Watershed health

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Otter Tail River Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

Authors

Dave Dollinger
Megan Handt
Cadie Olson
Sophia Vaughan
Mark Gernes
Andrew Butzer
Shawn Nelson
Bruce Monson

Contributors/acknowledgements

Becker County SWCD
Bemidji State University
Buffalo Red River Watershed District
Citizen Lake Monitoring Program Volunteers
Citizen Stream Monitoring Program Volunteers
Clearwater County
Clearwater County SWCD
Headwaters Science Center
Interstate Engineering
Minnesota Department of Agriculture
Minnesota Department of Health
Minnesota Department of Natural Resources
Otter Tail County Coalition of Lake Associations
Pelican River Watershed District
Red Lake Watershed District
Tamarac Interpretive Association
Tamarac National Wildlife Refuge
White Earth Nation

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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

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List of acronyms

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

DNR Minnesota Department of Natural Resources

DO Dissolved oxygen

E Eutrophic

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

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

IWM Intensive Watershed Monitoring

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDH Minnesota Department of Health

Analysis Procedure

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

NH3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PFAS Perfluoroalkyl Substances

PWI Protected Waters Inventory

SNA Scientific and Natural Area

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WID Waterbody Identification Number

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The Otter Tail River Watershed covers 1,249,541 acres (1,952 square miles) of western Minnesota. Located primarily within Otter Tail and Becker County, portions of the watershed are also found within Clay, Clearwater, Mahnomen, and Wilkin counties. This surface water rich watershed contains over 2,800 miles of streams and rivers and more than 1,300 lakes – more lakes than any other Red River Basin Watershed. Many of these lakes are highly valued resources used for recreation; they are an important component of the local economy. The Otter Tail River and numerous other streams are valued for both recreation and the aquatic life they support. More species of fish are found in the Otter Tail River Watershed than in any other Red River Basin Watershed. Some of these species are rare in the Red River Basin, and their distribution is restricted almost exclusively to the Otter Tail River Watershed. Most of the lakes are connected by rivers and streams. Two of the larger rivers in the watershed, the Otter Tail River and Pelican River, pass through numerous lakes. Many lakes are also connected by small tributary streams. This connectivity increases the risk of resource degradation due to the downstream movement of nutrient loads, bacteria, and sediment throughout the system.

Most of the land in the Otter Tail River Watershed is utilized for agricultural purposes (pasture, hay, row crop production); however, forest and wetlands are interspersed throughout much of the watershed. Forested land is especially prevalent in the northern region of the watershed, within the Northern Lakes and Forests Ecoregion. The watershed also spans across two other ecoregions: the North Central Hardwood Forests Ecoregion and the Lake Agassiz Plain Ecoregion. Hydrologic alterations (i.e. ditching, subsurface tiling, straightening of stream channels) are most extensive in the portion of the watershed located within the Lake Agassiz Plain Ecoregion. Compared to most other Red River Basin Watersheds, fewer miles of stream channel within the Otter Tail River Watershed have been altered. The watershed is also among the least susceptible to flooding because of the additional storage afforded by the many lakes.

In 2016, the Minnesota Pollution Control Agency (MPCA) began an intensive watershed monitoring (IWM) effort of lakes and streams within the Otter Tail River Watershed. Twenty-six stream sites were sampled for biology at the outlet of various sized subwatersheds. Stream water chemistry sampling was completed on 12 stream reaches by the Mississippi River Headwaters Science Center. The MPCA also sampled water quality on 29 lakes. Numerous volunteers who were enrolled in the Citizen Lake Monitoring Program (CLMP) provided data from lakes across the watershed. Their data, often spanning a multitude of years, was a valuable asset in the assessment of lakes within the watershed. In 2018, lakes and streams with sufficient data were assessed for aquatic life, aquatic recreation, and aquatic consumption. A total of 25 stream reaches were assessed for aquatic life and 22 stream reaches were assessed for aquatic recreation. Eighty lakes were assessed for aquatic life and 191 lakes were assessed for aquatic recreation.

Sixty-eight percent of the streams fully supported aquatic life and had good water quality. The diverse fish and macroinvertebrate communities can largely be attributed to good habitat and stable flow patterns. The natural stream channels and intact riparian zones found throughout the watershed foster the development of diverse, quality stream habitat. The remaining 32% of streams were found impaired for aquatic life; six of these were the result of poor fish and/or macroinvertebrate communities. Most of these biological impairments were attributed to poor habitat; these streams lacked habitat heterogeneity and had low channel stability. One impairment was the result of a barrier restricting fish migration within the Pelican River. Twenty-two dams are present on the Otter Tail River and at least six are present on the Pelican River. Many of these structures are barriers to fish migration. They are known to restrict the distribution of fish and mussel species throughout the watershed. Most streams had dissolved oxygen (DO) concentrations that were supportive of aquatic life. Only three stream reaches had aquatic life impairments due to low levels of DO. High total suspended solids (TSS) concentrations were evident on the lower Otter Tail River and Campbell Creek, a small headwater stream in the Upper Pelican River Subwatershed. Sediment levels and TSS concentrations were normal throughout the remainder of watershed.

Sixty-three percent of the assessed streams fully supported aquatic recreation. Higher levels of bacteria were found in three reaches of the Toad River Subwatershed, two reaches of the Pelican River, and one reach of the Otter Tail River; these reaches are all impaired for aquatic recreation.

Most lakes within the Otter Tail River Watershed have good water quality supportive of maintaining quality fisheries and recreational opportunities. Eighty-five percent of the 80 lakes assessed supported aquatic life. Numerous lakes contained intolerant fish species, such as the blacknose shiner, blackchin shiner, Iowa darter, banded killifish, and mimic shiner. Intolerant species are very sensitive to degradation and are often the first species to experience diminished distribution due to human influence. The presence of these species within these lakes is an indicator of excellent water quality and aquatic habitat. Ninety-one percent of assessed lakes fully support aquatic recreation. Of the 9% found to be impaired, most are relatively shallow and have higher phosphorus concentrations. Long-term inputs of phosphorus, coupled with internal loading in relatively shallow lakes can result in excess algal growth and reduced recreation opportunities. Three of the impaired lakes are located within the Tamarac National Wildlife Refuge; their impairment is the result of naturally occurring conditions (no human activities occur within their catchments).

Introduction

Water is one of Minnesota's most abundant and precious resources. The Minnesota Pollution Control Agency (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 water bodies 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 water body 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 Otter Tail River Watershed beginning in the summer of 2016. This report provides a summary of all water quality assessment results in the Otter Tail River 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: Minnesota's Water Quality Monitoring Strategy 2011 to 2021 (https://www.pca.state.mn.us/sites/default/files/p-gen1-10.pdf).

Watershed pollutant load monitoring

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term statewide river monitoring network initiated in 2007 and designed to obtain pollutant load information from 199 river monitoring sites throughout Minnesota. Monitoring sites span three ranges of scale:

Basin – major river main stem sites along the Mississippi, Minnesota, Rainy, Red, Des Moines, Cedar and St. Croix rivers

Major Watershed – tributaries draining to major rivers with an average drainage area of 1,350 square miles (8-digit HUC scale)

Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 square miles

The program utilizes state and federal agencies, universities, local partners, and MPCA staff to collect water quality and flow data to calculate nitrogen, phosphorus, and sediment pollutant loads.

Intensive watershed monitoring

The intensive watershed monitoring 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 water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 80 major watersheds (HUC-8) 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 one year within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, HUC-8, aggregated HUC-12 and HUC-14 (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 HUC-8 scale. The outlet of the major HUC-8 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 HUC-12 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 HUC-12 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 HUC-12, smaller watersheds (HUC-14, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated HUC-12 tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 2).

Figure 1. The Intensive watershed monitoring design in the Otter Tail River Watershed.

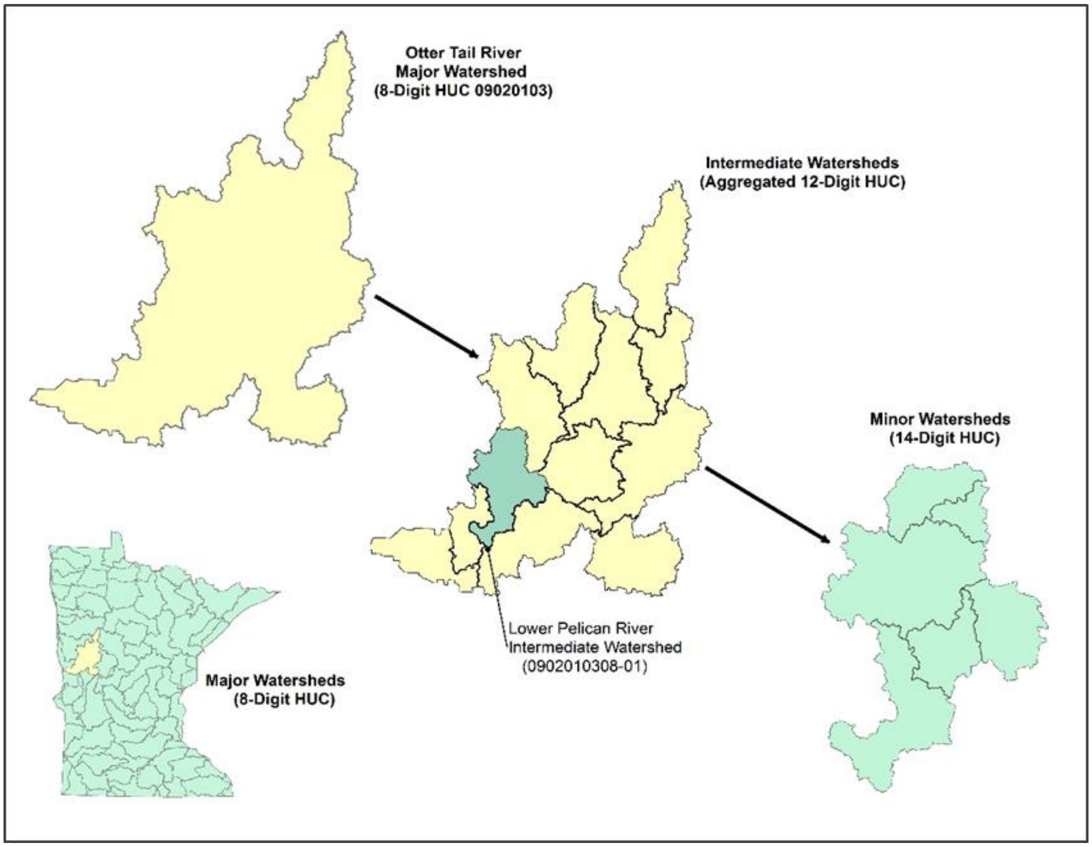
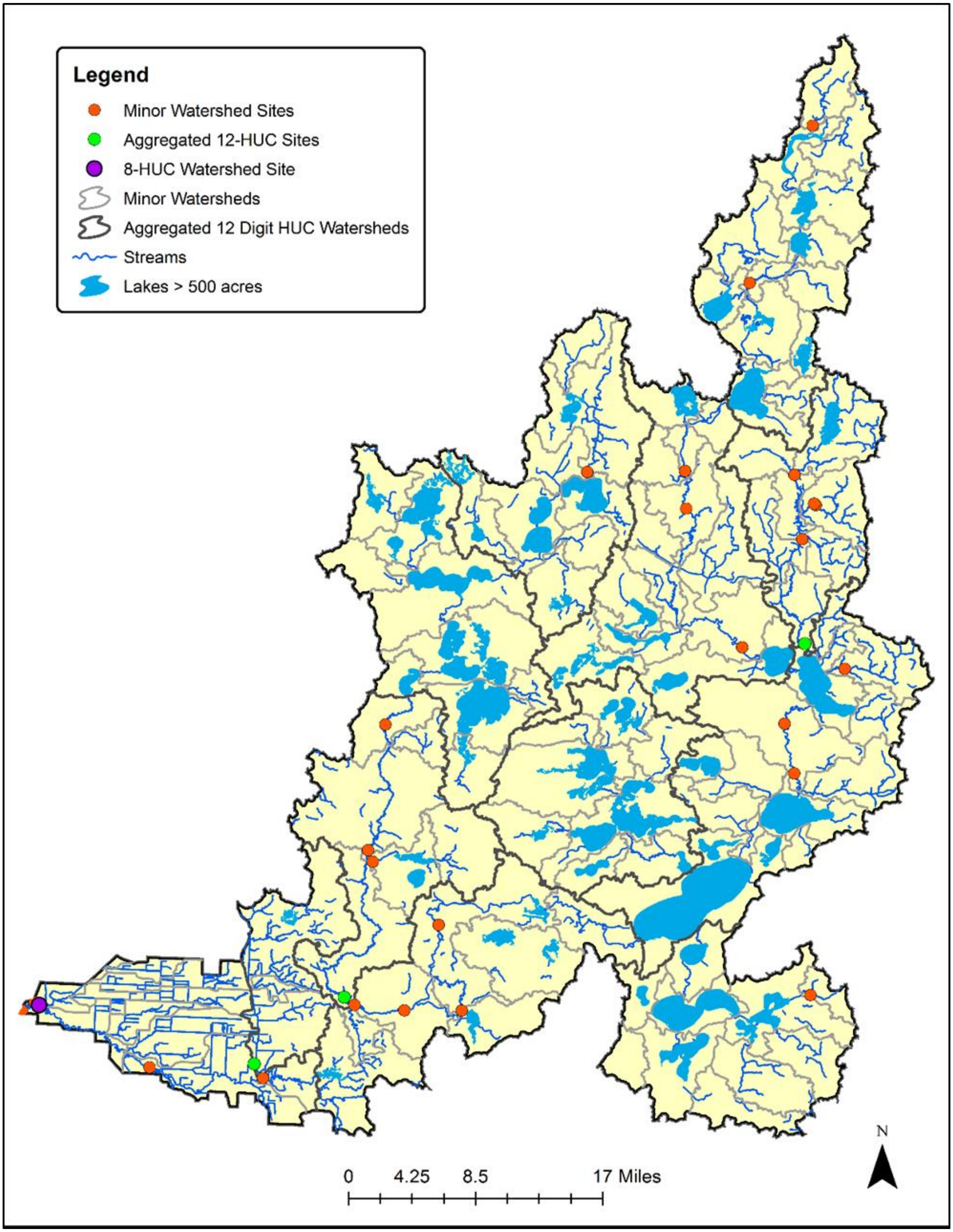


Figure 2. Intensive watershed monitoring sites for streams in the Otter Tail River Watershed.



Lake monitoring

Lakes most heavily used for recreation 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 (greater than 100 acres), 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 Otter Tail River Watershed are shown in Figure 2 and are listed in Appendices 2.1 and 2.2.

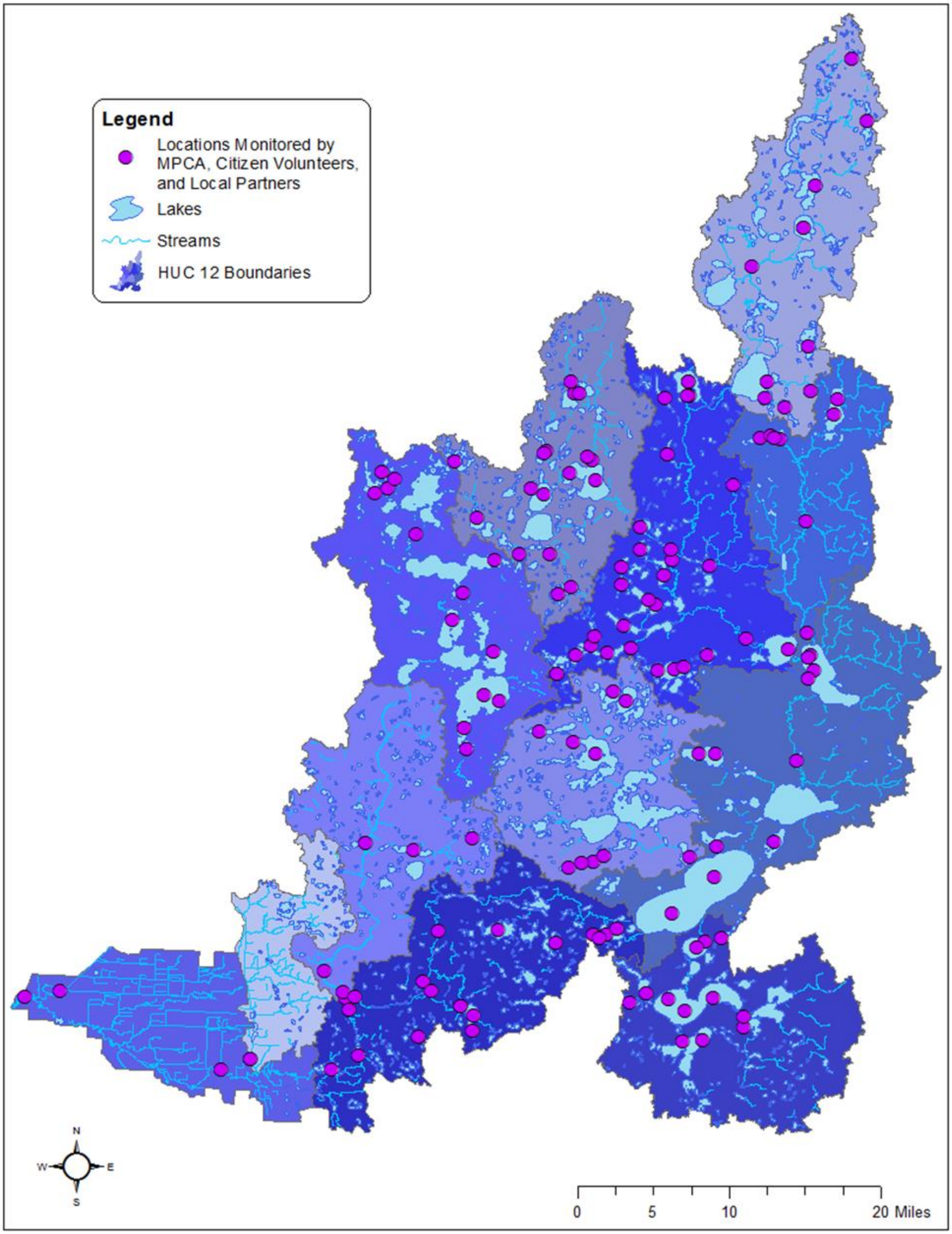
Citizen and local monitoring

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 intensive watershed monitoring process. Funding passes from MPCA through Surface Water Assessment Grants 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.

In the Otter Tail River Watershed, considerable data is provided through locally funded monitoring efforts. In particular, local lake associations, the Otter Tail County COLA, Becker County COLA, and Pelican River Watershed District provided much of the water quality data on lakes in the region.

The MPCA also coordinates two programs aimed at encouraging long-term citizen surface water monitoring: the 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 Otter Tail River Watershed.

Figure 3. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Otter Tail River Watershed.



Assessment methodology

The 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 2012)*. 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 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 water body 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, macroinvertebrates, 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, IBI's 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, TSS, 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 (Table 1). 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, which 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). These tiered aquatic life uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat (MPCA 2015). 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. **Tiered aquatic life use standards.**

Tiered aquatic life use	Acronym	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	Cold water 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	Cold water 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

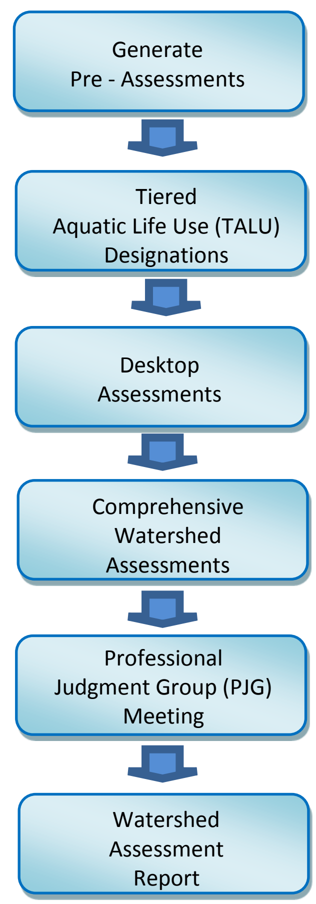
1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its WID), comprised of the United States Geological Survey (USGS) eight-digit hydrologic unit code (HUC-8) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the DNR. The Protected Waters Inventory (PWI) provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the WID 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.

Figure 4. Flowchart of aquatic life use assessment process.



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 aquatic life 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).

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-iw1-04j.pdf for guidelines and factors considered when making such determinations.

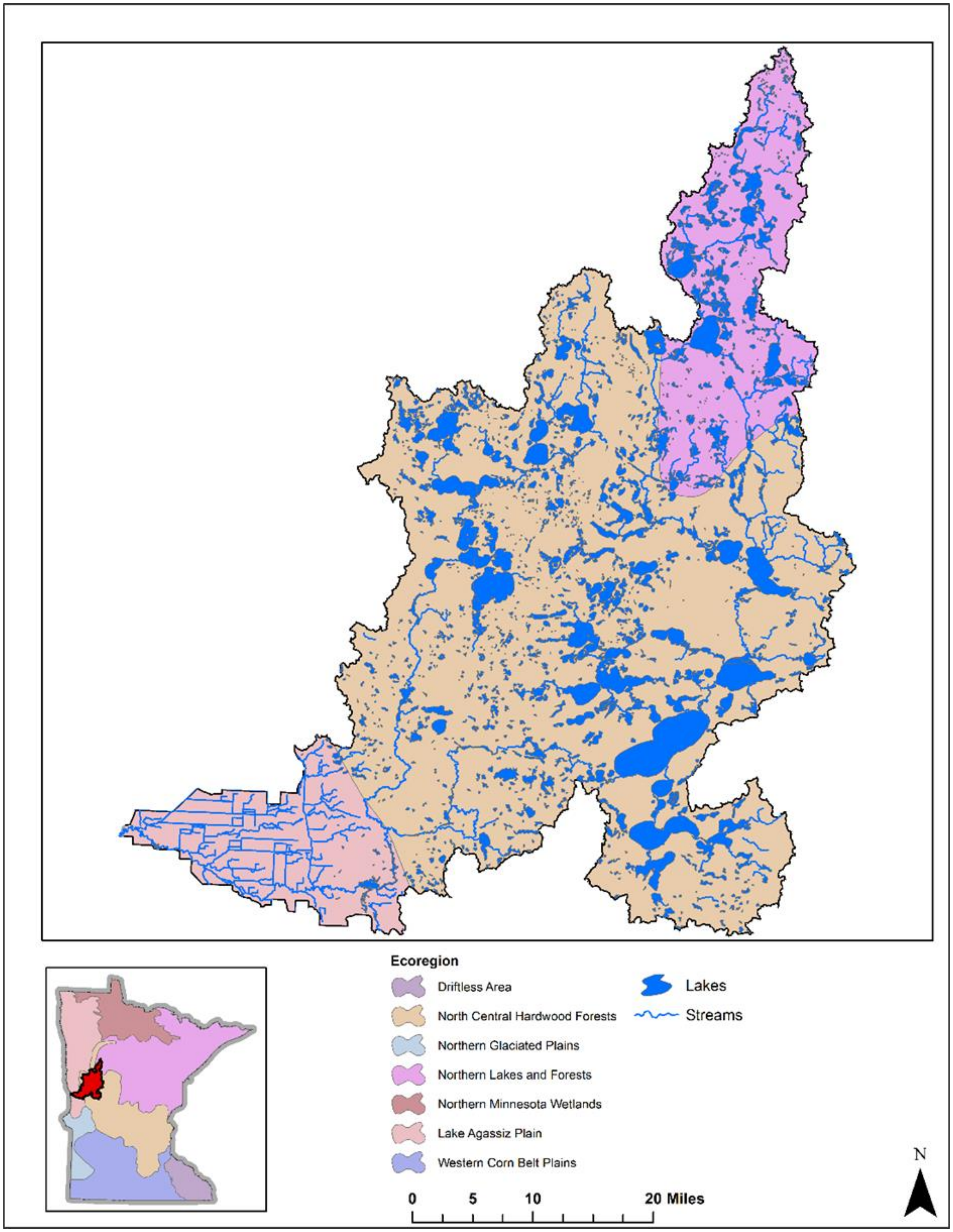
The last step in the assessment process is the Professional Judgment Group meeting. At this meeting, results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information 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 WID). 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

The Otter Tail River Watershed covers 1,249,541 acres (1,952 square miles) of land in western Minnesota. The majority of the watershed is within the counties of Otter Tail and Becker; however, smaller portions sprawl into Wilkin, Clearwater, Clay Counties, and Mahnomen counties. The watershed contains over 1,300 lakes – more than any other Red River Basin Watershed. Many of these lakes are greater than 1,000 acres in size and considered high value recreational resources.

The watershed lies within three ecoregions – the Northern Lakes and Forests Ecoregion (NLF), North Central Hardwood Forests Ecoregion (NCHF), and the Lake Agassiz Plain Ecoregion (LAP) (Figure 5). The headwaters of the Otter Tail River lie within the NLF ecoregion. The nutrient –poor glacial soils of this ecoregion support the growth of coniferous and northern hardwood forest (Omernik *et al.* 1988). Most tracts of coniferous forest within the watershed, including the prominent stands of white pine that were logged, are located in this region. Glaciers formed moraine hills, undulating till plains, extensive sandy outwash plains, and numerous lakes within this ecoregion (Omernik *et al.* 1988). The majority of the watershed lies within the NCHF ecoregion. Forests, wetlands, lakes, pasture, and croplands are all found within this ecoregion (Omernik *et al.* 1988). The soils within the NCHF ecoregion are generally fertile and suitable to row crop agriculture. Thus, a substantial amount of the land within this region of the watershed is used for agricultural purposes (pasture, hay, row crop production). Most of the lakes within the watershed also occur within this ecoregion. The southwestern portion of the watershed lies within the LAP ecoregion. The thick layers of lake sediments deposited by Glacial Lake Agassiz formed fertile soils in the LAP ecoregion (Krenz and Leitch 1993). Typical of many remnant lakebeds, the LAP ecoregion is very flat and featureless. Almost all of the land within this portion of the watershed is used for crop production.

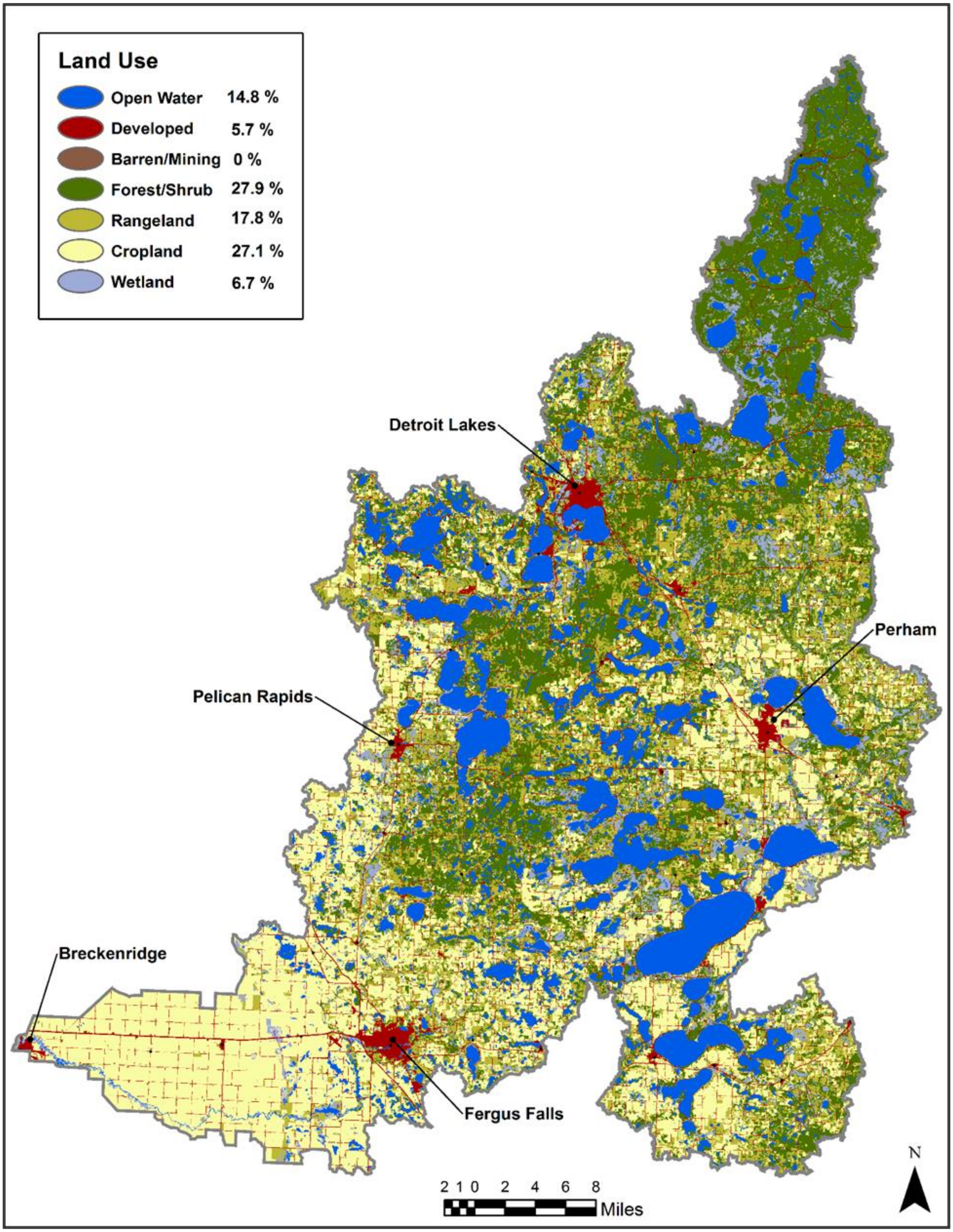
Figure 5. The Otter Tail River Watershed within the Lake Agassiz Plain, Northern Lakes and Forest, and North Central Hardwoods ecoregions of western Minnesota.



Land use summary

Historically, most of the land within the Otter Tail River Watershed was forested. Hardwood forests and oak savannah covered much of the central portion of the watershed while large tracts of pine were present in the far northern regions. Tallgrass prairie was interspersed with forested land along the western edge of the watershed and was especially prominent in the southwestern portion of the watershed (within the Lake Agassiz Plain ecoregion). This flat region of the watershed with poorly drained soils also had numerous areas of permanent and temporary wetlands (Krenz and Leitch 1993). Members of the Dakota Nation inhabited this watershed and the surrounding area until the early 1700s when the Ojibwe gained control of the land (1993). French Canadians and other fur traders entered this area during the late 17th century; fur trading was the most prominent industry within the area by the mid-18th century. Logging became an important industry during the mid-late 1800s. Numerous logging camps were constructed along rivers and lakes throughout the watershed. During this time, steamboats and the railroad began to foster settlement throughout western Minnesota (1993). By the early 1900's, the large tracts of pine within the northern portion of the watershed had been cleared by logging (West and Wilcox 1907). Oak timber had also been heavily harvested for use in the construction of the Northern Pacific Railroad (1907). Agricultural land drainage began as early as the mid-1800s to make more land within the Red River Basin available for agricultural production (Krenz and Leitch 1993). Extensive ditching and other hydrologic alterations were most common in the southwestern portion of the watershed. The network of ditches and subsurface tiling convey water from agricultural land to rivers and streams. These drainage practices resulted in the loss of most of the original wetlands. According to the National Land Cover Database (NLCD), today wetlands account for 6.7% of the land within the watershed (Figure 6) (USGS 2011). Most of the tallgrass prairie and areas of oak savannah have also been cleared and converted to agricultural land. Approximately 27.1% of the land within the watershed is used for row crop production and another 17.8% is used for pasture and hay (2011). The NRCS estimates 2,241 farms occur within the watershed and approximately 51% are less than 180 acres in size (USDA). Forests cover 27.9% of the land within the watershed (USGS 2011). The most contiguous tracts of forest lie within the relatively undeveloped northeastern region of the watershed where the Otter Tail River begins. The Tamarac National Wildlife Refuge and White Earth Indian Reservation are also in this region of the watershed. Developed land accounts for 5.7% of the watershed (2011). Most development is concentrated around larger communities such as Fergus Falls, Detroit Lakes, Pelican Rapids, and Perham; however, development is also prevalent around many of the larger lakes within the watershed. The numerous lakes (open water) scattered throughout the watershed account for 14.8% of the watershed area (2011).

Figure 6. Land use in the Otter Tail River Watershed.



Surface water hydrology

The headwaters of the Otter Tail River lie within the far northeastern portion of the Otter Tail River Watershed. This heavily forested, lake rich region is located within the White Earth Indian Reservation; approximately 68 square miles of this area is also located within the Tamarac National Wildlife Refuge (NWR). The Otter Tail River originates out of Elbow Lake as a small low gradient stream with a wetland riparian zone. The river flows south for approximately seven miles and consists of a series of short connecting channels between Little Bemidji Lake, Many Point Lake, and Round Lake. Dams are present at the outlet of each lake. After exiting Round Lake, the river winds south and west for approximately 12 miles, passing through several large wetland complexes and two dams before entering Height of Land Lake. The river flows through a dam at the outlet of Height of Land Lake and flows west through another large wetland area (and dam) before turning toward the south. The river has now left the NLF Ecoregion; an area characterized by nutrient poor soils and morainal hills, and entered the NCHF Ecoregion. This ecoregion contains varying topography and more productive soils. Row crop and pasture land become more prevalent as the river progresses south through this region. Most of this region of the watershed also lies within a glacial outwash plain containing thick deposits of sand and other fine sediments. As a result, crop irrigation is prevalent throughout the central region of the watershed. The river winds south for approximately 35 miles, passing through an impoundment (Albertson Lake) near Frazee, before turning southeast and entering Little and Big Pine Lake. Dams are present on the outlets of Albertson Lake, Little Pine Lake, and Big Pine Lake. The Toad River, a major tributary within the Otter Tail River Watershed, drains 111 square miles of land into Big Pine Lake. The Toad River originates from Little Toad Lake, located in the far northeastern region of the watershed, and flows primarily toward the south for 21 miles before emptying into Big Pine Lake. The headwaters of the Toad River are located within the heavily forested NLF Ecoregion. Land use within the remaining portion of the subwatershed consists primarily of pasture and hay with smaller patches of forest and row crop. The majority of the river maintains a low gradient character and is bordered by a wetland riparian zone. Portions of the Toad River have been straightened and even redirected from the original flow path. Several small tributary streams, including the cold water stream Deadhorse Creek, drain the land along the eastern edge of the Otter Tail River Watershed into the Toad River.

After exiting Big Pine Lake, the Otter Tail River flows south for approximately 15 miles, passing through Rush Lake and entering Otter Tail Lake. Dams are present at the outlet of both lakes. Otter Tail Lake also receives water from the Dead River (through Walker Lake), which drains 150 square miles of land within the south central region of the watershed. The Dead River drainage features numerous lakes and small wetlands (> 150 waterbodies). Forested land and agricultural land is distributed throughout this drainage. After exiting Otter Tail Lake, the Otter Tail River Continues winding west for approximately 17 miles. The river passes through numerous small lakes and two impoundments before turning south and entering a small impoundment. At this location, water from the river is routed through a diversion channel for cooling purposes at a power plant. This diversion channel later rejoins the river within the community of Fergus Falls. The river winds east, south, and then west before entering the community of Fergus Falls. The river passes through two impoundments located within the community and continues west before being joined by the Pelican River.

The Pelican River, the largest tributary of the Otter Tail River, drains 492 square miles of land along the western edge of the Otter Tail River Watershed. Much of the eastern half of the Pelican River Watershed is forested while the western half is a mixture of hay/pasture land and row crop. Numerous lakes are present within the upper Pelican River drainage. The Pelican River originates as a small-channelized stream from a wetland area located approximately six miles north of Detroit Lakes. The river flows south for 10 miles and empties into Detroit Lake. Almost the entire reach of the river from its headwaters to Detroit Lake has been altered (straightened). After exiting Detroit Lake, the Pelican River consists of short connecting channels between numerous lakes of various sizes. Dams are present at the outlet of most of these lakes. The river exits Prairie Lake, the last large lake within the flow path, and enters an impoundment located within the community of Pelican Rapids. With the exception of one impoundment located near Elizabeth, the remaining 42 miles of the Pelican River are continuous. Throughout its course, most of the Pelican River is low gradient and bordered by a wetland riparian zone. After the confluence of the Pelican River, the Otter Tail River enters the Lake Agassiz Plain – a flat area dominated by row crop agriculture. The flat topography and poor natural drainage within this ecoregion necessitated the creation of extensive drainage systems throughout this region of the watershed. The soils of the Lake Agassiz Plain consist of fine lake sediments; as a result, turbidity increases as the river progresses west. The river turns south and flows into two reservoirs – Dayton Hallow and Orwell Lake. Orwell Lake is a large reservoir that was constructed to store water for irrigation, flood control, and drinking water purposes. Flows are regulated on the remaining 29 miles of the Otter Tail River due to operation of the Orwell Dam. After Orwell Lake, the river winds west for approximately 8 miles and is joined by the tributary Judicial Ditch 2. Judicial Ditch 2 flows from north to south and drains 68 square miles of agricultural land. An extensive network of ditches drain the remaining portion of the Otter Tail River Watershed. Many of these ditches flow from east to west before converging with larger ditches that drain toward the south / southwest. A long segment of the lower Otter Tail River was also straightened to increase drainage and reduce flooding. This segment begins approximately 6 miles west of the Judicial Ditch 2 confluence and extends almost to Breckenridge Lake. The river returns to a natural channel and continues meandering west for 7 miles before entering the community of Breckenridge. The Otter Tail River passes through the community and joins the Bois de Sioux River to form the Red River of the North.

Throughout its 190-mile long flow path, the Otter Tail River passes through 18 lakes and more than 20 dams. The numerous lakes within the Otter Tail River Watershed provide a large amount of storage, which effectively reduces flooding (DNR 2010). Compared to other Red River Basin Watersheds, the Otter Tail River Watershed is among the least impacted by flooding (MPCA Watersheds). Many of the dams within the watershed were first constructed in the early 20th century for the purpose of aiding the movement of logs down the river. Others were constructed for maintaining water levels in lakes or generating hydroelectric power. Over the last decade, some of these aging structures were removed in favor of maintaining hydrologic continuity and eliminating the costs associated with maintenance (Aadland 2018).

Figure 7. Map of percent altered streams by major watershed (HUC-8)

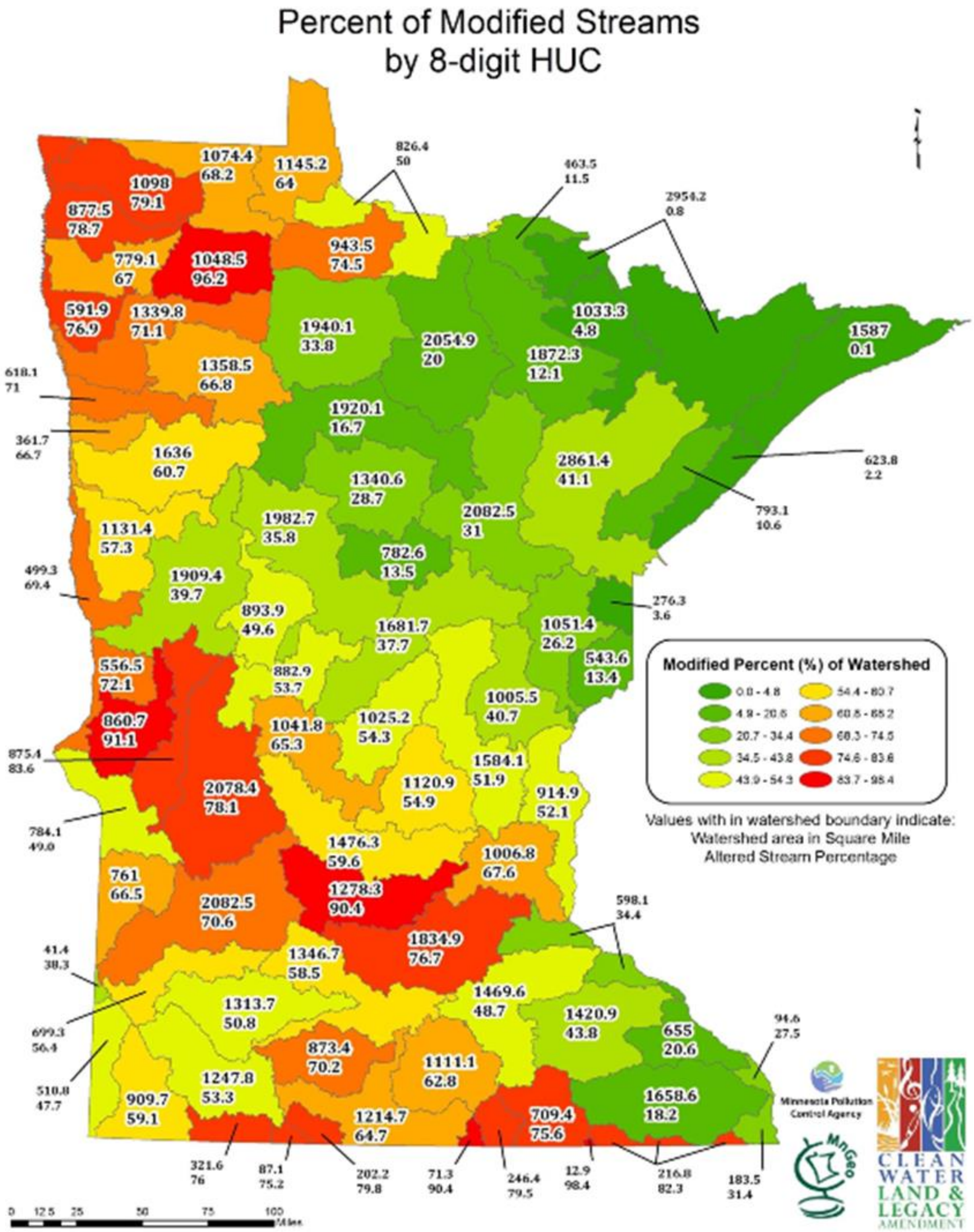
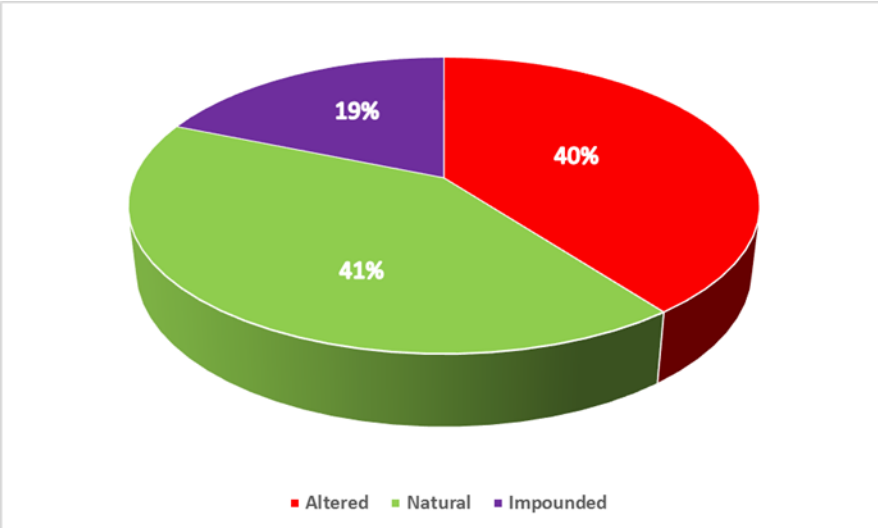


Figure 8. Comparison of natural to altered streams in the Otter Tail River Watershed (percentages derived from the Statewide Altered Water Course project).

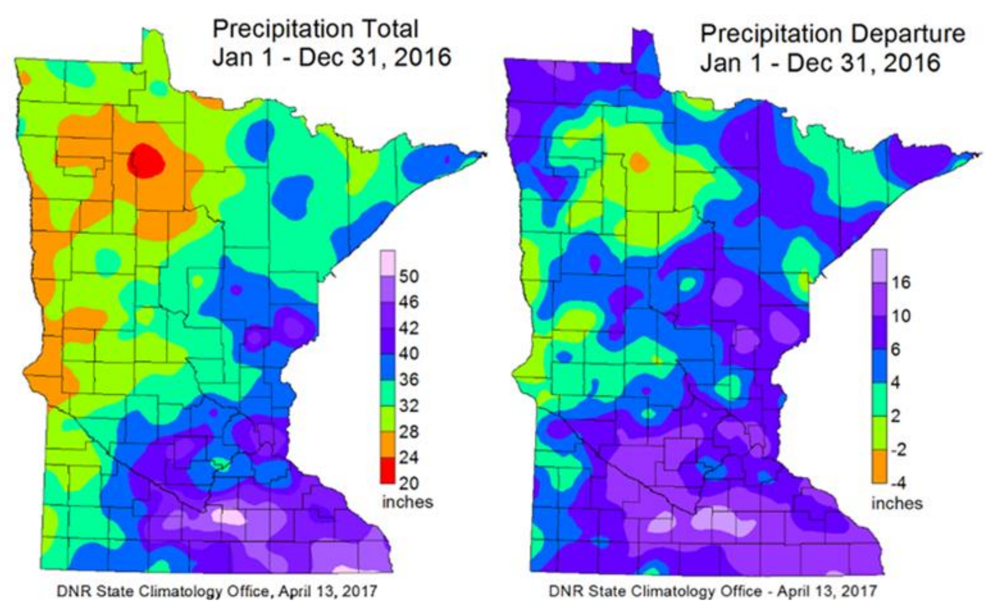


Climate and precipitation

Minnesota has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota ranges from 2.2 to 9.4˚C (NOAA); the mean summer (June-August) temperature for the Otter Tail River Watershed is 19.4˚C and the mean winter (December-February) temperature is -11.1˚ C (DNR: Minnesota State Climatology Office 2019a).

Precipitation is an important source of water input to a watershed. Figure 9 displays two representations of precipitation for calendar year 2016. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the southeastern portion of the state. According to this figure, the Otter Tail River Watershed area received 24 to 32 inches of precipitation in 2016. The display on the right shows the amount that precipitation levels departed from normal. The watershed area experienced precipitation that ranged from two to six inches above normal in 2016.

Figure 9. Statewide precipitation total (left) and precipitation departure (right) during 2016 (Source: DNR State Climatology Office 2019b).



The upper half of the Otter Tail River Watershed is located in the Northwest precipitation region while the lower half is located in the West Central precipitation region. [Figure 10](#) displays the areal average representation of precipitation in Northwest Minnesota for 20 and 100 years, *left and right respectively*, while [Figure 11](#) represents the West Central precipitation region. Though rainfall can vary in intensity and time of year, rainfall totals in the Northeast and West 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 10. Precipitation trends in northwest Minnesota from 1997-2016 (top) and 1917-2016 (bottom) (Source: WRCC 2018).

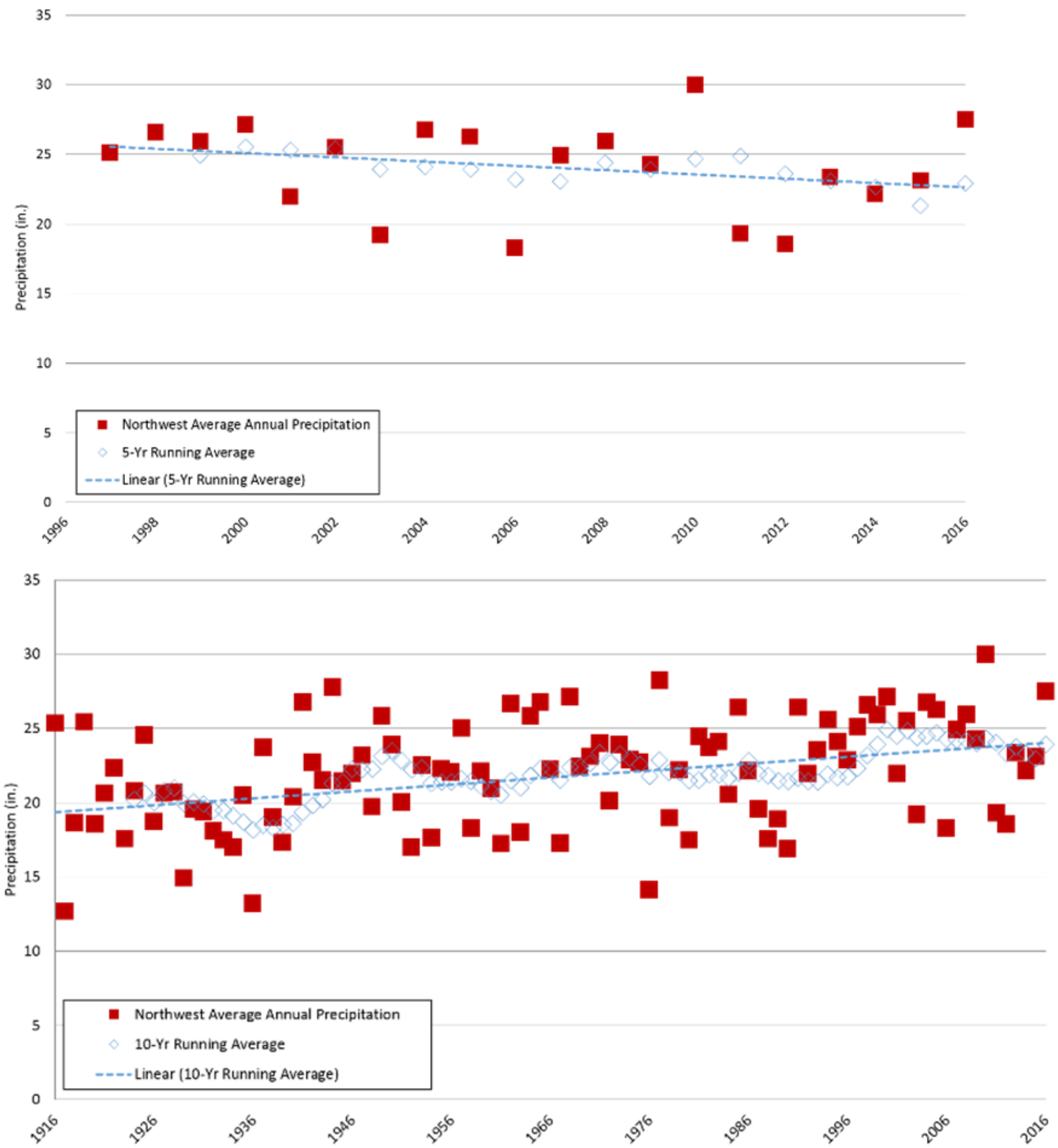
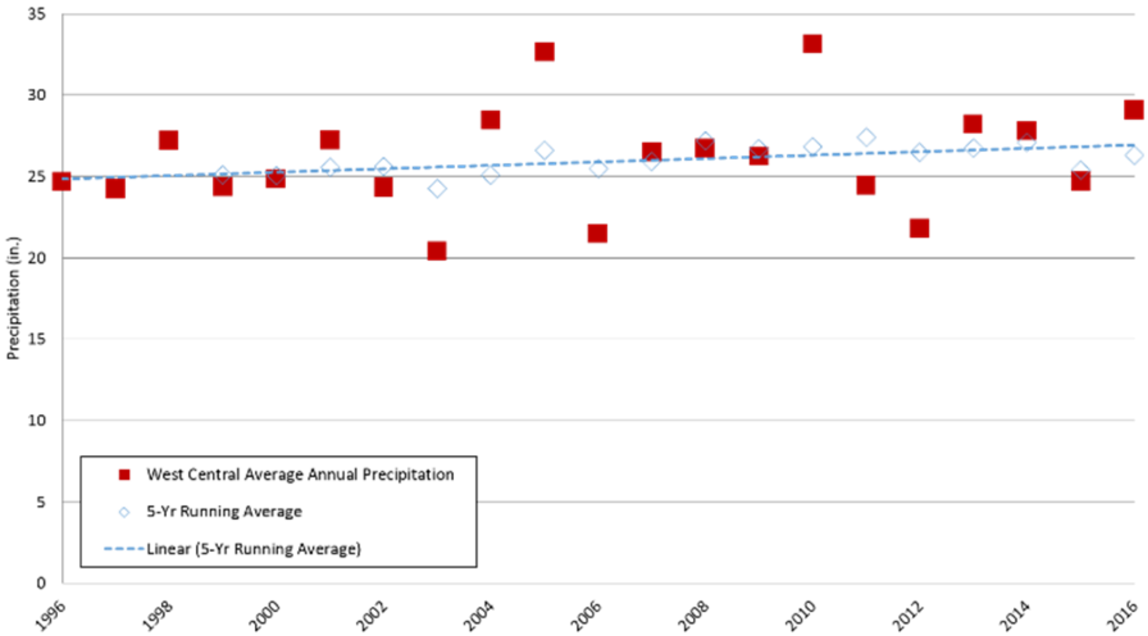
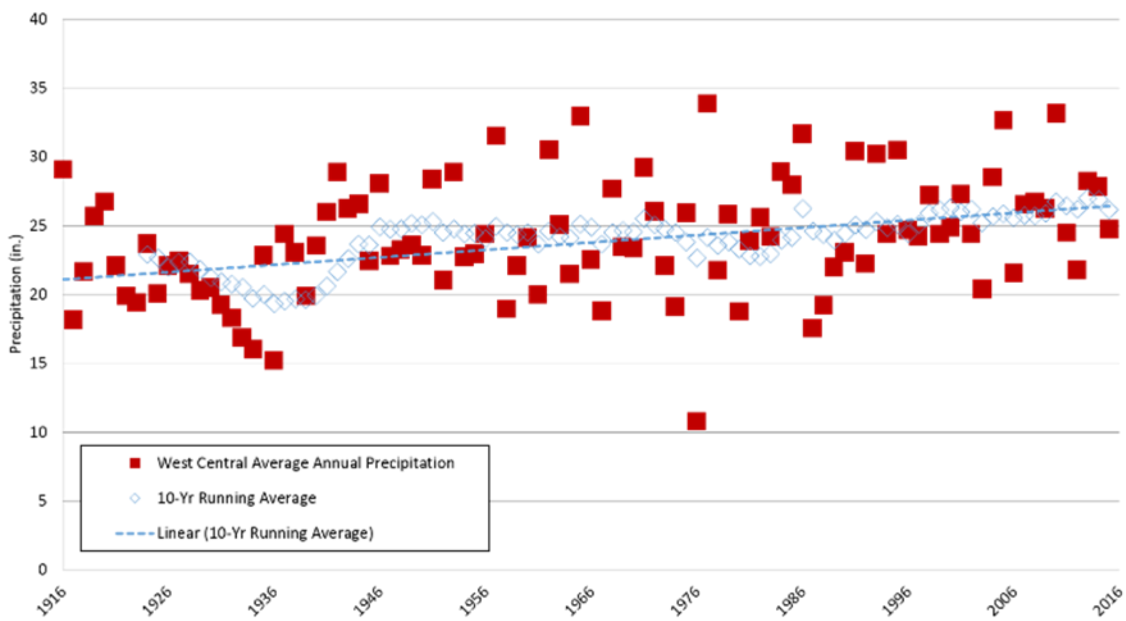


Figure 11. Precipitation trends in west central Minnesota from 1997-2016 (top) and 1917-2016 (bottom) (Source: WRCC 2018).





Hydrogeology and groundwater quality

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

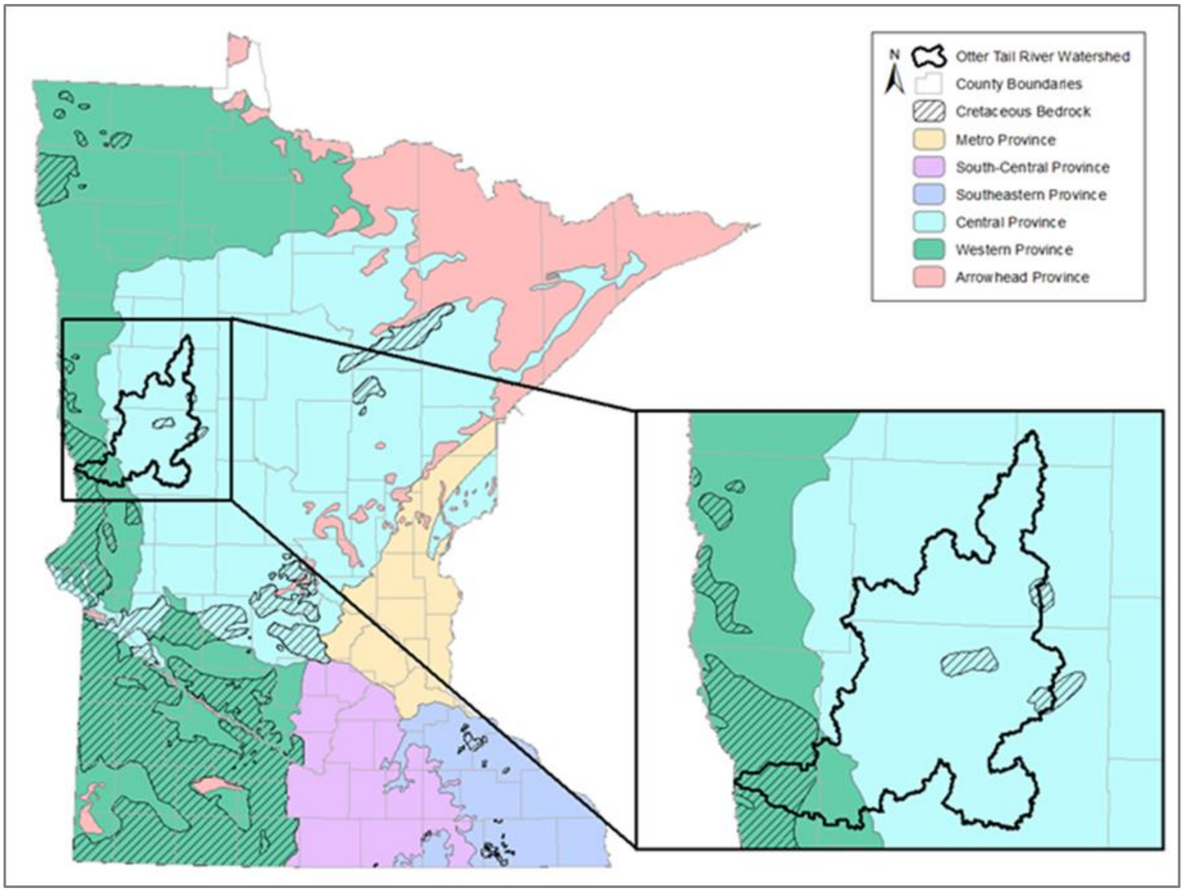
Surficial geology is identified as the earth material located below the topsoil and overlying the bedrock. Glacial sediment is at the surface over the entirety of the Otter Tail River Watershed and is the parent material for the soils that have developed since glaciation. The depth to bedrock ranges from approximately 175 to 1050 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 two ice lobes, the Des Moines and Wadena lobes, and post-glacial alterations to that sediment, including soil formation and peat accumulation. The geomorphology includes glacial lake sediment, moraines (end, ground, stagnation), outwash, and alluvium (Hobbs & 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 Otter Tail River Watershed, as well as Cretaceous bedrock associated with the Mesozoic era, which overlays the Precambrian bedrock. The main terrane groups found within the Precambrian bedrock include the Animikie Group and Wawa subprovince (Jirsa et al. 2011). The Cretaceous bedrock includes conglomerate, sandstone, shale and mudstone. The rock types found in the uppermost bedrock include felsic metavolcanic rock, granodiorite, intermediate volcanic rock, monzodiorite, sandstone, schist, sedimentary rock and slate (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 Otter Tail River Watershed is primarily located within the Central Groundwater Province with the southwestern tip located in the Western Groundwater Province and Cretaceous bedrock throughout the watershed (Figure 12). The Central Province has sand aquifers in thick sandy and clayey glacial drift, while the Western Province consists of clayey glacial drift (DNR 2001). The Cretaceous bedrock has layers of sandstone that are interbedded with thick layers of shale, located between older bedrock and glacial drift, and often utilized as local water sources (DNR 2001). The general availability of groundwater for the Central Province is good in the surficial sands, moderate availability in the buried sands, and limited in bedrock, while the Western Province is moderate in surficial sands and limited in buried lands and bedrock (DNR 2018a).

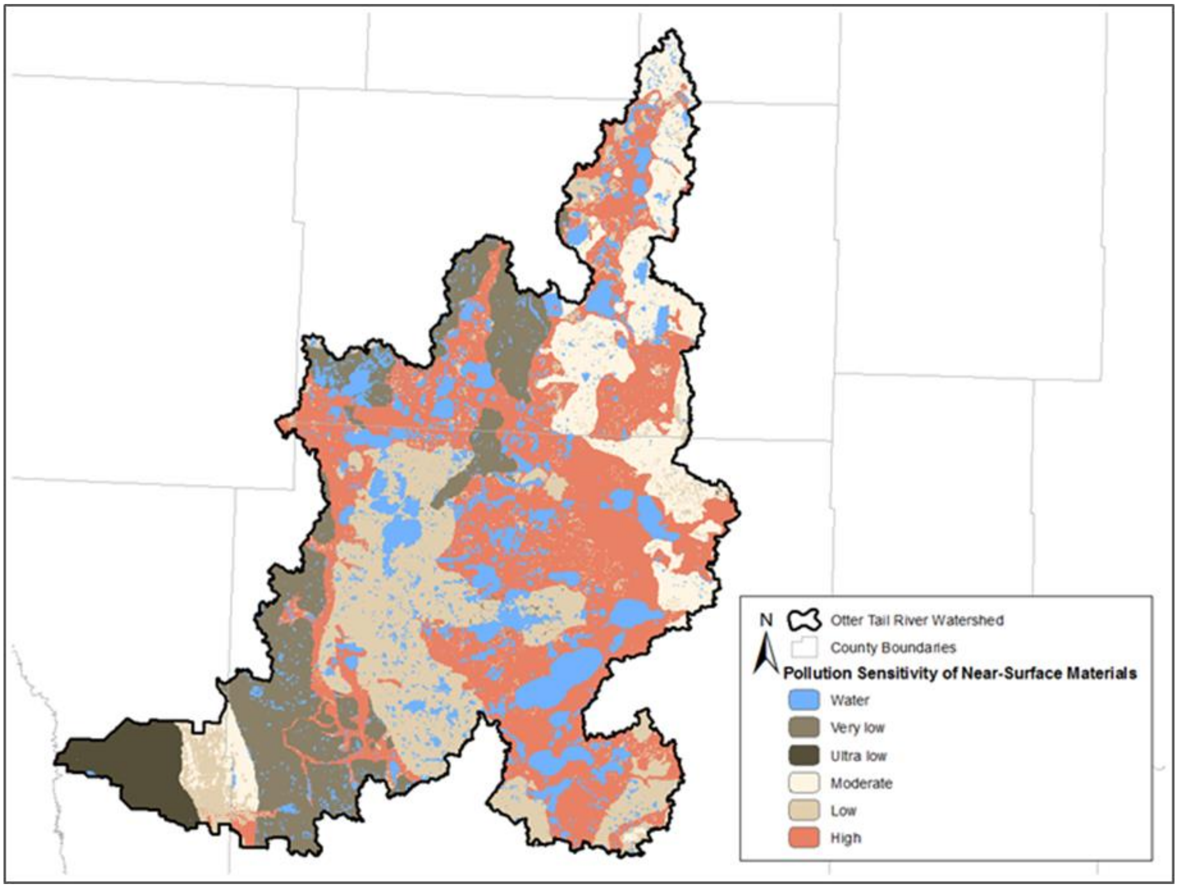
Figure 12. Groundwater provinces within the Otter Tail River Watershed (GIS Source: DNR 2001).



Groundwater pollution sensitivity

Surficial aquifers are typically more likely to be vulnerable to contamination, have direct hydrologic connections to local surface water, and influence the quality and quantity of local surface water. A 2016 statewide evaluation of pollution sensitivity of near-surface materials completed by the DNR is utilized to estimate pollution vulnerability up to ten 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, Otter Tail River Watershed is estimated to have ultra-low to moderate pollution sensitivity ratings with some high pollution sensitivity areas scattered throughout the watershed, most likely due to the presence of sand and gravel Quaternary geology (Figure 13) (DNR 2016).

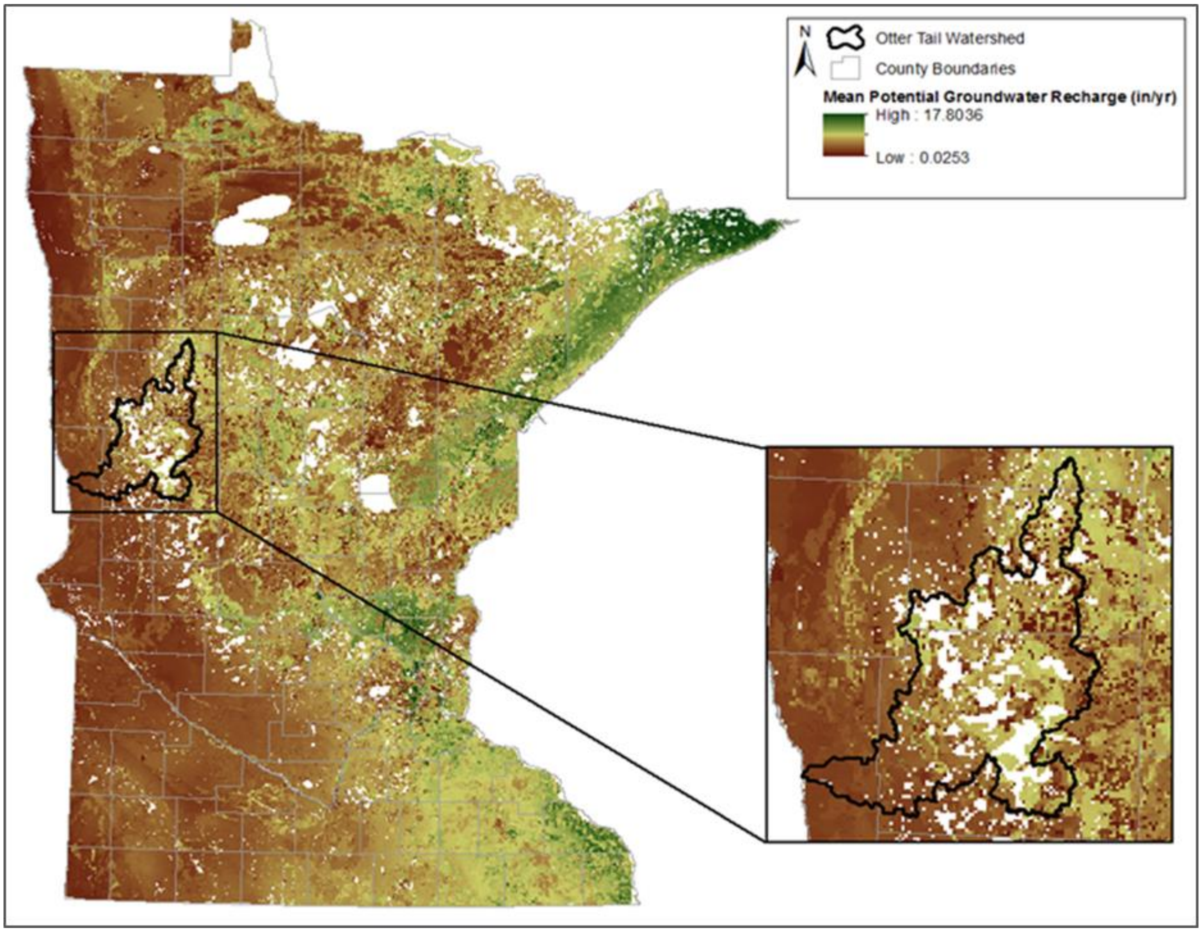
Figure 13. Pollution sensitivity of near surface materials for the Otter Tail River Watershed (GIS Source: DNR 2016).



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. Recharge of 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 14). 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 Otter Tail River Watershed, the average annual potential recharge rate to surficial materials ranges from 0.25 to 9.32 inches per year, with an average of 4.53 inches per year (Figure 14). The statewide average potential recharge is estimated to be four inches per year with 85% of all recharge ranging from three to eight inches per year. When compared to the statewide average potential recharge, the Otter Tail River Watershed receives approximately the same average potential recharge.

Figure 14. Average annual potential recharge rate to surficial materials in the Otter Tail River Watershed (1996-2010) (GIS Source: USGS 2015).



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 Minnesota Pollution Control Agency'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.

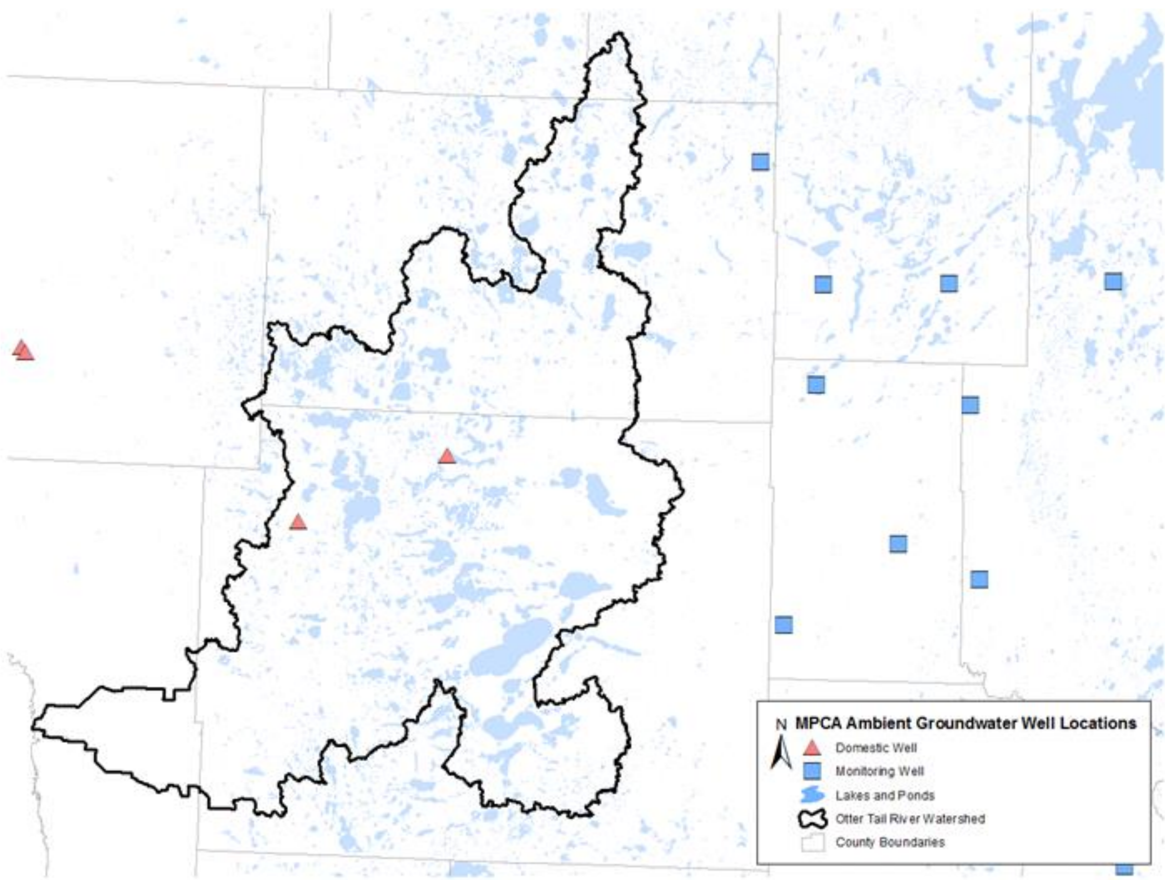
There are currently two domestic MPCA ambient groundwater monitoring wells within the Otter Tail River Watershed (Figure 15). Data collection for the network ranges from 2006 to 2018 for both of these wells. The most commonly detected analytes within this watershed were chloride, calcium, magnesium, potassium, barium, and strontium. All of these analytes are naturally occurring and released into the groundwater as the mineral dissolves over time and all detections were below water quality standards. There were exceedances of some contaminants identified in these wells. One domestic well had exceedances of inorganic nitrogen (nitrate and nitrite), while the other domestic well had exceedances of iron and manganese.

Inorganic nitrogen includes nitrate and nitrite that may contaminate water sources through excess fertilizer runoff, leakage from septic tanks and sewage, and erosion of natural deposits (EPA 2019). The maximum contaminant level (MCL) is 10 mg/L for nitrate and 1 mg/L for nitrite. For this analysis, 10 mg/L was used as the exceedance benchmark, since nitrate is the dominant form typically found in groundwater. Nitrate levels that exceed the MCL are considered dangerous for infants younger than six months due to the risk of methemoglobinemia (blue-baby syndrome), which could potentially be life threatening if untreated. It is recommended to use treatment if nitrate levels are above the MCL with ion exchange, reverse osmosis, or electrodialysis (EPA 2019).

Iron has a secondary maximum contaminant level (SMCL) of 300 µg/L, where exceedances can lead to noticeable nuisance affects (taste, color, odor), but are not considered to be a threat to human health (EPA 2019). These effects may include rusty color, metallic taste, pipe clogging and staining clothes and appliances. Conventional treatments, such as coagulation, flocculation, filtration, aeration, and granular activated carbon filters, are effective ways of removing color and odor associated with secondary contaminants (EPA 2019).

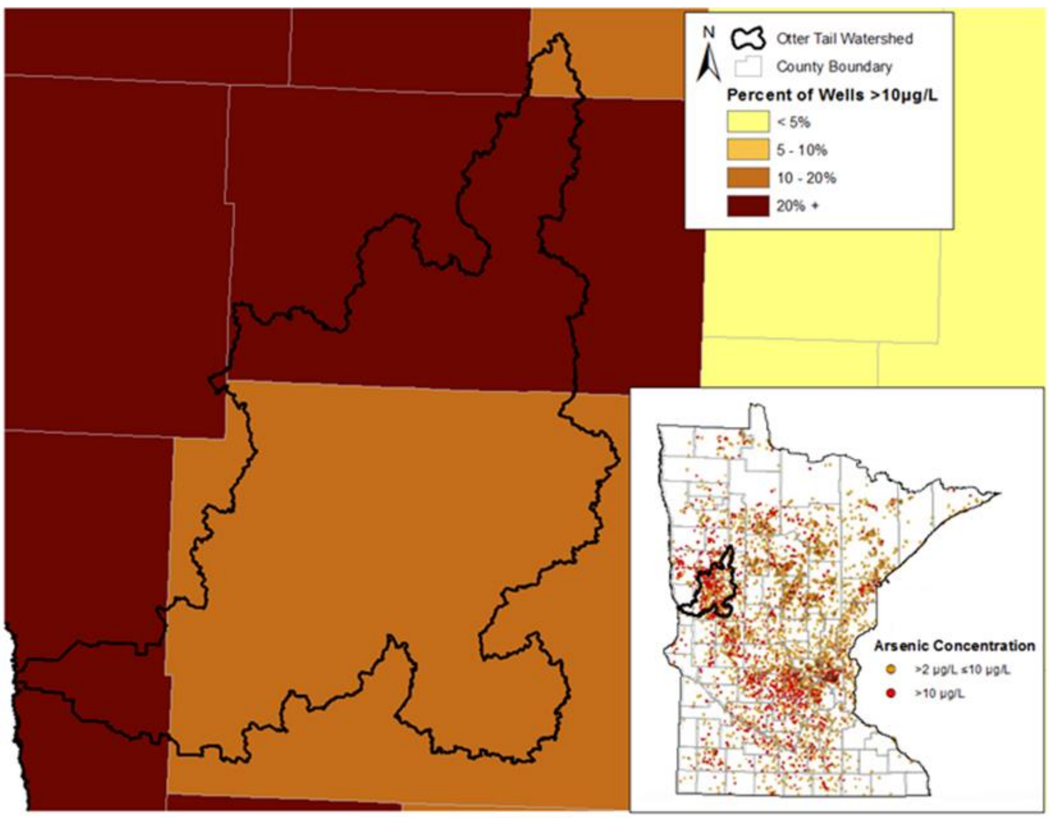
Manganese has a Health Based Value (HBV) of 100 µg/L. It is naturally occurring and commonly found in groundwater across the state. High concentrations of manganese give water a black to brown color, a bitter metallic taste, and may be unsafe for human consumption when concentrations are over the HBV, especially for infants. At low levels, manganese is considered beneficial, but high exposures can cause harm to the nervous system and issues with memory, attention and motor skills (MDH 2019). If their drinking water exceeds the HBV, individuals are advised by the MDH to utilize a carbon filter or bottled water, especially with infants and nursing mothers (MDH 2019a).

Figure 15. MPCA Ambient groundwater monitoring well locations within the Otter Tail River Watershed.



Another source of information on groundwater quality comes from the Minnesota Department of Health (MDH). Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that an average of 10% of all wells installed from 2008 to 2018 have arsenic levels above the MCL for drinking water of 10 ug/L (MDH, 2019b). In the Otter Tail River Watershed, many of new wells are within the water quality standards for arsenic levels, but exceedances to the MCL are common. By county, the percentages of wells identified with concentrations exceeding the MCL are as follows: Becker (26.9%), Wilkin (24.6%), and Otter Tail (19.7%) county (MDH 2019c) (Figure 16). It is important to reiterate that the percentages of arsenic concentration exceedances are per county, not specifically for Otter Tail River Watershed.

Figure 16. Percent wells with arsenic occurrence greater than the MCL for the Otter Tail River Watershed (2008-2016) (Source: MDH 2019c).



Groundwater quantity

High capacity withdrawals

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 back to the DNR annually. The changes in withdrawal volume 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 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 power generation, public water supply (municipals), and irrigation (DNR 2018b). According to the most recent DNR Permitting and Reporting

System (MPARS), in 2016 the permitted withdrawals within the Otter Tail River Watershed were primarily utilized for agricultural irrigation (53.4%). The locations of these high capacity withdrawals are shown in Figure 17. The remaining withdrawals include power generation (30.4%), water supply (9.8%), industrial processing (4.1%), non-crop irrigation (1.1%), special categories (0.95%), water level maintenance (0.29%), and heating/cooling (0.07%). From 1997 to 2016, special categories for this watershed consists of pollution containment, snow/ice making, livestock watering, aquaculture, dust control and construction non-dewatering. Special categories, albeit a minor contribution to the withdrawals in this watershed, have increased significantly over the last 20 years ($p<0.001$). Agricultural irrigation and water supply account for 63.1% of the permitted withdrawals and have been increasing during this time period ($p<0.01$). Figure 18 illustrates the total annual surface water and groundwater withdrawals within the watershed from 1997 – 2016.

Figure 17. Locations of active status high capacity withdrawals in 2016 within the Otter Tail River Watershed.

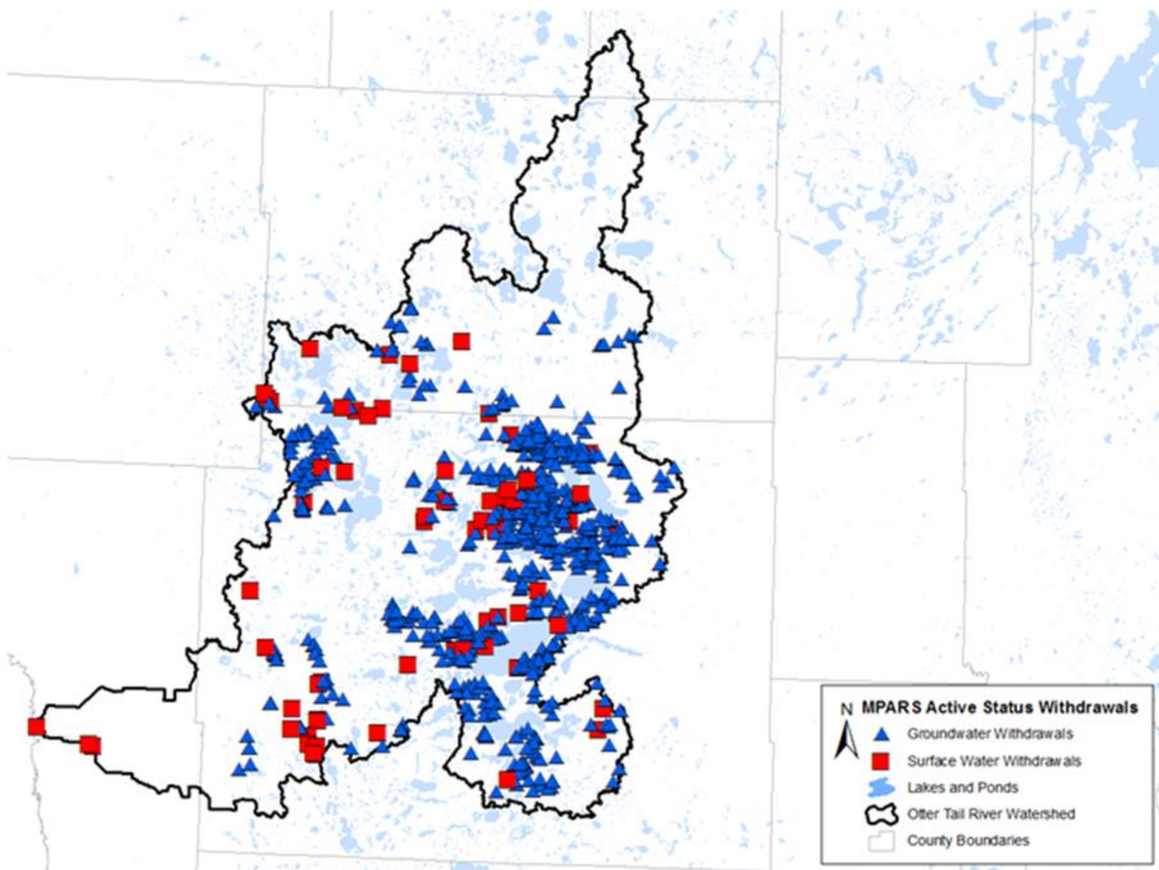
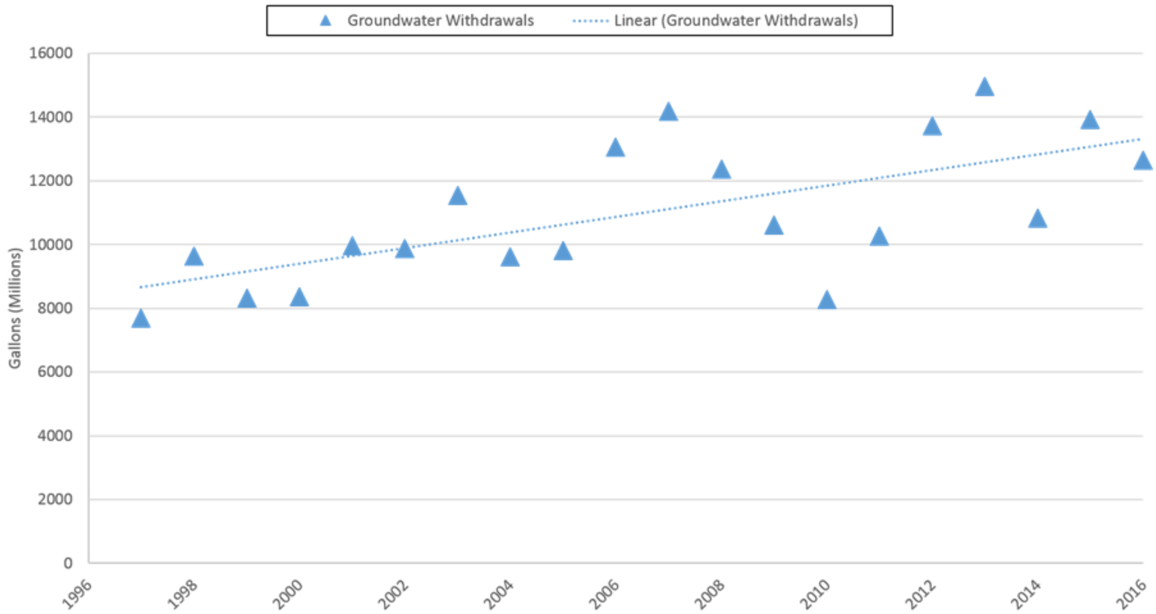
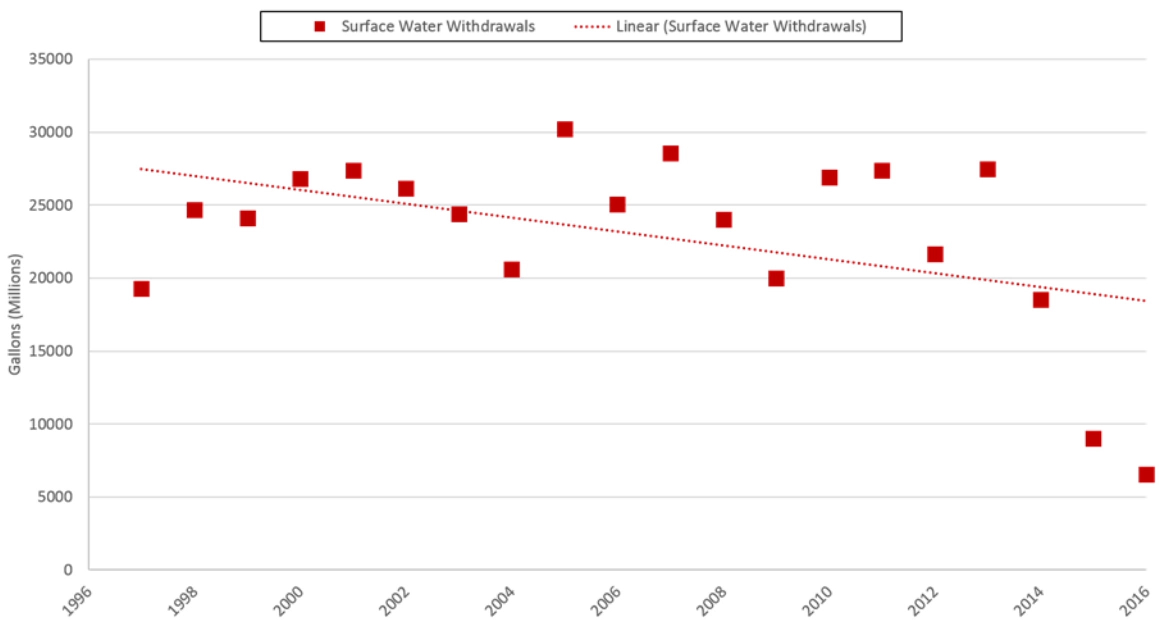


Figure 18. Total annual groundwater (top) and surface water (bottom) withdrawals in the Otter Tail River Watershed (1997-2016).





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.

Two of the 15 DNR observation wells (243492 and 244240) within the Otter Tail River Watershed were chosen for analysis based on data availability and geologic location as representation of depth to groundwater throughout the watershed (Figure 19). Depth to Water (DTW) was collected on a monthly basis and the average annual DTW was calculated. For observation well 243492 located near Detroit Lakes, groundwater elevation on an average annual basis from 1997 to 2016 has declined significantly ($p<0.01$) (Figure 20, top), while observation well 244240 near Vining also appears to be declining, but not at a significant rate (Figure 20, bottom).

Figure 19. DNR quaternary water table observation well locations within the Otter Tail River Watershed.

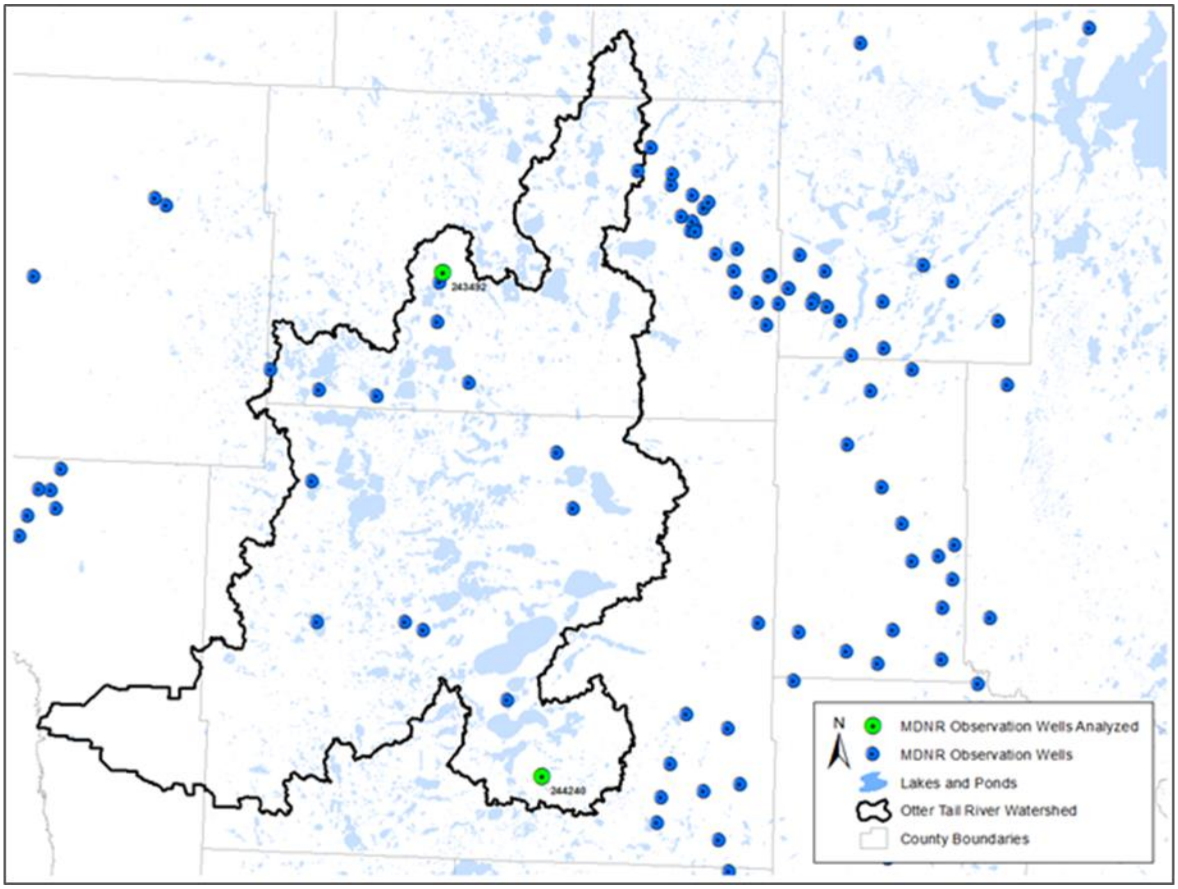
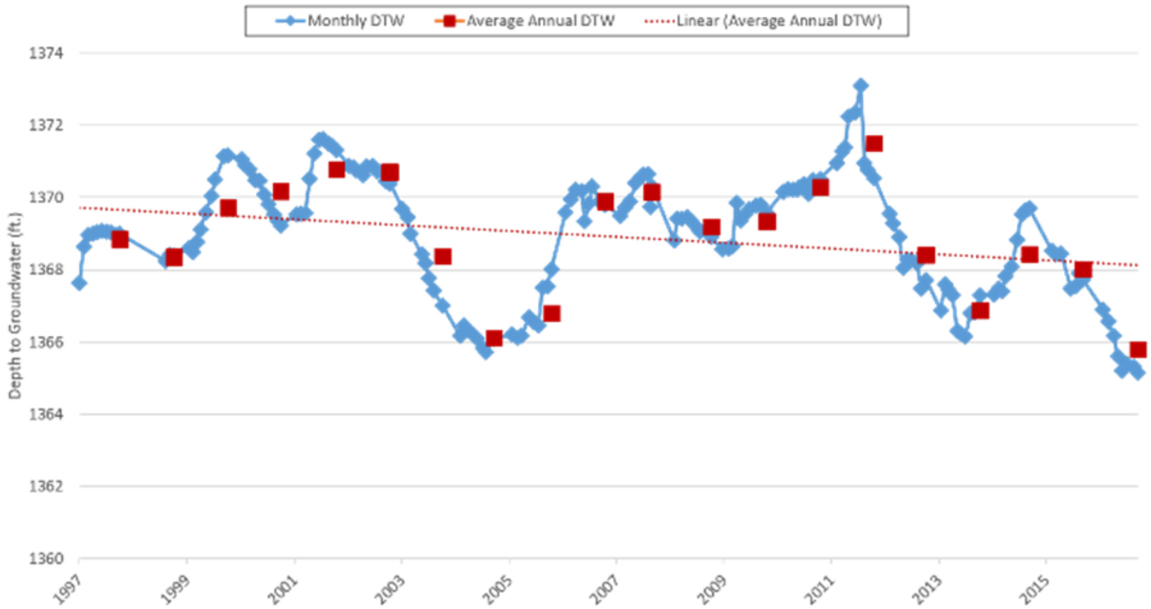
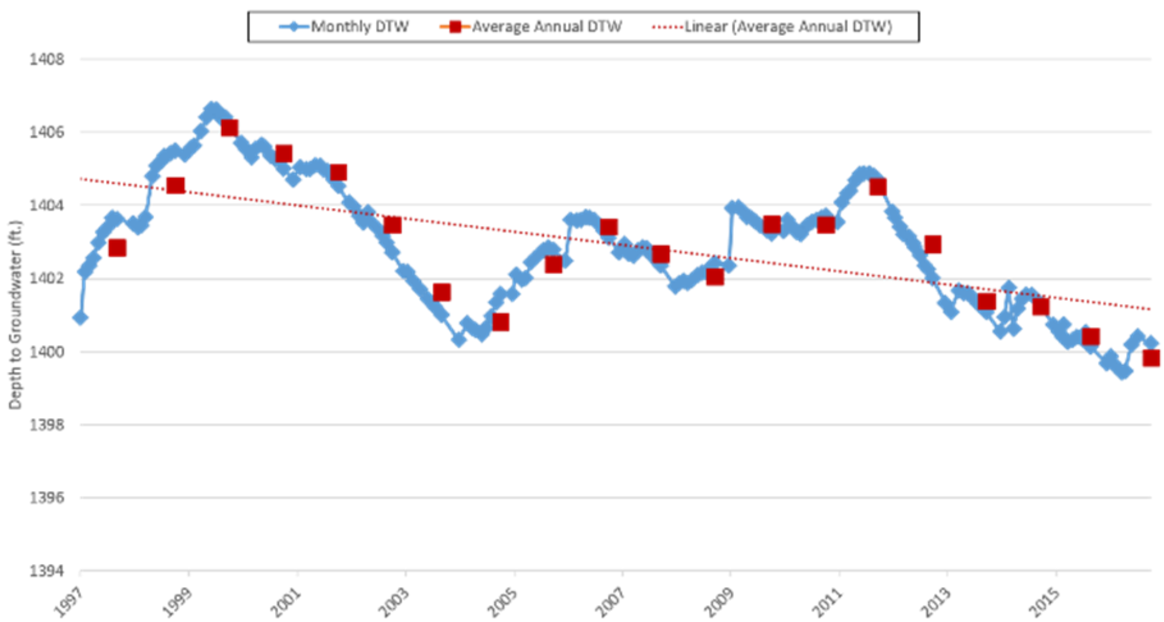


Figure 20. Depth to groundwater for observation well 243492 near Detroit Lakes (top) and observation well 244240 near Vining (bottom) (1997-2016).





Wetlands

Excluding the open water portion of lakes and rivers, the Otter Tail River Watershed supports an estimated 167,700 acres of wetlands, which is equivalent to 13.7% of the watershed area. Emergent wetlands make up over half (52%) of the total wetland area (Figure 21). The second most extensive wetland type is shallow water habitat (ponds and deep marshes) which comprise about one-third as much (17% of the total wetland area). Scrub-shrub and forested wetlands each make up nearly 16% of the total wetland area. An estimated 8.5% of the wetland area has a history of hydrologic alteration by partial drainage or excavation and approximately 4.7% of the wetland area is classified as "bog". Bogs are most common in the east and northeast region of the Otter Tail River Watershed. Bogs are wetlands with predominantly peat substrates derived from thick deposits of partially decomposed plant material that accumulates over time forming peat. Bogs can occur as forested, shrub dominated or as open herbaceous emergent dominated wetland communities. All of the estimates of wetland extent and distribution observations come from the original Minnesota National Wetland Inventory (NWI) mapped from primarily circa 1983-spring leaf-off imagery. The wetland inventory has recently been updated and is available as a provisional statewide dataset. For more information and status of Minnesota's NWI update, visit: http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html.

Surface geology in the Otter Tail River Watershed is complex, but is mostly comprised as a combination of glacial moraines, including both stagnation and ground moraines originating from two different glacial lobe advances, the Des Moines Lobe and the Wadena Lobe, both occurring during the Wisconsin Glacial Period. Moraines are responsible for much of the gentle rolling hill and valley terrain common in this watershed. Moraine geology is very conducive to formation of wetlands in the glacial till. The Otter Tail River Watershed cuts across portions of all three of Minnesota's major ecoregions: the Temperate Prairies to the west, the Mixed Wood Plains in the central region of the watershed and the Mixed Wood Shield Ecoregion in the northeastern part of the watershed.

Figure 21. Wetlands and surface water within the Otter Tail River Watershed. Wetland data are from the original Minnesota National Wetlands Inventory (circa 1983).

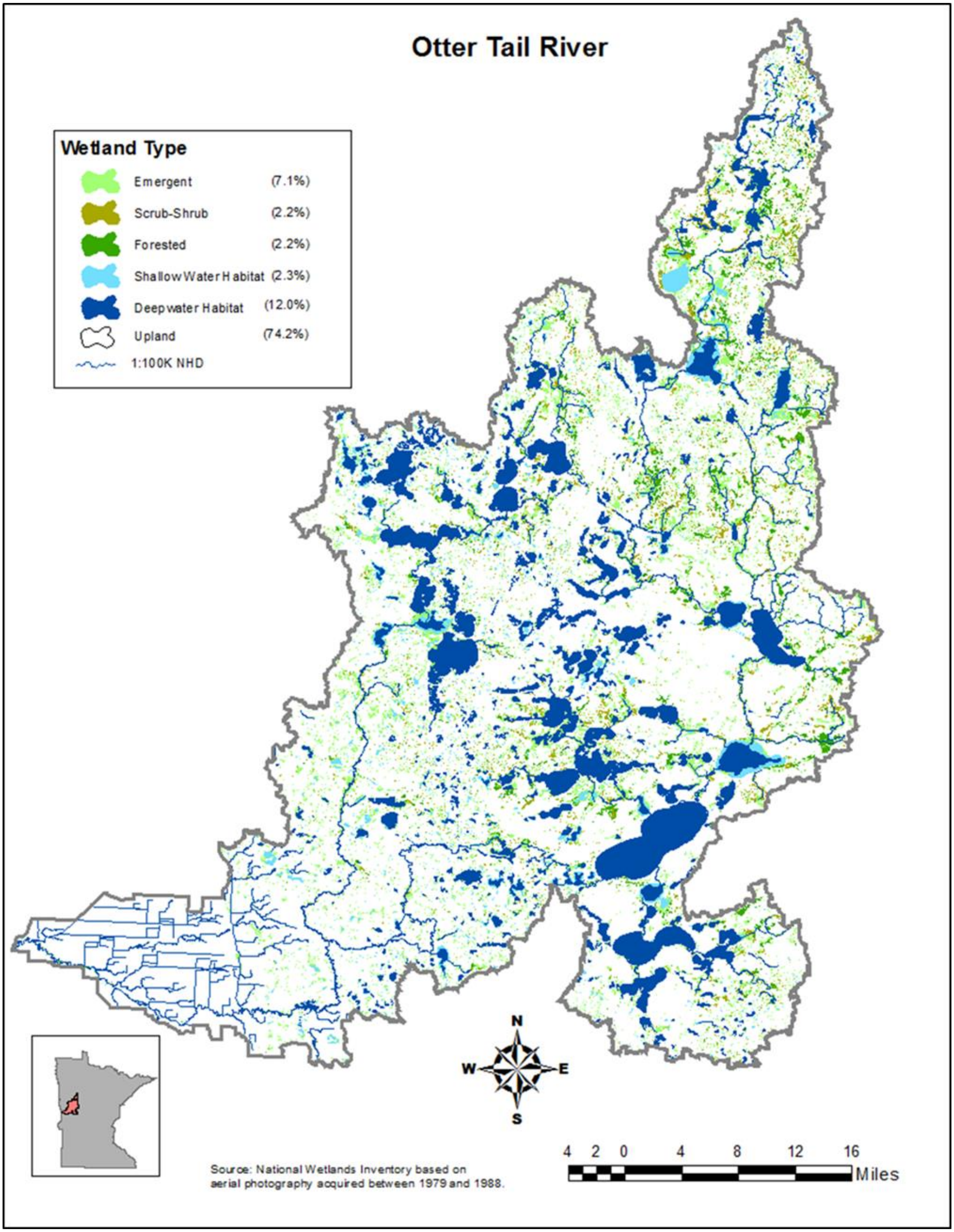
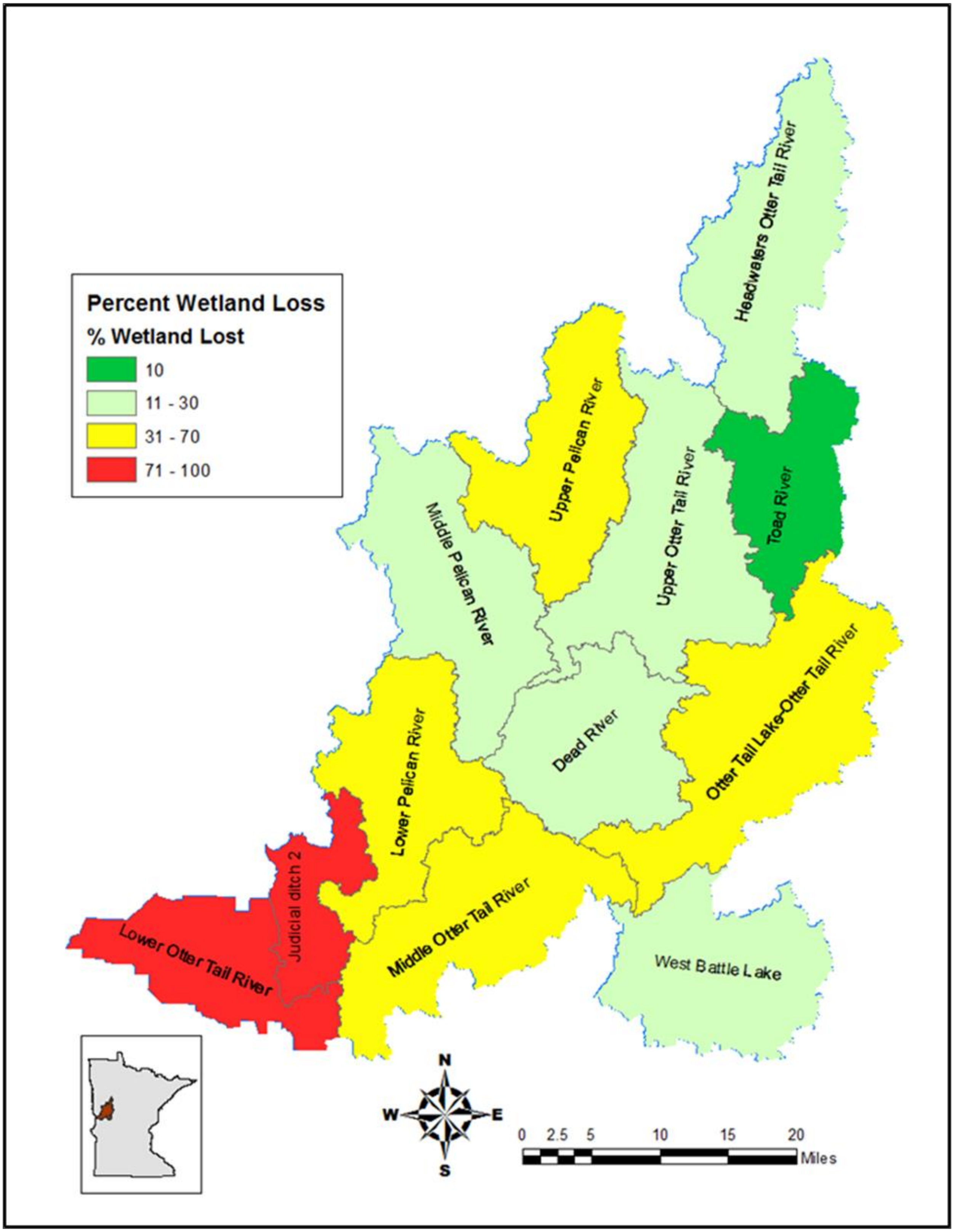


Figure 22. Estimated wetland conversion (loss) rates between historic wetland extent based on SSURGO Soil Data (ca 1983). Presented at HUC 12 subwatershed scale.



Historic conversion or loss of wetland area to drainage and filling has significantly reduced the prevalence of wetlands in the Otter Tail River Watershed. A geographic pattern of wetland change is apparent at the 12HUC subwatershed scale (Figure 22). Estimates of historic wetland extent were derived using drainage classifications of SSURGO soil polygons classed as 'Poorly Drained' and 'Very-Poorly Drained' as proxies for historic wetland extent. These results compare to wetland extent estimates based on original NWI data, to produce wetland loss estimates as a percentage at the HUC12 subwatershed scale. This analysis indicates that the Lower Otter Tail River and Judicial Ditch 2 subwatersheds have lost more than 70% of their historic wetland area. Once drained these southwestern subwatersheds on the glacial Lake Agassiz beach ridges and the lake plain have some of the most productive agricultural soils. It is not surprising these subwatersheds are the most extensively drained part of the watershed. In contrast, in the moraine dominated central subwatersheds and the NE highland region (including the Headwaters of Otter Tail River and Toad River Subwatersheds) have experienced significantly less historic wetland loss, retaining 70% or greater of their original wetland area.

Special wetland features

Greenwater Lake Scientific and Natural Area (SNA) is located in the Headwaters Otter Tail River Subwatershed. State water quality standards classify all surface waters, including wetlands, within SNAs as Outstanding Resource Value Waters (ORVWs) and prohibited from receiving pollutant discharges (Minn. R. ch. 7050). Though Greenwater Lake SNA is not specifically listed as an ORVW in state water quality standards, it is included as an unlisted Prohibited Discharge ORVW (7050.0335 subp 4). Thus, any proposed activity that would result in surface water degradation, including increased pollutant loading is prohibited. Greenwater Lake SNA includes, several wetland communities, including alder and black ash swamps, sedge meadows and rich fens.

Watershed-wide data collection methodology

Lake water sampling

The MPCA sampled 25 lakes between 2016 and 2017 for the assessment of aquatic recreation. There are currently 75 volunteers enrolled in the MPCA's CLMP that are conducting lake monitoring within the watershed. Considerable local monitoring occurs in this watershed, with many lakes having multiple years of water quality data available (Figure 3). 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 recreation use assessment requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth. Sulfate was sampled at a subset of lakes that are designated wild rice waters: Acorn, Crystal, Long, Orwell, Round, Sieverson, Town, and Wright. Nitrates were sampled at Wright Lake, which has a designated drinking water use.

Stream water sampling

Twelve water chemistry stations were sampled from May through September in 2016, and again from June through August of 2017, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated HUC 12 subwatershed that was >40 square miles in area (purple circle and green circles in (Figure 2). A SWAG was awarded to the Headwaters Science Center to intensively collect water chemistry at these 12 outlet stations. (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). In addition, there are currently nine volunteers enrolled in the MPCA's CSMP that are conducting stream monitoring within the watershed.

Stream flow methodology

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 HUC-12 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 84 lakes were monitored for fish community health in the Otter Tail River Watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2018 assessment was collected in the last five years. Waterbody assessments to determine aquatic life use support were completed for 80 lakes.

To measure the health of aquatic life at each lake, a fish 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 intensive watershed monitoring in the Otter Tail River Watershed was completed during the summer of 2016 and 2017. A total of 17 sites were newly established across the watershed and sampled (Figure 2). These sites were located near the outlets of most minor HUC-14 watersheds. In addition, 9 existing biological monitoring stations within the watershed were revisited in 2016 and 2017. These monitoring stations were initially established as part of a survey to collect biological data for biocriteria development, or as part of statewide EMAP (Environmental Monitoring and Assessment Program) survey. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2018 assessment was collected in 2016 and 2017. Twenty-one of the 25 WIDs assessed for aquatic life in the Otter Tail River Watershed included biological survey data (some assessments were made using water chemistry data). 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, indices of biological integrity (IBIs), specifically fish and macroinvertebrate 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 macroinvertebrate IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (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 HUC-8 pour point, as part of the Intensive Watershed Monitoring. All fish collected by the MPCA are analyzed for mercury and the two largest individual fish of each species are analyzed for polychlorinated biphenyls (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 poly - and perfluoroalkyl substances (PFAS), whole fish were shipped to AXYS Analytical Laboratory, which analyzed the homogenized fish fillets for 13 PFAS. Of the measured PFAS, 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 Minnesota Department of Health (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.

Pollutant load monitoring

Intensive water quality sampling occurs at all 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 TSS, total phosphorus (TP), dissolved orthophosphate, nitrate plus nitrite nitrogen (NO_3+NO_2-N), and total Kjeldahl nitrogen (TKN).

More information can be found at the WPLMN website.

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 2019, 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 (SSTS) 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 VOCs.

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 indicate 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. MPCA is also using 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 and achieve an unbiased estimate of the resource. Regional probabilistic survey results can provide a reasonable approximation of the current wetland quality in the watershed.

Individual aggregated HUC-12 subwatershed results

Aggregated HUC-12 subwatersheds

Assessment results for aquatic life and recreation use are presented for each aggregated HUC-12 subwatershed within the Otter Tail River Watershed. The primary objective is to portray all the full support and impairment listings within an aggregated HUC-12 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 HUC-12 subwatersheds contain the assessment results from the 2018 assessment cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2016 – 2017 intensive watershed monitoring effort, but also considers available data from the last ten years.

The proceeding pages provide an account of each aggregated HUC-12 subwatershed. Each account includes a brief description of the aggregated HUC-12 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 HUC-12 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 HUC-12 subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2018 assessment process (2020 U.S. Environmental Protection Agency [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, total phosphorus, chlorophyll-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) or cool or warm water community (2B). 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 HUC-12 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 HUC-12 subwatershed sections where available data exists. This includes aquatic recreation (phosphorus, chlorophyll-a, and Secchi) and aquatic life, where available (chloride and fish IBI). Similar to streams, parameter level and over all use decisions are included in the table.

Headwaters Otter Tail River Aggregated HUC-12 HUC 0902010301-01

The Headwaters Otter Tail River Subwatershed contains the source of the Otter Tail River and drains 182 square miles of land within the northern most portion of the watershed. Over two-thirds of this heavily forested subwatershed lies within the White Earth Reservation. A substantial portion also lies within the Tamarac National Wildlife Refuge. Numerous lakes are scattered throughout the subwatershed - a characteristic typical of the Northern Lakes and Forest Ecoregion. Major lakes include Elbow Lake, Many Point Lake, Island Lake, Round Lake, Flat Lake, and Height of Land Lake. Solid Bottom Creek is a cold water (trout) stream that originates out of one of the many small lakes and flows south into Elbow Lake. The Otter Tail River originates as a small low gradient stream flowing out of the south end of Elbow Lake. The river flows south and consists of a series of short connecting channels (< 0.6 miles long) between Little Bemidji Lake, Many Point Lake, and Round Lake. Dams are present at the outlet of all three lakes. The river continues flowing south, at times winding west/southwest, before being joined by the Egg River. The Egg River originates out of Little Rice Lake and flows south and west along the western edge of the subwatershed. The Egg River passes through numerous small lakes and wetlands before passing through Flat Lake and emptying into the Otter Tail River. The Otter Tail River continues to wind south, passing through several large wetland complexes (Chippewa Lake, Blackbird Lake, and Rice Lake) before entering Height of Land Lake. Dams are present at the outlet of Chippewa Lake, Rice Lake, and Height of Land Lake. The river flows west out of Height of Land Lake and enters the next subwatershed. Land use within the subwatershed is primarily forest (71.6 %) followed by open water (14.4 %), wetland (7.8 %), developed (2.6 %), and crop land (0.3 %) (USGS 2011). In 2016, the MPCA collected biological samples from two monitoring stations located on two stream segments. Water chemistry was intensively monitored at one station within the Headwaters Otter Tail River Subwatershed.

Table 2. Aquatic life and recreation assessments on stream reaches: Headwaters Otter Tail River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class***	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
09020103-565 **Solid Bottom Creek (Elbow Lake Creek),** *T143 R38W S32, north line to Elbow Lk*	09RD066	2.02	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--
09020103-610 **Otter Tail River,** *Headwaters (Round Lake 03-0155-00) to Unnamed Creek (Ice Cracking Lake Outlet)*	--	1.74	WWg	--	--	NA	NA	NA	MTS	NA	MTS	--	NA	SUP
09020103-611 **Otter Tail River,** *Unnamed Creek (Ice Cracking Lake Outlet) to Egg River*	05RD074	5	WWg	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	IF	SUP	SUP
09020103-612 **Otter Tail River,** *Egg River to Chippewa Lake*	--	1.81	WWg	--	--	IF	MTS	MTS	MTS	MTS	MTS	MTS	SUP	IF
09020103-614 **Otter Tail River,** *Chippewa Lake to Blackbird Lake*	--	0.32	WWg	--	--	NA	NA	NA	MTS	NA	MTS	- -	NA	--
09020103-618 **Otter Tail River,** *Rice Lake to Height of Land Lake*	--	0.02	WWg	--	--	NA	NA	NA	MTS	NA	MTS	- -	NA	SUP
09020103-744 **Egg River,** *Flat Lake to Otter Tail River*	--	1.77	WWg	--	--	NA	MTS	MTS	MTS	MTS	MTS	MTS	SUP	SUP
09020103-756 **Egg River,** *Little Rice Lake to Upper Egg Lake*	--	1.10	WWg	--	--	NA	MTS	MTS	MTS	NA	MTS	IF	IF	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 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: Headwaters Otter Tail River Aggregated HUC-12.

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		
Sieverson	03-0108-00	86	35	Deep Water	NLF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP
Green Water	03-0134-00	71	57	Deep Water	NLF	IF	--	--	--	IF	IF	IF	--	SUP
Juggler	03-0136-00	386	78	Deep Water	NLF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Island	03-0153-00	1168	38	Deep Water	NLF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Round	03-0155-00	1090	69	Deep Water	NLF	NT	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Ice Cracking	03-0156-00	338	73	Deep Water	NLF	IF	--	--	--	MTS	MTS	MTS	--	SUP
Tea Cracker	03-0157-00	124	--	Deep Water	NLF	IF	--	IF	--	IF	IF	IF	IF	IF
Many Point	03-0158-00	1687	92	Deep Water	NLF	IF	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Elbow	03-0159-00	988	76	Deep Water	NLF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
North Twin	03-0180-00	139	28	Deep Water	NLF	I	--	--	--	MTS	MTS	MTS	--	SUP
Height of Land	03-0195-00	3796	21	Deep Water	NLF	NT	MTS	--	--	IF	IF	EXS	SUP	IMP
Chippewa	03-0196-00	523	6	Deep Water	NLF	--	--	--	--	IF	IF	IF	--	IF
Blackbird	03-0197-00	165	6	Deep Water	NLF	--	--	IF	--	EXS	MTS	MTS	IF	IF

Johnson	03-0199-00	151	6	Deep Water	NLF	NT	--	IF	--	MTS	MTS	MTS	IF	SUP
Upper Egg	03-0206-00	467	21	Deep Water	NLF	NT	--	IF	--	EXS	EXS	EXS	IF	IMP
Carman	03-0209-00	117	27	Deep Water	NLF	I	--	IF	--	MTS	IF	MTS	IF	SUP
Waboose	03-0213-00	232	--	Deep Water	NLF	I	--	IF	--	EXS	EXS	EXS	IF	IMP
Winter	03-0216-00	116	14	Deep Water	NLF	NT	--	IF	--	MTS	EXS	MTS	IF	SUP
Little Bemidji	03-0234-00	292	58	Deep Water	NLF	--	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Mallard	03-0235-00	124	--	Deep Water	NLF	NT	--	--	--	EXS	EXS	EXS	IF	IMP
Unnamed	03-0236-00	16	--	Deep Water	NLF	--	--	--	--	IF	IF	IF	IF	IF
Flat	03-0242-00	1835	9	Deep Water	NLF	I	--	--	--	MTS	MTS	MTS	IF	SUP
Pickerel	15-0108-00	122	46	Deep Water	NLF	--	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Andrews	15-0112-00	35	--	Deep Water	NLF	--	--	--	--	IF	IF	IF	--	IF
Kibbee	15-0114-00	38	--	Deep Water	NLF	--	--	IF	--	--	--	IF	--	IF
Rock	15-0116-00	120	--	Deep Water	NLF	--	--	IF	--	MTS	MTS	MTS	IF	SUP
Lower Camp	15-0122-00	36	27	Deep Water	NLF	--	--	IF	--	IF	IF	IF	--	IF
Hoot Owl	15-0123-00	83	78	Deep Water	NLF	NT	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains

Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data

Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)

Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

Summary

Station 09RD066 was located on the cold water stream Solid Bottom Creek, upstream of the CR 133 crossing. This station was sampled twice, once in July of 2010 and again in July of 2016. The FIBI score was good for both visits. Brook trout were the most abundant species in the 2016 sample and the second most abundant in the 2010 sample. Both samples contained a similar number of warm water species and were indicative of a small headwater stream. Macroinvertebrates were also sampled twice - once in October of 2009 and in August of 2016. A poor MIBI score from the 2009 sample likely resulted from an incomplete accounting of all habitat types; rock and wood habitat were present but not sampled. The 2016 sample included all habitat types and the resulting higher MIBI score was a better representation of site conditions. Both samples contained cold water obligate taxa.

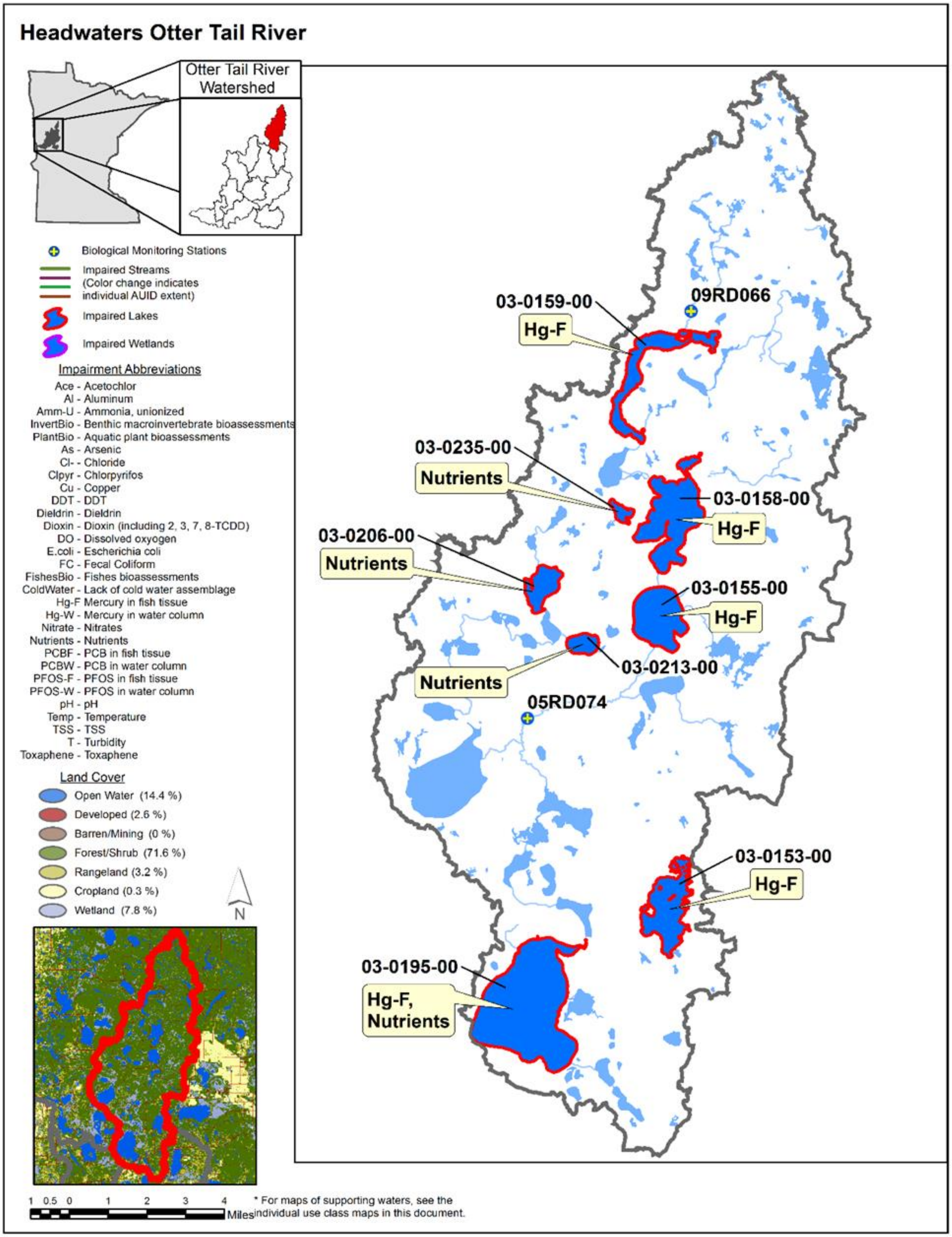
Station 05RD074 was located on the segment of the Otter Tail River that extends from the outlet of Ice Cracking Lake to the confluence of the Otter Tail River and Egg River. Overall, the fish and macroinvertebrate communities indicated support for aquatic life. A poor FIBI score from a sample taken in July of 2016 was the result of an unusually high number of blacknose dace (a tolerant, generalist species). Both fish samples contained a similar number of species along with high numbers of lithophilic spawners and insectivores. Caddisflies comprised nearly 40% of the 47 unique macroinvertebrate taxa and several of the caddisfly species were sensitive taxa. Excellent stream habitat was present at this station. A variety of cover types, good channel development, and extensive riffles comprised of cobble and gravel substrate occurred within the sampling reach.

Water chemistry data were available on multiple reaches of the Otter Tail River and Egg River. Low amounts of sediment and good concentrations of DO were present in all of them. Both streams also had low levels of bacteria, indicating support for aquatic recreation.

Aquatic recreation was assessed on 28 lakes. The majority of the lakes in this subwatershed have good water quality and support aquatic recreation. Upper Egg, Waboose, and Mallard lakes did not support aquatic recreation due to naturally occurring conditions. These lakes are located within the Tamarac National Wildlife Refuge and do not have any land use disturbances within their catchments that could contribute to a nutrient impairment. Long-term inputs of phosphorus paired with internal loading in relatively shallow lakes can result in excess algal growth and reduced recreation opportunities. Height of Land was the only lake in the subwatershed that did not support aquatic recreation and had appreciable lakeshore development.

Eight lakes were assessed for aquatic life use based on their fish communities: Juggler, Island, Round, Many Point, Elbow, Height of Land, Little Bemidji, and Pickerel. Both bluegill and yellow perch were found in all of the lakes except Many Point, which just had bluegill. Cisco, a pelagic fish requiring well-oxygenated cold water, were found in Many Point, Little Bemidji, and Elbow Lakes. Banded killifish, blackchin shiner, and Iowa darter (intolerant species) were captured in Island, Round, Height of Land, Little Bemidji, and Elbow Lake. All eight lakes had FIBI scores above the impairment threshold and were considered to fully support aquatic life. Round, Elbow, and Pickerel had exceptional FIBI scores.

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Headwaters Otter Tail River Aggregated HUC-12.



Upper Otter Tail River Aggregated HUC-12 HUC 0902010302-01

The Upper Otter Tail River Subwatershed drains 206.79 square miles of land within the north central region of the Otter Tail River Watershed. The Otter Tail River enters this subwatershed immediately after exiting Height of Land Lake. The river flows southwest and passes through a wetland impoundment called Hubble Pond. The river then turns and winds south for approximately 18 miles, passing from forested land into areas of agricultural land use, before entering an impoundment called Albertson Lake. Located on the southern edge of Frazee, Albertson Lake receives water from several small lakes (Fischer, Silver, and Murphy) located to the east. Albertson Lake also receives water from Town Lake and Acorn Lake located to the west. Dams are present at the outlet of Town Lake and Albertson Lake. After flowing out of Albertson Lake, the Otter Tail River winds south and passes through a shallow wetland lake called Rice Lake. The river then turns and flows east /southeast for approximately ten miles before entering Mud Lake. Mud Lake is connected to Pine Lake, the largest lake in the subwatershed. The Otter Tail River exits Pine Lake through a dam and enters the next subwatershed. Other major lakes within the subwatershed include Cotton, East Loon, Little McDonald, Long, Pickerel, and Rose. Several of these lakes are connected to the Otter Tail River through small outlet channels. Most of the upper portion and western edge of the subwatershed is forested. The majority of the land within the central and southern region of the subwatershed is used for agricultural purposes (hay and row crop). Land use within the subwatershed consists of forest (37.6 %), range land (23.7 %), cropland (14.1 %), open water (13.9 %), wetland (5.4 %) and developed (5.2 %) (USGS 2011). In 2016, the MPCA collected biological samples from two monitoring stations located on two stream segments. Water chemistry was intensively monitored at one station within the Upper Otter Tail River Subwatershed.

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

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-529 **Otter Tail River,** *Height of Land Lake to Albertson Lake*	10EM178, 16RD030	20.85	WWg	MTS	MTS	IF	IF	MTS	IF	MTS	MTS	IF	SUP	SUP
09020103-530 **Otter Tail River,** *Town Lake to Rice Lake*		5.01	WWg	--	--	IF	IF	MTS	IF	MTS	MTS	IF	IF	SUP
09020103-532 **Otter Tail River,** *Rice Lake to Mud Lake*	16RD028	10.51	WWg	MTS	MTS	EXS	IF	MTS	MTS	MTS	MTS	IF	IMP	SUP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 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: Upper Otter Tail River Aggregated HUC-12.

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		
Hungry	03-0166-00	227	50	Deep Water	NLF	--	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Acorn	03-0258-00	146	55	Deep Water	NCHF	--	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Town	03-0264-00	116	15	Shallow Water	NCHF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP
Eagle	03-0265-00	312	29	Deep Water	NCHF	--	EXS	MTS	--	MTS	MTS	MTS	IMP	SUP
Five	03-0269-00	164	--	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Perch	03-0273-00	44	37	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Howe	03-0283-00	168	24	Deep Water	NCHF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP
Cotton	03-0286-00	1781	28	Deep Water	NCHF	D	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Pickerel	03-0287-00	339	42	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Little Pine	56-0142-00	2066	78	Deep Water	NCHF	I	MTS	--	--	MTS	IF	MTS	SUP	SUP
Mud	56-0222-00	334	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Silver	56-0224-00	238	34	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Murphy	56-0229-00	306	30	Deep Water	NCHF	NT	--	IF	--	MTS	IF	MTS	IF	SUP
Devils	56-0245-00	337	67	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	IF	SUP
Little McDonald	56-0328-00	1260	109	Deep Water	NCHF	I	EXS	--	--	MTS	MTS	MTS	IMP	SUP

Grunard	56-0330-00	112	37	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Paul	56-0335-00	330	81	Deep Water	NCHF	D	EXS		--	MTS	MTS	MTS	IMP	SUP
Wimer	56-0355-00	286	58	Deep Water	NCHF	NT	--	--	--	IF	IF	IF	--	SUP
Fairy	56-0356-00	145	6	Shallow Water	NCHF	--	--	IF	--	MTS	MTS	MTS	IF	SUP
Five	56-0357-00	236	77	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Scalp	56-0358-00	246	90	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Rose	56-0360-00	1198	137	Deep Water	NCHF	NT	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Rice	56-0363-00	309	16	Shallow Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Jim	56-0364-00	100	27	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Six	56-0369-00	187	140	Deep Water	Deep Water	I	--	--	--	MTS	MTS	MTS	--	SUP
Sybil	56-0387-00	651	74	Deep Water	Deep Water	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Long (Main Lake)	56-0388-02	1256	128	Deep Water	Deep Water	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
East Spirit	56-0501-00	543	38	Deep Water	Deep Water	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
West Spirit	56-0502-00	258	18	Shallow Water	NCHF	--	--		--	--	--	--	--	IMP
East Loon	56-0523-00	1010	105	Deep Water	Deep Water	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Lawrence	56-0555-00	128	13	Shallow Water	Shallow Water	--	--	--	--	MTS	MTS	MTS	--	SUP
Kerbs	56-1636-00	104	100	Deep Water	Deep Water	I	--	--	--	MTS	MTS	MTS	--	SUP
Rusch	56-1641-00	108	32	Deep Water	Deep Water	--	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)

Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

Summary

Stations 10EM178 and 16RD030 were located on the segment of the Otter Tail River that extends from Height of Land Lake to Albertson Lake. Station 10EM178 was located furthest downstream and was sampled in 2011. The FIBI score was just above the impairment threshold. This station lacked coarse substrate, had poor channel development, and had abundant aquatic vegetation. The fish community was indicative of the low gradient habitat present. Blacknose shiner, an intolerant species often found in low gradient streams, was the second most abundant species in the sample. Despite marginal habitat, the MIBI score was good. While the sample was dominated by taxa that favor stagnant water and wetland conditions, it also contained sensitive mayfly and caddisfly taxa. Station 16RD030 was located upstream of CSAH 29. The 2016 FIBI score was good. Hornyhead chub, a sensitive insectivorous species, was the second most abundant species in the sample. When compared to station 10EM178, more coarse substrate and better stream habitat was available at station 16RD030. The 2016 visit MIBI score was good.

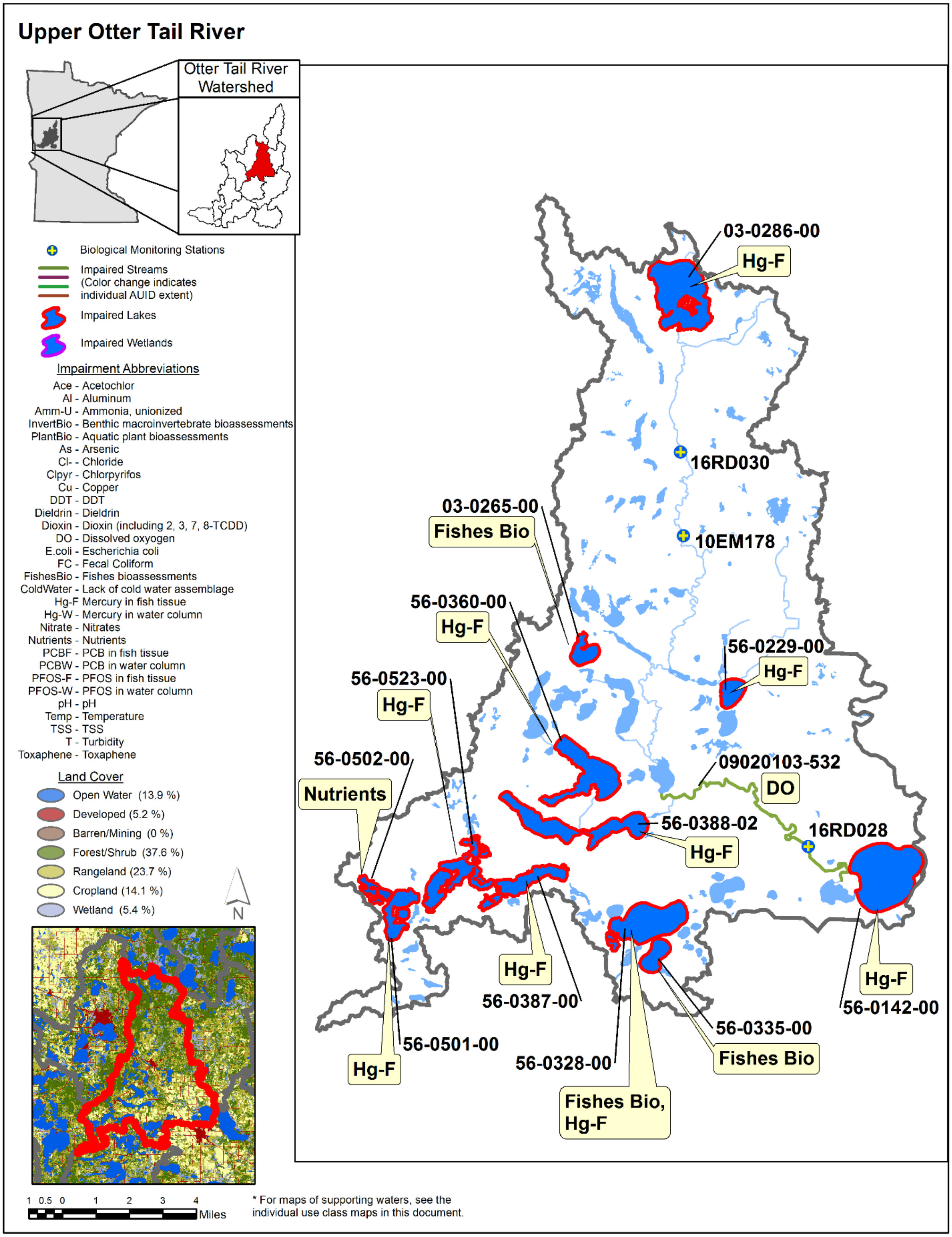
Station 16RD028 was located on the segment of the Otter Tail River that extends from Rice Lake to Mud Lake. This reach is currently listed as impaired for aquatic life based on exceedances of the DO standard (from the 1998 assessment). Recent data indicate numerous exceedances of the DO standard; the aquatic life impairment will remain. Surprisingly, the fish and macroinvertebrate communities indicated support for aquatic life. Numerous sensitive caddis fly taxa were present in the macroinvertebrate sample.

Available water quality data in this subwatershed are indicating low levels of phosphorus and high clarity in streams; all indications of good water quality for aquatic life. These reaches of the Otter Tail River are considered fully supporting of aquatic recreation based on low levels of bacteria.

Lakes within the subwatershed range from shallow (6 feet) to very deep (140 feet). Shallow lakes have less ability to assimilate phosphorus; however, this watershed is relatively intact, and phosphorus levels are low. Sufficient data were available to assess 32 lakes for aquatic recreation. All 32 lakes had good water quality and fully supported aquatic recreation. West Spirit Lake was listed as impaired for aquatic recreation in 2008. No recent data has been collected from this waterbody; therefore, the impairment will remain.

The fish community was used to assess aquatic life on 14 lakes: Hungry, Acorn, Eagle, Cotton, Pickerel, Little Pine, Little McDonald, Paul, Scalp, Rose, Sybil, Long, East Spirit, and East Loon. Of these lakes, Eagle, Little McDonald, and Paul were found to not support aquatic life. Scalp and Rose were considered to have exceptional fish communities. Acorn and Cotton had FIBI scores close to the impairment threshold. These two lakes also had moderate shoreline habitat quality and a relatively low proportion of top carnivore species in their samples. Thus, both lakes are considered vulnerable to future impairment. Cisco, a pelagic fish requiring well-oxygenated cold water, comprised the most biomass in gill nets for East Loon.

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Upper Otter Tail River Aggregated HUC-12.



Toad River Aggregated HUC-12 HUC 0902010303-01

The Toad River Subwatershed drains 111 square miles of land within the northeast portion of the Otter Tail River Watershed. Forested land is distributed throughout this subwatershed but is more prevalent across the northern and eastern regions. Rangeland, the other prominent land cover type, occurs primarily within the central and southern regions. Most lakes are located in the northern portion of the subwatershed, within the Northern Lakes and Forest ecoregion. Major lakes include Dead Lake, Mud Lake, Little Toad Lake, and Toad Lake. The Toad River originates from Little Toad Lake, which is located along the northern boundary of the subwatershed. The river winds south for approximately 1.3 miles and is joined by unnamed creek. Unnamed creek originates out of Toad Lake and flows southwest into the Toad River. The river continues south and passes from a more confined wooded river valley to the floor of a wide river valley. From this location and beyond, much of the Toad River is bordered by sedge meadows and has a low gradient character. After flowing south for approximately 3.5 miles, the Toad River is joined by Deadhorse Creek. Deadhorse Creek is a small cold water stream that supports brook trout and drains over fifteen square miles of land along the eastern edge of the subwatershed. After the confluence of Deadhorse Creek, the Toad River continues flowing south for 1.8 miles and is joined by the small low gradient tributary called Collette Creek. The river continues flowing south for approximately 3.2 miles and enters Dead Lake. Historically, the Toad River flowed through a 3.75-mile long channel around the east side of Dead Lake; however, flow was diverted from the original channel into a small tributary flowing into Dead Lake. The river flows south out of Dead Lake through an excavated channel that joins with the original channel. The river continues flowing south / southeast through 3.2 miles of channel that has been altered (straightened). The Toad River transitions back to a natural channel and flows south another 3.2 miles before emptying into Big Pine Lake. Land use within the subwatershed is primarily forest (42.9 %) followed by rangeland (28.1 %), wetland (10.2 %), cropland (10.0 %), open water (4.7 %), and developed (3.9 %) (USGS 2011). In 2016, the MPCA collected biological samples from four monitoring stations located on three stream segments. Water chemistry was intensively monitored at one station within the Toad River Subwatershed.

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

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-526 **Toad River,** *Little Toad Lake to T138 R38W S30, SW corner*	16RD025, 16RD026	10.59	WWg	EXS	MTS	IF	MTS	MTS	MTS	MTS	MTS	IF	IMP	IMP
09020103-563 **Dead Horse Creek,** *T138 R38W S4, north line to Toad River*	10RD079, 10RD082	6.35	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--
09020103-757 **Unnamed Creek,** *Unnamed Creek to Dead Lake*		2.76	WWg	--	--	IF	IF	IF	IF	MTS	MTS	IF	IF	IMP
09020103-770 **Toad River,** *Unnamed Creek to Pine Lake*	16RD022	4.08	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	IF	SUP	IMP

Key for Cell Shading: = existing impairment, listed prior to 2020 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)

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: Toad River Aggregated HUC-12.

							Aquatic Life Indicators:			Aquatic Recreation Indicators:				
Lake Name	DNR ID	Area (acres)	Max Depth (ft)	Assessment Method	Ecoregion	Secchi Trend	Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi	Aquatic Life Use	Aquatic Recreation Use
Toad	03-0107-00	1683	29	Deep Water	NLF	I	IF	--	--	MTS	EXS	MTS	IF	SUP
Little Toad	03-0189-00	401	65	Deep Water	NLF	I	IF	--	--	MTS	MTS	MTS	IF	SUP

Abbreviations for Ecoregion: **DA** = Driftless Area, **NCHF** = North Central Hardwood Forest, **NGP** = Northern Glaciated Plains, **NLF** = Northern Lakes and Forests, **NMW** = Northern Minnesota Wetlands, **RRV** = Red River Valley, **WCBP** = Western Corn Belt Plains
Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Summary

Stations 16RD026 and 16RD025 were located on the segment of the Toad River that extends from Little Toad Lake to T138 R38W S30, SW Corner. Both stations were sampled in 2016. Station 16RD026 was located furthest upstream, approximately 1.4 miles downstream of Little Toad Lake. The fish and macroinvertebrate communities indicated support for aquatic life. The fish sample contained good numbers of darters and other insectivorous species. The sampling reach contained extensive cobble and gravel riffles, deep pools, and a variety of cover types. Almost half of the macroinvertebrate taxa sampled were clinger taxa, which is indicative of the good riffle habitat in the reach. The sample also contained five intolerant taxa. Station 16RD025 was located approximately six miles downstream of station 16RD026. The fish and macroinvertebrate communities were poor. The fish sample contained higher numbers of detritivores and very tolerant species. Habitat within the sampling reach consisted of shifting sand and silt substrate, sparse cover, and poor channel development. The macroinvertebrate sample was dominated by tolerant taxa that were indicative of excessive sediment and low DO. This segment of the Toad River is impaired for aquatic life based on the poor biological communities at station 16RD025. This segment is also impaired for aquatic recreation based on elevated concentrations of bacteria during the summer months.

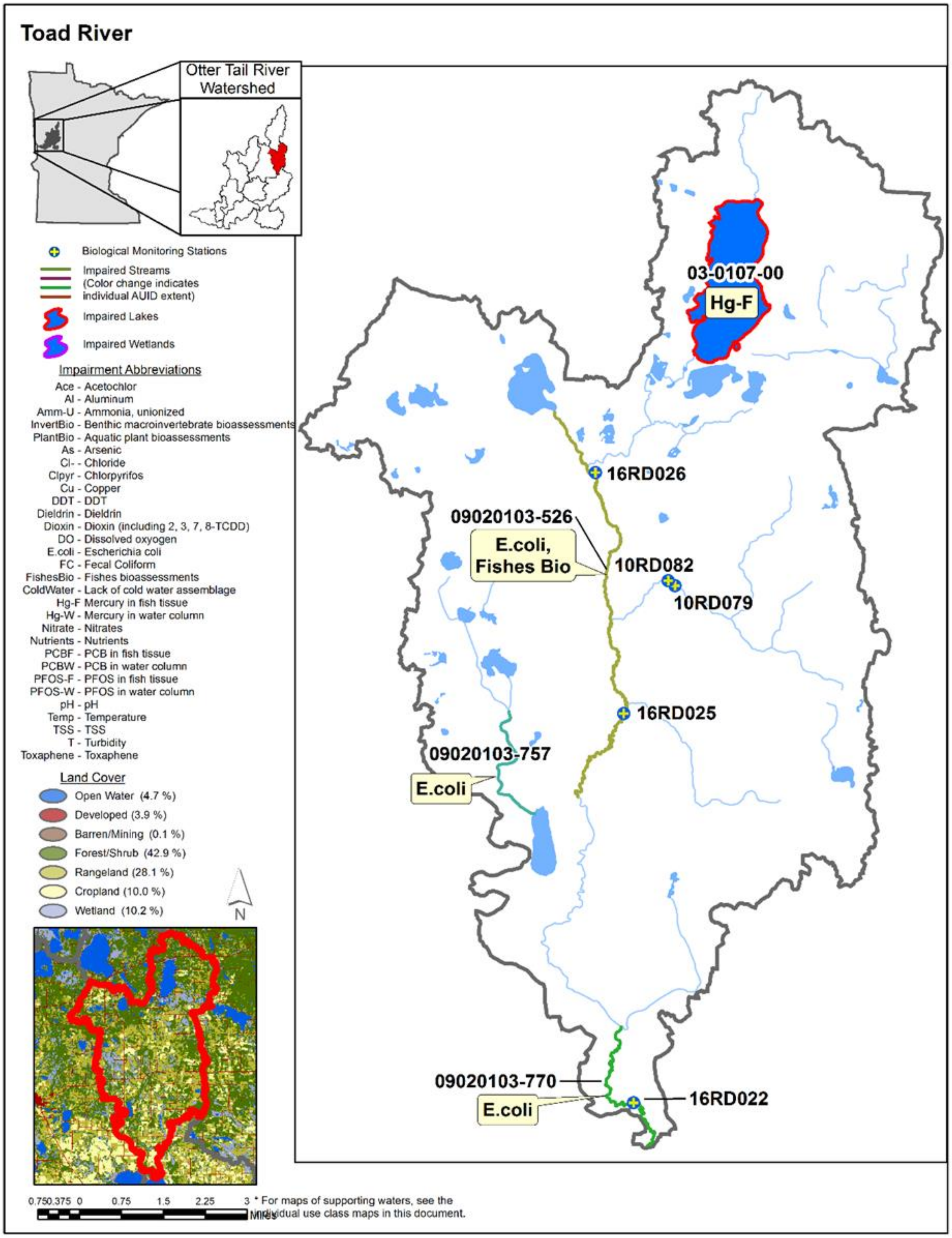
Station 16RD022 was located on the segment of the Toad River that extends from Unnamed Creek to Pine Lake. The 2017 sample FIBI score was almost exceptional. Of the 20 species sampled, 50% of them were insectivorous and 25% were considered sensitive. Over 60% of the total individuals in the sample were lithophilic spawners. Extensive cobble riffles, good channel development, and a variety of cover types were located within the sampling reach. The MIBI score was good. A moderate number of tolerant Dipteran taxa (true flies) were present in the sample along with several sensitive caddisfly and mayfly taxa. This segment is impaired for aquatic recreation based on elevated concentrations of bacteria during the summer months.

Stations 10RD079 and 10RD082 were located on the segment of the cold water stream Deadhorse Creek that extends from T138 R38W S4, north line to the Toad River. Station 10RD082 was sampled in 2011, and the FIBI score was good. Station 10RD079 was sampled in 2016, and the FIBI score was below the impairment threshold. The fish samples from each station contained 12 species; however, more pioneer species and fewer intolerant cold water species (i.e. brook trout) were present in the 10RD079 sample. Stream habitat at both stations was excellent and produced some of the highest MSHA scores in the Otter Tail River Watershed. Cobble riffles, good channel development, high channel stability, and a variety of cover types were present in both reaches. Macroinvertebrates were sampled in 2010 and 2016 at station 10RD079; they were sampled twice in 2010 at station 10RD082. The MIBI score was at or just above the impairment threshold for all samples. Coldwater taxa were observed in all samples along with numerous tolerant dipteran taxa. Based on the biological data gathered from these stations, this segment of Deadhorse Creek is considered vulnerable to future aquatic life impairments.

Many of the reaches in this subwatershed are short connectors between lakes or small tributaries to lakes. Sufficient data were available for larger streams; the two previously mentioned reaches of the Toad River (-770 and -526) and Unnamed creek (Unnamed creek to Dead Lake). All three of these reaches contained high levels of bacteria and are impaired for aquatic recreation.

Two lakes within this subwatershed, Toad and Little Toad, were monitored for aquatic recreation and aquatic life. Both lakes support aquatic recreation and have a similar percentage of littoral zone. Toad Lake has a more moderate depth profile, higher phosphorus, higher Chl-a, and a lower Secchi transparency than Little Toad Lake. Little Toad Lake has a greater maximum depth; consequently, phosphorus and Chl-a concentration are lower, and Secchi transparency is higher. Multiple biological surveys were completed on Toad and Little Toad Lakes. Both lakes had one FIBI score below the impairment threshold and one at or above; as a result, a conclusive assessment could not be made. Both lakes are considered vulnerable to future impairment and should be considered priorities for protection efforts.

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Toad River Aggregated HUC-12.



Otter Tail Lake-Otter Tail River Aggregated HUC-12 HUC 0902010306-01

The Otter Tail Lake – Otter Tail River Subwatershed drains 240 square miles of land within the east / southeast portion of the Otter Tail River Watershed. This subwatershed contains Otter Tail Lake, the largest lake in the Otter Tail River Watershed, along with two other prominent lakes - Rush Lake and Big Pine Lake. Other lakes present within the subwatershed include Marion, Long, and Buchanan. Most of the land within this subwatershed is used for agricultural purposes; crop irrigation is prevalent within the central and southern region. Forested land exists primarily along riparian corridors adjacent to lakes, streams, and wetlands. The river enters the northwest corner of the subwatershed and flows east into Big Pine Lake. Big Pine Lake receives water from the Toad River, which drains a 111 square mile subwatershed. Five small tributary streams drain the land within the northeastern region of the subwatershed into the east side of Big Pine Lake. The Otter Tail River passes through the dam at the outlet of Big Pine Lake and winds south past the community of Perham. The river continues winding south for 12 miles before being joined by Willow Creek. Immediately after joining with Willow Creek, the river enters the north side of Rush Lake. A small-unnamed tributary connects Rush Lake with Marion Lake and several smaller lakes. The river passes through a dam at the outlet of Rush Lake and flows south for approximately 3 miles before entering Otter Tail Lake. A small channel connects Walker Lake, located within the adjacent Dead Lake Subwatershed, to Otter Tail Lake. Walker Lake receives 149 square miles of drainage from the Dead Lake Subwatershed. The Otter Tail River flows through the dam at the outlet of Otter Tail Lake and enters the next subwatershed. Land use within the subwatershed is primarily cropland (27.4 %) followed by open water (19.8 %), forest (18.9 %), rangeland (18.3 %), wetland (9.5 %), and developed (6.0 %) (USGS 2011). In 2016, the MPCA collected biological samples from four monitoring stations located on three stream segments. Water chemistry was intensively monitored at one station within the Otter Tail Lake – Otter Tail River Subwatershed.

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

WID ***Reach name*,** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-521 **Otter Tail River,** *Big Pine Lake to Rush Lake*	05RD091, 16RD020	12.47	WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	MTS	SUP	SUP
09020103-622 **Unnamed creek,** *Unnamed Creek to Big Pine Lake*	05RD092	4.63	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 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.

Table 9. Lake assessments: Otter Tail Lake - Otter Tail River.

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		
Windy	56-0054-00	53	--	Shallow Lake	NCHF	--	--	--	--	IF	IF	IF	--	IF
Nitche	56-0126-00	73	28	Deep Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Big Pine	56-0130-00	4711	76	Deep Water	NCHF	I	MTS	--	--	MTS	EXS	MTS	SUP	SUP
Rush	56-0141-00	5158	68	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Pelican Bay	56-0202-00	45	--	Shallow Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Buchanan	56-0209-00	949	42	Deep Water	NCHF	NT	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Long	56-0210-00	1092	16	Shallow Water	NCHF	--	--	IF	--	EXS	EXS	EXS	IF	IMP
Boedigheimer	56-0212-00	163	26	Deep Water	NCHF	D	--	--	--	MTS	MTS	MTS	--	SUP
Head	56-0213-00	392	26	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Round	56-0214-00	264	36	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Otter Tail	56-0242-00	14025	120	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP

Marion	56-0243-00	1604	60	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Lone Pine	56-0322-00	79	79	Deep Water	NCHF	--	--	--	--	--	--	MTS	--	IF
Twin	56-0382-00	357	50	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Twin	56-1525-00	181	--	Shallow Water	NCHF	--	--	--	--	EXS	EXS	EXS	--	IMP

* **Abbreviations for Ecoregion:** DA **= Driftless Area,** NCHF **= North Central Hardwood Forest,** NGP **= Northern Glaciated Plains,** NLF **= Northern Lakes and Forests,** NMW **= Northern Minnesota Wetlands,** RRV **= Red River Valley,** WCBP **= Western Corn Belt Plains**

Abbreviations for Secchi Trend: **D** = decreasing/declining trend, **I** = increasing/improving trend, **NT** = no detectable trend, **--** = not enough data
Abbreviations for Indicator Evaluations: **--** = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Summary

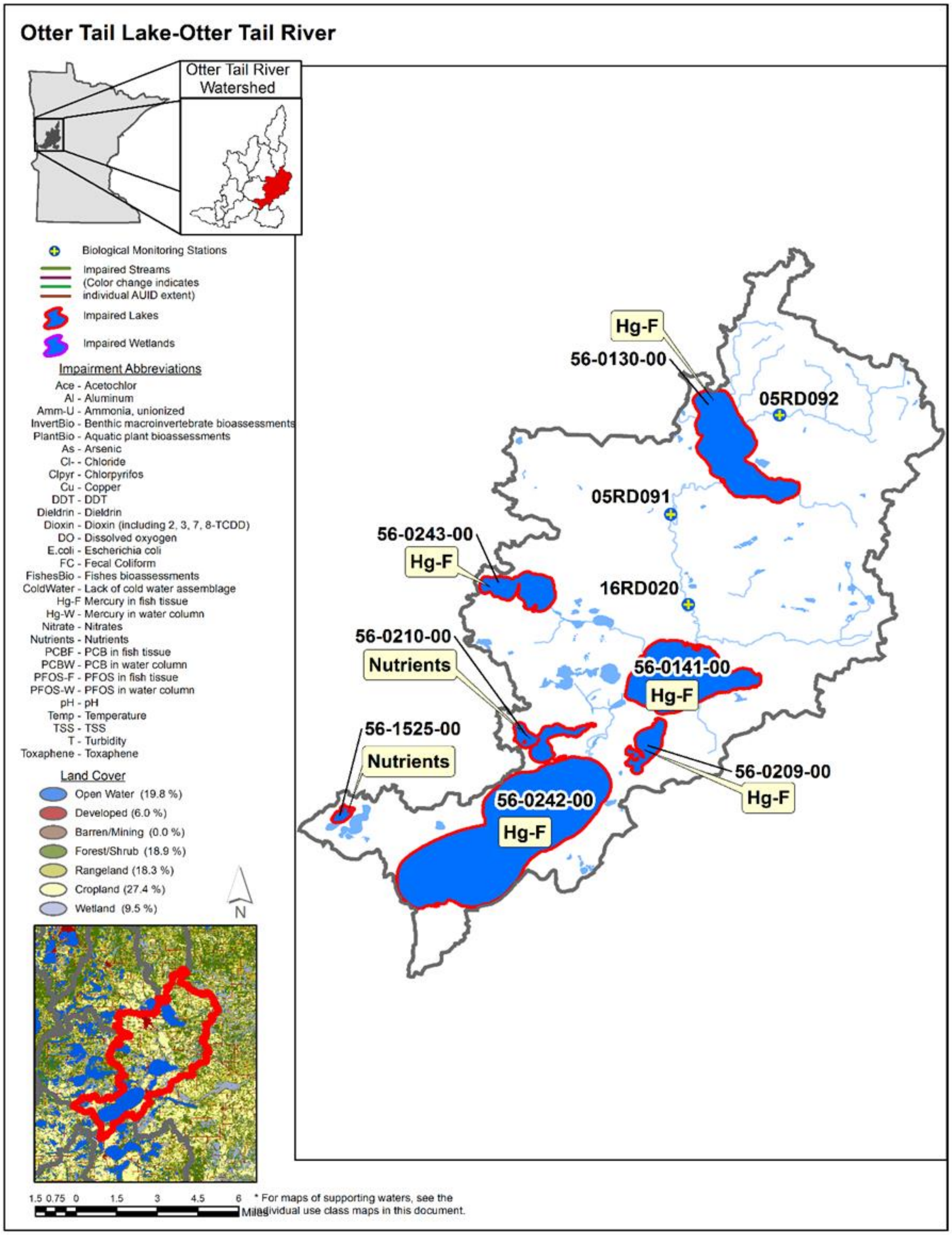
Station 05RD092 was located on an unnamed creek (tributary to Big Pine Lake). The 2016 sample FIBI score was good. Twelve species of fish were collected. Numerous tolerant and pioneering species were present in the sample along with moderate numbers of insectivorous and non-tolerant cyprinid species. Cobble and gravel riffles, good channel development, and a variety of cover types were present within the sampling reach. The 2016 sample MIBI score was just above the impairment threshold. The sample contained numerous tolerant taxa and some sensitive taxa. Chemistry data was limited to one sample collected during the biological monitoring visits, with most parameters meeting standards. A higher concentration of phosphorus was observed in this single sample. This reach is considered vulnerable to future aquatic life impairments based on the biological data.

Stations 05RD091 and 16RD020 were located on the segment of the Otter Tail River that extends from Big Pine Lake to Rush Lake. Station 05RD091 was located furthest upstream near the HWY 10 crossing. This station was sampled in 2016 and 2017. Station 16RD020 was located approximately two miles upstream of Rush Lake and was sampled in 2016. For every sample, the FIBI score was fair and a similar number of species (19-22) were collected. The fish samples contained higher numbers of non-lithophilic nest building species and serial spawning species along with low numbers of lithophilic spawners. Stream habitat within the sampling reach at 05RD091 was poor – most of the substrate within the reach consisted of shifting sand and little cover was present. Sand was the predominate substrate at station 16RD020; however, cobble and gravel substrate was also available along with a greater variety of cover types. The MIBI scores at both stations were good. Diverse communities (44 taxa) were observed in the samples from both stations. Sensitive mayfly and caddisfly taxa were present in each sample. This reach is considered vulnerable to a future aquatic life impairment based on the fish community. Water chemistry data available for this reach indicate good water quality - nutrient, sediment, and bacteria concentrations were all found to be low.

Eleven lakes within this subwatershed were assessed for aquatic recreation. Most lakes had low concentrations of phosphorus and Chl-a; they fully supported aquatic recreation. Long and Twin lakes were found to be impaired for aquatic recreation due to excess nutrients. These two lakes had high concentrations of phosphorus, which causes high Chl-a concentrations and potential nuisance algal blooms. Their shallow depths allow for nutrients to be re-suspended throughout the water column during wind events. There were not enough data to assess Windy, Nitche, Pelican Bay, and Long Pine lakes for aquatic recreation; available data indicate that all but Windy Lake likely support aquatic recreation use.

Four lakes were assessed for aquatic life using the fish community: Big Pine, Rush, Buchanan, and Marion. All four lakes were considered fully supporting of aquatic life based on the FIBI scores. Intolerant species such as cisco and lake sturgeon were found in Rush and Marion. The FIBI scores for Big Pine and Rush were positively influenced by a high diversity and proportion of small benthic dwelling species (i.e. various darters, mottled sculpin, and tadpole madtom). Buchanan’s FIBI score was positively influenced by the high proportion of biomass from insectivores and the low diversity and lack of biomass from tolerant species (i.e. black bullhead).

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Otter Tail Lake – Otter Tail River Aggregated HUC-12.



Dead River Aggregated HUC-12 — HUC 0902010304-01

The Dead River Subwatershed drains 149 square miles of land within the central portion of the Otter Tail River Watershed. This lake rich subwatershed contains over 150 bodies of water ranging from small wetland ponds to major recreational lakes. Some of the more prominent lakes include Dead Lake, Star Lake, and the McDonald Lakes. Forested land is present throughout the subwatershed but more prominent within the western region. Rangeland and cropland is distributed throughout the subwatershed. The Dead River originates out of Dead Lake – the largest lake within the subwatershed. Dead Lake receives water from four small tributaries that originate out of the various nearby lakes, including Mud Lake, Peterson Lake, and Star Lake. The river consists of a low gradient stream that winds through wetlands along its entire eight-mile course to Walker Lake. A small channel connects Walker Lake with Otter Tail Lake; Otter Tail Lake is in another subwatershed. Land use within the subwatershed is primarily forest (28.5 %) followed by open water (23.2 %), rangeland (20.8 %), cropland (13.4 %), wetland (9.9 %), and developed (4.1 %) (USGS 2011). Due to wetland and lake proximity, there were no chemistry or biological samples collected from streams within the Dead River Subwatershed. Twenty-five lakes were assessed for aquatic recreation and aquatic life.

Table 10. Lake assessments: Dead River Aggregated HUC-12.

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		
Walker	56-0310-00	577	29	Deep Water	NCHF	D	EXS	--	--	MTS	EXS	MTS	IMP	SUP
Unnamed	56-0312-00	6	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Tamarack	56-0320-00	140	10	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Wolf	56-0345-00	190	51	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
South Rice	56-0352-00	110	--	Shallow Water	NCHF	--	--	--	--	MTS	IF	IF	--	IF
Dead	56-0383-00	7437	65	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Star	56-0385-00	4378	94	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Big McDonald	56-0386-01	973	46	Deep Water	NCHF	I	EXS	--	--	MTS	MTS	MTS	IMP	SUP
West McDonald	56-0386-02	584	62	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Big McDonald #2	56-0386-03	557	33	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Peterson	56-0471-00	106	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP

Bray	56-0472-00	113	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Pickerel	56-0475-00	839	81	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Maine (Round)	56-0476-00	85	34	Deep Water	NCHF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP
Mud	56-0484-00	497	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
North Long	56-0489-00	150	27	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Round	56-0490-00	80	14	Shallow Water	NCHF	--	--	IF	--	IF	IF	IF	IF	IF
Horseshoe	56-0492-00	10	--	Shallow Water	NCHF	--	--	IF	--	IF	IF	IF	IF	IF
Moore	56-0499-00	117	--	Shallow Water	NCHF	--	--	--	--	MTS	IF	IF	--	IF
Alice	56-0506-00	172	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
East Silent	56-0517-00	312	48	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
West Silent	56-0519-00	333	58	Deep Water	NCHF	NT	EXS	--	--	MTS	MTS	MTS	IMP	SUP
Round	56-0522-00	170	18	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Long	56-0575-00	248	17	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Beers	56-0724-00	238	60	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	IF	SUP
Eddy	56-0737-00	137	34	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Mud	56-1148-00	113	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Berger	56-1149-00	311	--	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Hoffman	56-1627-00	145	16	Shallow Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

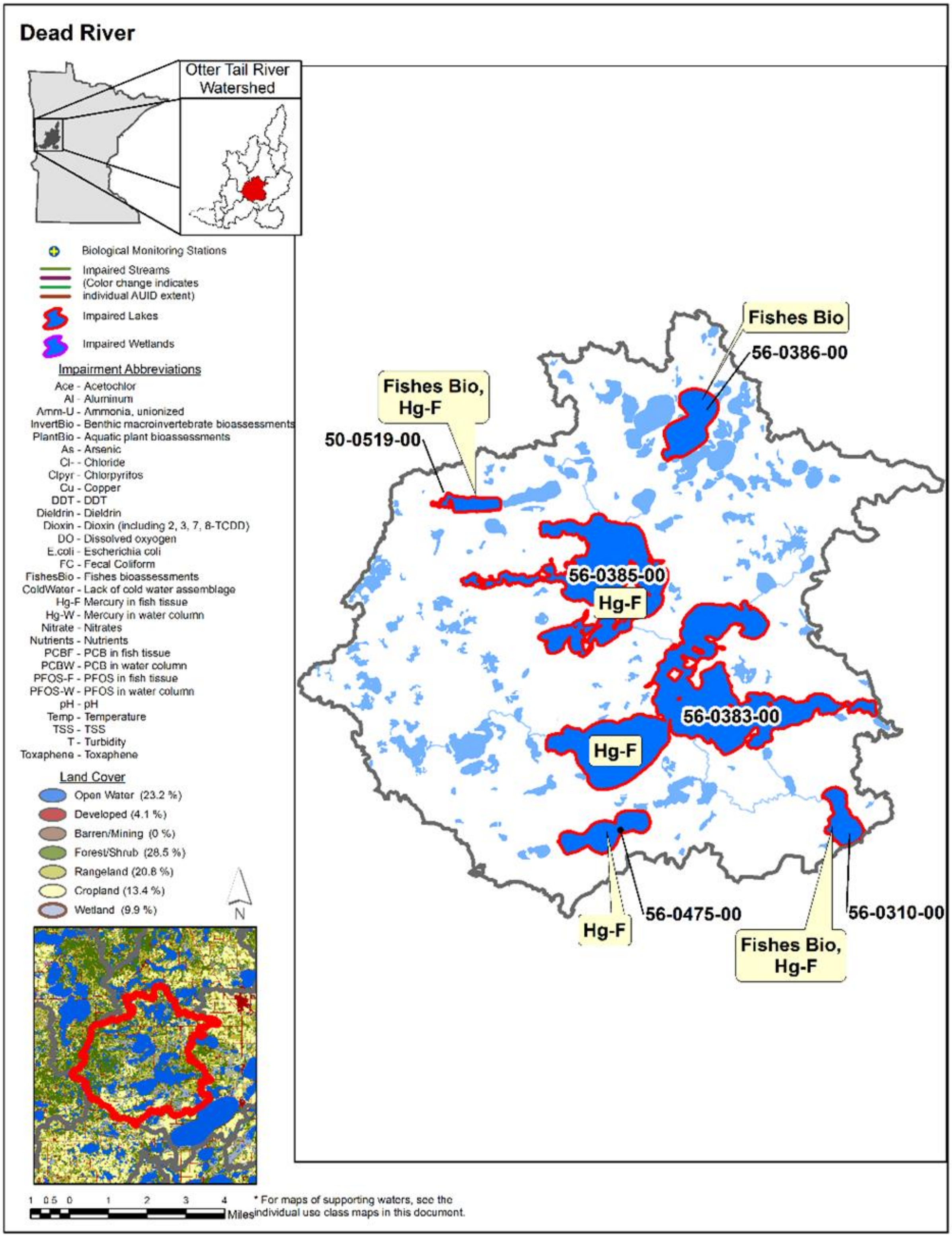
Summary

No biological monitoring stations were located within this subwatershed due to lake and wetland proximity. Water chemistry was also not monitored on streams due to lake proximity.

Twenty-five lakes were assessed for aquatic recreation. The majority of the lakes in this subwatershed have good water quality and support aquatic recreation. In general, phosphorus concentrations were low and therefore so was algal production. These conditions allow for clear water and good transparency, as shown by Secchi disk measurements meeting the standards. There was insufficient data to assess aquatic recreation on South Rice, Round, Horseshoe, and Moore Lake.

The fish community was used to assess aquatic life on eight lakes: Walker, Dead, Star, Big McDonald, West McDonald, Pickerel, East Silent, and West Silent. Five of these lakes (Dead, Star, West McDonald, Pickerel, and East Silent) had FIBI scores at or above the impairment threshold and were considered to support aquatic life. Star is considered vulnerable to future impairment because the 2017 FIBI score was at the impairment threshold. Walker, Big McDonald, and West Silent Lake were considered not supporting aquatic life based on FIBI scores below the impairment threshold. Intolerant species such as blacknose shiner, Iowa darter, and mimic shiner were found in Dead, Star, West McDonald, Pickerel, and Walker lakes. Northern pike were found in all lakes except West McDonald, Pickerel, and East Silent.

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



West Battle Lake Aggregated HUC-12 HUC 0902010305-01

The West Battle Lake Subwatershed drains 162 square miles of land within the southeastern portion of the Otter Tail River Watershed. Most of the land within the subwatershed is used for agricultural purposes (crop production and hay/pasture). Small parcels of forested land are distributed throughout the subwatershed but are more prominent within the eastern region. Numerous small lakes (< 100 acres) are scattered throughout the southeast region while larger lakes (West Battle, East Battle, Clitherall, and Blanche) are located within the central region of the subwatershed. No major rivers are present; most of the streams are small and flow between lakes. Brandborg Creek is a small cold water stream that originates near the community of Henning and flows west for 4.5 miles before emptying into East Battle Lake. A small unnamed tributary flows north through Siverson and Ellingson Lake and into Stuart Lake before entering East Battle Lake. A small channel through a wetland extends from the dam at the outlet of East Battle Lake to West Battle Lake. West Battle Lake also receives water from a small stream flowing out of Clitherall Lake. A small-unnamed stream serves as the outlet of West Battle Lake. The stream flows north, passing through Molly Stark Lake, Annie Battle Lake, and Blanche Lake before exiting the subwatershed and entering Otter Tail Lake. Land use within the subwatershed is primarily cropland (31.8 %) followed by forest (20.5 %), rangeland (19.8 %), open water (17.3 %), developed (5.4 %), and wetland (5.2 %) (USGS 2011). In 2016, the MPCA collected biological samples from one monitoring station located on one stream reach. Due to wetland and lake proximity, water chemistry was not intensively monitored on any stream reaches within the West Battle Lake Subwatershed. Seventeen lakes were assessed for recreation and nine lakes for aquatic life.

Table 11. Aquatic life and recreation assessments on stream reaches: West Battle Lake Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

				Aquatic Life Indicators:										
WID ***Reach name*****,** *Reach description*	**Biological Station ID**	**Reach Length (miles)**	**Use Class***	**Fish IBI**	**Invert IBI**	**Dissolved Oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Eutrophication**	**Aquatic Life**	**Aquatic Rec. (Bacteria)**
09020103-561 **Brandborg Creek,** *T133 R38W S28, east line to Battle Lake*	05RD089	3.23	CWg	MTS	MTS	IF	IF	IF	--	IF	IF	IF	SUP	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2020 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 12. Lake assessments: West Battle Lake Aggregated HUC-12.

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		
East Battle	56-0138-00	1964	87	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Unnamed	56-0147-00	29	--	Shallow Water	NCHF	--	--	IF	--	IF	IF	IF	IF	IF
Peterson	56-0171-02	37	8	Shallow Water	NCHF	--	--	--	--	MTS	IF	IF	IF	IF
Ellingson	56-0178-00	147	19	Deep Water	NCHF	--	--	--	--	MTS	IF	MTS	--	SUP
Siverson	56-0180-00	139	41	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Trulse	56-0187-00	103	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Stuart (main basin)	56-0191-01	681	49	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Stuart (Little West Bay)	56-0191-02	48	49	Deep Water	NCHF	I	MTS	--	--	--	--	MTS	SUP	IF
Ethel	56-0193-00	187	64	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Emma	56-0194-00	227	3.5	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Beauty Shore	56-0195-00	177	6	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP

Mason	56-0196-00	431	6	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Belmont	56-0237-00	273	34	Deep Water	NCHF	D	--	--	--	MTS	MTS	MTS	--	SUP
Clitherall	56-0238-00	2510	69	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
West Battle	56-0239-00	5515	108	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	IF	SUP
Blanche SOME HIGH SECCHI	56-0240-00	1286	64	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Annie Battle	56-0241-00	348	51	Deep Water	NCHF	--	MTS	--	--	--	--	--	SUP	--
Lundeberg	56-0289-00	144	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
First Silver	56-0302-01	513	43	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Second Silver	56-0302-02	189	43	Deep Water	NCHF	--	--	--	--	MTS	EXS	IF	--	IF
Third Silver (Main Bay)	56-0302-04	119	43	Deep Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Molly Stark	56-0303-00	145	48	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Elbow	56-0306-00	191	46	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
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Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐= insufficient information.

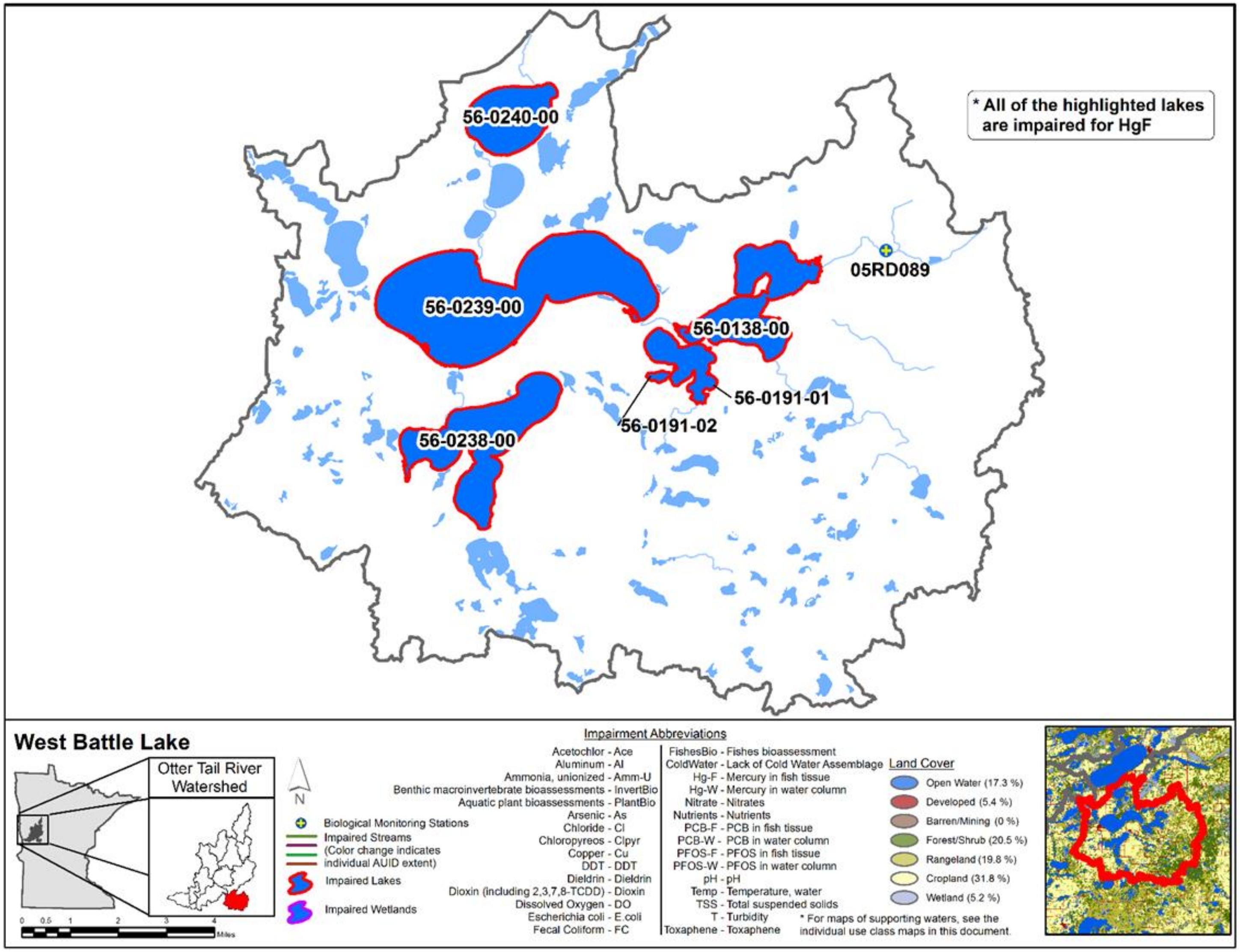
Summary

Station 05RD089 was located on Brandborg Creek. Brandborg Creek is a small cold water stream that is only 1 – 2 meters wide in some locations. Surprisingly, this small stream had historically supported a population of brown trout. The 2016 sample FIBI score was fair. Three species of fish were collected. The sample was dominated by northern redbelly dace – a sensitive headwater species. Temperature data collected from June through September in 2016 indicate a summer average temperature of 18.1 degrees Celsius. Sand and silt substrate was present throughout the sampling reach; limited coarse substrate was available. A variety of cover types was present throughout the reach. The MIBI score was good. Cold water obligate taxa were present within the macroinvertebrate sample.

In the West Battle Lake Subwatershed, 17 lakes were assessed for aquatic recreation. Most of the lakes had good water quality and support aquatic recreation. Several lakes had great water clarity, with Secchi values of 3 meters or higher. One such lake was Elbow Lake, with a mean Secchi value of 5.9 meters. There were insufficient data to assess aquatic recreation on the following lakes: Peterson, Stuart (Little West Bay), Second Silver, and Third Silver (Main Bay).

The fish community was used to assess aquatic life on nine lakes: East Battle, Stuart (Main Basin), Stuart (Little West Bay), Ethel, Clitherall, Blanche, Annie Battle, First Silver, and Molly Stark. All lakes were found to support aquatic life based on FIBI scores that were well above the impairment threshold. Cisco, a pelagic fish that requires well-oxygenated cold water, were found in Blanche, Annie Battle, and Molly Stark Lakes. Annie Battle and Molly Stark had very high FIBI scores that exceeded the exceptional threshold. The fish communities in these two lakes had a high diversity of intolerant species (i.e. banded Killifish, blackchin Shiner, Iowa darter, mimic shiner, logperch, muskellunge, and rock bass).

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the West Battle Lake Aggregated HUC-12.



Middle Otter Tail River Aggregated HUC-12 HUC 0902010309-01

The Middle Otter Tail River Subwatershed drains 179 square miles of land within the southern portion of the Otter Tail River Watershed. Within this subwatershed, numerous impoundments have been created on the Otter Tail River for the purpose of hydroelectric power generation. Most of the numerous lakes (> 200) that are present are less than 50 acres in size. Major lakes (> 500 acres) include Fish Lake, Wall Lake, Orwell Lake, Anna Lake, and West Long Lake. The majority of the land within this subwatershed is used for agricultural purposes (cropland and pasture). Due to the presence of Fergus Falls, the amount of developed land is considerably higher within this subwatershed. The Otter Tail River enters the northeast corner of the subwatershed and winds west for approximately 15 miles. The river passes through Deer Lake, East Lost Lake, Phelps Mill Pond, West Long Lake, and several wetlands before entering a 340-acre impoundment created by the Friberg-Taplin Gorge hydropower dam. The river exits the impoundment, then turns and flows south for seven miles before entering a small impoundment created by the Hoot Lake Diversion Dam. A diversion channel diverts water from the impoundment south into Hoot Lake and Wright Lake. This water, used for cooling purposes and hydroelectric power generation, later rejoins the Otter Tail River near Fergus Falls. After passing over the diversion structure, a 13 mile long loop of the river winds east, south, and then back west before entering the community of Fergus Falls. Two reservoirs created for hydropower generation are located within the community. The river continues west, passing through both reservoirs and bisecting Fergus Falls before being joined by the Pelican River. Draining
492 square miles of land, the Pelican River is the largest tributary to join with the Otter Tail River prior to its confluence with the Bois de Sioux River. After joining with the Pelican River, the Otter Tail River turns and flow south. The river passes through Dayton Hollow Reservoir and then flows west into Orwell Reservoir. The largest impoundment on the Otter Tail River, Orwell Reservoir was created for flood control and irrigation water storage. The Otter Tail River flows over the dam at the outlet of the reservoir and into the next subwatershed. Land use within the subwatershed is primarily cropland (42.1 %) followed by rangeland (19.2 %), forest (12.6 %), open water (11.9 %), developed (9.1 %), and wetland (5.0 %) (USGS 2011). In 2016, the MPCA collected biological samples from three monitoring stations located on three stream segments. Water chemistry was intensively monitored at two locations within the Middle Otter Tail River Subwatershed.

Table 13. Aquatic life and recreation assessments on stream reaches: Middle Otter Tail River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-773 **Otter Tail River,** *West Long Lake to River Diversion*	91RD009	15.50	WWg	MTS	MTS	IF	MTS	MTS	IF	MTS	MTS	MTS	SUP	SUP
09020103-774 **Otter Tail River,** *River Diversion to Unnamed Lake (56-1203-00)*	15EM084, 16RD012	13.53	WWg	MTS	MTS	IF	IF	MTS	MTS	MTS	IF	IF	SUP	SUP
09020103-574 **Otter Tail River,** *Unnamed Lake (56-0821-00) to Pelican River*	16RD034	2.75	WWg	MTS	MTS	IF	IF	MTS	MTS	MTS	MTS	MTS	SUP	IMP
09020103-503 **Otter Tail River,** *Pelican R to Dayton Hollow Reservoir*		2.95	WWg	--	--	IF	IF	IF	MTS	IF	MTS	IF	IF	--

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
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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 14. Lake assessments: Middle Otter Tail River Aggregated HUC-12.

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		
Round	56-0297-00	159	24	Shallow Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Deer	56-0298-00	440	26	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Brown	56-0315-00	101	5	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
East Lost (North bay)	56-0378-01	113	36	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Mud	56-0445-00	108	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Anna	56-0448-00	579	55	Deep Water	NCHF	--	EXS	MTS	--	MTS	MTS	MTS	IMP	SUP
Pleasant	56-0449-00	373	38	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Little Anna	56-0450-00	125	9	Shallow Water	NCHF	--	--	--	--	MTS	MTS	IF	--	SUP
Crooked	56-0458-00	132	--	Shallow Water	NCHF	--	--	--	--	EXS	EXS	IF	--	IMP
West Lost	56-0481-00	738	23	Shallow Water	NCHF	--	MTS	--	--	IF	IF	IF	SUP	IF
Sharp	56-0482-00	131	--	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Norway (East bay)	56-0569-01	314	19	Shallow Water	NCHF	NT	--	--	--	EXS	EXS	MTS	--	IMP
Norway (West bay)	56-0569-02	93	19	Shallow Water	NCHF	--	--	--	--	EXS	EXS	MTS	--	IMP
Bass	56-0570-00	302	36	Deep Water	NCHF	NT	IF	--	--	MTS	MTS	MTS	IF	SUP
East Red River	56-0573-00	87	--	Shallow Water	NCHF	--	--	--	--	--	--	NA	IF	NA

Long	56-0574-00	74	29	Deep Water	NCHF	I	--	--	--	--	--	MTS	--	IF
North Stang	56-0621-00	29	--	Shallow Water	NCHF	--	--	--	--	IF	IF	--	--	IF
South Stang (Glorvigan)	56-0629-00	90	--	Shallow Water	NCHF	--	--	--	--	--	--	IF	IF	IF
Wall	56-0658-00	720	27	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Fish	56-0684-00	929	14	Shallow Water	NCHF	--	EXS	MTS	--	MTS	MTS	MTS	IMP	SUP
Otter Tail River (Red River)	56-0711-00	339	55	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Hoot	56-0782-00	165	20	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Wright	56-0783-00	66	32	Deep Water	NCHF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP
Unnamed	56-0791-00	140	--	Shallow Water	NCHF	--	--	--	--	EXS	EXS	EXS	--	IMP
Dayton Hollow Reservoir	56-0824-00	265	32	Deep Water	NCHF	I	--	MTS	--	NA	NA	NA	IF	NA
Pebble	56-0829-00	178	62	Deep Water	NCHF	NT	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Horseshoe	56-0834-00	130	12	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Iverson	56-0846-00	54	18	Shallow Water	NCHF	--	--	--	--	--	--		IF	--
Unnamed	56-0848-00	34	--	Shallow Water	NCHF	--	--	--	--	IF	--	IF	--	IF
Alice	56-0867-00	37	--	Shallow Water	NCHF	--	--	--	--	IF	--	IF	--	IF
Orwell	56-0945-00	590	--	Shallow Water	NCHF	--	--	MTS	--	MTS	MTS	MTS	IF	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2020 reporting cycle; = new impairment; = full support of designated use; = insufficient information

Summary

Station 91RD009 was located on the segment of the Otter Tail River that extends from West Long Lake to the river diversion channel. The 2016 sample FIBI score was good. The fish sample contained many sensitive insectivorous species, including the rainbow darter, a rare species for the Red River Basin only found within the Otter Tail River Watershed (Figure 29). Clean, coarse substrate and a variety of cover types were available within the sampling reach. The reach also contained numerous mussel beds – some of these beds were so dense they covered portions of the streambed (Figure 29).

Figure 29. Mussel bed (darker objects) in the Otter Tail River at station 91RD009 (left) and image of rainbow darter (right) *Photo of rainbow darter courtesy of The North American Native Fishes Association*.

Station 16RD012 was located on the segment of the Otter Tail River that extends from the river diversion to an unnamed lake. The 2016 visit FIBI score was almost exceptional. Numerous sensitive species, insectivores, and lithophilic spawners were present in the fish sample. A cobble riffle, deep pools, and a variety of cover types were present within the sampling reach. The 2017 visit MIBI score was exceptional. The macroinvertebrate sample contained 55 unique taxa – 13 of these were caddis fly taxa. Numerous sensitive mayfly, caddisfly and stonefly taxa were present in the sample.

Station 16RD034 was located on the segment of the Otter Tail River that extends from an unnamed lake to the Pelican River. The 2017 visit FIBI score was good. The fish sample contained three different redhorse species (these are lithophilic spawning, insectivores) and the central stoneroller. The central stoneroller is a rare species within the Red River Basin whose distribution is restricted primarily to the Otter Tail River and Buffalo River

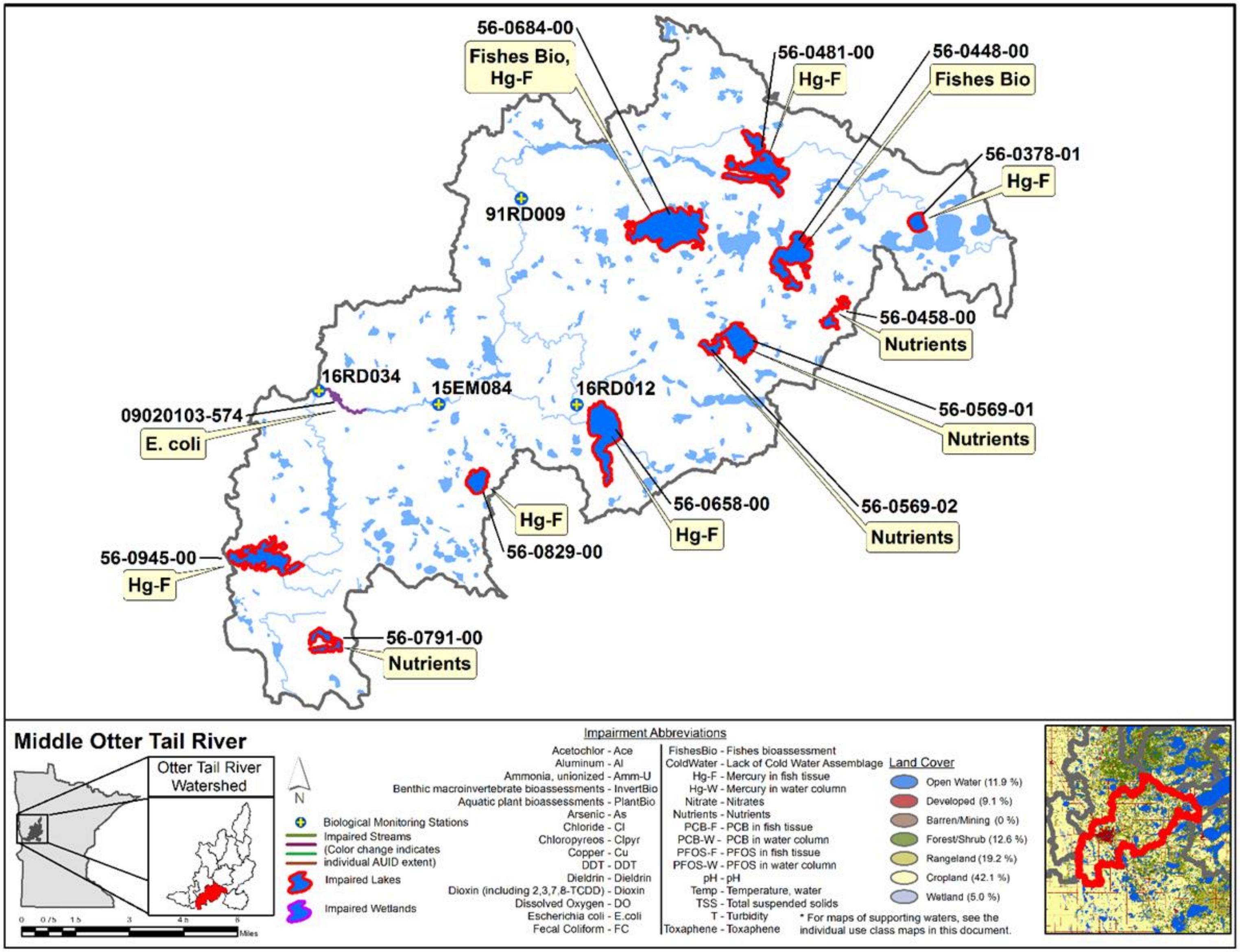
Watershed. The sampling reach contained sand substrate and limited patches of gravel along with a variety of cover types. The 2017 visit MIBI score was good. The macroinvertebrate sample contained 50 unique taxa. The sample included 11 caddisfly taxa – four of which were sensitive.

Water chemistry data indicate that all three segments of the Otter Tail River located upstream of the Pelican River confluence had low nutrient and sediment concentrations. Low levels of bacteria were found on all of these segments of the Otter Tail River, except the reach that extends from unnamed lake to the Pelican River. This reach had elevated concentrations of *E. coli* bacteria during two consecutive years of monitoring; consequently, this reach is impaired for aquatic recreation. Insufficient data were available on the segment of river downstream of the Pelican River confluence – aquatic recreation and aquatic life could not be assessed.

Aquatic recreation was assessed on 22 lakes within the subwatershed. Crooked, Norway (East and West Bays), and unnamed (56-0791-00) lakes did not support aquatic recreation. These are all shallow lakes; these basins do not have the capacity for external sources of phosphorus and internal loading will likely cause algal blooms to increase during summer months. There were insufficient data to assess aquatic recreation on West Lost, Long, North Stang, South Stang, unnamed (56-0848-00), and Alice lakes. East Red River and Dayton Hollow Reservoir were not assessed because neither retained water long enough for lake standards to apply. The remaining 18 lakes have good water quality and fully support aquatic recreation. Wall Lake does have a declining trend in water clarity and would be a priority for protection efforts.

The fish community was used to assess aquatic life on nine lakes: Deer, East Lost (North Bay), Anna, Pleasant, West Lost, Bass, Wall, Fish, and Pebble. Anna and Fish were found to not support aquatic life. Anna had FIBI scores from 2009 and 2014 that were well below the impairment threshold (and lower confidence interval). The FIBI scores for Anna Lake were negatively impacted by a high proportion of tolerant species and a relatively low proportion of top carnivore species. Fish Lake had FIBI scores below the impairment threshold, but still within the 90% confidence interval. This lake had a relatively high proportion of vegetative dwelling species; however, a relatively high proportion of tolerant species negatively influenced the FIBI score. The remaining six lakes were found to support aquatic life. Bluegill, northern pike, and largemouth bass were found in all supporting lakes, except for Deer, which had northern pike and bluegill. Iowa darter, johnny darter, and tadpole madtom were found in Deer, East Lost, Pleasant and Wall Lakes.

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Middle Otter Tail River Aggregated HUC-12.



Upper Pelican River Aggregated HUC-12 HUC 0902010307-02

The Upper Pelican River Subwatershed drains 154 square miles of land within the northwest portion of the Otter Tail River Watershed. In addition to the headwaters of the Pelican River, this subwatershed also contains numerous lakes, many of which the Pelican River flows through. Major lakes (> 500 acres) include: Floyd Lake, Detroit Lake, Sallie Lake, Melissa Lake, Leek Lake, Maude Lake, and Little Cormorant Lake. Forested land is distributed throughout the subwatershed but is especially prevalent along the eastern edge. Agricultural land use (hay/pasture and cropland) occurs throughout the subwatershed. Urban development is concentrated around the city of Detroit Lakes. The Pelican River originates as a small-channelized stream from a wetland area located approximately six miles north of Detroit Lakes. The Pelican River flows south for four miles and receives water from the outlet of Little Floyd Lake. The river continues flowing south another six miles, passes through the city of Detroit Lakes, and empties into Detroit Lake. Almost the entire reach of the river from its headwaters to Detroit Lake has been altered (straightened). Immediately after flowing west out of Detroit Lake, the Pelican River is joined by County Ditch 14. County Ditch 14 is a short (< 1 mile) ditch that originates out of St. Clair Lake and flows south along the western edge of Detroit Lake. For the next several miles, the Pelican River consists of short connecting channels between Detroit Lake, Muskrat Lake, Sallie Lake, and Melissa Lake. Dams are present at the outlets of Muskrat Lake, Sallie Lake, and Melissa Lake. The river flows south out of Melissa Lake and enters a series of small wetland lakes (Mill Pond and Buck Lake). Buck Lake receives water from a small tributary that flows out of Maud and Eunice Lake and passes through Mud Lake. The river exits Buck Lake and flows southwest into the next subwatershed. Land use within the subwatershed is primarily forest (33.5 %) followed by rangeland (21.3 %), open water (16.6 %), cropland (11.9 %), developed (9.2 %), and wetland (7.4%). In 2016, the MPCA collected biological samples from one monitoring station located on one stream reach. Water chemistry was intensively monitored at one station within the Pelican River Subwatershed.

Table 15. Aquatic life and recreation assessments on stream reaches: Pelican River Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-543 **Campbell Creek,** *Campbell Lake to Floyd Lake*	--	3.80	WWg	--	--	--	EXS	--	--	--	--	IF	IMP	--
09020103-771 **Pelican River,** *Headwaters to Highway 10*	--	9.91	WWg	--	--	--	MTS	--	--	--	--	MTS	SUP	--
09020103-772 **Pelican River,** *Highway 10 to Detroit Lake*	16RD032	0.97	WWg	EXS	EXS	EXS	MTS	MTS	MTS	MTS	MTS	IF	IMP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2020 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 16. Lake assessments: Upper Pelican River Aggregated HUC-12.

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		
Sauer	03-0355-00	183	39	Deep Water	NCHF	NT	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Munson	03-0357-00	128	26	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Fox	03-0358-00	131	24	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Sallie	03-0359-00	1257	50	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Muskrat	03-0360-00	68	18	Shallow Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Curfman	03-0363-00	119	24	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Glawe	03-0364-00	31	--	Shallow Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Abbey	03-0366-00	269	7	Shallow Water	NCHF	D	--	--	--	MTS	MTS	MTS	--	SUP
Meadow	03-0371-00	67	72	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Johnson	03-0374-01	170	30	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Reeves	03-0374-02	92	43	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Mill	03-0377-00	153	10	Shallow Water	NCHF	--	--	--	--	MTS	IF	MTS	--	SUP
Detroit	03-0381-00	3055	82	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
St. Clair	03-0382-00	142	7.5	Shallow Water	NCHF	NT	--	--	--	EXS	EXS	IF	--	IMP
Long	03-0383-00	405	61	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP

Little Floyd	03-0386-00	210	32	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Mud	03-0387-01	281	34	Deep Water	NCHF	NT	MTS	--	--	MTS	IF	MTS	SUP	SUP
Floyd (South bay)	03-0387-02	881	34	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Wine	03-0398-00	31	--	Shallow Water	NCHF	NT	--	--	--	EXS	EXS	EXS	--	IMP
Brandy	03-0400-00	324	--	Shallow Water	NCHF	I	--	--	--	MTS	IF	MTS	--	SUP
Sands	03-0420-00	84	11	Shallow Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Dart	03-0474-00	29	5	Shallow Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Melissa	03-0475-00	1846	43	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Pearl	03-0486-00	256	54	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Loon	03-0489-00	167	7.5	Shallow Water	NCHF	NT	--	--	--	IF	IF	IF	--	IF
Maud	03-0500-00	511	30	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Eunice	03-0503-00	369	30	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Little Cormorant	03-0506-00	1000	34	Deep Water	NCHF	NT	EXS	IF	--	MTS	IF	MTS	IMP	SUP
Hand	56-0527-00	153	14	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Trowbridge	56-0532-01	279	76	Deep Water	NCHF	--	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Leek	56-0532-02	331	76	Deep Water	NCHF	--	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Hook	56-0547-00	132	24	Shallow Water	NCHF	--	--	--	--	IF	IF	IF	--	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)

Key for Cell Shading: = existing impairment, listed prior to 2020 reporting cycle; = new impairment; = full support of designated use; = insufficient information

Summary

Station 16RD032 was located on the segment of the Pelican River that extends from Highway 10 to Detroit Lake. The 2016 sample FIBI score was poor. Seventeen species of fish were collected and almost half of them were generalist species. Low numbers of insectivores and lithophilic spawning species were present in the sample. Cobble riffle habitat and a variety of cover types were present within the sampling reach; however, most substrate was covered in algal growth. Excessive algal growth reduces the quality/availability of stream habitat. Mats of dead algae were observed floating on the surface (Figure 31). The MIBI score was poor. The sample was dominated by tolerant taxa. Water chemistry data indicate DO concentrations frequently fail to meet standards. Excess DO flux was also evident in the data. This reach will be impaired for aquatic life based on the poor biological communities and exceedances of the DO standard. This reach is also impaired for aquatic recreation due to the occurrence of elevated levels of bacteria throughout the summer months.

Figure 31. Filamentous algae at Station 16RD032.

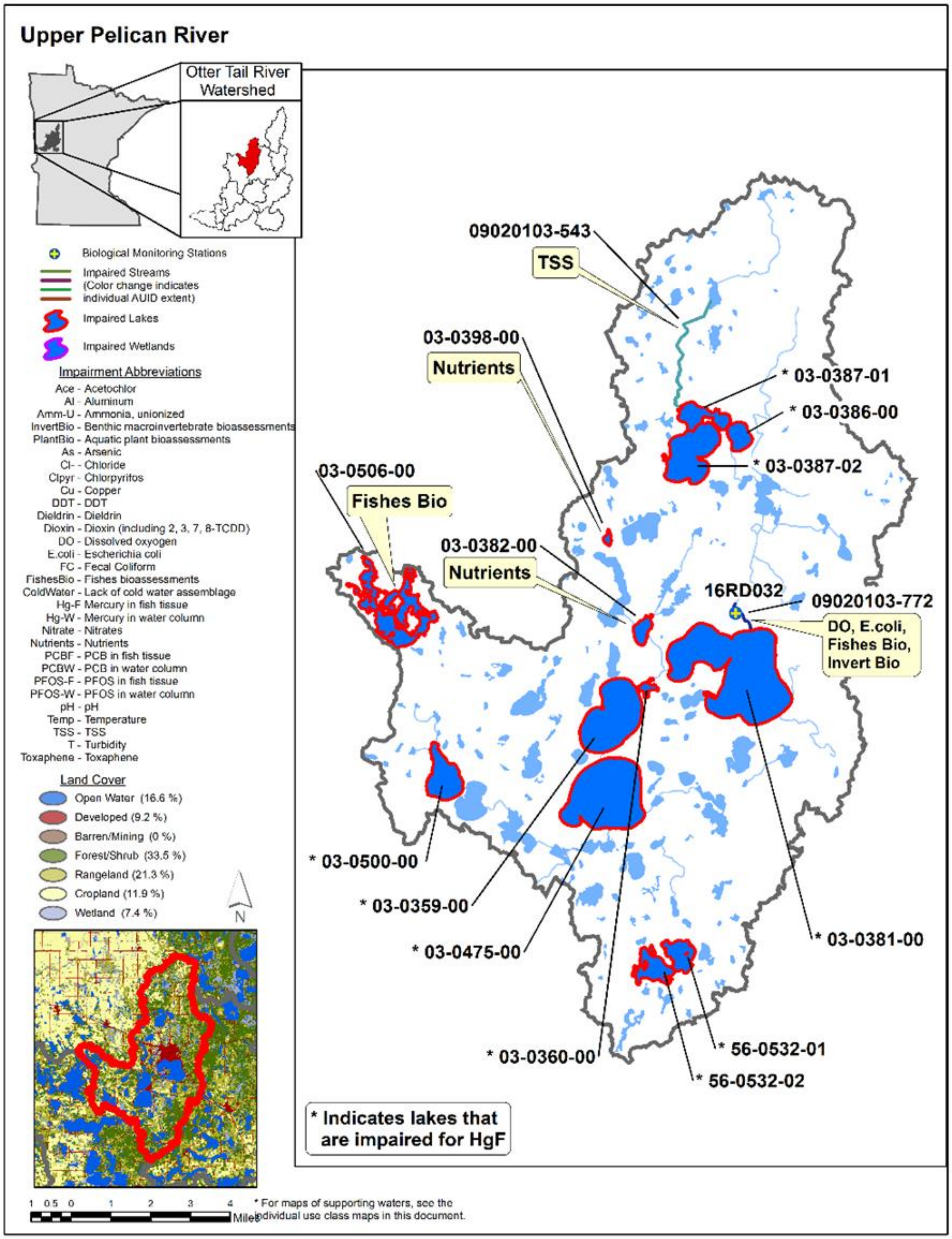
The water chemistry data indicate phosphorus concentrations were meeting the standard on the segment of the Pelican River that extends from the headwaters to Highway 10. The Pelican River Watershed District is working on reducing phosphorus loading to the Pelican River as a result of recent studies they have conducted. TSS concentrations were good on both reaches of the Pelican River; however, these reaches do sometimes experience periods of high TSS concentrations. Campbell Creek, which extends from Campbell Lake to Floyd Lake, frequently had TSS concentrations that exceeded the standard. Thus, this reach is impaired for aquatic life.

Twenty-nine lakes within the subwatershed were assessed for aquatic recreation. Most of the lakes have good water quality and support aquatic recreation. There were insufficient data to assess aquatic recreation on Dart, Loon, and Hook lakes. Two lakes, St. Clair and Wine, were previously listed and still do not support aquatic recreation due to excess nutrients. Both lakes are shallow and have limited capacity to handle inputs of phosphorus.

Internal cycling of nutrients will likely produce algal blooms. The TMDL is complete on St. Clair Lake. Little Cormorant Lake had phosphorus concentrations just below the water quality standard and Chl-a concentrations slightly above the standard. The Secchi transparency was also at the standard. This lake should be considered vulnerable to future impairment.

The fish community was used to assess aquatic life on 15 lakes. All lakes were considered to support aquatic life, except for Little Cormorant. Little Cormorant had low FIBI scores and is considered impaired. Lake Sallie had FIBI scores near the impairment threshold and is considered vulnerable to future impairment. Cisco, a pelagic species that requires cool well-oxygenated water, were captured in Lake Sallie and Little Floyd Lake. The pugnose shiner was captured in Lake Sallie, Little Floyd Lake, and Leek Lake. The pugnose shiner is a sensitive species that requires clean water and a healthy aquatic plant community. Long, Melissa, and Maud lakes all had high FIBI scores and were considered to have exceptional fish communities.

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Upper Pelican River Aggregated HUC 12.



Middle Pelican River Aggregated HUC-12 — HUC 0902010307-01

The Middle Pelican River Subwatershed drains 185 square miles of land within the west central portion of the Otter Tail River Watershed. Within this subwatershed, the Pelican River consists of short connecting channels between numerous lakes. Major lakes ($\geq$ 500 acres) include Upper Cormorant, Big Cormorant, Ida, Pelican, Lizzie (north and south portion), Franklin, Crystal, Lida, and Prairie. Much of the land within the eastern portion of the subwatershed is forested. Most agricultural land use occurs within the western half of the subwatershed and to the north of Pelican Lake. The Pelican River enters Little Pelican Lake located along the northeastern edge of the subwatershed and flows west into Pelican Lake. Pelican Lake (3,962 acres) is one of several large lakes the Pelican River passes through. Pelican Lake also receives water from Spring Creek, a small, three-mile long tributary connected to Big Cormorant Lake. The Pelican River flows south out of Pelican Lake and into the north end of Lake Lizzie. A dam is present at the outlet of Pelican Lake and on the inlet of Lake Lizzie. This 3-mile long segment of the Pelican River represents the longest continuous stretch of river within the entire subwatershed. Together, the North and South Lizzie lakes basin comprises 3,700 acres. South Lizzie Lake receives water from Crystal Lake and Lake Lida, the largest lake in the subwatershed. The river flows west for approximately one mile after exiting the South Lizzie Lake basin and enters Prairie Lake. A dam is present at the outlet of Lizzie Lake. The Pelican River flows through the dam on the south end of Prairie Lake and enters the next subwatershed. Land use within the subwatershed is primarily forest (26.0 %) followed by open water (25.4 %), rangeland (21.2 %), cropland (17.6 %), developed (5.2 %), and wetland (4.5 %) (USGS 2011). Due to lake proximity, biological samples were not collected within the subwatershed, and water chemistry was not intensively monitored. Twenty-two lakes were sampled for aquatic recreation and 13 lakes were sampled for aquatic life.

Table 17. Lake assessments: Middle Pelican River Aggregated HUC-12.

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		
Leif	03-0575-00	517	26	Deep Water	NCHF	D	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Big Cormorant	03-0576-00	3611	75	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Ida	03-0582-00	630	19	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Rossman	03-0587-00	266	19	Shallow Water	NCHF	I	--	--	--	MTS	EXS	MTS	--	SUP
Upper Cormorant	03-0588-00	897	29	Deep Water	NCHF	D	EXS	--	--	MTS	EXS	MTS	IMP	SUP
Nelson	03-0595-00	306	16	Shallow Water	NCHF	NT	--	--	--	MTS	MTS	MTS	--	SUP
Unnamed	03-0596-00	61	22	Shallow Water	NCHF	D	--	--	--	MTS	IF	MTS	--	SUP
Middle Cormorant	03-0602-00	367	39	Deep Water	NCHF	NT	EXS	--	--	MTS	MTS	MTS	IMP	SUP
Bijou	03-0638-00	219	27	Deep Water	NCHF	I	IF	--	--	MTS	IF	MTS	IF	SUP
Unnamed	03-0751-00	10	--	--	NCHF	--	--	--	--	--	--	IF	IF	IF
Otter	56-0577-00	69	64	Deep Water	NCHF	--	--	--	--			IF	--	IF
Holbrook	56-0578-00	148	14	Shallow Water	NCHF	--	--	IF	--	MTS	EXS	EXS	IF	IF
Twenty-one	56-0728-00	124	47	Deep Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
North Lida	56-0747-01	5458	48	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
South Lida	56-0747-02	768	48	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP

Crystal	56-0749-00	1398	55	Deep Water	NCHF	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Franklin	56-0759-00	1083	48	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Lizzie (north portion)	56-0760-01	1882	66	Deep Water	NCHF	I	MTS	IF	--	MTS	MTS	MTS	SUP	SUP
Rush-Lizzie(south portion)	56-0760-02	1846	66	Deep Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Little Pelican	56-0761-00	360	25	Deep Water	NCHF	--	--	IF	--	MTS	MTS	MTS	IF	SUP
Fish	56-0768-00	275	69	Deep Water	NCHF	I	--	MTS	--	MTS	MTS	MTS	IF	SUP
Bass	56-0770-00	51	33	Deep Water	NCHF	I	--	IF	--	MTS	MTS	MTS	IF	SUP
Pelican	56-0786-00	3939	64	Deep Water	NCHF	I	MTS	MTS	--	MTS	MTS	MTS	SUP	SUP
Prairie	56-0915-00	984	21	Deep Water	NCHF	I	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Tamarac	56-0931-00	428	11	Shallow Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Sand	56-0942-00	130	29	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains

Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data

Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)

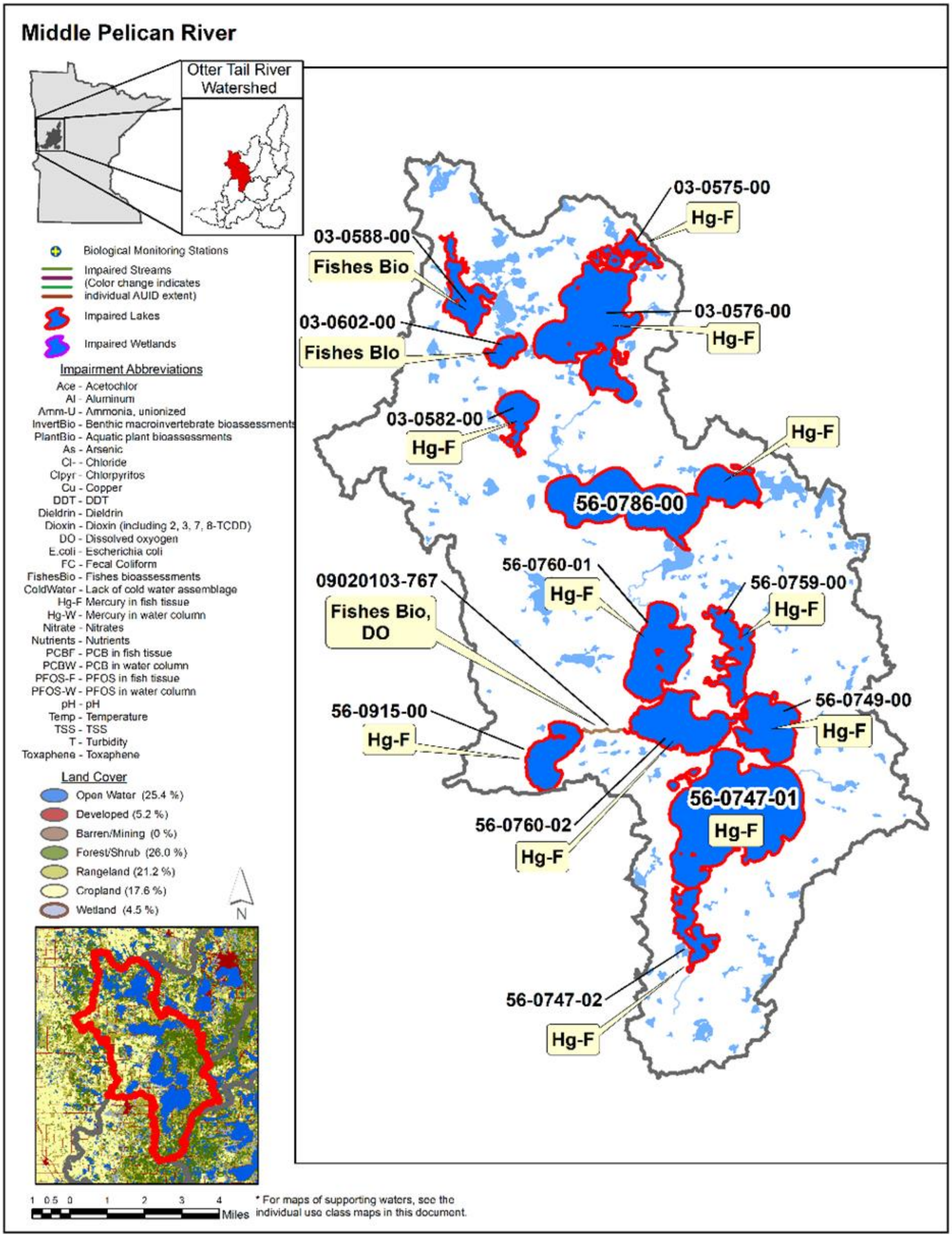
Key for Cell Shading: = existing impairment, listed prior to 2020 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Twenty-two lakes within the subwatershed were assessed for aquatic recreation. Most lakes were found to have good water quality and support aquatic recreation. Leif and Upper Cormorant Lakes both have declining trends in water clarity, with Chl-a concentrations exceeding the standard on Upper Cormorant. These basins should be considered priorities for protection efforts.

The fish community was used to assess aquatic life on 13 lakes: Leif, Big Cormorant, Ida, Upper Cormorant, Middle Cormorant, Bijou, North Lida, South Lida, Crystal, Franklin, Lizzie (north portion), Pelican, and Prairie. Most of the lakes had FIBI scores above the impairment threshold and were found to support aquatic life. Of the fully supporting lakes, Crystal Lake is considered to have an exceptional fish community. Bijou Lake was listed as insufficient information due to conflicting FIBI scores. Both Upper Cormorant and Middle Cormorant Lake were listed as not supporting aquatic life based on FIBI scores that were below the impairment threshold. Big Cormorant Lake had FIBI scores close to the impairment threshold and is considered vulnerable to future impairment. Blacknose shiner and blackchin shiner, both intolerant species indicative of good water quality and aquatic habitat, were found in Big Cormorant, Ida, North Lida, Lizzie, Pelican, Prairie, and Crystal Lake. Banded killifish and Iowa darter (both sensitive species) were found in Leif, Big Cormorant, Ida, Lizzie, and Prairie Lake. South Lida Lake contained Iowa Darters but not banded killifish.

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Middle Pelican River Aggregated HUC-12.



Lower Pelican River Aggregated HUC-12 HUC 0902010308-01

The Lower Pelican River Subwatershed drains 153 square miles of land within the western portion of the Otter Tail River Watershed. In contrast to the upstream subwatersheds, the Pelican River in this subwatershed only passes through two small impoundments and no large lakes. Almost 43 miles of continuous river channel is present, extending from the northern subwatershed boundary to the confluence of the Pelican River and the Otter Tail River. Agricultural land use occurs extensively within the western half (west of the Pelican River) and southern portion of this subwatershed. Most forested land is located on the east side of the Pelican River and north of Long Lake. Urban development occurs primarily within the communities of Elizabeth, Erhard, and Pelican Rapids; all are located along the US Highway 59 corridor. Smaller lakes are scattered throughout the subwatershed. Major lakes include Long, Jewett, and Devils. The Pelican River enters the subwatershed immediately after flowing out of Prairie Lake. The river winds south for approximately 1.5 miles and enters an impoundment located within the City of Pelican Rapids. The river passes through the dam at the lower end of the impoundment and flows west a short distance before turning toward the south. The river winds south for 19 miles before being joined by the tributary called Reed Creek. Reed Creek originates out of Reed Lake and flows west for 1.5 miles before joining with the Pelican River. Reed Lake receives water from an unnamed tributary flowing from the outlet of Long Lake, the largest lake in the subwatershed. The Pelican River continues flowing south for another 4 miles and enters a small impoundment near the community of Elizabeth. The river passes through the dam at the outlet of the impoundment and continues south / southwest for 19 miles before joining with the Otter Tail River. Land use within the subwatershed is primarily cropland (38.1 %) followed by rangeland (22.2 %), forest (20.1 %), open water (7.0 %), wetland (6.8 %), and developed (5.7 %) (USGS 2011). In 2016, the MPCA collected biological samples from four monitoring stations located on three stream reaches. Water chemistry was intensively sampled at two locations within the Lower Pelican River Subwatershed.

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

WID *Reach name*, *Reach description*	Biological 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	Eutrophication		
09020103-767 **Pelican River,** *Lk Lizzie to Reed Cr*	16RD016, 16RD019	23.60	WWg	EXS	MTS	EXS	MTS	MTS	MTS	MTS	MTS	IF	IMP	SUP
09020103-653 **Reed Creek,** *Reed Lake to Pelican River*	16RD047	1.49	WWg	MTS	MTS	IF	IF	IF	--	IF	IF	--	SUP	--
09020103-768 **Pelican River,** *Reed Creek to Otter Tail River*	16RD013	22.87	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	SUP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2020 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: Lower Pelican River Aggregated HUC-12.

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		
Tonseth	56-0690-00	142	27	Deep Water	NCHF	I	--	--	--	MTS	MTS	MTS	--	SUP
Heilberger	56-0695-00	209	47	Deep Water	NCHF	NT	MTS	--	--	MTS	MTS	MTS	SUP	SUP
Big Stone	56-0701-00	199	19	Shallow Water	NCHF	--	--	--	--	MTS	MTS	MTS	--	SUP
Anderson	56-0716-00	81	25	Deep Water	NCHF	--	--	--	--	IF	IF	IF	--	IF
Long	56-0784-00	739	73	Deep Water	NCHF	NT	--	--	--	MTS	MTS	MTS	IF	SUP
Jewett	56-0877-00	712	75	Deep Water	NCHF	I	EXS	--	--	MTS	MTS	MTS	IMP	SUP
Devils	56-0882-00	308	18	Shallow Water	NCHF	--	--	--	--	EXS	EXS	IF	--	IMP
Grandrud	56-0907-00	113	21	Shallow Water	NCHF	--	--	--	--	EXS	EXS	EXS	--	IMP
Hovland	56-1014-00	181	--	Shallow Water	NCHF	--	--	--	--	EXS	EXS	MTS	--	IMP
Unnamed	56-1582-00	12	--	Shallow Water	NCHF	--	--	IF	--	IF	IF	IF	IF	IF

Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2020 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Summary

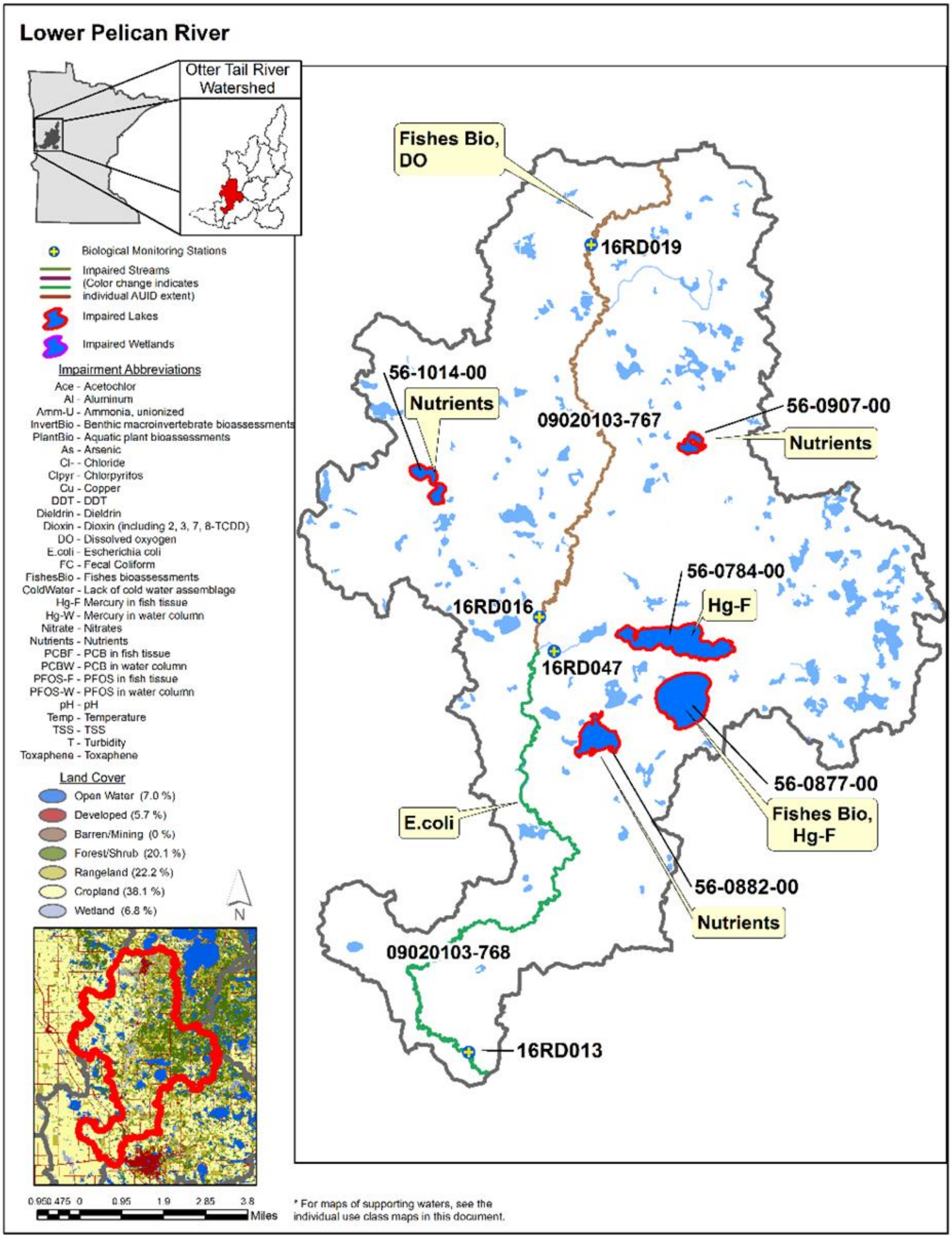
Stations 16RD019 and 16RD016 were located on the segment of the Pelican River that extends from Lake Lizzie to Reed Creek. Station 16RD019, located furthest upstream near Pelican Rapids, was sampled in 2016 and 2017. Station 16RD016 was located approximately 13 miles downstream of station 16RD019 and was sampled in 2017. All of the resulting FIBI scores were poor. Both samples from station 16RD019 featured diverse communities and contained a similar number (24 – 25) of species. The sample from station 16RD016 contained 18 species. All of the samples contained few later maturing and insectivorous species (i.e., redhorse and sucker species). A high number of generalist species was present in both samples from 16RD019. The sample from 16RD016 contained a high number of tolerant species. The stream habitat within both sampling reaches was indicative of a low gradient stream: sand and silt substrate, limited channel development, and abundant submergent aquatic vegetation. The 2017 visit MIBI scores for both stations were exceptional. Both samples contained over 40 taxa, including sensitive caddisfly and mayfly taxa. The presence of a robust macroinvertebrate community suggest that stream habitat and water chemistry are likely not factors limiting fish community development. The lack of later maturing, migratory insectivorous species (i.e., redhorse) and increased abundance of tolerant, generalist species can likely be attributed to a fish passage barrier (dam) located downstream of this reach. This segment of the Pelican River is impaired for aquatic life based on the fish community. This reach is also impaired for aquatic life based on low dissolved oxygen (DO) levels. Water chemistry data indicate frequent exceedances of the DO standard occur mid-reach near Erhard. DO flux (fluctuation) was also higher at this location. These exceedances did not occur further downstream at biological monitoring station 16RD016. Low levels of bacteria were found on this segment of the river; thus, it fully supports aquatic recreation.

Station 16RD013 was located on the segment of the Pelican River that extends from Reed Creek to the Otter Tail River. The 2016 visit FIBI score (74.1) was exceptional, and among the highest in the Otter Tail River Watershed. Twenty species of fish were collected. The five most abundant species were sensitive and/or insectivorous species. Three redhorse species, northern hogsucker, and multiple darter species were present in the sample. Few tolerant and generalist species were present. The sampling reach contained excellent habitat – extensive boulder riffles, deep pools, and a wide variety of cover types. The 2017 visit MIBI score was good. The sample contained 45 unique taxa, including several sensitive caddisfly taxa and numerous clinger taxa. The abundance of clinger taxa is supported by consistent flow and the availability of clean coarse substrate within the sampling reach. Water chemistry data indicate low levels of nutrients and sediment; however, bacteria levels consistently exceeded the standard during the summer months. This reach is impaired for aquatic recreation.

Eight lakes were assessed for aquatic recreation. Half of the lakes have good water quality and support aquatic recreation. Lakes Grandrud, Devils, and Hovland all had high phosphorus and Chl-a concentrations; thus, they do not support aquatic recreation. These basins are all-shallow and are susceptible to internal cycling of nutrients, which can drive algal blooms.

The fish community was used to assess aquatic life on Lakes Heilberger and Jewett. Heilberger Lake supported aquatic life based on the 2014 survey FIBI score. Insectivores made up 53% of trap net catch biomass, which positively impacted the FIBI score. The sample included the following species: hybrid sunfish, bluntnose minnow, bluegill, bowfin, and northern pike. Based on FIBI scores from surveys conducted in 2011 and 2014, Jewett Lake did not support aquatic life. Few tolerant species were captured; however, the low proportion of biomass from insectivores (10-20%) and top carnivores (44-51%) in gill nets negatively impacted the FIBI score. The sample included the following species: bluntnose minnow, bluegill, banded killifish, Iowa darter, yellow bullhead, and walleye.

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



Judicial Ditch No. 2 Aggregated HUC-12 HUC 0902010310-02

The Judicial Ditch No. 2 Subwatershed drains 68 square miles of land within the southwest portion of the Otter Tail River Watershed. The majority of this watershed is located within the Lake Agassiz Plain (LAP) ecoregion. The LAP ecoregion is very flat and features fertile soils formed by deposits from Glacial Lake Agassiz. For this reason, over 75 % of the land within the subwatershed is used for row crop agriculture. Most of the lakes within the subwatershed are located within the northeastern region, in the NCHF ecoregion. Many lakes are small (< 100 acres); some of the larger lakes (> 100 acres) include Oscar, Johnson, and Haldorsen. Judicial Ditch No. 2 originates in the far northwestern corner of the subwatershed, along the Wilkin and Otter Tail County border. The ditch flows south along the western edge of the subwatershed for 11.50 miles before emptying into the Otter Tail River. Most of this system is altered (straightened channel); only the last 0.8 miles are a natural channel. Numerous small, unnamed tributaries and ditches flow laterally from east to west across the subwatershed and drain into Judicial Ditch No. 2. Land use within the subwatershed is primarily cropland (76.2 %) followed by open water (6.0 %), rangeland (5.5 %), developed (4.9 %), wetland (4.4 %), and forest (2.9 %) (USGS 2011). In 2016, the MPCA collected biological samples from one monitoring station. Water chemistry was intensively monitored at one location within the Judicial Ditch No. 2 Subwatershed.

Table 20. Aquatic life and recreation assessments on stream reaches: Judicial Ditch No. 2 Aggregated HUC-12. Reaches are organized upstream to downstream in the table.

WID *Reach name,* *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-762 **Judicial Ditch 2,** *Unnamed ditch along 240th St to Unnamed ditch*		3.21	WWg	--	--	IF	IF	IF	MTS	MTS	MTS	IF	IF	IF
09020103-764, Judicial Ditch 2, *Unnamed ditch along 190th St to Otter Tail River*	16RD009	2.09	WWm	EXS	MTS	EXS	IF	MTS	MTS	MTS	MTS	IF	IMP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2020 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

Table 21. Lake assessments: Judicial Ditch No. 2 Aggregated HUC-12.

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		
Skogen Marsh	56-0977-00	41	--	Shallow Water	NCHF	--	--	--	--	IF	--	IF	--	IF
Johnson	56-0979-00	154	3	Shallow Water	NCHF	--	--	--	--	EXS	EXS	EXS	--	IMP
Oscar	56-0982-00	337	6	Shallow Water	NCHF	--	--	--	--	EXS	EXS	MTS	--	IMP
Haldorsen	56-0992-00	170	--	Shallow Water	NCHF	--	--	--	--	EXS	IF	MTS	--	IF

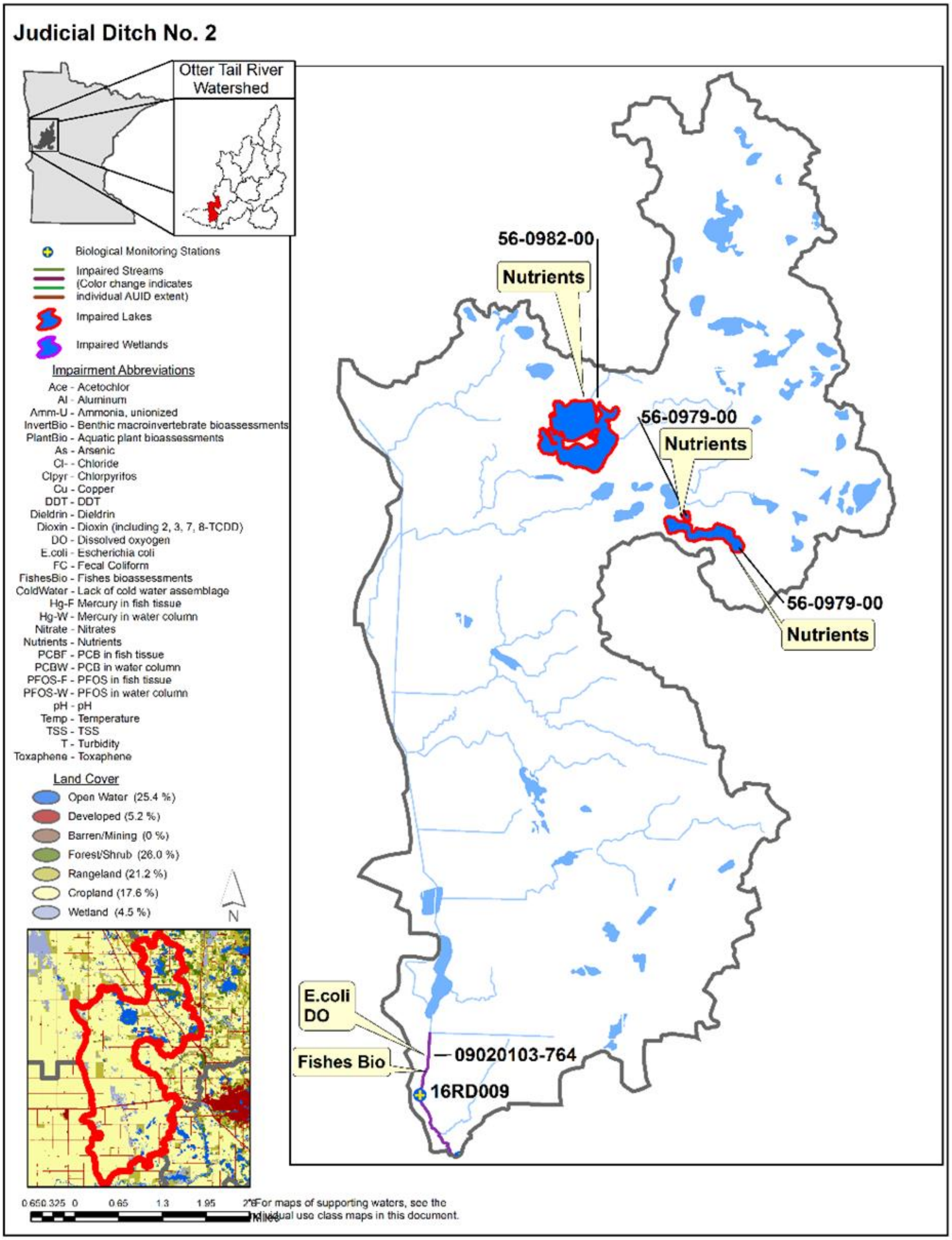
Abbreviations for Ecoregion: DA = Driftless Area, NCHF = North Central Hardwood Forest, NGP = Northern Glaciated Plains, NLF = Northern Lakes and Forests, NMW = Northern Minnesota Wetlands, RRV = Red River Valley, WCBP = Western Corn Belt Plains
Abbreviations for Secchi Trend: D = decreasing/declining trend, I = increasing/improving trend, NT = no detectable trend, -- = not enough data
Abbreviations for Indicator Evaluations: -- = No Data, **MTS** = Meets Standard; **EXS** = Exceeds Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Not Support (Impaired, exceeds standard)
Key for Cell Shading: = existing impairment, listed prior to 2020 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Summary

Station 16RD009 was located upstream of the CR 160 crossing on the segment of Judicial Ditch 2 that extends from the unnamed ditch along 190th St to the Otter Tail River. The 2016 visit FIBI score was poor. Only eight species of fish were collected and over 90% of the individuals in the sample were tolerant species. Habitat within the sampling reach was poor – no depth variability (entire reach consisted of a run), severely embedded coarse substrate, and sparse cover. A perched culvert at the CR 160 crossing restricts connectivity between most of Judicial Ditch 2 and the Otter Tail River. The 2016 visit MIBI score was fair. The sample contained only 28 taxa and over 80% of those taxa were tolerant. Water chemistry data indicate DO concentrations regularly exceed the standard; excess DO flux was evident in the data. *E.coli* concentrations also exceeded the standard. This reach is impaired for both aquatic life and aquatic recreation.

Four lakes were assessed for aquatic recreation. Skogen Marsh and Haldorsen Lake lacked sufficient data to make a use support determination. Lakes Johnson and Oscar were found to be impaired for aquatic recreation due to excess nutrients. Both lakes had high concentrations of phosphorus, which in turn causes high Chl-a concentrations and nuisance algal blooms. Additionally, their shallow depths allow mixing to occur throughout the water column during wind events. This mixing distributes nutrients throughout the water column and supports algal production.

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Judicial Ditch No. 2 Aggregated HUC-12.



Lower Otter Tail River Aggregated HUC-12 HUC 0902010310-01

The Lower Otter Tail River Subwatershed drains 115 square miles of land within the southwestern portion of the Otter Tail River Watershed. The final 34 miles of the Otter Tail River flow across this subwatershed prior to joining with the Bois de Sioux River and forming the Red River of the North. The entire subwatershed lies within the Lake Agassiz Plain (LAP) ecoregion. This remnant lakebed of Glacial Lake Agassiz is very flat and features fertile soils; as a result, almost 90% of the land within this subwatershed is used for row crop production. The flat topography and poor natural drainage typical of this ecoregion necessitated the creation of extensive drainage systems. The Otter Tail River enters the eastern side of the subwatershed immediately after exiting Orwell Reservoir. The river winds west for 8 miles and is joined by the tributary called Judicial Ditch No. 2. Judicial Ditch No. 2 drains a 68 square mile subwatershed located along the southwestern edge of the Otter Tail River Watershed. After joining with Judicial Ditch No. 2, the river continues winding west / northwest for 19 miles before entering an impoundment called Breckenridge Lake. Nearly all of the river, from Orwell Reservoir to Breckenridge Lake, has been altered (straightened). Numerous ditches and small tributary streams drain into the Otter Tail River along this entire reach. After exiting Breckenridge Lake, the river channel is natural, and it continues winding northwest for 3.2 miles before being joined by the tributary called County Ditch 3. County Ditch 3 flows primarily southwest along the western edge of the subwatershed. This ditch receives water from an extensive network of ditches that drain a large area across the northern half of the subwatershed. After joining with County Ditch 3, the Otter Tail River continues west and passes through Breckenridge before joining with the Bois de Sioux River. Land use within the subwatershed is primarily cropland (87.8 %) followed by development (5.9 %), rangeland (2.3 %), wetland (2.0 %), and open water (1.7 %) (USGS 2011). In 2016, the MPCA collected biological samples from three monitoring stations located on three stream segments. Water chemistry was intensively monitored at two locations within the Lower Otter Tail River Subwatershed.

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

WID ***Reach name,*** *Reach description*	Biological Station ID	Reach Length (miles)	Use Class*	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Eutrophication	Aquatic Life	Aquatic Rec. (Bacteria)
09020103-506 **Otter Tail River,** *Orwell Dam to JD 2*	91RD001	7.68	WWg	MTS	MTS	NA	NA	NA	MTS	NA	MTS	NA	SUP	IF
09020103-504 **Otter Tail River,** *JD 2 to Breckenridge Lake*	16RD008	18.66	WWg	MTS	EXS	IF	EXS	MTS	MTS	MTS	MTS	MTS	IMP	SUP
09020103-761 **Unnamed Creek,** *CD 3 to Otter Tail River*		2.76	WWg	--	--	IF	IF	MTS	MTS	MTS	MTS	IF	IF	IMP
09020103-502 **Otter Tail River,** *Breckenridge Lake to Bois de Sioux River*	10EM060, 16RD001	8.23	WWg	EXS	IF	MTS	EXS	EXS	MTS	MTS	MTS	MTS	IMP	SUP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2020 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.

Summary

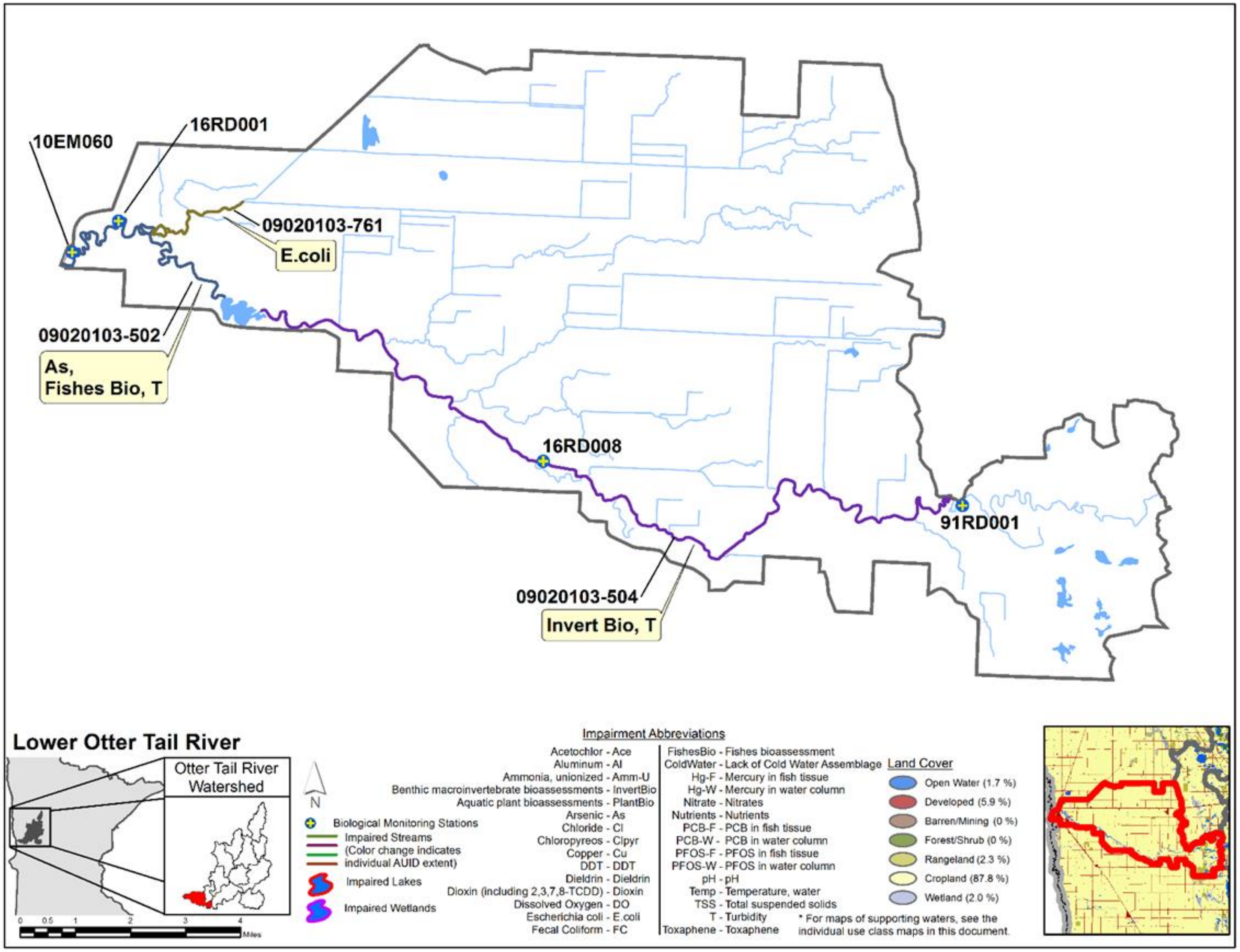
Station 91RD001 was located on the segment of the Otter Tail River that extends from Orwell Dam to Judicial Ditch 2. The 2017 sample FIBI score was the highest score in the Otter Tail River Watershed. The diverse fish sample contained 25 species of fish, including four redhorse species. Almost 70% of the individuals in the sample were insectivorous. When compared to other stations located on the Otter Tail River, fewer generalist and serial spawning species were collected at 91RD001. The sampling reach lacked riffle habitat; however, there were isolated patches of cobble and a fair amount of gravel substrate present. Cover types included undercut banks, large woody debris, and submergent aquatic vegetation. The 2017 visit MIBI score was good. The majority of the caddisfly taxa present within the sample were tolerant net spinners from the family Hydropsychidae. When compared to the other stations located downstream, more sensitive caddisfly and mayfly taxa were collected here.

Station 16RD008 was located on the segment of the Otter Tail River that extends from Judicial Ditch 2 to Breckenridge Lake. The 2017 visit FIBI score was exceptional. The fish sample contained 29 species and was one of the most diverse samples collected in the watershed. Many of these species were sensitive insectivores. This segment of the Otter Tail River has been channelized; therefore, stream habitat was relatively homogenous. The entire sampling reach consisted of a sand and gravel run with sparse patches of submergent vegetation. The 2017 visit MIBI score was poor. Poor diversity was present within the sample (only 23 taxa were collected) and most taxa were tolerant. This reach is impaired for aquatic life based on the MIBI score. This reach was also considered impaired for aquatic life in 2004 based on turbidity; more recent data indicate that TSS are high early in the season but meeting the standard during the warmer months. Phosphorus and DO data indicate good water quality is present later in the summer.

Stations 16RD001 and 10EM060 were located on the segment of the Otter Tail River that extends from Breckenridge Lake to the Bois de Sioux River. Station 16RD001 was located furthest upstream near the CSAH 16 crossing. The 2017 sample FIBI score was poor. The fish sample contained low numbers of insectivores and lithophilic spawners and was dominated by tolerant, generalist species. The stream habitat within the sampling reach was so poor macroinvertebrates could not be sampled. This station had the lowest MSHA score (35) of any station located on the Otter Tail River. The entire sampling reach consisted of a run with thick, lose sand and silt substrate. Station 10EM060 was located 0.6 miles upstream of the confluence of the Otter Tail River and Bois de Sioux River. This station was sampled in 2011 and 2015. The 2011 sample FIBI score was just below the impairment threshold. The sample contained 31 species and was the most diverse sample in the watershed. An unusually high number of black bullhead, a very tolerant species, was present in the sample. This sample was also collected later in the year following an extended period of high flow during the summer of 2011 so less emphasis was placed on this sample during assessments. The 2015 visit FIBI was exceptional. The sample contained a high number of insectivorous and piscivorous species. Both samples contained smallmouth buffalo, freshwater drum, and white bass – three species not collected at any other location during the IWM process. Compared to station 16RD001, more cover and coarse substrate was available at station 10EM060. This reach is impaired for aquatic life based on the FIBI score and poor habitat at station 16RD001. TSS also exceed the standard on this reach, resulting in an aquatic life impairment.

Water chemistry data indicate that downstream of JD (WID -504 and -502) the Otter Tail River fully supports aquatic recreation. The segment of the unnamed creek that extends from County Ditch 3 to the Otter Tail River contained high levels of *E. coli* bacteria and is impaired for aquatic recreation.

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



Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Otter Tail River Watershed, 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. Waters identified as priorities for protection or restoration work were also identified. 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 Otter Tail River Watershed.

Stream water quality

Thirty-one of the 231 stream reaches were assessed (Table 23). Of the assessed streams, 17 streams were considered to fully support aquatic life and 14 streams fully supported aquatic recreation. One stream was classified as a limited value resource water and assessed accordingly. Throughout the watershed, 16 stream reaches did not support aquatic life and/or recreation. Of those reaches, eight are non-supporting for aquatic life and eight are non-supporting for aquatic recreation.

Table 23. Assessment summary for stream water quality in the Otter Tail River Watershed.

				Supporting		Non-supporting			
Watershed	Area (acres)	# Total WIDs	# Assessed WIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	# Delistings
09020103	**1,222,038**	**231**	**31**	**17**	**14**	**8**	**8**	**12 AL, 7 AR**	**0 AL, 0 AR**
0902010301-01	116,982	30	6	4	4	0	0	1 AL, 1 AR	0 AL, 0 AR
0902010302-01	132,347	5	3	1	3	1	0	1 AL	0 AL, 0 AR
0902010303-01	71,093	103	4	2	0	1	3	5 AL, 3 AR	0 AL, 0 AR
0902010306-01	153,757	16	2	2	1	0	0	0 AL, 0 AR	0 AL, 0 AR
0902010304-01	95,469	1	0	0	0	0	0	0 AL, 0 AR	0 AL, 0 AR
0902010305-01	104,146	9	1	1	0	0	0	0 AL, 0 AR	0 AL, 0 AR
0902010309-01	114,759	15	4	3	3	0	1	2 AL, 0 AR	0 AL, 0 AR
0902010307-02	98,840	30	3	1	0	2	1	1 AL, 0 AR	0 AL, 0 AR
0902010307-01	118,891	5	0	0	0	0	0	0 AL, 1 AR	0 AL, 0 AR
0902010308-01	*98,041*	7	3	2	1	1	1	0 AL, 0 AR	0 AL, 0 AR

Watershed	Area (acres)	# Total WIDs	# Assessed WIDs	Supporting # Aquatic Life	Supporting # Aquatic Recreation	Non-supporting # Aquatic Life	Non-supporting # Aquatic Recreation	Insufficient Data	# Delistings
0902010310-02	43,731	4	1	0	0	1	1	1 AL, 1 AR	0 AL, 0 AR
0902010310-01	73,976	6	4	1	2	2	1	1 AL, 1 AR	0 AL, 0 AR

Lake water quality

Two hundred and twenty-nine lakes greater than ten acres were assessed; 68 fully supported aquatic life and 174 supported aquatic recreation (Table 24). Twelve lakes did not support aquatic life and 17 did not support aquatic recreation. Additionally, 67 lakes had insufficient data to make an assessment.

Table 24. Assessment summary for lake water chemistry in the Otter Tail River Watershed.

Watershed	Area (acres)	Lakes >10 acres (assessed)	Supporting # Aquatic Life	Supporting # Aquatic Recreation	Non-supporting # Aquatic Life	Non-supporting # Aquatic Recreation	Insufficient Data	# Delistings
09020103 **HUC 8**	**1,222,038**	**229**	**68**	**174**	**12**	**17**	**67**	**0**
0902010301-01	116,982	28	8	17	0	4	16	0
0902010302-01	132,347	32	11	32	3	1*	5	0
0902010303-01	71,093	2	0	2	0	0	2	0
0902010304-01	95,469	27	5	25	3	0	6	0
0902010305-01	104,146	23	9	17	0	0	6	0
0902010306-01	153,757	15	4	9	0	2	5	0
0902010307-01	118,891	25	10	22	2	0	8	0
0902010307-02	98,840	32	14	27	1	2	3	0
0902010308-01	98,041	10	1	5	1	3	3	0
0902010309-01	114,759	31	6	18	2	4	12	0
0902010310-01	73,976	0	--	--	--	--	--	--
0902010310-02	43,731	4	0	0	0	2	2	0

* **This was a previous impairment from 2008; this waterbody was not assessed in 2018.**

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) have been analyzed in fish tissue samples collected from the Otter Tail River and 66 lakes in the watershed. Samples were collected by DNR fisheries staff from 1970 to 2017 and MPCA biomonitoring staff collected fish from the Otter Tail River in 2017.

Forty-eight of the 66 tested lakes are on the 2018 Impaired Waters Inventory (IWI) for mercury in fish tissue (Table 25). Thirty-six of the lakes on the IWI qualified for inclusion in the Minnesota Statewide Mercury TMDL.

PCBs were tested in representative species from 30 lakes and the Otter Tail River. PCB concentrations were mostly less than the reporting limits. White Sucker and Common carp in Dayton Hollow Reservoir (56-0824-00) had PCB concentrations above the 0.2-ppm threshold for impairment in 1978, but when tested again in 1989 the four tested species (including carp) were below or very near the detection limit of 0.05 ppm. No other PCB results exceeded the impairment threshold.

Table 25. Fish contaminants table.

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
DOWID	Waterway	Species	Year	Anatomy[1]	Fish	Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
09020103-502	**OTTER TAIL R.**	Common Carp	2017	FILSK	3	3	18.9	18.6	19.0	0.400	0.313	0.451	3	0.025	0.025	Y
		Channel catfish	2017	FILSK	2	2	13.5	11.9	15.0	0.296	0.286	0.305	2	0.025	0.025	Y
		Golden redhorse	2017	FILSK	2	2	13.9	12.4	15.3	0.293	0.124	0.461	2	0.025	0.025	Y
		Silver redhorse	2017	FILSK	1	1	13.7	13.7	13.7	0.100	0.100	0.100	1	0.025	0.025	Y
		Walleye	2017	FILSK	1	1	12.3	12.3	12.3	0.380	0.380	0.380				
03-0107-00	**TOAD***	Black bullhead	1991	FILET	4	1	10.8	10.8	10.8	0.031	0.031	0.031				
		Black crappie	1991	FILSK	1	1	11.2	11.2	11.2	0.090	0.090	0.090	1	0.01	0.01	Y
			2006	FILSK	8	1	10.1	10.1	10.1	0.082	0.082	0.082				
			2016	FILSK	4	1	9.9	9.9	9.9	0.058	0.058	0.058				
		Bluegill sunfish	1991	FILSK	17	3	8.1	6.8	9.6	0.041	0.033	0.046	2	0.01	0.01	Y
			2016	FILSK	4	1	7.3	7.3	7.3	0.052	0.052	0.052				
		Common Carp	1991	FILSK	1	1	33.0	33.0	33.0	0.140	0.140	0.140	1	0.01	0.01	Y
		Largemouth bass	2006	FILSK	5	5	11.7	9.1	13.5	0.106	0.064	0.149				
			2016	FILSK	6	6	12.6	10.2	14.3	0.119	0.073	0.160				
		Northern pike	1991	FILSK	22	7	23.0	18.5	31.6	0.114	0.043	0.210	6	0.01	0.01	Y
			2001	FILSK	20	20	19.7	13.6	27.0	0.132	0.049	0.257				
			2006	FILSK	18	18	20.5	14.8	26.8	0.138	0.084	0.361				
			2011	FILSK	14	14	21.1	16.6	26.6	0.119	0.057	0.203				
			2016	FILSK	7	7	23.2	17.0	28.9	0.166	0.069	0.391				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Toad (continued)		Walleye	1991	FILSK	21	9	17.1	11.3	24.5	0.212	0.085	0.500	8	0.01	0.01	Y
			2006	FILSK	7	7	19.6	13.5	26.8	0.209	0.093	0.420				
			2016	FILSK	8	8	18.7	14.4	22.4	0.205	0.080	0.329				
		White sucker	1991	FILSK	7	3	19.4	17.6	20.3	0.063	0.044	0.077	3	0.01	0.01	Y
		Yellow bullhead	1991	FILET	7	3	11.5	11.2	11.7	0.180	0.160	0.200	3	0.01	0.01	Y
		Yellow perch	2001	WHORG	7	2	6.0	5.6	6.4	0.022	0.020	0.024				
			2006	WHORG	10	4	6.2	5.6	7.4	0.042	0.030	0.051				
03-0153-00	**ISLAND***	Bluegill sunfish	2007	FILSK	12	1	7.9	7.9	7.9	0.022	0.022	0.022				
			2017	FILSK	1	1	8.5	8.5	8.5	0.030	0.030	0.030				
		Northern pike	2007	FILSK	4	4	21.6	20.0	25.0	0.136	0.120	0.160				
			2017	FILSK	6	6	19.6	17.0	20.5	0.159	0.094	0.236				
		Smallmouth bass	2007	FILSK	5	5	14.4	10.5	17.3	0.161	0.078	0.344				
		Walleye	2007	FILSK	5	5	19.3	16.6	24.0	0.219	0.139	0.418				
			2017	FILSK	4	4	14.7	10.7	17.2	0.098	0.043	0.149				
		White sucker	2007	FILSK	5	1	17.8	17.8	17.8	0.030	0.030	0.030				
			2017	FILSK	1	1	19.0	19.0	19.0	0.016	0.016	0.016				
		Yellow perch	2007	FILSK	8	1	10.2	10.2	10.2	0.071	0.071	0.071				
03-0155-00	**ROUND**	Black crappie	2015	FILSK	4	1	10.8	10.8	10.8	0.064	0.064	0.064				
		Bluegill sunfish	2015	FILSK	10	1	6.5	6.5	6.5	0.042	0.042	0.042				
		Largemouth bass	2015	FILSK	8	8	13.3	12.5	14.6	0.151	0.112	0.198				
		Northern pike	2015	FILSK	8	8	20.6	16.6	25.4	0.150	0.074	0.247				
		Walleye	2015	FILSK	8	8	15.8	11.5	21.7	0.145	0.084	0.189				
		White sucker	2015	FILSK	5	1	16.9	16.9	16.9	0.027	0.027	0.027				
03-0158-00	**MANY POINT**	Bluegill sunfish	1993	FILSK	9	1	7.5	7.5	7.5	0.043	0.043	0.043				
			2001	FILSK	6	1	7.0	7.0	7.0	0.020	0.020	0.020				
			2013	FILSK	9	2	7.1	6.7	7.5	0.058	0.042	0.073				
		Bowfin (dogfish)	2001	FILSK	2	1	24.3	24.3	24.3	0.574	0.574	0.574	1	0.01	0.01	Y
		Cisco (Lake herring)	2013	FILSK	3	1	12.2	12.2	12.2	0.032	0.032	0.032				
		Northern pike	1993	FILSK	23	5	23.0	12.7	38.1	0.196	0.061	0.500	2	0.0175	0.025	
			2013	FILSK	8	8	19.9	18.0	21.7	0.256	0.171	0.397				
		Walleye	1993	FILSK	17	4	16.8	11.7	22.2	0.200	0.100	0.290	1	0.011	0.011	Y
			2013	FILSK	6	6	16.3	12.5	21.3	0.259	0.164	0.463				
		White sucker	1993	FILSK	7	1	16.2	16.2	16.2	0.016	0.016	0.016	1	0.01	0.01	Y
03-0159-00	**ELBOW**	Sunfish family	2003	FILSK	4	1	7.1	7.1	7.1	0.080	0.080	0.080				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Elbow (continued)		Bluegill sunfish	2015	FILSK	10	1	7.0	7.0	7.0	0.067	0.067	0.067				
		Cisco (Lake herring)	2003	FILSK	5	1	15.9	15.9	15.9	0.153	0.153	0.153				
			2015	FILSK	5	1	13.5	13.5	13.5	0.055	0.055	0.055				
		Northern pike	2003	FILSK	6	6	23.7	18.1	30.3	0.353	0.263	0.641				
			2012	FILSK	15	15	20.1	14.8	26.6	0.228	0.132	0.370				
			2015	FILSK	8	8	23.9	18.6	36.2	0.377	0.259	0.743				
		Walleye	2003	FILSK	5	5	19.3	16.9	22.4	0.504	0.427	0.627				
			2015	FILSK	8	8	19.8	15.2	27.2	0.485	0.210	0.929				
		White sucker	2003	FILSK	3	1	17.1	17.1	17.1	0.070	0.070	0.070				
		Yellow perch	2003	FILSK	2	1	10.9	10.9	10.9	0.181	0.181	0.181				
03-0195-00	**HEIGHT OF LAND***	Bluegill sunfish	2010	FILSK	10	2	7.6	7.0	8.2	0.037	0.034	0.039				
		Northern pike	2010	FILSK	8	8	20.4	16.9	30.3	0.136	0.095	0.253				
		Walleye	2010	FILSK	8	8	17.5	11.4	26.9	0.091	0.046	0.194				
		White sucker	2010	FILSK	5	1	16.8	16.8	16.8	0.032	0.032	0.032				
03-0286-00	**COTTON***	Black crappie	2007	FILSK	10	1	10.0	10.0	10.0	0.072	0.072	0.072				
			2016	FILSK	5	1	10.0	10.0	10.0	0.058	0.058	0.058				
		Bluegill sunfish	1991	FILSK	10	1	6.7	6.7	6.7	0.042	0.042	0.042				
			2007	FILSK	10	1	7.3	7.3	7.3	0.051	0.051	0.051				
			2016	FILSK	10	1	7.3	7.3	7.3	0.035	0.035	0.035				
		Largemouth bass	2016	FILSK	5	5	14.0	13.0	15.3	0.101	0.082	0.126				
		Northern pike	1991	FILSK	21	5	22.6	13.5	30.9	0.295	0.057	0.470	3	0.01	0.01	Y
			2016	FILSK	4	4	18.8	16.8	21.2	0.084	0.050	0.153				
		Walleye	1991	FILSK	21	4	19.7	13.4	27.7	0.220	0.088	0.440	3	0.01	0.01	Y
			2016	FILSK	5	5	17.5	14.1	22.7	0.104	0.070	0.131				
		White sucker	1991	FILSK	12	2	15.3	12.7	17.9	0.036	0.020	0.051	1	0.01	0.01	Y
			2016	FILSK	5	1	17.6	17.6	17.6	0.015	0.015	0.015				
		Yellow perch	2016	FILSK	10	1	8.9	8.9	8.9	0.040	0.040	0.040				
03-0287-00	**PICKEREL**	Black crappie	2017	FILSK	1	1	11.3	11.3	11.3	0.040	0.040	0.040				
		Bluegill sunfish	2017	FILSK	4	1	8.1	8.1	8.1	0.077	0.077	0.077				
		Largemouth bass	2017	FILSK	2	2	14.7	13.3	16.1	0.271	0.165	0.377				
		Northern pike	2017	FILSK	8	8	19.8	16.8	24.0	0.138	0.082	0.280				
		Walleye	2017	FILSK	8	8	17.3	13.9	20.0	0.250	0.109	0.538				
		White sucker	2017	FILSK	5	1	17.9	17.9	17.9	0.070	0.070	0.070				
03-0359-00	**SALLIE***	Bluegill sunfish	2014	FILSK	10	1	7.2	7.2	7.2	0.084	0.084	0.084				

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
DOWID	Waterway	Species	Year	Anatomy[1]	Fish	Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Sallie (continued)		Largemouth bass	2007	FILSK	7	7	12.2	6.6	15.0	0.192	0.068	0.266				
		Northern pike	1970	PLUG	2	2	19.5	18.8	20.2	0.265	0.200	0.330				
			1984	FILSK	5	1	21.2	21.2	21.2	0.240	0.240	0.240				
			2014	FILSK	8	8	25.9	20.1	30.6	0.361	0.185	0.621				
		Walleye	1970	FILSK	1	1	12.3	12.3	12.3	0.370	0.370	0.370				
			1984	FILSK	5	1	17.4	17.4	17.4	0.380	0.380	0.380				
			2007	FILSK	3	3	14.2	10.2	20.0	0.129	0.099	0.185				
			2014	FILSK	8	8	17.7	14.6	21.3	0.319	0.254	0.470				
		White sucker	1970	PLUG	2	2	20.5	19.6	21.3	0.235	0.150	0.320				
			1984	FILSK	5	1	17.2	17.2	17.2	0.060	0.060	0.060				
03-0360-00	**MUSKRAT***	Black crappie	2016	FILSK	5	1	8.9	8.9	8.9	0.243	0.243	0.243				
		Bluegill sunfish	1993	FILSK	10	1	6.8	6.8	6.8	0.140	0.140	0.140				
			2016	FILSK	10	1	7.0	7.0	7.0	0.157	0.157	0.157				
		Northern pike	1993	FILSK	18	5	23.6	17.0	30.2	0.502	0.420	0.690	1	0.01	0.01	1
			2016	FILSK	7	7	22.5	18.1	25.8	0.460	0.308	0.566				
		Walleye	2016	FILSK	1	1	18.5	18.5	18.5	0.302	0.302	0.302				
03-0381-00	**DETROIT***	Black crappie	2015	FILSK	7	1	9.3	9.3	9.3	0.159	0.159	0.159				
		Bluegill sunfish	1992	FILSK	10	1	6.6	6.6	6.6	0.078	0.078	0.078				
			2015	FILSK	10	1	6.9	6.9	6.9	0.055	0.055	0.055				
		Largemouth bass	2015	FILSK	3	3	12.6	12.3	12.8	0.247	0.222	0.276				
		Northern pike	1992	FILSK	32	5	22.7	14.0	33.6	0.372	0.260	0.510	1	0.014	0.014	
			2015	FILSK	8	8	23.5	19.7	26.8	0.354	0.238	0.466				
		Walleye	1992	FILSK	24	3	16.6	11.9	21.1	0.350	0.160	0.610	1	0.019	0.019	
			2015	FILSK	8	8	18.5	15.6	21.7	0.430	0.287	0.676				
		White sucker	1992	FILSK	11	2	19.6	17.8	21.3	0.064	0.058	0.070	1	0.01	0.01	Y
			2015	FILSK	2	1	17.3	17.3	17.3	0.033	0.033	0.033				
03-0383-00	**LONG**	Bluegill sunfish	2011	FILSK	10	2	7.9	7.6	8.1	0.125	0.121	0.129				
		Cisco (Lake herring)	2011	FILSK	5	1	18.2	18.2	18.2	0.213	0.213	0.213				
		Northern pike	2011	FILSK	8	8	24.5	19.1	30.2	0.433	0.304	0.756				
		Walleye	2011	FILSK	8	8	17.5	14.1	24.5	0.482	0.372	0.689				
		White sucker	2011	FILSK	5	1	18.5	18.5	18.5	0.041	0.041	0.041				
03-0386-00	**LITTLE FLOYD****	Bluegill sunfish	1996	FILSK	10	1	6.2	6.2	6.2	0.070	0.070	0.070				
		Cisco (Lake herring)	1996	FILSK	7	1	16.9	16.9	16.9	0.210	0.210	0.210	1	0.01	0.01	Y
		Northern pike	1996	FILSK	27	6	23.0	15.0	32.8	0.362	0.190	0.530	1	0.01	0.01	Y

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Little Floyd (continued)		Walleye	1996	FILSK	14	4	18.9	10.7	25.2	0.540	0.200	0.910	1	0.01	0.01	Y
03-0387-00	**FLOYD**	Black bullhead	2016	FILET	3	1	11.8	11.8	11.8	0.057	0.057	0.057				
		Black crappie	2016	FILSK	5	1	11.0	11.0	11.0	0.152	0.152	0.152				
		Bluegill sunfish	1996	FILSK	10	1	6.5	6.5	6.5	0.059	0.059	0.059				
			2016	FILSK	10	1	7.8	7.8	7.8	0.120	0.120	0.120				
		Brown bullhead	2016	FILET	3	1	13.5	13.5	13.5	0.030	0.030	0.030				
		Largemouth bass	2016	FILSK	15	5	13.3	11.4	15.3	0.454	0.314	0.559				
		Northern pike	1996	FILSK	30	6	23.3	15.0	31.6	0.417	0.180	0.700				
			2016	FILSK	5	5	22.9	18.8	27.8	0.452	0.236	0.802				
		Walleye	1996	FILSK	19	5	18.5	12.7	25.3	0.442	0.170	0.710	1	0.01	0.01	Y
			2016	FILSK	5	5	18.0	16.2	18.9	0.433	0.354	0.503				
		White sucker	1996	FILSK	8	1	20.1	20.1	20.1	0.047	0.047	0.047				
			2016	FILSK	5	1	18.5	18.5	18.5	0.049	0.049	0.049				
		Yellow bullhead	2016	FILET	2	1	12.4	12.4	12.4	0.288	0.288	0.288				
03-0475-00	**MELISSA****	Black crappie	2004	FILSK	7	1	10.7	10.7	10.7	0.176	0.176	0.176				
		Bluegill sunfish	2004	FILSK	9	1	7.0	7.0	7.0	0.048	0.048	0.048				
			2014	FILSK	10	1	7.2	7.2	7.2	0.061	0.061	0.061				
		Brown bullhead	2004	FILET	4	1	13.6	13.6	13.6	0.040	0.040	0.040				
		Hybrid sunfish	2004	FILSK	2	1	7.4	7.4	7.4	0.078	0.078	0.078				
		Largemouth bass	2004	FILSK	3	3	15.0	13.4	17.8	0.414	0.207	0.807				
		Northern pike	2004	FILSK	5	5	26.1	22.7	29.0	0.328	0.156	0.592				
			2014	FILSK	8	8	23.7	18.6	32.3	0.317	0.200	0.494				
		Walleye	2004	FILSK	5	5	20.3	17.0	25.0	0.334	0.270	0.390				
			2014	FILSK	7	7	16.1	13.7	18.5	0.194	0.161	0.224				
		White sucker	2004	FILSK	2	1	18.8	18.8	18.8	0.073	0.073	0.073				
			2014	FILSK	5	1	17.1	17.1	17.1	0.064	0.064	0.064				
		Yellow bullhead	2004	FILET	3	1	12.3	12.3	12.3	0.237	0.237	0.237				
03-0489-00	**LOON**	Bluegill sunfish	2007	FILSK	11	1	7.1	7.1	7.1	0.098	0.098	0.098				
03-0500-00	**MAUD****	Bluegill sunfish	2010	FILSK	10	2	7.4	7.0	7.7	0.093	0.073	0.113				
			2016	FILSK	10	1	7.1	7.1	7.1	0.132	0.132	0.132				
		Largemouth bass	2010	FILSK	8	8	14.4	13.3	15.6	0.558	0.390	0.809				
			2016	FILSK	7	7	14.2	11.5	16.2	0.604	0.351	0.837				
		Northern pike	2010	FILSK	8	8	22.6	17.3	29.5	0.587	0.332	1.389				
			2016	FILSK	8	8	19.2	14.2	26.8	0.329	0.172	0.592				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Maud (continued)		Pumpkinseed sunfish	2016	FILSK	10	1	6.8	6.8	6.8	0.059	0.059	0.059				
		Walleye	2010	FILSK	8	8	23.8	20.5	27.9	0.909	0.454	1.688				
			2016	FILSK	4	4	21.4	18.0	26.6	0.795	0.437	1.386				
		Yellow bullhead	2010	FILET	5	1	11.6	11.6	11.6	0.490	0.490	0.490				
			2016	FILET	2	1	7.6	7.6	7.6	0.046	0.046	0.046				
03-0506-00	**LITTLE CORMORANT**	Bluegill sunfish	2017	FILSK	6	1	7.2	7.2	7.2	0.081	0.081	0.081				
		Largemouth bass	2017	FILSK	4	4	13.4	10.0	15.0	0.446	0.173	0.645				
		Northern pike	2017	FILSK	5	5	25.4	20.5	28.9	0.470	0.345	0.577				
		Walleye	2017	FILSK	1	1	27.0	27.0	27.0	1.024	1.024	1.024				
		White sucker	2017	FILSK	1	1	18.9	18.9	18.9	0.050	0.050	0.050				
03-0575-00	**LEIF****	Bluegill sunfish	2008	FILSK	10	3	7.2	7.0	7.5	0.189	0.160	0.244				
		Common Carp	2008	FILSK	8	2	25.5	23.0	27.9	0.083	0.081	0.084				
		Largemouth bass	2008	FILSK	5	5	13.6	10.1	16.4	0.458	0.297	0.586				
		Northern pike	2008	FILSK	7	7	22.6	18.1	28.1	0.367	0.279	0.411				
		Walleye	2008	FILSK	8	8	19.3	14.7	24.5	0.651	0.340	1.044				
03-0576-00	**BIG CORMORANT***	Bluegill sunfish	1990	FILSK	10	1	6.8	6.8	6.8	0.056	0.056	0.056	1	0.01	0.01	Y
		Common Carp	1990	FILSK	7	2	23.5	21.1	25.8	0.061	0.039	0.082	2	0.027	0.044	
		Northern pike	1990	FILSK	1	1	34.4	34.4	34.4	0.480	0.480	0.480	1	0.01	0.01	Y
			2008	FILSK	23	23	19.8	13.0	32.3	0.198	0.048	0.610				
			2014	FILSK	12	12	20.1	14.8	24.0	0.296	0.100	0.522				
		Walleye	1990	FILSK	22	4	19.4	12.6	27.0	0.448	0.140	1.000	4	0.01325	0.023	
		White sucker	1990	FILSK	16	2	14.0	10.9	17.1	0.043	0.028	0.057	1	0.01	0.01	Y
		Yellow perch	2008	WHORG	10	2	6.5	5.6	7.4	0.031	0.027	0.034				
03-0582-00	**IDA***	Black crappie	2013	FILSK	4	1	8.2	8.2	8.2	0.052	0.052	0.052				
		Bluegill sunfish	1993	FILSK	10	1	7.0	7.0	7.0	0.058	0.058	0.058				
			2013	FILSK	5	1	7.6	7.6	7.6	0.063	0.063	0.063				
		Largemouth bass	2013	FILSK	3	3	14.1	10.8	17.1	0.240	0.151	0.351				
		Northern pike	1993	FILSK	20	4	24.8	18.4	34.3	0.203	0.110	0.450	1	0.01	0.01	Y
			2013	FILSK	7	7	23.8	18.5	34.2	0.290	0.113	0.708				
		Walleye	1993	FILSK	24	3	17.5	12.6	22.4	0.159	0.078	0.290	1	0.01	0.01	Y
			2013	FILSK	6	6	19.2	17.7	20.4	0.242	0.162	0.349				
		White sucker	1993	FILSK	6	1	19.1	19.1	19.1	0.030	0.030	0.030				
		Yellow bullhead	2013	FILET	5	1	12.1	12.1	12.1	0.139	0.139	0.139				
03-0588-00	**UPPER CORMORANT**	Black crappie	2012	FILSK	8	2	8.2	6.4	9.9	0.135	0.035	0.234				

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
DOWID	Waterway	Species	Year	Anatomy[1]	Fish	Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Upper Cormorant (continued)		Bluegill sunfish	2012	FILSK	10	2	7.3	6.4	8.1	0.098	0.082	0.113				
		Common Carp	2012	FILSK	1	1	27.4	27.4	27.4	0.141	0.141	0.141				
		Largemouth bass	2012	FILSK	4	4	13.0	9.8	16.3	0.266	0.120	0.466				
		Northern pike	2012	FILSK	5	5	20.9	18.2	24.1	0.241	0.147	0.381				
		Walleye	2012	FILSK	5	5	19.5	14.5	28.2	0.383	0.154	0.743				
56-0130-00	**BIG PINE***	Bluegill sunfish	2011	FILSK	10	2	8.1	7.2	9.0	0.070	0.069	0.071				
		Cisco (Lake herring)	1996	FILSK	1	1	14.3	14.3	14.3	0.067	0.067	0.067	1	0.01	0.01	Y
		Northern pike	1996	FILSK	15	4	25.1	18.7	33.2	0.161	0.085	0.250	1	0.01	0.01	Y
		Walleye	1996	FILSK	26	4	17.6	10.9	24.1	0.216	0.045	0.450				
			2011	FILSK	8	8	18.4	14.5	23.1	0.180	0.102	0.312				
		Yellow perch	1996	FILSK	10	1	7.5	7.5	7.5	0.049	0.049	0.049				
56-0138-00	**EAST BATTLE****	Bluegill sunfish	1996	FILSK	8	1	6.3	6.3	6.3	0.069	0.069	0.069				
			2013	FILSK	9	2	7.2	6.8	7.6	0.067	0.066	0.067				
		Northern pike	1996	FILSK	16	3	20.9	16.0	25.3	0.497	0.300	0.710				
		Walleye	1996	FILSK	21	5	19.4	13.2	25.3	0.586	0.230	0.860	1	0.01	0.01	Y
			2013	FILSK	8	8	17.3	13.6	21.5	0.535	0.369	0.885				
		White sucker	1996	FILSK	3	1	21.4	21.4	21.4	0.100	0.100	0.100				
56-0141-00	**RUSH***	Bluegill sunfish	1992	FILSK	10	1	7.1	7.1	7.1	0.044	0.044	0.044				
			2010	FILSK	10	2	6.9	6.4	7.3	0.029	0.026	0.032				
			2016	FILSK	10	1	7.4	7.4	7.4	0.037	0.037	0.037				
		Common Carp	1992	FILSK	6	2	24.3	22.3	26.3	0.135	0.099	0.170	2	0.017	0.019	
		Northern pike	1992	FILSK	18	3	22.6	18.2	27.1	0.184	0.093	0.320	1	0.01	0.01	Y
		Walleye	1992	FILSK	13	3	17.4	12.8	22.6	0.213	0.100	0.400	1	0.01	0.01	Y
			2010	FILSK	8	8	16.6	14.3	19.6	0.179	0.146	0.214				
			2016	FILSK	8	8	16.3	14.6	21.4	0.246	0.150	0.457				
		White sucker	1992	FILSK	8	1	16.2	16.2	16.2	0.027	0.027	0.027				
		Yellow bullhead	2010	FILET	5	1	11.2	11.2	11.2	0.113	0.113	0.113				
56-0142-00	**LITTLE PINE***	Bluegill sunfish	2011	FILSK	10	2	8.5	8.0	8.9	0.064	0.041	0.087				
		Cisco (Lake herring)	1999	FILSK	5	1	14.1	14.1	14.1				1	0.01	0.01	Y
		Northern pike	1999	FILSK	8	8	24.1	19.2	39.5	0.193	0.100	0.380	1	0.01	0.01	Y
		Walleye	1999	FILSK	8	8	15.7	12.7	22.5	0.244	0.160	0.410	1	0.01	0.01	Y
			2011	FILSK	8	8	17.5	13.7	21.0	0.296	0.181	0.511				
		Yellow perch	1999	FILSK	8	1	8.7	8.7	8.7	0.130	0.130	0.130				
56-0191-00	**STUART**	Bluegill sunfish	2006	FILSK	10	1	7.4	7.4	7.4	0.100	0.100	0.100				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in) Mean	Length (in) Min	Length (in) Max	Mercury (mg/kg) Mean	Mercury (mg/kg) Min	Mercury (mg/kg) Max	PCBs (mg/kg) N	PCBs (mg/kg) Mean	PCBs (mg/kg) Max	PCBs (mg/kg) < RL
Stuart (continued)			2015	FILSK	10	1	7.3	7.3	7.3	0.111	0.111	0.111				
		Walleye	2006	FILSK	5	5	18.8	16.4	21.5	0.610	0.427	0.729				
			2015	FILSK	4	4	18.8	14.7	22.0	0.425	0.392	0.456				
56-0209-00	**BUCHANAN***	Bluegill sunfish	2008	FILSK	10	1	7.1	7.1	7.1	0.164	0.164	0.164				
		Northern pike	2008	FILSK	5	5	20.7	19.3	22.3	0.454	0.373	0.549				
56-0229-00	**MURPHY***	Bluegill sunfish	2007	FILSK	10	1	7.5	7.5	7.5	0.021	0.021	0.021				
		Northern pike	2007	FILSK	6	6	20.0	15.9	27.9	0.165	0.096	0.376				
56-0238-00	**CLITHERALL***		1990	FILSK	2	1	11.1	11.1	11.1	0.290	0.290	0.290	1	0.01	0.01	Y
		Black bullhead	1990	FILET	4	1	12.0	12.0	12.0	0.190	0.190	0.190	1	0.01	0.01	Y
		Bluegill sunfish	1990	FILSK	10	1	6.4	6.4	6.4	0.045	0.045	0.045	1	0.01	0.01	Y
			2012	FILSK	10	2	7.8	7.3	8.3	0.060	0.057	0.062				
		Common Carp	1990	FILSK	8	1	21.5	21.5	21.5	0.024	0.024	0.024	1	0.01	0.01	Y
		Northern pike	1990	FILSK	13	3	22.8	18.6	27.6	0.243	0.160	0.320	3	0.013	0.019	
			2012	FILSK	7	7	22.7	18.7	31.2	0.438	0.315	0.608				
		Walleye	1990	FILSK	11	3	19.3	13.2	26.7	0.447	0.200	0.690	3	0.01	0.01	Y
		White sucker	1990	FILSK	11	2	14.7	11.9	17.4	0.029	0.020	0.037	2	0.01	0.01	Y
		Yellow bullhead	2012	FILET	5	1	13.9	13.9	13.9	0.209	0.209	0.209				
56-0239-00	**WEST BATTLE***	Bluegill sunfish	1995	FILSK	8	1	6.5	6.5	6.5	0.044	0.044	0.044				
			2010	FILSK	5	1	6.8	6.8	6.8	0.050	0.050	0.050				
		Largemouth bass	1995	FILSK	3	1	11.6	11.6	11.6	0.200	0.200	0.200				
		Northern pike	1995	FILSK	23	5	21.5	13.5	31.2	0.323	0.085	0.670	1	0.01	0.01	Y
		Walleye	1995	FILSK	10	3	18.7	15.4	22.4	0.457	0.270	0.690				
			2010	FILSK	8	8	15.7	12.1	22.8	0.340	0.234	0.524				
		White sucker	1995	FILSK	5	1	20.8	20.8	20.8	0.072	0.072	0.072				
		Yellow bullhead	2010	FILET	5	1	11.2	11.2	11.2	0.153	0.153	0.153				
56-0240-00	**BLANCHE***	Bluegill sunfish	2010	FILSK	10	2	7.3	6.9	7.7	0.054	0.040	0.067				
		Walleye	2010	FILSK	8	8	15.8	12.8	19.6	0.277	0.175	0.491				
		Yellow bullhead	2010	FILET	5	1	12.3	12.3	12.3	0.272	0.272	0.272				
56-0242-00	**OTTER TAIL***	Bluegill sunfish	2007	FILSK	5	1	7.4	7.4	7.4	0.018	0.018	0.018				
		Largemouth bass	2007	FILSK	7	7	11.3	8.7	14.1	0.162	0.046	0.335				
		Northern pike	1970	PLUG	2	2	27.5	22.0	33.0	0.430	0.390	0.470				
			1984	FILSK	5	1	20.6	20.6	20.6	0.200	0.200	0.200				
			1989	FILSK	6	2	21.9	17.0	26.7	0.370	0.300	0.440	2	0.05	0.05	Y
		Shorthead redhorse	1970	PLUG	2	2	17.7	15.5	19.8	0.460	0.040	0.880				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Otter Tail (continued)			1984	FILSK	5	1	19.4	19.4	19.4	0.220	0.220	0.220				
		Walleye	1970	PLUG	18	18	10.7	6.4	13.1	0.055	0.050	0.110				
			1971	PLUG	20	20	23.1	19.2	28.4	0.708	0.280	1.300				
			1984	FILSK	5	1	16.4	16.4	16.4	0.370	0.370	0.370				
			1989	FILSK	15	5	18.5	13.1	24.0	0.546	0.250	0.940	5	0.05	0.05	Y
			2007	FILSK	12	12	14.8	9.5	22.2	0.240	0.104	0.630				
			2015	FILSK	8	8	16.9	15.2	19.0	0.287	0.198	0.344				
		White sucker	1989	FILSK	3	1	17.0	17.0	17.0	0.110	0.110	0.110	1	0.05	0.05	Y
		Yellow perch	1989	FILSK	3	1	8.7	8.7	8.7	0.230	0.230	0.230	1	0.05	0.05	Y
			2015	FILSK	10	1	9.1	9.1	9.1	0.147	0.147	0.147				
56-0243-00	**MARION***	Bluegill sunfish	2003	FILSK	9	1	7.4	7.4	7.4	0.063	0.063	0.063				
			2012	FILSK	10	2	8.6	8.3	8.9	0.063	0.060	0.066				
		Northern pike	2003	FILSK	6	6	22.9	19.4	26.2	0.300	0.246	0.346				
			2012	FILSK	8	8	21.2	18.1	28.6	0.333	0.264	0.415				
		Walleye	2003	FILSK	6	6	18.4	15.7	21.2	0.278	0.231	0.317				
		Yellow bullhead	2012	FILET	5	1	10.6	10.6	10.6	0.158	0.158	0.158				
56-0302-00	**SILVER**	Rock bass	2011	FILSK	10	2	8.7	8.4	8.9	0.083	0.068	0.097				
		Walleye	2011	FILSK	8	8	14.9	11.6	19.4	0.160	0.079	0.251				
56-0310-00	**WALKER***	Black bullhead	1990	FILET	4	1	12.3	12.3	12.3	0.064	0.064	0.064	1	0.01	0.01	Y
		Black crappie	1990	FILSK	3	1	11.2	11.2	11.2	0.062	0.062	0.062	1	0.01	0.01	Y
		Bluegill sunfish	1990	FILSK	8	1	6.8	6.8	6.8	0.032	0.032	0.032	1	0.01	0.01	Y
		Common Carp	1990	FILSK	3	2	22.1	19.6	24.5	0.076	0.064	0.087	2	0.01	0.01	Y
		Northern pike	1990	FILSK	10	3	17.4	13.9	21.3	0.101	0.083	0.110	3	0.01	0.01	Y
		Walleye	1990	FILSK	7	4	19.7	12.5	26.9	0.377	0.088	0.800	3	0.01	0.01	Y
		White sucker	1990	FILSK	4	1	17.7	17.7	17.7	0.058	0.058	0.058	1	0.01	0.01	Y
56-0328-00	**LITTLE MCDONALD***	Bluegill sunfish	1996	FILSK	8	1	7.5	7.5	7.5	0.050	0.050	0.050				
			2016	FILSK	10	1	6.8	6.8	6.8	0.085	0.085	0.085				
		Northern pike	1996	FILSK	22	6	22.3	14.7	33.7	0.292	0.080	0.690	1	0.01	0.01	Y
		Walleye	1996	FILSK	22	5	20.2	12.8	28.4	0.478	0.150	0.950	1	0.04	0.04	
			2016	FILSK	8	8	17.2	11.7	21.3	0.330	0.090	0.555				
		White sucker	1996	FILSK	3	1	21.0	21.0	21.0	0.060	0.060	0.060				
56-0360-00	**ROSE***	Bluegill sunfish	2009	FILSK	10	2	6.9	6.6	7.2	0.064	0.064	0.064				
		Walleye	2009	FILSK	7	7	16.6	15.3	18.8	0.358	0.286	0.469				
56-0378-00	**EAST LOST**	Bluegill sunfish	2014	FILSK	10	1	7.2	7.2	7.2	0.067	0.067	0.067				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
East Lost (continued)		Walleye	2014	FILSK	8	8	19.6	15.6	24.5	0.342	0.184	0.668				
56-0383-00	**DEAD***	Black bullhead	1985	FILET	10	1	9.5	9.5	9.5				1	0.05	0.05	Y
		Bluegill sunfish	1997	FILSK	10	1	7.4	7.4	7.4	0.046	0.046	0.046				
		Northern pike	1997	FILSK	11	11	21.7	11.3	31.7	0.170	0.094	0.420	2	0.01	0.01	Y
			2009	FILSK	14	14	19.8	14.0	27.2	0.178	0.084	0.297				
			2015	FILSK	16	15	19.0	16.1	25.2	0.235	0.101	0.405				
		Walleye	1997	FILSK	11	11	17.2	13.2	23.1	0.208	0.080	0.350	2	0.01	0.01	Y
56-0385-00	**STAR***	Black bullhead	1985	FILET	10	1	9.7	9.7	9.7				1	0.05	0.05	Y
		Black crappie	1991	FILSK	10	1	8.8	8.8	8.8	0.081	0.081	0.081				
		Bluegill sunfish	1991	FILSK	10	1	8.0	8.0	8.0	0.061	0.061	0.061				
			2012	FILSK	10	2	8.3	7.8	8.7	0.047	0.038	0.055				
			2015	FILSK	10	1	7.7	7.7	7.7	0.047	0.047	0.047				
		Common Carp	1991	FILSK	8	3	17.9	13.6	21.3	0.036	0.027	0.044	2	0.01	0.01	Y
		Largemouth bass	1991	FILSK	9	2	12.7	9.9	15.4	0.190	0.120	0.260	1	0.01	0.01	Y
		Northern pike	1991	FILSK	21	5	22.6	12.8	34.0	0.214	0.120	0.290	3	0.01	0.01	Y
		Rock bass	1991	FILSK	10	1	8.9	8.9	8.9	0.120	0.120	0.120				
		Walleye	1991	FILSK	20	3	17.4	14.1	21.6	0.193	0.140	0.270	2	0.01	0.01	Y
			2012	FILSK	7	7	15.7	10.7	19.6	0.216	0.135	0.326				
			2015	FILSK	8	8	17.7	15.6	19.0	0.317	0.214	0.454				
		White sucker	1991	FILSK	8	2	14.3	11.1	17.4	0.026	0.020	0.031	1	0.01	0.01	Y
		Yellow bullhead	2012	FILET	5	1	12.2	12.2	12.2	0.121	0.121	0.121				
		Yellow perch	1991	FILSK	10	1	8.1	8.1	8.1	0.070	0.070	0.070				
56-0386-01	**BIG MCDONALD**	Bluegill sunfish	2008	FILSK	10	1	7.3	7.3	7.3	0.049	0.049	0.049				
			2017	FILSK	10	1	7.0	7.0	7.0	0.052	0.052	0.052				
		Northern pike	2008	FILSK	5	5	19.3	16.1	22.0	0.136	0.089	0.188				
		Walleye	2017	FILSK	8	8	15.3	13.7	19.6	0.148	0.102	0.383				
56-0386-02	**WEST MCDONALD**	Bluegill sunfish	2011	FILSK	10	2	7.4	7.1	7.6	0.033	0.028	0.037				
		Walleye	2011	FILSK	8	8	18.3	17.4	20.1	0.166	0.115	0.248				
56-0387-00	**SYBIL***	Bluegill sunfish	2004	FILSK	8	1	6.8	6.8	6.8	0.037	0.037	0.037				
			2013	FILSK	10	2	8.3	8.0	8.6	0.062	0.061	0.063				
		Northern pike	2004	FILSK	5	5	17.4	15.3	20.4	0.204	0.175	0.235				
		Walleye	2004	FILSK	5	5	15.5	11.8	19.5	0.263	0.172	0.413				
			2013	FILSK	7	7	18.0	14.5	28.3	0.392	0.277	0.647				
56-0388-00	**LONG***	Bluegill sunfish	2011	FILSK	10	2	7.1	6.5	7.7	0.045	0.038	0.052				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Long (continued)			2015	FILSK	8	1	7.0	7.0	7.0	0.056	0.056	0.056				
		Northern pike	1999	FILSK	24	24	21.8	16.3	31.2	0.282	0.080	0.580	1	0.011	0.011	Y
		Walleye	2011	FILSK	10	10	18.1	13.3	22.8	0.278	0.206	0.391				
			2015	FILSK	8	8	18.4	15.9	20.2	0.517	0.370	0.628				
		White sucker	2015	FILSK	5	1	16.1	16.1	16.1	0.049	0.049	0.049				
		Yellow perch	1999	WHORG	10	10	5.8	4.9	7.0	0.084	0.030	0.230				
56-0448-00	**ANNA**	Bluegill sunfish	2014	FILSK	10	1	7.3	7.3	7.3	0.062	0.062	0.062				
		Walleye	2014	FILSK	8	8	16.1	11.9	20.0	0.155	0.075	0.295				
56-0475-00	**PICKEREL***	Bluegill sunfish	1993	FILSK	10	1	6.6	6.6	6.6	0.029	0.029	0.029				
		Cisco (Lake herring)	1993	FILSK	5	1	16.1	16.1	16.1	0.120	0.120	0.120	1	0.02	0.02	Y
		Northern pike	1993	FILSK	2	2	24.4	23.4	25.4	0.190	0.190	0.190	2	0.0175	0.025	
		Smallmouth bass	1993	FILSK	17	4	13.3	10.4	16.3	0.134	0.065	0.270	1	0.024	0.024	
		Walleye	1993	FILSK	17	4	19.3	11.1	25.5	0.475	0.078	0.960	3	0.022	0.029	
			2000	FILSK	24	24	17.2	11.2	23.7	0.296	0.110	0.590				
			2008	FILSK	22	22	15.4	11.2	19.8	0.216	0.090	0.488				
			2016	FILSK	15	15	16.1	13.1	20.3	0.378	0.171	0.733				
		Yellow perch	2000	WHORG	10	10	6.4	6.0	6.7	0.083	0.040	0.140				
			2008	WHORG	9	2	6.4	6.0	6.7	0.033	0.033	0.033				
56-0481-00	**WEST LOST***	Bluegill sunfish	2015	FILSK	10	1	7.4	7.4	7.4	0.048	0.048	0.048				
		Northern pike	2015	FILSK	6	6	21.2	15.3	27.0	0.330	0.172	0.422				
56-0501-00	**EAST SPIRIT***	Bluegill sunfish	2013	FILSK	10	2	8.0	7.9	8.1	0.137	0.131	0.143				
		Northern pike	2013	FILSK	8	8	21.4	19.0	27.3	0.315	0.264	0.351				
56-0519-00	**WEST SILENT****	Bluegill sunfish	2005	FILSK	8	1	8.0	8.0	8.0	0.106	0.106	0.106				
		Northern pike	2005	FILSK	6	6	22.8	16.2	32.0	0.622	0.205	2.159				
56-0523-00	**EAST LOON****	Bluegill sunfish	2013	FILSK	10	2	7.6	7.3	7.9	0.134	0.082	0.186				
		Walleye	2013	FILSK	8	8	19.4	15.5	22.7	0.862	0.674	1.427				
56-0532-00	**LEEK (TROWBRIDGE)***	Bluegill sunfish	2014	FILSK	10	1	7.6	7.6	7.6	0.071	0.071	0.071				
		Northern pike	2014	FILSK	8	8	20.7	16.3	28.1	0.332	0.280	0.410				
56-0658-00	**WALL***	Bluegill sunfish	1993	FILSK	10	1	7.0	7.0	7.0	0.085	0.085	0.085	1	0.01	0.01	Y
			2013	FILSK	10	2	7.4	7.1	7.6	0.064	0.057	0.070				
			2017	FILSK	10	1	7.0	7.0	7.0	0.057	0.057	0.057				
		Largemouth bass	1993	FILSK	4	1	11.1	11.1	11.1	0.220	0.220	0.220				
		Northern pike	1993	FILSK	16	4	24.8	19.4	30.9	0.365	0.340	0.380	1	0.01	0.01	Y
		Walleye	1993	FILSK	25	4	19.8	14.3	25.7	0.488	0.210	0.740	1	0.019	0.019	

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
DOWID	Waterway	Species	Year	Anatomy[1]	Fish	Samples	Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Wall (continued)			2013	FILSK	8	8	15.9	13.4	22.3	0.366	0.230	0.485				
			2017	FILSK	8	8	16.5	14.2	19.2	0.584	0.361	0.892				
		White sucker	1993	FILSK	9	2	20.2	17.8	22.5	0.062	0.045	0.079	2	0.02	0.03	
56-0684-00	**FISH****	Black crappie	2002	FILSK	10	1	7.5	7.5	7.5	0.048	0.048	0.048				
		Bluegill sunfish	2015	FILSK	10	1	8.1	8.1	8.1	0.034	0.034	0.034				
		Northern pike	2002	FILSK	5	5	26.8	21.5	31.0	0.187	0.110	0.240				
			2007	FILSK	24	24	23.5	19.1	28.3	0.202	0.146	0.287				
		Walleye	2002	FILSK	5	5	18.3	15.8	21.2	0.391	0.236	0.610				
			2015	FILSK	8	8	18.4	13.9	25.0	0.213	0.076	0.489				
		White sucker	2015	FILSK	5	1	18.1	18.1	18.1	0.033	0.033	0.033				
		Yellow perch	2007	WHORG	10	2	6.0	5.8	6.2	0.035	0.033	0.037				
56-0747-01	**NORTH LIDA***	Bluegill sunfish	1991	FILSK	10	1	7.0	7.0	7.0	0.073	0.073	0.073				
			2012	FILSK	5	1	7.6	7.6	7.6	0.038	0.038	0.038				
		Common Carp	1991	FILSK	2	2	25.3	24.5	26.1	0.125	0.110	0.140	2	0.01	0.01	Y
		Cisco (Lake herring)	1991	FILSK	16	2	12.7	8.6	16.7	0.110	0.110	0.110	1	0.019	0.019	
		Largemouth bass	1991	WHORG	6	1	6.5	6.5	6.5	0.110	0.110	0.110				
		Northern pike	1991	FILSK	21	4	25.5	17.7	35.2	0.415	0.190	0.610	3	0.01	0.01	Y
		Rock bass	1991	FILSK	10	1	8.7	8.7	8.7	0.150	0.150	0.150				
		Smallmouth bass	1991	FILSK	2	1	11.9	11.9	11.9	0.200	0.200	0.200				
		Walleye	1991	FILSK	24	3	16.4	11.0	21.2	0.540	0.190	0.920	2	0.013	0.016	
			2012	FILSK	8	8	17.0	10.1	18.6	0.408	0.174	0.510				
		White sucker	1991	FILSK	18	3	16.8	11.3	21.3	0.065	0.027	0.100	1	0.01	0.01	Y
		Yellow bullhead	2012	FILET	5	1	12.9	12.9	12.9	0.443	0.443	0.443				
		Yellow perch	1991	WHORG	15	1	6.3	6.3	6.3	0.099	0.099	0.099				
56-0747-02	**SOUTH LIDA****	Bluegill sunfish	2009	FILSK	10	2	7.6	7.2	7.9	0.071	0.069	0.072				
			2015	FILSK	10	1	7.7	7.7	7.7	0.071	0.071	0.071				
		Cisco (Lake herring)	2009	FILSK	8	2	16.1	14.9	17.3	0.127	0.123	0.131				
		Northern pike	2015	FILSK	1	1	24.3	24.3	24.3	0.216	0.216	0.216				
		Walleye	2009	FILSK	8	8	19.0	12.3	24.3	0.483	0.138	0.688				
			2015	FILSK	8	8	19.5	14.3	24.5	0.450	0.184	0.779				
56-0749-00	**CRYSTAL***	Bluegill sunfish	2006	FILSK	10	1	7.5	7.5	7.5	0.143	0.143	0.143				
			2014	FILSK	10	1	8.6	8.6	8.6	0.089	0.089	0.089				
		Walleye	2006	FILSK	6	6	17.1	13.8	20.1	0.717	0.426	1.043				
			2014	FILSK	8	8	16.3	14.5	18.5	0.367	0.281	0.477				

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
56-0759-00	**FRANKLIN****	Bluegill sunfish	2007	FILSK	10	1	7.6	7.6	7.6	0.102	0.102	0.102				
			2016	FILSK	10	1	6.4	6.4	6.4	0.052	0.052	0.052				
		Walleye	2007	FILSK	6	6	16.5	13.4	20.1	0.518	0.316	0.992				
			2016	FILSK	8	8	13.2	11.9	16.1	0.215	0.167	0.301				
56-0760-00	**LIZZIE****	Black crappie	2007	FILSK	5	1	9.7	9.7	9.7	0.368	0.368	0.368				
		Bluegill sunfish	1995	FILSK	10	1	7.0	7.0	7.0	0.110	0.110	0.110				
			2007	FILSK	10	1	7.5	7.5	7.5	0.097	0.097	0.097				
			2016	FILSK	10	1	7.1	7.1	7.1	0.124	0.124	0.124				
		Cisco (Lake herring)	1995	FILSK	15	3	14.1	11.1	16.8	0.122	0.086	0.140	1	0.01	0.01	Y
		Largemouth bass	1995	FILSK	3	1	13.8	13.8	13.8	0.450	0.450	0.450				
			2007	FILSK	5	5	12.2	10.1	13.6	0.336	0.296	0.362				
		Northern pike	1995	FILSK	20	5	21.7	14.3	32.4	0.374	0.190	0.510	1	0.01	0.01	Y
		Smallmouth bass	2007	FILSK	1	1	10.0	10.0	10.0	0.202	0.202	0.202				
		Walleye	1995	FILSK	11	3	18.7	15.8	22.1	0.640	0.320	1.150	1	0.02	0.02	Y
			2016	FILSK	8	8	17.6	14.1	21.4	0.595	0.387	0.800				
56-0784-00	**LONG****	Bluegill sunfish	2007	FILSK	10	1	7.3	7.3	7.3	0.089	0.089	0.089				
			2016	FILSK	10	1	7.2	7.2	7.2	0.061	0.061	0.061				
		Walleye	2007	FILSK	6	6	17.4	14.1	21.1	0.494	0.233	0.806				
			2016	FILSK	8	8	19.1	13.8	27.2	0.533	0.370	0.961				
56-0786-00	**PELICAN***	Black crappie	1992	FILSK	5	1	9.2	9.2	9.2	0.120	0.120	0.120				
		Bluegill sunfish	1992	FILSK	10	1	7.1	7.1	7.1	0.060	0.060	0.060				
			2011	FILSK	10	2	8.3	7.7	8.9	0.060	0.056	0.063				
			2015	FILSK	10	1	7.6	7.6	7.6	0.113	0.113	0.113				
		Cisco (Lake herring)	1992	FILSK	7	1	8.9	8.9	8.9	0.076	0.076	0.076	1	0.043	0.043	
		Largemouth bass	1992	FILSK	7	2	15.0	12.5	17.4	0.695	0.290	1.100	1	0.01	0.01	Y
		Northern pike	1992	FILSK	20	3	22.5	18.2	26.9	0.380	0.320	0.490	1	0.01	0.01	Y
		Walleye	1992	FILSK	24	3	17.7	14.3	20.9	0.500	0.400	0.570	1	0.023	0.023	
			2011	FILSK	8	8	15.0	10.5	18.5	0.268	0.174	0.439				
			2015	FILSK	8	8	16.7	14.0	19.4	0.374	0.221	0.576				
56-0824-00	**DAYTON HOLLOW RES.**	Bluegill sunfish	1978	WHORG	1	1	9.0	9.0	9.0	0.180	0.180	0.180	1	0.026	0.026	
			1989	FILSK	8	1	6.5	6.5	6.5	0.280	0.280	0.280	1	0.05	0.05	
		Common Carp	1978	PLUSK	5	1	20.9	20.9	20.9	0.130	0.130	0.130	1	0.1	0.1	Y
				WHORG	5	1	20.9	20.9	20.9	0.100	0.100	0.100	1	0.281	0.281	
			1989	FILSK	3	1	22.1	22.1	22.1	0.700	0.700	0.700	1	0.057	0.057	

DOWID	Waterway	Species	Year	Anatomy[1]	Total Fish	Number Samples	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
							Mean	Min	Max	Mean	Min	Max	N	Mean	Max	< RL
Dayton Hollow Res. (continued)		Silver redhorse	1978	WHORG	1	1	18.5	18.5	18.5	0.130	0.130	0.130	1	0.195	0.195	
			1989	FILSK	3	1	16.5	16.5	16.5	0.320	0.320	0.320	1	0.05	0.05	
		Walleye	1978	WHORG	4	1	11.4	11.4	11.4	0.130	0.130	0.130	1	0.079	0.079	
			1989	FILSK	3	1	18.0	18.0	18.0	0.700	0.700	0.700	1	0.05	0.05	
		White sucker	1978	WHORG	4	1	12.9	12.9	12.9	0.080	0.080	0.080	1	0.151	0.151	
56-0829-00	**PEBBLE***	Bluegill sunfish	1996	FILSK	10	1	6.9	6.9	6.9	0.100	0.100	0.100				
			2011	FILSK	10	2	7.0	6.5	7.4	0.088	0.087	0.089				
		Cisco (Lake herring)	1996	FILSK	2	1	13.3	13.3	13.3	0.100	0.100	0.100	1	0.01	0.01	Y
		Northern pike	2011	FILSK	8	8	21.9	17.0	29.9	0.391	0.302	0.584				
		Walleye	1996	FILSK	18	5	17.5	13.2	23.0	0.564	0.320	0.830	1	0.01	0.01	Y
56-0877-00	**JEWETT***	Black crappie	2002	FILSK	9	1	9.2	9.2	9.2	0.158	0.158	0.158				
		Bluegill sunfish	2002	FILSK	10	1	7.1	7.1	7.1	0.157	0.157	0.157				
			2005	FILSK	10	1	7.5	7.5	7.5	0.140	0.140	0.140				
		Cisco (Lake herring)	2002	FILSK	4	1	10.0	10.0	10.0	0.170	0.170	0.170				
		Walleye	2002	FILSK	5	5	20.0	11.6	26.7	0.927	0.354	1.470				
			2005	FILSK	8	8	17.3	14.1	19.5	0.327	0.246	0.422				
			2008	FILSK	23	23	15.3	11.5	23.7	0.323	0.125	0.464				
			2014	FILSK	15	15	18.0	12.3	21.6	0.450	0.272	0.590				
		Yellow perch	2008	WHORG	10	2	6.7	6.5	6.9	0.076	0.059	0.093				
56-0915-00	**PRAIRIE***	Bluegill sunfish	2001	FILSK	10	1	6.9	6.9	6.9	0.131	0.131	0.131				
		Northern pike	2001	FILSK	7	7	21.8	14.9	30.4	0.545	0.263	1.388				
			2013	FILSK	15	15	23.8	16.6	33.9	0.530	0.343	1.015				
		White sucker	2001	FILSK	5	1	19.2	19.2	19.2	0.150	0.150	0.150				
56-0945-00	**ORWELL***	Black crappie	1999	FILSK	11	1	9.1	9.1	9.1	0.130	0.130	0.130				
			2016	FILSK	10	1	9.0	9.0	9.0	0.060	0.060	0.060				
		Common Carp	1999	FILSK	5	1	18.6	18.6	18.6	0.150	0.150	0.150	1	0.039	0.039	
		Walleye	1999	FILSK	8	8	15.4	12.9	18.8	0.161	0.110	0.230				
			2016	FILSK	8	8	16.7	12.6	23.2	0.261	0.187	0.511				

* Impaired for mercury in fish tissue as of 2018 Draft Impaired Waters Inventory; categorized as EPA Category 4a for waters covered by the Statewide Mercury TMDL.

** Impaired for mercury in fish tissue as of 2018 Draft Impaired Waters Inventory; categorized as EPA Category 5 for waters needing a TMDL.

1 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; WHORG—whole organism.

Pollutant load monitoring

Table 26. Location of WPLMN sites within the Otter Tail River Watershed.

Site Type	Stream Name	USGS ID	DNR/MPCA ID	EQuIS ID
Major Watershed	Otter Tail River at Breckenridge, CSAH16	NA	H56105001	S002-000
Subwatershed	Otter Tail River nr Elizabeth, CSAH10	05030500	E56050001	S005-142
Subwatershed	Pelican River nr Fergus Falls, MN210	NA	H56048002	S000-556

Average annual flow weighted mean concentrations (FWMCs) of TSS, TP, and NO_3+NO_2-N for major watershed stations statewide are presented below in Figure 37, with the Otter Tail River 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; thus it can be 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 wastewater treatment plants. Major “non-point” sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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. The Otter Tail River is used directly as a drinking water source by the city of Fergus Falls (Wright Lake). The Otter Tail River is a tributary to the Red River of the North - a source for drinking water by larger cities in the Red River Basin (Fargo, North Dakota, Moorhead, Minnesota and Grand Forks, North Dakota).

More information, including results for the outlet and subwatershed stations, can be found at the WPLMN website.

When compared to the other major watersheds in the Red River of the North Basin, Figure 37 shows the average annual TSS, TP, and NO_3+NO_2-N FWMCs for the Otter Tail River are less than most.

Substantial year-to-year variability in water quality occurs for most rivers and streams, including the Otter Tail River. Results for individual years are shown in Figure 38 below.

Figure 37. 2007 - 2016 average annual TSS, TP, and NO3-NO2-N flow weighted mean concentrations, and runoff by major watershed.

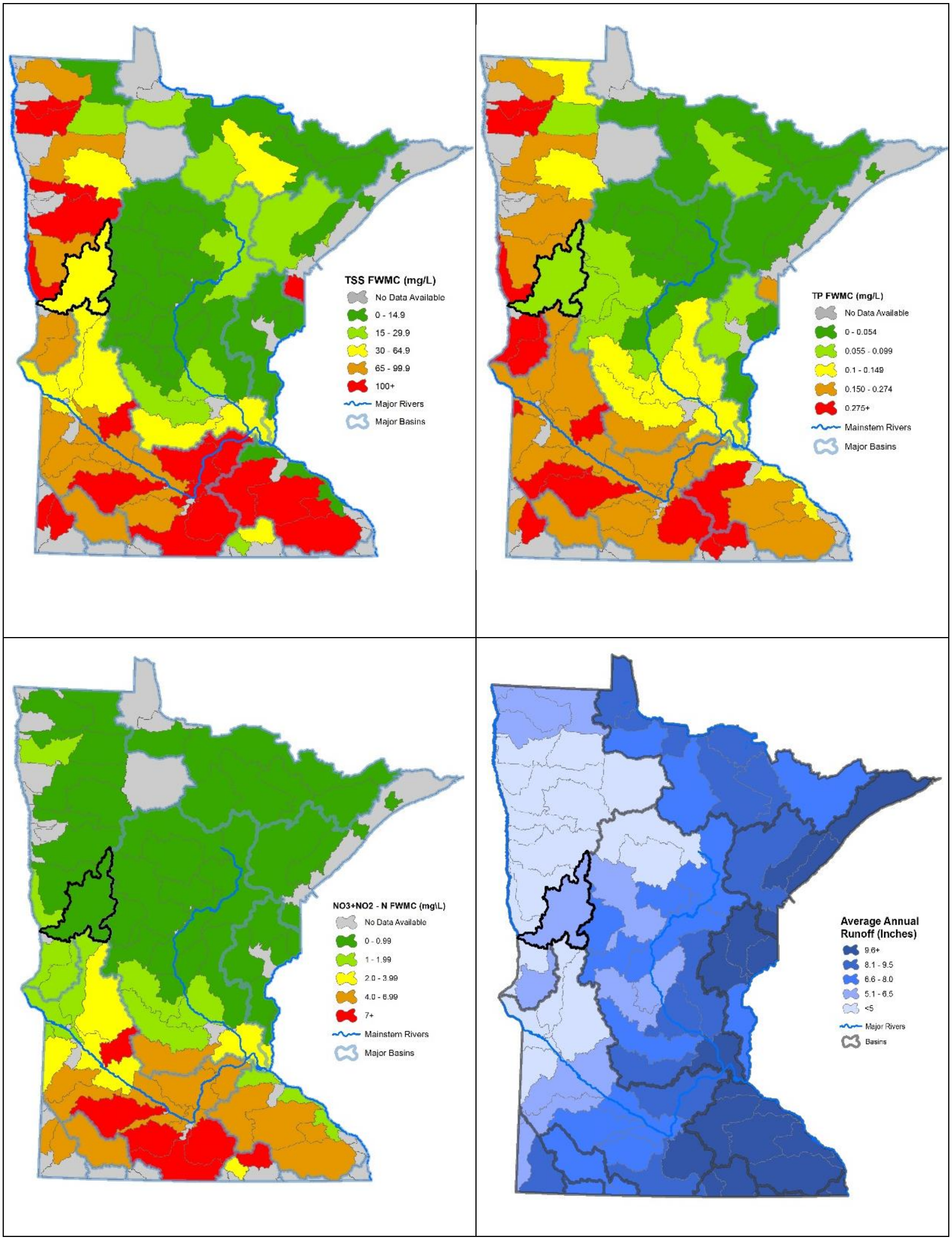
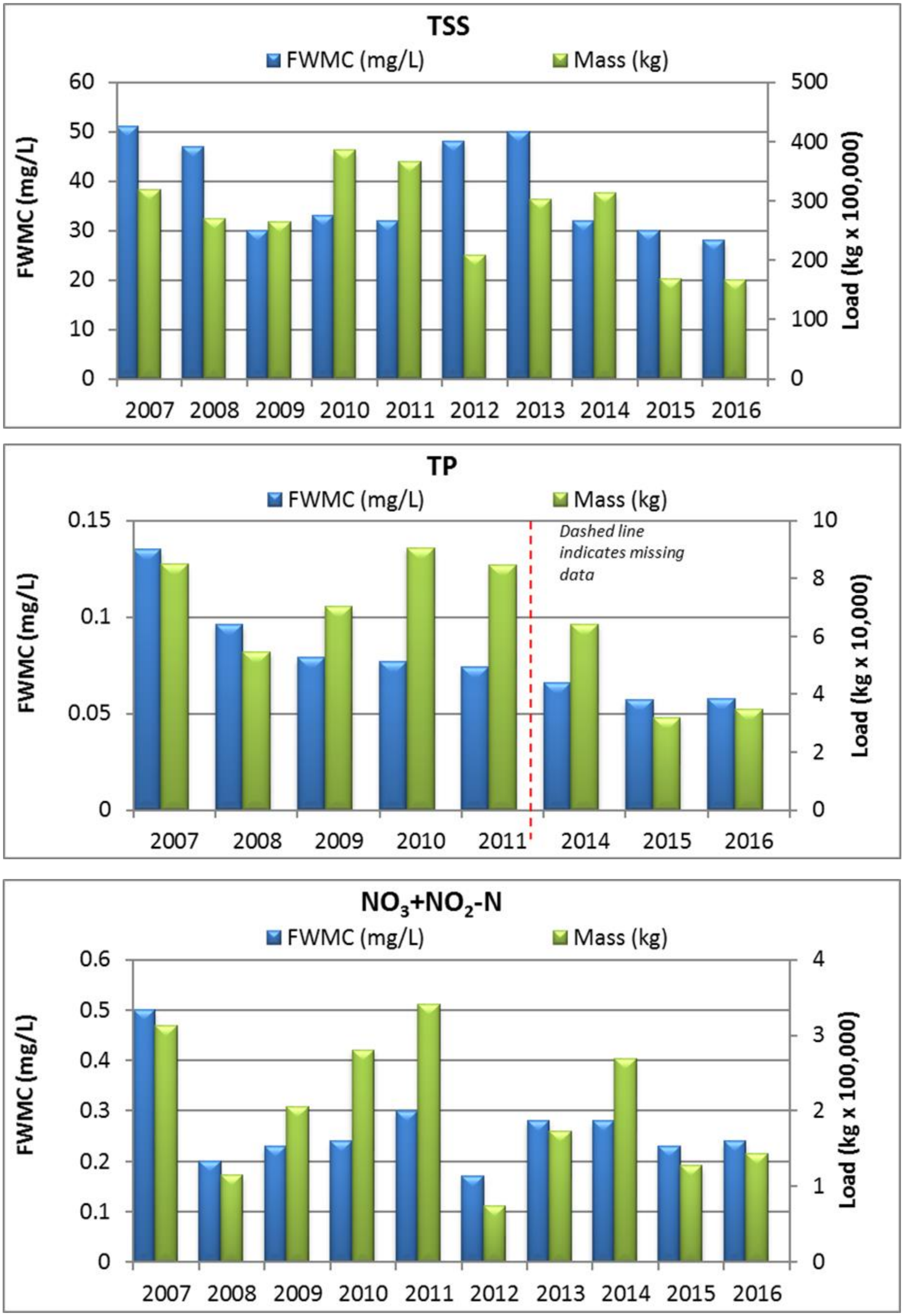
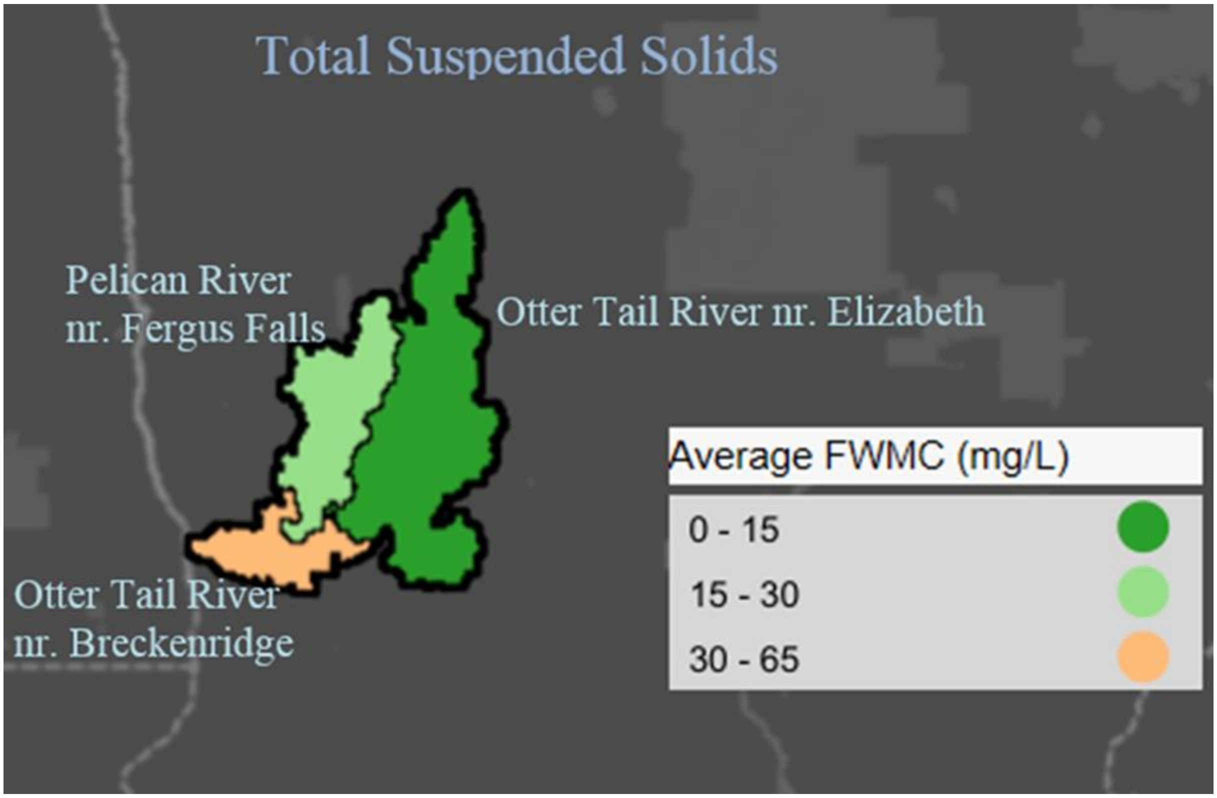


Figure 38. TSS, TP, and NO3+NO2-N flow weighted mean concentrations and loads for the Otter Tail River near Breckenridge, Minnesota.



A review of data from sites within the Otter Tail River Watershed shows decreasing water quality from east to west for TSS and TP with the highest inputs coming from the lower, agriculturally dominated section of the watershed (Figure 39). Nitrate + Nitrite nitrogen and Total Kjeldahl nitrogen levels are low and consistent across the watershed.

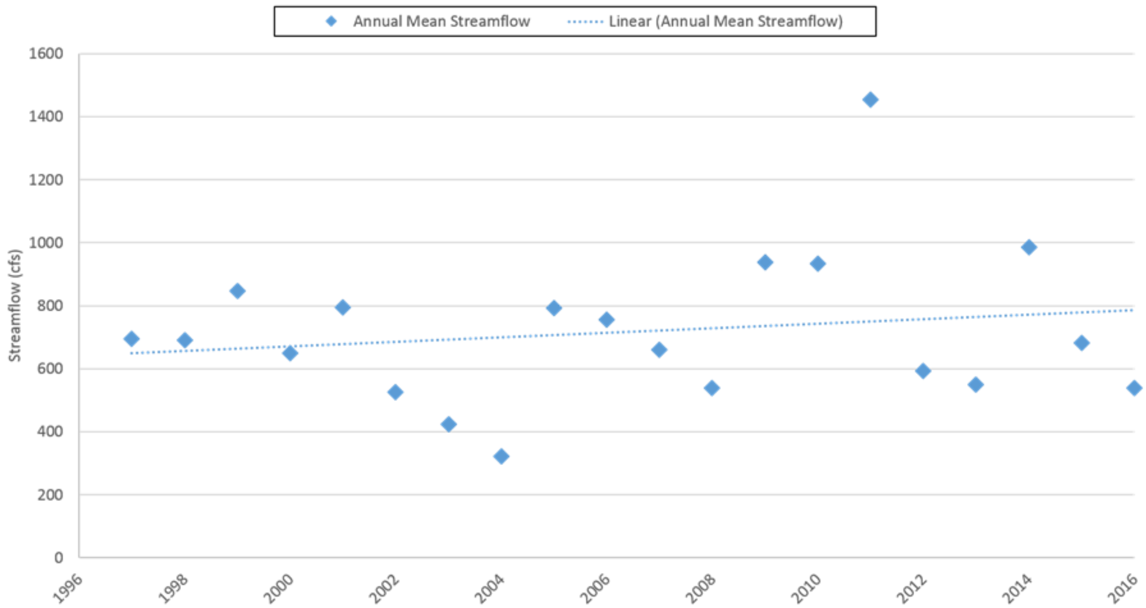
Figure 39. TSS average flow weighted mean concentrations for WPLMN sites in the Otter Tail River Watershed.

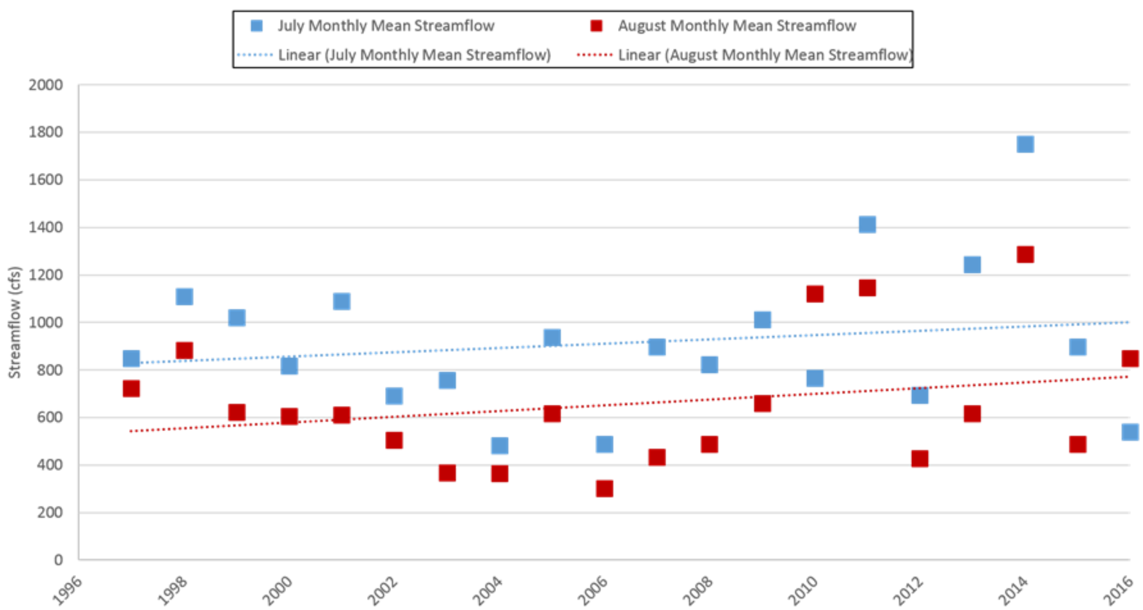


Stream flow

Stream flow data from the United States Geological Survey's real-time streamflow gaging station for the Otter Tail River was analyzed for annual mean streamflow and summer monthly mean streamflow (July and August). Figure 40 (*top*) is a display of the annual mean streamflow for the Otter Tail River near Fergus Falls, Minnesota for water years 1997 to 2016. The data shows that although annual mean streamflow appears to be increasing over time, there is no statistically significant trend. Figure 40 (*bottom*) displays July and August mean flows for the same time frame, for the same water body. Graphically, the data also appears to be increasing 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).

Figure 40. Annual mean (*top*) and monthly mean (*bottom*) streamflow for the Otter Tail River near Fergus Falls, Minnesota (1997-2016) (Source: USGS, 2019).





Wetland condition

Most of the Otter Tail River Watershed is in the Mixed Wood Plains ecoregion, while the portion on the beach ridge and the Lake Agassiz Plain is in the Temperate Prairies ecoregion, and the upper NE region is in the Mixed Wood Shield ecoregion. In general, wetland condition in these three ecoregions is very different. 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 27). In the Mixed Wood Plains ecoregion, which includes most of the watershed, 82% of the wetlands are in either Fair or Poor condition, essentially the opposite condition outcome compared to wetlands in the NE portion of the watershed. Wetlands in the lower portion of the Otter Tail River Watershed, in the Temperate Prairies ecoregion, likely have the same relative condition regime as those in the Mixed Wood Plains ecoregion.

Table 27. 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%

Wetlands in both the Mixed Wood Plains and in the Temperate Prairies are commonly 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 much of the Otter Tail River Watershed, as with other HUC-8 watersheds within the Mixed Wood Plains and Temperate Prairies ecoregions, water quality management efforts should focus on protecting high quality wetlands present, including efforts to limit hydrologic alternations and the spread of invasive species which are known to rapidly and dramatically impact wetland quality.

Figure 41. Stream Tiered Aquatic Life Use designations in the Otter Tail River Watershed.

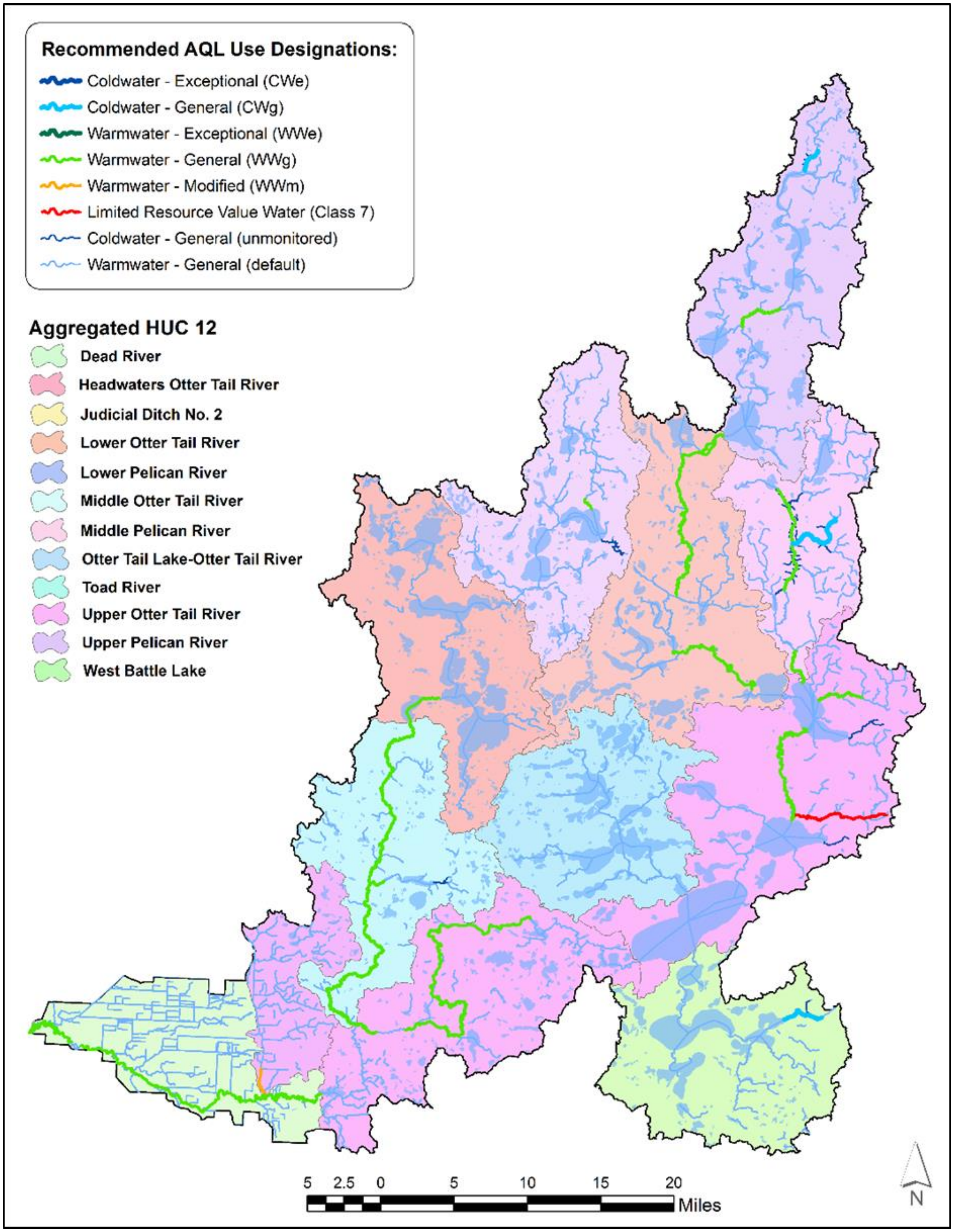


Figure 42. Fully supporting waters by designated use in the Otter Tail River Watershed.

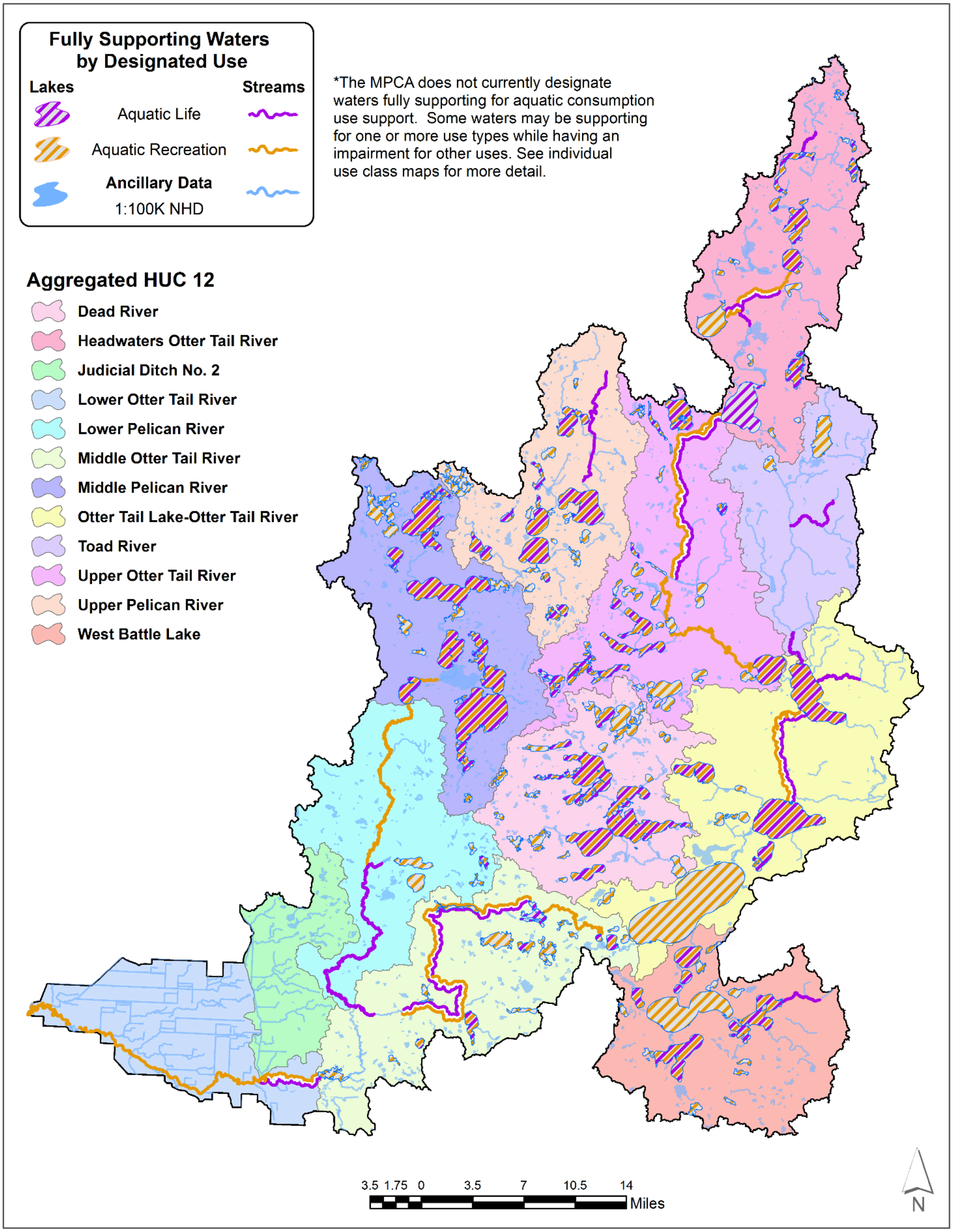


Figure 43. Impaired waters by designated use in the Otter Tail River Watershed.

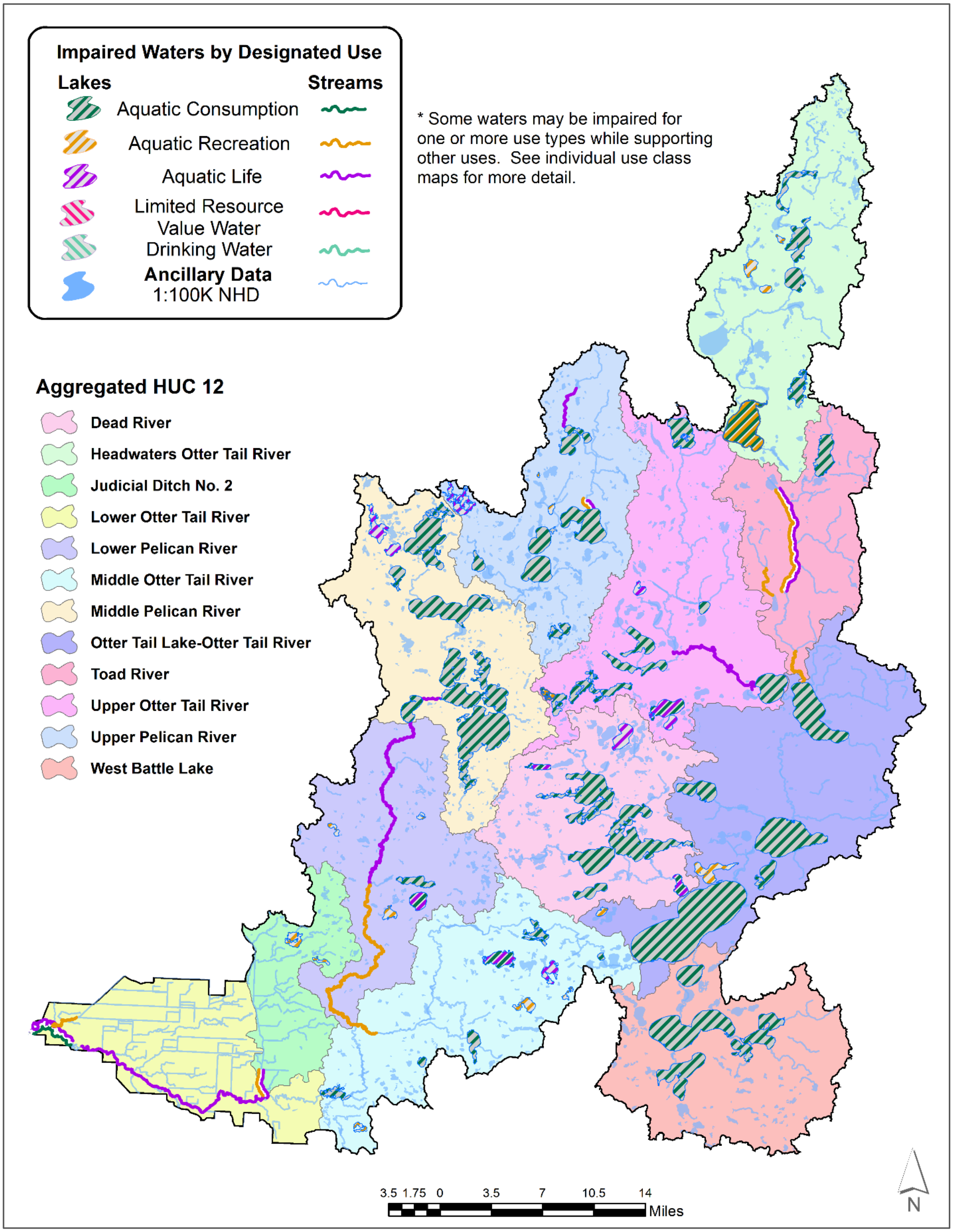


Figure 44. Aquatic consumption use support in the Otter Tail River Watershed.

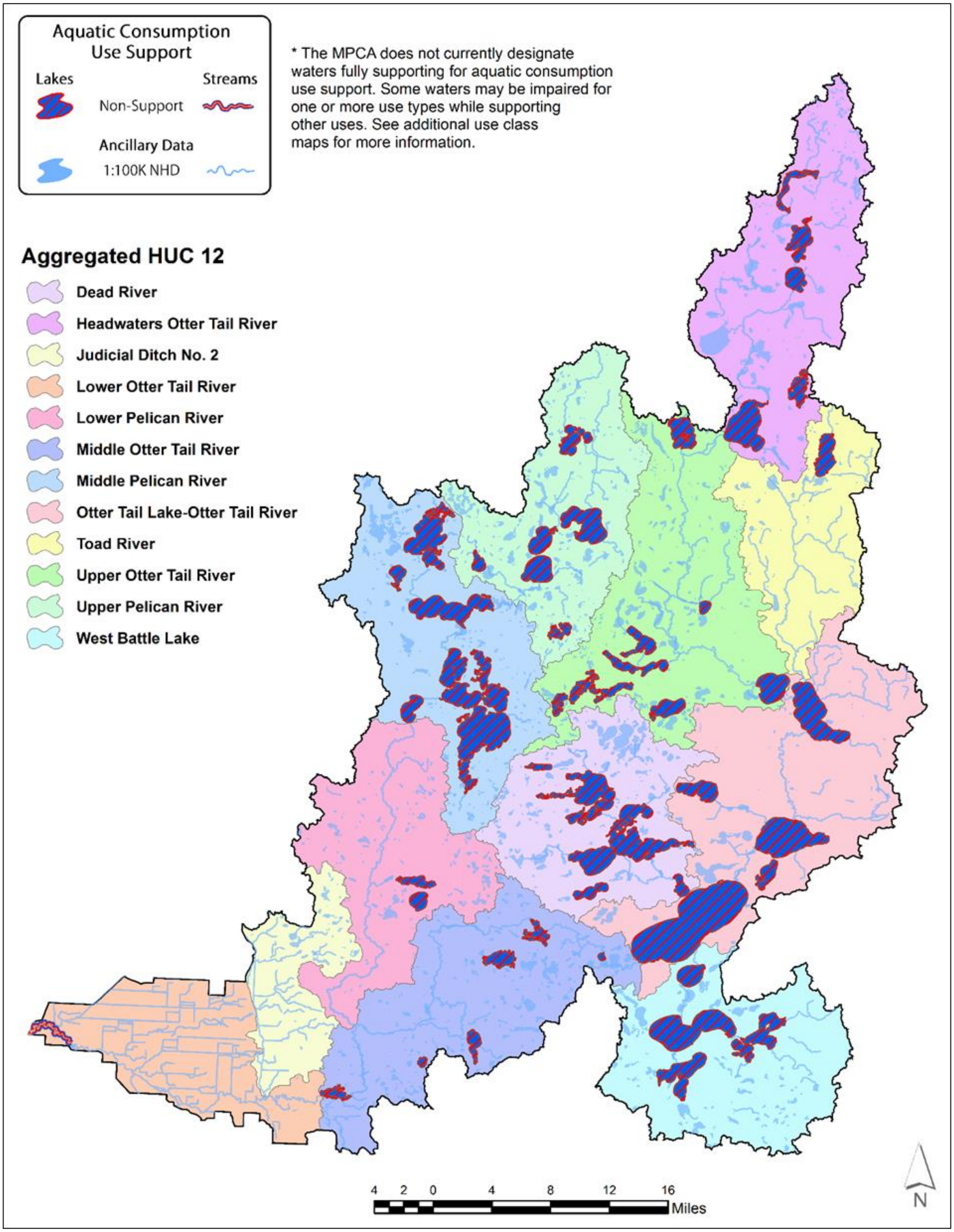


Figure 45. Aquatic life use support in the Otter Tail River Watershed.

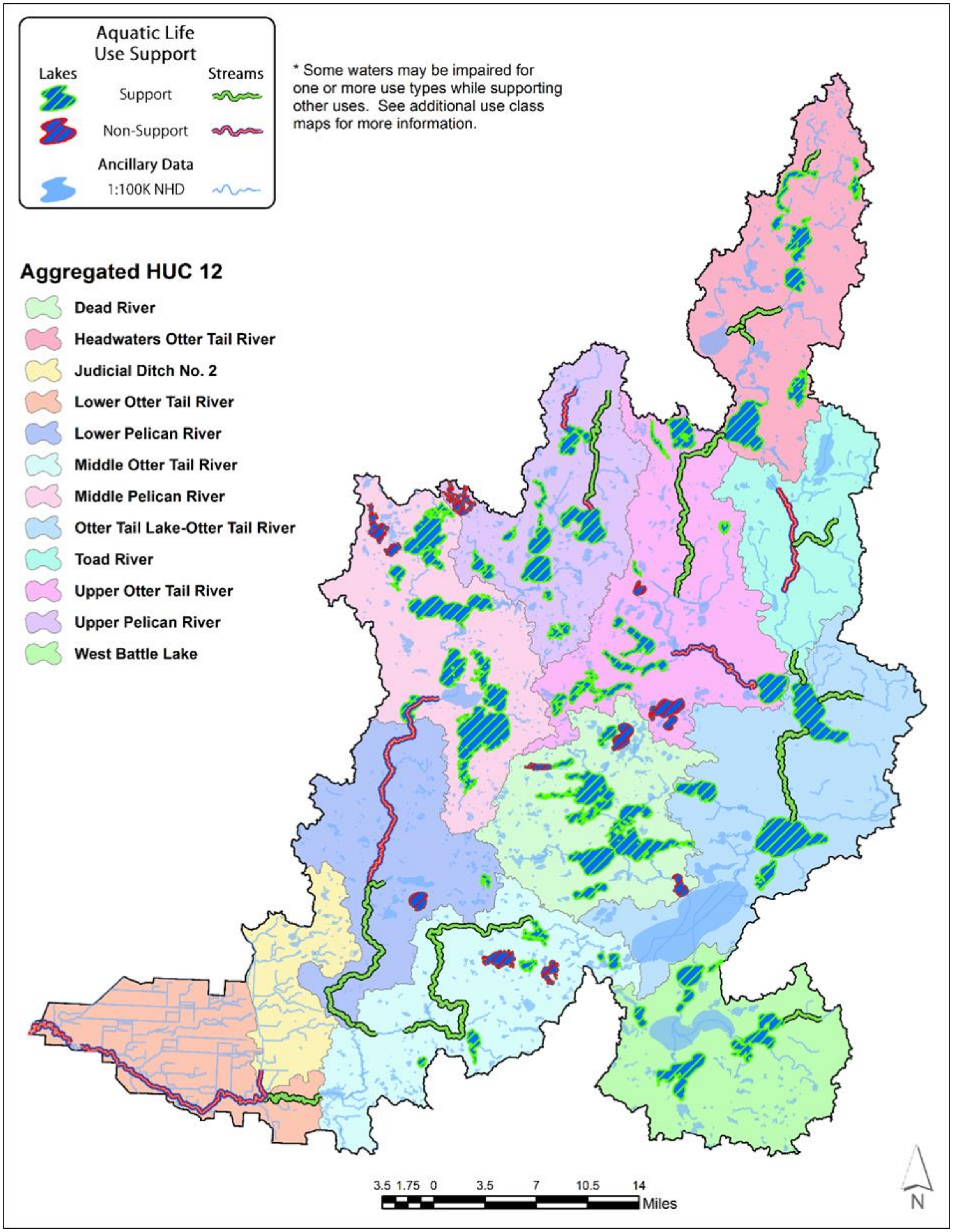
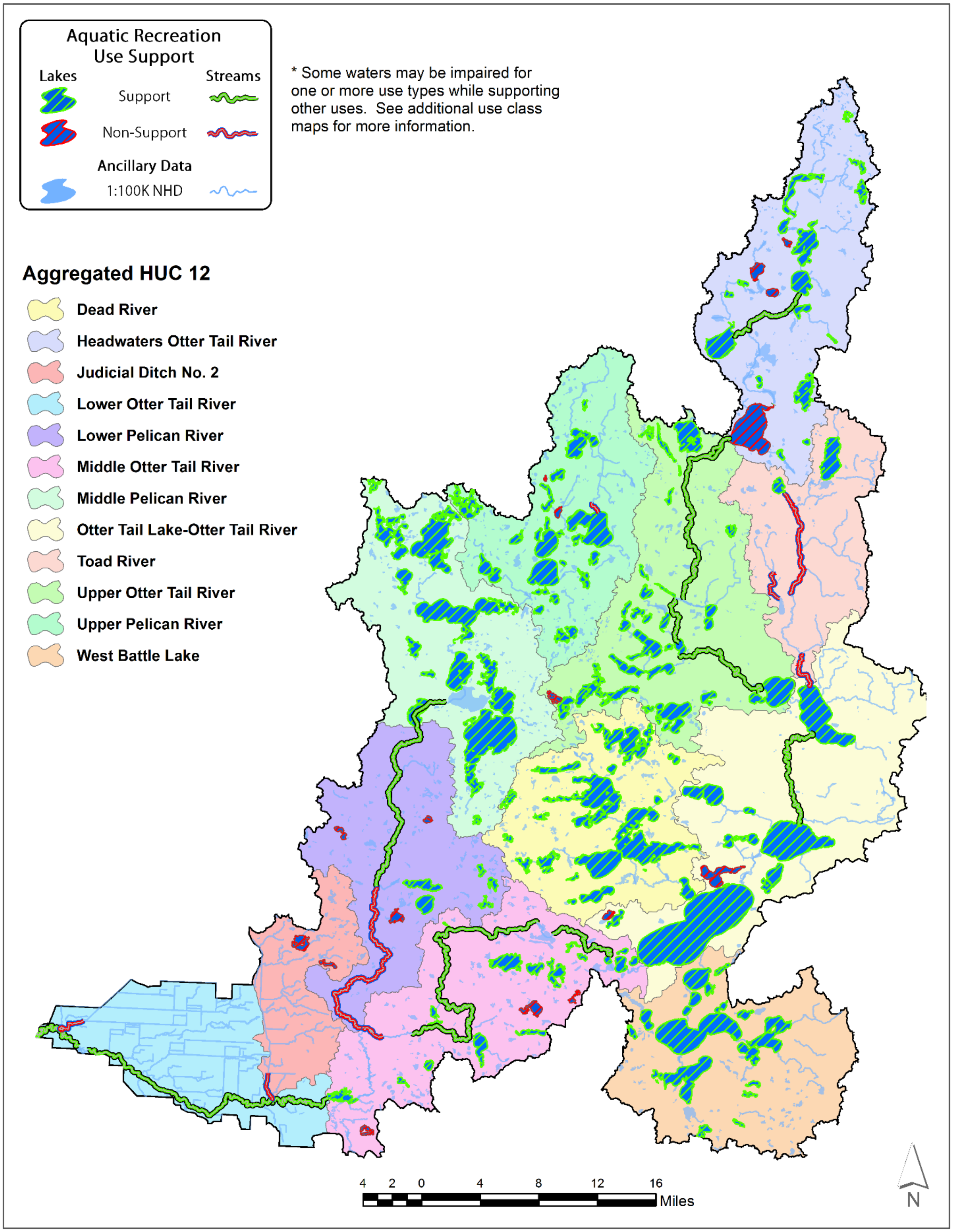


Figure 46. Aquatic recreation use support in the Otter Tail River Watershed.



Transparency trends for the Otter Tail River Watershed

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 also incorporates any agency and partner data submitted to EQUIS. The trends are calculated using a Seasonal Kendall statistical test for waters with a minimum of eight years of transparency data; Secchi disk measurements in lakes and Secchi Tube measurements in streams.

Citizen volunteer monitoring occurs at 15 streams and 103 lakes within the watershed. Recent data analysis indicate increasing water clarity trends on two stream reaches: the lower Otter Tail River (09020103-502) in Breckenridge and an unnamed creek (09020103-901), which flows between Mud Lake and Little Toad Lake. There are trends indicating improving water clarity on 61 lakes throughout this watershed (Table 28). Seventeen lakes had declining trends in water clarity. Extensive datasets are required for developing accurate long-term trends in water quality. Maintaining current citizen monitoring programs, adding more volunteers, and expanding monitoring activities throughout the watershed will be ideal for tracking water quality changes over time.

Table 28. Water clarity trends.

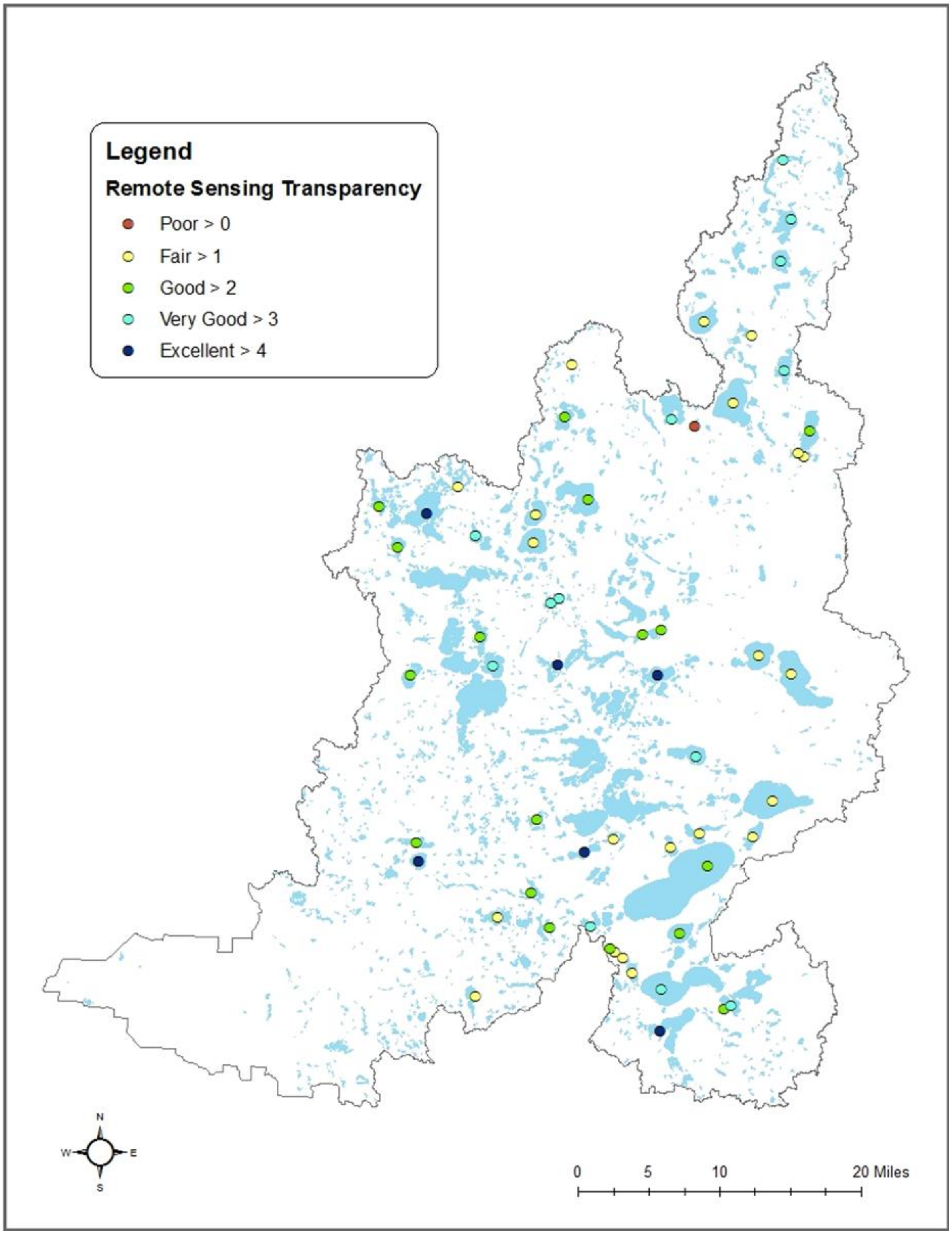
Otter Tail River HUC 09020103	Streams	Lakes
Number of sites w/increasing trend	2	61
Number of sites w/decreasing trend	0	17
Number of sites w/no trend	7	49

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 widespread 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 Otter Tail River Watershed

The University of Minnesota, in partnership with MPCA, conducts remote sensing of lake clarity (Figure 47). 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 47. Remotely sensed Secchi transparency on lakes in the Otter Tail River Watershed.



Priority Waters for Protection and Restoration in the Otter Tail River Watershed

The MPCA, DNR, and BWSR have developed methods to help identify waters that are a high priority for protection and restoration activities. Protecting lakes and streams from degradation requires consideration of how human activities impact the lands draining to the water. In addition, helping to determine the risk for degradation allows for prioritization to occur, so 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 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 the following: does the water body have an active lake or river association, is the waterbody publically accessible, the presence of wild rice, the 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. 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 6. 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 Otter Tail River Watershed, highest protection priority is suggested for 51 lakes. Cotton Lake was also identified as a priority for protection as aquatic life was near the impairment threshold and water quality was in decline. As mentioned above, all of these lakes are currently meeting water quality standards.

The results for selected indicators and risk priority ranking for streams are shown in Appendix 7. Stream protection is driven by how close the stream is to having an impaired biological community, the density of roads and disturbed land use in the immediate and larger drainage area, and how much land is protected in the watershed. In the Otter Tail River Watershed, 10 General Use streams were identified as high priority: Dead Horse Creek, Brandborg Creek, Reed Creek, Unnamed Creek (09020103-622), Otter Tail River (09020103-521, 09020103-574, 09020103-773, and 09020103-774), and Pelican River (09020103-768 and 09020103-771). While these streams currently meet standards, work done to maintain current conditions is important to prevent impairment in the future.

Summaries and recommendations

Eighty-six species of fish have been documented in the Red River Basin. MPCA biological monitoring crews captured 65 species of fish during the IWM stream sampling in the Otter Tail River Watershed. The majority of the fish samples collected within the watershed contained 13 – 17 species. The greatest diversity was observed at stations located on the Lower Otter Tail and Pelican Rivers, where most samples contained 20 – 30 species. Common shiners, white suckers, and johnny darters were the most commonly sampled species. These species were present at 20 or more monitoring locations; all of them are commonly found throughout the Midwest. Common shiners were the most abundant species sampled (3,348 individuals). Common shiners can utilize a variety of habitat types but are most often found within small to medium sized clear streams with sand and gravel substrate (Becker 1983). White suckers inhabit streams of various gradients as well as many lakes. The species can adapt well to different habitats and is tolerant of higher levels of turbidity (Becker 1983). The johnny darter inhabits both lakes and streams but prefers smaller streams with sand and gravel substrate (Becker 1983). Most of the headwater streams, as well as many larger streams within the watershed provide ideal habitat for these species.

Some of the species collected during the IWM process are considered rare in the Red River Basin and their distribution (within the basin) is almost exclusively restricted to the Otter Tail River Watershed. Species such as the pugnose shiner, northern hogsucker, and the rainbow darter have only been collected from the Otter Tail River Watershed (Aadland et al. 2005; Koel and Peterka 1998). These species require excellent water quality and stream habitat. With the exception of the pugnose shiner, which was also found in Reed Creek, these species were collected from the Otter Tail River and /or Pelican River. Other rare species found within the Otter Tail River Watershed have only been documented in one or two other Red River Basin watersheds – or at a specific location on the Red River itself. These species include the weed shiner, logperch, greater redhorse, bowfin, and central stoneroller (Koel and Peterka 1998). All of these species, except the logperch, were only collected from the Otter Tail and/or Pelican River. The logperch was also found in the Toad River. Most of these species are fairly common in the neighboring Minnesota River drainage. Their occurrence within the Otter Tail River Watershed and the Red River Basin is likely the result of a connection that occurred between the Minnesota River drainage and Red River drainage (Aadland et al. 2005; Schmidt 2016). Low laying, marshy areas adjacent to these basin divides may occasionally become inundated during floods and provide a passageway for fish between the two drainages. One such connection exists along the Laurentian Divide near Browns Valley, Minnesota (Schmidt 2016). At this location, a culvert under a roadway separates the two drainages; flooding events on either side will cause water to drain into the opposite drainage (Schmidt 2016). The additional species that crossed over into the Otter Tail Watershed added to an already diverse fish assemblage. When compared to all other watersheds within the Red River Basin, species richness is highest within the Otter Tail (Aadland et al. 2005; Koel and Peterka 1998).

The macroinvertebrate community in the Otter Tail River Watershed is generally diverse. Twenty-nine visits were made to 26 stations from 2008-2018; 234 unique taxa were identified from the samples. Of these 29 visits, 25 were above the MIBI impairment threshold and reflective of the good water quality within the watershed. Most invertebrate samples were collected from the Otter Tail River main stem and low-gradient streams; however, some faster flowing streams with riffle habitat were also sampled. On average, 41 unique taxa were collected per visit, with station 16RD012 (Otter Tail River) having the highest richness (55 species). Four cold water stations located on Brandborg, Deadhorse (two stations), and Solid Bottom Creeks contained notable taxa, including the caddisflies *Limnephilus*, *Glossosoma*, and *Lype diversa*, the stoneflies *Isoperla* and *Amphinemura*, and the midges *Odontomesa* and *Eukiefferiella*.

Additionally, fifteen sensitive taxa were found throughout the watershed. The caddisfly *Lepidosoma* was the most common sensitive genus, with 75 individuals collected among five stations. The 2016 samples collected from stations 16RD026 (Toad River) and 05RD074 (Otter Tail River) held the most sensitive taxa for a single station (5 each). The most abundant genera collected in the watershed are *Simulium*, *Iswaeon*, *Hyalella*, *Baetis*, and *Polypedilum*, which are all tolerant to disturbance and ubiquitous throughout Minnesota. *Simulium* (blackfly) were collected at all except one station and in very high relative abundances in this watershed. There were no endangered, threatened, or species of special concern collected in the Otter Tail River Watershed during this study. Overall, the macroinvertebrate community of the Otter Tail River Watershed is in good health, but protection and restoration measures should be enacted to prevent further degradation.

Most streams within the Otter Tail River Watershed featured biological communities that were in good condition. The development of healthy biological communities can be attributed to relatively stable flow patterns and the availability of diverse stream habitat. Many streams within the watershed are still in their natural state; their channels have not been dredged or straightened. Natural channels and intact riparian zones provide the most diverse stream habitat. Most biological impairments within the watershed were related to poor stream habitat (Lower Otter Tail River, Toad River, Judicial Ditch 2). These stations had relatively homogeneous habitat – sand/silt substrate, sparse cover, and poor channel development. Channel stability was lower and coarse substrate was often embedded in loose, shifting sediment at these stations. These conditions favor biological communities that are tolerant of disturbance. Further investigation, including geomorphology measurements, will be conducted on these reaches to determine the cause(s) of sediment instability. Most other Red River Basin Watersheds have experienced more extensive hydrologic alterations (i.e. straightening of natural channels, ditching, wetland drainage, and land use changes – see Figure 7). The destruction of valuable stream habitat has led to reduced fish assemblages within many of these watersheds. Besides reducing habitat heterogeneity, hydrologic alterations also result in greater flow variability, which affects habitat availability and its composition (Horowitz 1978; Matthews 1998). Fish assemblage data collected from 1,026 sites located throughout the Red River Basin were used to correlate the occurrence of fish species with specific environmental factors (Koel and Peterka 2003). The results of the analysis indicated the most determinate factor influencing fish assemblage structure was flow variability (Koel and Peterka 2003). Highly variable flow patterns favor tolerant, generalist species, which are able to adapt to constantly changing stream conditions (Horowitz 1978; Matthews 1998). The Otter Tail River Watershed, with its many lakes and moderately altered hydrology, has relatively stable flow patterns that favor species with more specific habitat requirements.

While the watershed exhibits low flow variability and less extensive hydrologic alterations, it does contain numerous dams that reduce hydrologic connectivity. Twenty-two dams are present on the Otter Tail River and at least seven are present on the Pelican River. Some of these structures are completely impassable barriers to fish migration; others may be passable under seasonally high flows or have fish passageways constructed around them. These barriers and their effects on fish migrations pose a great threat to the integrity of biological communities within the Otter Tail River Watershed. Fish migrate for a variety of reasons, including to access spawning habitat, to escape stressful conditions, and for finding seasonal (winter) habitat (Aadland 2015; Aadland et al. 2005). The survival of a species is often dependent upon migration. One aquatic life impairment on the Pelican River is the result of a barrier dam located near Elizabeth. Species such as the northern hogsucker, rainbow darter, channel catfish, and various redhorse species are absent upstream of the dam. The samples collected from this reach contained higher numbers of more tolerant, generalist species (i.e. common carp, creek chub, fathead minnow, black bullhead) and lacked later maturing insectivorous species (i.e. redhorse species). Tolerant, generalist species are able to endure stressful conditions such as low DO during winter months or low flows and high water temperatures during drought conditions (Aadland et al. 2005, Matthews 1998). More sensitive, specialist species need access to refuge in order to survive these conditions and are unable to reach these areas because of barriers. Many of the same species absent from the Pelican River are also absent from the Otter Tail River above the Friberg-Taplin Gorge Dam. The numerous lakes located on the Otter Tail River likely provide refuge and have allowed other more specialized species to persist (when compared to the Pelican River).

The loss of hydrologic connectivity also threatens mussel populations throughout the Otter Tail River Watershed. Many of the fish species restricted by barrier dams are important hosts to the larval stage of freshwater mussels (Aadland 2015, 2018). Loss of their host species of fish will result in loss of the mussel. Dam construction is responsible for most of the recent mussel extinctions in North America (Haag 2009). The importance and beneficial role of mussels within aquatic ecosystems is often not understood and/or undervalued. Mussels help stabilize streambeds, increase the diversity of other benthic invertebrates, and filter impurities such as harmful contaminants and bacteria from the water (Aadland 2018). During the IWM process, some very dense mussel beds were found in the Otter Tail River two miles below the Friberg-Taplin Gorge Dam. The presence of these beds is an indicator of good water quality and excellent habitat - this stretch of river is a high value resource that should be protected from degradation. Some mussel species are very long lived and can persist long after the loss of their host species (Haag 2009). Mussel species present within the watershed upstream of barriers may be relic populations destined for extirpation due to loss of their host fish species (Aadland 2015, 2018). Whenever possible, efforts should be made to remove barriers and restore hydrologic connectivity throughout the Otter Tail River Watershed.

Most streams had water quality that was supportive of aquatic life and aquatic recreation. DO concentrations were generally good throughout the watershed; only three aquatic life impairments were due to low DO. High total suspended solids (TSS) concentrations were evident on the lower Otter Tail River and resulted in two reaches being impaired for aquatic life. This portion of the watershed lies within the Lake Agassiz Plain Ecoregion. The easily erodible soils of this region contain fine clay particles that readily suspend in the water column and will remain suspended for long periods of time. The intensive land use activities and hydrologic alterations within this portion of the watershed result in increased sediment inputs and stream channel erosion. Campbell Creek, a small headwater stream within the Upper Pelican River Subwatershed, also had TSS concentrations that exceeded the standard. Sediment levels and TSS concentrations were low to normal throughout the remainder of watershed. Sixty-three percent of the streams assessed for aquatic recreation were found fully supporting. Low levels of bacteria were found throughout most of the watershed. The Toad River Subwatershed contained higher levels of bacteria; as a result, three stream reaches were impaired for aquatic recreation. Two reaches of the Pelican River and one reach of the Otter Tail River also had consistently high levels of bacteria and are impaired for aquatic recreation. Work will need to be done to improve water quality within the impaired streams. Alternatively, with so many stream segments supporting both aquatic life and aquatic recreation use, protection efforts will be crucial to maintaining these resources.

The Otter Tail River Watershed has a high density of lakes with good water quality that supports recreational use and healthy aquatic communities. Two hundred thirty-two lakes had at least one water quality measurement available. Of these lakes, 191 had sufficient data to assess aquatic recreation use and 80 had sufficient data to assess aquatic life use. One hundred seventy-four lakes supported aquatic recreation use and 17 lakes were found to be impaired. This watershed contains a mixture of deep and shallow lakes. Deep lakes, which typically have a high recreational quality, have the ability to assimilate phosphorus within lakebed sediments. This not only limits internal nutrient loading within the lake itself, but also prevents phosphorus from being transferred to lakes further downstream. Shallow lakes often have higher phosphorus concentrations because they lack the ability to assimilate phosphorus. Most of the lakes that failed to support aquatic recreation use are relatively shallow and likely mix during large wind events. Shallow lakes that experience mixing events are vulnerable to nuisance algae blooms. Algal blooms reduce water clarity, thereby limiting the passage of sunlight through the water column and inhibiting the growth of native aquatic plants. In these lakes, protection of aquatic vegetation needs to be prioritized because these plants aid in phosphorus removal and nutrient uptake. Highly connected watersheds can also be vulnerable to eutrophication if nutrient loads from human activities increase anywhere “upstream” in the system. The excess nutrients can flow through these systems causing water quality to degrade in downstream waterbodies.

Sixty-eight lakes supported aquatic life use and 12 lakes were found to be impaired. The fish community in many lakes included intolerant fish species, such as the blacknose shiner, blackchin shiner, Iowa darter, banded killifish, and mimic shiner. Intolerant species are very sensitive to degradation and are often the first species to experience diminished distribution due to human influence. The presence of these species is an indicator of excellent water quality and aquatic habitat.

Groundwater Summary and Recommendations

Groundwater protection should be considered 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 increased from 1997 to 2016 at a statistically significant rate ($p<0.01$). The water table elevation for one of the DNR observation wells analyzed has displayed significant decreasing trends over the most recent 20 years of data collected ($p<0.01$). Overall, groundwater withdrawals have been increasing, the average potential groundwater recharge rate is comparable to the state average, 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 collected from two domestic wells within the MPCA Ambient Groundwater Monitoring Network indicate that although there were some detections of contaminants, the results were primarily within water quality limits. The majority of detections were from naturally occurring contaminants, while the most common exceedances were inorganic nitrogen (MCL), iron (SMCL), and manganese (HBV). Although arsenic was not detected in the domestic wells sampled by the MPCA, it is commonly found in this region of the state. Arsenic is linked to the presence of a clay layer and low DO levels, often associated with the Des Moines glacial lobe till, which is abundant in this area. Furthermore, the pollution sensitivity of near-surface materials throughout the watershed should be considered. While many of the areas ranged from ultra-low to moderate pollution sensitivity ranking, there are large areas that have 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.

Additional and continued monitoring will increase the understanding of the health of the watershed and its groundwater resources and aid in identifying the extent of the issues present and risk associated. 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.

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Appendix 1 – Water chemistry definitions

Dissolved oxygen (DO) - Oxygen dissolved in water required by aquatic life for metabolism. DO enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. DO 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 - Orthophosphate (OP) is a water-soluble form of phosphorus that is readily available to algae (bioavailable). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater 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, which 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 Otter Tail River Watershed

EQuIS ID	Biological Station ID	WID	Waterbody Name	Location	Aggregated 12-digit HUC
S008-841	16RD012	09020103-774	Otter Tail River	At Ridgewood Circle, 3 mi. E of Fergus Falls	0902010309-01
S008-842	16RD016	09020103-767	Pelican River	At Reed Creek Rd, 3.5 mi. N of Elizabeth	0902010308-01
S000-537	16RD020	09020103-521	Otter Tail River	At 390th St, 4.5 mi. SE of Perham	0902010306-01
S008-843	16RD022	09020103-770	Toad River	At CSAH 13, 4.5 mi. NE of Perham	0902010303-01
S008-844	16RD028	09020103-532	Otter Tail River	At 425th Ave, 2.5 mi. SE of Luce	0902010302-01
S002-176	16RD032	09020103-772	Pelican River	At Corbett Rd, in Detroit Lakes	0902010307-02
S003-937	05RD074	09020103-611	Otter Tail River	In Tamarac NWR (USFWS), 16 mi. NE of Detroit Lakes	002010301-01
S002-000	16RD001	09020103-502	Otter Tail River	At 11th St Bridge in Breckenridge	0902010310-01
S007-459	16RD002	09020103-761	County Ditch 3	At CSAH 10, 2.5 mi. NE of Breckenridge	0902010310-01
S008-840	16RD009	09020103-764	Judicial Ditch 2	At CR 160, 3.5 mi. SE of Foxhome	0902010310-02
S000-556	16RD013	09020103-768	Pelican River	At MN 210 1.1 mi. W of Fergus Falls	0902010308-01
S008-845	16RD034	09020103-574	Otter Tail River	Access at 2 Rivers Rd and canoe 0.5 mi.	0902010309-01

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Otter Tail River Watershed

WID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
09020103-565	09RD066	Solid Bottom Creek	Upstream of Hwy 113, 1 mi. E of Elbow Lake	Clearwater	0902010301-01
09020103-611	05RD074	Otter Tail River	Upstream of Tea Cracker Trail, 14 mi. NE of Detroit Lakes	Becker	0902010301-01
09020103-529	16RD030	Otter Tail River	Upstream of CSAH 29, 6.5 mi. E of Detroit Lakes	Becker	0902010302-01
09020103-529	10EM178	Otter Tail River	Downstream of Wannigan Rd, 3 mi. N of Frazee	Becker	0902010302-01
09020103-532	16RD028	Otter Tail River	Upstream of 425th Ave, 2.5 mi SE of Luce	Otter Tail	0902010302-01
09020103-563	10RD079	Deadhorse Creek	Upstream of CR 39, 3 mi. NW of Evergreen	Becker	0902010303-01
09020103-563	10RD082	Deadhorse Creek	Downstream of CR 39, 3 mi. NW of Evergreen	Becker	0902010303-01
09020103-526	16RD026	Toad River	West off end of 165th St, 2.5 mi. SW of Toad Lake	Becker	0902010303-01
09020103-526	16RD025	Toad River	Downstream of 125th St (Abandoned St W of CSAH 39), 6 mi. E of Frazee	Becker	0902010303-01
09020103-770	16RD022	Toad River	Downstream of CSAH 13, 4.5 mi. NE of Perham	Otter Tail	0902010303-01
09020103-622	05RD092	Trib to Big Pine Lake	Downstream of CR 52, 13 mi. SE of Frazee	Otter Tail	0902010306-01
09020103-521	05RD091	Otter Tail River	Downstream of Hwy 10, 1.5 mi. SE of Perham	Otter Tail	0902010306-01
09020103-521	16RD020	Otter Tail River	Downstream of 390th St, 5 mi. SE of Perham	Otter Tail	0902010306-01
09020103-523	16RD037	Willow Creek	Upstream of CSAH 14, 5 mi. W of New York Mills	Otter Tail	0902010306-01
09020103-561	05RD089	Brandborg Creek	Downstream of Brandborg Creek Rd, 2 mi. W of Henning	Otter Tail	0902010305-01
09020103-773	91RD009	Otter Tail River	Downstream of CSAH 10, 5 mi. NE of Fergus Falls	Otter Tail	0902010309-01
09020103-774	16RD012	Otter Tail River	Upstream of Ridgewood Cir, 3 mi. E of Fergus Falls	Otter Tail	0902010309-01
09020103-574	16RD034	Otter Tail River	1.75 mi. downstream of Hwy 59, 1 mi. W of Fergus Falls	Otter Tail	0902010309-01
09020103-772	16RD032	Pelican River	Adjacent to Jackson Ave, in Detroit Lakes	Becker	0902010307-02
09020103-767	16RD019	Pelican River	Upstream of 410th St, 1 mi. SW of Pelican Rapids	Otter Tail	0902010308-01
09020103-767	16RD016	Pelican River	Upstream of Reed Creek Rd, 3.5 mi. N of Elizabeth	Otter Tail	0902010308-01
09020103-653	16RD047	Reed Creek	Upstream of 310th St, 3 mi. N of Elizabeth	Otter Tail	0902010308-01
09020103-768	16RD013	Pelican River	Upstream of Hwy 210, 3 mi. W of Fergus Falls	Otter Tail	0902010308-01
09020103-764	16RD009	Judicial Ditch 2	Upstream of CR 160, 3.5 mi. SE of Foxhome	Wilkin	0902010310-02
09020103-506	91RD001	Otter Tail River	4.5 mi. upstream of CSAH 19, 5.5 mi SE of Foxhome	Otter Tail	0902010310-01
09020103-504	16RD008	Otter Tail River	Downstream of CSAH 17, 7 mi. SE of Breckenridge	Wilkin	0902010310-01
09020103-502	16RD001	Otter Tail River	Upstream of CSAH 16, 0.5 mi. N of Breckenridge	Wilkin	0902010310-01
09020103-502	10EM060	Otter Tail River	Downstream of Main St, in Breckenridge	Wilkin	0902010310-01

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	71	49	NA	±11
2	Southern Streams	2B	66	50	35	±9
3	Southern Headwaters	2B	74	55	33	±7
10	Southern Coldwater	2A	82	50	NA	±9
4	Northern Rivers	2B	67	38	NA	±9
5	Northern Streams	2B	61	47	35	±9
6	Northern Headwaters	2B	68	42	23	±16
7	Low Gradient	2B	70	42	15	±10
11	Northern Coldwater	2A	60	35	NA	±10
Invertebrates						
1	Northern Forest Rivers	2B	77	49	NA	±10.8
2	Prairie Forest Rivers	2B	63	31	NA	±10.8
3	Northern Forest Streams RR	2B	82	53	NA	±12.6
4	Northern Forest Streams GP	2B	76	51	37	±13.6
5	Southern Streams RR	2B	62	37	24	±12.6
6	Southern Forest Streams GP	2B	66	43	30	±13.6
7	Prairie Streams GP	2B	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 WID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 12: 0902010301-01 (Headwaters Otter Tail River)							
09020103-565	09RD066	Solid Bottom Creek	15.64	11	35	50.33	20-Jul-10
09020103-565	09RD066	Solid Bottom Creek	15.64	11	35	45.04	06-Jul-16
09020103-611	05RD074	Otter Tail River	94.56	5	47	55.13	20-Jun-16
09020103-611	05RD074	Otter Tail River	94.56	5	47	39.80	30-Aug-16
HUC 12: 0902010302-01 (Upper Otter Tail River)							
09020103-529	16RD030	Otter Tail River	228.69	5	47	50.87	15-Aug-11
09020103-529	10EM178	Otter Tail River	209.08	5	47	53.15	20-Jun-16
09020103-532	16RD028	Otter Tail River	352.48	4	38	49.62	21-Jun-16
HUC 12: 0902010303-01 (Toad River)							
09020103-563	10RD079	Deadhorse Creek	15.21	11	35	30.75	22-Jun-16
09020103-563	10RD082	Deadhorse Creek	15.20	11	35	40.59	08-Jul-10
09020103-526	10RD026	Toad River	40.98	6	42	56.49	20-Jun-16
09020103-526	10RD025	Toad River	80.32	5	47	37.04	20-Jun-16
09020103-770	10RD022	Toad River	110.32	5	47	60.36	21-Jun-17
HUC 12: 0902010306-01 (Otter Tail Lake – Otter Tail River)							
09020103-622	05RD092	Trib to Pine Lake	18.49	6	42	53.89	22-Jun-16
09020103-521	05RD091	Otter Tail River	567.49	4	38	35.82	05-Jul-16
09020103-521	05RD091	Otter Tail River	567.49	4	38	40.32	10-Aug-17
09020103-521	16RD020	Otter Tail River	601.77	4	38	42.23	05-Jul-16
09020103-523	16RD037	Willow Creek	19.42	7	42	42.70	02-Aug-16
HUC 12: 0902010305-01 (West Battle Lake)							
09020103-561	05RD089	Brandborg Creek	6.34	11	35	39.89	22-Jun-16
HUC 12: 0902010309-01 (Middle Otter Tail River)							
09020103-773	91RD009	Otter Tail River	1131.25	4	38	49.89	08-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
09020103-774	16RD012	Otter Tail River	1149.92	4	38	64.99	06-Jul-16
09020103-574	16RD034	Otter Tail River	1194.56	4	38	52.22	08-Aug-17
HUC 12: 0902010307-02 (Upper Pelican River)							
09020103-772	16RD032	Pelican River	56.54	5	47	27.34	22-Jun-16
HUC 12: 0902010308-01 (Lower Pelican River)							
09020103-767	16RD019	Pelican River	346.90	5	47	34.97	21-Jun-16
09020103-767	16RD019	Pelican River	346.90	5	47	32.00	28-Aug-17
09020103-767	16RD016	Pelican River	418.44	4	38	35.58	29-Aug-17
09020103-653	16RD047	Reed Creek	39.19	7	42	68.36	21-Jun-16
09020103-768	16RD013	Pelican River	492.37	1	49	74.15	21-Jun-16
HUC 12: 0902010310-02 (Judicial Ditch No. 2)							
09020103-764	16RD009	Judicial Ditch 2	64.17	2	50	35.17	22-Jun-16
HUC 12: 0902010310-01 (Lower Otter Tail River)							
09020103-506	91RD001	Otter Tail River	1734.20	1	49	82.22	30-Aug-17
09020103-504	16RD008	Otter Tail River	1826.20	1	49	70.62	29-Aug-17
09020103-502	16RD001	Otter Tail River	1906.69	1	49	33.25	29-Aug-17
09020103-502	10EM060	Otter Tail River	1907.88	1	49	47.86	22-Sep-11
09020103-502	10EM060	Otter Tail River	1907.88	1	49	76.89	12-Aug-15

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

National Hydrography Dataset (NHD) Assessment Segment WID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Invert Class	Threshold	MIBI	Visit Date
HUC 12: 0902010301-01 (Headwaters Otter Tail River)							
09020103-565	09RD066	Solid Bottom Creek	15.64	8	32	29.45	07-Oct-09
09020103-565	09RD066	Solid Bottom Creek	15.64	8	32	35.31	15-Aug-16
09020103-611	05RD074	Otter Tail River	94.56	3	53	58.46	29-Aug-16
HUC 12: 0902010302-01 (Upper Otter Tail River)							
09020103-529	16RD030	Otter Tail River	209.08	5	37	52.78	08-Aug-17
09020103-529	10EM178	Otter Tail River	228.69	6	43	69.36	10-Aug-11
09020103-532	16RD028	Otter Tail River	352.48	6	43	67.00	08-Aug-17
HUC 12: 0902010303-01 (Toad River)							
09020103-563	10RD079	Deadhorse Creek	15.21	8	32	37.01	21-Sep-10
09020103-563	10RD079	Deadhorse Creek	15.21	8	32	30.37	25-Aug-16
09020103-563	10RD082	Deadhorse Creek	15.20	8	32	36.60	22-Sep-10
09020103-563	10RD082	Deadhorse Creek	15.20	8	32	33.27	22-Sep-10
09020103-526	16RD026	Toad River	40.98	3	53	63.66	05-Oct-16
09020103-526	16RD025	Toad River	80.32	4	51	54.06	07-Aug-17
09020103-770	16RD022	Toad River	110.32	5	37	45.08	07-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 12: 0902010306-01 (Otter Tail Lake – Otter Tail River)							
09020103-622	05RD092	Trib. to Big Pine Lake	18.49	3	53	55.33	29-Aug-16
09020103-521	05RD091	Otter Tail River	567.49	2	31	57.02	07-Aug-17
09020103-521	16RD020	Otter Tail River	601.77	2	31	53.06	07-Aug-17
09020103-523	16RD037	Willow Creek	19.42	6	43	44.2	31-Aug-16
HUC 12: 0902010305-01 (West Battle Lake)							
09020103-561	05RD089	Brandborg Creek	6.34	9	43	50.89	31-Aug-16
HUC 12: 0902010309-01 (Middle Otter Tail River)							
09020103-773	91RD009	Otter Tail River	1131.25	2	31	53.75	29-Aug-17
09020103-774	16RD012	Otter Tail River	1149.92	2	31	70.31	29-Aug-17
09020103-574	16RD034	Otter Tail River	1194.56	2	31	46.97	28-Aug-17
HUC 12: 0902010307-02 (Upper Pelican River)							
09020103-772	16RD032	Pelican River	56.54	5	37	36.30	08-Aug-17
HUC 12: 0902010308-01 (Lower Pelican River)							
09020103-767	16RD019	Pelican River	346.90	6	43	64.54	28-Aug-17
09020103-767	16RD016	Pelican River	418.44	6	43	66.58	28-Aug-17
09020103-653	16RD047	Reed Creek	39.19	5	37	71.56	28-Aug-17
09020103-768	16RD013	Pelican River	492.37	6	43	55.24	29-Aug-17
National Hydrography Dataset (NHD) Assessment Segment WID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Invert Class**	**Threshold**	**MIBI**	**Visit Date**
HUC 12: 0902010310-02 (Judicial Ditch No. 2)							
09020103-764	16RD009	Judicial Ditch 2	64.17	7	41	27.83	30-Aug-16
HUC 12: 0902010310-01 (Lower Otter Tail River)							
09020103-506	91RD001	Otter Tail River	1734.20	2	31	43.32	29-Aug-17
09020103-504	16RD008	Otter Tail River	1826.20	2	31	26.00	29-Aug-17
09020103-502	10EM060	Otter Tail River	1907.88	2	31	21.32	14-Sep-15

Appendix 4.1 – Fish species found during biological monitoring surveys

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
bigmouth shiner	8	34
black bullhead	13	833
black crappie	12	49
blackchin shiner	3	4
blacknose dace	14	2247
blacknose shiner	7	196
blackside darter	18	181
bluegill	18	132
bluntnose minnow	12	292
bowfin	4	7
brassy minnow	4	9
brook stickleback	7	96
brook trout	3	177
brown bullhead	4	23
central mudminnow	17	364
central stoneroller	2	27
channel catfish	5	75
common carp	11	158
common shiner	20	3448
creek chub	18	1354
emerald shiner	3	119
fathead minnow	13	723
freshwater drum	1	7
Gen: Percina	1	2
Gen: redhorses	2	19
golden redhorse	10	179
golden shiner	5	24
goldeye	2	33
greater redhorse	3	24
green sunfish	13	178
hornyhead chub	11	666
hybrid minnow	1	1
hybrid sunfish	6	123
Iowa darter	9	129
johnny darter	21	709
lamprey ammocoete	3	11
largemouth bass	12	335
logperch	11	206
longnose dace	5	60

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
mimic shiner	3	5
mooneye	1	1
mottled sculpin	2	6
northern brook lamprey	2	2
northern hogsucker	6	52
northern pike	15	97
northern redbelly dace	7	387
orangespotted sunfish	5	114
pearl dace	4	48
pugnose shiner	2	2
pumpkinseed	7	31
quillback	3	11
rainbow darter	1	3
rock bass	13	116
sand shiner	3	9
sauger	1	1
shorthead redhorse	8	151
silver redhorse	9	75
smallmouth bass	9	276
smallmouth buffalo	1	3
spotfin shiner	9	735
spottail shiner	5	42
stonecat	2	4
tadpole madtom	8	50
walleye	6	13
weed shiner	7	66
white bass	1	4
white crappie	1	1
white sucker	25	759
yellow bullhead	9	91
yellow perch	13	256

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Acari		
Acari	27	166
Amphipoda		
Amphipoda	1	1
Gammarus	3	34
Hyalella	22	490
Basommatophora		
Ancylidae	1	3
Ferrissia	16	68
Gyraulus	4	24
Helisoma	1	1
Lymnaeidae	1	4
Physa	2	2
Physella	16	163
Planorbella	1	1
Planorbidae	2	3
Pseudosuccinea columella	3	5
Stagnicola	2	7
Coleoptera		
Dubiraphia	16	90
Elmidae	3	5
Gymnochthebius	1	1
Gyrinus	2	2
Haliplus	3	3
Helichus	4	4
Hydraena	1	1
Laccophilus	1	2
Macronychus	1	1
Macronychus glabratus	10	68
Optioservus	14	179
Stenelmis	21	162
Tropisternus	1	5
Decapoda		
Orconectes	13	13
Diptera		
Ablabesmyia	7	16
Antocha	3	3
Atherix	3	25
Brillia	6	18

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Cardiocladius	3	3
Ceratopogoninae	5	30
Chironomini	5	6
Chironomus	5	7
Cladotanytarsus	4	11
Clinotanypus	1	1
Conchapelopia	3	4
Corynoneura	5	13
Cricotopus	20	134
Cryptochironomus	1	1
Demicryptochironomus	1	1
Dicranota	6	14
Dicrotendipes	7	21
Dixa	2	3
Dixidae	1	1
Empididae	4	5
Endochironomus	1	2
Ephydridae	9	12
Eukiefferiella	5	5
Glyptotendipes	2	14
Hemerodromia	17	50
Hybomitra	1	1
Labrundinia	6	12
Limonia	1	1
Lopescladius	2	2
Micropsectra	8	26
Microtendipes	13	44
Nanocladius	4	5
Natarsia	1	1
Neoplasta	5	9
Nilotanypus	3	5
Nilothauma	1	1
Odontomesa	1	1
Orthocladiinae	6	8
Orthocladius	4	5
Orthocladius (Symposiocladius)	2	2
Parakiefferiella	3	3
Paramerina	1	1
Parametriocnemus	8	76
Paratanytarsus	7	15
Pentaneura	11	21
Phaenopsectra	9	13

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Polypedilum	27	303
Potthastia	2	4
Procladius	3	3
Psectrocladius	1	1
Pseudochironomus	3	24
Rheocricotopus	6	9
Rheotanytarsus	23	198
Simuliidae	2	3
Simulium	28	1244
Stempellinella	7	13
Stenochironomus	10	20
Stictochironomus	1	1
Synorthocladius	1	1
Tabanidae	2	2
Tanypodinae	3	3
Tanypus	1	2
Tanytarsini	4	4
Tanytarsus	15	61
Thienemanniella	20	41
Thienemannimyia	3	5
Thienemannimyia Gr.	18	59
Tipula	7	9
Tribelos	1	2
Tvetenia	7	29
Xenochironomus xenolabis	5	5
Xylotopus par	2	2
Zavrelimyia	1	1
Ephemeroptera		
Acentrella parvula	5	31
Acerpenna	8	54
Acerpenna pygmaea	9	195
Anafroptilum	1	1
Anthopotamus	1	1
Anthopotamus myops	2	5
Baetidae	1	11
Baetis	11	388
Baetis brunneicolor	7	132
Baetis flavistriga	8	91
Baetis intercalaris	5	76
Baetisca	2	2
Caenis	3	3
Caenis diminuta	10	111

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Caenis hilaris	4	31
Fallceon	3	24
Heptagenia	1	6
Heptageniidae	2	5
Hexagenia	1	1
Isonychia	1	1
Iswaeon	19	644
Labiobaetis frondalis	3	8
Labiobaetis propinquus	7	127
Leptophlebia	1	17
Leptophlebiidae	16	152
Leucrocuta	4	5
Maccaffertium	21	161
Maccaffertium exiguum	1	1
Maccaffertium mediopunctatum	6	19
Maccaffertium vicarium	2	9
Nixe	1	4
Plauditus	3	16
Procloeon	3	3
Stenacron	9	33
Tricorythodes	21	205
Haplotaxida		
Oligochaeta	20	73
Hemiptera		
Aquarius	1	1
Belostoma flumineum	9	13
Corixidae	1	6
Neoplea striola	3	5
Notonecta	1	1
Heterostropha		
Valvata	1	1
Hirudinea		
Hirudinea	7	10
Hydrozoa		
Hydrozoa	2	3
Lepidoptera		
Parapoynx	6	24
Petrophila	1	1
Nematoda		
Nemata	5	7
Neotaenioglossa		

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Hydrobiidae	8	117
Odonata		
Aeshna	1	1
Anax junius	3	3
Argia	2	6
Boyeria vinosa	2	2
Calopterygidae	3	8
Calopteryx	5	11
Calopteryx aequabilis	6	8
Coenagrionidae	11	122
Corduliidae	2	2
Enallagma signatum	1	1
Hetaerina	2	6
Hetaerina americana	1	3
Ophiogomphus	1	1
Somatochlora minor	1	1
Platyhelminthes		
Trepaxonemata	9	29
Turbellaria	2	12
Plecoptera		
Acroneuria	7	12
Agnetina	1	4
Amphinemura	1	1
Capniidae	2	9
Isoperla	7	22
Paragnetina media	1	1
Perlidae	1	2
Pteronarcys	4	8
Taeniopteryx	1	4
Trichoptera		
Brachycentrus numerosus	4	138
Ceraclea	9	40
Ceratopsyche	12	176
Ceratopsyche alhedra	1	9
Ceratopsyche bronta	4	68
Ceratopsyche morosa	7	47
Ceratopsyche slossonae	5	67
Ceratopsyche sparna	1	16
Cheumatopsyche	21	238
Chimarra	4	32
Glossosoma	4	39
Glossosomatidae	2	11

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Helicopsyche	3	29
Helicopsyche borealis	10	123
Hydatophylax argus	1	1
Hydropsyche	9	36
Hydropsyche betteni	8	134
Hydropsyche incommoda	1	18
Hydropsyche orris	1	1
Hydropsyche phalerata	3	9
Hydropsyche placoda	5	38
Hydropsyche simulans	3	22
Hydropsychidae	15	124
Hydroptila	7	36
Hydroptilidae	5	15
Lepidostoma	9	121
Leptoceridae	3	4
Limnephilidae	9	33
Limnephilus	3	9
Lype	2	20
Lype diversa	1	2
Micrasema rusticum	8	52
Molanna	2	2
Mystacides	4	82
Nectopsyche	3	30
Nectopsyche candida	1	2
Nectopsyche diarina	9	40
Neophylax fuscus	2	18
Neureclipsis	7	27
Nyctiophylax	2	4
Ochrotrichia	1	18
Oecetis	2	14
Oecetis avara	10	27
Oecetis furva	1	6
Oecetis testacea	13	52
Oxyethira	1	5
Philopotamidae	1	1
Phryganeidae	1	1
Polycentropodidae	4	4
Protoptila	8	91
Psychomyia flavida	2	7
Psychomyiidae	1	4
Ptilostomis	4	5
Pycnopsyche	3	5

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Triaenodes	6	47
Trichoptera	1	1
Uenoidae	2	5
Veneroida		
Dreissena polymorpha	2	2
Pisidiidae	19	94

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
3	09RD066	Solid Bottom Creek	5	13	21.4	14	23.3	76.7	Good
4	05RD074	Otter Tail River	5	12.5	22.5	14	23	77.0	Good
Average Habitat Results: ***Headwaters Otter Tail River Aggregated 12 HUC***			**5**	**12.8**	**21.9**	**14**	**23.2**	**76.9**	**Good**
2	16RD026	Toad River	3.8	8	21.6	12	21.5	66.9	Good
2	10RD079	Dead Horse Creek	2.5	13.5	19.8	13	23.5	72.3	Good
1	10RD082	Dead Horse Creek	1.5	11.5	21	16	35	85	Good
2	16RD025	Toad River	4	10	8	7	9.5	38.5	Poor
2	16RD022	Toad River	2.8	11.3	22.1	11	19	66.2	Good
Average Habitat Results: ***Toad River Aggregated HUC 12***			**2.9**	**10.9**	**18.5**	**11.8**	**21.7**	**65.8**	**Good**
2	16RD030	Otter Tail River	3.8	9	18	12.5	11.5	54.8	Good
1	10EM178	Otter Tail River	4.3	11	15	13	14	57.3	Fair
2	16RD028	Otter Tail River	3.4	11.5	15	13	7.5	50.4	Fair
Average Habitat Results: ***Upper Otter Tail River Aggregated HUC 12***			**3.8**	**10.5**	**16**	**12.8**	**11**	**54.2**	**Fair**
2	05RD092	Trib. to Big Pine Lk	2	10.5	19.6	15	25	72.1	Good
3	05RD091	Otter Tail River	3	10.5	14	8.3	9.7	45.5	Fair
2	16RD020	Otter Tail River	3.3	10.5	18.7	8.5	17.5	58.5	Fair
2	16RD037	Willow Creek	2.5	10.5	6.5	16	16	51.5	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
Average Habitat Results: *Otter Tail Lake – Otter Tail River Aggregated 12 HUC*			**2.7**	**10.5**	**14.7**	**11.9**	**17.1**	**56.9**	**Fair**
1	05RD089	Brandborg Creek	3	11	12	13.5	15	54.4	Fair
Average Habitat Results: *West Battle Lake Aggregated HUC 12*			**3**	**11**	**12**	**13.5**	**15**	**54.4**	**Fair**
2	91RD009	Otter Tail River	2.5	10.3	22.9	11	17	63.6	Fair
2	16RD012	Otter Tail River	3.1	8.5	18.5	16	21	67.1	Good
2	16RD034	Otter Tail River	3	10.3	19.7	14.5	15	62.5	Fair
Average Habitat Results: *Middle Otter Tail River Aggregated HUC 12*			**2.9**	**9.7**	**20.3**	**13.8**	**17.7**	**64.4**	**Fair**
2	16RD032	Pelican River	0.6	9.3	18.2	12.5	17	57.6	Fair
Average Habitat Results: *Upper Pelican River Aggregated 12 HUC*			**0.6**	**9.3**	**18.2**	**12.5**	**17**	**57.6**	**Fair**
3	16RD019	Pelican River	1.75	10	12	13	13.7	50.4	Fair
2	16RD016	Pelican River	2.5	10.8	14	13	15	55.3	Fair
2	16RD047	Reed Creek	2.5	11.8	17.4	16	18.5	66.2	Good
2	16RD013	Pelican River	1.25	10.5	19.6	17	19	67.4	Good
Average Habitat Results: *Lower Pelican River Aggregated 12 HUC*			**2**	**10.8**	**15.8**	**14.8**	**16.5**	**59.8**	**Fair**
2	16RD009	Judicial Ditch 2	0	7	11.4	8	3.5	29.9	Poor
Average Habitat Results: *Judicial Ditch No. 2 Aggregated HUC 12*			**0**	**7**	**11.4**	**8**	**3.5**	**29.9**	**Poor**
2	91RD001	Otter Tail River	0	7.8	19.3	10.5	17.5	55	Fair
2	16RD008	Otter Tail River	1.9	8.3	19	7.5	13.5	50.1	Fair
1	16RD001	Otter Tail River	0	6	13	7	9	35	Poor
2	10EM060	Otter Tail River	1	9.3	12.5	10	23	55.8	Fair
Average Habitat Results: *Lower Otter Tail River Aggregated HUC 12*			**0.7**	**7.8**	**15.9**	**8.8**	**15.8**	**48.9**	**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)

Appendix 6 – Lake protection and prioritization results

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority
03-0107-00	Toad	26.2	Improving trend	15%	83	A
03-0108-00	Sieverson	14.1	No data provided	8%	3	B
03-0134-00	Green Water	17.1	Insufficient data	6%	6	C
03-0136-00	Juggler	9.8	Improving trend	4%	6	A
03-0153-00	Island	21.9	No evidence of trend	6%	36	B
03-0155-00	Round	18.1	Improving trend	8%	211	C
03-0156-00	Ice Cracking	17.1	Insufficient data	7%	34	B
03-0158-00	Many Point	14.3	Insufficient data	4%	171	C
03-0159-00	Elbow	16.1	No evidence of trend	7%	114	B
03-0166-00	Hungry	21.1	Insufficient data	6%	16	B
03-0180-00	North Twin	15.9	No evidence of trend	14%	11	B
03-0189-00	Little Toad	24.7	Improving trend	7%	52	C
03-0195-00	Height of Land	34.5	No evidence of trend	9%	784	NA
03-0196-00	Chippewa	139.0	Insufficient data	3%	1,722	C
03-0197-00	Blackbird	34.4	Insufficient data	1%	350	C
03-0199-00	Johnson	24.6	Insufficient data	0%	4	C
03-0206-00	Upper Egg	43.4	Insufficient data	4%	68	C
03-0209-00	Carman	19.6	Insufficient data	6%	39	C
03-0213-00	Waboose	45.6	Insufficient data	3%	18	B
03-0216-00	Winter	25.2	Insufficient data	3%	54	C
03-0234-00	Little Bemidji	13.7	Insufficient data	6%	84	C
03-0242-00	Flat	32.5	Insufficient data	3%	156	B
Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority
03-0258-00	Acorn	21.6	No data provided	18%	4	A
03-0260-00	Chilton	20.0	Insufficient data	20%	6	B
03-0264-00	Town	29.5	No data provided	51%	22	B
03-0265-00	Eagle	17.4	Insufficient data	12%	6	A
03-0266-00	Albertson	21.0	Insufficient data	23%	203	C
03-0273-00	Perch	29.2	No evidence of trend	4%	2	C
03-0283-00	Howe	27.8	Insufficient data	8%	17	C
03-0286-00	Cotton	18.1	Declining trend	13%	34	A
03-0287-00	Pickerel	15.3	Improving trend	8%	12	B
03-0355-00	Sauer	23.1	Insufficient data	16%	11	B
03-0357-00	Munson	20.4	No evidence of trend	45%	3	A
03-0358-00	Fox	15.2	Improving trend	22%	2	A
03-0359-00	Sallie	40.9	No evidence of trend	32%	308	B
03-0360-00	Muskrat	34.7	No evidence of trend	22%	132	C
03-0363-00	Curfman	22.9	No evidence of trend	36%	4	A
03-0366-00	Abbey	49.6	No evidence of trend	27%	8	B
03-0371-00	Meadow	17.1	No evidence of trend	38%	2	A
03-0374-01	Johnson	26.3	No evidence of trend	10%	22	C
03-0374-02	Reeves	26.5	No evidence of trend	10%	20	C
03-0377-00	Mill	20.0	Insufficient data	29%	119	C
03-0381-00	Detroit	24.6	Improving trend	42%	185	A
03-0382-00	St. Clair	84.7	No evidence of trend	40%	68	NA
03-0383-00	Long	15.1	No evidence of trend	38%	9	A
03-0386-00	Little Floyd	25.4	No evidence of trend	22%	53	C
03-0387-01	Mud	34.1	No evidence of trend	28%	77	C
03-0387-02	Floyd	18.8	Improving trend	28%	52	A
03-0420-00	Sands	33.7	Insufficient data	11%	3	C

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority
03-0474-00	Dart	52.3	Insufficient data	56%	3	C
03-0475-00	Melissa	23.7	No evidence of trend	38%	243	B
03-0486-00	Pearl	29.1	No evidence of trend	27%	15	A
03-0489-00	Loon	34.0	Insufficient data	28%	20	B
03-0500-00	Maud	17.0	No evidence of trend	31%	22	A
03-0503-00	Eunice	16.2	Declining trend	37%	25	A
03-0506-00	Little Cormorant	39.2	No evidence of trend	38%	26	A
03-0575-00	Leif	33.0	No evidence of trend	32%	19	A
03-0576-00	Big Cormorant	17.9	No evidence of trend	31%	93	A
03-0577-00	Dahlberg	273.0	Insufficient data	54%	55	C
03-0582-00	Ida	31.1	No evidence of trend	40%	18	A
03-0587-00	Rossman	48.8	Improving trend	18%	19	B
03-0588-00	Upper Cormorant	31.3	Declining trend	30%	49	A
03-0595-00	Nelson	25.0	No evidence of trend	13%	34	C
03-0596-00	Unnamed (Larsen)	51.7	No evidence of trend	14%	3	C
03-0602-00	Middle Cormorant	18.7	No evidence of trend	33%	35	A
03-0638-00	Bijou	37.7	Improving trend	41%	9	A
15-0108-00	Pickerel	8.5	Insufficient data	6%	3	A
15-0122-00	Lower Camp	12.2	No data provided	0%	4	C
15-0123-00	Hoot Owl	8.0	Insufficient data	1%	7	C
56-0126-00	Nitche	18.3	No data provided	13%	3	B
56-0130-00	Big Pine	35.8	Improving trend	31%	1,463	C
56-0138-00	East Battle	15.9	Improving trend	37%	127	A
56-0141-00	Rush	29.3	No evidence of trend	44%	1,369	B
56-0142-00	Little Pine	28.9	Improving trend	58%	842	B
56-0171-02	Peterson	86.6	Insufficient data	82%	16	C
56-0178-00	Ellingson	38.0	Insufficient data	54%	44	C

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority
03-0474-00	Dart	52.3	Insufficient data	56%	3	C
56-0191-01	Stuart	15.3	Improving trend	45%	42	A
56-0193-00	Ethel	11.6	No evidence of trend	57%	5	A
56-0194-00	Emma	12.8	Insufficient data	8%	2	B
56-0195-00	Beauty Shore	16.5	Insufficient data	22%	2	A
56-0196-00	Mason	15.0	Insufficient data	59%	4	A
56-0209-00	Buchanan	21.2	Insufficient data	69%	16	A
56-0210-00	Long	125.0	No data provided	30%	88	B
56-0213-00	Head	25.5	Insufficient data	20%	25	B
56-0214-00	Round	29.5	Improving trend	48%	5	A
56-0224-00	Silver	26.0	Insufficient data	37%	13	A
56-0229-00	Murphy	32.1	Insufficient data	19%	97	B
56-0237-00	Belmont	16.5	Insufficient data	53%	19	A
56-0238-00	Clitherall	12.3	No evidence of trend	70%	77	A
56-0239-00	West Battle	14.1	Improving trend	69%	246	A
56-0240-00	Blanche	15.9	Improving trend	6%	190	C
56-0241-00	Annie Battle	13.0	Insufficient data	19%	124	C
56-0242-00	Otter Tail	20.2	No evidence of trend	65%	1,949	A
56-0243-00	Marion	21.1	No evidence of trend	39%	29	A
56-0245-00	Devils	15.3	No evidence of trend	33%	27	A
56-0293-00	Crane	21.2	Insufficient data	64%	46	A
56-0297-00	Round	22.4	Improving trend	17%	2	A
56-0298-00	Deer	18.6	No evidence of trend	32%	834	C
56-0302-01	First Silver	22.4	Improving trend	60%	17	A
56-0302-02	Second Silver	49.7	Insufficient data	60%	31	B
56-0302-04	Third Silver (Main Bay)	20.3	Insufficient data	60%	12	A
56-0303-00	Molly Stark	11.0	Insufficient data	71%	96	B

03-0474-00	Dart	52.3	Insufficient data	56%	3	C
56-0310-00	Walker	37.1	Declining trend	30%	353	A
56-0315-00	Brown	25.3	Insufficient data	49%	3	A
56-0320-00	Tamarack	38.4	Insufficient data	12%	37	C
56-0328-00	Little McDonald	9.6	Improving trend	20%	17	A
56-0330-00	Grunard	17.3	Insufficient data	15%	2	B
56-0335-00	Paul	10.9	Declining trend	26%	6	A
56-0345-00	Wolf	22.4	Insufficient data	41%	12	A
56-0355-00	Wimer	22.3	Insufficient data	21%	14	B
56-0356-00	Fairy	13.6	Insufficient data	31%	1	A
56-0357-00	Five	11.7	Insufficient data	2%	4	C
56-0358-00	Scalp	10.7	Improving trend	5%	9	B
56-0360-00	Rose	14.4	No evidence of trend	27%	31	A
56-0363-00	Rice	29.2	Insufficient data	8%	406	C
56-0364-00	Jim	22.2	Insufficient data	12%	1	B
56-0368-00	Graham	31.2	Insufficient data	12%	2	A
56-0369-00	Six	9.2	Improving trend	2%	2	B
56-0378-02	East Lost	50.7	Improving trend	26%	2,424	C
56-0382-00	Twin	20.2	Insufficient data	22%	9	A
56-0383-00	Dead	23.4	Improving trend	14%	302	A
56-0385-00	Star	18.0	Improving trend	19%	142	A
56-0386-01	Big McDonald	14.6	No evidence of trend	19%	19	A
56-0386-02	West McDonald	10.1	No evidence of trend	28%	10	A
56-0386-03	Big McDonald #2	13.8	Improving trend	14%	8	A
56-0387-00	Sybil	10.9	No evidence of trend	33%	30	A
56-0388-02	Long (main lake)	21.5	No evidence of trend	31%	119	A
56-0448-00	Anna	14.4	No data provided	62%	27	A
Lake ID	**Lake Name**	**Mean TP**	**Trend**	**% Disturbed Land Use**	**5% Load Reduction Goal**	**Priority**

56-0449-00	Pleasant	20.3	Insufficient data	53%	37	A
56-0450-00	Little Anna	46.5	Insufficient data	59%	50	C
56-0475-00	Pickerel	12.1	Declining trend	56%	13	A
56-0476-00	Maine (Round)	39.5	Insufficient data	43%	6	B
56-0481-00	West Lost	18.0	No data provided	31%	948	C
56-0489-00	North Long	20.0	Insufficient data	0%	14	C
56-0490-00	Round	32.5	Insufficient data	2%	16	C
56-0501-00	East Spirit	14.3	Improving trend	27%	19	A
56-0502-00	West Spirit	75.3	No evidence of trend	13%	15	NA
56-0517-00	East Silent	10.2	Declining trend	16%	6	A
56-0519-00	West Silent	11.1	No evidence of trend	10%	5	A
56-0522-00	Round	31.9	Insufficient data	19%	43	C
56-0523-00	East Loon	13.3	Declining trend	24%	37	A
56-0527-00	Hand	17.3	Insufficient data	9%	3	B
56-0532-02	Leek (Trowbridge)	18.0	Declining trend	13%	21	A
56-0547-00	Hook	28.2	Insufficient data	4%	5	C
56-0555-00	Lawrence	30.3	Insufficient data	14%	9	C
56-0569-01	Norway	122.7	Insufficient data	62%	78	C
56-0570-00	Bass	36.1	Insufficient data	64%	15	A
56-0575-00	Long	20.7	Insufficient data	15%	15	B
56-0578-00	Holbrook	44.5	Insufficient data	8%	15	C
56-0658-00	Wall	28.5	No evidence of trend	50%	48	A
56-0684-00	Fish	31.3	Insufficient data	57%	40	A

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority
56-0690-00	Tonseth	18.9	Insufficient data	9%	11	C
56-0695-00	Heilberger	14.8	No evidence of trend	21%	7	A
56-0701-00	Big Stone	51.0	Insufficient data	14%	32	C
56-0711-00	Otter Tail River (Red River)	20.3	Insufficient data	22%	1,060	C
56-0716-00	Anderson	33.8	No data provided	4%	12	C
56-0724-00	Beers	14.7	Insufficient data	7%	4	A
56-0728-00	Twenty-one	16.1	Insufficient data	7%	6	B
56-0737-00	Eddy	25.8	Insufficient data	12%	7	B
56-0747-01	North Lida	19.5	Improving trend	19%	116	A
56-0747-02	South Lida	31.5	Declining trend	19%	124	B
56-0749-00	Crystal	21.6	Improving trend	6%	29	A
56-0759-00	Franklin	22.4	Improving trend	9%	29	A
56-0760-00	Lizzie	35.0	No data provided	27%	993	C
56-0760-01	Lizzie (north portion)	16.1	Improving trend	27%	415	B
56-0760-02	Rush-Lizzie(south portion)	20.0	Insufficient data	27%	390	B
56-0761-00	Little Pelican	24.9	Declining trend	18%	238	A
56-0768-00	Fish	12.2	Improving trend	15%	193	C
56-0770-00	Bass	16.5	No evidence of trend	40%	0	A
56-0782-00	Hoot	22.8	Insufficient data	49%	3	A
56-0783-00	Wright	19.5	No data provided	30%	3	A
56-0784-00	Long	20.0	No evidence of trend	18%	76	B
56-0786-00	Pelican	16.6	Improving trend	39%	390	A
56-0824-00	Otter Tail River - Dayton Hollow Reservoir	42.8	Insufficient data	81%	1,222	C
Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% Load Reduction Goal	Priority

56-0829-00	Pebble	22.4	Insufficient data	44%	5	A
56-0834-00	Horseshoe	34.2	Insufficient data	63%	11	B
56-0877-00	Jewett	20.7	Improving trend	56%	10	A
56-0882-00	Devils	100.4	Insufficient data	46%	44	B
56-0907-00	Grandrud	62.3	Insufficient data	23%	7	B
56-0915-00	Prairie	21.8	No evidence of trend	57%	435	B
56-0931-00	Tamarac	25.6	Improving trend	59%	18	A
56-0942-00	Sand	36.6	Insufficient data	75%	11	A
56-0945-00	Orwell	81.1	Insufficient data	72%	2,544	C
56-0979-00	Johnson	97.7	Insufficient data	76%	18	C
56-0982-00	Oscar	158.4	Insufficient data	77%	83	C
56-1627-00	Hoffman	27.5	No evidence of trend	33%	12	B
56-1636-00	Kerbs	8.2	Improving trend	39%	1	A
56-1641-00	Rusch	22.7	Insufficient data	30%	10	B

Appendix 7 – Stream protection and prioritization results

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09020103-506	Otter Tail River	General	Warm	Neither	Medium	High	Low	B
09020103-521	Otter Tail River	General	Warm	One	Medium	Med/High	Med/Low	A
09020103-529	Otter Tail River	General	Warm	Neither	Med/High	Medium	Medium	B

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
09020103-561	Brandborg Creek	General	Cold	One	High	High	Low	A
09020103-563	Dead Horse Creek	General	Cold	Both	Med/Low	Med/High	Med/Low	A
09020103-565	Solid Bottom (Elbow Lake Creek)	General	Cold	One	Low	Med/Low	High	B
09020103-574	Otter Tail River	General	Warm	Neither	High	High	Low	A
09020103-611	Otter Tail River	General	Warm	One	Low	Med/Low	Medium	B
09020103-612	Otter Tail River	General	Warm	Neither	Low	Med/Low	Med/Low	C
09020103-622	Unnamed creek	General	Warm	One	Med/High	High	Low	A
09020103-653	Reed Creek	General	Warm	Neither	Med/High	High	Low	A
09020103-744	Egg River	General	Warm	Neither	Med/Low	Low	Med/Low	C
09020103-768	Pelican River	General	Warm	Neither	Med/High	High	Low	A
09020103-770	Toad River	General	Warm	Neither	Med/High	Med/High	Med/Low	B
09020103-771	Pelican River	General	Warm	Neither	High	High	Med/Low	A
09020103-773	Otter Tail River	General	Warm	Neither	Med/High	High	Low	A
09020103-774	Otter Tail River	General	Warm	Neither	High	High	Low	A