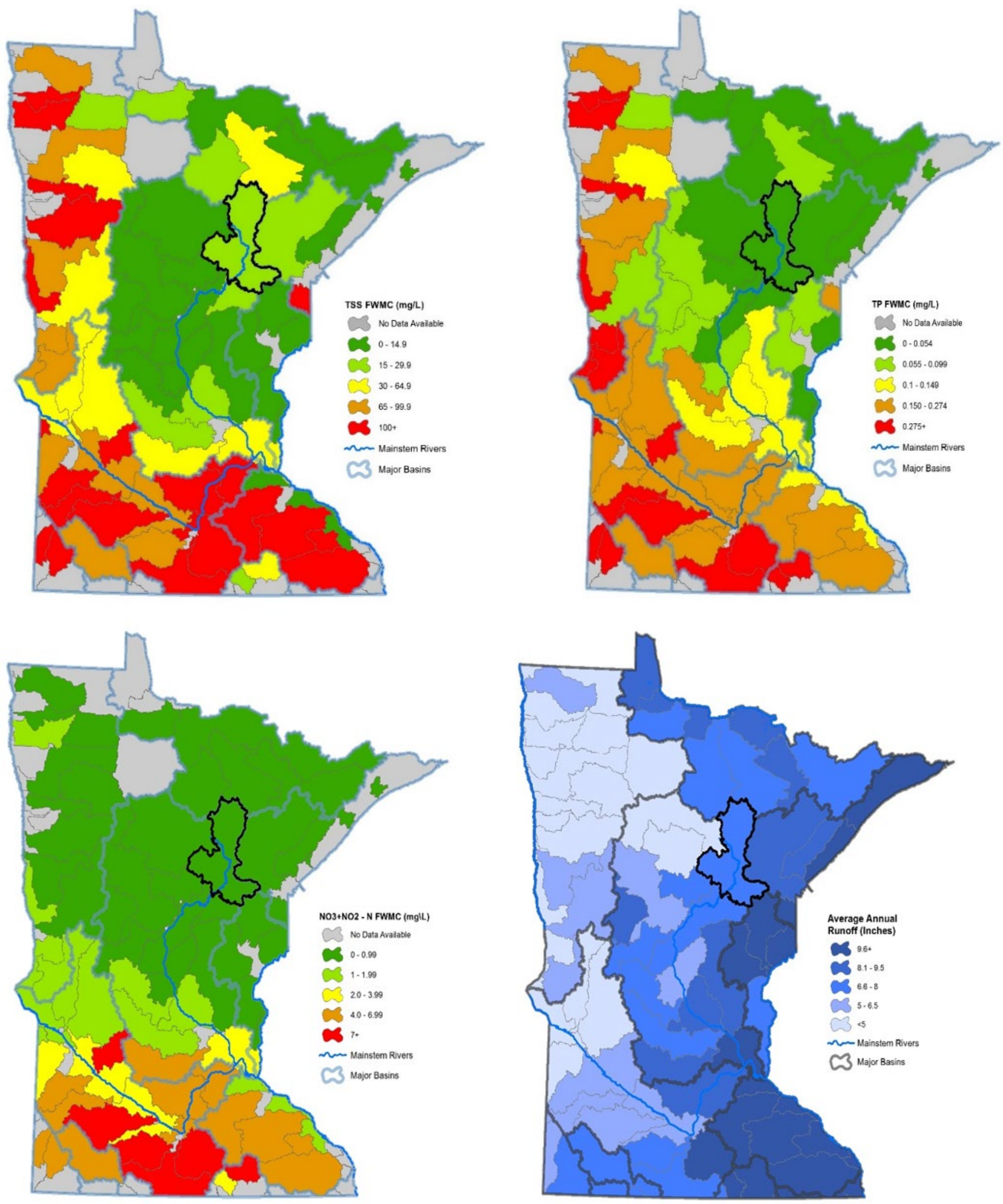
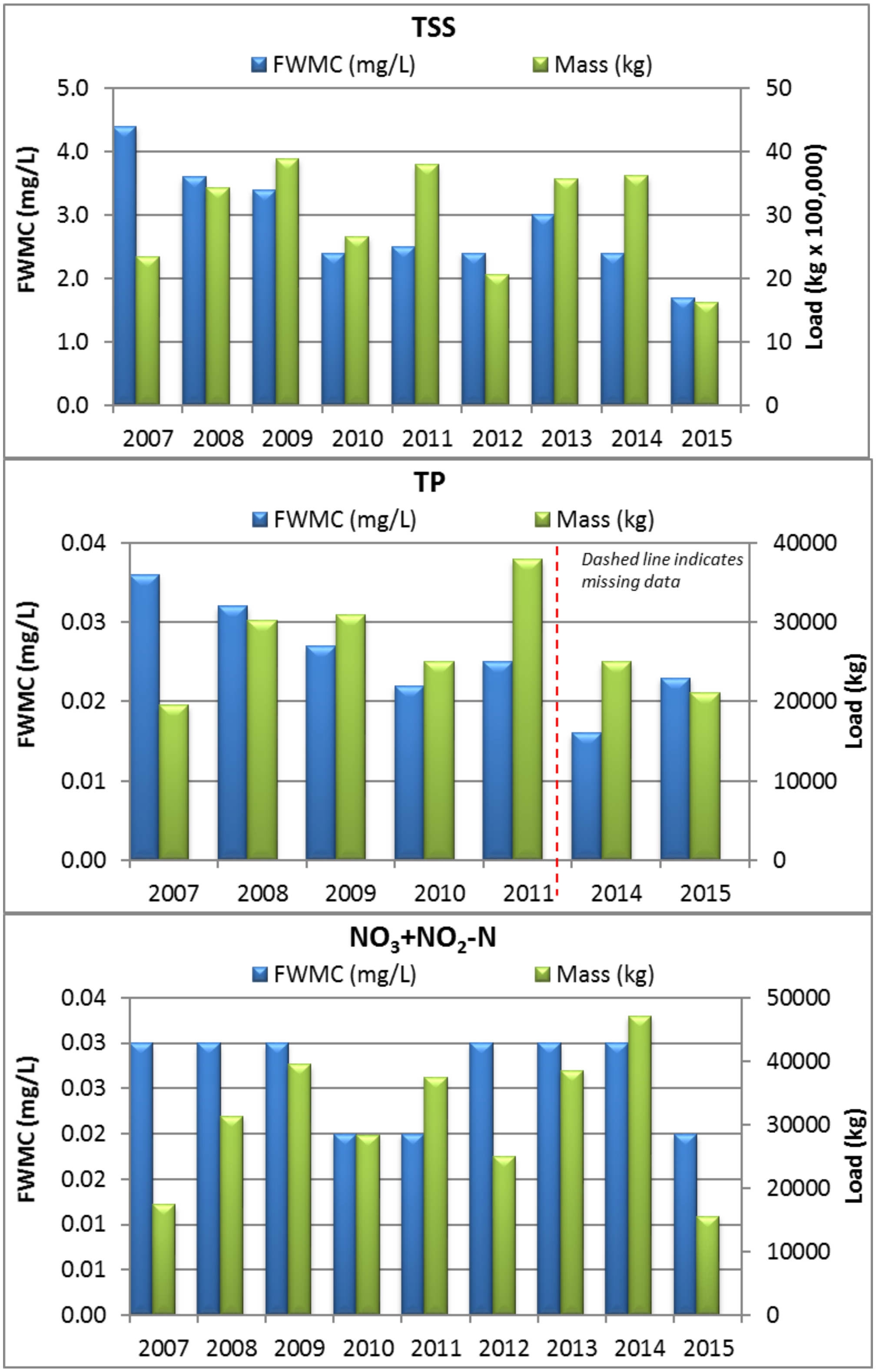


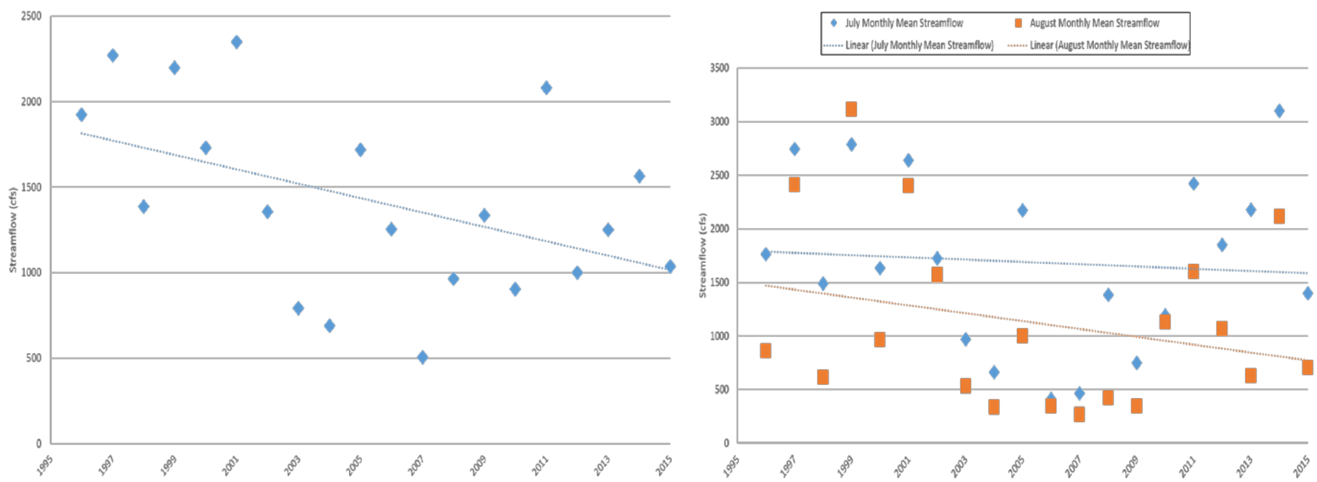
Figure 46. TSS, TP, and NO3+NO2-N flow weighted mean concentrations and loads for the Mississippi River at Grand Rapids, Minnesota.



Stream flow

Stream flow data from the USGS's real-time streamflow gaging stations for one river in the Mississippi River-Grand Rapids Watershed was analyzed for annual mean discharge and summer monthly mean discharge (July and August). Figure 48 (*left*) is a display of the annual mean discharge for the Mississippi River at Grand Rapids, Minnesota from water years 1996 to 2015. The data shows that although streamflow appears to be decreasing over time, there is no statistically significant trend ($p<0.1$). Figure 48 (*right*) displays July and August mean flows for the same time frame, for the same waterbody. Graphically, the data appears to be decreasing in July and August, but neither with significance. By way of comparison at a state level, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends (Streitz, 2011). For additional streamflow data throughout Minnesota, please visit the USGS website: http://waterdata.usgs.gov/mn/nwis/rt.

Figure 47. Annual mean (*left*) and monthly mean (*right*) streamflow for the Mississippi River at Grand Rapids, Minnesota (1996-2015). (Source: USGS, 2016)



Wetland condition

The Mississippi River-Grand Rapids Watershed occurs entirely within the Mixed Wood Shield Ecoregion. Wetland condition, in this ecoregion is very good, especially when compared to other ecoregions in the state. Based on plant community floristic quality, 84% of the wetlands in the Mixed Wood Shield Ecoregion are estimated to be in Exceptional or Good condition and an estimated 0% are in Poor condition (Table 41). In the other two ecoregions of the state wetland condition results are essentially opposite. In these more degraded regions of the state significant extents of wetland area is dominated by invasive plants, particularly narrow-leaf cattail (*Typha angustifolia*), hybrid cattail (*Typha X glauca*), and reed canary grass (*Phalaris arundinacea*). These invasive plants often outcompete native species due to their tolerance of nutrient enrichment, hydrologic alterations and toxic pollutants such as chlorides (Galatowisch 2012) and thus strongly influence the composition and structure of the wetland plant community. In the Mississippi River-Grand Rapids Watershed and other HUC8 watersheds located within the Mixed Wood Shield Ecoregion water quality efforts should focus on protecting the quality wetland resource that is present including efforts to limit hydrologic alterations and the spread of invasive species which are known to rapidly and dramatically impact wetland quality.

Table 41. Wetland biological condition by major ecoregions based on floristic quality. Results are expressed as an extent (i.e., percentage of wetland acres) and include essentially all wetland types (MPCA 2015).

Vegetation Condition in All Wetlands			
Condition Category	**Mixed Wood Shield**	**Mixed Wood Plains**	**Temperate Prairies**
Exceptional	64%	6%	7%
Good	20%	12%	11%
Fair	16%	42%	40%
Poor		40%	42%

Figure 48. Stream Tiered Aquatic Life Use designations in the Mississippi River-Grand Rapids Watershed.

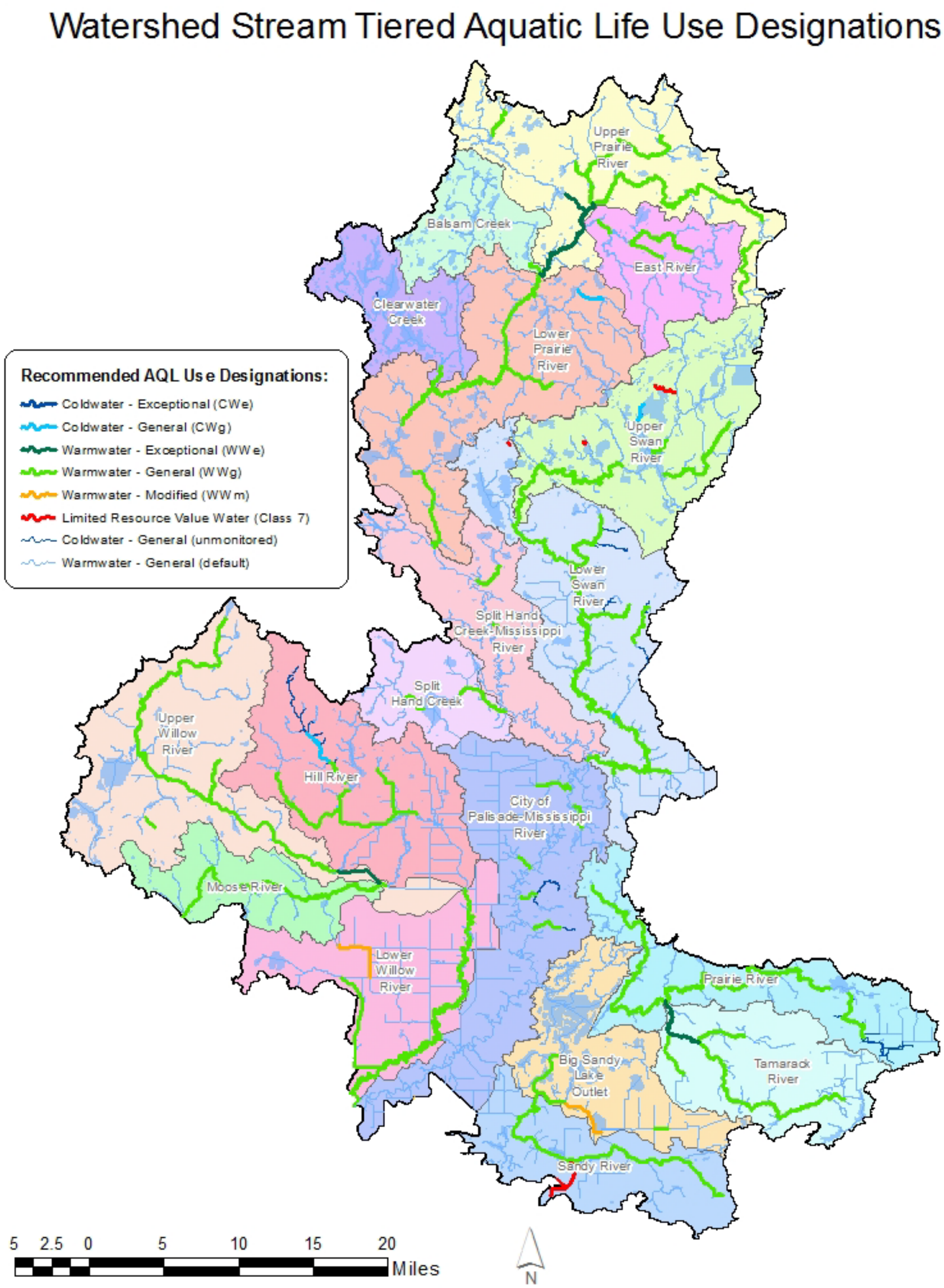


Figure 49. Fully supporting waters by designated use in the Mississippi River-Grand Rapids Watershed.

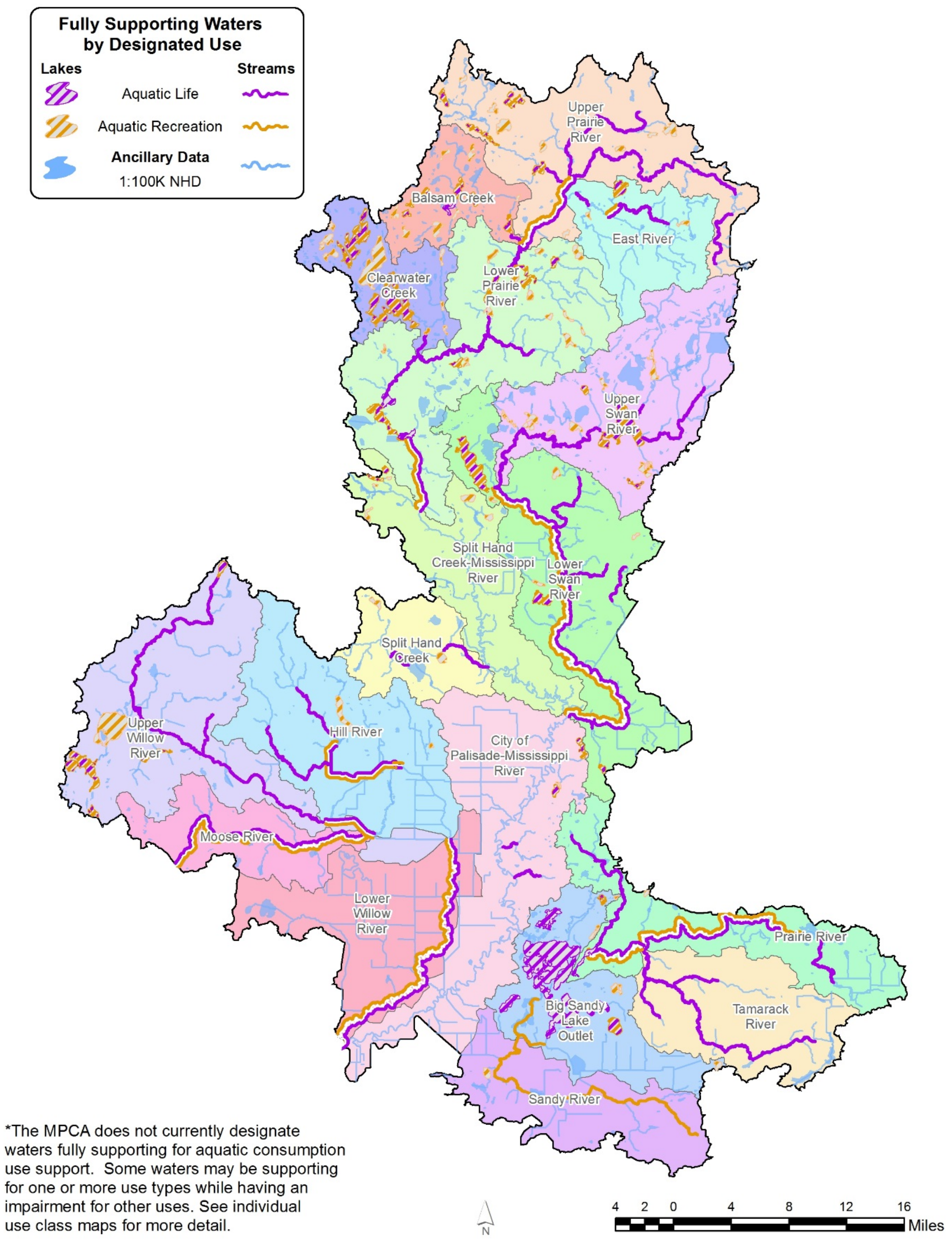


Figure 50. Impaired waters by designated use in the Mississippi River-Grand Rapids.

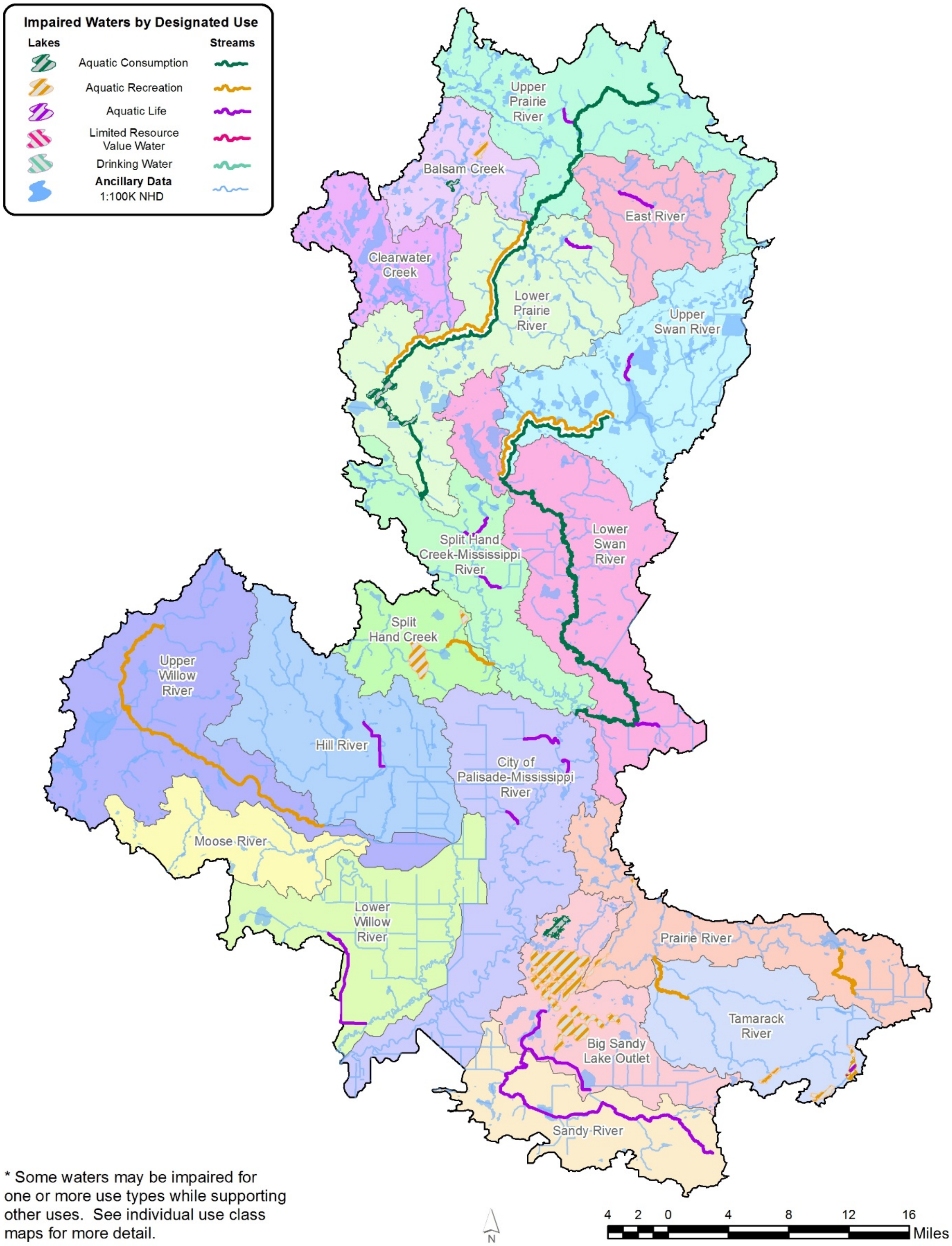


Figure 51. Aquatic consumption use support in the Mississippi River-Grand Rapids Watershed.

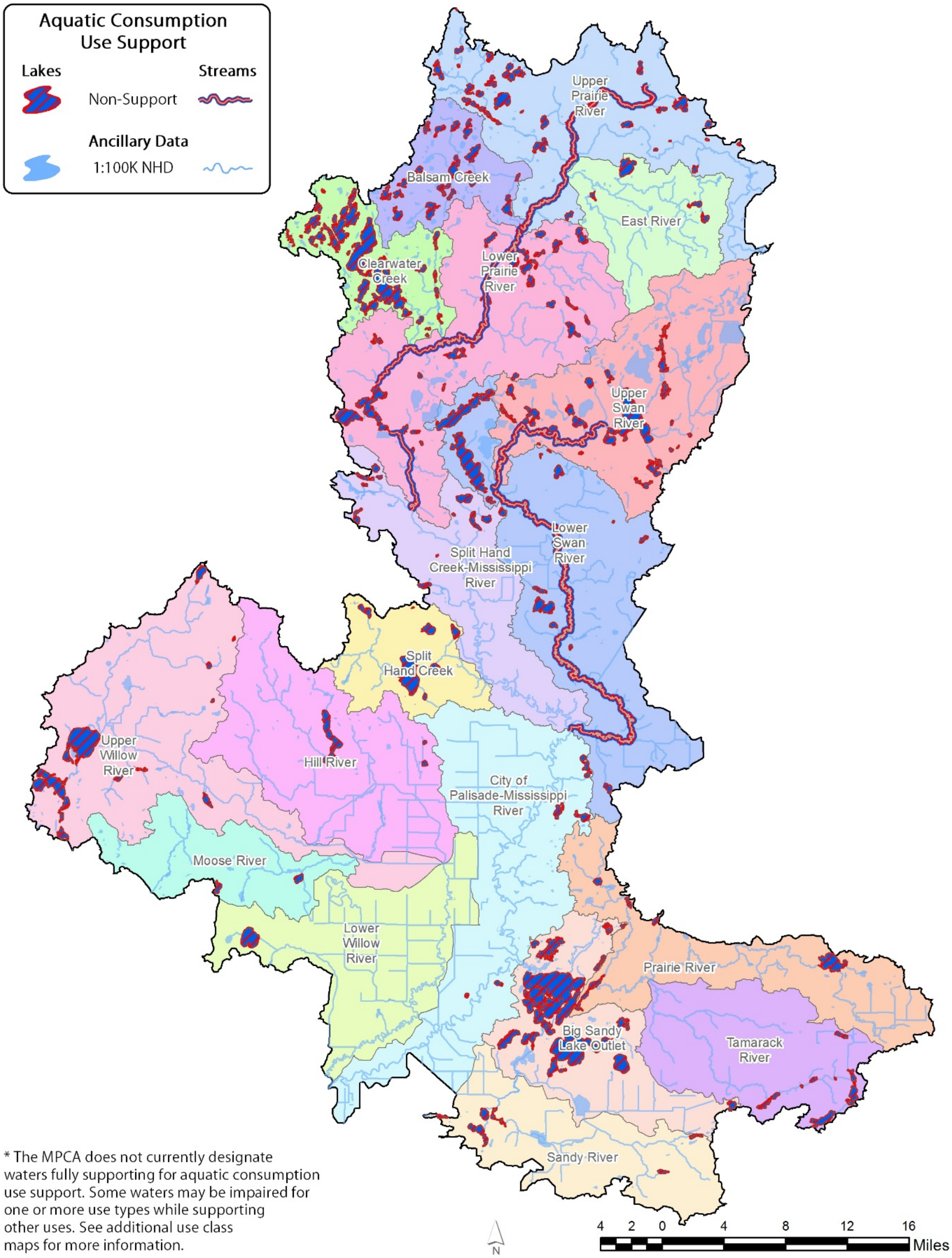


Figure 52. Aquatic life use support in the Mississippi River-Grand Rapids Watershed.

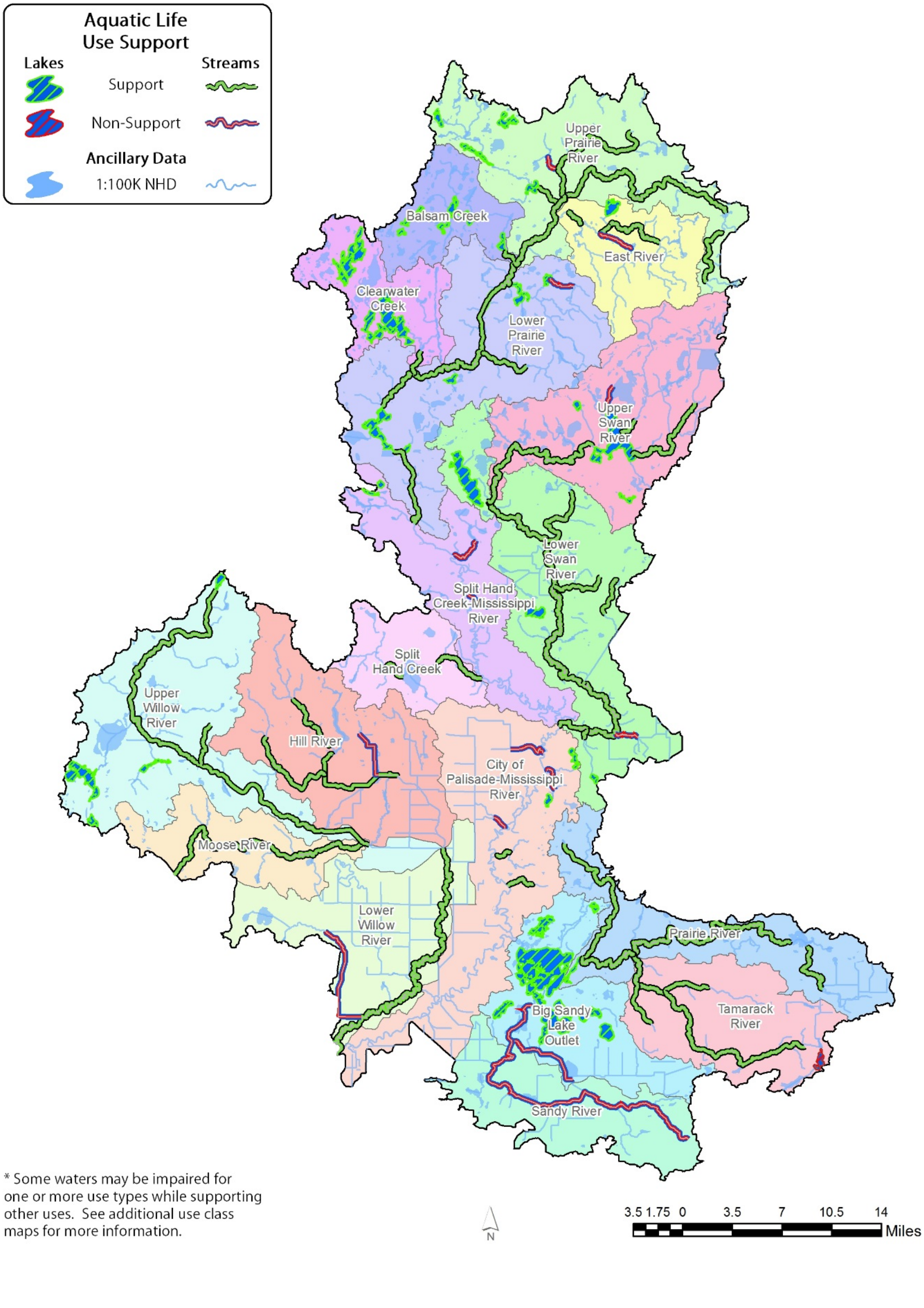
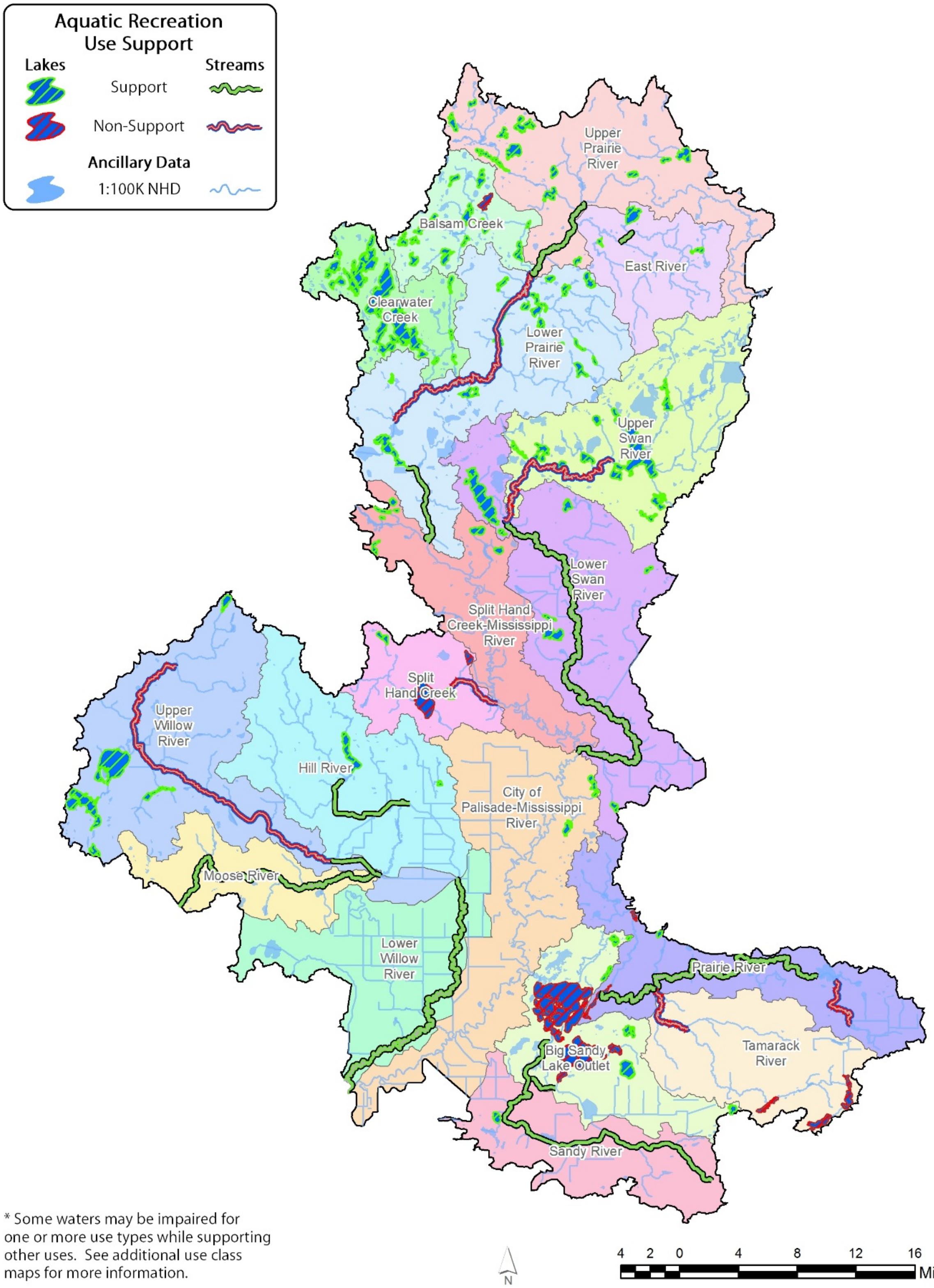


Figure 53. Aquatic recreation use support in the Mississippi River-Grand Rapids Watershed.



Transparency trends for the Mississippi River-Grand Rapids Watershed

The MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state, and incorporates any relevant agency and partner data submitted to EQuIS. The water clarity trends are calculated using a Seasonal Kendall statistical test for sites with a minimum of 8 years of transparency data; Secchi disk measurements in lakes and Secchi tube measurements in streams.

For the most recent year where data are finalized (2015 for streams, and 2016 for lakes), volunteers had monitored 1 stream and 70 lakes sites. Of the lake sites that are monitored by volunteers, 21 show an improving trend, and 13 show a declining trend observed in water clarity. The lone stream site and 36 lake sites show no long-term trend.

Table 42. Water clarity trends at citizen stream monitoring sites.

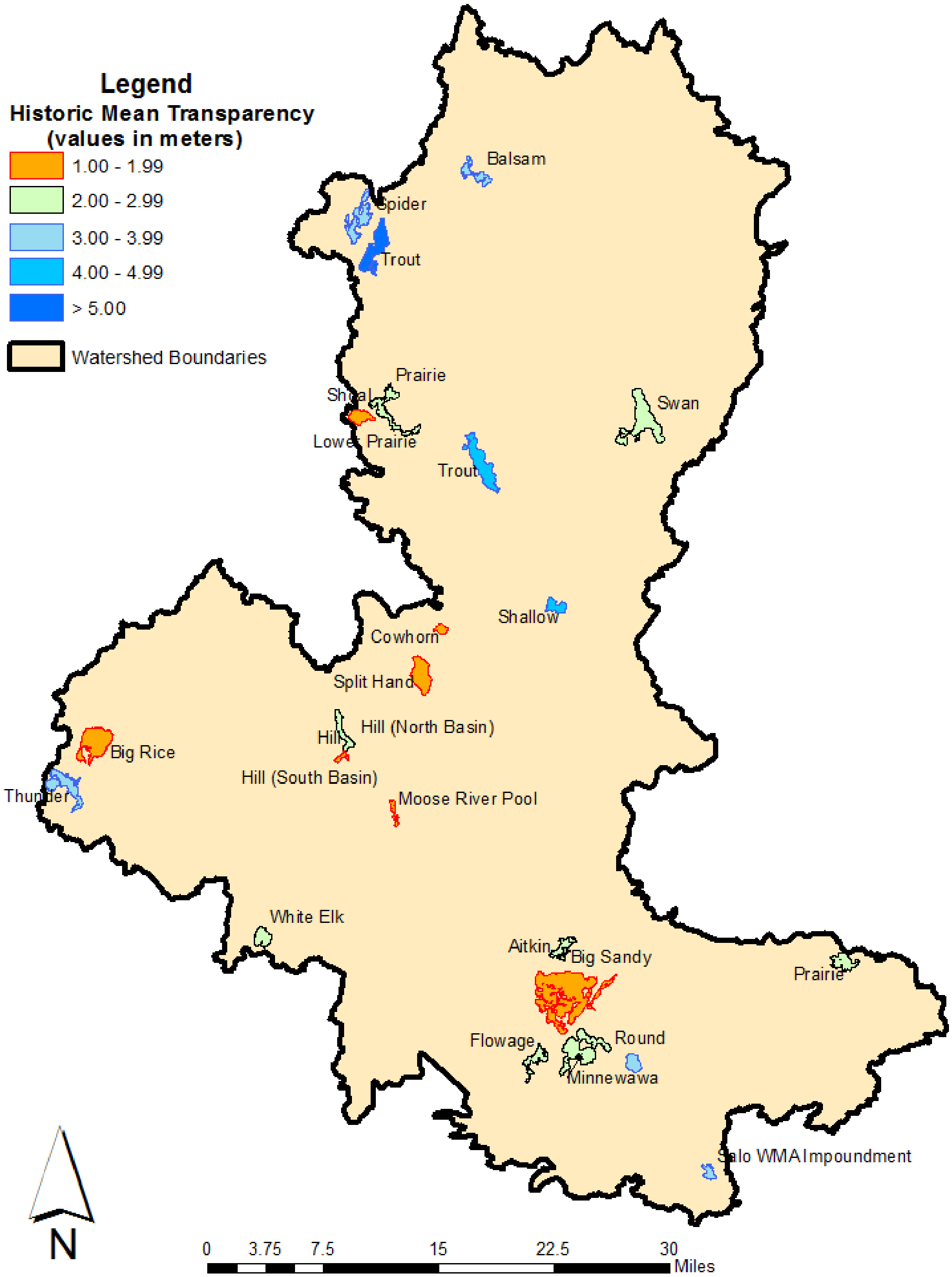
Miss. R.-Grand Rapids (07010103)	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/ increasing trend	0	21
number of sites w/ decreasing trend	0	13
number of sites w/ no trend	1	36

In June 2014, the MPCA published its final trend analysis of river monitoring data located statewide based on the historical Milestones Network. The network is a collection of 80 monitoring locations on rivers and streams across the state with good, long-term water quality data. The period of record is generally more than 30 years, through 2010, with monitoring at some sites going back to the 1950s. While the network of sites is not necessarily representative of Minnesota's rivers and streams as a whole, they do provide a valuable and wide-spread historical record for many of the state's waters. Starting in 2017, the MPCA will be switching to the Pollutant Load Monitoring Network for long term trend analysis on rivers and streams. Data from this program has much more robust sampling and will cover over 100 sites across the state.

Remote sensing for lakes in the Mississippi River-Grand Rapids Watershed

The University of Minnesota, in partnership with MPCA, conducts remote sensing of lake clarity. The information provides a snapshot of water transparency during late summer over a span of 30 years. Secchi disk transparency data is paired with satellite imagery to come up with estimates of water clarity across the state. While there are limitations to the data, such as cloud cover, vegetation, or stained water altering the estimated Secchi transparency, it does provide information to help prioritize monitoring and protection efforts on lakes which do not have water quality data.

Figure 54. Remotely sensed Secchi transparency on lakes in the Mississippi River-Grand Rapids Watershed.



Priority waters for protection and restoration in the Mississippi River – Grand Rapids Watershed

The MPCA and DNR have been developing methods to help identify waters that are high priority for protection and restoration activities. Protecting lakes and streams from degradation requires consideration of how human activities affect the lands draining to the water. In addition, helping to determine the risk for degradation allows prioritization to occur; thus, limited resources can be directed to waters that would benefit most from implementation efforts.

The results of the analysis are provided to watershed project teams for use during Watershed Restoration and Protection Strategy (WRAPS) and One Watershed One Plan or other local water plan development. The results of the analysis are considered a preliminary sorting of possible protection priorities and should be followed by a discussion and evaluation with other resource agencies, project partners and stakeholders. Other factors that are typically considered during the protection prioritization process include: whether a water has an active lake or river association, is publically accessible, presence of wild rice, presence of invasive, rare or endangered species, as well as land use information and/or threats from proposed development. Opportunities to gain or enhance multiple natural resource benefits ("benefit stacking") is another consideration during the final protection analysis. At present, the prioritization methodology has been developed for lakes based on recreation use and is summarized below (MPCA 2017). Stream Protection and Prioritization method development is nearing completion. Waterbodies identified during the assessment process as vulnerable to impairment are also included in the summary below.

The results for selected indicators and the risk priority ranking for each lake are shown in Appendix 7. Protection priority should be given to lakes that are particularly sensitive to an increase in phosphorus with a documented decline in water quality (measured by Secchi transparency), a comparatively high percentage of developed land use in the area, or monitored phosphorus concentrations close to the water quality standard.

In the Mississippi River - Grand Rapids Watershed, highest protection priority is suggested for lakes that meet the NLF nutrient standard but are sensitive to additional inputs, including: Woodbury, Lawrence, Horseshoe (near Grand Rapids) and Trout (near Bovey). Other lakes identified as having a high priority for protection based on exceptional fish communities include the Wabana chain of lakes, Balsam, Shallow, Thunder, No-ta-she-bun and Hale (in Grand Rapids). As mentioned above, all these lakes are currently meeting water quality standards.

Lakes that barely meet/exceed the NLF nutrient standard, or have data that are close (but inconclusive) and are in need of protection include Prairie (near Floodwood), Bass, Rock, Rat, Wolf, Little Split Hand, and Prairie (north of Grand Rapids).

Summaries and recommendations

The Mississippi River-Grand Rapids Watershed contains a number of the state's high value water resources. With nearly 70% privately owned land in the watershed, it will be necessary to work cooperatively with landowners to maintain these high value resources. Overall, biological communities in most rivers and streams in the watershed are good, with only 19% of stream segments failing to meet aquatic life standards. The Prairie River, West Fork Prairie River, Tamarack River, and Willow River Ditch have excellent fish and macroinvertebrate communities, resulting in these streams being designated as Exceptional Use. The habitat in these streams are rated as good to exceptional, and should be addressed by WRAPs to protect the natural riparian corridors.

Seventy-five species of fish have been documented within the Upper Mississippi River Basin. In 2015 and 2016, MPCA staff collected 51 species of fish (this number only includes fish collected from tributaries to the Mississippi River) in the Mississippi River-Grand Rapids Watershed. Six fish species (Banded Killifish, Bluntnose minnow, Channel Catfish, Hybrid Minnow, Mukellunge, and Stonecat) were observed at only one location. Interestingly, mottled scuplin were observed at 20 sites throughout the central and western portions of the watershed. However, mottled sculpin were absent from both Prairie River drainages, even though these streams would appear to have adequate habitat and water quality to support these fish. It is plausible that historic logging may have wiped out populations within these drainages and they have yet to recover. Mottled sculpin are a sensitive species, often found in clear, cool, and flowing waters. The most commonly sampled species in the watershed was White Sucker, which was captured at 85 of the 93 sites. The White Sucker is tolerant of a wide variety of conditions, including low DO. The abundance of White Suckers may be due in part to the high proportion of low gradient, naturally low DO streams across the watershed. Nearly 23,000 fish were captured and released during this monitoring effort.

The macroinvertebrate community in the Mississippi River-Grand Rapids Watershed is diverse and generally healthy. Over 10,500 individual organisms representing 376 unique taxa were collected and identified from the samples. This diversity is the result of the good quality and variety of streams throughout the watershed. A majority of the watershed is characterized by low gradient streams with little anthropogenic disturbance, however faster flowing streams with riffle habitats were also sampled. Some of the notable sensitive taxa in these streams were the caddisflies *Chimarra, Lepidostoma, Neureclipsis*, Oxyethira, and *Phylocentropus,* the dragonflies *Cordulegaster, Macromia illinoiensis,* and *Ophiogomphus rupinsulensis,* and the midges *Lopescladius, Nilothauma, Synorthocladius,* and *Stempellinella*. There are also several coldwater streams in the watershed: notable taxa in these streams were the dragonfly *Somatochlora minor*, the stonefly *Amphinemura,* the mayfly *Ephemerella,* the midges *Eukieferiella, Heterotrisocladius,* and *Odontomesa,* and the caddisflies *Glossosoma intermedium, Glossosoma nigrior, Goera,* and *Lype diversa*. No endangered, threatened or species of special concern were collected in the Mississippi River-Grand Rapids Watershed during this study. However, the majority of the biological monitoring sites had strong macroinvertebrate IBI scores and robust macroinvertebrate communities. Six sensitive taxa (*Amphinemura, Demicryptochironomus, Hagenius brevistylus, Micrasema sprulesi, Neophylax oligius,* and *Ophiogomphus rupinsulensis*) were recorded by the MPCA for the first time in this watershed.

Beaver dams prevented the collection of fish and macroinvertebrates in several streams, and appear to be a natural stressor, particularly to the fish communities. Dams create a loss of stream connectivity, which can limit fish migration. This can prevent fish from accessing prime spawning habitats in smaller headwater streams. Beaver management should be addressed across the watershed, but most notably along the Sandy River where beavers are restricting fish passage.

The most widespread impairment found in the watershed's lakes is high levels of mercury in fish tissue. The Mississippi River and 37 lakes are currently listed as impaired. Most of the PCB concentrations in fish tissue were near or below the reporting limit (0.01 - 0.05 mg/kg). The highest PCB concentration was 0.12 mg/kg in a lake trout taken in 1990 from Trout Lake (31-0410). 0.12 mg/kg is below the threshold for impairment (0.2 mg/kg). All results of PFOS were less than the reporting limits except for a black crappie from Tamarack Lake in 2007, which had a measured PFOS concentration of 1.95 µg/kg.

The Mississippi River-Grand Rapids Watershed has a high density of lakes with good to excellent water quality. Two hundred-sixteen lake basins had at least one water quality measurement available. Of these lake basins, 117 had enough water quality information to conduct a formal assessment of aquatic recreation and 45 had enough information to conduct aquatic life assessments. One hundred and six lakes fully supported aquatic recreation and 11 did not support aquatic recreation. Forty-four of the 49 lakes that were assessed for aquatic life supported the use; 1 lake (Lower Island Lake, near Cromwell) failed to meet the aquatic life standards.

The Mississippi River-Grand Rapids Watershed has a mixture of deep and shallow lakes. Deep lakes have the greater capacity to assimilate and store phosphorus within the water column (typically in the hypolimnion). This not only limits internal nutrient loading within deep lakes but also removes phosphorus from being transferred to lakes further downstream. Typically, shallow lakes have higher phosphorus concentrations because they do not have this ability to trap phosphorus. Most of the lakes that did not support aquatic recreation were relatively shallow and frequently mix during windy days. As in any watershed, the best way to prevent lakes from becoming eutrophic is to keep nutrients available at their sources, rather than transporting them into the waterways.

Groundwater protection should be considered both for quantity and quality. Quantity is based on the amount of water withdrawn versus the amount of water being recharged to the aquifer. Groundwater withdrawals in the watershed have decreased from 1996 to 2015 at a statistically significant rate ($p<0.001$) while surface water levels have increased ($p<0.1$). The water table elevation, or depth to groundwater, for one of the DNR observation wells within the watershed has displayed significant decreasing trends over the most recent 20 years of data collected ($p<0.001$). Overall, groundwater withdrawals have been declining and shifting toward surface water withdrawals, the average potential groundwater recharge rate is comparable to the state average, streamflow appears to be decreasing (not statistically significantly), and the watershed's water table has exhibited some signs of decline. While fluctuations due to seasonal variations are normal, long-term changes in elevations should not be ignored.

Groundwater quality data from the MPCA Ambient Groundwater Monitoring Program indicated that although there were many detections of analytes, the majority were within water quality limits. Chloride was the most commonly detected contaminant within the wells, which is a growing concern associated with deicing agents as expansion of urban areas continues. It is estimated that the development pressure is moderate to high in many areas of the watershed where land is converted from farms, timberland and lakeshore to recreation and lake and country homes (NRCS, 2008). Two analytes, iron and manganese exceeded the drinking water quality standards at one of the domestic wells. However, the samples were collected from spigots outside the resident's home and are not necessarily representative of what the residents are drinking (i.e. filters, water softener). Baseline water quality data indicated that the northeast region has groundwater quality that is considered good, despite some exceedances to drinking water criteria. There were relatively high numbers of exceedances to the arsenic MCL for drinking water in private wells for this area. Arsenic is primarily naturally occurring and can be linked to presence of a clay layer and low dissolved oxygen levels, often associated with the Des Moines glacial lobe till, which is abundant in this region. Furthermore, the pollution sensitivity of near-surface materials throughout the watershed should be considered. While many of the areas had very low to moderate rankings, some areas had high vulnerability, correlating with sand and gravel quaternary geology. These areas may experience a possible risk of contamination due to high infiltration rates. While it may appear that this watershed does not exhibit a great risk, it is important to continue to monitor potentially harmful sites in order to inhibit possible water pollution.

Increased localized monitoring efforts will help accurately define the risks and extent of any issues within the watershed. Adoption of best management practices will benefit both surface and groundwater.

Overall, rivers and streams in the Mississippi River-Grand Rapids Watershed appear to be in good condition. Biological communities are generally good, four streams have been designated as Exceptional. Strategies are needed to address the limited number of aquatic life and aquatic recreation impairments, while protection strategies should be developed to maintain existing high quality resources. Some examples of actions that could help maintain the current conditions, and prevent degradation for surface waters include:

- Protect natural vegetative buffers along riparian zones
- Limit the alteration and/or removal of wetlands
- Continue civic engagement within the watershed to educate on the benefits of clean water, and how to keep it clean
- Promote shoreline restoration as development along lakes increase
- Promote forest stewardship plans to maintain the large expanses of forested lands in this watershed
- Develop nutrient management plans for the few areas in the watershed that have agricultural uses
- Consider plugging some ditched wetlands to avoid nutrient or DO impairments

Literature cited

Galatowitsch, S.A. 2012. Why invasive species stymie wetland restoration; Society of Wetland Scientists Research Brief, No. 2012-0001. 4 pp.

Hobbs, H.C. and Goebel, J. E. (1982), Geologic Map of Minnesota, Quaternary Geology, S-01. Minnesota Geological Survey. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://conservancy.umn.edu/handle/11299/60085

Jirsa, M.A., Boerboom, T. J., Chandler, V.W., Mossler, J. H., Runkel, A. C. and Setterholm, D. R. (2011), Geologic Map of Minnesota, Bedrock Geology, S-21. Minnesota Geological Survey. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://conservancy.umn.edu/handle/11299/101466

King, K.E. 1980. A History of Drainage Law in Minnesota with Special Emphasis on the Legal Status of Wetlands. Water Resources Research Center: Bulletin 106. University of Minnesota Graduate School. Minneapolis, MN. 48 p.

Kroening, S. and Ferrey, M. (2013), The Condition of Minnesota's Groundwater, 2007-2011. Document number: wq-am1-06. https:/www.pca.state.mn.us/sites/default/files/wq-am1-06.pdf

Larson, A.M. 2007. *The White Pine Industry in Minnesota: A History*. University of Minnesota Press, Minneapolis, MN. 432 p.

Minnesota Department of Health (2012a), Manganese: Tiered Health Based Guidance for Water.

Minnesota Department of Health (2012b), Manganese and Drinking Water. Retrieved from http://www.health.state.mn.us/divs/eh/risk/guidance/gw/mninfosheet.pdf

Minnesota Department of Health (2016a), Arsenic in Private Wells: Facts & Figures. Retrieved from https://apps.health.state.mn.us/mndata/arsenic_wells

Minnesota Department of Health (2016b), Private Wells - Arsenic. Retrieved from https://apps.health.state.mn.us/mndata/webmap/wells.html

Minnesota Department of Health (2018), Health-Based Values and Risk Assessment Advice for Water. Retrieved from http://www.health.state.mn.us/divs/eh/risk/guidance/hbvraawater.html

Minnesota Department of Natural Resources (2001), Figure1. Minnesota Ground Water Provinces.

Minnesota Department of Natural Resources (2016), Pollution Sensitivity of Near-Surface Materials. County Geologic Atlas Program. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://gisdata.mn.gov/dataset/geos-hydrogeology-atlas-hg02

Minnesota Department of Natural Resources (2018a), Groundwater Provinces. Retrieved from http://dnr.state.mn.us/groundwater/provinces/index.html

Minnesota Department of Natural Resources (2018b), Water use- Water Appropriations Permit Program. Retrieved from http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Minnesota Department of Natural Resources: State Climatology Office (2016), Annual Precipitation Maps. Retrieved from http://www.dnr.state.mn.us/climate/historical/annual_precipitation_maps.html

Minnesota Department of Natural Resources: State Climatology Office (2017), Climate. Retrieved from http://www.dnr.state.mn.us/faq/mnfacts/climate.html

Minnesota Pollution Control Agency (1999), Baseline Water Quality of Minnesota's Principal Aquifers: Region 1, Northeast Minnesota.

Minnesota Pollution Control Agency (2005), Minnesota's Ground Water [PowerPoint slides].

Minnesota Pollution Control Agency (MPCA). 2007. Minnesota Statewide Mercury Total Maximum Daily Load. Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (MPCA). 2008. Watershed Approach to Condition Monitoring and Assessment. Appendix 5.2 *in* Biennial Report of the Clean Water Council. Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (MPCA). 2015. Status and Trends of Wetlands in Minnesota: Vegetation Quality Baseline. wq-bwm-1-09. Minnesota Pollution Control Agency, St. Paul, MN.

Minnesota Pollution Control Agency (MPCA). 2016. Guidance Manual for Assessing the Quality of Minnesota Surface Water for the Determination of Impairment: 305(b) Report and 303(d) List. Environmental Outcomes Division, Minnesota Pollution Control Agency, St. Paul, Minnesota.

Minnesota Pollution Control Agency (2018), What's In My Neighborhood. Retrieved from https://www.pca.state.mn.us/data/whats-my-neighborhood

Minnesota Rules Chapter 7050. 2008. Standards for the Protection of the Quality and Purity of the Waters of the State. Revisor of Statutes and Minnesota Pollution Control Agency, St. Paul, Minnesota.

Morey, G.B., and Meints, J. (2000), Geologic Map of Minnesota, Bedrock Geology, S-20. Minnesota Geological Survey. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://mrdata.usgs.gov/geology/state/state.php?state=MN

National Oceanic and Atmospheric Administration: National Centers for Environmental Information (NOAA) (2016), Climate at a Glance: Time Series. Retrieved from http://www.ncdc.noaa.gov/cag/time-series/us/21/0/tavg/12/12/1895-2015?base_prd=true&firstbaseyear=1895&lastbaseyear=2000

National Resource Conservation Service (NRCS). 2008. Rapid Watershed Assessment: Prairie-Willow (MN) HUC: 07010103. NRCS. USDA. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_021558.pdf

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the Upper Midwest States. EPA/600/3-88/037. Corvalis, OR: United States Environmental Protection Agency. 56 p.

Streitz, A. (2011), Minnesota Pollution Control Agency. Retrieved from http://www.mgwa.org/newsletter/mgwa2011-4.pdf

United States Environmental Protection Agency (2017), National Primary Drinking Water Regulations. Retrieved from https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#main-content

United States Geological Survey (2007), Ground Water Recharge in Minnesota. Retrieved from http://pubs.usgs.gov/fs/2007/3002/pdf/FS2007-3002_web.pdf

United States Geological Survey (2015), Mean Annual Potential Groundwater Recharge Rates from 1996-2010 for Minnesota. Methodology documented in Smith, E.A. and Westernbroek, S.M., 2015 Potential groundwater recharge for the state of Minnesota using the Soil-Water-Balance model, 1996-2010: U.S. Geological Survey Investigations Report 2015-5038. Using: *ArcGIS* [GIS software]. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute. Retrieved from https://conservancy.umn.edu/handle/11299/60085

United States Geological Survey (2016), Aquifers and Groundwater. Retrieved from http://water.usgs.gov/edu/earthgwaquifer.html

United States Geological Survey (2018), USGS 05211000 Mississippi River at Grand Rapids, MN. Retrieved from https://waterdata.usgs.gov/nwis/inventory/?site_no=05211000

Western Regional Climate Center (WRCC) (2017), U.S.A. Divisional Climate Data. Retrieved from http://www.wrcc.dri.edu/spi/divplot1map.html

Zhang, H. (1998), Geologic Atlas of Stearns County, Minnesota: Hydrogeology of the Quaternary Water Table System. County Atlas Series, Atlas C-10, part B, Plate 8 of 10, Hydrogeology of the Quaternary Water-table System.

Appendix 1. Water chemistry definitions

Dissolved oxygen (DO) - Oxygen dissolved in water required by aquatic life for metabolism. Dissolved oxygen enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. Dissolved oxygen is removed from the water when organisms metabolize or breathe. Low DO often occurs when organic matter or nutrient inputs are high, and light inputs are low.

Escherichia coli (*E. coli*) - A type of fecal coliform bacteria that comes from human and animal waste. E. coli levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of *E. coli*.

Nitrate plus Nitrite – Nitrogen - Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, these species can stimulate excessive levels of algae in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-nitrogen to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen (nitrate-N), with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however, concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

Orthophosphate (OP) - OP is a water soluble form of phosphorus that is readily available to algae (bioavailable). While OPs occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

pH - A measure of the level of acidity in water. Rainfall is naturally acidic, but fossil fuel combustion has made rain more acid. The acidity of rainfall is often reduced by other elements in the soil. As such, water running into streams is often neutralized to a level acceptable for most aquatic life. Only when neutralizing elements in soils are depleted, or if rain enters streams directly, does stream acidity increase.

Total Kjeldahl nitrogen (TKN) - The combination of organically bound nitrogen and ammonia in wastewater. TKN is usually much higher in untreated waste samples then in effluent samples.

Total Phosphorus (TP) - Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Increasing the amount of phosphorus entering the system therefore increases the growth of aquatic plants and other organisms. Excessive levels of Phosphorous over stimulate aquatic growth and resulting in the progressive deterioration of water quality from overstimulation of nutrients, called eutrophication. Elevated levels of phosphorus can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries and toxins from cyanobacteria (blue green algae) which can affect human and animal health.

Total Suspended Solids (TSS) – TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity.

Higher turbidity results in less light penetration that may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

Unionized Ammonia (NH3) - Ammonia is present in aquatic systems mainly as the dissociated ion $NH4^{+}$, which is rapidly taken up by phytoplankton and other aquatic plants for growth. Ammonia is an excretory product of aquatic animals. As it comes in contact with water, ammonia dissociates into $NH4^{+}$ ions and ^{-}OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 2.1. Intensive watershed monitoring water chemistry stations in the Mississippi River-Grand Rapids Watershed

EQuIS ID	Biological Station ID	AUID	Waterbody Name	Location	Aggregated 12-digit HUC
S008-480	15UM053	07010103-759	Prairie River	@ CR-336, 6-miles NW of Nashwauk, MN	0701010301-01
S008-476	15UM060	07010103-712	East River	@ MN-65, 6.4-miles N of Nashwauk, MN	0701010301-02
S008-478	15EM049	07010103-760	Prairie River	@ CR-60, 2.7-miles SW of Lawrence, MN	0701010302-01
S003-667	15UM049	07010103-508	Prairie River	@ US-169, 2-mile NE of Grand Rapids, MN	0701010302-01
S008-477	15UM047	07010103-574	Split Hand Creek	@ CR-3, 0.9-miles S of Split Hand, MN	0701010303-02
S001-922	15UM084	07010103-754	Swan River	@ CR-431, 4-miles NE of Jacobson, MN	0701010304-01
S000-936	15UM071	07010103-753	Swan River	@ CSAH-10, 3.5-miles S of Bovey, MN	0701010304-02
S002-446	00UM020	07010103-515	Prairie River	@ 145th Ave, 6.5-miles NE of Sheshabee, MN	0701010305-01
S008-441	15UM012	07010103-758	Tamarack River	@ CR-64, 1.25-miles N of Haugen, MN	0701010305-02
S002-442	07UM082	07010103-519	Minnewawa Creek	@MN-65, 5-miles N of McGregor, MN	0701010306-01
S003-306	15UM022	07010103-512	Sandy River	@ CR-62, 2.8-miles NW of McGregor, MN	0701010306-02
S008-440	15UM041	07010103-526	Hill River	@ 640th Rd., 3.5-miles SE of Hill City, MN	0701010307-01
S008-442	10EM200	07010103-748	Willow River	@ CSAH-3, 3-miles W of Palisade, MN	0701010308-01
S008-443	15UM019	07010103-716	Willow River Ditch	@ Jack Pine Dr., 2-mile E of Macville, MN	0701010308-02
S004-408	15UM021	07010103-749	Moose River	@ US-169, 7.5-miles S of Hill City, MN	0701010308-03

Appendix 2.2. Intensive watershed monitoring biological monitoring stations in the Mississippi River-Grand Rapids Watershed

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07010103-760	00UM003	Prairie River	Upstream of CR 325, 10 mi. NE of Grand Rapids	Itasca	Lower Prairie River
07010103-542	00UM006	Day Brook	Upstream of Hwy 65, 14 mi. N of Nashwauk	Itasca	Upper Prairie River
07010103-554	00UM014	Trib. to Willow River	Upstream of CR 200, 10 mi. E of Remer	Cass	Upper Willow River
07010103-515	00UM020	Prairie River	Upstream of north/south rd. @ Balsam Town Hall off CR 64	Aitkin	Prairie River
07010103-514	00UM021	West Savanna River	Downstream of Savanna Portage State Park Rd, 13 mi. NE of Sheshebee	Aitkin	Prairie River
07010103-519	07UM082	Minnewawa Creek	Upstream of CR 65, 8 mi. E of Palisade	Aitkin	Big Sandy Lake Outlet
07010103-762	09UM087	Morrison Brook	Upstream of CR 74, 1 mi. W of Hill City	Aitkin	Hill River
07010103-603	09UM088	Hasty Brook	Upstream of Prairie Lake Rd, 5.2 mi. N of Cromwell	Carlton	Prairie River
07010103-506	10EM066	Swan River	N of 682nd St, 3 mi. SE of Warba	Aitkin	Lower Swan River
07010103-573	10EM125	Willow River	Adjacent to Hwy 6, 1 mi. NE of Remer	Cass	Upper Willow River
07010103-506	10EM194	Swan River	~0.25 mi. S of CR 69, 2 mi. S of Marble	Itasca	Lower Swan River
07010103-509	10EM200	Willow River	Upstream of CR 3 (480th St), 3 mi. W of Pallisade	Aitkin	Lower Willow River
07010103-516	15EM039	Prairie River	Upstream of Moen Rd, 8.5 mi. NW of Cromwell	St. Louis	Prairie River
07010103-760	15EM049	Prairie River	2.5 mi. downstream of CSAH 60 (Clearwater Rd), 5 mi. N of Bovey	Itasca	Lower Prairie River
07010103-512	15UM001	Sandy River	Downstream of CR 16, 6 mi. E of McGregor	Aitkin	Sandy River
07010103-518	15UM004	Minnewawa Creek	Upstream of CR 73, 5 mi. N of McGregor	Aitkin	Big Sandy Lake Outlet
07010103-757	15UM007	Tamarack River	Downstream of CR 126, 1 mi. W of Wright	Carlton	Tamarack River
07010103-757	15UM008	Tamarack River	Upstream of McMillan Rd, 5 mi. NW of Wright	Aitkin	Tamarack River
07010103-734	15UM009	Little Tamarack River	Downstream of 110th Ave, 6.5 mi. NW of Wright	Aitkin	Tamarack River
07010103-735	15UM010	Trib. to Tamarack River	Downstream of 500th Ln, 5 mi. N of Tamarack	Aitkin	Tamarack River
07010103-758	15UM012	Tamarack River	Upstream of CR 64, 5.5 mi. N of Tamarack	Aitkin	Tamarack River
07010103-516	15UM014	Prairie River	Downstream of 140th Ave, 1 mi. NE of Balsam	Aitkin	Prairie River
07010103-514	15UM016	West Savanna River	Downstream of 575th Ln, 6 mi. NE of Libby	Aitkin	Prairie River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07010103-602	15UM017	Libby Brook	Upstream of CR 36, 5 mi. N of Libby	Aitkin	City of Palisade-Mississippi River
07010103-716	15UM019	Willow River	Adjacent to unnamed road off of Jack Pine Dr, 2 mi. E of Haypoint	Aitkin	Upper Willow River
07010103-623	15UM020	Trib. to Mississippi River	Downstream of Hwy 65, 0.5 mi. NE of Balsam	Aitkin	City of Palisade-Mississippi River
07010103-749	15UM021	Moose River	Upstream of Hwy 169, 1 mi. S of Haypoint	Aitkin	Moose River
07010103-512	15UM022	Sandy River	Upstream of CR 62, 3 mi. NE of McGregor	Aitkin	Sandy River
07010103-748	15UM025	Willow River	Upstream of CR 18, 7 mi. NE of Palisade	Aitkin	Lower Willow River
07010103-741	15UM026	White Elk Creek	Downstream of 500th Ln, 0.5 mi. E of Waukenabo	Aitkin	Lower Willow River
07010103-599	15UM031	Michaud Brook	Upstream of Michaud Lake Dr (S of CR 161), 4 mi. W of Shovel Lake	Cass	Upper Willow River
07010103-751	15UM032	Willow River	Adjacent to private drive E of 64th St. NE, 2 mi. S of Remer	Cass	Upper Willow River
07010103-525	15UM035	Willow River, North Fork	Upstream of FR 2319, 4 mi. NE of Remer	Cass	Upper Willow River
07010103-751	15UM039	Willow River	Downstream of private driveway off CR 67, 9 mi. SW of Hill City	Aitkin	Upper Willow River
07010103-738	15UM040	Little Hill RIver	End of private ATV trail off of 368th Pl, 3 mi. SW of Hill City	Aitkin	Hill River
07010103-526	15UM041	Hill River	Adjacent to 640th Ln, 5 mi. SE of Hill City	Aitkin	Hill River
07010103-526	15UM042	Hill River	Downstream of private drive W of Hwy 169, 4 mi. SW of Hill City	Aitkin	Hill River
07010103-739	15UM044	Trib. to Hill River Ditch	Downstream of Annie Dagel Rd, 4.5 mi. SE of Hill City	Aitkin	Hill River
07010103-761	15UM045	Morrison Brook	Downstream of CR 241 (County Line Rd), 3.5 mi. NE of Hill City	Aitkin	Hill River
07010103-732	15UM046	Split Hand Creek	Adjacent to CR 432, 7 mi. NE of Hill City	Itasca	Split Hand Creek
07010103-574	15UM047	Split Hand Creek	Upstream of CR 68, 7 mi. SW of Warba	Itasca	Split Hand Creek
07010103-726	15UM048	Trib. to Mississippi River	Upstream of Bluebird Dr, 1 mi. W of Blackberry	Itasca	Split Hand-Mississippi River
07010103-508	15UM049	Prairie River	Upstream of Hwy 169, 10 mi. NE of Grand Rapids	Itasca	Lower Prairie River
07010103-571	15UM050	Prairie River, West Fork	Upstream of FR off of Hwy 53, 15 mi. NW of Nashwauk	Itasca	Upper Prairie River
07010103-696	15UM051	Balsam Creek	Upstream of snowmobile trail off of CR 333, 10 mi. NW of Nashwauk	Itasca	Balsam Creek
07010103-759	15UM053	Prairie River	Upstream of CR 336, 9 mi. NW of Nashwauk	Itasca	Upper Prairie River
07010103-618	15UM055	Sucker Brook	Upstream of CR 336, 5 mi. NW of Marble	Itasca	Lower Prairie River
07010103-722	15UM056	Trib. to Bray Lake	Adjacent to CR 56, 6 mi. NW of Nashwauk	Itasca	Lower Prairie River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07010103-717	15UM057	Trib. to Prairie River	Adjacent to FR 150, 15 mi. NW of Nashwauk	Itasca	Upper Prairie River
07010103-543	15UM058	Prairie River	Adjacent to SFR 150, 15 mi. NW of Nashwauk	Itasca	Upper Prairie River
07010103-712	15UM060	East River	Downstream of Hwy 65, 9.5 mi. N of Nashwauk	Itasca	East River
07010103-719	15UM061	Trib. to East River	Upstream of Hwy 65, 9 mi. N of Nashwauk	Itasca	East River
07010103-714	15UM062	East River	End of Blandin Logging Rd off of CR 545, 11 mi. NW of Nashwauk	Itasca	East River
07010103-721	15UM063	Deer Creek	Downstream of Hibtac Forest Rd off CR 710, 5 mi. N of Stevenson	St. Louis	Upper Prairie River
07010103-718	15UM064	East River	Upstream of forest trail off of CR 539, 7 mi. NW of Stevenson	Itasca	East River
07010103-590	15UM066	Pickerel Creek	Adjacent to CR 65, 1 mi. E of Kevin	Itasca	Upper Swan River
07010103-590	15UM067	Pickerel Creek	Downstream of Essar Steel Rd, 2 mi. N of Pengilly off Hwy 169	Itasca	Upper Swan River
07010103-583	15UM069	O'Brien Creek	Downstream of Itasca Greenway Snowmobile Tr off of Town Hall Rd, 2.5 mi. SE of Pengilly	Itasca	Upper Swan River
07010103-545	15UM070	Hay Creek	Downstream of Itasca Greenway Snowmobile trail, 4 mi. SE of Pengilly	Itasca	Upper Swan River
07010103-753	15UM071	Swan River	Upstream of CR 10, 7 mi. E of Grand Rapids	Itasca	Upper Swan River
07010103-754	15UM073	Swan River	Upstream of Hwy 10, 5 mi. SE of Warba	Itasca	Lower Swan River
07010103-594	15UM074	Sand Creek	Upstream of CR 445, 5 mi. N of Warba	Itasca	Lower Swan River
07010103-594	15UM075	Sand Creek	End of Power Line Tr, 10 mi. S of Calumet	Itasca	Lower Swan River
07010103-754	15UM078	Swan River	Downstream of Hwy 72, 2 mi. S of Warba	Itasca	Lower Swan River
07010103-754	15UM079	Swan River	Upstream of CR 431, 4 mi. SW of Swan River	Itasca	Lower Swan River
07010103-689	15UM080	Bruce Creek	Downstream of CR 431, 3 mi. S of Swan River	Itasca	Lower Swan River
07010103-608	15UM081	Bruce Creek	Upstream of CR 74, 2 mi. E of Warba	Itasca	Lower Swan River
07010103-595	15UM082	Unnamed creek (Warba Creek)	Adjacent to CR 8 (Felix Rd), 1 mi. N of Warba	Itasca	Lower Swan River
07010103-595	15UM083	Unnamed creek (Warba Creek)	Downstream of Feeley Unit FR, 3 mi. NE of Warba	Itasca	Lower Swan River
07010103-754	15UM084	Swan River	Upstream of CR 431, 3 mi. S of Swan River	Itasca	Lower Swan River
07010103-727	15UM088	Trib. to Mississippi River	Upstream of CR 72, 3 mi. SW of Philbin	Itasca	Split Hand-Mississippi River
07010103-728	15UM089	Trib. to Swan River	Upstream of 154th Ave, 7 mi. E of Jacobson	Aitkin	Lower Swan River
07010103-729	15UM090	Trib. to Swan River	Adjacent to Itasca Greenway Tr, 2 mi. E of Jacobson	Aitkin	Lower Swan River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07010103-731	15UM091	Trib. to Mississippi River	Upstream of private drive W of Hwy 65, 1 mi. N of Ball Bluff	Aitkin	City of Palisade-Mississippi River
07010103-587	15UM094	Clearwater Creek	Adjacent to Chippewa National Forest Rd, 1 mi. S of CR 60, 9 mi NE of Taconite	Itasca	Clearwater Creek
07010103-526	15UM105	Hill River	Upstream of private drive W of Hwy 169, 4 mi. SW of Hill City	Aitkin	Hill River
07010103-594	15UM106	Sand Creek	Downstream of CR 445, 5 mi. No of Warba	Itasca	Lower Swan River
07010103-749	15UM115	Moose River	Downstream of CR 29, 2 mi. S of Swarta	Aitkin	Moose River
07010103-512	16UM064	Sandy River	Upstream of CR 16, 6 mi. E of McGregor	Aitkin	Sandy River
07010103-526	16UM150	Hill River	Downstream of 640th Ln, 7 mi. SE of Hill City	Aitkin	Hill River
07010103-730	16UM151	Trib. to Mississippi River	Downstream of private drive W of Hwy 65, 2 mi. N of Ball Bluff	Aitkin	City of Palisade-Mississippi River
07010103-756	16UM152	Trib. to Mississippi River	Upstream of Great River Rd (CR 10), 3 mi. SW of Jacobson	Aitkin	City of Palisade-Mississippi River
07010103-732	16UM165	Split Hand Creek	Upstream of CR 432, 7 mi. NE of Hill City	Itasca	Split Hand Creek
07010103-733	16UM167	Pokegama Creek	Downstream of Pokegama Creek FR, 5 mi. SW of Ball Bluff	Aitkin	City of Palisade-Mississippi River
07010103-714	16UM168	East River	End of Blandin Logging Rd off of CR 545, 11 NW of Nashwauk	Itasca	East River
07010103-719	16UM169	Trib. to East River	Upstream of Hwy 65, 9 mi. N of Nashwauk	Itasca	East River
07010103-761	16UM170	Morrison Brook	Adjacent to 690th Ln, 5 mi. NW of Hill City	Aitkin	Hill River
07010103-545	99UM061	Hay Creek	0.2 mi. E of Hwy 12, E of Swan Lake	Itasca	Upper Swan River

Appendix 3.1. Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Exceptional Use Threshold	General Use Threshold	Modified Use Threshold	Confidence Limit
Fish						
1	Southern Rivers	2B, 2C	71	49	NA	±11
2	Southern Streams	2B, 2C	66	50	35	±9
3	Southern Headwaters	2B, 2C	74	55	33	±7
10	Southern Coldwater	2A	82	50	NA	±9
4	Northern Rivers	2B, 2C	67	38	NA	±9
5	Northern Streams	2B, 2C	61	47	35	±9
6	Northern Headwaters	2B, 2C	68	42	23	±16
7	Low Gradient	2B, 2C	70	42	15	±10
11	Northern Coldwater	2A	60	35	NA	±10
Invertebrates						
1	Northern Forest Rivers	2B, 2C	77	49	NA	±10.8
2	Prairie Forest Rivers	2B, 2C	63	31	NA	±10.8
3	Northern Forest Streams RR	2B, 2C	82	53	NA	±12.6
4	Northern Forest Streams GP	2B, 2C	76	51	37	±13.6
5	Southern Streams RR	2B, 2C	62	37	24	±12.6
6	Southern Forest Streams GP	2B, 2C	66	43	30	±13.6
7	Prairie Streams GP	2B, 2C	69	41	22	±13.6
8	Northern Coldwater	2A	52	32	NA	±12.4
9	Southern Coldwater	2A	72	43	NA	±13.8

Appendix 3.2. Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
Upper Prairie River: 0701010301-01							
07010103-542	00UM006	Day Brook	31	Northern Headwaters	42	67.3	7/15/2015
07010103-571	15UM050	Prairie River, West Fork	33.6	Low Gradient	61	52.4	6/15/2015
07010103-571	15UM050	Prairie River, West Fork	33.6	Low Gradient	61	71.7	6/14/2016
07010103-759	15UM053	Prairie River	215.5	Northern Streams	61	87.5	6/24/2015
07010103-717	15UM057	Trib. to Prairie River	15.5	Northern Headwaters	42	25.2	6/30/2015
07010103-717	15UM057	Trib. to Prairie River	15.5	Northern Headwaters	42	34.1	7/21/2016
07010103-543	15UM058	Prairie River	39.5	Northern Headwaters	42	49.3	6/24/215
07010103-721	15UM063	Deer Creek	6.7	Northern Headwaters	42	41.1	6/19/2015
East River: 0701010301-02							
07010103-712	15UM060	East River	35.3	Low Gradient	42	44.9	7/15/2015
07010103-719	15UM061	Trib. to East River	13.9	Northern Headwaters	42	41.9	6/30/2015
07010103-714	15UM062	East River	63.4	Northern Streams	47	64.5	6/29/2015
07010103-718	15UM064	East River	25	Northern Headwaters	42	69.4	6/23/2015
07010103-719	16UM169	Trib. to East River	58.7	Northern Headwaters	42	58.7	6/14/2016
Lower Prairie River: 0701010302-01							
07010103-760	00UM003	Prairie River	443.8	Northern Streams	47	62.6	6/23/2015
07010103-760	00UM003	Prairie River	443.8	Northern Streams	47	54	7/21/2015
07010103-760	15EM049	Prairie River	376	Northern Streams	47	68.9	6/23/2015
07010103-618	15UM055	Sucker Brook	30.1	Northern Headwaters	42	40.8	6/14/2016
07010103-722	15UM056	Trib. to Bray Lake	11.8	Northern Coldwater	35	31.4	8/8/2015
07010103-722	15UM056	Trib. to Bray Lake	11.8	Northern Coldwater	35	18.5	6/14/2016
Clearwater Creek: 0701010302-02							
07010103-587	15UM094	Clearwater Creek	61.5	Northern Streams	47	74.1	7/8/2015

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
Balsam Creek: 0701010302-03							
07010103-696	15UM051	Balsam Creek	50.9	Northern Streams	47	74.9	6/23/2015
Split Hand-Mississippi River: 0701010303-01							
07010103-726	15UM048	Trib. to Mississippi River	10.2	Northern Headwaters	42	35.6	6/15/2016
07010103-727	15UM088	Trib. to Mississippi River	7.1	Northern Headwaters	42	0	8/12/2015
Split Hand Creek: 0701010303-02							
07010103-732	15UM046	Split Hand Creek	20.5	Northern Headwaters	42	53.8	6/8/2015
07010103-574	15UM047	Split Hand Creek	48.1	Northern Headwaters	42	65.1	6/16/2015
07010103-732	16UM165	Split Hand Creek	20.6	Low Gradient	42	61	6/13/2016
Lower Swan River: 0701010304-01							
07010103-506	10EM066	Swan River	315.5	Northern Streams	47	69.2	9/19/2011
07010103-506	10EM066	Swan River	315.5	Northern Streams	47	69.7	6/22/2015
07010103-506	10EM194	Swan River	132.8	Northern Streams	47	66.6	7/7/2010
07010103-506	10EM194	Swan River	132.8	Northern Streams	47	68.3	6/9/2015
07010103-754	15UM073	Swan River	184.5	Northern Streams	47	82.6	6/16/2015
07010103-594	15UM074	Sand Creek	20.2	Northern Headwaters	42	63.6	6/10/2015
07010103-594	15UM075	Sand Creek	5.9	Northern Headwaters	42	57.8	6/23/2015
07010103-754	15UM078	Swan River	245.1	Northern Streams	47	73	7/14/2015
07010103-754	15UM079	Swan River	266.5	Northern Streams	47	90.6	7/20/2015

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07010103-689	15UM080	Bruce Creek	18.7	Northern Coldwater	35	57.1	6/9/2015
07010103-608	15UM081	Bruce Creek	11.8	Northern Headwaters	42	66.4	6/10/2015
07010103-595	15UM082	Unnamed creek (Warba Creek)	7	Northern Headwaters	42	28.6	6/9/2015
07010103-595	15UM082	Unnamed creek (Warba Creek)	7	Northern Headwaters	42	46.5	6/16/2016
07010103-595	15UM083	Unnamed creek (Warba Creek)	2.8	Northern Headwaters	42	41.3	6/9/2015
07010103-754	15UM084	Swan River	292.8	Northern Streams	47	78.7	7/13/2015
07010103-728	15UM089	Trib. to Swan River	9.1	Northern Headwaters	42	37.7	8/12/2015
07010103-728	15UM089	Trib. to Swan River	9.1	Northern Headwaters	42	0	6/15/2016
07010103-594	15UM106	Sand Creek	20.3	Northern Headwaters	42	65.3	9/2/2015
Upper Swan River: 0701010304-02							
07010103-590	15UM066	Pickerel Creek	2.3	Northern Coldwater	35	37.3	6/10/2015
07010103-590	15UM067	Pickerel Creek	2	Northern Coldwater	35	17.2	6/19/2015
07010103-583	15UM069	O'Brien Creek	9.9	Northern Headwaters	42	59.7	6/19/2015
07010103-545	15UM070	Hay Creek	48.1	Northern Headwaters	42	74	7/9/2015
07010103-753	15UM071	Swan River	147.7	Northern Streams	47	76	6/9/2015
07010103-545	99UM061	Hay Creek	57.4	Northern Streams	47	61	8/6/2015
Prairie River: 0701010305-01							
07010103-515	00UM020	Prairie River	175.9	Northern Streams	47	76.2	6/24/2015
07010103-514	00UM021	West Savanna River	20.9	Northern Headwaters	42	69.1	7/3/2014
07010103-603	09UM088	Hasty Brook	26.2	Northern Headwaters	42	58.9	7/8/2010

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
07010103-603	09UM088	Hasty Brook	26.2	Northern Headwaters	42	54.7	7/16/2015
07010103-516	15UM014	Prairie River	66.5	Northern Streams	47	61.2	7/14/2015
07010103-514	15UM016	West Savanna River	19.2	Northern Headwaters	42	44	7/20/2015
Tamarack River: 0701010305-02							
07010103-757	15UM007	Tamarack River	38.7	Low Gradient	42	57.1	7/13/2015
07010103-757	15UM008	Tamarack River	50.3	Northern Streams	47	50.7	7/13/2015
07010103-734	15UM009	Little Tamarack River	27.6	Northern Headwaters	42	54.7	6/10/2015
07010103-735	15UM010	Trib. to Tamarack River	11.9	Low Gradient	42	36.3	7/16/2015
07010103-758	15UM012	Tamarack River	81.7	Northern Streams	61	80.2	6/18/2015
07010103-758	15UM012	Tamarack River	81.7	Northern Streams	47	75.9	8/31/2016
Bid Sandy Lake Outlet: 0701010306-01							
07010103-519	07UM082	Minnewawa Creek	57.3	Northern Streams	47	34.3	7/30/2007
07010103-519	07UM082	Minnewawa Creek	57.3	Northern Streams	47	33.4	6/14/2016
07010103-518	15UM004	Minnewawa Creek	32.2	Northern Headwaters	23	16.5	6/16/2016
Sandy River: 0701010306-02							
07010103-512	15UM022	Sandy River	68.7	Northern Streams	47	26.3	8/22/2016
07010103-512	16UM064	Sandy River	17.5	Northern Headwaters	42	0.1	9/19/2016
Hill River: 0701010307-01							
07010103-762	09UM087	Morrison Brook	24.4	Northern Headwaters	42	55.8	7/8/2010
07010103-762	09UM087	Morrison Brook	24.4	Northern Headwaters	42	48.6	8/24/2016
07010103-738	15UM040	Little Hill River	27.6	Northern Headwaters	42	65.8	6/22/2015

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07010103-526	15UM041	Hill River	102.4	Northern Streams	47	64.2	6/17/2015
07010103-526	15UM042	Hill River	44.3	Low Gradient	42	79.8	8/12/2015
07010103-739	15UM044	Trib. to Hill River Ditch	10.9	Northern Headwaters	42	15.9	6/30/2015
07010103-739	15UM044	Trib. to Hill River Ditch	10.9	Northern Headwaters	42	29.9	6/16/2016
07010103-761	15UM045	Morrison Brook	19.3	Northern Coldwater	35	45.8	6/10/2015
07010103-761	16UM170	Morrison Brook	21.1	Northern Coldwater	35	21.6	8/25/2016
Lower Willow River: 0701010308-01							
07010103-509	10EM200	Willow River	485.9	Northern Streams	47	76.6	7/25/2011
07010103-509	10EM200	Willow River	485.9	Northern Streams	47	67.3	7/16/2015
07010103-748	15UM025	Willow River	412.6	Northern Streams	47	57.9	7/14/2015
07010103-741	15UM026	White Elk Creek	24.1	Northern Headwaters	42	0	7/20/2015
07010103-741	15UM026	White Elk Creek	24.1	Northern Headwaters	42	30	9/19/2016
Upper Willow River: 0701010308-02							
07010103-554	00UM014	Trib. to Willow River	5.8	Northern Headwaters	42	31.3	7/20/2016
07010103-573	10EM125	Willow River	42.1	Northern Headwaters	42	79	8/16/2010
07010103-716	15UM019	Willow River Ditch	173.5	Northern Streams	61	68.7	8/12/2015
07010103-599	15UM031	Michaud Brook	2.6	Northern Headwaters	42	22.6	7/23/2015
07010103-599	15UM031	Michaud Brook	2.6	Northern Headwaters	42	35.5	7/20/2016
07010103-751	15UM032	Willow River	51.1	Northern Streams	47	57.5	6/11/2015
07010103-525	15UM035	Willow River, North Fork	17.5	Northern Headwaters	42	59.4	6/17/2015

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Threshold	FIBI	Visit Date
07010103-751	15UM039	Willow River	147	Northern Streams	47	74	7/14/2015
Moose River: 0701010308-03							
07010103-749	15UM021	Moose River	61.3	Northern Streams	47	42.5	6/22/2015
07010103-749	15UM115	Moose River	47.5	Low Gradient	42	68	8/27/2015
City of Palisade-Mississippi River: 0701010309-01							
07010103-602	15UM017	Libby Brook	5.3	Northern Headwaters	42	50.7	6/10/215
07010103-602	15UM017	Libby Brook	5.3	Northern Headwaters	42	32.8	6/15/2016
07010103-623	15UM020	Trib. to Mississippi River	7.4	Northern Headwaters	42	44.9	8/27/2015
07010103-731	15UM091	Trib. to Mississippi River	7.2	Northern Headwaters	42	32.6	7/23/2015
07010103-731	15UM091	Trib. to Mississippi River	7.2	Northern Headwaters	42	34.1	8/24/2016
07010103-730	16UM151	Trib. to Mississippi River	10.5	Northern Headwaters	42	26.6	6/16/2016
07010103-756	16UM152	Trib. to Mississippi River	13.9	Northern Headwaters	42	0	8/25/2016
07010103-733	16UM167	Pokegama Creek	28.3	Northern Headwaters	42	11.1	6/13/2016

Appendix 3.3. Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
Upper Prairie River: 0701010301-01							
07010103-717	15UM057	Unnamed creek	15.49	4	51	53.13	20-Aug-15
07010103-542	00UM006	Day Brook	30.98	3	53	57.17	29-Jul-15
07010103-571	15UM050	Prairie River, West Fork	33.63	4	76	84.00	11-Aug-15
07010103-543	15UM058	Prairie River	39.54	4	51	75.09	01-Sep-15
07010103-759	15UM053	Prairie River	215.46	4	76	83.00	11-Aug-15
East River: 0701010301-02							
07010103-719	16UM169	Unnamed creek	13.90	4	51	34.18	24-Aug-16
07010103-718	15UM064	East River	25.03	3	53	80.89	02-Sep-15
07010103-712	15UM060	East River	35.35	4	51	43.00	29-Jul-15
07010103-712	15UM060	East River	35.35	4	51	70.79	24-Aug-16
07010103-714	16UM168	East River	63.34	3	53	70.64	24-Aug-16
Lower Prairie River: 0701010302-01							
07010103-722	15UM056	Unnamed creek	11.84	8	32	48.59	18-Aug-15
07010103-618	15UM055	Sucker Brook	30.06	4	51	89.99	20-Aug-15
07010103-508	15UM049	Prairie River	500.64	1	49	54.00	11-Aug-15
Clearwater Creek: 0701010302-03							
07010103-587	15UM094	Clearwater Creek	61.54	3	53	62.17	01-Sep-15
Balsam Creek: 0701010302-03							
07010103-696	15UM051	Balsam Creek	50.89	3	53	75.33	01-Sep-15
Split Hand Creek-Mississippi River: 0701010303-01							
07010103-727	15UM088	Unnamed creek	7.06	4	51	50.00	19-Aug-15
07010103-726	15UM048	Unnamed creek	10.19	3	53	48.89	25-Aug-16
Split Hand Creek: 0701010303-02							
07010103-732	15UM046	Unnamed creek	20.55	4	51	48.55	26-Aug-15
07010103-574	15UM047	Split Hand Creek	48.12	4	51	80.00	12-Aug-15

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
Lower Swan River: 0701010304-01							
07010103-595	15UM083	Unnamed creek (Warba Creek)	2.78	4	51	59.38	12-Aug-15
07010103-594	15UM075	Sand Creek	5.92	4	51	60.58	12-Aug-15
07010103-595	15UM082	Unnamed creek (Warba Creek)	6.97	4	51	85.58	12-Aug-15
07010103-729	15UM090	Unnamed creek	8.82	4	51	76.04	01-Sep-15
07010103-728	15UM089	Unnamed creek	9.13	4	51	65.02	23-Aug-16
07010103-728	15UM089	Unnamed creek	9.13	4	51	74.00	11-Aug-15
07010103-689	15UM080	Bruce Creek	18.68	8	32	35.12	12-Aug-15
07010103-594	15UM106	Sand Creek	20.28	3	53	69.95	02-Sep-15
07010103-754	15UM073	Swan River	184.54	4	51	74.46	19-Aug-15
07010103-754	15UM078	Swan River	245.08	4	51	77.18	31-Aug-15
07010103-754	15UM079	Swan River	266.52	3	53	51.91	12-Aug-15
07010103-754	15UM084	Swan River	292.81	4	51	90.47	23-Aug-16
07010103-754	10EM066	Swan River	315.55	4	51	51.27	16-Aug-10
07010103-754	10EM066	Swan River	315.55	4	51	85.00	12-Aug-15
Upper Swan River: 0701010304-02							
07010103-590	15UM067	Pickerel Creek	2.01	8	32	25.12	20-Aug-15
07010103-590	15UM066	Pickerel Creek	2.26	8	32	16.58	11-Aug-15
07010103-590	15UM066	Pickerel Creek	2.26	8	32	21.93	24-Aug-16
07010103-583	15UM069	O'Brien Creek (Welcome Creek)	9.94	3	53	63.45	20-Aug-15
07010103-545	15UM070	Hay Creek	48.08	3	53	39.99	02-Sep-15
07010103-545	99UM061	Hay Creek	57.40	4	51	60.16	16-Sep-15
07010103-753	10EM194	Swan River	132.84	3	53	65.53	13-Aug-15
07010103-753	10EM194	Swan River	132.84	3	53	75.75	21-Sep-10
07010103-753	15UM071	Swan River	147.67	3	53	50.25	03-Sep-15

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
Prairie River: 0701010305-01							
07010103-514	00UM021	West Savanna River	20.92	3	53	60.02	11-Aug-14
07010103-514	00UM021	West Savanna River	20.92	3	53	78.61	23-Aug-16
07010103-603	09UM088	Hasty Brook	26.21	3	53	63.42	21-Sep-09
07010103-603	09UM088	Hasty Brook	26.21	3	53	67.23	31-Aug-15
07010103-516	15EM039	Prairie River	37.75	4	51	69.00	17-Aug-15
07010103-516	15UM014	Prairie River	66.51	3	53	56.38	01-Sep-15
Tamarack River: 0701010305-02							
07010103-735	15UM010	Unnamed creek	11.90	4	51	61.12	01-Sep-15
07010103-734	15UM009	Little Tamarack River	27.59	4	51	66.55	26-Aug-15
07010103-757	15UM007	Tamarack River	38.71	4	51	79.45	31-Aug-15
07010103-757	15UM008	Tamarack River	50.34	4	51	88.75	01-Sep-15
07010103-758	15UM012	Tamarack River	81.66	4	76	66.71	01-Sep-15
07010103-758	15UM012	Tamarack River	81.66	4	76	80.11	23-Aug-16
Big Sandy Lake Outlet: 0701010306-01							
07010103-518	15UM004	Minnewawa Creek	32.17	4	37	18.26	25-Aug-16
07010103-518	15UM004	Minnewawa Creek	32.17	4	37	34.75	27-Aug-15
07010103-519	07UM082	Minnewawa Creek	57.31	4	51	44.23	06-Aug-07
07010103-519	07UM082	Minnewawa Creek	57.31	4	51	67.55	27-Aug-15
Sandy River: 0701010306-02							
07010103-512	15UM001	Sandy River	17.82	3	53	49.96	31-Aug-15
07010103-512	15UM022	Sandy River	68.71	4	51	46.79	31-Aug-16
Hill River: 0701010307-01							
07010103-739	15UM044	Unnamed ditch	10.94	4	51	63.78	26-Aug-15
07010103-761	15UM045	Morrison Brook	19.27	8	32	37.33	26-Aug-15
07010103-761	16UM170	Morrison Brook	21.09	8	32	34.86	13-Sep-16
07010103-762	09UM087	Morrison Brook	24.42	3	53	55.84	21-Sep-09

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
Hill River: 0701010307-01 (continued)							
07010103-762	09UM087	Morrison Brook	24.42	3	53	56.21	26-Aug-15
07010103-526	15UM105	Hill River	44.20	4	51	75.00	11-Aug-15
07010103-526	15UM042	Hill River	44.33	4	51	67.24	26-Aug-15
07010103-526	15UM041	Hill River	102.36	4	51	34.93	26-Aug-15
07010103-526	15UM041	Hill River	102.36	4	51	61.79	22-Aug-16
07010103-526	16UM150	Hill River	111.04	4	51	46.49	22-Aug-16
Lower Willow River: 0701010308-01							
07010103-741	15UM026	White Elk Creek	24.05	4	51	56.56	25-Aug-16
07010103-748	15UM025	Willow River	412.64	4	51	80.87	27-Aug-15
07010103-748	10EM200	Willow River	485.88	4	51	57.13	18-Aug-11
07010103-748	10EM200	Willow River	485.88	4	51	61.40	27-Aug-15
Upper Willow River: 0701010308-02							
07010103-599	15UM031	Unnamed creek (Michaud Brook)	2.60	3	53	32.23	22-Aug-16
07010103-599	15UM031	Unnamed creek (Michaud Brook)	2.60	3	53	47.62	11-Aug-15
07010103-554	00UM014	Unnamed creek	5.80	3	53	41.64	22-Aug-16
07010103-554	00UM014	Unnamed creek	5.80	3	53	43.00	11-Aug-15
07010103-525	15UM035	Willow River, North Fork	17.52	4	51	72.00	11-Aug-15
07010103-751	10EM125	Willow River	42.14	4	51	53.62	11-Aug-11
07010103-751	15UM032	Willow River	51.08	4	51	76.00	11-Aug-15
07010103-751	15UM039	Willow River	147.02	4	51	61.00	11-Aug-15
07010103-716	15UM019	Willow River Ditch	173.52	4	76	72.74	27-Aug-15
07010103-716	15UM019	Willow River Ditch	173.52	4	76	84.13	27-Aug-15
Moose River: 0701010308-03							
07010103-749	15UM115	Moose River	47.46	4	51	63.43	27-Aug-15
City of Palisade-Mississippi River: 0701010309-01							
07010103-602	15UM017	Unnamed creek (Libby Brook)	5.26	3	53	45.65	01-Sep-15
07010103-731	15UM091	Unnamed creek	7.23	4	51	73.35	13-Sep-16

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
City of Palisade-Mississippi River: 0701010309-01 (continued)							
07010103-623	15UM020	Unnamed Ck (Two Rivers Springs)	7.44	4	51	63.85	24-Aug-16
07010103-730	16UM151	Unnamed creek	10.49	4	51	80.33	24-Aug-16
07010103-756	16UM152	Unnamed ditch	13.92	4	51	12.17	24-Aug-16
07010103-733	16UM167	Pokegama Creek	28.31	3	53	22.51	24-Aug-16

Appendix 4.1. Fish species found during biological monitoring surveys

CommonName	Quantity of Stations Where Present	Quantity of Individuals Collected
banded killifish	1	1
bigmouth buffalo	4	10
bigmouth shiner	6	52
black bullhead	10	696
black crappie	20	94
blackchin shiner	3	3
blacknose dace	19	510
blacknose shiner	28	127
blackside darter	13	225
bluegill	22	143
bluntnose minnow	1	1
bowfin	9	27
brassy minnow	14	247
brook stickleback	26	302
brook trout	2	9
brown bullhead	6	9
burbot	52	369
central mudminnow	73	2097
channel catfish	1	1
common shiner	61	3005
creek chub	46	1894
fathead minnow	12	257
finescale dace	5	14
Gen: redhorses	4	32
golden shiner	26	209
greater redhorse	3	4
hornyhead chub	33	774
hybrid minnow	1	1
hybrid sunfish	3	85
Iowa darter	9	29
johnny darter	65	2480
largemouth bass	34	397
logperch	25	229
longnose dace	20	252
mimic shiner	6	93
mottled sculpin	19	179
muskellunge	1	2
northern pike	52	297
northern redbelly dace	17	197
pearl dace	6	31

CommonName	Quantity of Stations Where Present	Quantity of Individuals Collected
pumpkinseed	12	53
rock bass	47	576
shorthead redhorse	28	569
silver redhorse	23	203
smallmouth bass	17	172
spotfin shiner	16	327
spottail shiner	4	23
stonecat	1	2
tadpole madtom	40	135
trout-perch	4	24
walleye	20	39
white sucker	85	3658
yellow bullhead	8	27
yellow perch	52	1489

Appendix 4.2. Macroinvertebrate species found during biological monitoring surveys

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Acentrella rallatoma	0	0
Anafroptilum	3	6
Kribiodorum perpulchrum	0	0
Pericoma / Telmatoscopus	0	0
Thienemannimyia Gr.	19	140
Bezzia/Palpomyia	1	1
Odontomyia /Hedriodiscus	0	0
Hydrozoa	2	1
Turbellaria	4	11
Oligochaeta	3	6
Lumbriculidae	2	3
Lumbriculus	1	0
Enchytraeus	6	8
Henlea	2	1
Mesenchytraeus	1	0
Limnodrilus	1	0
Aulodrilus	6	16
Naididae	2	1
Stylaria	4	8
Dero	2	1
Nais	6	9

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Hirudinea	10	21
Gastropoda	2	1
Campeloma	1	0
Cipangopaludina	1	0
Valvata	3	2
Hydrobiidae	13	496
Lymnaeidae	7	7
Lymnaea stagnalis	1	0
Pseudosuccinea columella	2	13
Bulimnaea	1	0
Bulimnaea megasoma	1	0
Stagnicola	1	0
Ancylidae	2	1
Ferrissia	16	166
Planorbidae	6	21
Gyraulus	8	26
Helisoma anceps	2	1
Promenetus exacuous	2	1
Planorbula armigera	2	2
Micromenetus	2	4
Planorbella	3	11
Physidae	4	4
Physa	7	39
Physella	17	190
Pisidiidae	21	404
Caecidotea	6	32
Amphipoda	2	2
Gammarus	1	0
Hyalella	22	1073
Crangonyx	3	9
Cambaridae	2	2
Cambarus	2	1
Orconectes	9	10
Heptageniidae	10	60
Stenonema femoratum	1	0
Leucrocuta	4	11
Stenacron	13	39
Baetidae	10	51
Baetis	7	155
Acentrella	2	4
Baetis intercalaris	4	10
Baetis brunneicolor	7	45

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Baetis flavistriga	8	42
Paracloeodes minutus	1	0
Callibaetis	1	0
Isonychia	2	2
Metretopodidae	1	0
Leptophlebiidae	17	159
Leptophlebia	2	20
Paraleptophlebia	3	31
Ephemerellidae	3	3
Ephemerella	1	0
Ephemerella subvaria	1	0
Eurylophella	6	15
Tricorythodes	6	37
Caenis	8	34
Caenis diminuta	10	88
Caenis hilaris	3	3
Baetisca	5	38
Ephemera	5	4
Hexagenia	1	0
Ephoron album	2	1
Anisoptera	1	0
Aeshnidae	5	7
Anax junius	1	0
Aeshna	4	7
Aeshna umbrosa	4	4
Boyeria	4	6
Boyeria vinosa	8	21
Basiaeschna janata	4	4
Gomphidae	5	5
Gomphus	2	1
Hagenius brevistylus	2	1
Ophiogomphus	2	3
Ophiogomphus rupinsulensis	1	0
Libellulidae	1	0
Libellula	2	1
Macromia illinoiensis	1	0
Somatochlora	1	0
Somatochlora minor	2	1
Sympetrum vicinum	2	1
Corduliidae	5	14
Cordulegaster	1	0
Epitheca canis	1	0

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Calopterygidae	8	30
Calopteryx	13	53
Calopteryx maculata	3	3
Calopteryx aequabilis	8	30
Coenagrionidae	10	49
Pteronarcys	2	10
Amphinemura	1	0
Capniidae	2	1
Taeniopteryx	2	14
Perlidae	1	0
Acroneuria	3	6
Acroneuria lycorias	3	7
Acroneuria abnormis	2	1
Paragnetina media	3	3
Perlodidae	1	0
Isoperla	4	5
Perlesta	1	0
Corixidae	9	16
Sigara	5	13
Hesperocorixa	1	0
Palmacorixa	2	1
Callicorixa	1	0
Notonecta	2	1
Neoplea	3	4
Neoplea striola	6	20
Belostoma	1	0
Belostoma flumineum	7	30
Lethocerus	1	0
Ranatra	1	0
Gerridae	2	1
Rheumatobates	3	2
Rhagovelia	2	2
Microvelia	3	4
Mesovelia	2	1
Haliplus	7	21
Dytiscidae	4	8
Acilius	2	1
Desmopachria convexa	3	4
Hydaticus	2	1
Hygrotus	3	2
Laccophilus	3	2
Hydroporus	3	2
Liodessus	9	40

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Gyrinus	7	11
Dineutus	2	1
Hydraena	6	17
Hydrophilidae	6	6
Laccobius	2	1
Anacaena	5	20
Tropisternus	3	3
Enochrus	2	2
Helophorus	2	3
Hydrochus	2	1
Scirtidae	2	1
Helichus	1	0
Elmidae	1	0
Stenelmis	11	90
Dubiraphia	17	129
Optioservus	9	98
Ancyronyx variegatus	6	10
Macronychus	2	2
Macronychus glabratus	11	226
Sialis	9	20
Corydalidae	2	1
Chauliodes	2	1
Nigronia	3	2
Sisyra	2	1
Trichoptera	1	0
Protoptila	4	17
Philopotamidae	1	0
Chimarra	4	10
Chimarra obscura	2	1
Psychomyia flavida	2	7
Phylocentropus	1	0
Lype diversa	5	42
Hydropsychidae	12	119
Cheumatopsyche	18	320
Hydropsyche	13	287
Hydropsyche betteni	14	159
Hydropsyche dicantha	1	0
Hydropsyche scalaris	2	4
Hydropsyche simulans	2	7
Hydropsyche valanis	1	0
Hydropsyche placoda	1	0
Ceratopsyche	7	93
Ceratopsyche vexa	2	105

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Ceratopsyche bronta	2	9
Ceratopsyche morosa	1	0
Ceratopsyche slossonae	1	0
Ceratopsyche sparna	1	0
Ceratopsyche alhedra	1	0
Hydroptilidae	4	4
Hydroptila	10	33
Oxyethira	12	47
Phryganeidae	5	8
Ptilostomis	12	27
Limnephilidae	16	155
Hydatophylax	2	1
Hydatophylax argus	2	1
Glyphopsyche irrorata	2	1
Neophylax oligius	2	1
Limnephilus	1	0
Pycnopsyche	6	7
Goera	1	0
Nemotaulius hostilis	1	0
Molanna	5	5
Leptoceridae	3	5
Triaenodes	5	9
Mystacides	2	8
Oecetis	5	8
Oecetis avara	8	46
Oecetis persimilis	2	2
Nectopsyche	1	0
Nectopsyche diarina	2	2
Ceraclea	6	37
Lepidostoma	2	30
Brachycentrus	2	1
Brachycentrus numerosus	5	130
Micrasema	2	16
Micrasema rusticum	4	11
Micrasema sprulesi	1	0
Helicopsyche	3	43
Helicopsyche borealis	12	130
Polycentropodidae	5	5
Polycentropus	6	25
Neureclipsis	11	52
Nyctiophylax	5	6
Glossosomatidae	1	0

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Glossosoma	1	0
Glossosoma intermedium	1	0
Glossosoma nigrior	1	0
Paraponyx	2	1
Petrophila	1	0
Parapoynx	3	10
Tipulidae	1	0
Tipula	4	5
Limoniinae	2	1
Antocha	1	0
Helius	1	0
Hexatoma	1	0
Ulomorpha	1	0
Dicranota	2	2
Psychodidae	1	0
Dixidae	1	0
Dixa	1	0
Dixella	6	13
Culicidae	4	5
Anopheles	5	11
Simuliidae	3	3
Simulium	20	873
Ceratopogonidae	6	5
Atrichopogon	4	3
Forcipomyia	2	1
Dasyhelea	2	1
Ceratopogoninae	7	34
Chironomidae	1	0
Lasiodiamesa	2	1
Tanypodinae	10	15
Clinotanypus	3	5
Natarsia	4	3
Ablabesmyia	13	70
Conchapelopia	3	2
Guttipelopia	1	0
Labrundinia	12	29
Larsia	2	1
Nilotanypus	6	6
Pentaneura	5	30
Telopelopia okoboji	2	1
Thienemannimyia	4	10
Zavrelimyia	8	22
Procladius	9	33

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Potthastia	2	2
Odontomesa	1	0
Orthocladiinae	7	7
Brillia	4	3
Corynoneura	8	16
Cricotopus	20	185
Diplocladius cultriger	1	0
Doncricotopus	2	1
Doncricotopus bicaudatus	1	0
Eukiefferiella	1	0
Gymnometriocnemus	2	1
Heterotrissocladius	1	0
Limnophyes	4	4
Lopescladius	2	1
Nanocladius	5	14
Orthocladius	10	17
Parachaetocladius	1	0
Paracricotopus	1	0
Parakiefferiella	5	17
Parametriocnemus	10	61
Psectrocladius	7	20
Rheocricotopus	11	27
Synorthocladius	4	4
Thienemanniella	12	24
Tvetenia	7	31
Xylotopus par	6	14
Chironomini	3	3
Chironomus	4	60
Cladopelma	1	0
Cryptochironomus	5	4
Cryptotendipes	1	0
Demicryptochironomus	1	0
Dicrotendipes	5	25
Endochironomus	4	19
Glyptotendipes	4	7
Lauterborniella agrayloides	2	1
Microtendipes	18	103
Nilothauma	1	0
Parachironomus	5	8
Paracladopelma	1	0

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Paralauterborniella nigrohalterale	3	3
Paratendipes	4	7
Phaenopsectra	6	6
Polypedilum	24	320
Saetheria	1	0
Stenochironomus	15	56
Stictochironomus	4	5
Tribelos	6	10
Xenochironomus xenolabis	2	1
Tanytarsini	8	8
Cladotanytarsus	2	1
Micropsectra	17	176
Paratanytarsus	15	142
Rheotanytarsus	21	208
Stempellina	2	1
Stempellinella	15	53
Tanytarsus	17	157
Neozavrelia	1	0
Stratiomyidae	4	3
Atherix	1	0
Tabanidae	4	5
Chrysops	2	1
Empididae	4	3
Roederiodes	1	0
Hemerodromia	15	26
Neoplasta	2	1
Dolichopodidae	1	0
Ephydridae	7	9
Epitheca spinigera	1	0
Gymnochthebius	3	2
Fridericia	3	2
Acerpenna pygmaea	7	45
Procloeon	14	56
Nemata	8	22
Orthocladius (Symposiocladius)	4	11
Acerpenna	12	114
Labiobaetis	3	4
Plauditus	1	0
Labiobaetis dardanus	2	1
Labiobaetis propinquus	9	106

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Pseudocloeon propinquum	3	27
Uenoidae	3	9
Oecetis furva	3	5
Oecetis testacea	8	76
Acentrella parvula	2	1
Pseudocentroptiloides usa	1	0
Maccaffertium	13	201
Maccaffertium vicarium	7	34
Maccaffertium mediopunctatum	2	2
Aquarius	1	0
Platambus	1	0
Heterosternuta	1	0
Neoporus	3	4
Sanfilippodytes	1	0
Acari	18	112
Iswaeon	9	61
Trepaxonemata	3	3
Naidinae	2	3
Tubificinae	7	23

Appendix 5. Minnesota Stream Habitat Assessment results

Habitat information documented during each fish sampling visit is provided. This table convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the aggregated HUC-12 subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	00UM006	Day Brook	5	12	22	15	30	84	Good
3	15UM050	Prairie River, West Fork	5	11.2	11.3	13	13.7	54.1	Fair
2	15UM053	Prairie River	5	11.5	14	10	14	54.5	Fair
3	15UM057	Trib. to Prairie River	5	12.5	13	15.3	16	61.8	Fair
2	15UM058	Prairie River	5	12	15.9	11	20	63.9	Fair
2	15UM063	Deer Creek	4.4	13	19.8	12	27.5	76.6	Good
Average Habitat Results: *Upper Prairie River Aggregated 12 HUC*			**4.9**	**12**	**16**	**12.7**	**20.2**	**65.8**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
3	15UM060	East River	5	12	13.7	14.3	14.7	59.7	Fair
1	15UM061	Trib. to East River	5	10	18.6	18	25	76.6	Good
1	15UM062	East River	5	12	20	11	23	71	Good
2	15UM064	East River	5	13.3	23.5	13.5	25.5	80.8	Good
Average Habitat Results: *East River Aggregated 12 HUC*			**2**	**11.8**	**19**	**14.2**	**22**	**72**	**Good**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	00UM003	Prairie River	4.5	11.5	11.5	14	15.5	57	Fair
2	15UM049	Prairie River	2.5	10.8	18.6	10.5	20	62.3	Fair
3	15UM055	Sucker Brook	5	10	10	10.7	13.7	49.4	Fair
4	15UM056	Trib. to Bray Lake	4.5	12.5	19.2	13	24	73.2	Good
1	15EM049	Prairie River	5	13	18.9	17	20	73.9	Good
Average Habitat Results: *Lower Prairie River Aggregated 12 HUC*			**4.3**	**11.6**	**15.6**	**13**	**18.6**	**63.2**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15UM094	Clearwater Creek	5	13	18.8	16	18	70.8	Good
Average Habitat Results: *Clearwater Creek Aggregated 12 HUC*			**5**	**13**	**18.8**	**16**	**18**	**70.8**	**Good**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15UM051	Balsam Creek	5	13.3	20.2	16.5	25	80	Good
Average Habitat Results: *Balsam Creek Aggregated 12 HUC*			**5**	**13.3**	**20.2**	**16.5**	**25**	**80**	**Good**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
5	15UM048	Trib. to Mississippi River	4.1	11.3	15.4	10.2	13	54	Fair
4	15UM088	Trib. to Mississippi River	5	11.4	11.8	10.8	11.5	50.4	Fair
Average Habitat Results: *Split Hand-Mississippi River Aggregated 12 HUC*			**4.6**	**11.4**	**13.6**	**10.5**	**12.3**	**52.2**	**Fair**

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15UM046	Split Hand Creek	5	13	19	15	16.5	68.5	Good
2	15UM047	Split Hand Creek	3	11.5	12	6	7.5	40	Poor
2	16UM165	Split Hand Creek	5	11	15	13	15	59	Fair
Average Habitat Results: *Split Hand Creek Aggregated 12 HUC*			**4.3**	**11.8**	**15.3**	**11.3**	**13**	**55.8**	**Fair**

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
4	10EM066	Swan River	4.7	12.3	9.9	12.5	18	57.6	Fair
3	10EM194	Swan River	4.2	12	20.2	13.7	23.7	73.7	Good
2	15UM073	Swan River	4.3	10.3	15	9.5	11	50	Fair
1	15UM074	Sand Creek	4.5	12.5	17.3	14	28	76.3	Good
2	15UM075	Sand Creek	5	11	11	11	12	50	Fair
2	15UM078	Swan River	4.3	8.8	12.3	9	13	47.3	Fair
2	15UM079	Swan River	4.3	12.8	20.8	13	25	75.8	Good
2	15UM080	Bruce Creek	4.6	8.5	12	8.5	13	46.6	Fair
1	15UM081	Bruce Creek	5	12.5	6.9	14	19	57.4	Fair
3	15UM082	Unnamed Creek (Warba Creek)	4.5	12.3	13.3	7.3	12	49.4	Fair
2	15UM083	Unnamed Creek (Warba Creek)	5	13.5	14.5	5	12.5	50.5	Fair
3	15UM084	Swan River	5	11.7	13.7	12.3	18.3	61.1	Fair

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
5	15UM089	Trib. to Swan River	5	11.6	11.5	10.8	12.4	51.3	Fair
2	15UM090	Trib. to Swan River	5	10	12.5	10	12.5	50	Fair
2	15UM106	Sand Creek	5	9	17.2	14	29	74.2	Good
Average Habitat Results: *Lower Swan River Aggregated 12 HUC*			**4.7**	**11.3**	**13.9**	**11**	**17.3**	**58.1**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	15UM065	Unnamed Ditch	2.5	13	11	11	9	46.5	Fair
3	15UM066	Pickerel Creek	4.8	12.7	11.7	13.7	14.7	57.4	Fair
2	15UM067	Pickerel Creek	3.8	13.3	11.3	9.5	14.5	52.3	Fair
2	15UM069	O'Brien Creek	3.8	12.5	19.5	12	20	67.8	Good
2	15UM070	Hay Creek	5	11.5	17.2	12	19	64.7	Fair
2	15UM071	Swan River	2	3.3	13.7	14	17.5	59.4	Fair
2	99UM061	Hay Creek	5	10.5	12.8	16	19	63.3	Fair
Average Habitat Results: *Upper Swan River Aggregated 12 HUC*			**3.8**	**11**	**13.9**	**12.6**	**16.2**	**58.8**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	00UM020	Prairie River	5	11	15.5	11	15	57.5	Fair
3	00UM021	West Savanna River	5	11.5	18.1	13.3	19.3	67.3	Good
3	09UM088	Hasty Brook	5	13.3	20.7	14.3	27	80.3	Good
2	15UM014	Prairie River	5	12	15.7	12	12.5	57.2	Fair
1	15UM016	West Savanna River	5	12.5	16	15	22	70.5	Good
1	15EM039	Prairie River	5	11	6	13	13	48	Fair
Average Habitat Results: *Prairie River Aggregated 12 HUC*			**5**	**11.9**	**15.3**	**13.1**	**18.1**	**63.5**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15UM007	Tamarack River	3.5	11	18	13.5	15.5	61.5	Fair
2	15UM008	Tamarack River	4.3	11.3	18.8	14	16	64.3	Fair
2	15UM009	Little Tamarack River	5	8	14.5	12	13	52.5	Fair
3	15UM010	Trib. to Tamarack River	5	9.3	8.3	13.3	13	49	Fair
4	15UM012	Tamarack River	5	11.5	14.7	9.5	15	55.7	Fair
Average Habitat Results: *Tamarack River Aggregated 12 HUC*			**4.6**	**10.2**	**14.9**	**12.5**	**14.5**	**56.6**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
4	07UM082	Minnewawa Creek	5	10.1	9.7	11.5	10.8	47	Fair
4	15UM004	Minnewawa Creek	4.6	11.8	7.5	9	5.3	38.1	Poor
Average Habitat Results: *Big Sandy Lake Outlet Aggregated 12 HUC*			**4.8**	**11**	**8.6**	**10.3**	**8.1**	**42.6**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	15UM001	Sandy River	3.3	7.5	16.2	11.5	14.5	52.9	Fair
2	15UM022	Sandy River	4	10.5	19	7	11	51.5	Fair
1	16UM064	Sandy River	5	11	19	9	13	57	Fair
Average Habitat Results: *Sandy River Aggregated 12 HUC*			**4.1**	**9.7**	**18.1**	**9.2**	**12.8**	**53.8**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
4	09UM087	Morrison Brook	3.8	10.3	15.2	13.3	16	58.5	Fair
2	15UM040	Little Hill River	5	10.5	13.9	15	17	61.4	Fair
3	15UM041	Hill River	5	9.3	15	11	7	47.3	Fair
2	15UM042	Hill River	4.5	10.5	14.5	9	8	46.5	Fair
3	15UM044	Trib. to Hill River Ditch	5	11	10.9	8.7	9	44.5	Fair
2	15UM045	Morrison Brook	2	5	19.5	12	17.5	55.5	Fair
1	15UM105	Hill River	5	10	7	12	6	40	Fair
1	16UM150	Hill River	5	11	8	16	11	51	Fair
2	16UM170	Morrison Brook	5	11.5	8	12.5	13.5	50.5	Fair
Average Habitat Results: *Hill River Aggregated 12 HUC*			**4.5**	**9.9**	**12.4**	**12.2**	**11.7**	**50.6**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	10EM189	Unnamed Ditch	5	13	3	12	7	40	Fair
3	10EM200	Willow River	5	10.8	19.3	13.3	19	67.5	Good
1	15UM023	Trib. to Willow River	2.5	7.5	9	7	7	33	Fair
2	15UM025	Willow River	5	9.5	14.5	7.5	10	46.5	Fair
5	15UM026	White Elk Creek	3.9	9.5	13.9	14	11.2	52.4	Fair
1	15UM028	Trib. to Willow River	1.5	7.5	9	6	10	34	Fair
1	15UM029	Unnamed Ditch	3	10	8	10	10	41	Fair
Average Habitat Results: *Lower Willow River Aggregated 12 HUC*			**3.7**	**9.7**	**11**	**10**	**10.6**	**44.9**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
4	00UM014	Trib. to Willow River	5	12.6	20.7	13.5	24.5	76.4	Good
1	10EM125	Willow River	5	12	12	15	20	64	Fair
3	15UM019	Willow River	5	9.5	15.7	9	6.7	45.8	Fair
5	15UM031	Michaud Brook	5	10.9	19.2	14	22.6	71.1	Good
2	15UM032	Willow River	4.5	9.3	12	12.5	18	56.2	Fair
1	15UM034	Birch Brook	2.5	9.5	9	12	6	39	Poor
2	15UM035	Willow River, North Fork	5	10	15.7	11.5	13.5	55.7	Fair
2	15UM039	Willow River	3.8	9	8	15.5	15	51.3	Fair
Average Habitat Results: *Upper Willow River Aggregated 12 HUC*			**4.8**	**10.4**	**14**	**12.9**	**15.8**	**57.4**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	15UM021	Moose River	5	10.5	12	11	8	46.5	Fair
2	15UM115	Moose River	5	11	11.3	12	18	57.3	Fair
Average Habitat Results: *Moose River Aggregated 12 HUC*			**5**	**10.8**	**11.7**	**11.5**	**13**	**51.9**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
3	15UM017	Libby Brook	5	12.2	15.8	11	20.7	64.6	Fair
1	15UM018	Trib. to Mississippi River	1.8	8	7	12	9	37.8	Poor
3	15UM020	Trib. to Mississippi River	5	10.8	10.7	14.7	12.7	53.8	Fair
1	15UM087	Pokegama Creek	5	10.5	18	13	11	57.5	Fair
4	15UM091	Trib. to Mississippi River	3.9	11.9	10.9	10	15.5	52.2	Fair
2	16UM151	Trib. to Mississippi River	4	11	14.5	7	12	48.5	Fair
2	16UM152	Trib. to Mississippi River	4	11.5	10	12.5	3.5	41.5	Fair
2	16UM167	Pokegama Creek	5	12	16.8	13	17.5	64.3	Fair
Average Habitat Results: *City of Palisade-Mississippi River Aggregated 12 HUC*			**4.2**	**11**	**13**	**11.7**	**12.7**	**52.5**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Appendix 6. Fish contaminants: summary of fish length, mercury, PCBs, and PFOS by waterway-species-year

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			PFOS (µg/kg)				
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
01002300	ROUND*	Bluegill sunfish	2012	FILSK	10	2	7.5	7.2	7.7	0.105	0.101	0.109								
		Northern pike	2012	FILSK	8	8	19.0	17.5	23.7	0.343	0.272	0.459								
		Walleye	2012	FILSK	4	4	22.8	19.7	25.8	0.816	0.652	0.889								
		Yellow bullhead	2012	FILET	5	1	10.7	10.7	10.7	0.311	0.311	0.311								
01003300	MINNEWAWA*	Bluegill sunfish	1992	FILSK	8	1	7.3	7.3	7.3	0.034	0.034	0.034								
			2012	FILSK	10	2	7.7	7.2	8.1	0.050	0.041	0.059								
		Black crappie	2012	FILSK	10	2	9.1	8.5	9.6	0.061	0.059	0.063								
		Brown bullhead	1992	FILET	8	1	11.6	11.6	11.6	0.034	0.034	0.034	1	0.01	0.01	Y				
		Northern pike	1984	FILSK	12	3	23.1	18.5	27.5	0.133	0.120	0.150								
			1992	FILSK	24	4	24.5	18.3	30.8	0.153	0.110	0.230	1	0.025	0.025	Y				
			2012	FILSK	8	8	20.5	17.3	24.2	0.223	0.157	0.465								
		Walleye	1984	FILSK	7	3	17.8	13.4	22.2	0.223	0.170	0.290								
			1992	FILSK	23	4	20.0	13.5	27.0	0.291	0.083	0.480	1	0.031	0.031					
			2012	FILSK	6	6	19.0	17.3	20.5	0.280	0.204	0.344								
		Yellow bullhead	2012	FILET	5	1	12.0	12.0	12.0	0.100	0.100	0.100								
01003600	WAKEFIELD**	Bluegill sunfish	2013	FILSK	10	2	8.1	7.7	8.5	0.178	0.167	0.189								
		Black crappie	2013	FILSK	10	2	9.7	8.7	10.7	0.217	0.164	0.270								
		Northern pike	2013	FILSK	8	8	19.3	16.5	21.8	0.781	0.600	0.968								
		Walleye	2013	FILSK	4	4	16.6	13.5	18.6	0.741	0.584	0.923								
		Yellow bullhead	2013	FILET	4	1	12.6	12.6	12.6	0.580	0.580	0.580								
01003800	REMOTE**	Bluegill sunfish	2014	FILSK	7	1	6.7	6.7	6.7	0.064	0.064	0.064								
		Black crappie	2014	FILSK	11	1	9.1	9.1	9.1	0.246	0.246	0.246								
		Northern pike	2014	FILSK	6	6	23.4	21.2	27.3	0.518	0.367	0.657								
		Yellow bullhead	2014	FILSK	4	1	10.0	10.0	10.0	0.556	0.556	0.556								
01004000	AITKIN	Bluegill sunfish	2008	FILSK	9	1	8.1	8.1	8.1	0.047	0.047	0.047								
			2016	FILSK	6	1	9.5	9.5	9.5	0.090	0.090	0.090								
		Black crappie	2008	FILSK	3	1	8.1	8.1	8.1	0.052	0.052	0.052								
			2016	FILSK	10	1	9.1	9.1	9.1	0.050	0.050	0.050								
		Brown bullhead	2016	FILET	4	1	14.3	14.3	14.3	0.128	0.128	0.128								

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)			
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
		Northern pike	2008	FILSK	4	4	23.3	22.0	26.4	0.199	0.161	0.239								
			2016	FILSK	8	8	20.0	17.6	22.3	0.226	0.067	0.320								
		Pumpkinseed sunfish	1993	FILSK	8	1	6.9	6.9	6.9	0.058	0.058	0.058								
		Walleye	2008	FILSK	3	3	20.1	16.5	22.0	0.314	0.163	0.418								
			2016	FILSK	3	3	18.7	17.6	19.3	0.444	0.369	0.538								
		Yellow bullhead	2016	FILET	1	1	12.0	12.0	12.0	0.240	0.240	0.240								
01004200	GLACIER**	Bluegill sunfish	2011	FILSK	9	2	6.8	6.4	7.1	0.079	0.077	0.081								
		Black crappie	2011	FILSK	10	2	8.5	7.9	9.1	0.130	0.082	0.178								
		Northern pike	2011	FILSK	8	8	21.6	16.5	28.2	0.340	0.177	0.634								
		Yellow bullhead	2011	FILET	5	1	12.9	12.9	12.9	0.423	0.423	0.423								
01004600	BALL BLUFF*	Bluegill sunfish	2011	FILSK	10	2	7.7	7.1	8.2	0.094	0.080	0.107								
		Black crappie	2011	FILSK	3	1	9.5	9.5	9.5	0.051	0.051	0.051								
		Northern pike	2011	FILSK	8	8	20.6	18.6	22.3	0.278	0.139	0.447								
		Walleye	2011	FILSK	4	4	24.8	23.3	25.7	0.771	0.624	1.002								
		White sucker	2011	FILSK	3	1	12.1	12.1	12.1	0.019	0.019	0.019								
01006200	BIG SANDY*	Black crappie	1992	FILSK	9	1	10.2	10.2	10.2	0.140	0.140	0.140								
		Northern pike	1984	FILSK	8	3	26.3	21.6	28.6	0.437	0.280	0.640	1	0.05	0.05	Y				
			1992	FILSK	6	3	25.1	17.1	35.9	0.443	0.290	0.700	1	0.025	0.025	Y				
			2010	FILSK	13	13	18.5	15.5	23.5	0.266	0.155	0.394								
			2016	FILSK	14	14	20.0	14.8	25.4	0.406	0.141	0.744								
		Walleye	1984	FILSK	5	2	18.5	12.0	25.0	0.500	0.310	0.690								
			1992	FILSK	8	1	11.9	11.9	11.9	0.310	0.310	0.310	1	0.01	0.01	Y				
01007000	ROUND**	Bluegill sunfish	2009	FILSK	7	1	7.6	7.6	7.6	0.115	0.115	0.115								
		Black crappie	1999	FILSK	3	1	12.3	12.3	12.3	0.350	0.350	0.350								
		Cisco (Lake herring)	1999	FILSK	5	1	15.1	15.1	15.1	0.170	0.170	0.170	1	0.01	0.01	Y				
		Northern pike	1985	FILSK	5	1	16.1	16.1	16.1	0.540	0.540	0.540								
			1999	FILSK	8	8	19.5	14.9	25.3	0.398	0.120	0.710								
			2009	FILSK	6	6	21.3	17.5	25.3	0.353	0.189	0.454								
		Walleye	1985	FILSK	5	1	17.2	17.2	17.2	0.970	0.970	0.970								
			1999	FILSK	4	4	16.4	13.0	19.1	0.418	0.270	0.540								
			2009	FILSK	2	2	15.3	13.3	17.2	0.434	0.425	0.443								

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)			
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
01007700	RAT	Bluegill sunfish	2011	FILSK	10	2	7.5	7.0	7.9	0.047	0.047	0.047								
		Black crappie	2011	FILSK	10	2	9.1	8.1	10.0	0.051	0.050	0.052								
		Northern pike	2011	FILSK	8	8	19.8	15.4	26.0	0.152	0.072	0.230								
		Walleye	2011	FILSK	2	2	18.8	18.4	19.2	0.259	0.230	0.287								
		Yellow bullhead	2011	FILET	5	1	10.7	10.7	10.7	0.230	0.230	0.230								
01014200	HILL*	Bluegill sunfish	2005	FILSK	2	1	8.0	8.0	8.0	0.123	0.123	0.123								
			2009	FILSK	4	1	7.7	7.7	7.7								1	4.95	4.95	Y
		Black crappie	2005	FILSK	6	1	9.7	9.7	9.7	0.060	0.060	0.060								
			2009	FILSK	4	1	9.4	9.4	9.4								1	4.93	4.93	Y
		Largemouth bass	2009	FILSK	1	1	13.0	13.0	13.0	0.273	0.273	0.273					1	4.98	4.98	Y
		Northern pike	1985	FILSK	7	2	19.7	17.2	22.1	0.250	0.240	0.260								
			2005	FILSK	5	5	24.6	21.4	27.1	0.224	0.192	0.258								
			2009	FILSK	7	7	19.0	13.0	27.6	0.249	0.116	0.328					4	4.915	5.05	Y
		Rock bass	2008	FILSK	5	1	6.9	6.9	6.9	0.183	0.183	0.183								
		Pumpkinseed sunfish	2008	FILSK	5	1	6.8	6.8	6.8	0.061	0.061	0.061								
		Walleye	1985	FILSK	15	3	17.9	13.8	23.2	0.473	0.210	0.900								
			2005	FILSK	6	6	17.2	13.0	22.9	0.257	0.181	0.589								
			2009	FILSK	8	7	17.8	10.6	24.7	0.270	0.118	0.386					5	4.874	5.1	Y
09005700	EAGLE*	Black crappie	1996	FILSK	7	1	7.6	7.6	7.6	0.050	0.050	0.050								
		Northern pike	2016	FILSK	8	8	23.8	18.7	27.8	0.308	0.088	0.470								
		Walleye	1996	FILSK	15	4	18.6	14.0	22.6	0.293	0.120	0.570	1	0.01	0.01	Y				
			2016	FILSK	8	8	15.6	11.4	21.3	0.246	0.095	0.494								
		White sucker	1996	FILSK	2	1	17.8	17.8	17.8	0.040	0.040	0.040								
		Yellow bullhead	2016	FILET	4	1	10.9	10.9	10.9	0.110	0.110	0.110								
		Yellow perch	2016	FILSK	10	1	7.9	7.9	7.9	0.062	0.062	0.062								
09006200	CROSS**	Bowfin	1996	FILSK	4	1	20.6	20.6	20.6	0.600	0.600	0.600	1	0.01	0.01	Y				
		Bluegill sunfish	1996	FILSK	10	1	7.1	7.1	7.1	0.160	0.160	0.160								
		Northern pike	1996	FILSK	9	4	28.4	22.0	39.0	0.775	0.380	1.800	1	0.01	0.01	Y				
		Walleye	1996	FILSK	6	2	21.1	18.5	23.6	1.250	1.100	1.400								
			2002	FILSK	3	3	17.2	16.5	17.6	0.591	0.560	0.650								
09006700	TAMARACK**	Black crappie	2007	FILSK	9	1	7.3	7.3	7.3	0.131	0.131	0.131					1	1.95	1.95	

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			PFOS (µg/kg)				
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
			2016	FILSK	1	1	8.5	8.5	8.5	0.156	0.156	0.156								
		Northern pike	1985	FILSK	8	2	19.1	17.8	20.4	0.670	0.580	0.760								
			2007	FILSK	6	6	18.3	15.1	20.7	0.350	0.135	0.650								
			2016	FILSK	8	8	21.5	17.6	34.1	0.638	0.281	1.542								
		Shorthead redhorse	2016	FILSK	5	1	16.1	16.1	16.1	0.212	0.212	0.212								
		Walleye	1985	FILSK	5	2	15.3	13.5	17.0	0.750	0.680	0.820								
			2016	FILSK	1	1	11.7	11.7	11.7	0.297	0.297	0.297								
11006200	THUNDER*	Black crappie	2012	FILSK	7	2	9.5	8.8	10.1	0.060	0.055	0.064								
		Cisco (Lake herring)	2012	FILSK	7	1	15.9	15.9	15.9	0.126	0.126	0.126								
		Northern pike	2012	FILSK	7	7	27.2	22.5	33.7	0.338	0.219	0.573								
		Walleye	2012	FILSK	7	7	20.0	14.9	26.3	0.394	0.200	0.558								
31002000	HART	Bluegill sunfish	2007	FILSK	6	1	7.0	7.0	7.0	0.051	0.051	0.051					1	0.98	0.98	Y
		Black crappie	2007	FILSK	4	1	10.4	10.4	10.4	0.136	0.136	0.136								
31003200	O'BRIEN	Bluegill sunfish	1993	FILSK	10	1	6.6	6.6	6.6	0.130	0.130	0.130								
		Northern pike	1993	FILSK	22	4	24.7	19.0	32.1	0.595	0.400	0.740	1	0.01	0.01	Y				
		White sucker	1993	FILSK	1	1	18.0	18.0	18.0	0.098	0.098	0.098	1	0.01	0.01	Y				
31004700	HORSEHEAD	Northern pike	1983	FILSK	5	1	18.5	18.5	18.5	0.750	0.750	0.750								
31006700	SWAN*	Bluegill sunfish	1985	FILSK	9	1	5.5	5.5	5.5	0.070	0.070	0.070								
				WHORG	9	1	5.5	5.5	5.5											
			2000	FILSK	10	1	7.2	7.2	7.2	0.080	0.080	0.080								
		Northern pike	1985	FILSK	5	1	26.4	26.4	26.4	0.360	0.360	0.360								
				WHORG	5	1	26.4	26.4	26.4											
			2000	FILSK	7	7	24.4	20.0	29.4	0.344	0.200	0.590								
			2013	FILSK	8	8	24.3	19.3	31.6	0.414	0.274	0.629								
		Walleye	1985	FILSK	5	1	12.0	12.0	12.0	0.260	0.260	0.260								
				WHORG	5	1	12.0	12.0	12.0											
			2013	FILSK	7	7	20.0	15.0	23.3	0.688	0.308	1.064								
		White sucker	2000	FILSK	7	1	17.6	17.6	17.6	0.060	0.060	0.060								
			2013	FILSK	5	1	16.6	16.6	16.6	0.044	0.044	0.044								
		Yellow perch	2013	FILSK	5	1	6.8	6.8	6.8	0.149	0.149	0.149								
31006900	BUCK*	Bluegill sunfish	1996	FILSK	10	1	8.6	8.6	8.6	0.040	0.040	0.040								

DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
		Northern pike	1986	FILSK	15	3	22.3	19.1	26.4	0.233	0.170	0.300								
			1996	FILSK	26	6	23.2	15.1	33.9	0.167	0.030	0.370	1	0.01	0.01	Y				
			2013	FILSK	13	13	19.4	14.5	25.4	0.173	0.069	0.310								
		Walleye	1986	FILSK	1	1	20.6	20.6	20.6	0.370	0.370	0.370								
			2013	FILSK	3	3	22.7	19.1	25.4	0.363	0.200	0.453								
		White sucker	1996	FILSK	4	1	16.5	16.5	16.5	0.030	0.030	0.030								
		Yellow perch	1986	WHORG	2	1	5.9	5.9	5.9	0.050	0.050	0.050								
31008400	SHALLOW*	Bluegill sunfish	2009	FILSK	5	1	6.9	6.9	6.9	0.064	0.064	0.064					1	5	5	Y
		Northern pike	2009	FILSK	7	7	23.1	13.4	29.2	0.437	0.362	0.555					3	5.04	5.82	Y
		Walleye	2009	FILSK	8	8	16.9	12.4	20.4	0.208	0.132	0.270					3	5.16	5.82	Y
31010600	OX HIDE*	Bluegill sunfish	1999	FILSK	10	1	6.9	6.9	6.9	0.080	0.080	0.080								
		Largemouth bass	1982	FILSK	5	1	11.4	11.4	11.4	0.280	0.280	0.280								
				WHORG	5	1	11.4	11.4	11.4											
		Northern pike	1982	FILSK	5	2	19.7	17.2	22.1	0.370	0.360	0.380								
				WHORG	3	1	22.1	22.1	22.1											
			1999	FILSK	8	8	21.6	16.9	27.0	0.271	0.140	0.660	1	0.01	0.01	Y				
		White sucker	1999	FILSK	4	1	17.5	17.5	17.5	0.040	0.040	0.040								
31010800	SNOWBALL**	Bluegill sunfish	2003	FILSK	7	1	7.3	7.3	7.3	0.057	0.057	0.057								
			2013	FILSK	9	2	7.8	7.0	8.5	0.056	0.051	0.061								
		Black crappie	2003	FILSK	4	1	12.2	12.2	12.2	0.105	0.105	0.105								
		Crappie, unknown species	1989	FILSK	5	1	8.6	8.6	8.6	0.063	0.063	0.063	1	0.02	0.02					
		Northern pike	1982	FILSK	34	6	22.4	18.2	27.6	0.675	0.300	1.610								
				WHORG	13	1	22.5	22.5	22.5											
			2003	FILSK	6	6	22.8	17.7	28.5	0.514	0.183	0.923								
			2013	FILSK	8	8	23.1	19.5	31.9	0.643	0.356	1.811								
		Walleye	1982	FILSK	5	1	18.4	18.4	18.4	0.920	0.920	0.920								
			1989	FILSK	6	2	17.5	15.4	19.5	0.610	0.260	0.960	2	0.0235	0.025					
			2003	FILSK	6	6	19.5	15.1	23.5	0.397	0.163	0.742								
			2013	FILSK	5	5	20.1	17.8	22.1	0.357	0.290	0.451								
		White sucker	2003	FILSK	3	1	16.1	16.1	16.1	0.044	0.044	0.044								
			2013	FILSK	5	1	17.9	17.9	17.9	0.046	0.046	0.046								

DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Length (in) Mean	Min	Max	Mercury (mg/kg) Mean	Min	Max	PCBs (mg/kg) N	Mean	Max	< RL	PFOS (µg/kg) N	Mean	Max	< RL
31011100	UPPER PANASA*	Black bullhead	2014	FILSK	5	1	9.4	9.4	9.4	0.017	0.017	0.017								
		Brown bullhead	1991	FILET	8	1	9.7	9.7	9.7	0.020	0.020	0.020								
		Northern pike	1991	FILSK	12	3	22.5	16.9	27.5	0.093	0.060	0.140	1	0.048	0.048					
			2014	FILSK	7	7	23.4	19.6	27.3	0.241	0.164	0.269								
		Walleye	1991	FILSK	16	3	17.3	12.0	21.1	0.150	0.060	0.210	1	0.048	0.048					
		White sucker	1991	FILSK	7	2	16.4	14.7	18.0	0.040	0.030	0.050	1	0.033	0.033					
		Yellow perch	1991	FILSK	10	1	9.7	9.7	9.7	0.100	0.100	0.100								
31011200	LOWER PANASA*	Black bullhead	1998	FILET	10	1	10.5	10.5	10.5	0.053	0.053	0.053								
		Northern pike	2014	FILSK	8	8	20.2	15.0	24.4	0.222	0.157	0.288								
		Walleye	1998	FILSK	10	10	19.4	15.4	22.2	0.277	0.130	0.440								
		White sucker	2014	FILSK	5	1	16.3	16.3	16.3	0.028	0.028	0.028								
		Yellow perch	1998	FILSK	10	1	10.6	10.6	10.6	0.100	0.100	0.100								
			2014	FILSK	10	1	6.0	6.0	6.0	0.078	0.078	0.078								
31015200	WOLF**	Black crappie	1991	FILSK	10	1	8.7	8.7	8.7	0.150	0.150	0.150								
		Northern pike	1991	FILSK	15	5	24.2	13.6	38.5	0.484	0.170	1.000	4	0.01	0.01	Y				
		Walleye	1991	FILSK	7	3	18.3	13.7	22.6	0.567	0.240	0.790	2	0.01	0.01	Y				
		White sucker	1991	FILSK	8	2	15.1	13.0	17.1	0.150	0.110	0.190	1	0.017	0.017					
31019300	CROOKED**	Bluegill sunfish	1988	FILSK	5	1	7.3	7.3	7.3	0.160	0.160	0.160								
			2005	FILSK	7	1	7.0	7.0	7.0	0.169	0.169	0.169								
		Black crappie	1999	FILSK	10	1	6.7	6.7	6.7	0.160	0.160	0.160								
		Cisco (Lake herring)	1999	FILSK	2	1	13.3	13.3	13.3	0.240	0.240	0.240	1	0.01	0.01	Y				
			2005	FILSK	3	1	11.1	11.1	11.1	0.126	0.126	0.126								
		Northern pike	1988	FILSK	9	4	23.7	19.0	27.7	0.600	0.540	0.680								
			1999	FILSK	8	8	20.6	15.6	29.5	0.485	0.250	1.220	1	0.01	0.01	Y				
			2005	FILSK	6	6	23.1	16.1	35.5	0.635	0.357	1.048								
		Walleye	1988	FILSK	11	5	19.3	13.5	25.5	0.864	0.450	1.400	1	0.01	0.01	Y				
			1999	FILSK	3	3	14.1	11.6	17.8	0.493	0.410	0.660								
			2005	FILSK	4	4	15.3	10.9	23.0	0.753	0.501	1.176								
		White sucker	1999	FILSK	3	1	17.8	17.8	17.8	0.240	0.240	0.240								
31021600	TROUT**	Bluegill sunfish	2013	FILSK	5	1	6.8	6.8	6.8	0.084	0.084	0.084								

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)			
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
		Black crappie	1999	FILSK	10	1	8.6	8.6	8.6	0.140	0.140	0.140								
		Crappie, unknown species	1989	FILSK	5	1	7.5	7.5	7.5	0.170	0.170	0.170	1	0.018	0.018					
		Largemouth bass	1989	FILSK	2	1	14.8	14.8	14.8	0.290	0.290	0.290	1	0.028	0.028					
		Northern pike	1984	FILSK	12	3	22.6	19.1	27.6	0.750	0.300	1.610								
			1986	FILSK	3	1	20.9	20.9	20.9	0.320	0.320	0.320	1	0.02	0.02	Y				
			1999	FILSK	8	8	24.9	21.1	28.7	0.555	0.360	0.890	1	0.019	0.019					
			2013	FILSK	8	8	23.1	20.0	27.2	0.478	0.258	0.591								
		Smallmouth bass	1989	FILSK	2	1	16.6	16.6	16.6	0.780	0.780	0.780	1	0.041	0.041					
			2013	FILSK	4	4	14.1	11.5	16.7	0.434	0.352	0.500								
		Walleye	1984	FILSK	5	1	18.4	18.4	18.4	0.920	0.920	0.920								
			1986	FILSK	16	4	15.8	13.3	18.6	0.700	0.280	1.400	1	0.05	0.05	Y				
			1989	FILSK	3	1	21.7	21.7	21.7	1.200	1.200	1.200	1	0.097	0.097					
			2001	FILSK	5	5	13.9	11.0	19.9	0.195	0.132	0.377								
			2013	FILSK	7	7	20.2	13.9	21.9	0.851	0.265	1.192								
		White sucker	1999	FILSK	5	1	17.7	17.7	17.7	0.160	0.160	0.160								
			2013	FILSK	5	1	14.5	14.5	14.5	0.044	0.044	0.044								
31023100	LAWRENCE**	Black crappie	2010	FILSK	10	2	8.7	7.9	9.4	0.167	0.117	0.217								
		Northern pike	2010	FILSK	8	8	20.3	13.8	23.7	0.411	0.174	0.529								
		Redhorse, unknown species	2010	FILSK	3	1	17.1	17.1	17.1	0.146	0.146	0.146								
		Walleye	2010	FILSK	9	9	14.3	12.2	20.5	0.479	0.303	1.076								
31025900	BALSAM**	Bluegill sunfish	2016	FILSK	1	1	6.5	6.5	6.5	0.079	0.079	0.079								
		Black crappie	2011	FILSK	4	1	8.1	8.1	8.1	0.029	0.029	0.029								
		Cisco (Lake herring)	2011	FILSK	5	1	13.2	13.2	13.2	0.038	0.038	0.038								
		Northern pike	2011	FILSK	8	8	28.1	22.6	35.1	0.338	0.156	0.707								
			2016	FILSK	7	7	25.0	19.0	30.8	0.250	0.202	0.328								
		Walleye	2011	FILSK	2	2	21.3	21.1	21.5	0.299	0.292	0.305								
31026000	WHITE SWAN	Northern pike	1986	FILSK	10	10	23.3	17.5	27.1	0.417	0.180	0.630								
31034500	SCRAPPER	Black crappie	2016	FILSK	6	1	9.2	9.2	9.2	0.050	0.050	0.050								
		Northern pike	2016	FILSK	6	6	27.0	18.4	34.8	0.317	0.166	0.565								
31035300	SPLIT HAND	Black crappie	2004	FILSK	10	1	10.9	10.9	10.9	0.031	0.031	0.031								

DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Length (in) Mean	Min	Max	Mercury (mg/kg) Mean	Min	Max	PCBs (mg/kg) N	Mean	Max	< RL	PFOS (µg/kg) N	Mean	Max	< RL
		Cisco (Lake herring)	2004	FILSK	4	1	16.4	16.4	16.4	0.038	0.038	0.038								
		Walleye	2004	FILSK	5	5	13.5	12.4	14.2	0.073	0.059	0.081								
31038400	PRAIRIE**	Black crappie	2000	FILSK	11	1	8.1	8.1	8.1	0.170	0.170	0.170								
			2012	FILSK	5	1	8.7	8.7	8.7	0.275	0.275	0.275								
		Northern pike	1985	FILSK	14	4	24.4	18.2	30.5	0.590	0.580	0.610								
			2000	FILSK	6	6	20.7	18.4	25.0	0.398	0.300	0.520								
			2012	FILSK	6	6	22.4	16.5	30.6	0.590	0.411	0.804								
		Redhorse, unknown species	2000	FILSK	6	1	17.7	17.7	17.7	0.370	0.370	0.370								
		Smallmouth bass	2000	FILSK	3	3	13.7	11.0	16.5	0.563	0.420	0.820								
		Shorthead redhorse	2012	FILSK	5	1	17.6	17.6	17.6	0.302	0.302	0.302								
		Walleye	1985	FILSK	12	3	17.5	14.0	20.6	0.803	0.500	0.960								
			2000	FILSK	7	7	18.6	13.6	25.7	0.759	0.370	1.620								
31039200	WABANA*	Bluegill sunfish	2015	FILSK	10	1	7.0	7.0	7.0	0.035	0.035	0.035								
		Cisco (Lake herring)	2015	FILSK	5	1	17.5	17.5	17.5	0.157	0.157	0.157								
		Largemouth bass	2008	FILSK	5	5	12.3	8.8	15.0	0.272	0.159	0.350								
		Northern pike	1985	FILSK	5	1	23.2	23.2	23.2	0.380	0.380	0.380								
		Walleye	2015	FILSK	8	8	18.4	14.5	22.1	0.193	0.108	0.302								
		Yellow perch	1985	WHORG	9	1	2.5	2.5	2.5	0.210	0.210	0.210								
31040300	BOSLEY	White sucker	1985	WHORG	5	1	17.4	17.4	17.4	0.240	0.240	0.240								
31041000	TROUT*	Bluegill sunfish	1990	FILSK	1	1	7.9	7.9	7.9	0.032	0.032	0.032	1	0.01	0.01	Y				
			2015	FILSK	1	1	6.3	6.3	6.3	0.069	0.069	0.069								
		Largemouth bass	1990	FILSK	1	1	9.9	9.9	9.9	0.120	0.120	0.120	1	0.01	0.01	Y				
		Lake trout	1990	FILSK	7	6	23.8	17.6	28.2	0.268	0.050	0.580	6	0.07	0.12					
			2015	FILSK	2	2	27.7	25.0	30.4	0.270	0.081	0.459								
		Northern pike	1990	FILSK	1	1	23.4	23.4	23.4	0.250	0.250	0.250	1	0.01	0.01	Y				
			2015	FILSK	8	8	27.3	24.1	30.5	0.441	0.290	0.566								
		Walleye	1990	FILSK	2	1	23.1	23.1	23.1	0.530	0.530	0.530	1	0.014	0.014					
31042900	CUTAWAY*	Bluegill sunfish	1990	FILSK	8	1	7.1	7.1	7.1	0.061	0.061	0.061	1	0.01	0.01	Y				
		Brown bullhead	1990	FILET	6	1	11.5	11.5	11.5	0.063	0.063	0.063	1	0.01	0.01	Y				

							Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			PFOS (µg/kg)				
DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
		Northern pike	1990	FILSK	15	3	22.3	18.0	27.9	0.233	0.230	0.240	3	0.01	0.01	Y				
		White sucker	1990	FILSK	2	2	16.9	14.4	19.3	0.147	0.024	0.270	2	0.01	0.01	Y				
31043900	PLANTATION*	Bluegill sunfish	1990	FILSK	9	1	7.0	7.0	7.0	0.044	0.044	0.044	1	0.01	0.01	Y				
		Northern pike	1990	FILSK	14	4	24.7	18.9	31.4	0.265	0.180	0.420	4	0.01	0.01	Y				
31053300	BLANDIN*	Bluegill sunfish	1990	FILSK	8	1	7.5	7.5	7.5	0.059	0.059	0.059	1	0.01	0.01	Y				
			2012	FILSK	5	1	7.6	7.6	7.6	0.120	0.120	0.120								
		Black bullhead	1990	FILET	5	1	11.4	11.4	11.4	0.069	0.069	0.069	1	0.01	0.01	Y				
		Cisco (Lake herring)	1990	FILSK	2	1	12.9	12.9	12.9	0.088	0.088	0.088	1	0.01	0.01	Y				
		Largemouth bass	1990	FILSK	3	1	9.9	9.9	9.9	0.150	0.150	0.150	1	0.01	0.01	Y				
		Northern pike	1987	FILSK	3	1	20.9	20.9	20.9	0.320	0.320	0.320	1	0.01	0.01	Y				
			1990	FILSK	11	2	19.1	16.9	21.3	0.295	0.280	0.310	2	0.01	0.01	Y				
			2012	FILSK	6	6	19.5	17.0	23.9	0.377	0.300	0.493								
		Shorthead redhorse	1990	FILSK	4	1	17.4	17.4	17.4	0.210	0.210	0.210	1	0.01	0.01	Y				
		Walleye	1990	FILSK	6	3	15.8	10.4	21.3	0.340	0.210	0.410	3	0.023	0.049					
			2012	FILSK	4	4	14.7	11.2	18.4	0.419	0.328	0.463								
		White sucker	1987	FILSK	5	1	16.8	16.8	16.8	0.160	0.160	0.160								
			1990	FILSK	4	1	16.8	16.8	16.8	0.088	0.088	0.088	1	0.01	0.01	Y				
		Yellow bullhead	1990	FILET	1	1	10.8	10.8	10.8	0.250	0.250	0.250	1	0.01	0.01	Y				
			2012	FILET	5	1	12.3	12.3	12.3	0.282	0.282	0.282								
31064400	ISLAND	Largemouth bass	1986	FILSK	6	1	10.2	10.2	10.2	0.180	0.180	0.180								
		Smallmouth bass	1986	FILSK	7	1	9.5	9.5	9.5	0.160	0.160	0.160								
31064500	KREMER	Rainbow trout	1984	FILSK	10	1	8.3	8.3	8.3	0.070	0.070	0.070								
31122500	O'BRIEN RES. #4*	Black crappie	1989	FILSK	6	1	6.4	6.4	6.4	0.160	0.160	0.160	1	0.02	0.02	Y				
			1993	FILSK	6	1	7.7	7.7	7.7	0.170	0.170	0.170								
		Crappie, unknown species	1989	FILSK	6	1	6.4	6.4	6.4	0.160	0.160	0.160	1	0.01	0.01	Y				
		Largemouth bass	1993	FILSK	4	2	11.5	9.9	13.0	0.405	0.280	0.530								
			2013	FILSK	2	2	14.2	11.8	16.6	0.575	0.475	0.674								
		Northern pike	1989	FILSK	4	2	23.0	23.0	23.0	0.570	0.570	0.570	2	0.04	0.04					
			1993	FILSK	17	3	22.0	17.9	26.2	0.407	0.280	0.530	1	0.01	0.01	Y				

DOWID	Waterway	Species	Year	Anatomy	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)				PFOS (µg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL	N	Mean	Max	< RL
			2013	FILSK	4	4	20.0	17.5	21.9	0.595	0.510	0.686								
		Walleye	1989	FILSK	2	2	15.1	15.1	15.1	0.590	0.590	0.590	2	0.029	0.029					
			1993	FILSK	2	2	17.1	14.1	20.0	0.445	0.370	0.520	1	0.01	0.01	Y				
		White sucker	1989	FILSK	6	2	17.5	17.5	17.5	0.210	0.210	0.210	2	0.026	0.026					
			1993	FILSK	6	2	18.4	16.9	19.9	0.200	0.130	0.270	1	0.027	0.027					
			2013	FILSK	5	1	17.1	17.1	17.1	0.061	0.061	0.061								
		Yellow perch	2013	FILSK	5	1	10.9	10.9	10.9	0.232	0.232	0.232								
69084800	PRAIRIE**	Black crappie	2005	FILSK	10	1	8.7	8.7	8.7	0.127	0.127	0.127								
			2015	FILSK	10	1	8.1	8.1	8.1	0.160	0.160	0.160								
		Cisco (Lake herring)	1990	FILSK	9	2	13.2	11.0	15.4	0.135	0.130	0.140	2	0.01	0.01	Y				
			2005	FILSK	6	1	14.4	14.4	14.4	0.164	0.164	0.164								
			2015	FILSK	5	1	11.7	11.7	11.7	0.079	0.079	0.079								
		Northern pike	1983	FILSK	8	3	22.2	16.8	27.5	0.300	0.190	0.510								
			1990	FILSK	14	3	17.4	14.2	21.0	0.230	0.160	0.310	3	0.01	0.01	Y				
			2005	FILSK	6	6	28.4	20.7	35.5	0.563	0.372	0.829								
			2015	FILSK	8	8	24.3	17.5	30.5	0.507	0.275	0.759								
		Walleye	1983	FILSK	5	2	15.1	12.4	17.7	0.365	0.230	0.500								
			1990	FILSK	15	3	15.8	10.9	20.1	0.363	0.240	0.440	3	0.01	0.01	Y				
			2005	FILSK	5	5	19.0	16.1	22.4	0.910	0.720	1.164								
			2015	FILSK	8	8	17.0	12.0	21.1	0.568	0.302	0.836								
		White sucker	1990	FILSK	16	2	14.3	12.0	16.5	0.079	0.072	0.085	2	0.01	0.01	Y				
69090600	DAY	Black crappie	1989	FILSK	5	1	7.1	7.1	7.1	0.250	0.250	0.250	1	0.01	0.01	Y				
		Northern pike	1989	FILSK	3	1	24.5	24.5	24.5	0.580	0.580	0.580	1	0.081	0.081					
		Walleye	1989	FILSK	3	1	17.9	17.9	17.9	1.100	1.100	1.100	1	0.069	0.069					
		White sucker	1989	FILSK	6	1	14.4	14.4	14.4	0.160	0.160	0.160	1	0.01	0.01	Y				

Appendix 7. Lake protection and prioritization results

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
01002300	Round	11.0	No Evidence of Trend	9%	5	A
01004600	Ball Bluff	6.1	Insufficient Data	3%	3	A
01005800	Vanduse	12.4	No Evidence of Trend	7%	4	A
09006300	Woodbury	36.4	Decreasing Trend	6%	92	A
11006200	Thunder	11.7	Decreasing Trend	4%	48	A
31006900	Buck	18.4	No Evidence of Trend	7%	9	A
31008400	Shallow	10.3	No Evidence of Trend	7%	7	A
31010600	Ox Hide	4.5	Insufficient Data	7%	5	A
31014100	Shoal	6.8	No Evidence of Trend	3%	3	A
31019000	North Twin	12.3	Increasing Trend	16%	7	A
31019100	South Twin	9.5	No Evidence of Trend	14%	5	A
31019200	Nashwauk	10.2	Insufficient Data	6%	4	A
31021600	Trout	32.7	Increasing Trend	10%	161	A
31023100	Lawrence	20.5	Decreasing Trend	3%	564	A
31025500	Snaptail	13.2	No Evidence of Trend	5%	8	A
31025800	King	31.1	No Evidence of Trend	5%	12	A
31026800	Round	10.4	Insufficient Data	5%	5	A
31028100	Wasson	11.0	Insufficient Data	4%	9	A

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31034900	Antler	7.7	No Evidence of Trend	5%	4	A
31037300	Hale	11.4	No Evidence of Trend	21%	8	A
31037400	Forest	18.1	Insufficient Data	62%	2	A
31037600	Horseshoe	20.9	Insufficient Data	14%	6	A
31039500	Bluewater	8.6	Increasing Trend	6%	6	A
31039900	Little Wabana	9.6	Increasing Trend	5%	1	A
31063600	Wolf	9.4	Insufficient Data	7%	3	A
31077500	No-ta-she-bun	6.5	Insufficient Data	5%	2	A
01000900	Douglas	31.0	Insufficient Data	4%	11	B
01002200	Island	20.1	No Evidence of Trend	4%	10	B
01003800	Remote	20.4	Insufficient Data	4%	4	B
01006300	Bass	23.8	Insufficient Data	4%	3	B
01007000	Round	9.3	Insufficient Data	4%	17	B
01007200	Rock	20.8	Insufficient Data	5%	25	B
01007700	Rat	27.4	No Evidence of Trend	4%	22	B
01019600	Otter	36.0	Insufficient Data	2%	5	B
09006200	Cross	36.2	No Evidence of Trend	14%	16	B
09006800	Cole	15.7	No Evidence of Trend	5%	3	B
11006900	Bass	18.9	No Evidence of Trend	5%	10	B
11007300	Big Rice	20.6	Insufficient Data	4%	90	B

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31002000	Hart	11.5	No Evidence of Trend	3%	21	B
31002600	Twin	13.8	Insufficient Data	4%	12	B
31004800	Libby	34.3	Insufficient Data	1%	13	B
31007000	O'Leary	18.6	Insufficient Data	5%	3	B
31008200	Sand	15.6	Insufficient Data	8%	4	B
31010800	Snowball	10.4	Insufficient Data	7%	5	B
31012000	Big McCarthy	13.7	Insufficient Data	6%	10	B
31012400	Big Sucker	18.2	No Evidence of Trend	4%	15	B
31013700	Kennedy	10.1	Insufficient Data	5%	2	B
31014500	Thirty	17.3	Insufficient Data	4%	3	B
31015000	Scooty	12.9	Insufficient Data	2%	4	B
31019800	Little Cowhorn	46.2	No Evidence of Trend	4%	16	B
31020600	Mud	15.2	Insufficient Data	3%	7	B
31020900	Round	27.8	No Evidence of Trend	5%	3	B
31021800	Shamrock	7.7	Insufficient Data	5%	2	B
31022300	Big Diamond	12.0	Insufficient Data	2%	4	B
31022700	Holman	10.0	Insufficient Data	6%	9	B
31023000	Bass	11.6	Insufficient Data	3%	2	B
31024000	Inkey	14.6	Insufficient Data	6%	4	B
31027200	Buckman	20.0	Insufficient Data	5%	10	B

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31036100	Hale	18.1	No Evidence of Trend	11%	12	B
31036600	Carlson	18.2	Insufficient Data	5%	7	B
31037000	McKinney	27.0	No Evidence of Trend	9%	11	B
31037200	Ice	13.9	No Evidence of Trend	20%	6	B
31039200	Wabana	10.4	Increasing Trend	3%	95	B
31041000	Trout	8.9	No Evidence of Trend	2%	63	B
31041300	Burrows	18.9	No Evidence of Trend	5%	11	B
31042400	Burnt Shanty	15.2	No Evidence of Trend	5%	6	B
31042900	Cutaway	9.1	Insufficient Data	3%	20	B
31043200	Lost Moose	9.7	Insufficient Data	5%	4	B
31053800	Spider	10.9	Increasing Trend	2%	24	B
31063400	Irma	11.6	Insufficient Data	2%	15	B
01001400	Savanna	31.5	Insufficient Data	2%	70	C
01001500	Shumway	18.3	Insufficient Data	0%	2	C
01002400	Loon	12.5	Insufficient Data	1%	0	C
01004200	Glacier	14.9	Insufficient Data	0%	4	C
01005300	Rat House	40.0	Insufficient Data	2%	47	C
01005700	Little Ball Bluff	6.8	Insufficient Data	4%	4	C
01005900	Hay	18.8	Insufficient Data	1%	12	C
01006000	Sandy River	38.1	No Evidence of Trend	6%	472	C

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
01007101	Davis (Main Bay)	65.0	Insufficient Data	4%	474	C
01007102	Steamboat	80.1	Insufficient Data	4%	544	C
01007600	Sanders	56.0	Insufficient Data	30%	16	C
01011100	Washburn	27.3	Insufficient Data	4%	11	C
01014200	Hill	19.9	No Evidence of Trend	4%	109	C
01014800	White Elk	25.0	Insufficient Data	1%	41	C
01019700	Little McKinney	42.0	Insufficient Data	1%	100	C
01020000	Shovel	18.0	Insufficient Data	2%	8	C
01020100	Holy Water	11.8	Insufficient Data	0%	2	C
11000900	Little Thunder	11.1	No Evidence of Trend	1%	29	C
31004300	Long	19.9	Insufficient Data	1%	22	C
31005100	Stingy	19.6	Insufficient Data	3%	17	C
31005200	Bower	15.3	Insufficient Data	2%	6	C
31005400	Twenty Four	28.3	Insufficient Data	0%	3	C
31005700	Sherry	29.3	Insufficient Data	2%	16	C
31006700	Swan	20.3	Increasing Trend	5%	247	C
31009300	Little Sand	12.8	No Evidence of Trend	2%	8	C
31009600	Lammon Aid	12.3	Insufficient Data	3%	7	C
31011100	Upper Panasa	27.8	Insufficient Data	10%	31	C
31011200	Lower Panasa	21.9	Insufficient Data	8%	37	C

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31011500	Bass	12.1	Insufficient Data	2%	2	C
31012100	Moose	20.1	Insufficient Data	4%	15	C
31012300	Little McCarthy	20.5	Insufficient Data	7%	6	C
31013500	South Fork	19.5	Insufficient Data	6%	24	C
31014700	Bray	14.4	Insufficient Data	6%	35	C
31015200	Wolf	37.9	Insufficient Data	1%	184	C
31015400	Hartley	12.3	No Evidence of Trend	4%	55	C
31019300	Crooked	17.1	No Evidence of Trend	3%	512	C
31020700	Bass	16.5	Insufficient Data	2%	2	C
31021000	Blackberry	24.8	No Evidence of Trend	4%	30	C
31021400	Clearwater	21.6	No Evidence of Trend	4%	7	C
31021700	Island	11.8	Insufficient Data	5%	3	C
31021900	O'Reilly	11.3	Insufficient Data	2%	12	C
31023800	Lower Lawrence	18.6	Insufficient Data	3%	459	C
31024200	Moose	18.9	Insufficient Data	4%	62	C
31024700	Lower Balsam	17.6	Insufficient Data	4%	100	C
31025400	Iaasac	16.0	No Evidence of Trend	11%	1	C
31025900	Balsam	14.9	No Evidence of Trend	4%	93	C
31026000	White Swan	21.0	Increasing Trend	1%	4	C
31026500	Bluebill	30.1	Insufficient Data	3%	55	C

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31026601	Long (Main Bay)	15.9	Insufficient Data	3%	48	C
31026700	Gunny Sack	35.0	Insufficient Data	3%	60	C
31027100	Marble	28.9	Insufficient Data	3%	29	C
31027600	Someman	21.0	Insufficient Data	4%	43	C
31030500	Ann	22.3	Insufficient Data	2%	13	C
31030800	Bartlet	18.5	Insufficient Data	1%	2	C
31034100	Little Split Hand	32.5	No Evidence of Trend	2%	136	C
31034400	Hanson	8.2	Insufficient Data	3%	13	C
31034600	Upper Hanson	11.9	Insufficient Data	3%	9	C
31034800	Sawyer	18.6	Insufficient Data	1%	5	C
31035600	Cowhorn	17.0	Insufficient Data	1%	13	C
31038400	Prairie	26.9	No Evidence of Trend	3%	1166	C
31038900	Murphy	20.9	Insufficient Data	2%	11	C
31039400	Little Trout	12.3	No Evidence of Trend	2%	44	C
31039600	Middle Hanson	14.0	Insufficient Data	3%	11	C
31040200	Clearwater	9.9	Insufficient Data	3%	49	C
31040300	Bosley	58.0	Insufficient Data	5%	11	C
31040700	Hay	10.0	Insufficient Data	3%	5	C
31041400	Moon	17.5	Insufficient Data	6%	1	C
31043100	Moss	11.0	Insufficient Data	4%	1	C

Lake ID	Lake name	Mean TP	Trend	% Disturbed land use	5% Load reduction goal	Priority
31043400	Snowshoe	21.0	Insufficient Data	6%	1	C
31043800	Sand	16.0	Increasing Trend	4%	18	C
31048400	Blandin	13.5	Insufficient Data	0%	2	C
31053300	Mississippi River - Blandin Reservoir	38.5	Insufficient Data	4%	7073	C
31061300	Little Long	15.6	No Evidence of Trend	3%	27	C
31063000	Shelly	13.8	Insufficient Data	1%	4	C
31063800	Beaver	9.5	Insufficient Data	0%	1	C
31064200	Adele	15.0	Insufficient Data	0%	2	C
31064300	Doctor	5.0	Insufficient Data	0%	0	C
31064400	Island	9.5	Insufficient Data	0%	1	C
31064500	Kremer	23.0	Insufficient Data	1%	12	C
31064600	Surprise	40.0	Insufficient Data	2%	14	C
31094500	Haskell	12.4	Insufficient Data	3%	24	C
69084800	Prairie	27.0	No Evidence of Trend	3%	154	C
69092000	Stuart	46.0	Insufficient Data	3%	3	C

Appendix 8. Mississippi River assessments

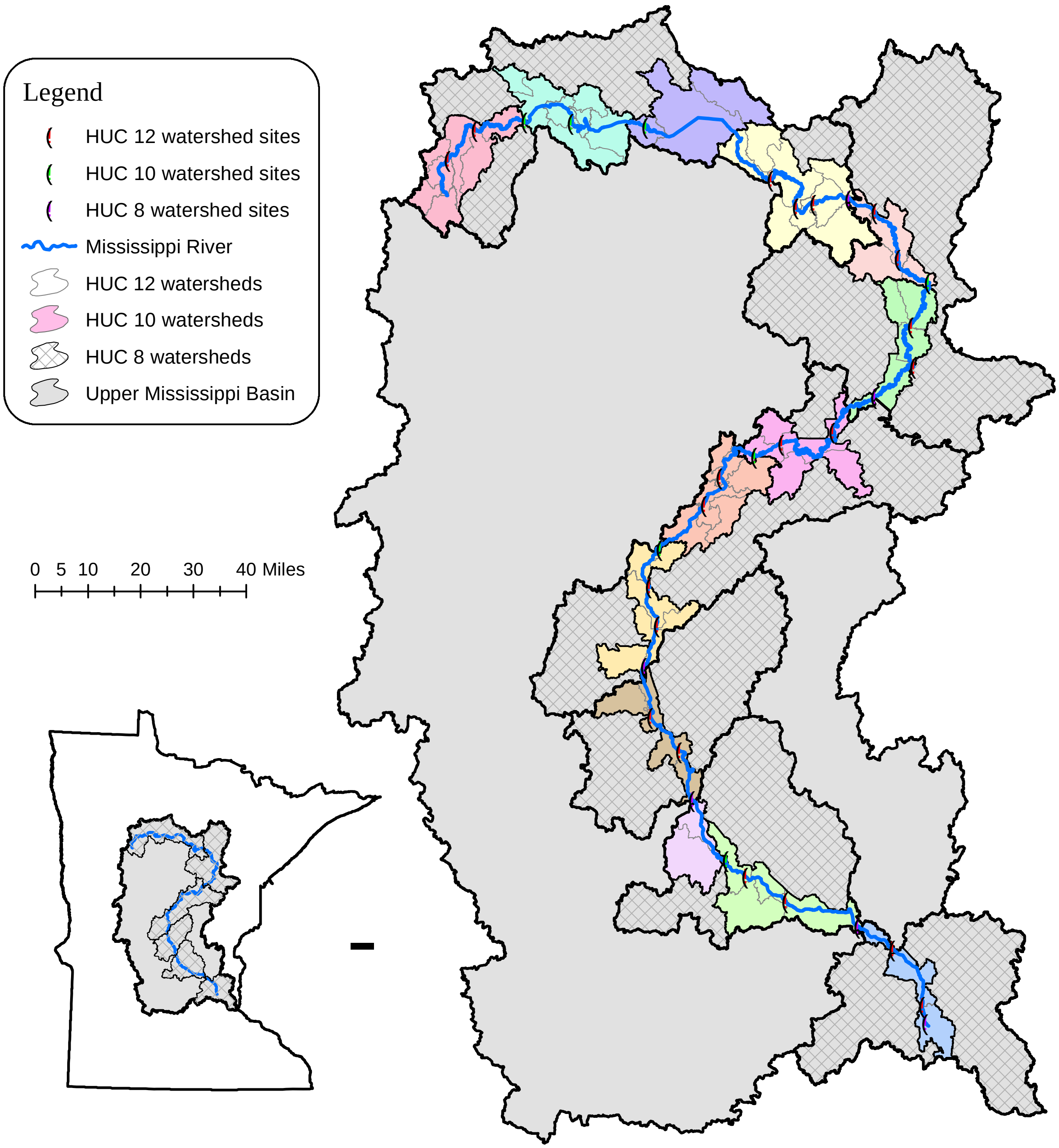
Large river monitoring

A large river monitoring strategy has been developed to augment the watershed approach for the monitoring, assessment, and Clean Water Act (CWA) reporting of water resources within Minnesota. Like the watershed monitoring strategy, large river monitoring more intensively and systematically monitors these resources to determine their overall health, identify impairments, and identify waters in need of additional protection. For the purposes of fulfilling our monitoring and assessment objectives, large rivers are defined as large main-stem rivers that flow through multiple major watersheds and therefore, were not sufficiently represented by watershed monitoring. In Minnesota, these include the St. Croix, Minnesota, Upper Mississippi, Red, and Rainy rivers. The Lower Mississippi (below Upper St. Anthony Falls) also meets the definition of a large river but is treated separately due to ongoing interstate efforts to develop a consistent and comprehensive monitoring strategy to fulfill CWA objectives for interstate waters of the Mississippi River.

Large rivers are longitudinally sampled in a systematic manner as sampling locations are selected near the hydrologic unit boundary at each of three scales; HUC 8, HUC 10 and HUC 12. Within each scale, varying levels of monitoring are conducted in order to assess large rivers for applicable designated uses (i.e., fishing, swimming, and supporting aquatic life such as fish and insects). The outlet of major HUC 8 watersheds (purple dots in Figure 55) are sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. HUC 10 watershed boundaries are nested within HUC 8 watersheds and are sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support (green dots in Figure 55). Within each HUC 10, smaller subwatershed delineations (HUC 12's) are sampled near each boundary for biology to assess aquatic life use support (Figure 55).

Where major dischargers occur, additional monitoring stations are added upstream and/or downstream if necessary to bracket the facilities. Chemical and biological data are collected at these stations to enhance assessments and to inform permitting and TMDL programs. In addition, if not already captured within the design strategy, all major tributaries (HUC 8 scale) are similarly bracketed to adequately characterize water quality conditions and contributions.

Figure 55. Example of site distribution utilizing large river monitoring design (Upper Mississippi River).



Mississippi River - 07010103-707 - Cohasset Dam to Swan River

The Split Hand Creek - Mississippi River HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010103-707. This reach originates at the Cohasset Dam and extends to the Swan River confluence, 43 miles downstream. The city of Grand Rapids, Minnesota is located near the beginning of this reach. Both aquatic life and aquatic recreation use were found to be full support during the 2015 assessment cycle. Aquatic consumption use is not supporting (mercury in fish tissue).

The supporting aquatic life use assessment was based on fish-IBI scores and water chemistry data, all of which indicate healthy conditions for aquatic life. All water quality parameter data available met standards and indicate supporting water quality conditions including a substantial DO dataset that is considered insufficient only because not enough pre 9:00 am data was available to determine as full support (Table 43).

The consolidated HUC 10 reach (07010103-707) combined four smaller segments, all of which are impaired for aquatic consumption use (mercury in fish tissue) and have approved TMDL plans. Therefore, the mercury impairment and approved TMDL plan will be applied to the new consolidated segment as well.


Mississippi River upstream of Jacobson

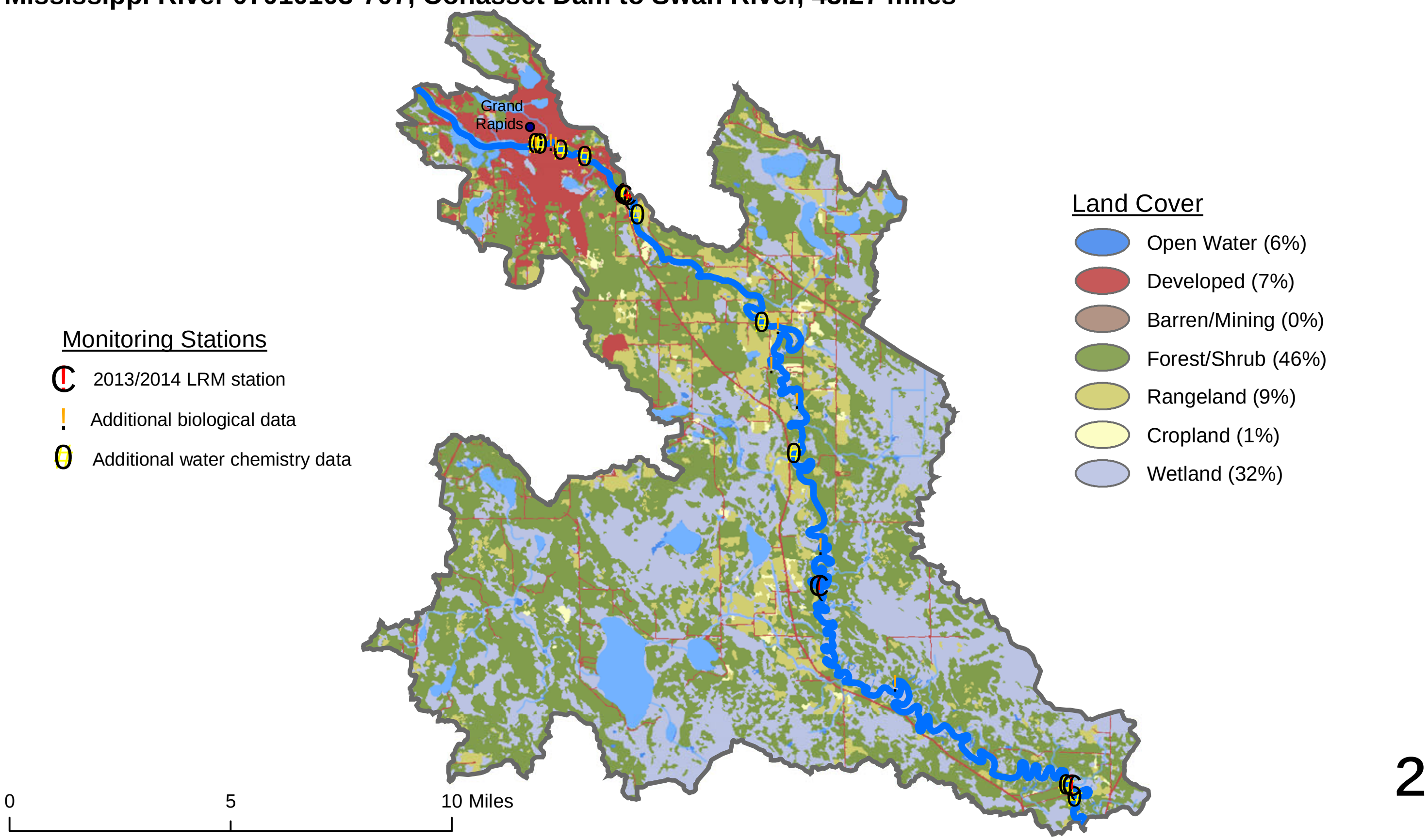
Table 43. Designated use support assessments on Mississippi River assessment reach – 07010103-707, Cohasset Dam to Swan River.

AUID ***Reach Name***, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	**Eutrophication** Phosphorous	Response Indicator	**Aquatic Life**	**Aquatic Recreation** (Bacteria)	**Aquatic Consumption**
07010103-707, ***Mississippi River***, *Cohasset Dam to Swan River*	43.27	2Bg	MTS	--	IF	MTS	MTS	MTS	MTS	MTS	--	MTS	MTS	SUP	SUP	IMP

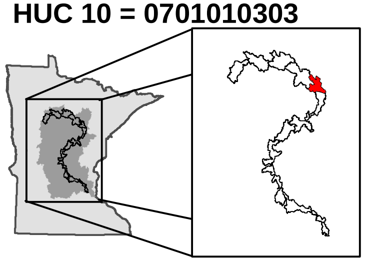
Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Figure 56. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010103-707.

Mississippi River 07010103-707, Cohasset Dam to Swan River, 43.27 miles



HUC 10 = 0701010303



Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Full Support	
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in fish tissue

Mississippi River - 07010103-708 - Swan River to Willow River

The city of Palisade - Mississippi River HUC-10 subwatershed includes the Mississippi River assessment reach defined as AUID 07010103-708. This reach originates at the Swan River confluence and extends to the confluence with the Willow River, 60 miles downstream. Both aquatic life (TSS) and aquatic consumption (mercury in fish tissue) use were found to be non-supporting during the 2015 assessment cycle. Aquatic recreation use was found to be full support.

TSS and secchi tube data both have a high frequency of values that exceed the water quality standard for aquatic life use. This implies that water quality conditions can be turbid and possibly a stressor for aquatic life. Fish-IBI scores indicate a healthy fish community, however, macroinvertebrate data was not available for this reach and are often more adversely impacted by high TSS than fish. Other available water chemistry parameters within this reach with sufficient data sets are supporting of the aquatic life use (Table 44). However, a robust data set exhibiting high exceedance rates for TSS (62.3%) and secchi tube (21.7%) necessitate a determination of impairment for aquatic life use.

The consolidated HUC 10 reach (07010103-708) combined two segments, both of which are impaired for aquatic consumption use (mercury in fish tissue) and have approved TMDL plans. Therefore, the mercury impairment and approved TMDL plan will be applied to the new consolidated segment as well.

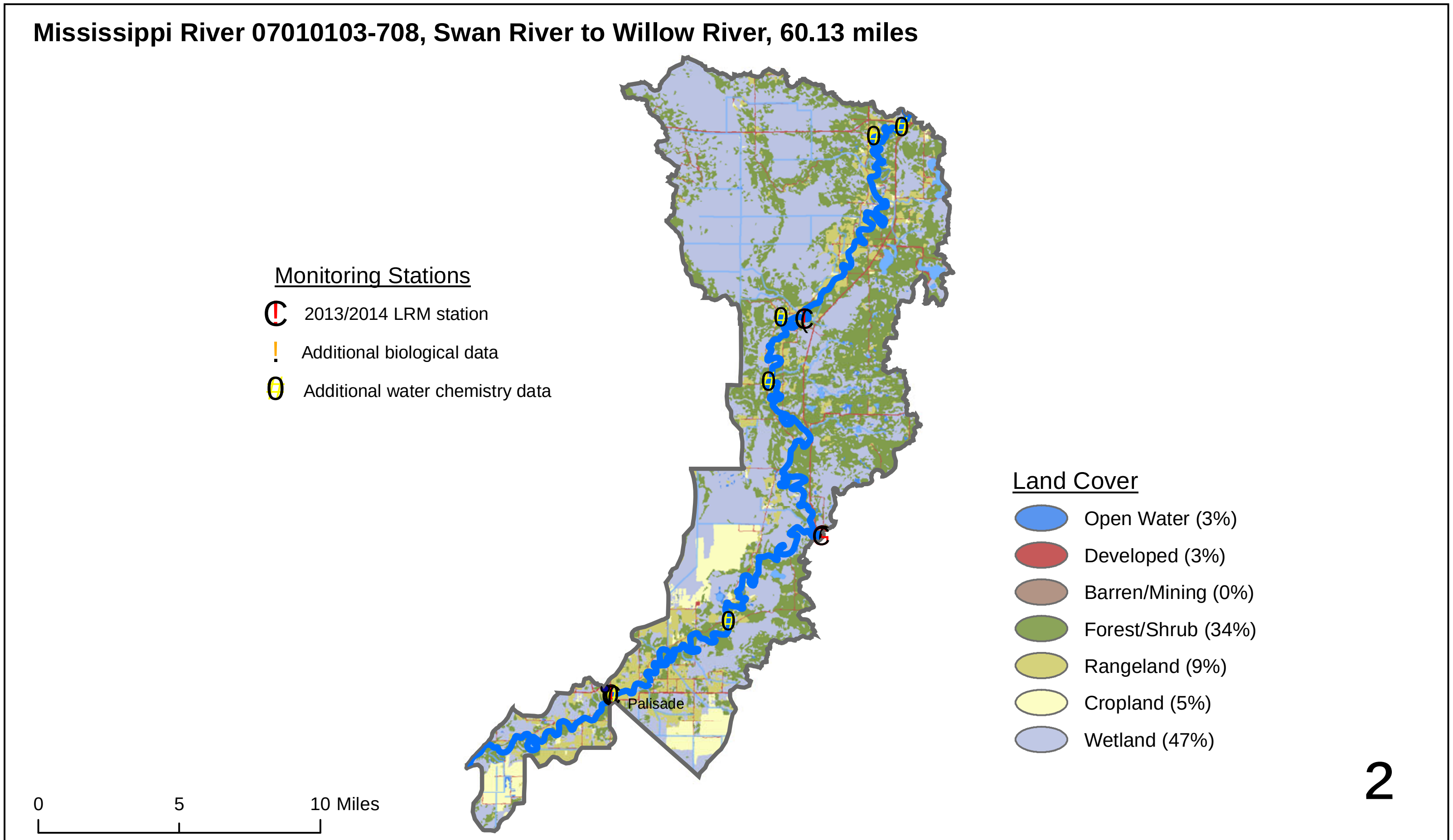
Mississippi River at Palisade

Table 44. Designated use support assessments on Mississippi River assessment reach – 07010103-708, Swan River to Willow River.

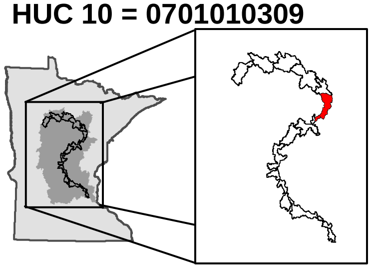
AUID ***Reach Name*****,** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Aquatic Life Indicators:**									**Eutrophication**		**Aquatic Life**	**Aquatic Recreation** (Bacteria)	**Aquatic Consumption**
			Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator			
07010103-708, ***Mississippi River***, *Swan River to Willow River*	60.13	2Bg	MTS	--	IF	EXS	EXS	MTS	MTS	IF	--	MTS	MTS	IMP	SUP	IMP

Abbreviations for Indicator Evaluations: **- -** = No Data; **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **NA** = Not Assessed
Abbreviations for Use Support Determinations: **- -** = No Data, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2016 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Figure 57. Use support assessments, impairments, monitoring, and land use characteristics for Mississippi River assessment reach 07010103-708.



HUC 10 = 0701010309



Designated Use	Assessment Status	Impairment Parameter(s)
Aquatic Life	Non-support	Total suspended solids
Aquatic Recreation	Full Support	
Aquatic Consumption	Non-support	Mercury in fish tissue

Biological monitoring stations and IBI scores for Upper Mississippi River assessment reaches within Mississippi River-Grand Rapids Watershed

Bold Station IDs indicate stations selected and monitored in 2013 as part of large river monitoring effort by MPCA.

Biological Station ID	EQuIS ID	Drainage Area (mi²)	Fish Class	F-IBI	Threshold	Sample Date	Invert Class	M-IBI	Threshold	Sample Date
07010103-707, Mississippi River (Cohasset Dam to Swan River), length = 43.27 miles, use class = 2Bg										
98UM004		3271	4	62	38	7/22/1998				
07UM233		3275	4	69	38	7/17/2007				
00UM090		3275	4	53.7	38	8/23/2000	1	57.1	49	9/26/2000
13UM022	S007-333	3279	4	69.1	38	7/24/2013				
98UM005		3810	4	65.5	38	7/23/1998				
07UM235		3812	4	49.5	38	7/18/2007				
07UM236		3813	4	66.5	38	7/18/2007				
07UM237		3835	4	63.5	38	7/20/2007				
13UM021		3839	4	66.9	38	7/20/2007				
13UM021		3839	4	65	38	7/24/2013				
07UM239		3902	4	58	38	9/13/2007				
13UM020	S007-332	3921	4	68.2	38	7/23/2013				
07010103-708, Mississippi River (Swan River to Willow River), length = 60.13 miles, use class = 2Bg										
13UM019		4301	4	71.4	38	8/14/2013				
13UM018		4365	4	66.7	38	7/23/2013				
98UM006		4817	4	85	38	7/24/1998				
98UM006	S003-663	4817	4	80.3	38	7/25/2013				