Long Prairie River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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List of Acronyms

AUID Assessment Unit Identification Determination

CCSI Channel Condition and Stability Index

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DOP Dissolved Orthophosphate

E Eutrophic

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

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MnDNR Minnesota Department of Natural Resources

MINLEAP Minnesota Lake Eutrophication

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 Phosphorus

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

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 Phosphorus

TSS Total Suspended Solids

USGS United States Geological Survey

WPLMN Water Pollutant Load Monitoring Network

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Executive summary

The Long Prairie River Watershed (07010108) lies within the west-central portion of Minnesota, originating from Lake Carlos in east-central Douglas County.The Long Prairie River flows approximately 92 miles through Todd and Morrison Counties where it enters the Crow Wing River approximately one mile south-east of Motley. The watershed covers approximately 571,712 acres (893 mi^2) and includes 65 lakes greater than 10 acres and 26 named stream assessment units (AUIDs).

The Long Prairie River provides habitat for aquatic life, riparian corridors for wildlife, and recreational opportunities such as fishing, swimming and canoeing. Today, roughly 54% of the watersheds landscape is utilized for cropland and/or pasture, 24% is forested, 7.5% is open water, and 6% is developed land that is used for housing, business and industrial complexes, county roads and city streets (Figure 7).

In 2011, the Minnesota Pollution Control Agency (MPCA) initiated an intensive watershed monitoring effort of the Long Prairie River Watershed's surface waters. Thirty-seven stream sites were sampled for biology at the outlets of variable sized subwatersheds within the Long Prairie River Watershed. These locations included the mainstem Long Prairie River, outlets of major tributaries, and the headwaters of smaller streams. As part of this effort, MPCA staff joined with the Morrison, Douglas, and Todd County Soil and Water Conservation Districts (SWCD) as well as the Otter Tail County Coalition of Lake Associations (COLA) to complete stream and lake water chemistry sampling. In 2013, a holistic approach was taken to assess all of the watershed's surface waterbodies for support or non-support of aquatic life, recreation, and fish consumption, where sufficient data was available. Twenty stream stream segments (e.g. AUIDs) and sixty lakes were attempted to be assessed in this effort. (Not all lake and stream AUIDs were able to be assessed due to insufficient data, modified channel condition or their status as limited resources waters).

Throughout the watershed, eight streams fully support aquatic life and four fully support aquatic recreation. Twelve streams do not support aquatic life and three do not support aquatic recreation. Aquatic recreation impairments are due to high bacteria levels. Three AUIDs will be proposed for delisting of their current impairment status: Long Prairie River (AUID 07010108-501) for Dissolved Oxygen, Long Prairie River (AUID - 504) for F-IBI, and Eagle Creek (AUID - 507) for F-IBI and M-IBI.

Of the 65 lakes greater than 10 acres, 50 lakes support and 10 do not support aquatic recreation, while three do not support aquatic life due to high chloride concentrations.

Six AUIDs were not assessed for aquatic biology because the reach was over 50% channelized. Channelized reaches are currently not being assessed until new biological standards are developed. However a more general characterization of biological quality at channelized streams indicated that their condition ranged from poor to good for both fish and macroinvertebrates.

The primary resource concerns in the watershed are low dissolved oxygen concentrations on the Long Prairie River, as well as wind and water soil erosion and surface and ground water management/quality throughout the watershed. Changes in landuse patterns including increased development, wetland removal, and agriculture have all likely contributed to sediment and pollutant loadings to surface waters, thus reducing populations of sensitive aquatic species.

Introduction

Water is one of Minnesota's most abundant and precious resources. The MPCA is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) which requires states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of 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 (CWLA) 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 Long Prairie River Watershed beginning in the summer of 2011 and concluding in summer of 2013. This report provides a summary of all water quality assessment results in the Long Prairie River Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

I. 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 81 major watersheds (Figure 1). The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA 2007) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Pollutant Load Monitoring Network

Funded with appropriations from Minnesota's Clean Water Legacy Fund, the Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers. Since the network's inception in 2007, the WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MnDNR) flow gaging stations, with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations and Minnesota Pollution Control Agency WPLMN staff to compute annual pollutant loads at 79 river monitoring sites across Minnesota. The network is in the process of being expanded to the subwatershed level, effectively tripling the number of monitoring sites. Intensive water quality sampling occurs year round at all WPLMN sites. Data will also be used to assist with TMDL studies and implementation plans, watershed modeling efforts and watershed research projects.

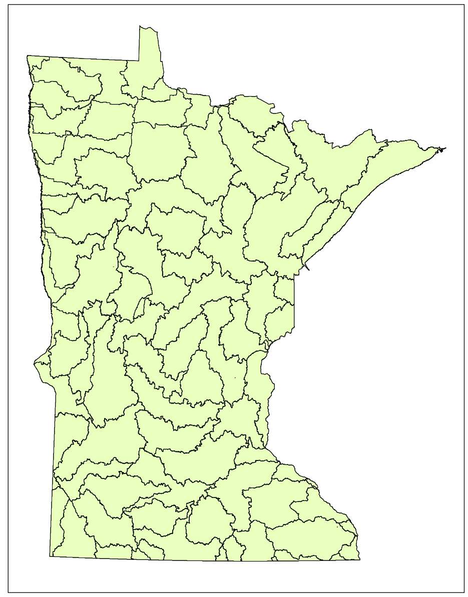

Figure 1. Major watersheds within Minnesota (8 digit HUC scale).

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. 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 81 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, HUC-11 and HUC-14 (Figure 2). 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 3) 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 HUC-11 is the next smallest subwatershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each HUC-11 outlet (green triangles in Figure 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each HUC-11, smaller subwatersheds (HUC-14s, typically 10-20 mi^2), are sampled at each outlet that flows into the major HUC-11 tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots and triangles in Figure 3).

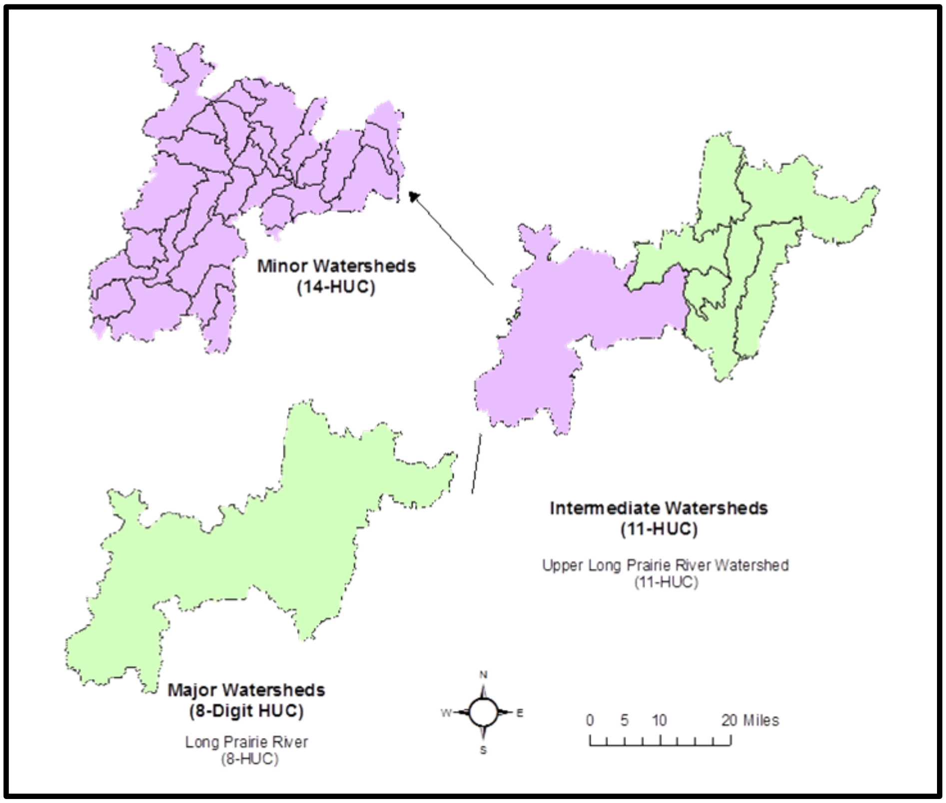

Figure 2. The intensive watershed monitoring design.

Within the intensive watershed monitoring strategy, lakes are selected to represent the range of conditions and lake type (size and depth) found within the watershed. Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported. Lakes are sampled monthly from May-September for a two-year period. Other than evaluyating chloride levels, there is currently no tool that allows us to determine if lakes are supporting aquatic life; however, a method that includes monitoring fish and aquatic plant communities is in development.

Specific locations for sites sampled as part of the intensive monitoring effort in the Long Prairie River Watershed are shown in Figure 3 and are listed in Appendix 2, Appendix 4.2, Appendix 4.3, Appendix 5.2 and Appendix 5.3.

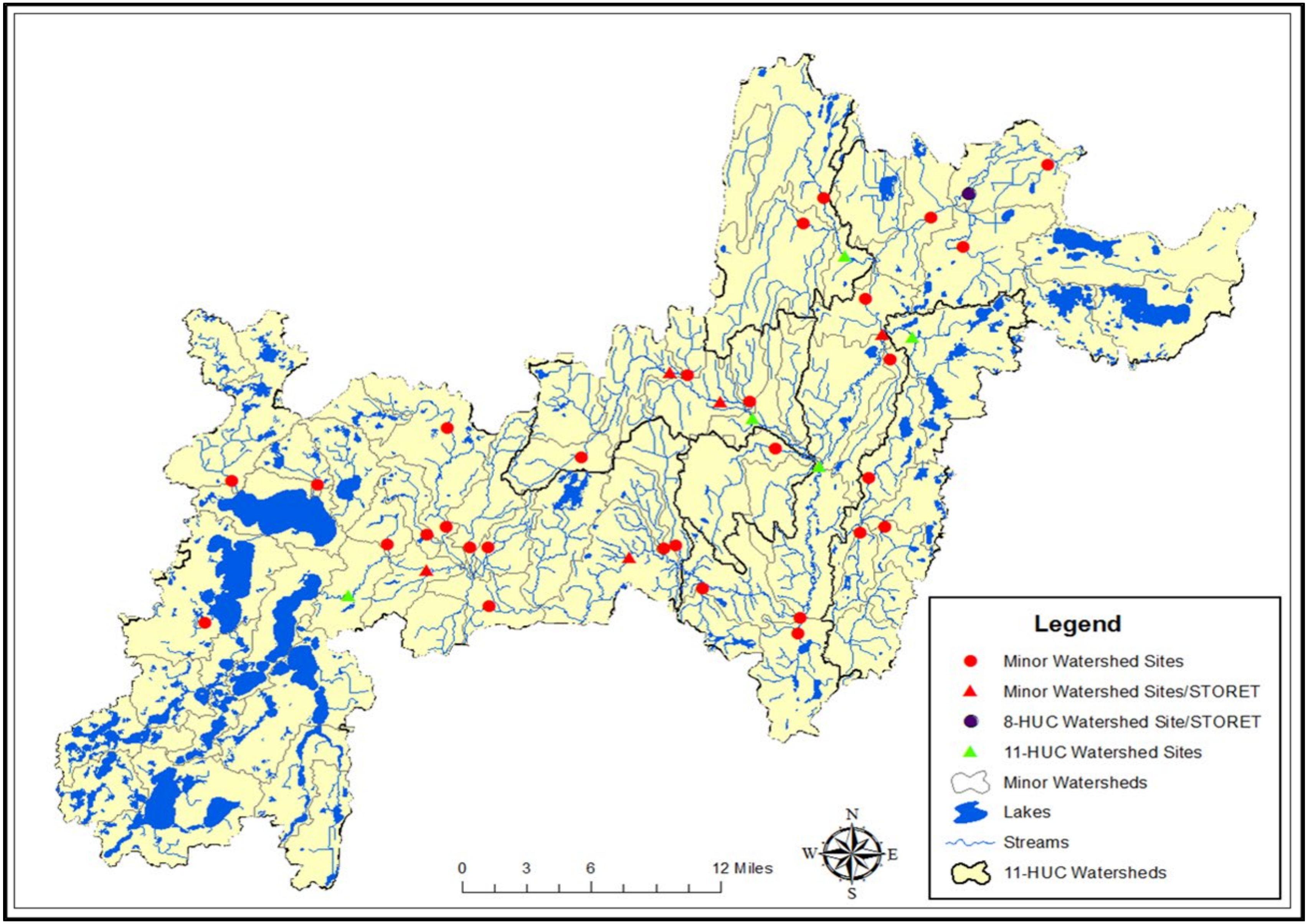

Figure 3. Intensive watershed monitoring sites for streams in the Long Prairie River River Watershed.

Citizen and local monitoring

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

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 4 provides an illustration of the locations where citizen monitoring data were used for assessment in the Long Prairie River Watershed.

The Clean Water Act 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 2010). http://www.pca.state.mn.us/index.php/view-document.html?gid=8601.

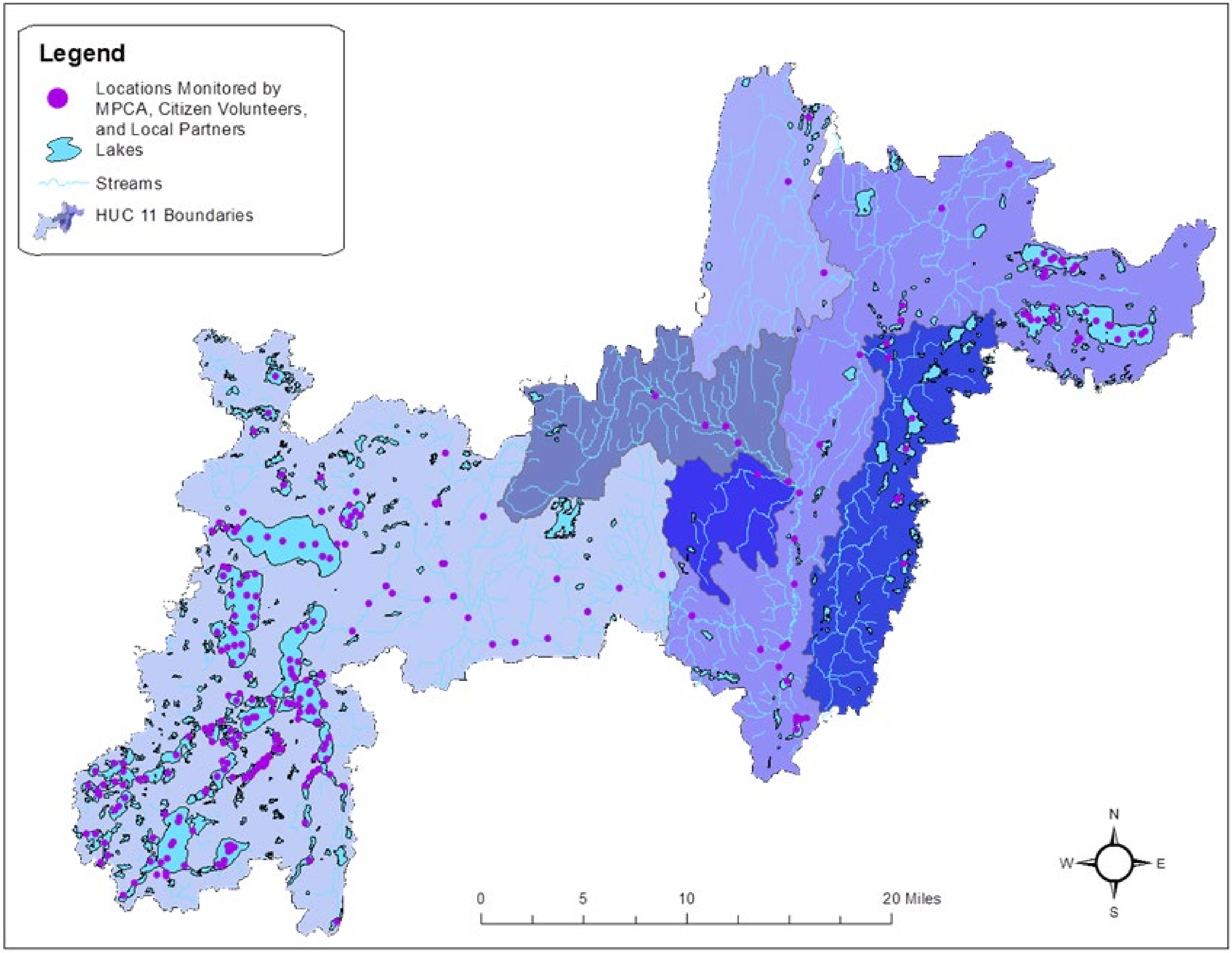

Figure 4. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Long Prairie River Watershed.

II. Assessment methodology

The Clean Water Act 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 2010). http://www.pca.state.mn.us/index.php/view-document.html?gid=8601.

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 life means the maintenance of a healthy aquatic community, including fish, invertebrates and plants. The sampling of aquatic organisms for assessment is called biological monitoring. Biological monitoring 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. Interpretations of narrative criteria for aquatic life in streams are based on multi-metric biological indices including the Fish Index of Biological Integrity (Fish IBI), which evaluates the health of the fish community, and the Macroinvertebrate Index of Biological Integrity (Invert IBI), which evaluates the health of the aquatic invertebrate community. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life, including pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride and turbidity.

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.

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, dissolved oxygen and toxic pollutants.

Assessment units

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

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

Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA’s assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 5.

The first step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. This is largely an automated process performed by logic programmed into a database application and the results are referred to as ‘Pre-Assessments’. 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 (e.g. desktop) using computer applications to analyze the data for potential temporal or spatial trends as well as gain a better understanding of any attenuating circumstances that should be considered (e.g. flow, time/date of data collection, or habitat).

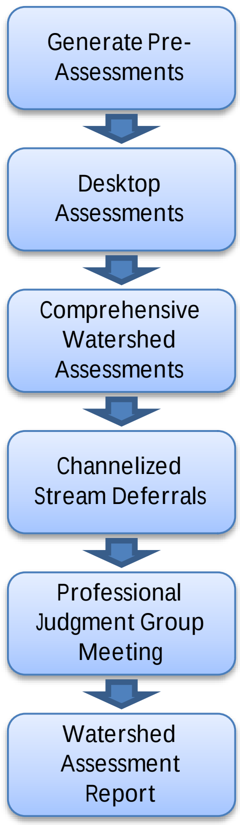

Figure 5. Flowchart of aquatic life use assessment process.

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody, implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2010) http://www.pca.state.mn.us/index.php/view-document.html?gid=16988 for guidelines and factors considered when making such determinations.

Any new impairment (e.g. waterbody not attaining its beneficial use) is first reviewed using GIS to determine if greater than 50% of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the Tiered Aquatic Life Use (TALU) framework. 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). However, in this report, channelized reaches with biological data are evaluated on a "good-fair-poor" system to help evaluate their condition (see Section IV and Appendix 5.1).

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

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments and volunteers. The data must meet rigorous quality assurance protocols before being used. All monitoring data required or paid for by MPCA are entered into EQuIS (Environmental Quality Information System), MPCA's data system and are also uploaded to the US Environmental Protection Agency's data warehouse. Data for monitoring projects with federal or state funding are required to be stored in EQuIS (e.g. Clean Water Partnership, CWLA Surface Water Assessment Grants and TMDL program). Many local projects not funded by MPCA also choose to submit their data to the MPCA in an EQuIS-ready format so that the monitoring data may be utilized in the assessment process. Prior to each assessment cycle, the MPCA sends out a request for monitoring data to local entities and partner organizations.

Period of record

The MPCA uses data collected over the most recent ten year period for all water quality assessments. This time-frame provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data for the entire period is not required to make an assessment. The goal is to use data that best represents current water quality conditions. Therefore, recent data for pollutant categories such as toxics, lake eutrophication and fish contaminants may be given more weight during assessment.

III. Watershed overview

Physical setting

From its source at Lake Carlos, the Long Prairie River flows north eastward 92 miles to its confluence with the Crow Wing River roughly one mile south-east of Motley. Beginning shortly downstream of the headwaters, a major transition occurs from hardwood forests with many wetlands and lakes to a prairie landscape with few wetlands and lakes. Towards the outlet of the watershed the landscape again transitions into more forests and lakes with less agricultural lands. The watershed covers 893 mi^2 and drains approximately 571,712 acres. The main portion of the watershed begins in central Douglas County and encompasses portions of Otter Tail, Todd, Morrison, and Wadena Counties.

History

The Long Prairie River played a vital role in the early settlement pattern of Todd County (Todd County SWCD, 2011). The lands were first inhabited by the Dakota and Ojibwe Indian tribes. European imigrants first established settlements in the areas around the river and its grass filled valleys as early as the 1840s. The valleys provided hunting grounds while the river itself provided a link with the Crow Wing and Mississippi Rivers. Settler used flat bottomed boats and steamboats for transportation and shipping on the Long Prarie River. By the mid-1960s those early settlements had grown into the communities of Long Prairie,Motley, Clotho and Browerville.

During this same time period commercial logging began in the area. Eagle, Moran, Fish Trap, and Turtle Creeks were all large enough, at that time, to power mills and float logs to the Long Prairie River where they joined other log rafts on their way to the Crow Wing and Mississippi Rivers (Todd County SWCD 2011). Pre-Europeant settlement maps show that 65.5% of the area was covered in a variety of hard woods and pines. By the 1990s only 21% of the area was forested and over 60% of the area was cultivated forhay, pasture, or grassland (Todd County SWCD 2011). The removal of thehardwood forests resulted in increased erosion and gradual filling in of streams with sediment.

As settlements in the Long Prairie River Watershed grew, logging operations began to slow. Roads and railroads became the new modes of transportation for shipping. Landowners turned to the river as a source of water for themselves, livestock, and irrigation. Industries also began to use the river as a source of water and as a discharge point for waste materials. Today, irrigation for agriculture is common throughout the watershed, but most landowners now get water from the shallow sand aquifers along the river. The river still provides many recreation opportunities such as swimming, canoeing, and fishing for species such as walleye and northern pike.

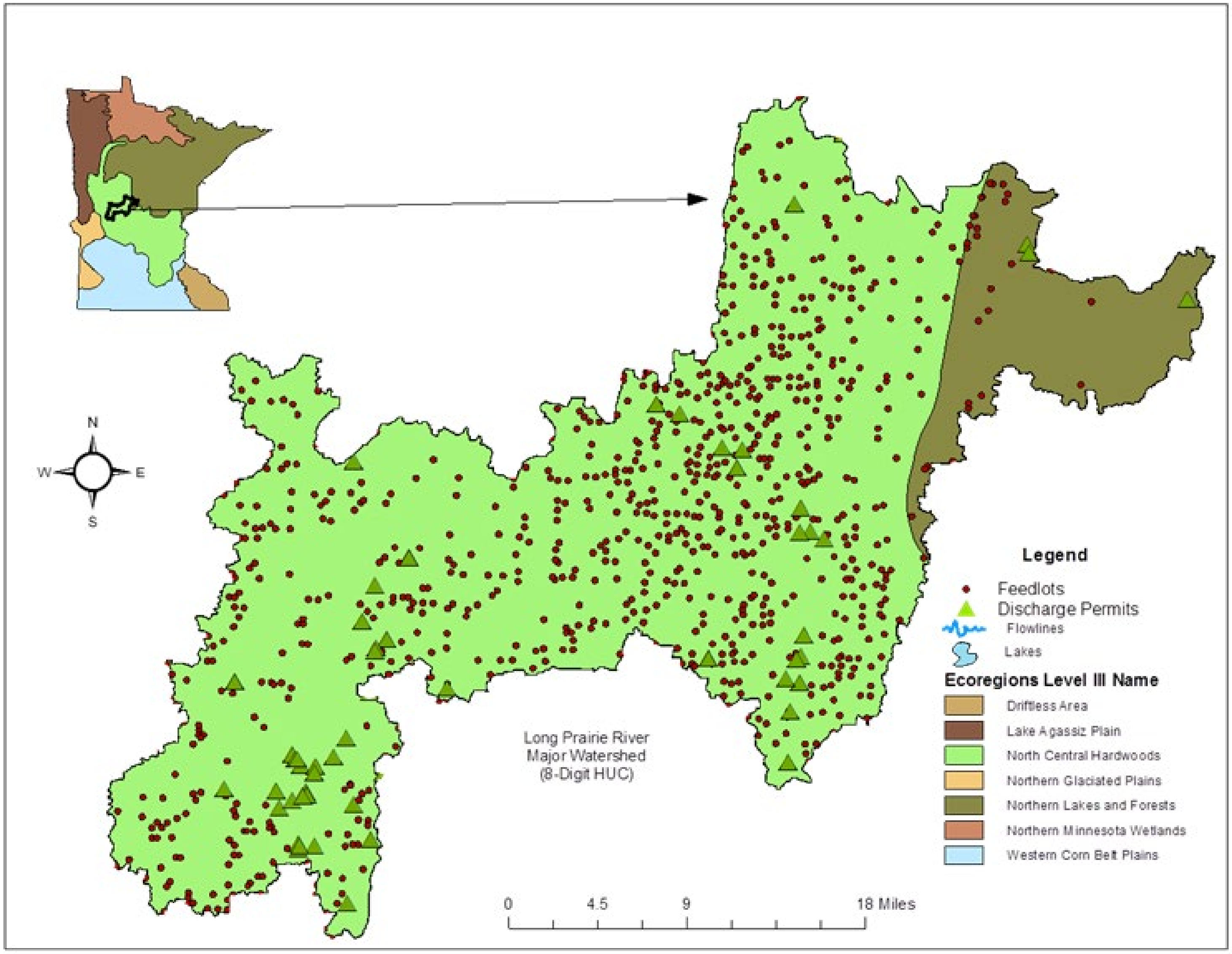

Figure 6. Permitted feedlots and NPDES discharges within the Long Prairie River Watershed, Northern Lakes and Forests and the North Central Hardwood Forests ecoregions of Central Minnesota.

Land use summary

Many types of land use occur within the Long Prairie River Watershed including wild rice beds, grass and cattail marshes, farm fields, riparian forests, and urban areas. The western portion of the watershed is typified by many lakes and streams scattered among agricultural and forested areas. Agricultural lands become more prominent further east in the watershed with very few lakes, and river banks that are lined by farm fields. In the extreme eastern portion of the watershed lakes again become numerous and the landscape is dominated by forests.

The Long Prairie River Watershed lies within two of Minnesota's ecoregions (Figure 6). The watershed is predominantly located within the North Central Harwood Forest (NCHF) ecoregion, but a small section in the Northern Lakes and Forests (NLF) Ecoregion occurs near the watershed's discharge into the Crow Wing River. Land cover in the watershed is distributed as follows: 27.7% rangeland, 26.5% cropland, 24% forest/shrub, 8% wetland, 7.5% open water, and 6% developed (Figure 7). Approximately 95% of the watershed's acreage is privately owned (NRCS 2007). Sixty percent of agricultural producers in the watershed earn their living entirely off the land. Area farms are largely comprised of smaller family farms. However, a relatively small percentage of farms exceed 1,000 acres in size. Forty-nine percent of the operations are less than 180 acres, 48% are from 180 to 1,000 acres, and the remaining farms are greater than 1,000 acres in size (NRCS 2007).

Thirty-nine thousand, eight hundred and twenty-nine people reside within the Long Prairie River Watershed (MnDNR 2013), equating to roughly 45 people per square mile. The largest population centers are located in the towns of Alexandria, Long Prairie, and Motley.

Vegetation: The NLF consists primarily of coniferous and northern hardwood forests, which includes tree species such as yellow birch, maples, oaks, and many pine species. The NCHF ecoregion is comprised of a mixture of forests, wetlands, cropland, and grasslands (MnDNR 2013). The forests consist mostly of sugar and red maples, yellow birch, aspen, spruce, hemlock, and white pine stands. A variety of wetland plant species occur, consisting mostly of rushes, cattails, and sedges (NRCS 2007).

Terrain: The NLF terrain is comprised of relatively nutrient-poor glacial soils, coniferous and northern hardwood forests, undulating till plains, morainal hills, broad lacustrine basins, and extensive sandy outwash plains. Soils in this ecoregion are thicker than those in more northern Minnesota and generally lack the growing ability of soils in adjacent ecoregions to the south (EPA 2010). The NCHF ecoregion is transitional between the predominantly forested NLF to the north and the agricultural ecoregions to the south. Land use/land cover in this ecoregion consists of a mosaic forests, wetlands and lakes, cropland agriculture, pasture, and dairy operations. The growing season is generally longer and warmer than that of the NLF and the soils are more arable and fertile, contributing to the greater agricultural component of land use.

Wildlife: Whitetail deer, pheasants, rabbits, squirrels, coyote, multiple hawk species, and a variety of waterfowl species are common wildlife in both of the ecoregions. Common fish species include northern pike, walleye, bluegill, crappie, large and smallmouth bass, and many minnow species (MnDNR 2013).

Land use/human activities: Private landowners make up nearly the entire watershed (95%) with crop and dairy farming making up a majority of the private landuse. State owned lands are the second largest ownership (1.5%) followed by small tracts of conservancy and federal lands. Hunting for big and small game, upland birds, and waterfowl commonly take place within the watershed (NRCS 2007), as well as fishing on the many lakes.

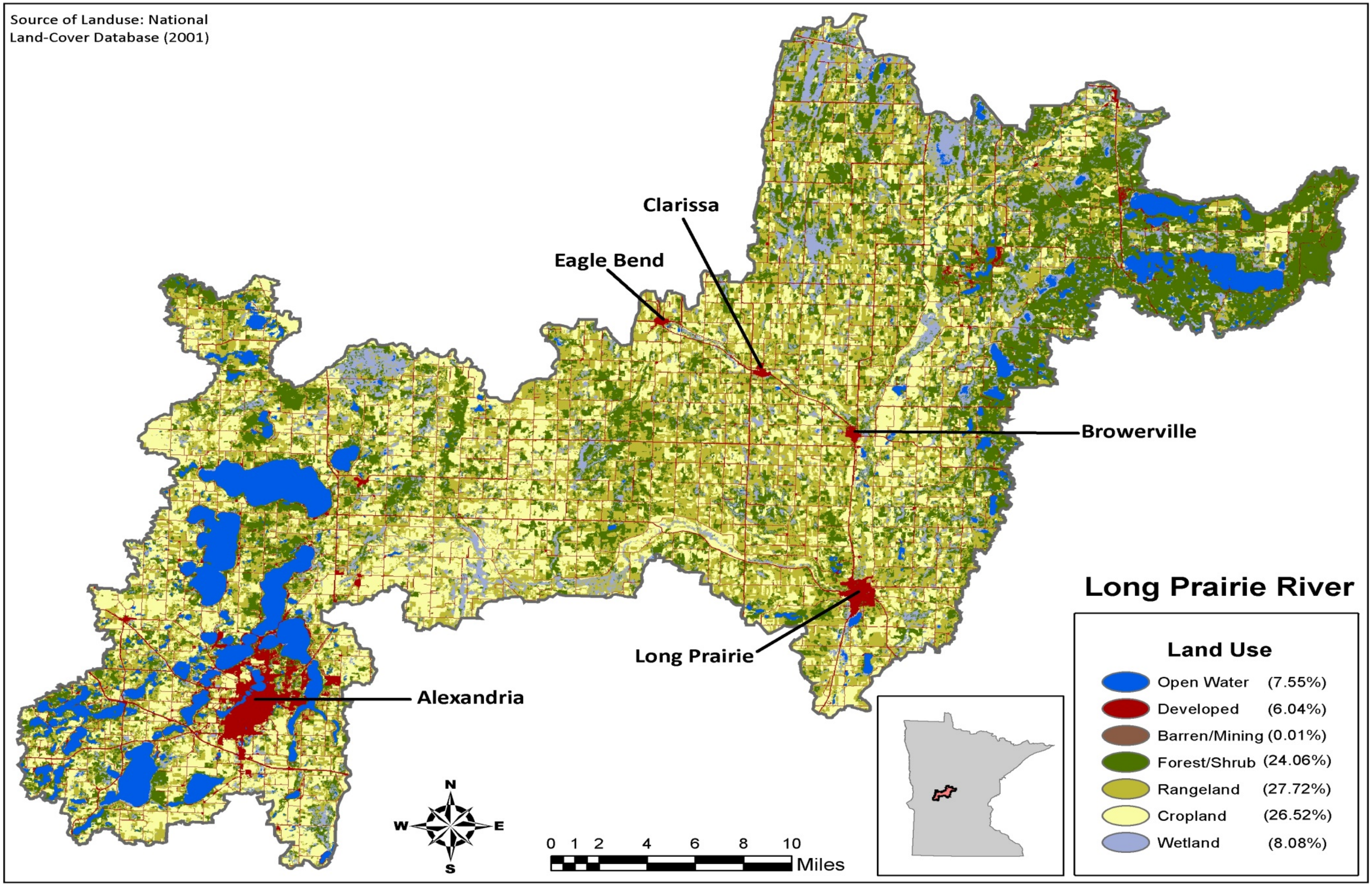

Figure 7. Land use in the Long Prairie River Watershed.

Surface water hydrology

Originating at Lake Carlos in Douglas County, the Long Prairie River flows easterly through western Todd County into the town of Long Prairie where it turns and flows north. The river continues to flow north entering the extreme northwest corner of Morrison County where it enters the Crow Wing River roughly one mile south-east of the town of Motley.

The highest elevation of the Long Prairie River Watershed is 1,663 feet above sea level found in the western and southwestern portions of the watershed, with decreasing elevations across the eastern and northeastern portions of the watershed (NRCS 2007). Throughout its course, the river drops 456 feet to an elevation of 1,207 with an overall mean gradient decrease of 4.8 feet per river mile. The western and southwestern portions of the watershed are lake-rich with fewer lakes in the eastern portion of the watershed. Some of the major lakes within the watershed include Miltona, Ida, Carlos, Le Homme Dieu, Latoka, Shamineau, Fish Trap, and Alexander Lakes. Several tributaries feed into the Long Prairie River mainstem including Moran, Turtle and Eagle Creeks.

There are 20 MnDNR documented dams within the watershed (Boyle, personal communication), however only one of those is located on the Long Prairie River. This dam is located just downstream of Lake Miltona, at the headwaters of the river.

Climate and precipitation

The ecoregion has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.5˚C; the mean summer temperature for the Long Prairie River Watershed is 18.9˚C; and the mean winter temperature is -11.7˚C (Minnesota State Climatologists Office, 2003).

Precipitation is the source of almost all water inputs to a watershed. The Long Prairie River Watershed area received 28-32 inches of precipitation in 2011 resulting in annual runoff that ranged from two to six inches above normal (Figure 8).

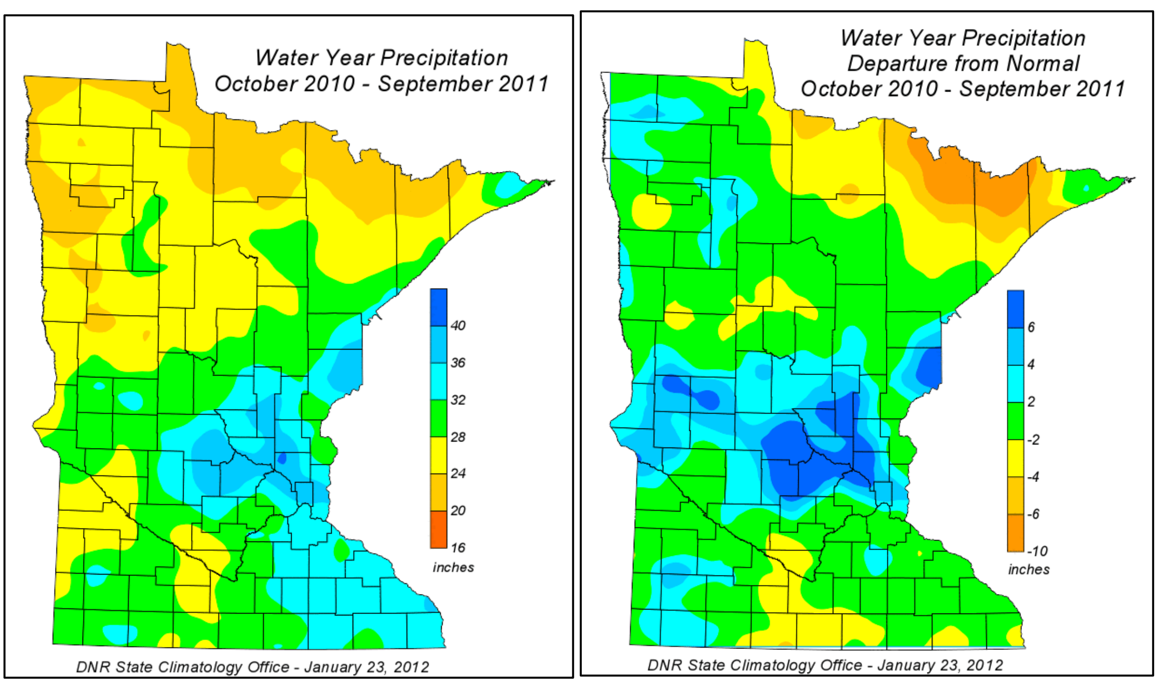

Figure 8. State-wide precipitation levels during the 2011 water year.

(Figure 9) displays the areal average representation of precipitation in west-central Minnesota. An aerial average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center, available as a link on the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html. Though rainfall can vary in intensity and time of year, rainfall totals in the west-central region display no significant trend over the last 20 years. However, precipitation in west central Minnesota exhibits a statistically significant rising trend over the past 100 years, p=0.001 (Figure 10). This is a strong trend and matches similar trends throughout Minnesota.

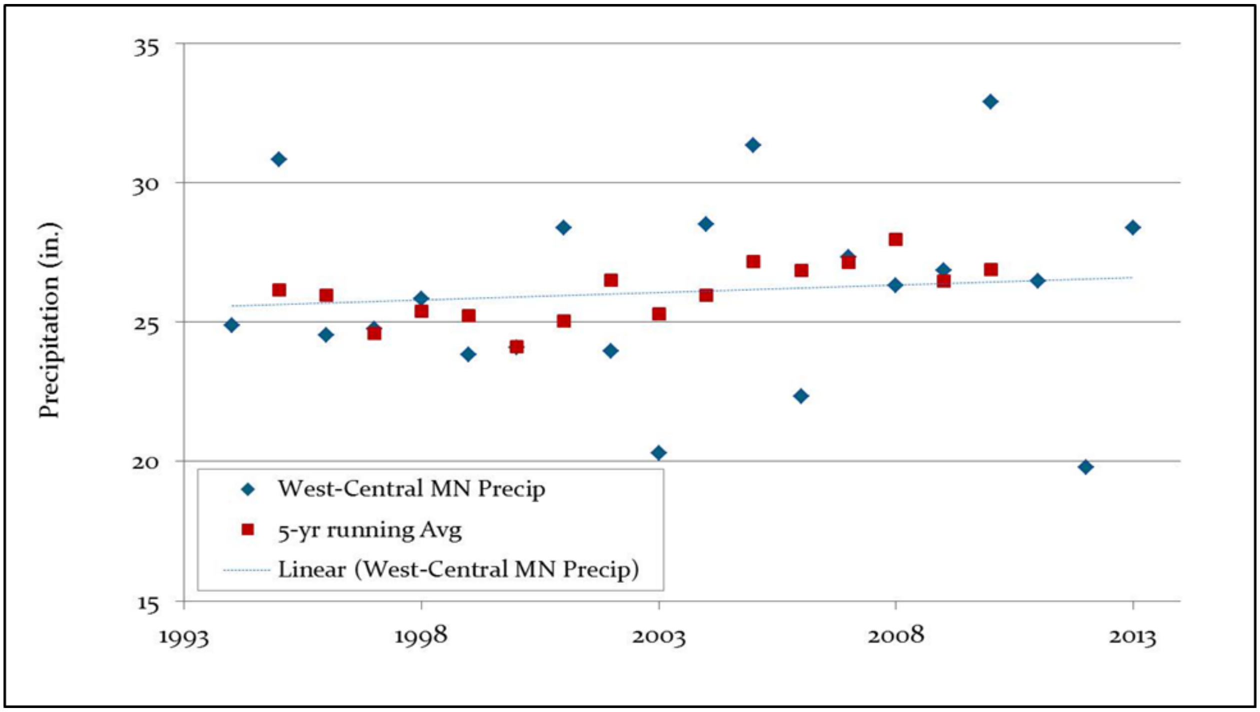

Figure 9. Precipitation trends in West Central Minnesota (1993-2013) with five year running average.

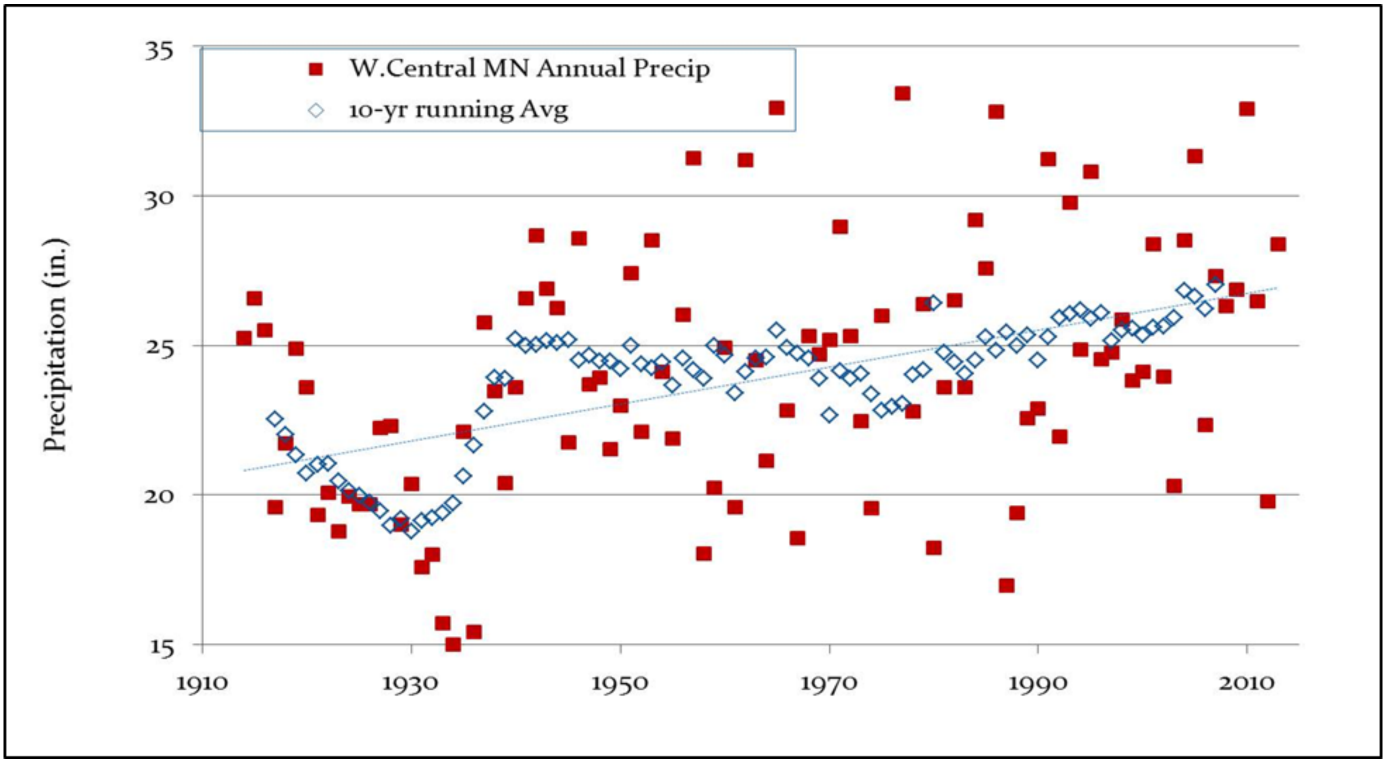

Figure 10. Precipitation trends in West Central Minnesota (1913-2013) with ten- year running average.

Hydrogeology

The hydrogeology of the Long Prairie River Watershed is dominated by glacial deposits, with the largest hydrologic feature being the outwash sands at the surface deposited by glacial activity (MPCA, 1998). Most groundwater supplies are pumped from the surficial sand aquifers and a number of buried sand aquifers. In fact, within Todd County alone, 99% of the wells are constructed in these shallow, quaternary sediments. These sands are very transmissible and as a result, water levels of surficial water bodies as well as base flow in the Long Prairie River are closely related to groundwater levels in the surficial aquifer (Peterson 2010).

Wetlands

The watershed is situated at the eastern edge of the historic prairie pothole region typical of west-central and southwestern Minnesota. The watershed's surface geology derives from Wadena Lobe glacial processes as part of the Alexandria Moraine complex where stagnation and ground moraine complexes predominate. As a result, gentle undulating hill and valley topography composed of sand and gravel till is common. The main stream corridor flows through finer textured outwash soils. This hill, valley and flat outwash till geology created ideal conditions for diverse wetland resources to develop in several hydrogeomorphic settings including depressional, slope and floodplain flats. Wetlands are recognized as important ecosystems which provide many vital watershed benefits by slowing and retaining water, thereby providing flood reduction and pollutant treatment and protection of downstream waters, as well as providing vital wildlife habitat (Mitsch and Gosselink 2007).

IV. Watershed-wide data collection methodology

Watershed Pollutant Load Monitoring Network

A long term WPLMN stream monitoring station is located on the Long Prairie River on 313th Ave., north of the town of Philbrook. Intensive water quality sampling occurs year round at this site. Approximately thirty-five grab samples are collected at the site per year with sampling frequency greatest during periods of moderate to high flow (Figure 11). Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

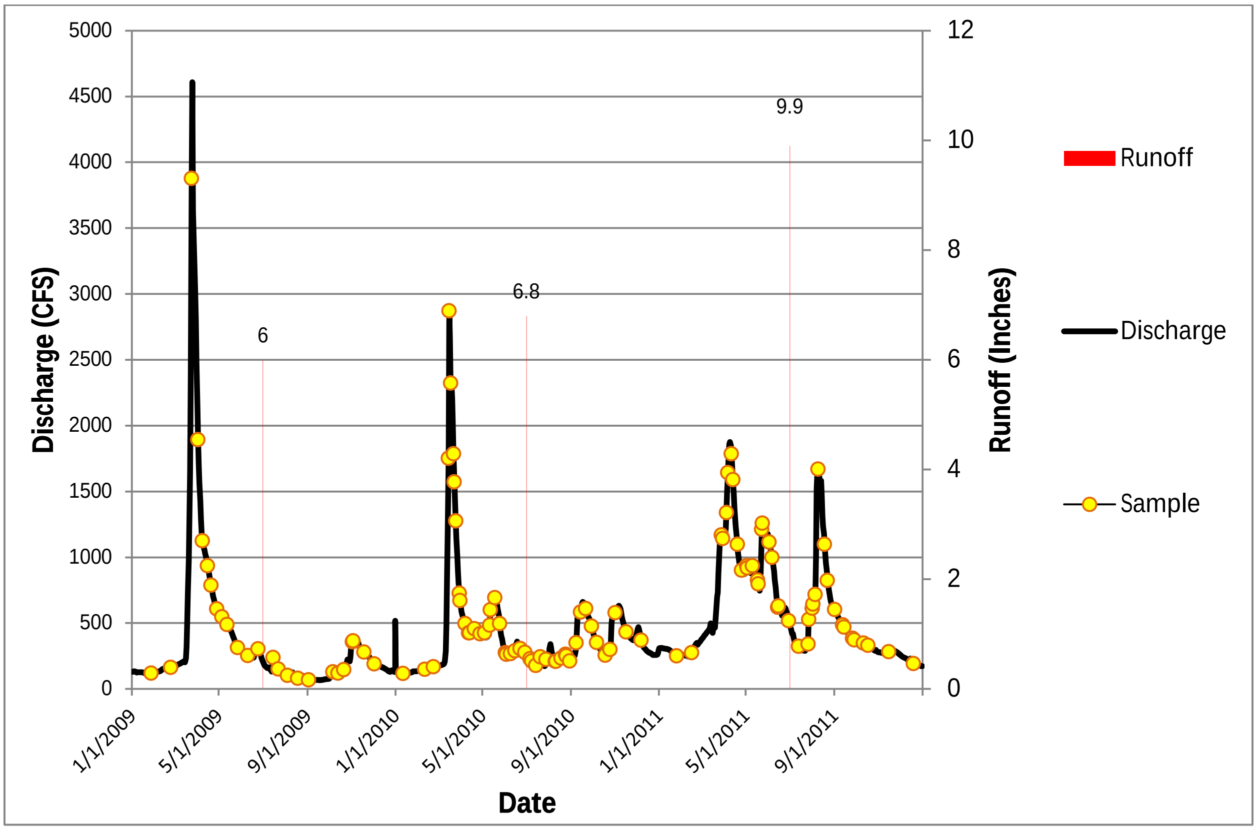

Figure 11. Hydrograph and annual runoff for the Long Prairie River near Philbrook 2009 to 2011.

Annual water quality and daily average discharge data (Figure 11) are coupled in the "FLUX32," pollutant load model, originally developed by Dr. Bill Walker and recently upgraded, by the U.S. Army Corp of Engineers and MPCA. FLUX32 allows the user to create seasonal or discharge constrained concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary output includes annual and daily pollutant loads and flow weighted mean concentrations (pollutant load/total seasonal flow volume). Loads and flow weighted mean concentrations (FWMC) are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (nitrate-N) and total Kjeldahl nitrogen (TKN).

Stream water sampling

Six water chemistry stations throughout the watershed were sampled from May thru September in 2011, and again in June thru August of 2012, 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 HUC-11 subwatershed that was >40 square miles in area (green triangles in Figure 3). A Surface Water Assessment Grant (SWAG) was awarded to Morrison County SWCD to sample one water chemistry site in Morrison County. MPCA staff collected water chemistry at five additional stations (see Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study).

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Long Prairie River Watershed was completed during the summer of 2011. A total of 37 sites on 26 stream reaches were established across the watershed and sampled. These sites were located near the outlets of the HUC 8, 11 and 14 subwatersheds. Several existing sites were re-visited and three new sites were established in 2012 and/or 2013 to gather additional data to help in the assessment process. While data from the last ten years contributed to the watershed assessments, the majority of data utilized for the 2013 assessment was collected in 2011. Waterbody assessments to determine aquatic life use support were conducted for 20 stream reaches. Waterbody assessments were not conducted for six reaches because criteria for channelized reaches had not been developed prior to the assessments. Nonetheless, the 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. Qualitative ratings for non-assessed reaches are included in Appendix 5.1.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically Fish and Invertebrate 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 Invertebrate 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 4.1). 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). In 2014, new IBI thresholds were developed and used for biological assessments, including some follow up assessment in the Long Prairie River Watershed. While the majority of sites in this report were assessed in 2013 using the old thresholds, a small number of sites were assessed in 2014 using the new IBI thresholds. The IBI thresholds and results for each individual biological monitoring station can be found in Appendices 4.1, 4.2, and 4.3.

Fish contaminants

Mercury was analyzed in fish tissue samples collected from the Long Prairie River and 22 lakes in the watershed. Polychlorinated biphenyls (PCBs) were measured in fish from the river and 14 lakes. MPCA biological monitoring staff collected the fish from the river in 2011. Minnesota DNR fisheries staff collected all other fish.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled, filleted, and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture Laboratory performed all mercury and PCBs analyses of fish tissue.

The Impaired Waters List is submitted every even year to the U.S. EPA for the agencies approval. MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs and PFOS 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 because of PCBs or PFOS, 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 (200 ppb) for PFOS.

Prior to 2006, mercury concentrations in fish tissue were assessed for water quality impairment based on the MDHs fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90^{th} percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples per species are required to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These earlier studies identified that high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. Therefore, continued widespread frequent monitoring of smaller river systems was not necessary. The current watershed monitoring approach includes screening for PCBs in representative predator and forage fish collected at the pour point stations in each major watershed.

Lake water sampling

The MPCA received data from 65 lakes in the Long Prairie River Watershed and was able to assess 60 lakes for aquatic recreation use. MPCA was responsible for collecting water chemistry samples on 41 lakes. The Long Prairie River watershed is rich with lakes and has a good network of local sampling partners. These partners were responsible for collecting water chemistry data through Surface Water Assessment Grants (SWAG) in order to assess all components of the aquatic life and recreation use standards. SWAGs were awarded to Douglas County SWCD (13 lakes), Todd County SWCD (two lakes), and the Otter Tail County Coalition of Lake Associations (two lakes). MPCA also uses data collected by local sampling partners independent of our grant program for assessments; this watershed has many lake associations that collect water quality data independent of agency initiatives. In addition, there are currently 26 volunteers enrolled in the MPCA's Citizen Lake Monitoring Program (CLMP) that are conducting lake monitoring within the watershed. Data collected by volunteers allows for a more robust data set for aquatic recreation use assessment and provides trend data for year outside of the IWM schedule.

Groundwater quality

The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These ambient wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

Groundwater/Surface water withdrawals

The Department of Natural Resources permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or 1 million gallons/year. Permit holders are required to track water use and report back to the MnDNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html.

The changes in withdrawal volume detailed in this report are a representation of water use and demand in the watershed and are taken into consideration when the MnDNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

Groundwater quantity

Monitoring wells from the MnDNR 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. Data from these wells and others are available at:
http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html.

Stream Flow

The United States Geological Survey (USGS) maintains real-time stream flow gaging stations across the United States. Measurements can be viewed at http://waterdata.usgs.gov/nwis/rt.

Wetlands

The MPCA began wetland biological monitoring and collecting associated wetland water chemistry in the early 1990s. This work has focused on depressional wetlands (e.g. marshes) which occur in a depressional geomorphic setting. This work resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, and crustaceans) IBIs for evaluating the ecological condition or health of depressional wetlands. Both IBIs are on a 0 to 100 scale with higher scores indicating better condition. In 2011 the MPCA began using floristic quality assessment to assess the quality of all Minnesota wetland types based on plant communities. Wetland sampling protocols can be viewed at:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html. The MPCA does not monitor wetlands systematically by watershed. Depressional wetland IBIs have been used in a survey of wetland condition where results are summarized statewide and for each of Minnesota's level II ecoregions (Genet 2012). Depressional wetland condition results within this report are based on data from the statewide survey and earlier indicator development projects.

V. Individual watershed results

HUC-11 Subwatersheds

Assessment results for aquatic life and recreation use are presented for each HUC-11 subwatershed within the Long Prairie River. The primary objective is to portray all the assessment results (i.e. waters that support and do not support their designated uses) within an HUC-11 subwatershed resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire HUC-8 watershed including aquatic consumption, and drinking water assessments (where applicable) is included in (Appendix 3). 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 HUC-11 subwatersheds contain the assessment results from the 2013 assessment cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2011 intensive watershed monitoring effort, but also considers available data from the last ten years.

Thefollowing pages provide an account of each HUC-11 subwatershed. Each account includes a brief description of the subwatershed, and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, b) biological condition of channelized streams and ditches, c) stream habitat quality, d) channel stability, e) water chemistry for the HUC-11 outlet, and g) lake aquatic recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the 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 subwatershed (e.g. where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2013 assessment process 2014 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 (e.g. standards); these determinations were made during the desktop phase of the assessment process (Figure 5). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli or fecal coliform) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Stream reaches that do not have sufficient information for either an aquatic life or aquatic recreation assessment (from current or previous assessment cycles) are not included in these tables, but are included in Appendix 5.2 and Appendix 5.3. 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 HUC-11 subwatershed as well as in the Watershed-Wide Results and Discussion section.

Channelized stream evaluations

Biological criteria have not been developed yet for channelized streams and ditches, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support is not yet possible for channelized streams in Minnesota. Though not an official assessment of aquatic life, aseparate table within each HUC-11 summary provides a narrative rating of the condition of fish and macroinvertebrate communities at channelized streams based on the IBI results. The narrative ratings are based on aquatic life use assessment thresholds for each individual IBI class (see Appendix 5.1). IBI scores above this threshold are given a “good” rating, scores falling below this threshold by less than ~15 points (i.e., value varies slightly by IBI class) are given a “fair” rating, and scores falling below the threshold by more than ~15 points are given a “poor” rating. For more information regarding channelized stream evaluation criteria refer to Appendix 5.1.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each HUC-11 subwatershed section. These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the habitat at 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 HUC-11 subwatershed.

Stream stability results

Stream channel stability information evaluated during each macroinvertebrate sampling visit is provided in each HUC-11 subwatershed section. These tables display the results of the Channel Condition and Stability Index (CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates three regions of the stream channel (upper banks, lower banks, and bottom) which may provide an indication of stream channel geomorphic changes and loss of habitat quality due to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2007, and is collected once at each biological station. The final row in each table displays the average CCSI scores and a rating for the HUC-11 subwatershed.

Watershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the HUC-11 subwatershed. This data along with other data collected within the ten year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to the standards or expectations used for assessing aquatic life and recreation.

Lake assessments

A summary of lake water quality is provided in the HUC-11 subwatershed sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for all lakes in the watershed are available in Appendix 7. Lake models and corresponding morphometric inputs can be found in Appendix 6.

Upper Long Prairie River Subwatershed HUC 07010108010

The Upper Long Prairie River Subwatershed is located in central Douglas County and is the largest of all subwatersheds, draining an area of 408 mi^2. This subwatershed contains the headwaters of the Long Prairie River, originating from Lake Carlos on its east shore. The land use consists mostly of range and cropland, comprising 26 and 33% of this subwatershed, respectively. In addition, the subwatershed also consists of the most open water of any subwatershed, comprising 12% of the total landscape (Figure 13) and the town of Alexandria, the largest community within the watershed. The water chemistry monitoring for this subwatershed is the outlet station 00UM076 on the Long Prairie River at Miltona Carlos Rd NE, one mile north of Carlos.

Table 1. Aquatic life and recreation assessments on stream reaches: Upper Long Prairie River Subwatershed.

AUID *Reach Name,* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07010108-595 ***Trib to Lake Miltona,*** *Headwater to Lake Miltona*	1.62	2B, 3C	11UM034 13UM179	Upstream of CSAH 14, 2 mi. NW of Miltona Downstream of CSAH 14, 2 mi. NW of Miltona	EXS	EXS	--	--	--	--	--	--	--	NS	NA
07010108-512 ***Spruce Creek,*** *T131 R36W S31, north line to Unnamed Lake (21-0034-00)*	7.4	1B, 2A, 3B	09UM089	Upstream of 100th St, 6.5 mi. SE of Parker's Prairie	EXP	EXP	--	--	--	--	--	--	--	NS	NA
07010108-505 ***Long Prairie River,*** *Spruce Creek to Eagle Creek*	49.75	2B, 3C	10EM042 11UM024 11UM025	1.75 mi. upstream of CSAH 1, 7 mi. E of Carlos Downstream of CSAH 38, in Clotho Downstream CSAH 3, 5.5 E of Carlos	EXP	MTS	EXS	MTS	--	MTS	MTS	--	MTS	NS	FS
07010108-534 ***Long Prairie River,*** *Headwaters (Lake Carlos 21-0057-00) to end of Wetland (CSAH 65)*	6.92	2B, 3C	00UM076	Upstream of Miltona Carlos Road, 1 mi NW of Carlos	MTS ***	MTS	EXP	MTS	--	MTS	MTS	--	IF	NS	IF
07010108-535 ***Long Prairie River,*** *End of Wetland (CSAH 65) to Spruce Creek*	4.84	2B, 3C	11UM030 10EM070 13UM187	Upstream of CSAH 3, 1 mi. N of Belle River Downstream of Hauer Ln., 5 mi. NE of Carlos Downstream of CR 3 NE, 4.5 mi. SE of Miltona	MTS ***	MTS	EXS	MTS	--	MTS	MTS	--	--	NS	NA
07010108-522 ***Stormy Creek,*** *Unnamed Creek to Unnamed Creek*	7.4	2B, 3C	11UM027	Upstream of CSAH 5, 5 mi. SE of Miltona	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07010108-520 ***Spruce Creek,*** *Unnamed Lake (21-0034-00) to Long Prairie River*	6.16	2B, 3C	11UM028	Upstream of Willow Rd NE, 4 mi. SE of Miltona	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07010108-587 ***Freeman's Creek,*** *County Ditch 4 to Long Prairie River*	6.88	2B, 3C	11UM022	Downstream of 181st Ave, 7 mi. SW of Browerville	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07010108-552 ***Unnamed Creek,*** *County Ditch 11 to Lake Miltona*	1.6	2B, 3C	11UM033	Upstream of CSAH 14, 6 mi. SW of Parkers Prairie	NA*	NA*	IF	MTS	--	MTS	MTS	--	EX	FS	NS

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
**Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.
***Due to absence of the 2013 assessments, this assessment decision is unofficial until the 2014 assessment cycle.

Table 2. Non-assessed biological stations on channelized AUIDs: Upper Long Prairie River Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07010108-524 **Unnamed Ditch,** *Headwater to marsh in T129 R38W S27*	1.28	7	11UM032	Upstream of Lake Ida Rd NW, 6 mi. NW of Alexandria	Good	Fair
07010108-552 ***Unnamed Creek,*** *County Ditch 11 to Lake Miltona*	1.61	2B, 3C	11UM033	Upstream of CSAH 14, 6 mi. SW of Parkers Prairie	Good	Good
07010108-517 ***Unnamed Creek,*** *Unnamed Lake (21-0038-00) to Long Prairie River*	2.5	7	11UM031	Downstream of CSAH 5, 2 mi. SE of Miltona	Poor	Good

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 3. Minnesota Stream Habitat Assessment (MSHA): Upper Long Prairie River 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
1	11UM032	Trib. To Lake Ida	1	10.5	4	10	1	26.5	Poor
1	11UM033	County Ditch 11	0	3.5	20.85	7	23	54.35	Fair
2	11UM034	Trib. to Lake Miltona	3.75	13.25	15.025	17	23.5	72.53	Good
1	13UM179	Trib. to Lake Miltona	5	12	20.5	12	30	79.5	Good
3	00UM076	Long Prairie River	1	8.66	18.6	14	19	61.27	Fair
1	11UM031	Trib. to Long Prairie River	2.5	14	9	15	24	64.5	Fair
2	11UM030	Long Prairie River	2.5	10.25	18	16	14.25	63.75	Fair
1	10EM070	Long Prairie River	3	9	20	14	22	68	Good
2	09UM089	Spruce Creek	2.875	11	11.5	13	17	55.38	Fair
1	11UM028	Spruce Creek	1.5	9.5	16	15	15	57	Fair
1	11UM027	Stormy Creek	2.5	10.5	18	17	30	78	Good
2	11UM025	Long Prairie River	3	8.5	16.7	12.5	16.5	57.2	Fair
2	10EM042	Long Prairie River	2.5	8	15.93	9.5	15	50.93	Fair
3	11UM024	Long Prairie River	1	8.67	14.47	10.33	12.67	47.13	Fair
1	11UM022	Freeman's Creek	1.25	5	18.8	15	29	69.05	Good
1	13UM187	Long Prairie River	2.5	9	20	15	15	61.5	Fair
Average Habitat Results: *Upper Long Prairie River Subwatershed*			**2.24**	**9.46**	**16.1**	**13.27**	**19.18**	**60.25**	**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)

Table 4. Channel Condition and Stability Assessment (CCSI): Upper Long Prairie River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	10EM070	Long Prairie River	6	13	4	1	24	Stable
2	00UM076	Long Prairie River	12	9	16	2.5	39.5	Fairly Stable
1	11UM031	Trib. to Long Prairie River	5	9	11	3	28	Fairly Stable
1	11UM033	County Ditch 11	10	7	11	3	31	Fairly Stable
1	11UM022	Freeman's Creek	10	10	8	3	31	Fairly Stable
1	11UM028	Spruce Creek	9	7	12	3	31	Fairly Stable
1	11UM027	Stormy Creek	11	12	8	3	34	Fairly Stable
2	11UM024	Long Prairie River	6.5	7	20	4	37.5	Fairly Stable
1	11UM025	Long Prairie River	8	6	16	1	31	Fairly Stable
1	11UM034	Trib. to Lake Miltona	12	17	18	3	50	Moderately Unstable
1	13UM179	Trib. to Lake Miltona	22	30	10	3	65	Moderately Unstable
1	09UM089	Spruce Creek	8	7	32	4	51	Moderately Unstable
1	11UM030	Long Prairie River	7	11	15	2	35	Fairly Stable
Average Stream Stability Results: *Upper Long Prairie River Subwatershed*			**9.72**	**11.15**	**13.92**	**2.7**	**37.53**	**Fairly Stable**

Qualitative channel stability ratings
= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Table 5. Outlet water chemistry results: Upper Long Prairie River Subwatershed.

Station Location:	At Miltona Carlos Rd NE, 1 mi. NW of Carlos, Minnesota							
EQuIS ID:	S002-905							
Station #:	00UM076							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard**	**# of WQ Exceedances**
Ammonia-nitrogen	mg/L	9	0.00	0.00	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	4.0	11.5	7.9	7.4	5.0	1
pH	--	18	7.7	8.8	8.3	8.4	6.5-9.0	0
Transparency, tube with disk	cm	15	>100	>100	>100	>100	>20	0
Turbidity	FNU	3	0.3	8.7	4.4	4.3	25.0 NTU	0
Escherichia coli	MPN/100mL	17	16	280	93	55	1260	0
Escherichia coli (geometric mean)	MPN/100mL	17	30	136		71	126	1
Chlorophyll-a, corrected	ug/L	0						
Pheophytin-a	ug/L	0						
Inorganic nitrogen (nitrate and nitrite)	mg/L	2	0.07	0.08	0.08	0.08		
Kjeldahl nitrogen	mg/L	9	0.5	0.8	0.7	0.7		
Phosphorus	ug/L	9	13	28	19	18		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	9	1.2	3.6	2.2	2.0		
Total volatile solids	mg/L	9	0.0	3.2	1.8	2.0		
Sulfate	mg/L	0						
Specific conductance	uS/cm	18	408	480	443	440		
Temperature, water	deg C	19	8.5	27.4	21.1	22.1		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

**Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the: Upper Long Prairie River Subwatershed, a component of the IWM work conducted between May and September in 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.

Table 6. Lakes within the Upper Long Prairie River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Mill Pond	21-0034-00	48	E	100.0	3.7	1.5*		40.1	15.1	2.0	FS	IF
Union	21-0041-00	155	M	52.8	13.7	4.8		19.2	6.6	4.0	FS	IF
Burgen	21-0049-00	210	M	29.0	13.1	7.3		23.9	9.0	2.6	FS	IF
Henry	21-0051-00	152	E	61.5	9.8	4.2		55.8	19.3	1.7	NS	NS
Geneva	21-0052-00	663	E	51.4	19.2	6.2		26.4	9.1	3.1	FS	NA
Agnes	21-0053-00	162	E	43.4	9.4	4.9		94.8	30.0	1.4	NS	NS
Victoria	21-0054-00	447	M	28.6	18.3	9.0	I	22.5	8.1	3.1	FS	IF
Jessie	21-0055-00	134	E	61.9	7.9	3.4	D	55.2	30.3	1.5	NS	NA
Le Homme Dieu	21-0056-00	1,892	E	44.0	25.9	6.2		37.8	9.4	3.3	FS	NA
Carlos	21-0057-00	3,017	M	36.1	49.7	14.3		15.3	4.6	3.4	FS	IF
Vermont	21-0073-00	312	M	65.9	18.0	3.7		16.4	3.4	4.5	FS	NA
Irene	21-0076-00	691	E	35.6	13.4	6.0	NT	26.9	12.7	2.3	FS	NA
Darling	21-0080-00	1,126	M	50.2	18.9	5.7	NT	19.8	6.3	3.0	FS	IF
Winona	21-0081-00	220	H	100.0	2.4	1.0*	NT	218.2	161.7	0.5	NS	NS
Miltona	21-0083-00	5,924	M	48.3	32.0	7.2	I	19.7	6.1	3.9	FS	NA
Skoglund Slough	21-0084-00	199	E					31.6	13.1	1.5	FS	NA
Andrew	21-0085-00	970	M	35.0	25.3	8.6	NT	22.7	6.8	2.6	FS	NA
Mary	21-0092-00	2,559	E	43.0	10.4	4.2	D	28.6	10.8	1.8	FS	IF
Alvin	21-0093-00	132	M					20.7	6.7	2.4	FS	NA
Louise	21-0094-00	220	M	45.0	10.1	4.5	NT	18.2	8.0	2.7	FS	NA
North Union	21-0095-00	134	M	78.9	12.8	2.8		19.4	6.5	3.0	FS	NA
Stony	21-0101-00	118	M	55.8	17.7	3.9		16.5	4.5	3.9	FS	NA

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Brophy	21-0102-00	281	M	51.2	13.4	4.4	NT	22.3	6.0	3.0	FS	NA
Cowdrey	21-0103-00	251	M	36.0	15.8	6.7	NT	21.7	5.5	3.6	FS	NA
Lottie	21-0105-00	98	M	84.0	9.4	1.8		20.9	4.9	3.3	FS	NA
LATOKA (NORTH BAY)	21-0106-01	554	M		33.8	11.0	NT	14.9	4.0	4.2	FS	IF
LATOKA (SOUTH BAY)	21-0106-02	213	M		33.8	11.0	NT	15.2	4.1	4.1	FS	IF
Mina	21-0108-00	447	M	36.4	37.5	9.8		15.1	3.3	3.7	FS	IF

Table 6. Lakes within the Upper Long Prairie River Subwatershed Continued

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Cook	21-0111-00	118	E	68.6	15.2	3.0		33.8	4.0	3.3	FS	NA
Charley	21-0120-00	162	M	78.5	10.1	2.4		21.9	6.0	2.5	FS	NA
Ida	21-0123-00	4,506	M	38.9	32.3	8.6	NT	17.9	5.0	4.0	FS	NA
Spring	21-0130-00	106	M	45.2	16.5	5.1		22.0	9.9	2.9	FS	NA
LOBSTER (EAST BAY)	21-0144-01	714	M	50.2	18.7	4.8	I	21.6	7.2	2.8	FS	IF
LOBSTER (WEST BAY)	21-0144-02	617	E	54.4	9.5	3.9	NT	25.7	9.7	2.3	FS	IF
Grants	21-0150-00	206	M	25.0	18.3	6.8		21.5	4.7	3.1	FS	IF
Blackwell	21-0151-00	306	M	64.8	12.5	3.9		23.1	5.4	2.8	FS	NA
Echo	21-0157-00	104	E	68.4	12.2	3.3		47.7	18.8	1.5	NS	NA
Mill	21-0180-00	461	E	40.0	12.2	5.1	I	37.4	12.5	2.5	FS	IF
Round	21-0197-00	76	M	54.8	9.1			21.7	6.5	1.8	FS	NA
Crooked (Northwest Bay)	21-0199-01		M		7.3			19.3	3.9	2.6	FS	NA
Crooked (East Crooked)	21-0199-02		E		7.3			43.3	28.2	1.1	NS	IF
Nelson	56-0065-00	337	E	100*	2.1	1*		73.0	36.9	1.0	NS	NA
Fish	56-0066-00	500	E	98.4	5.2	1.8		83.1	52.5	1.1	NS	IF
Twin	56-0067-00	144	E					81.6	42.2	1.3	NS	NA

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information
O - Oligotrophic

Summary

The Upper Long Prairie River Subwatershed consists of nine assessable AUIDs, three of which are located on the mainstem of the Long Prairie River. All biological monitoring sites (except 10EM070) located on the mainstem of the Long Prairie River were resampled for fish in 2013 because2011 and/or 2012 results were inconclusive due to high water levels, strong flows and F-IBI scores all near their respective thresholds. For the purpose of this report, final assessments were made using the 2013 samples as well as all samples within the past ten years. However, all assessment results that include samples from 2013 must be considered unofficial until the 2014 assessment cycle occurs.

F-IBI scores within the Upper Long Prairie River Subwatershed were similar in the two upstream AUIDs (07010108-534 and -535) but they declined downstream, resulting in a F-IBI impairment on AUID -505 (most downstream AUID). All of the MSHA scores were rated fair (except 10UM070) (Table 3) and they were positively correlated with F-IBI scores. Sites located in the two upstream AUIDs all had higher MSHA scores than those in the lower AUID, specifically for fish cover, which in turn correlated with higher F-IBI scores. Most sites in these upstream reaches of the Long Prairie River have a wetland riparian zone, abundant submerged vegetation, and sandy substrates. Sites that included logs, emergent vegetation, and more submergent vegetation present had higher MSHA scores.

Dissolved oxygen (DO) levels are problematic throughout the Long Prairie River (all AUIDs except the most downstream (-501) are impaired for DO), likely due to the abundance of wetlands the river flows through. The variable DO concentrations had an impact on the number of fish taxa found at each site. For example, AUID -535 had low DO readings at the most upstream site (11UM030) and the lowest F-IBI score. DO levels recovered downstream and F-IBI scores were correspondingly higher. Overall, fish communities within these DO improvished segments of the Long Prairie River were consistently comprised of tolerant wetland species (e.g. bullhead, northern pike, sunfish) and most were lacking the sensitive and more riverine species (e.g. greater redhorse, smallmouth bass) that would improve the F-IBI scores. Macroinvertebrate communities however appear to do well within the river, as all M-IBI scores exceeded their applicable biocriteria (Appendix 4.3).

The smaller non-channelized tributaries within the Upper Long Prairie River Subwatershed had variable F-IBI and M-IBI results (Table 2) and there was little correlation with habitat (Table 3). For example, Stormy and Freeman's Creeks both had good MSHA scores, however Stormy Creek had F-IBI and M-IBI scores well above the thresholds while Freeman's Creek had a F-IBI score at the threshold and an M-IBI well below the threshold. Spruce Creek had a fair MSHA score, specifically good for substrate and riparian, but did not meet the thresholds for either F-IBI nor M-IBI. The channelized sites were similar. 11UM032 had a very poor MSHA score but good F-IBI and fair M-IBI. 11UM031 had a nearly good MSHA score but scored poor for fish and good for M-IBI. The variable biological results within the smaller tributary streams appear to indicate that fish and macroinvertebrate community health may not be not solely dependent on current habitat conditions. Factors such as flow conditions, water levels, and/or site specific stressors may be contributing factors to the varying biological communities.

The un-named tributary to Lake Miltona is a single AUID with two sites, one upstream (11UM034) and one downstream (13UM179) of CSAH 14. The sites had the highest MSHA scores in this subwatershed, however F-IBI and M-IBI scores were well below their respective thresholds. A large factor in the poor fish communities, specifically at 11UM034, may be the culvert passing under CSAH 14. This culvert can be perched during low flows and water passing through the culvert may be too turbulent during high flows, both scenarios prohibiting fish passage (Figure 12). Two fish species were sampled at 11UM034 while 13UM179 had 11 species. Although the fish community sampled at 13UM179 was comprised of many lake species (e.g. sunfish, perch, bullhead) and was still considered impaired, nearly all of these species were not found upstream of the culvert. Suitable habitat for lithophilic spawning fish species is available upstream of the culvert but fish do not appear to be able to access it.

Figure 12. Downstream portion of culvert under CSAH 14 on the Tributary to Lake Miltona.

Stream water quality data were available for the Long Prairie River from its headwaters at Lake Carlos to CSAH 65. This AUID is approximately 6.9 miles long. Water chemistry data were collected near the outlet of the Upper Long Prairie River Subwatershed. The Long Prairie River exceeded the standard for bacteria based on only one geometric mean exceedance which was slightly above the standard. As a result this reach was not listed as impaired for aquatic recreation. More bacteria data will need to be collected in order to determine if an actual impairment is present. No individual sampling event exceeded the water quality standard of 1260 MPN/100ml (Table 5). Since bacteria levels are typically low, aquatic recreation use is likely supported. Some DO samples exceeded the standard indicating impairment for aquatic life. However, this impairment was found to be attributed to natural background from a large wetland complex along the periphery of the stream channel.

The Upper Long Prairie River Subwatershed has the highest density of lakes in the Long Prairie River HUC-8 Watershed. Lakes in this area were formed during the last glaciation in deep deposits of sand and gravel glacial outwash. As a result, lakes in the western portion of the watershed are very diverse with a mixture of deep and shallow lakes in both urban and agricultural areas. The majority of lakes in this watershed are highly connected to one another, forming the headwaters of the Long Prairie River which begins at the outlet of Lake Carlos. Lake Carlos is part of the MnDNR's Sentinel Lakes program and has a comprehensive lake report available at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/lakes/sentinel-lakes.html.

Sixty lake basins in the Upper Long Prairie Subwatershed had sufficient data to assess for aquatic recreation (Table 6). Fifty lakes fully support aquatic recreation, indicating that algal blooms should not impact recreational use. Ten lakes did not support aquatic recreation due to excess nutrients. Five additional lakes had insufficient water quality data to assess them for aquatic recreation. Aquatic life assessments were based solely on available chloride data. As a result three lakes - Henry, Agnes, and Winona - were found to be impaired for aquatic life use.

Overall, lake water quality in the Upper Long Prairie Subwatershed is good, however, there are areas of concern. Lakes that were found to be impaired for aquatic recreation were located near the Upper Long Prairie Subwatershed boundary and drain to the chain of lakes that form the Long Prairie River. This is concerning because these lakes are likely transporting nutrients to lakes downstream that are currently meeting aquatic recreation standards. Nelson, Fish, and Twin are located in the northern portion of the watershed and were impaired for aquatic recreation use. These three lakes are shallow lakes and have large surface areas and small watersheds. This type of lake morphometry promotes wind mixing that redistributes sediments throughout the water column and causes internal loading of phosphorus. Phosphorus inputs from the watershed must be reduced in order to improve water quality in these lakes. Echo and East Crooked Lakes are located in the southwestern portion of the watershed. Both are moderately deep and have small watersheds limited to their individual lake catchments. This is concerning because lakes with small watershed areas typically do not have elevated levels of nutrients. Land use in these watersheds should be evaluated and best land management practices (BMPs) should be in place. Henry, Agnes, and Winona are all located in Alexandria and have highly developed watersheds. Since development is so dense in this area it is critical that runoff based pollutant contributions are intensively managed. Jesse Lake has development around the periphery of the lake with the rest of the watershed being cropland and pasture. As a result both land use and near shore development need to reduce nutrient contributions in order to improve water quality.

The majority of lakes that fully support aquatic recreation are deep and have the ability to sequester phosphorus in the bottom sediments. However, in shallow lakes eliminating phosphorus inputs is vital to maintaining good water quality because these lakes are unable to sequester phosphorus. Residents of these lakes should use BMPs to reduce any possible inputs of phosphorus from lawn care products or other localized sources. Maintaining forest and other natural lands within these lakes watersheds will aid in limiting urban and rural phosphorus inputs that are critical to maintaining good water quality.

Many of these lakes are located near Alexandria, Minnesota and are a popular vacation destination. When lakes see a large amount of recreational use, people must be conscientious of how their activities affect a lakes overall health. Removal, of native aquatic plants not only reduces fish habitat but can also be detrimental to water quality since aquatic vegetation has the ability to tie up phosphorus in plant biomass. As a result, aquatic plant beds should be protected. Aquatic invasive species (AIS) are also a major concern in this watershed. Recently, Zebra Mussels were found in Lake Carlos. AIS species such as Zebra Mussels are extremely detrimental to the overall health of lakes and great effort should be taken to limit the spreads of AIS species to additional lakes in the Upper Long Prairie Subwatershed.

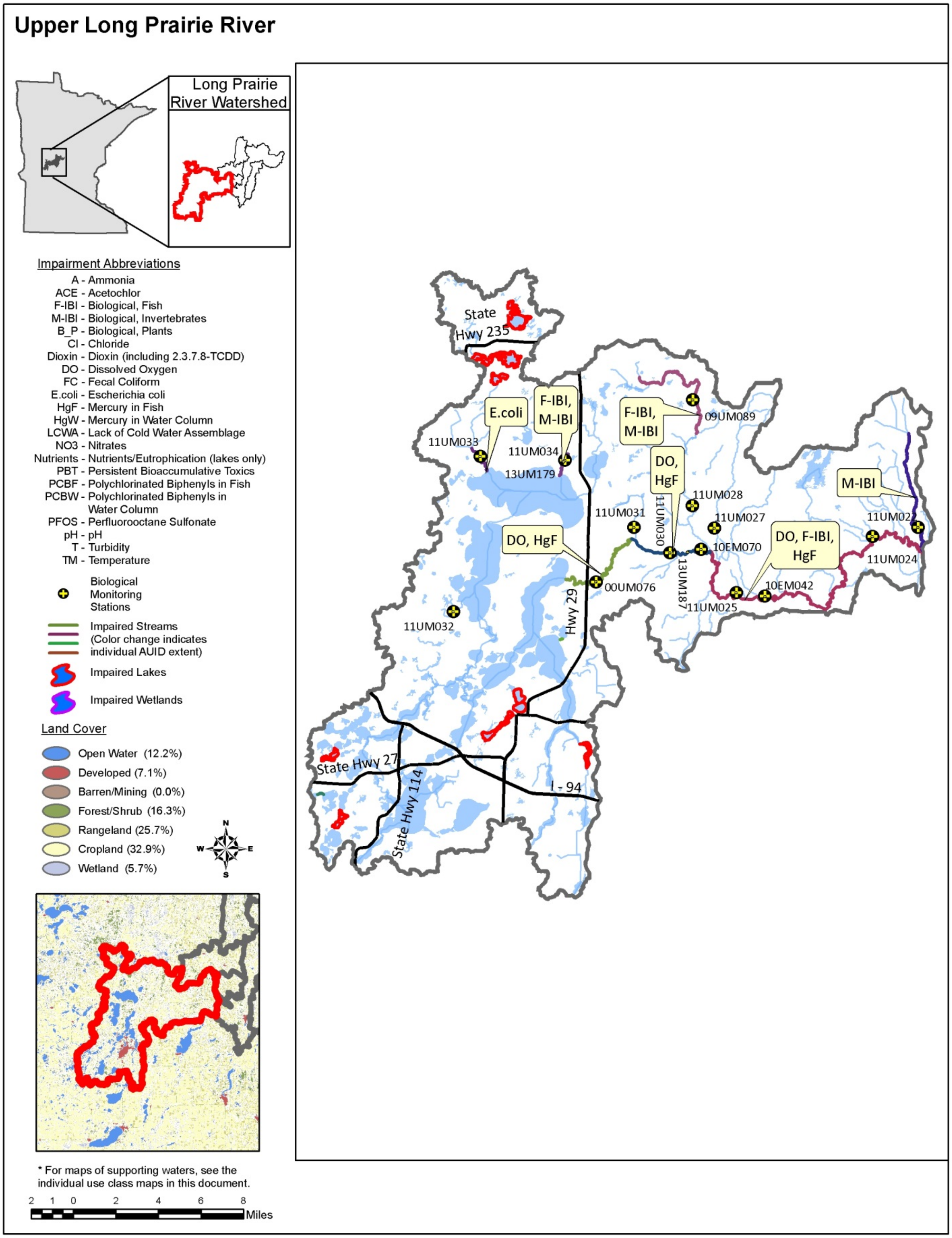

Figure 13. Currently listed impaired waters by parameter and land use characteristics in the Upper Long Prairie Subwatershed.

Harris Creek Subwatershed HUC 07010108020

The Harris Creek Subwatershed is located in west-central Todd County and encompasses an area of 27 mi^2. The subwatershed lies in the transition zone betweem the western lake rich portion of the Long Prairie River Watershed and the more eastern agricultural area. It is the smallest of all the subwatersheds and is predominately comprised of range and cropland (42 and 29%, respectively) (Figure 14). The subwatershed drains the 17.7 mile long Harris Creek, which flows east to its confluence with Eagle Creek near County Highway 21, one-half mile northeast of Browerville. The tributaries to Harris Creek include many unnamed ditches and creeks.

Table 7. Aquatic life and recreation assessments on stream reaches: Harris Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07010108-592 ***Harris Creek,*** *Unnamed Creek to Eagle Creek*	3.09	2B, 3C	11UM013	Downstream of 225th St, 1.5 mi. NW of Browerville	MTS	EXP	--	--	--	--	--	--	--	NS	NA

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 %) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

**Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.

Table 8. Minnesota Stream Habitat Assessment (MSHA): Harris Creek 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
1	11UM013	Harris Creek	1.25	5	20.1	13	30	69.35	Good
		Average Habitat Results: ***Harris Creek Subwatershed***	**1.25**	**5**	**20.1**	**13**	**30**	**69.35**	Good

Qualitative habitat ratings

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

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

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

Table 9. Channel Condition and Stability Assessment (CCSI): Harris Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11UM013	Harris Creek	19	9	11	4	43	Fairly Stable
Average Stream Stability Results: ***Harris Creek Subwatershed***			**19**	**9**	**11**	**4**	**43**	**Fairly Stable**

Qualitative channel stability ratings

= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Summary

Only one site near the outlet of Harris Creek (11UM013) was sampled within the Harris Creek Subwatershed. The F-IBI is above its respective threshold and is positively correlated with a good MSHA score, specifically for substrate, fish cover, and channel morphology (Table 8) and a fairly stable CCSI rating (Table 9). However, the macroinvertebrate community was impaired suggesting that they may be responding to other factors (e.g. hydrology, water chemistry). A one time water chemistry sample taken at the time of biological sampling did not show any concentrations high enough to effect the biological communities and there was no water quality station within this subwatershed.

The Harris Creek Subwatershed does not include any assessable lakes.

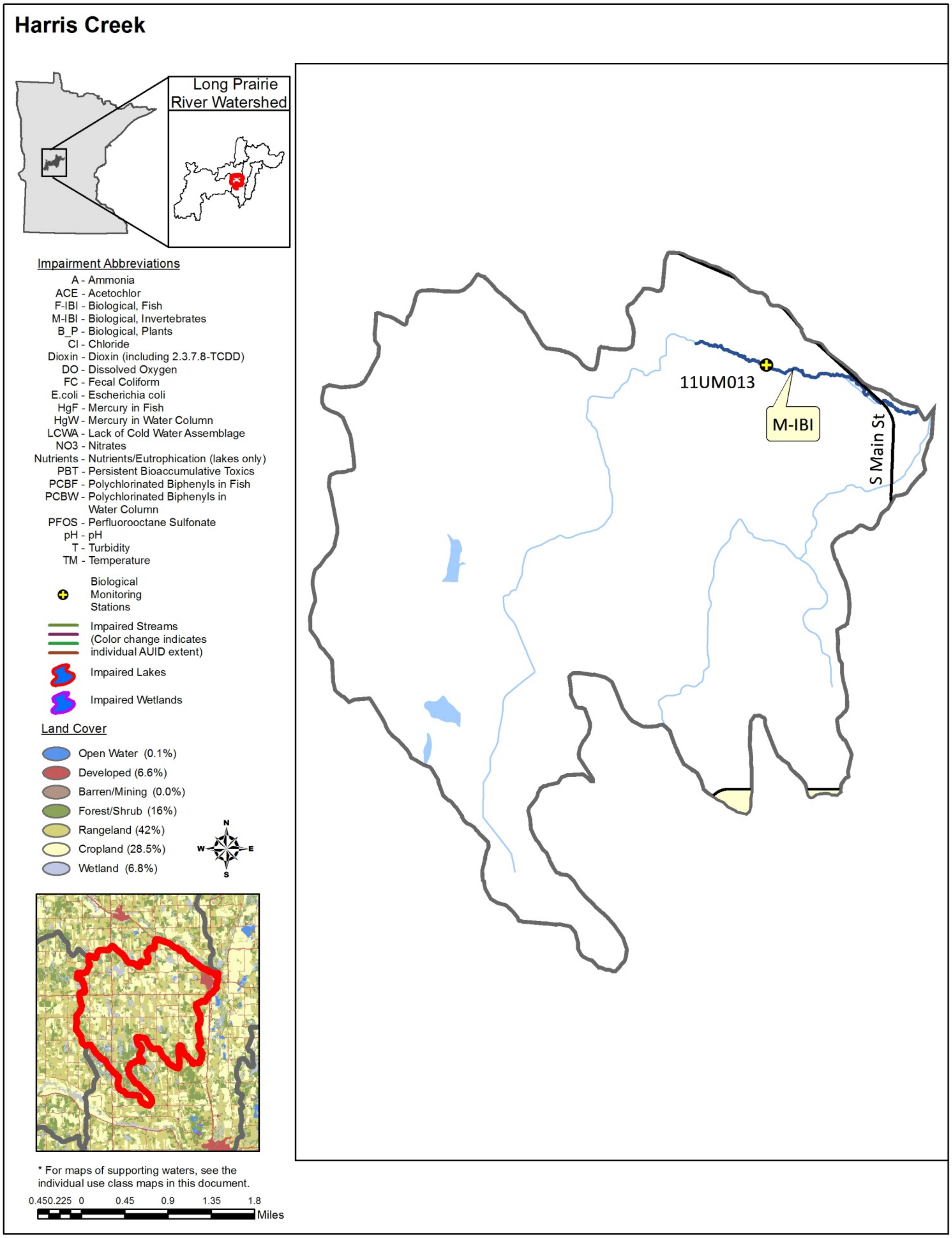

Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Harris Creek Subwatershed.

Eagle Creek Subwatershed HUC 07010108030

The Eagle Creek Subwatershed encompasses 74.7 mi^2 and is located in central Todd County. Eagle Creek originates from an unnamed marsh and flows south for a short period before turning north and flowing through the town of Eagle Bend. After going through town, the river turns and flows southeast to its confluence with the Long Prairie River, one mile northeast of Browerville. The subwatershed includes two named tributaries to Eagle Creek, County Ditch 31 and Harris Creek, as well as many unnamed tributaries. The landscape is mostly range and cropland, 39 and 32% respectively (Figure 15). The water chemistry monitoring station for this subwatershed is represented by the outlet station 00UM075 on Eagle Creek at County Road 89, two miles southeast of Clarissa.

Table 10. Aquatic life and recreation assessments on stream reaches: Eagle Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07010108-507 ***Eagle Creek***, *Headwaters to Long Prairie River*	27.12	2B, 3C	11UM017 00UM075 11UM015**	Upstream of 175th Ave, 2 mi. SE of Eagle Bend Upstream of CR 89, Approx. 2 mi SE of Clarissa Downstream of Frank St., in Clarissa	MTS	MTS	IF	MTS	--	MTS	MTS	--	EX	FS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

** Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.

Table 11. Non-assessed biological stations on channelized AUIDs: Eagle Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological tation ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07010108-507 ***Eagle Creek***, *Headwaters to Long Prairie River*	27.12	2B, 3C	11UM015	Downstream of Frank St., in Clarissa	Good	Good

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 12. Minnesota Stream Habitat Assessment (MSHA): Eagle Creek 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
1	11UM017	Eagle Creek	1.25	12	9	16	17	55.25	Fair
1	11UM015	Eagle Creek	1.5	5	17.85	17	25	66.35	Good
2	00UM075	Eagle Creek	3.125	10.5	14.625	11.5	27.5	67.25	Good
Average Habitat Results: *Eagle Creek Subwatershed*			**1.96**	**9.17**	**13.83**	**14.83**	**23.17**	**62.95**	**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)

Table 13. Channel Condition and Stability Assessment (CCSI): Eagle Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11UM017	Eagle Creek	7	9	10	4	30	Fairly Stable
1	11UM015	Eagle Creek	10	7	11	3	31	Fairly Stable
1	00UM075	Eagle Creek	8	9	10	5	32	Fairly Stable
Average Stream Stability Results: *Eagle Creek Subwatershed*			**8.33**	**8.33**	**10.33**	**4**	**31**	**Fairly Stable**

Qualitative channel stability ratings

= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Table 14. Outlet water chemistry results: Eagle Creek Subwatershed.

Station Location:	**At CR 89, 2 mi. SE of Clarissa, Minnesota**							
EQuIS ID:	**S000-723**							
Station #:	**00UM075**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard**	**# of WQ Exceedances**
Ammonia-nitrogen	mg/L	9	0.00	0.00	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	4.8	10.5	8.1	8.0	5.0	1
pH	--	19	7.2	8.4	7.9	7.8	6.5-9.0	0
Transparency, tube with disk	cm	2	49	78	64	64	>20	0
Turbidity	FNU	3	2.0	7.1	5.2	6.4	25.0 NTU	0
Escherichia coli	MPN/100mL	15.0	60	1700	300	120	1260	2
Escherichia coli (geometric mean)	MPN/100mL	15.0	122	454		160	126	2
Chlorophyll-a, corrected	ug/L	0						
Pheophytin-a	ug/L	0						
Inorganic nitrogen (nitrate and nitrite)	mg/L	8	0.06	0.29	0.20	0.21		
Kjeldahl nitrogen	mg/L	9	0.4	1.5	1.0	1.0		
Phosphorus	ug/L	9	56	210	123	119		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	8	2.0	13.0	5.6	4.8		
Total volatile solids	mg/L	9	1.2	5.6	2.8	2.4		
Sulfate	mg/L	0						
Specific conductance	uS/cm	19	328	675	573	609		
Temperature, water	deg C	19	12.3	20.9	17.2	17.4		

Summary

Three biological monitoring sites are located within the Eagle Creek Subwatershed, all of which are located on Eagle Creek's single 27 mile long AUID. MSHA scores within this subwatershed rate from fair to good (Table 12), specifically scoring high for fish cover and channel morphology. In addition, CCSI ratings indicate that Eagle Creek is fairly stable at all sample locations, especially the upper and lower banks (Table 13). In response to the high quality stream characteristics, the F-IBI and M-IBI scores all meet their respective thresholds. The channelized reach (11UM015) met biological thresholds and had good habitat scores, but it did receive the lowest F-IBI and M-IBI scores in the subwatershed. These lower scores may be a result of the site being channelized (not assessed) and possible urban stressors given the sites location within the town of Clarissa. As a result of these assessments, the previous F-IBI and M-IBI impairments on AUID 07010108-507 will be proposed for delisting. One time water chemistry samples taken at the time of biological sampling at these sites resulted in no elevated concentrations that may affect biological communities.

Stream water quality data were available for Eagle Creek from its headwaters to the Long Prairie River. Water chemistry data were collected near the pour point of the Eagle Creek Subwatershed. Eagle Creek exceeded the standard for bacteria and is considered impaired for aquatic recreation use. This impairment was based on two geometric mean exceedances and two individual sampling event exceedances of the water quality standard of 1260 MPN/100ml (Table 14). Since bacteria can be high at times and moderate or low at other times, recreational use is limited.

The Eagle Creek Subwatershed has no assessed lakes.

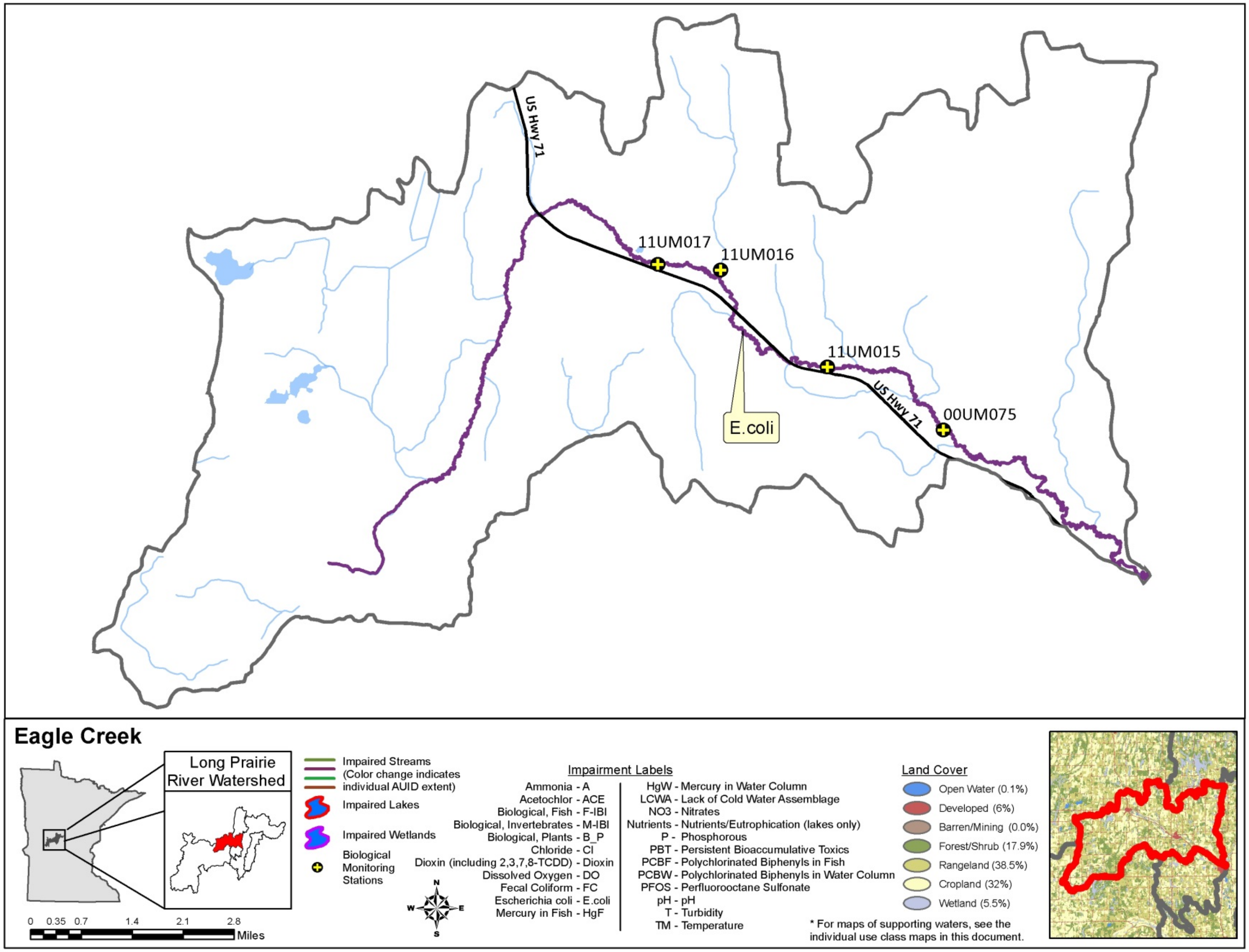

Figure 15. Currently listed impaired waters by parameter and land use characteristics in the Eagle Creek Subwatershed.

Turtle Creek Subwatershed HUC 07010108040

The Turtle Creek Subwatershed, immediately downstream of the Upper Long Prairie River Subwatershed, drains an area of 77.7 mi^2 and is located in east-central Todd County. Turtle Creek flows north, parallel to the Long Prairie River before turning west to its confluence with the Long Prairie River near Township Road 79 and Turtle Lake (77-0088-00), approximately 7.5 miles north of Browerville. Land use in the subwatershed is largely forest (37%), while range and cropland make up a significant amount of the remaining landscape; 27 and 18% respectively (Figure 16). The tributaries to Turtle Creek include many unnamed ditches and creeks. The water chemistry monitoring station for this subwatershed is the outlet station 11UM010 on Turtle Creek at Oak Ridge Road, eight miles NE of Browerville.

Table 15. Aquatic life and recreation assessments on stream reaches: Turtle Creek Subwatershed.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07010108-513 ***Turtle Creek,*** *Headwaters to Long Prairie River*	28.23	2B, 3C	00UM078 11UM010	Downstream of CR 14, 3 mi E. of Browerville Upstream of Township Road 357 (Oak Ridge Rd), 8 mi. NE of Browerville	MTS	MTS	IF	MTS	--	MTS	MTS	--	MTS	FS	FS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

** Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.

Table 16. Non-assessed biological stations on channelized AUIDs: Turtle Creek Subwatershed.

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07010108-600 ***Unnamed Creek,*** *Unnamed Creek to Unnamed Creek*	1.92	2B, 3C	11UM012	Upstream of 284th Ave, 3 mi. SE of Browerville	Good	Fair (2)

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 17. Minnesota Stream Habitat Assessment (MSHA): Turtle Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Us (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11UM012	Unnamed Creek	0.75	11.5	20.7	15	35	82.95	Good
2	00UM078	Turtle Creek	1.75	7.25	11.8	14	22.5	57.3	Fair
2	11UM010	Turtle Creek	3.125	5.5	20.325	14	27.5	70.45	Good
Average Habitat Results: *Turtle Creek Subwatershed*			**1.875**	**8.08**	**17.608**	**14.33**	**28.33**	**70.233**	**Good**

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

Table 18. Channel Condition and Stability Assessment (CCSI): Turtle Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
2	11UM012	Unnamed Creek	11.5	18	14	2.5	51	Moderately Unstable
1	11UM010	Turtle Creek	27	27	15	2	71	Moderately Unstable
1	00UM078	Turtle Creek	27	24	22	2	75	Moderately Unstable
Average Stream Stability Results: *Turtle Creek Subwatershed*			**21.8**	**23**	**17**	**2.08**	**6**	**Moderately Unstable**

Qualitative channel stability ratings
= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Table 19. Outlet water chemistry results: Turtle Creek Subwatershed.

Station Location:	**At Oak Ridge Road, 8 mi. NE of Browerville, Minnesota**							
EQuIS ID:	**S002-901**							
Station #:	**11UM010**							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard**	**# of WQ Exceedances**
Ammonia-nitrogen	mg/L	8	0.00	0.00	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	0.9	8.2	5.8	6.4	5.0	4
pH	--	19	6.7	8.1	7.5	7.5	6.5-9.0	0
Transparency, tube with disk	cm	2	72	95	84	84	>20	0
Turbidity	FNU	3	0.3	12.1	6.2	6.2	25.0 NTU	0
Escherichia coli	MPN/100mL	16	23	280	74	39	1260	0
Escherichia coli (geometric mean)	MPN/100mL	16	47	48		48	126	0
Chlorophyll-a, corrected	ug/L	0						
Pheophytin-a	ug/L	0						
Inorganic nitrogen (nitrate and nitrite)	mg/L	1	0.09	0.09	0.09	0.09		
Kjeldahl nitrogen	mg/L	8	0.9	1.9	1.3	1.2		
Phosphorus	ug/L	8	45	264	93	74		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	9	2.4	5.6	3.8	3.6		
Total volatile solids	mg/L	9	1.6	4.4	2.5	2.4		
Sulfate	mg/L	0						
Specific conductance	uS/cm	19	262	355	304	299		
Temperature, water	deg C	19	13.4	24.2	19.9	20.1		

Table 20. Lakes within the Turtle Creek Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Coal	77-0046-00	178	M	43.0	7.6	4.5		17.6	11.1	2.6	FS	IF
Mill	77-0050-00	166	M	78.1	5.2	2.7		18.8	10.8	1.8	FS	IF
Rice	77-0061-00	675	E	100*	1.5	1*		49.8	11.8	1.3	FS	IF
Thunder	77-0066-00	233	E	100.0	4.3	2.2		29.1	19.0	1.2	FS	IF
Turtle	77-0088-00	124	M	33.1	11.9	5.9		17.5	7.1	2.6	FS	IF

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information
O - Oligotrophic

Summary

The Turtle Creek Subwatershed consists of one assessable AUID on the Turtle Creek mainstem with two sites, and one non-assessable (channelized) AUID on a small tributary to Turtle Creek (Unnamed Creek) with one site. Fish communities on Turtle Creek varied significantly. The most upstream site (00UM078) had 12 species while the downstream site (11UM010) had 22 species. The habitat was similar between the two sites (Table 17), except for substrate quality which was better at 11UM010. The composition of the fish community suggests that substrate quality may be the primary factor influencing the observed differences in the fish community between these two sites. Many sensitive and gravel dwelling species such as hornyhead chub, burbot, and logperch were sampled at 11UM010. However these species were absent at 00UM078 where finer sediments were found. Macroinvertebrate scores for these two sites meet their respective thresholds; interestingly however, samples collected from site 11UM010 were very different. The total taxa sampled were similar (36 and 34, respectively) between 2011 and 2012, however, the composition of the community (i.e. percentage of specific individuals) differed such that M-IBI scores went from 35 in 2011 to 61 in 2012 (Appendix 4.3). The reason for these differences is unclear as the same number of samples were taken from the same habitats during both years. However, it is possible that several high flow events prior to sampling in 2011 may have affected the ability of some macroinvertebrate species to colonize. One time water chemistry samples taken at time of fish sampling indicate no harmful concentrations.

The F-IBI score at the unnamed tributary to Turtle Creek (11UM012) indicates a good fish community that included multiple sensitive species such as Iowa darter and northern redbelly dace. The M-IBI score was slightly below the threshold but within the confidence limit. The good F-IBI and fair M-IBI ratings correspond to a very high MSHA score of 83, which is the highest in the Long Prairie River Watershed. Once again, substrate appears to be a large factor in fish abundance with high substrate scores at 11UM010 and 11UM012 coinciding with high F-IBI scores.

Stream water quality data was collected near the outlet of the Turtle Creek Subwatershed. This site represents the entire 28 mile long reach of the turtle River from its headwaters to its confluence with the Long Prairie (AUID 07010108-513). Turtle Creek meets the standard for bacteria and fully supports aquatic recreation. Bacteria data had no geometric mean exceedances or individual sampling event exceedances of the water quality standard of 1260 MPN/100ml (Table 19). Bacteria levels in this reach were low, suggesting that bacteria should not limit recreational use. Although DO was not assessed, several concentrations were below the standard (Table 19). All other water chemistry parameters met their respective aquatic life standards.

Five lakes in the Turtle Creek Subwatershed had sufficient data to assess for for aquatic recreation (Table 20). All five, Coal, Mill, Rice, Thunder, and Turtle Lakes fully support aquatic recreation, indicating that algal blooms should not impact recreational use.

All of these lakes are located along the eastern portion of the subwatershed. Rice Lake has a large surface area and is shallow. Wind mixing could be a potential issue if phosphorus levels increase. Aquatic plants should also be protected because they utilize available phosphorus and tie it up in plant biomass. Rice Lake has a large lake catchment and in turn had the highest concentrations of TP, Chl-a, and Secchi of assessed lakes in this watershed. Best land management practices need to be promoted to limit nutrient inputs in order to maintain current water quality conditions in Rice Lake. Coal, Mill, Thunder, and Turtle lakes have small surface areas and have small contributing lake catchments. Forested areas along these lakes serve as a buffer for excess nutrients entering the lake during runoff events. It is critical that these natural areas are protected in order to maintain good water quality.

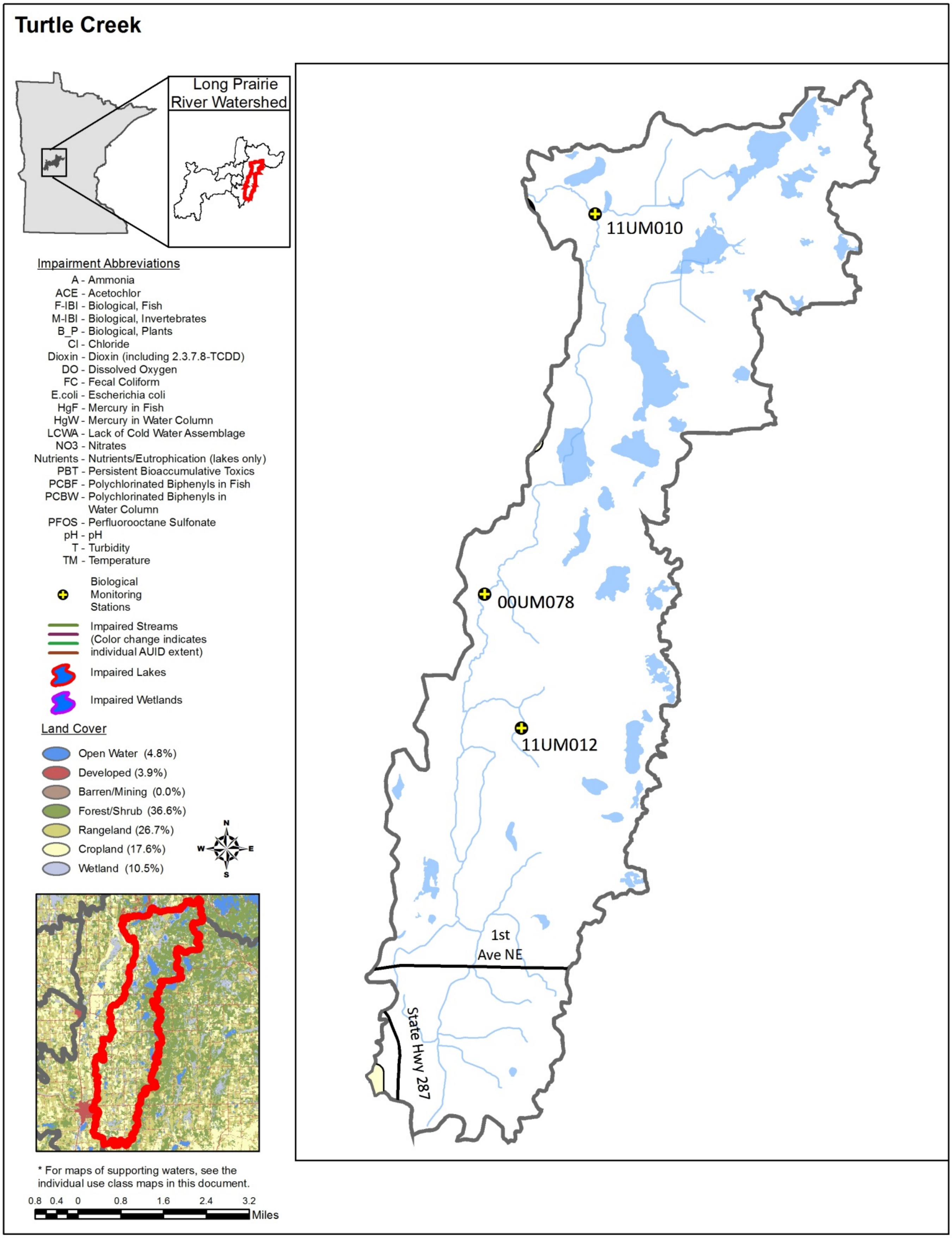

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Turtle Creek Subwatershed.

Moran Creek Subwatershed HUC 07010108050

The Moran Creek Subwatershed is located in northern Todd and southern Wadena Counties and encompasses an area of 71.4 mi^2. Moran Creek originates in an unnamed marsh and flows north for approximately six miles. Here, it begins to bend southeast where it flows to its confluence with the Long Prairie River, approximately 11 miles north of Browerville near CSAH 26 and CSAH 21. Tributaries to Moran Creek include County Ditch 25 and many unnamed ditches and creeks. The Moran Creek Subwatershed is largely comprised of rangeland and forest with 33 and 28%, respectively. Cropland makes up 16% of the watershed (Figure 17). The water chemistry monitoring station for this subwatershed is at the outlet station 11UM008 on Moran Creek at 255th Avenue, eight miles southwest of Staples.

Table 21. Aquatic life and recreation assessments on stream reaches: Moran Creek Subwatershed.

AUID *Reach Name,* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07010108-511 ***Moran Creek,*** *Headwaters to Long Prairie River*	23.17	2B, 3C	00UM077 11UM008	Upstream of CR 24, 5 mi S.W. of Staples Downstream of 255th Ave, 8 mi. SW of Staples	MTS	MTS	EXP	MTS	--	MTS	MTS	--	EX	FS	NS
07010108-603 **Unnamed Creek,** *Unnamed Creek to Unnamed Creek*	3.7	2B, 3C	11UM009	Downstream of CR 74, 6 mi. SW of Staples	MTS	MTS	--	--	--	--	--	--	--	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

** Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.

Table 22. Minnesota Stream Habitat Assessment (MSHA): Moran Creek 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	00UM077	Moran Creek	3.33	10.8	9	12.67	21.3	57.17	Fair
1	11UM009	County Ditch 25	3.75	15	16	6	23	63.75	Fair
1	11UM008	Moran Creek	2.5	11	11.6	11	20	56.1	Fair
Average Habitat Results: *Moran Creek Subwatershed*			**3.14**	**12.22**	**12.31**	**9.78**	**21.4**	**58.89**	**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)

Table 23. Channel Condition and Stability Assessment (CCSI): Moran Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11UM008	Moran Creek	4	7	8	4	23	Stable
1	00UM077	Moran Creek	4	12	18	3	37	Fairly Stable
1	11UM009	County Ditch 25	7	13	18	3	41	Fairly Stable
Average Stream Stability Results: *Moran Creek Subwatershed*			**5**	**10.67**	**14.67**	**3.33**	**33.67**	**Fairly Stable**

Qualitative channel stability ratings

= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Table 24. Outlet water chemistry results: Moran Creek Subwatershed.

Station Location:	At 255th Avenue, 8 mi. SW of Staples, Minnesota							
EQuIS ID:	S002-903							
Station #:	11UM008							
Parameter	Units	# of Samples	Minimum	Maximum	Mean	Median	WQ Standard	# of WQ Exceedances
Ammonia-nitrogen	mg/L	9	0.00	0.00	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	3.4	8.6	7.0	7.2	5.0	1
pH	--	19	7.0	8.3	7.7	7.8	6.5-9.0	0
Transparency, tube with disk	cm	1	94	94	94	94	>20	0
Turbidity	FNU	2	3.3	6.6	5.0	5.0	25.0 NTU	0
Escherichia coli	MPN/100mL	16	65	1400	264	170	1260	1
Escherichia coli (geometric mean)	MPN/100mL	16	145	296		161	126	3
Chlorophyll-a, corrected	ug/L	0						
Pheophytin-a	ug/L	0						
Inorganic nitrogen (nitrate and nitrite)	mg/L	0						
Kjeldahl nitrogen	mg/L	9	0.7	1.3	1.0	1.0		
Phosphorus	ug/L	9	32	83	58	56		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	9	<1.0	4.0	2.2	2.0		
Total volatile solids	mg/L	9	<1.0	2.4	1.6	2.0		
Sulfate	mg/L	0						
Specific conductance	uS/cm	19	288	564	465	497		
Temperature, water	deg C	19	12.7	22.3	18.2	19.1		

Table 25. Lakes within the Moran Creek Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Dower	77-0138-00	139	M	59.2	10.4	4.0		13.1	3.7	4.1	FS	IF

Abbreviations: **D** -- Decreasing/Declining Trend; **I** -- Increasing/Improving Trends; **NT** – No Trend; **H** – Hypereutrophic; **E** – Eutrophic; **M** – Mesotrophic; **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information; **O** - Oligotrophic

Summary

The high F-IBI and M-IBI scores at the three sites within the Moran Creek Subwatershed were positively related to stream habitat (Table 22), particularly high land use and riparian scores. F-IBI scores at both sites were above the upper confidence limits with many sensitive and gravel dwelling species present such as hornyhead chub, mottled sculpin, and blacknose dace. M-IBI scores were both above the thresholds with 00UM077 being above the upper confidence limit.

Stream water quality data were available for Moran Creek from its headwaters to the Long Prairie River. Water chemistry data were collected near the outlet of the Moran Creed Subwatershed. Moran Creek exceeded the standard for bacteria and is impaired for aquatic recreation use. The impairment was based on three geometric mean exceedances and one individual sampling event that exceeded the water quality standard of 1260 MPN/100ml (Table 24). Since bacteria can be high at times and moderate or low at other times, recreational use is limited. Moran Creek was exceeding dissolved oxygen standards at the upstream site (00UM077) but recovered and met standards at the downstream site (11UM008). Due to the DO recovery and the biological communities meeting standards, it was decided to not list the AUID as impaired due to low DO levels.

The Moran Creek Subwatershed has very few lakes. Dower Lake, located just west of Staples was the only lake in this watershed to have sufficient data for assessment (Table 25) and fully supports aquatic recreation, indicating that algal blooms should not impact recreational use. Dower Lake is located in the northern portion of the subwatershed which is primarily forest and wetland. There is a large park on the eastern shore of the lake with a swimming beach. In addition, a large fishing pier is present to provide anglers with fishing opportunities. The lake is a highly valued resource to the local community and needs to be protected. Best land management practices should be promoted to limit nutrient inputs from within the watershed. In addition, forested areas and wetlands should remain as a buffer for excess nutrients entering the lake during runoff events. It is critical that these natural areas are protected in order to maintain good lake water quality.

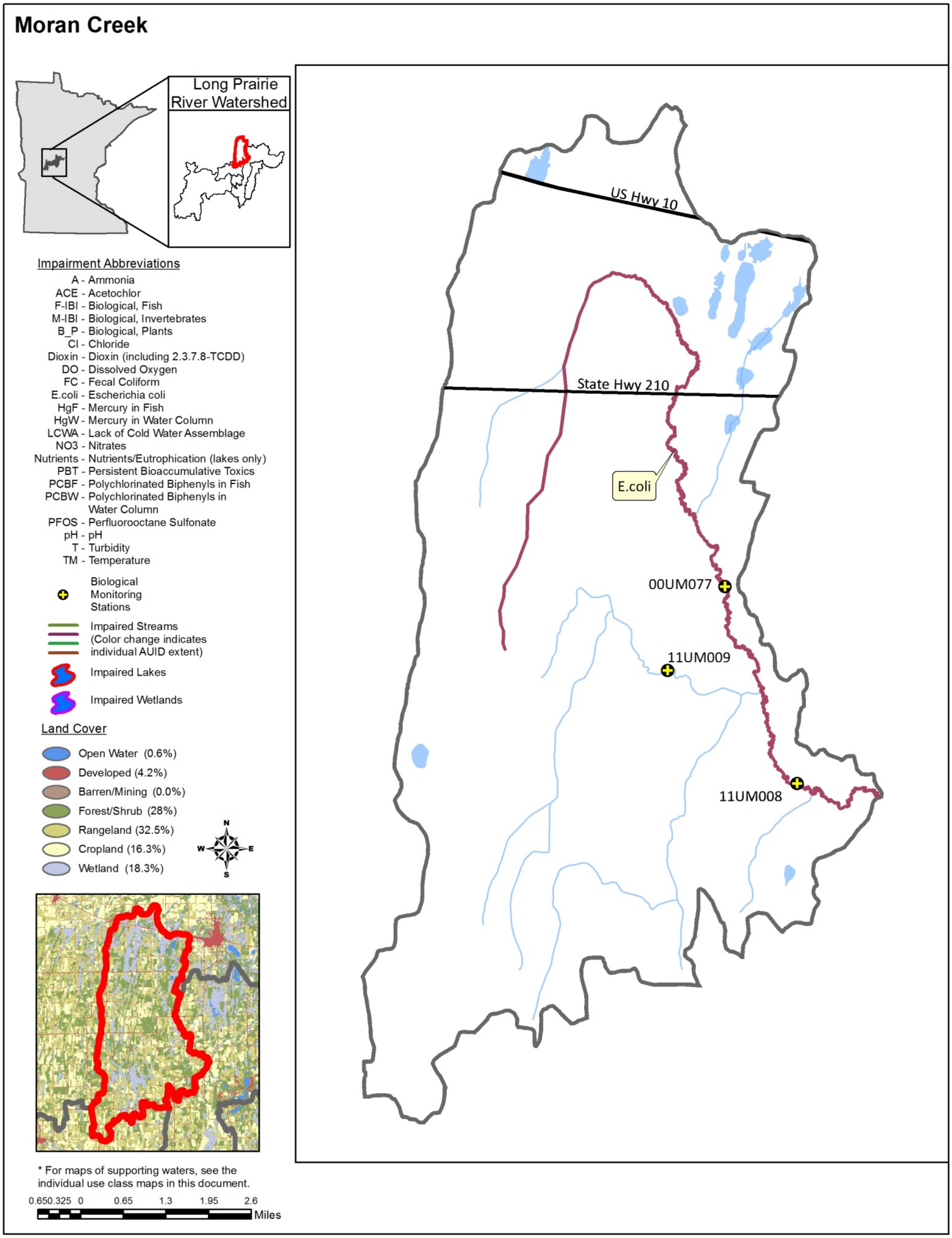

Figure 17. Currently listed impaired waters by parameter and land use characteristics in the Moran Creek Subwatershed.

Long Prairie River Subwatershed HUC 07010108060

The Long Prairie River Subwatershed is located in central Todd and northwestern Morrison Counties, comprising 234.5 mi^2. The subwatershed flows through the center of the Long Prairie River HUC-8 Watershed, from the southernmost point of the watershed to the north-northeast portion. The major tributaries to the Long Prairie River Subwatershed include Venewitz and Fish Trap Creeks among numerous other unnamed ditches and creeks. In addition to these tributaries, this subwatershed receives all of the water from the five upstream subwatersheds. Land use within the subwatershed is predominately rangeland and forest, comprising 36 and 24%. Cropland makes up 20% of the subwatershed (Figure 18). The water chemistry monitoring stations for this subwatershed are at outlet stations 11UM019 at CR 14, 0.5 mi. E of Browerville and 11UM001 upstream of Township Road 29 in Philbrook, both of which are located on the Long Prairie River.

Table 26. Aquatic life and recreation assessments on stream reaches: Long Prairie River Subwatershed.

AUID *Reach Name,* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07010108-568 ***Venewitz Creek,*** *Charlotte Lake to Long Prairie River*	2.05	2B, 3C	11UM020	Upstream of 230th St, 0.5 mi. SW of Long Prairie	EXS	--	--	--	--	--	--	--	--	NS	NA
07010108-503 ***Long Prairie River,*** *Turtle Creek to Moran Creek*	5.01	2B, 3C	11UM004	Upstream of Township Road 350 (400th St), 10 mi. S of Staples	MTS	MTS	--	--	--	--	--	--	--	NS	NA
07010108-502 ***Long Prairie River,*** *Moran Creek to Fish Trap Creek*	7.45	2B, 3C	11UM001	Upstream of Twp. Rd. 29 (313th Ave.) in Philbrook	MTS	MTS	IF	MTS	--	MTS	MTS	--	IF	NS	IF
07010108-505 ***Long Prairie River,*** *Spruce Creek to Eagle Creek*	49.75	2B, 3C	00UM074 11UM019 13UM175	Downstream of Pub. Access off Lake St. in Long Prairie Upstream of CSAH 14, 0.5 mi. E of Browerville W of Hwy 30 and Hwy 5 Intersection, 3.5 mi N of LP	EXP ***	MTS	EXS	MTS	--	MTS	MTS	--	MTS	NS	FS
07010108-501 ***Long Prairie River,*** *Fish Trap Creek to Crow Wing River*	8.8	2B, 3C	--	--	--	--	MTS	MTS	--	MTS	MTS	--	MTS	FS	FS
07010108-504 ***Long Prairie River,*** *Eagle Creek to Turtle Creek*	13.45	2B, 3C	11UM005 00UM079	Upstream of Oak Ridge Rd, 7.5 mi. NE of Browerville Upstream of CR 62, 6 mi. E of Clarissa	MTS ***	NA	EXP	MTS	--	MTS	--	--	--	NS	NA

Abbreviations for Indicator Evaluations: -- = No Data, NA = Not Assessed, IF = Insufficient Information, MTS = Meets criteria; EXP = Exceeds criteria, potential impairment; EXS = Exceeds criteria, potential severe impairment; EX = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: NA = Not Assessed, IF = Insufficient Information, NS = Non-Support, FS = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

** Aquatic Life assessment and/or impairments for this site have been deferred until the adoption of Tiered Aquatic Life Uses due to the site being predominantly (>50%) channelized.

*** Due to absence of the 2013 assessments, this assessment decision is unofficial until the 2014 assessment cycle.

Table 27. Non-assessed biological stations on channelized AUIDs: Long Prairie River Subwatershed.

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07010108-594 ***Trib. to Long Prairie River,*** *Keller Lake to Long Prairie River*	2.83	2B	11UM021	Upstream of CSAH 38, 3.5 mi. NW of Long Prairie	Good	Good
07010108-599 ***Unnamed Creek,*** Unnamed Creek to Long Prairie River	1.97	2B	11UM006	Upstream of CSAH 18, 6 mi. NE of Browerville	Poor	Poor
07010108-514 ***Fish Trap Creek,*** *Headwater (Fish Trap Lake 18-0400-00) to Long Prairie River)*	9.53	2B, 3C	11UM007	Upstream of Quicken Rd., 7.5 mi. SW of Motley	Fair	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 28. Minnesota Stream Habitat Assessment (MSHA): Long Prairie River 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
1	11UM021	Trib. to Long Prairie	2.5	13	20	13	29	77.5	Good
1	11UM020	Venewitz Creek	1.75	11	4	14	14	44.75	Poor
2	00UM074	Long Prairie River	1.875	10.5	16.625	10.5	21.5	58.85	Fair
1	11UM019	Long Prairie River	3.5	10.5	18	16	21	69	Good
1	11UM006	Trib. to Long Prairie	2.5	8.5	9	5	2	27	Poor
2	11UM004	Long Prairie River	1.25	10.75	10	15	2	39	Poor
1	11UM007	Fish Trap Creek	2.5	9.5	9	13	12	46	Fair
1	11UM001	Long Prairie River	3.25	12	14.9	12	21	63.15	Fair
1	11UM005	Long Prairie River	2.5	12	16.5	17	24	72	Good
1	00UM079	Long Prairie river	2.5	10	12	12	21	57.5	Fair
1	13UM175	Long Prairie River	0	9.5	17	12	18	56.5	Fair
Average Habitat Results: *Long Prairie River Subwatershed*			**2.15**	**10.77**	**13.19**	**12.96**	**16.83**	**55.69**	**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 < 45E)

Table 29. Channel Condition and Stability Assessment (CCSI): Long Prairie River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11UM021	Trib. to Long Prairie River	8	6	4	4	22	Stable
3	11UM001	Long Prairie River	11	12	17	2.5	42.5	Fairly Stable
1	11UM006	Trib. to Long Prairie River	10	5	22	4	41	Fairly Stable
1	11UM007	Fish Trap Creek	6	6	30	3	45	Moderately Unstable
2	11UM004	Long Prairie River	19.5	8.5	24.5	3	55.5	Moderately Unstable
2	00UM074	Long Prairie River	15.5	17	18	4.5	56	Moderately Unstable
Average Stream Stability Results: *Long Prairie River Subwatershed*			**12.9**	**10.4**	**20.4**	**3.4**	**47.1**	**Moderately Unstable**

Qualitative channel stability ratings

= Stable: CCSI < 27 = Fairly stable: 27 < CCSI < 45 = Moderately unstable: 45 < CCSI < 80 = Severely unstable: 80 < CCSI < 115 = Extremely unstable: CCSI > 115

Table 30. Outlet water chemistry results: Long Prairie River Subwatershed

Station Location:	At CR 14, 0.5 mi. E of Browerville, Minnesota							
EQuIS ID: S002-910	S002-910							
Station #:	11UM019							
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard**	**# of WQ Exceedances**
Ammonia-nitrogen	mg/L	9	0.00	0.00	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	0.5	8.4	5.1	5.7	5.0	8
pH	--	18	7.0	8.5	7.7	7.7	6.5-9.0	0
Transparency, tube with disk	cm	4	83	94	89	89	>20	0
Turbidity	FNU	3	4.0	11.0	8.0	8.9	25.0 NTU	0
Escherichia coli	MPN/100mL	16	20	1300	151	74	1260	1
Escherichia coli (geometric mean)	MPN/100mL	16	41	130		64	126	0
Chlorophyll-a, corrected	ug/L	0						
Pheophytin-a	ug/L	0						
Inorganic nitrogen (nitrate and nitrite)	mg/L	3	0.08	0.18	0.11	0.08		
Kjeldahl nitrogen	mg/L	9	0.5	1.3	0.9	0.8		
Phosphorus	ug/L	9	36	271	143	139		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	9	1.2	7.6	3.9	4.0		
Total volatile solids	mg/L	9	1.2	3.6	2.1	2.0		
Sulfate	mg/L	0						
Specific conductance	uS/cm	18	431	561	501	511		
Temperature, water	deg C	19	13.3	25.0	20.3	21.6		

Table 31. Outlet water chemistry results: Long Prairie River Subwatershed.

Station Location:	Upstream of Twp. Rd. 29 (313th Avenue) in Philbrook							
EQuIS ID:	S002-900							
Station #:	11UM001							
Parameter	Units	# of Samples	Minimum	Maximum	Mean	Median	WQ Standard	# of WQ Exceedances
Ammonia-nitrogen	mg/L	16	0.00	0.01	0.00	0.00	0.04	0
Chloride	mg/L	0					230	
Dissolved oxygen (DO)	mg/L	19	2.1	15.6	7.0	6.1	5.0	4
pH	--	19	7.1	9.8	8.3	8.2	6.5-9.0	0
Transparency, tube with disk	cm	19	>100	>100	>100	>100	>20	0
Turbidity	FNU	2	0.9	3.7	2.3	2.3	25.0 NTU	0
Escherichia coli	MPN/100mL	15.0	17	1046	181	74	1260	0
Escherichia coli (geometric mean)	MPN/100mL	15.0	68	174		69	126	1
Chlorophyll-a, corrected	ug/L	19	1.0	8.0	2.6	2.0		
Pheophytin-a	ug/L	9	<1	<1	<1	<1		
Inorganic nitrogen (nitrate and nitrite)	mg/L	13	0.04	0.42	0.19	0.19		
Kjeldahl nitrogen	mg/L	19	0.4	9.1	1.2	0.7		
Phosphorus	ug/L	19	37	216	92	82		
Orthophosphate	ug/L	0						
Total suspended solids	mg/L	19	1.0	13.0	4.7	4.0		
Total volatile solids	mg/L	19	1.0	6.0	2.9	3.0		
Sulfate	mg/L	0						
Specific conductance	uS/cm	19	395	510	475	482		
Temperature, water	deg C	19	12.5	27.2	21.0	21.8		

Table 32. Lakes within the Long Prairie River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Alexander	49-0079-00	2,990	M	31.0	19.8	7.7	I	18.3	6.7	4.7	FS	NA
Shamineau	49-0127-00	1,453	M	46.0	15.8	5.7	NT	14.5	4.5	4.5	FS	NA
Crookneck	49-0133-00	200	E	78.0	5.5	2.6		26.9	7.0	2.7	FS	NA
Ham	49-0136-00	63	M	52.6	7.0			16.3	6.2	3.5	FS	NA
Fish Trap	49-0137-00	1,320	E	26.6	12.8	6.2	I	24.5	8.7	3.4	FS	NA
Fawn	77-0076-00	142	M	93.0	6.4	2.0		17.4	3.0	3.6	FS	NA
Pine Island	77-0077-00	156	M	100*	4.9	2*		19.5	4.6	3.2	FS	NA
Latimer	77-0105-00	210	E	40.4	9.3	5.1	D	71.1	48.0	1.2	NS	IF
Charlotte	77-0120-00	181	M	25.0	25.6	10.8		15.1	4.2	3.6	FS	IF
Horseshoe	77-0128-00	122	M	71.2	7.3	2.6	NT	14.5	5.1	3.1	FS	IF

Abbreviations: **D** – Decreasing/Declining Trend; **I** – Increasing/Improving Trends; **NT** – No Trend; **M** – Mesotrophic; **H** – Hypereutrophic; **E** – Eutrophic; **IF** – Insufficient Information; **FS** – Full Support; **NS** – Non-Support; **O** – Oligotrophic

Summary

The Long Prairie River Subwatershed consists of six assessable AUIDs, five of which are located on the mainstem Long Prairie River. The most upstream AUID (-505) begins in the Upper Long Prairie Subwatershed, and carries with it the dissolved oxygen (DO) impairment which continues through AUID -502 on Long Prairie River. The DO recovers at the most downstream AUID so that there is no DO impairment by the time the Long Prairie River flows into the Crow Wing River. The abundance of different fish taxa within the Long Prairie River mainstem varied between sites (17-27 species). However, the presence of larger, long lived species as well as the abundance of tolerant species at certain sites resulted in noticeable differences in the F-IBI scores (Appendix 4.2).

At the most upstream AUID (-505), F-IBI scores were below the threshold at the upstream (00UM074) and downstream (11UM019) sites, but well above the upper confidence limit at the middle site (13UM175). The middle site had fewer taxa but the composition of the fish community was better. For example, greater redhorse (sensitive) were present here and absent in the two other sites. At the upstream and downstream sites central mudminnows and common shiners (both tolerant species) made up a majority of the individuals, suggesting that low DO may be an issue. Flows at these two sites are slow to moderate in contrast to the middle site where faster flows and riffles are present. The increased flow and presence of riffle habitat may be providing more oxygen at the middle site which is reflected in the fish species composition at this site. Lastly, the upstream and downstream sites are both located near residential and/or industrial areas where there is the possibility of a localized stressor that may impact the biological communities. Macroinvertebrate samples were only taken at the upstream site. The M-IBI score was above the upper confidence limit. Neither the MSHA scores (Table 28) or water chemistry samples taken at the time of fish sampling indicated any potential stressors to biological communities.

The next downstream AUID (-504) had two sites, both of which were impaired for F-IBI based on samples taken prior to this survey. However, both sites scored above the confidence limit during the 2012 and 2013 sampling events and are being proposed for possible de-listing of the F-IBI impairment in 2014. Although F-IBI scores at both sites were good, the presence/absence of certain species resulted in some variation in the F-IBI scores (Appendix 4.2). The presence of greater redhorse, smallmouth bass, and a total of 26 species at 11UM005 versus their absence and only 17 species at 00UM079 resulted in a F-IBI score ten points lower at 00UM079. MSHA scores (Table 28) indicate that habitat is better at 11UM005, specifically for substrate and fish cover which correlates well with the higher F-IBI score and the presence of gravel dwelling species.

The two downstream AUIDs each have one site. Both sites meet the biological criteria for fish and macroinvertebrates (Appendices 4.2 and 4.3). MSHA scores are positively correlated with F-IBI scores between these two sites, specifically substrate and channel morphology (Table 28). Similar to AUID -504, the presence of gravel dwelling species such as shorthead redhorse, smallmouth bass, and hornyhead chub and fewer tolerant species such as central mudminnows confirm that conditions are better at the upstream site (11UM001) versus the downstream site (11UM004). Both sites were also sampled for macroinvertebrates in 2011 and 2012. Interestingly, both sites scored below the threshold in 2011 but well above the upper confidence limit in 2012. The 2011 M-IBI scores were likely low due to high water events which may have had an effect sampling and macroinvertebrate community composition. For example, three habitat types were sampled at 11UM001 in 2012 but only one habitat type was sampled in 2011, likely due to the high water covering such habitats as wood and rock. Water chemistry samples did not show any potential stressors in these AUIDs.

The health of the aquatic communities within the smaller tributaries of this subwatershed appear to be limited by habitat, specifically poor substrates and channel morphology characteristics. Of the three channelized (non-assessed) tributaries, only 11UM021 received a good MSHA score (Table 28) which correlated with good F-IBI and M-IBI scores. The remaining channelized streams scored poor (11UM006) and nearly poor (11UM007), and in turn had low scores for F-IBI and M-IBI (Appendices 5.2 and 5.3). The lone assessable tributary received a poor MSHA and a F-IBI score well below the lower confidence interval. The site was not sampled for macroinvertebrates.

Stream water quality data were available for the Long Prairie River from Spruce Creek to Eagle Creek. This AUID is approximately 49.6 miles long. Water chemistry data were collected near the outlet of the Long Prairie River Subwatershed. The Long Prairie River meets the standard for bacteria, and fully supports aquatic recreation. There were no geometric mean exceedances of the bacteria standard and only one sample exceeded of the standard of 1260 MPN/100ml (Table 30). Levels of bacteria in this reach were generally low, suggesting that bacteria should not limit recreational use. The existing dissolved oxygen impairment will be carried forward as the current assessment data set for dissolved oxygen confirms the existing impairment.

Stream water quality data were also available for the Long Prairie River from Moran Creek to Fish Trap Creek. This AUID is approximately 4.5 miles long. Water chemistry data were collected near the outlet of the Long Prairie River Subwatershed. This reach of the Long Prairie River meets the standard for bacteria and fully supports aquatic recreation. There was one geometric mean exceedance and no individual sampling event exceeded the water quality standard for bacteria of 1260 MPN/100ml (Table 31). Levels of bacteria in this reach were low, suggesting that bacteria should not limit recreational use.

As a result of the new biological and chemical sampling and subsequent water body assessments, two stream segments of the Long Prairie River will be proposed for delisting. The lower reach of the Long Prairie River from Fish Trap Creek to the Crow Wing River (AUID 07010108-501) will be delisted for Dissolved Oxygen and the Long Prairie River from Eagle Creek to Turtle Creek (AUID - 504) will be delisted for F-IBI.

Lakes in this region are typically deep and have watersheds that primarily consist of forest, cropland, and pasture. Nine lakes in the Long Prairie River Subwatershed had sufficient data to asses for aquatic recreation (Table 32). Alexander, Shamineau, Crookneck, Ham, Fish Trap, Fawn, Pine Island, Charlotte, and Horseshoe lakes fully supported aquatic recreation, indicating that algal blooms should not impact recreational use. Latimer Lake did not support aquatic recreation because of excess nutrients.

Charlotte and Horseshoe Lakes are relatively small and have developed shorelines with watershed areas that are dominated by cropland. Both of these lakes have diffuse drainages to the Long Prairie River. As a result, it is important that the water quality of these lakes is considered prior to further development of the watershed. A small cluster of lakes to the north that include Pine Island and Fawn Lakes have small watersheds that are highly forested. To maintain good water quality in these lakes BMPs should attempt to keep forested areas intact. Fish Trap, Alexander, and Shamineau are all relatively large lakes in the northeastern portion of the Long Prairie River Subwatershed. Ham and Crookneck are in close proximity to these lakes but are much smaller in size. These lakes also have forested watersheds due in part to the designated Scientific and Natural Areas that are located nearby.

Latimer Lake had the highest concentrations of TP, Chl-a, and Secchi of all the assessed lakes in the Long Prairie River Subwatershed. The land use within its watershed is primarily cropland and pasture. There is also development around the periphery of the lake. As a result, nutrient contributions that are likely the result of poor land use practices in the watershed and near the shore of the lake should be reduced in order to improve water quality.

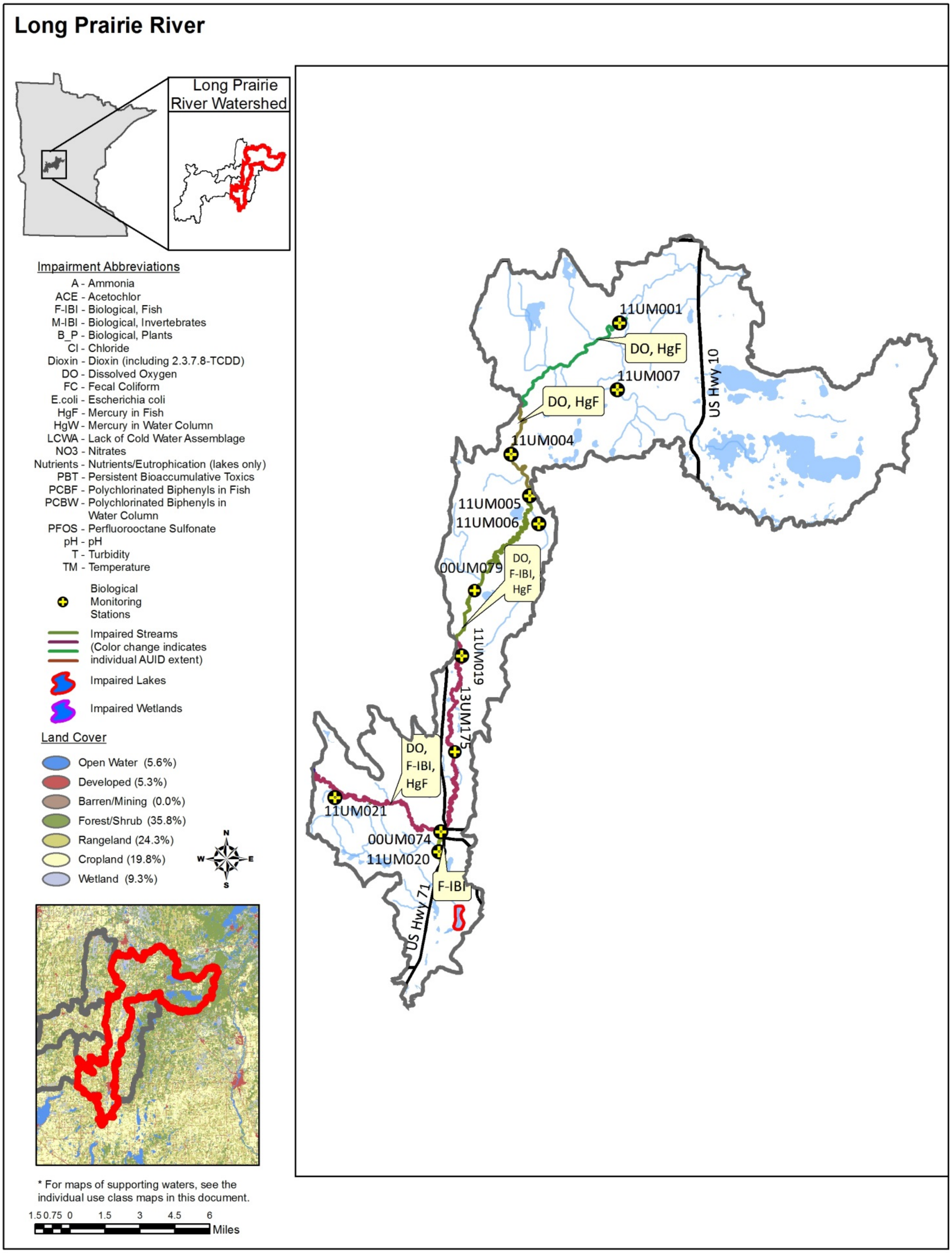

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Long Prairie River Subwatershed.

VI. Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed of the Long Prairie River, grouped by sample type. Summaries are provided for load monitoring data results near the mouth of the river, for aquatic life and recreation uses in streams and lakes throughout the watershed, and for aquatic consumption results at select river and lake locations along the watershed. Additionally, groundwater monitoring results and long-term monitoring trends 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 Long Prairie River Watershed.

Watershed Polluntant Load Monitoring Network

A long term WPLMN station is located on theLong Prairie River near the town of Philbrook on 313th Avenue. Many years of quality data from throughout Minnesota combined with previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA, 2008). Of the state's three RNR's (North, Central, South), the Long Prairie River's monitoring station is located within the Central RNR.

Annual flow weighted mean concentrations (FWMCs) were calculated and compared for years 2009-2011 (Figure 19, Figure 20, Figure 21 and Figure 22) and compared to the RNR standards (only TP and TSS draft standards are available for the Central RNR). It should be noted that while a FWMC exceeding given water quality standard is generally a good indicator the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent ten year period and not based on comparisons with FWMCs (MPCA, 2012). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. However, as a general rule, elevated levels of total suspended solids (TSS) and nitrate plus nitrite-nitrogen (nitrate-N) are generally regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP) can be attributed to either "non-point" as well as "point", or end of pipe, sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development, rather than after low intensity post-canopy events where less surface runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in FWMCs and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher with DOP and nitrate-N concentrations tending to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and nitrate-N levels tend to be elevated. In many cases, it is a combination of climatic factors from which the pollutant loads are derived.

Total suspended solids

Water clarity refers to the transparency of water. 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. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

Analysis has shown a strong correlation to exist between the measures of TSS and turbidity. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. High turbidity results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae species (MPCA and MSUM, 2009). An overabundance of algae can lead to increases in turbidity, further compounding the problem. Periods of high turbidity often occur when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles and overland flow transports fine particles of silt and clay into rivers and streams (MPCA and MSUM, 2009).

Currently, the State of Minnesota's TSS standards are in development and must be considered draft standards until approved. Within the Central RNR, the river would be considered impaired when greater than 10% of the individual samples exceed the TSS draft standard of 30 mg/L (MPCA, 2011). Laboratory results from 2009 through 2011 show 0, 1.5 and 0% of the individual TSS samples exceeded the 30 mg/L draft standard, respectively. None of the computed FWMCs for the three sampling years exceeded the 30 mg/L draft standard. (Figure 19). The highest TSS concentrations were generally during spring snow melt. Although the data may not reflect long-term trends, TSS FWMCs do not show a trend while annual loads show an increasing trend over the three years (Figure 19 and Table 33). Often, there is a strong correlation between pollutant loads and annual runoff volume; the differences may be due strictly to differences in annual runoff volume (Figure 11).

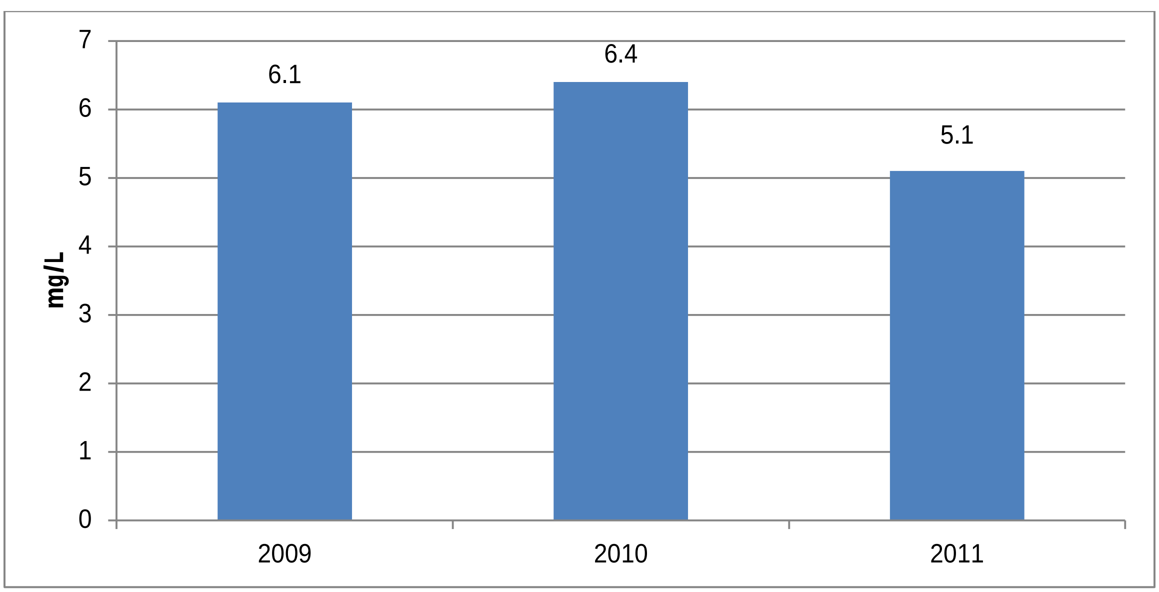

Figure 19. Total Suspended Solids (TSS) flow weighted mean concentrations at Long Prairie River near Philbrook.

	2009	2010	2011
Parameter	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	2,120,139	2,488,826	2,920,280
Total Phosphorus	33,649	36,461	54,244
Ortho Phosphorus	15,705	18,085	26,531
Nitrate + Nitrite Nitrogen	14,9322	158,116	173,267

Table 33. Annual pollutant loads by parameter calculated for the Long Prairie River.

Total phosphorus

Nitrogen, phosphorus, and potassium are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension, 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels overstimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality from overstimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension, 1999). Elevated levels of phosphorus in rivers and streams 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 (University of Missouri Extension, 1999). In “non-point” source dominated watersheds, total phosphorus (TP) concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

TP standards for Minnesota’s rivers are also in development and must be considered draft standards until approved. Within the Central RNR, the TP draft standard is 0.1 mg/L as a summer average. Summer average violations of one or more “response” variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. Concentrations from 2009, 2010 and 2011 show that 10, 10 and 36% of the individual TP samples exceeded the 0.1 mg/L draft standard, respectively. FWMCs from 2009 to 2011 are less than the draft standard at 0.097, 0.093, and 0.094 mg/L, respectively Figure 20. At this site, TP concentrations are generally highest during the spring and summer.

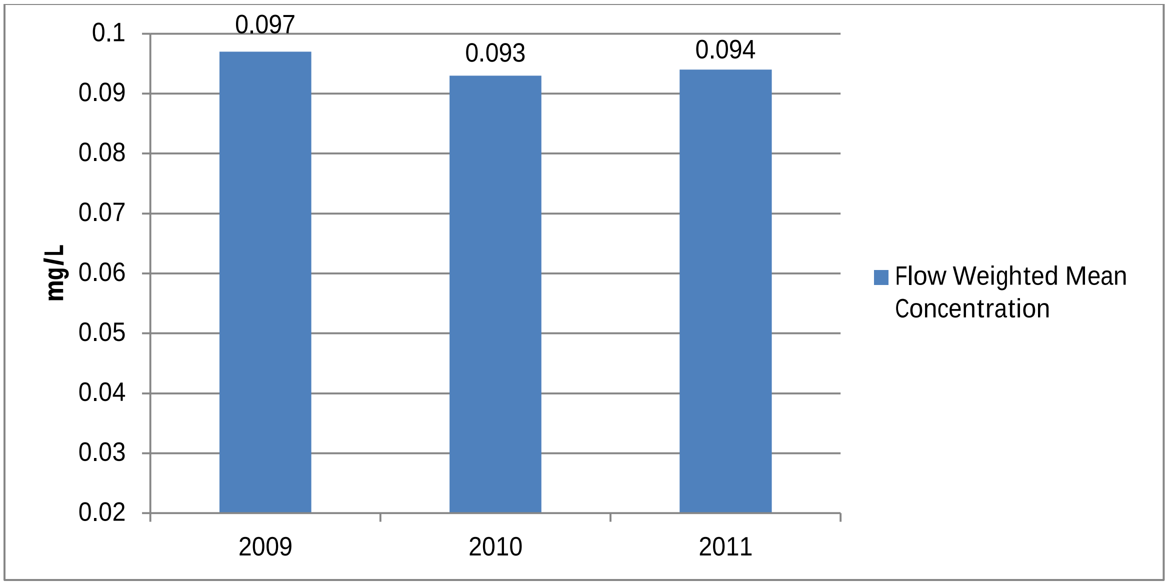

Figure 20. Total Phosphorus (TP) flow weighted mean concentrations for the Long Prairie River.

Dissolved orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available for plant uptake (MPCA and MSUM, 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The 2009 through 2011 FWMC ratio of DOP to TP shows that 46 to 49% of TP is in the orthophosphate form. Figure 21 indicates DOP FWMC appears to be relatively insensitive to the annual runoff volume.

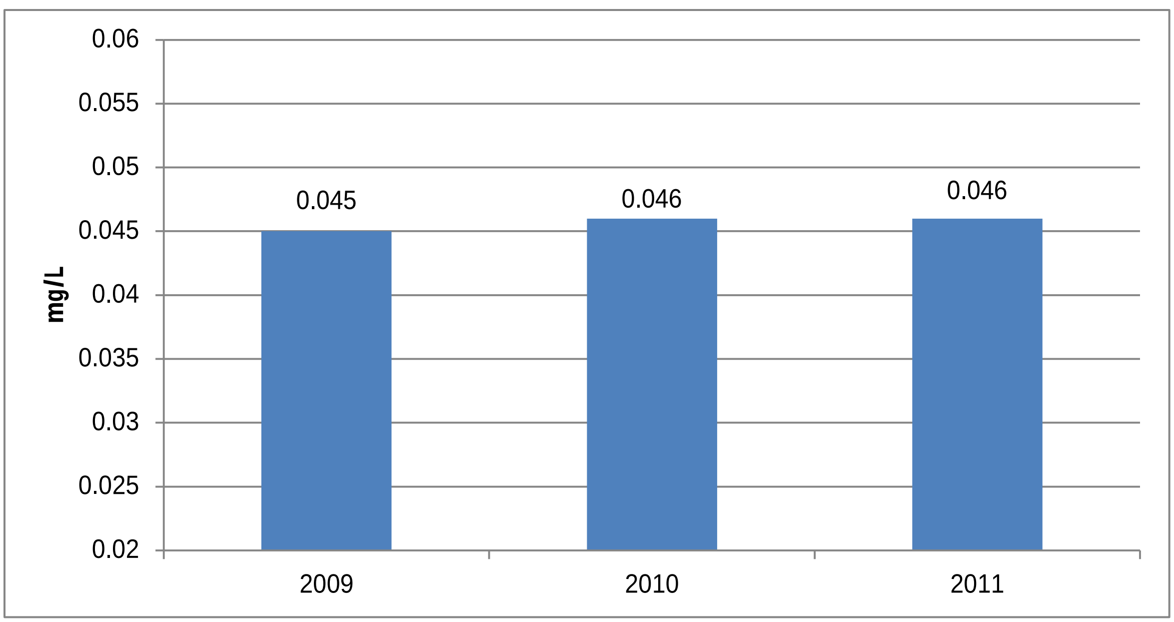

Figure 21. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the Long Prairie River.

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, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA, 2008). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-N to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen, 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.

Nitrate- N can also be a common toxicant to aquatic organisms in Minnesota's surface waters, with invertebrates appearing to be the most sensitive to nitrate toxicity. Draft nitrate-N standards have been proposed (2012) for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate-N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA, 2010).

Nitrate plus nitrite nitrogen FWMCs from 2009 through 2011 for the Long Prairie Watershed were 0 .43, 0.40, and 0 .28 mg/L, respectively (Figure 22). Calculations of the Long Prairie River's annual nitrate-N loads show a negative relationship to the annual runoff volume over the three year sampling period.

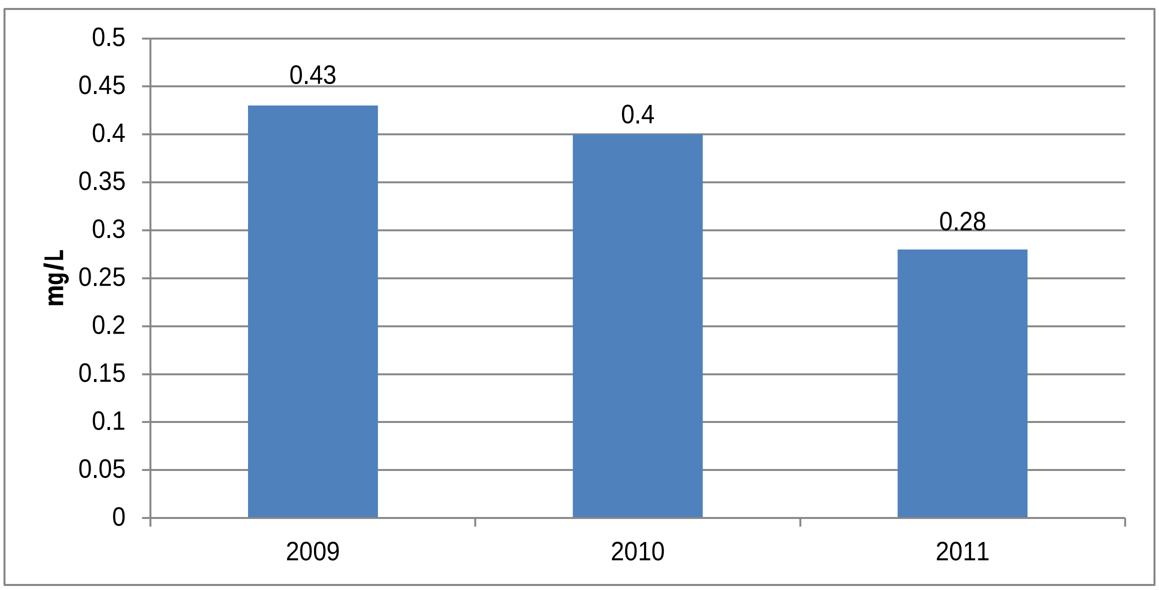

Figure 22. Nitrate + Nitrite Nitrogen (Nitrate-N) flow weighted mean concentrations for the Long Prairie River.

Stream water quality

Within the Long Prairie River watershed, 20 of the 26 stream AUIDs that were sampled were assessed (Table 26). Of the assessed streams, eight fully support aquatic life and four streams fully support aquatic recreation. Twelve AUIDs are non-supporting for aquatic life and three are non-supporting for aquatic recreation.

Overall, water quality conditions are fair with low dissolved oxygen being the most prevalent stressor occurring in the Long Prairie River Watershed. Dissolved oxygen impairments occur throughout the watershed, specifically on the Long Prarie River, with DO impairments occurring on five of the six assessed AUIDs (all except the most downstream AUID). These low DO concentrations are likely due in part to the large wetland complex that the Long Praire River flows through. In addition, Moran Creek did not meet DO standards, however it was not designated as impaired because the biological communities were good and DO concentrations recovered downstream. Bacteria impairments were also found but to a lesser extent, occurring in three of seven assessed AUIDs. Turbidity, chloride and pH were at appropriate levels, with no impairments occurring in the watershed.

Table 34. Assessment summary for stream water quality in the Long Prairie River Watershed.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**# Delistings**
07010108 HUC-8	**571,712**	**26**	**20**	**8**	**4**	**12**	**3**	**2**	**3**
Upper Long Prairie River 0701010810	261,120	11	10	3	1	6	1	1	0
Harris Creek 070108020	17,280	1	1	0	0	1	0	0	0
Eagle Creek 07010830	47,808	1	1	1	0	0	1	0	1
Turtle Creek 070108040	49,728	2	1	1	1	0	0	0	0
MoranCreek 070108050	45,696	2	2	2	0	0	1	0	0
Long Prairie River 070108060	150,080	9	5	1	2	5	0	1	2

Biological monitoring

Fish

Historically, throughout the Upper Mississippi River Basin, there have been 84 different species of fish sampled. Although the Long Prairie River Watershed only encompasses a small portion of the Upper Mississippi River Basin, 46 of these 84 species were found. This watershed does not have any fish species identified by the Minnesota Department of Natural Resources (MnDNR) as endangered or threatened, however has two special concern: least darters and pugnose shiners. The MnDNR has however identified two aquatic invasive species that exist within this watershed, Eurasian water milfoil and Zebra Muscles.

Some species were found at many sites with high densities, while other species were found at limited sites in low numbers. The most commonly found fish species within the watershed was the central mudminnow which was sampled at 35 of 37 sites. However, the species sampled in the highest numbers was the common shiner, totaling 4,148 individuals (found at 28 of 37 sites). Other species that were commonly found throughout the watershed included creek chub, johnny darter, white sucker, and northern pike, all of which were sampled at roughly 75% of the sites. In contrast, two species were only sampled at one site and in low numbers; finescale dace and silver redhorse. A list of the species sampled, how many sites each species were sampled at, and the total number of individuals can be found in Appendix 8.

Invertebrates

Between 2009 and 2012 the MPCA biological monitoring crews collected aquatic macroinvertebrates from 30 stream stations within the Long Prairie River Watershed. In total 11,580 organisms were identified, representing 38 families, 135 genera and 60 species (Appendix 4.2). Macroinvertebrates were predominantly (~76%) collected from two major stream habitat types, undercut banks/over-hanging vegetation and aquatic macrophytes. The majority of the streams sampled in this watershed fall into the glide pool habitat type, with the remaining streams in the riffle/run/rock type streams. The glide pool habitat type may be thought of as a low gradient stream; often habitats within these streams are woody debris, submerged aquatic macrophytes and overhanging vegetation. Therefore, it is not a surprise that the dominant macroinvertebrates were taxa that are commonly found in these habitats, namely scuds from the genus *Hyalella*, blackflies from the genus *Simulium*, mayflies from the genus *Iswaeon*, midges from the genera *Polypedilum* and *Rheotanytarsus*, and snails from the genus *Physa*. Many of these taxa are ubiquitous in their distributions across the state and are relatively tolerant of stress. Conversely, *Iswaeon* is a sensitive baetid mayfly found in many low gradient streams throughout the central part of the state.

Many of the streams in the Long Prairie River Watershed are meeting standards for aquatic life. Those streams that were determined to have impaired aquatic macroinvertebrates were often dominated by tolerant taxa and/or did not have in-stream habitats that provide productive habitats for macroinvertebrate colonization. The lack of these habitats is likely related to the stream channel alterations that have taken place in many of the headwater and middle order streams in this watershed. Based on recent estimates, 54% of the streams within this watershed have altered channels (Figure 39). The lack of coarse substrates due to unnatural stream alterations and sedimentation can significantly impact macroinvertebrate taxonomic diversity.

Eagle and Moran Creeks provide examples of streams within this watershed that contain exceptional macroinvertebrate communities and good habitat. Many of the biological monitoring stations on these streams contained several sensitive taxa suggesting that where there are good habitat conditions and good water quality, macroinvertebrate communities within the Long Prairie River Watershed will flourish. Because of the good-to-exceptional aquatic macroinvertebrate resources within Eagle and Moran Creeks, respectively, these stream should be protected to maintain these populations.

Lake water quality

Sixty of the 75 lakes within the Long Prairie Watershed were assessed. Of the assessed lakes, 50 supported aquatic recreation and 10 of the assessed lakes did not support aquatic recreation. The results suggest that water quality in lakes of the Long Prairie Watershed are generally in fair to good condition. Lakes in this watershed are a highly valued resource and steps should be taken to protect and maintain the lakes with good water quality conditions and improve the lakes that do not support aquatic recreation.

Table 35. Assessment summary for lake water chemistry in the Long Prairie River Watershed.

			Supporting		Non-supporting			
Watershed	Area (acres)	Lakes >10 Acres	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	# Delistings
07010108 HUC 8	**571,712**	**65**	**0**	**50**	**3**	**10**	**5**	**0**
7010108050	45,696	1	-	1	-	0	0	0
7010108060	150,080	11	-	10	-	1	0	0
7010108040	49,728	5	-	5	-	0	0	0
7010108030	47,808	0	-	-	-	-	-	0
7010108010	261,120	48	-	34	3	9	4	0
7010108020	17,280	0	-	-	-	-	-	0

Fish contaminant results

Thirteen fish species from the Long Prairie Rriver and watershed lakes were tested for mercury and/or PCBs. A total of 1618 fish were tested between 1988 and 2012. Fish species are identified by codes that are defined by their common and scientific names in Table 36.

Table 37 is a summary of contaminant concentrations by waterway, fish species, and year. The table shows which contaminants, species, and years were sampled within a given lake. "No. Fish" indicates the total number of fish analyzed and "N" indicates the samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish (BGS) and yellow perch (YP). Since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET).

The Long Prairie River was tested in 1992, 2002, and 2012. Mean mercury concentrations in northern pike (NP) collected in all years were above the 0.2 mg/kg water quality standard for mercury in fish tissue. Rock bass and white sucker collected in 2012 had mean mercury levels lower than the northern pike, but were still above the 0.2mg/kg threshold. Northern pike, white sucker, and common carp from the river were tested for PCBs. All PCBs levels were below the detection limit.

All waters that are listed as impaired for mercury in fish are identified in Table 37 with a red asterisk (*). Twelve of the lakes that are impaired are included under the Statewide Mercury TMDL. The other two impaired lakes—Carlos (21-0057) and Mina (21-0108) had mercury levels in the fish that were too high to be included in the Statewide Mercury TMDL; therefore, they are classified as needing separate TMDLs for mercury in fish tissue.

From all tested fish in the Long Prairie watershed, the highest mercury concentration was 1.90 mg/kg in a northern pike from Lake Carlos, collected in 1992. The mercury levels in northern pike from Lake Carlos continued to be high in more recent years, although they did not reach the levels measured in 1992. Maximum mercury concentrations in walleye were 1.57 mg/kg in Darling Lake (21-0080) from 2004 and 1.46 mg/kg in Lakota (21-0106) from 2009. The walleye from Darling Lake had the highest mean mercury concentration of 1.011 mg/kg based on seven walleye collected in 2004.

PCBs concentrations in fish tissue from the lakes were near or below the reporting limit.

Overall, the fish contaminant results show that PCBs have never been shown to be a concern in the Long Prairie River Watershed, whereas the mercury concentrations in fish tissue have remained relatively high in the 14 lakes tested in the watershed.

Table 36. Fish species codes, common names, and scientific names.

Species	Common Name	Scientific Name
BGS	Bluegill sunfish	*Lepomis macrochirus*
BKB	Black bullhead	*Ictalurus melus*
BKS	Black crappie	*Pomoxis nigromaculatis*
C	Common Carp	*Cyprinus carpio*
CIS	Cisco	*Coregonus artedii*
LMB	Largemouth bass	*Micropterus salmoides*
NP	Northern pike	*Esox Lucius*
RKB	Rock bass	*Ambloplites rupestris*
SF	Pumpkinseed sunfish	*Lepomis gibbosus*
WE	Walleye	*Sander vitreus*
WHS	White crappie	*Pomoxis annularis*
YEB	Yellow bullhead	*Ictalurus natalis*
YP	Yellow perch	*Perca flavescens*

Table 37. Summary statistics of mercury and PCBs, by waterway-species-year.

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
LONG PRAIRIE RIVER*	07010108 -534, -535, -505, -504, -503, -502, -501	RM 46.8, NEAR LONG PRAIRIE	NP	1992	FILSK	1	17.8	17.8	17.8	1	0.260			1	< 0.01
			WSU	1992	FILSK	18	14.9	14.0	16.5	3	0.123	0.110	0.140	2	< 0.01
		RM 94.2-77.5, LAKE CARLOS	NP	1992	FILSK	6	17.7	12.3	23.9	3	0.393	0.300	0.540	1	< 0.01
		M-96-10, TODD CTY TO MOTLEY	C	2002	FILSK	3	26.6	26.6	26.6	1	0.271			1	< 0.01
			NP	2002	FILSK	2	18.4	18.1	18.7	2	0.295	0.237	0.352		
			RKB	2002	FILSK	9	7.5	7.5	7.5	1	0.280				
		UPSTREAM OF 313TH AVE IN PHILBROOK, 11UM001	NP	2012	FILSK	7	18.7	17.5	20.1	7	0.344	0.301	0.407	2	< 0.025
			RKB	2012	FILSK	5	8.3	8.3	8.3	1	0.271				
			WSU	2012	FILSK	5	15.3	12.4	18.4	5	0.207	0.076	0.308	2	< 0.025
			YP	2012	FILSK	4	8.1	8.1	8.1	1	0.127				
BURGEN*	21004900		BGS	1992	FILSK	10	6.4	6.4	6.4	1	0.048				
			NP	1992	FILSK	13	22.1	18	27.2	3	0.337	0.200	0.500	1	< 0.01
			WSU	1992	FILSK	7	17.3	17	17.3	1	0.034			1	< 0.01
HENRY	21005100		BKB	1991	FILET	5	8.9	8.9	8.9	1	0.075			1	0.055
			BKS	1991	FILSK	8	6.4	6.4	6.4	1	0.078			1	< 0.01
GENEVA*	21005200		BGS	2008	FILSK	10	8.4	8.4	8.4	1	0.145				
			BKS	2008	FILSK	10	10.3	10	10.3	1	0.090				
			C	2008	FILSK	3	18.3	18	18.3	1	0.045				
			NP	2008	FILSK	5	22.3	19	27.2	5	0.298	0.218	0.363		
			WE	2008	FILSK	4	19.1	16	24.2	4	0.473	0.190	0.828		
AGNES*	21005300		BKB	1991	FILET	8	10.1	10	10.1	1	0.052			1	0.06

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
			BKS	1991	FILSK	8	7.1	7.1	7.1	1	0.210			1	0.036
				2003	FILSK	10	9.3	9.3	9.3	1	0.171				
			WSU	1991	FILSK	1	12.7	13	12.7	1	0.023			1	0.04
VICTORIA*	21005400		BGS	1992	FILSK	10	7.3	7.3	7.3	1	0.170				
				2012	FILSK	10	6.8	6.4	7.1	2	0.068	0.057	0.078		
			BKS	2012	FILSK	10	8.8	8.2	9.3	2	0.081	0.070	0.092		
			NP	1992	FILSK	12	25.4	19	30.4	4	0.375	0.310	0.420	1	0.01
				2012	FILSK	6	20.4	17	25.1	6	0.251	0.180	0.317		
			WE	2012	FILSK	8	17.1	12	21.7	8	0.362	0.170	0.596		
			YEB	1992	FILET	8	10.8	11	10.8	1	0.210			1	0.018
LE HOMME DIEU*	21005600		BGS	1992	FILSK	10	6.4	6.4	6.4	1	0.048				
				2012	FILSK	10	6.8	6.5	7	2	0.054	0.051	0.057		
			BKS	2012	FILSK	10	10.0	9.5	10.4	2	0.121	0.121	0.121		
			NP	1994	FILSK	26	24.7	19	31.2	5	0.360	0.280	0.500	1	< 0.01
				2012	FILSK	8	22.0	17	26.5	8	0.432	0.211	0.616		
			WE	1992	FILSK	19	19.5	13	26	4	0.435	0.220	0.580	1	< 0.01
				2012	FILSK	8	14.1	12	17.6	8	0.337	0.258	0.467		
			WSU	1992	FILSK	8	19.5	18	20.9	2	0.046	0.027	0.064	1	0.03
CARLOS**	21005700		BGS	2007	FILSK	11	6.8	6.8	6.8	1	0.089				
				2008	FILSK	10	6.9	6.9	6.9	1	0.108				
			BKS	2007	FILSK	10	10.0	10	10	1	0.269				
			C	2008	FILSK	3	21.7	22	21.7	1	0.058				
			LMB	2007	FILSK	5	12.0	11	13.3	5	0.436	0.352	0.520		

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
			NP	1992	FILSK	20	25.5	19	33.7	4	0.903	0.430	1.900	1	0.012
				2000	FILSK	23	21.8	16	30.2	23	0.367	0.050	0.910		
				2008	FILSK	24	20.3	17	24.5	24	0.380	0.219	0.821		
			RKB	1992	FILSK	10	9.2	9.2	9.2	1	0.290				
				2008	FILSK	10	8.9	8.3	9.4	2	0.467	0.410	0.523		
			SF	2008	FILSK	8	7.1	6.9	7.3	2	0.074	0.066	0.082		
			WE	1994	FILSK	19	19.4	16	24.1	4	0.634	0.400	0.925	1	0.019
			WSU	1992	FILSK	9	19.0	17	20.9	2	0.059	0.054	0.063	1	< 0.01
			YP	2000	WHORG	10	6.8	5.8	9.2	10	0.184	0.070	0.280		
				2008	WHORG	5	6.6	6.6	6.6	1	0.189				
IRENE*	21007600		BGS	2010	FILSK	10	6.8	6	7.6	2	0.020	0.016	0.024		
			NP	2000	FILSK	24	22.5	18	30.5	24	0.132	0.090	0.220		
				2005	FILSK	23	22.2	17	31	23	0.230	0.097	0.379		
				2010	FILSK	9	20.9	18	23.6	9	0.119	0.049	0.350		
			WE	2010	FILSK	9	15.1	11	18.8	9	0.098	0.082	0.114		
			YEB	2010	FILET	4	11.0	11	11	1	0.047				
			YP	2000	WHORG	7	5.6	5.5	5.8	7	0.017	0.010	0.020		
				2005	WHORG	12	6.4	5.8	6.9	2	0.028	0.026	0.030		
DARLING*	21008000		BGS	2004	FILSK	10	6.8	6.8	6.8	1	0.207				
				2012	FILSK	9	7.0	6.6	7.4	2	0.101	0.097	0.105		
			BKS	2012	FILSK	10	9.9	9.2	10.6	2	0.130	0.130	0.130		
			C	2004	FILSK	3	27.7	28	27.7	1	0.143				
			NP	2012	FILSK	6	21.6	18	25.3	6	0.436	0.324	0.639		

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
			WE	2004	FILSK	7	20.8	12	26.9	7	1.011	0.333	1.569		
				2012	FILSK	6	14.8	13	18.9	6	0.413	0.288	0.588		
WINONA	21008100		BKB	1988	FILET	15	10.5	8.9	12.8	5	0.026	0.020	0.047	5	0.022
			BKS	1991	FILSK	15	7.2	7.2	7.2	1	0.043			1	0.033
				2008	FILSK	8	9.0	9	9	1	0.059				
			C	2008	FILSK	3	25.0	25	25	1	0.012				
			LMB	2008	FILSK	5	13.2	9.5	15.2	5	0.026	0.010	0.046		
			NP	1988	FILSK	5	27.1	25	29	5	0.060	0.032	0.110	5	0.014
				2008	FILSK	1	30.1	30	30.1	1	0.027				
			WSU	1988	FILSK	15	16.6	15	17.9	5	0.020	0.020	0.020	5	0.016
				1991	FILSK	14	15.4	13	17.6	2	0.020	0.020	0.020	2	0.028
MILTONA*	21008300		BGS	1990	FILSK	4	6.7	6.7	6.7	1	0.059			1	< 0.01
				2011	FILSK	9	7.8	7.2	8.3	2	0.035	0.034	0.036		
			BKS	2011	FILSK	8	10.4	8.9	11.8	2	0.104	0.049	0.159		
			NP	2011	FILSK	8	21.0	19	24.5	8	0.189	0.124	0.259		
			WE	1990	FILSK	11	16.8	13	21.5	3	0.307	0.130	0.550	3	< 0.01
				2011	FILSK	7	16.0	12	17.5	7	0.196	0.114	0.279		
			WSU	1990	FILSK	8	19.5	17	21.6	2	0.075	0.052	0.098	2	< 0.01
ANDREW*	21008500		NP	1999	FILSK	21	20.5	16	26.7	21	0.299	0.130	0.480	1	< 0.01
				2007	FILSK	24	20.4	16	29.7	24	0.247	0.087	0.620		
				2012	FILSK	15	19.7	15	34.4	15	0.340	0.234	0.700		
			WE	1993	FILSK	13	15.9	9.5	21.7	3	0.347	0.150	0.610	2	0.022
			WSU	1993	FILSK	8	20.4	20	20.4	1	0.057			1	0.01

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
			YP	1993	FILSK	10	9.5	9.5	9.5	1	0.290				
				1999	WHORG	10	5.9	5	6.4	10	0.057	0.040	0.090		
				2007	WHORG	10	5.6	5.4	5.8	2	0.057	0.051	0.062		
MARY*	21009200		BGS	1990	FILSK	10	6.5	6.5	6.5	1	0.085			1	< 0.01
				2009	FILSK	8	7.1	6.8	7.4	2	0.053	0.052	0.054		
			BKS	2009	FILSK	8	9.9	9.4	10.4	2	0.036	0.034	0.038		
			LMB	2009	FILSK	8	12.9	12	13.7	8	0.108	0.081	0.141		
			NP	2009	FILSK	8	20.8	19	23	8	0.129	0.010	0.180		
			WE	1990	FILSK	14	17.0	13	20.5	3	0.307	0.190	0.470	3	< 0.01
				2009	FILSK	8	16.4	13	18.1	8	0.077	0.045	0.119		
LATOKA*	21010600 21010601 – North Bay 21010602 – South Bay		BGS	1993	FILSK	30	6.4	6.4	6.4	3	0.081	0.081	0.081		
				2009	FILSK	15	7.6	7.6	7.6	3	0.146	0.146	0.146		
			BKS	2009	FILSK	30	9.1	8.3	9.8	6	0.141	0.099	0.182		
			C	1993	FILSK	18	23.8	23	25.1	6	0.065	0.051	0.078	3	< 0.01
			CIS	2009	FILSK	3	14.5	15	14.5	3	0.218	0.218	0.218		
			LMB	2009	FILSK	24	13.2	10	16.7	24	0.456	0.329	0.659		
			NP	2009	FILSK	24	18.6	16	23.1	24	0.331	0.213	0.572		
			WE	1993	FILSK	75	19.3	12	25.8	12	0.703	0.370	1.100	3	< 0.01
				2009	FILSK	24	20.3	15	28.5	24	0.911	0.360	1.462		
MINA**	21010800		BGS	2007	FILSK	10	6.6	6.6	6.6	1	0.154				
			LMB	2007	FILSK	5	12.4	11	14.1	5	0.666	0.492	0.884		
IDA*	21012300		BGS	1991	FILSK	10	6.5	6.5	6.5	1	0.079				
				2011	FILSK	5	6.7	6.7	6.7	1	0.028				

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
			BKS	2011	FILSK	10	10.7	10	11.1	2	0.101	0.089	0.112		
			NP	2011	FILSK	8	19.5	18	20.5	8	0.194	0.127	0.301		
			WE	1991	FILSK	20	17.8	13	22.8	3	0.427	0.220	0.700	1	< 0.01
				2011	FILSK	8	20.1	14	25.2	8	0.424	0.231	0.653		
			WSU	1991	FILSK	5	19.5	18	21.3	2	0.090	0.079	0.100	2	< 0.01
LOBSTER*	21014400		BGS	1996	FILSK	30	6.2	6.2	6.2	3	0.100	0.100	0.100		
				2009	FILSK	15	6.5	6.5	6.5	3	0.141	0.141	0.141		
			BKS	2009	FILSK	27	8.2	7.9	8.4	6	0.106	0.101	0.111		
			LMB	2009	FILSK	21	10.9	9.7	13.2	21	0.286	0.225	0.329		
			NP	1996	FILSK	69	21.2	14	28.2	18	0.373	0.140	0.720	12	0.05
				2009	FILSK	24	21.6	19	28.4	24	0.331	0.114	0.454		
			WE	2009	FILSK	24	15.1	13	17.7	24	0.290	0.225	0.374		
			WSU	1996	FILSK	3	13.2	13	13.2	3	0.020	0.020	0.020		
MILL	21018000		NP	2012	FILSK	8	20.3	18	25.8	8	0.355	0.267	0.517		
			WE	2012	FILSK	8	17.8	16	20.6	8	0.552	0.434	0.711		
SHAMINEAU*	49012700		BGS	2010	FILSK	10	7.1	6.9	7.3	2	0.052	0.050	0.054		
			BKS	2010	FILSK	9	8.1	7.9	8.3	2	0.027	0.026	0.027		
			WE	2010	FILSK	8	18.1	14	28.2	8	0.189	0.126	0.424		
			WSU	2010	FILSK	4	11.7	12	11.7	1	0.010				
FISH TRAP	49013700		BKS	1998	FILSK	10	9.6	9.6	9.6	1	0.020				
			NP	1998	FILSK	10	21.5	19	26.2	10	0.102	0.048	0.230		
			WE	1998	FILSK	10	17.9	13	23.6	10	0.075	0.047	0.110		
			WSU	1998	FILSK	6	18.0	18	18	1	0.080				

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANAT-OMY[2]	NO. FISH	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)	
							Mean	Min	Max	N	Mean	Min	Max	N	Mean
FISH*	56006600		BGS	2006	FILSK	8	7.1	7.1	7.1	1	0.061				
			WE	2006	FILSK	6	18.1	13	23.6	6	0.324	0.202	0.466		
LATIMER	77010500		BKS	1995	FILSK	8	9.3	9.3	9.3	1	0.040				
			NP	1995	FILSK	11	19.9	17	24	3	0.049	0.037	0.068	1	< 0.01
			WSU	1995	FILSK	3	19.9	20	19.9	1	0.057				

* Impaired for mercury in fish tissue as of 2012 Draft Impaired Waters List; categorized as EPA Class 4a for waters covered by the Statewide Mercury TMDL.
**Impaired for mercury and categorized as EPA Class 5 and requires a separate TMDL from the Statewide TMDL.
[1] Species codes are defined in Table 36.
[2] Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism.

Groundwater quality

Groundwater quality in north central Minnesota, including the Long Prairie River Watershed is generally good. The 1998 Baseline Report by the MPCA of the North Central Region found that while the surficial aquifers may contain higher concentrations of chemicals which are mobile in soil like nitrate and chloride, most chemicals were detected at levels below drinking water criteria.

The MPCA's Ambient Groundwater Monitoring Program has more recently sampled nine sites within the Long Prairie River Watershed (Figure 23). Results from these wells did not indicate a significant change from the baseline study findings.

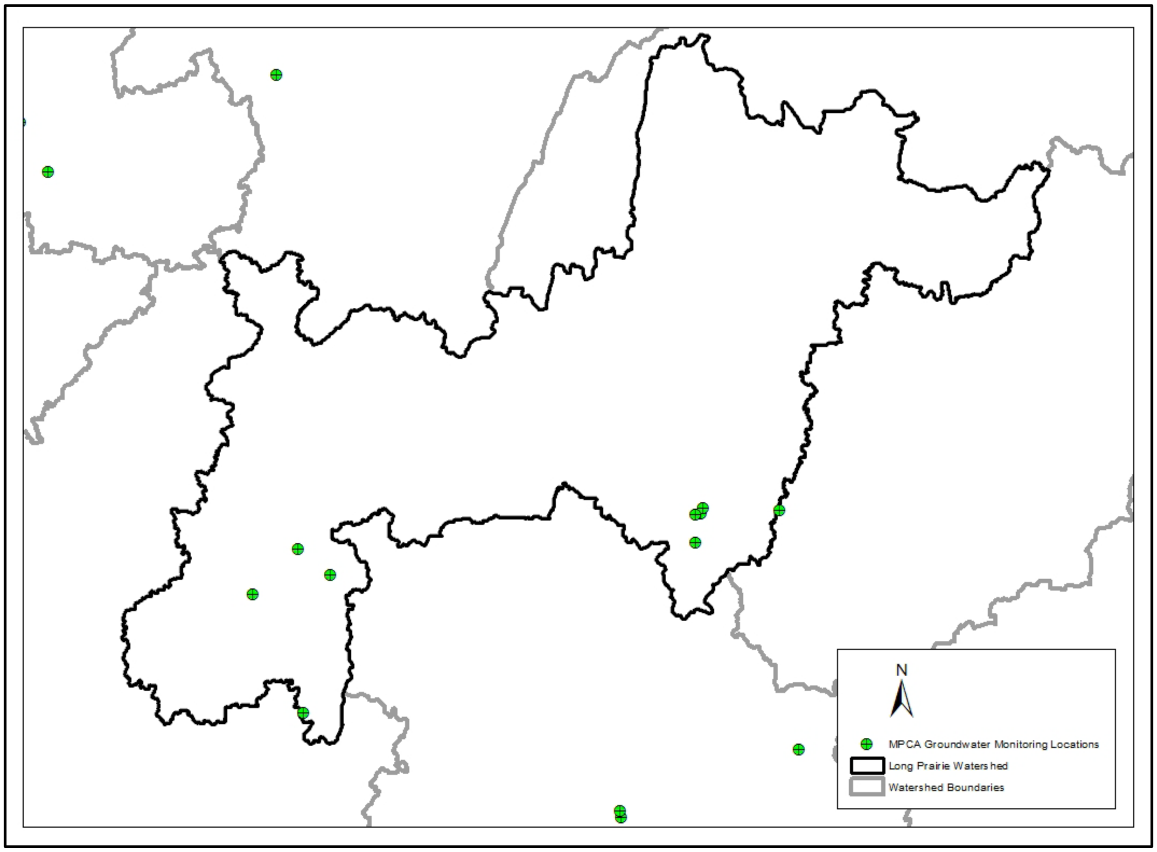

Figure 23. MPCA ambient groundwater monitoring wells in and around the Long Prairie River Watershed.

The Minnesota Department of Agriculture annually monitors pesticide and nitrate concentrations in groundwater across the state. The Central Sands region of Minnesota, including the Long Prairie River Watershed, has been identified by the MDA as being particularly vulnerable due to its sandy surficial geology and heavy agricultural use.

In 2012, pesticides were detected in the Central Sands Region but not at levels exceeding drinking water criteria. Nitrate, however, was present in 98% of the wells sampled and at a median concentration of 15 mg/L. Of those samples, 18% were at or below background level of three milligrams per liter (mg/L) and 59% were above 10 mg/L. Though nitrate is not uncommon in agricultural areas, the median concentration is above the Health Risk Limit of 10 mg/L.

Groundwater quantity

The MnDNR and Todd County Soil and Water Conservation District have a number of active groundwater monitoring wells in and around this particular watershed. An analysis of groundwater levels obtained from these wells up to 2008 was published in the Geologic Atlas of Todd County. That study found that groundwater levels have not changed significantly over time.

Three observation wells (21002, 77013, and 49026) throughout the Long Prairie River Watershed were chosen based on data availability and geologic location within the watershed. Observation well 21002, in the western portion of the watershed, exhibits a moderately significant rising trend (p=0.05) in groundwater levels, while observation well 77013 in the central portion of the watershed exhibits a significant decrease in groundwater levels (p=0.01). Observation well 49026, in the northeast portion of the watershed, exhibits no statistically significant trend in groundwater elevation change.

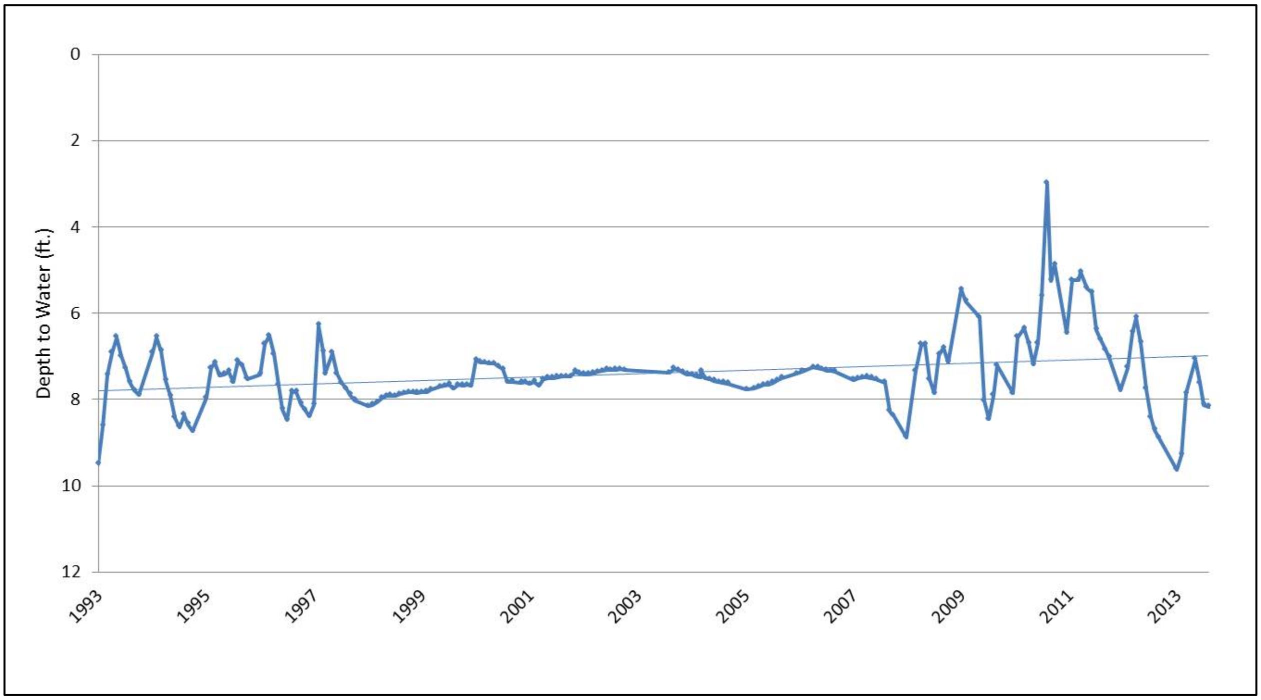

Figure 24. Observation Well 21002, located in the western area of Long Prairie Watershed near Belle River, Minnesota in Douglas County (1993-2013).

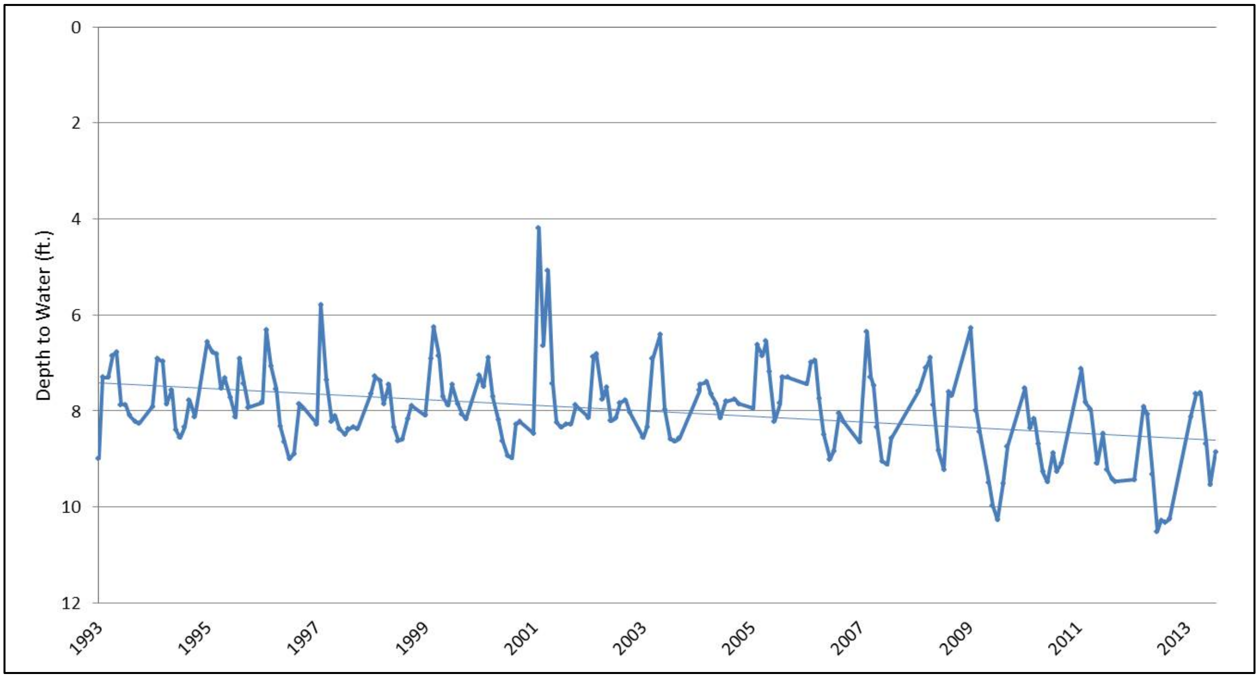

Figure 25. Observation Well 77013, located in the central area of Long Prairie Watershed near Clarissa, Minnesota in Todd County (1993-2013).

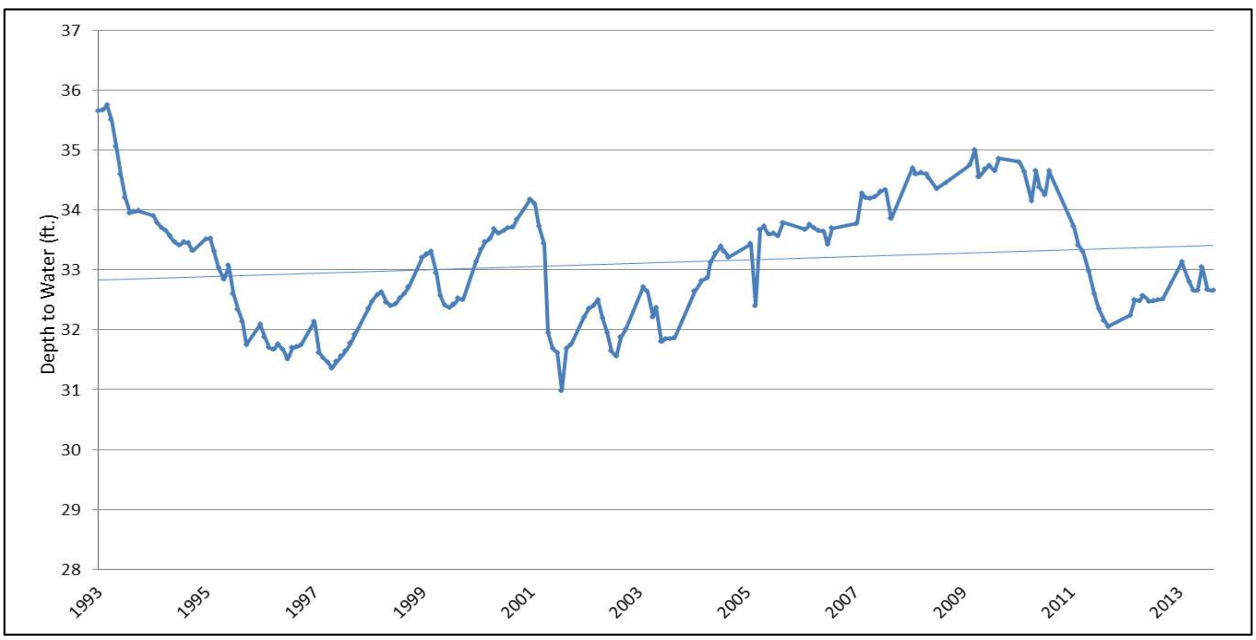

Figure 26. Observation Well 49026, located in the eastern area of Long Prairie River Watershed in Morrison County (1993-2013).

Groundwater/Surface water withdrawals

There are many permitted high-capacity groundwater and surface water withdrawals in the Long Prairie River Watershed (Figure 27). The three largest permitted consumers of water in the state (in order) are municipalities, industry and irrigation. The withdrawals within the Long Prairie River Watershed are mostly irrigation and industrial use. As illustrated by the map, most of the high capacity groundwater users are located in the surficial sands near the Long Prairie River in the middle of Todd County. Of these, three-quarters are used for major crop irrigation (Petersen, 2010).

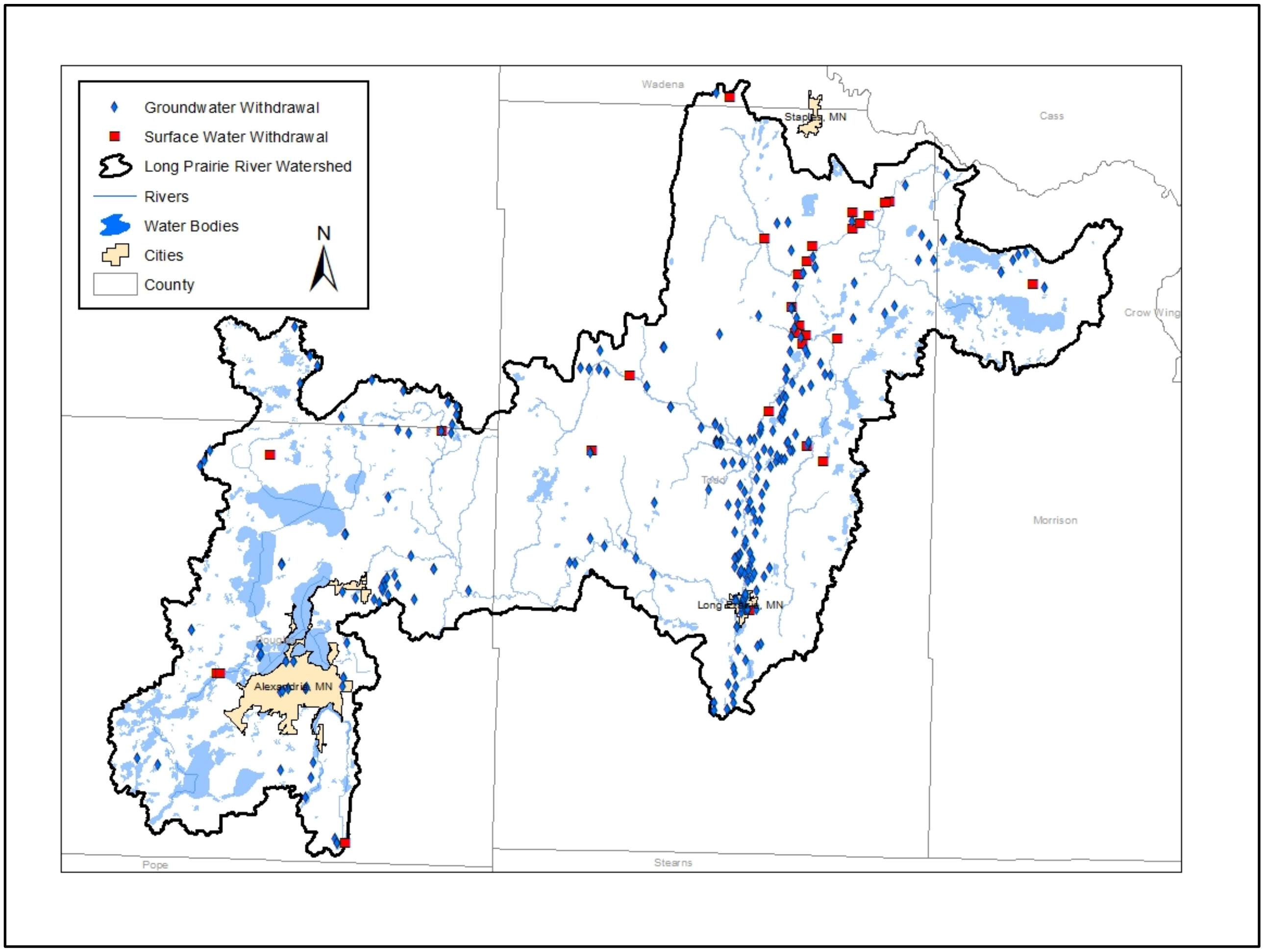

Figure 27. Locations of 2011 permitted groundwater and surface water withdrawals in the Long Prairie River Watershed.

Total permitted withdrawals from the watershed from 1991-2011 are displayed in [Figure 28](). Groundwater withdrawals are blue diamonds with total surface water withdrawals are red squares. During this time period, total groundwater withdrawals exhibit a very significant rising trend (p=0.001) while surface water withdrawals exhibit a less-significant rising trend (p=0.01).

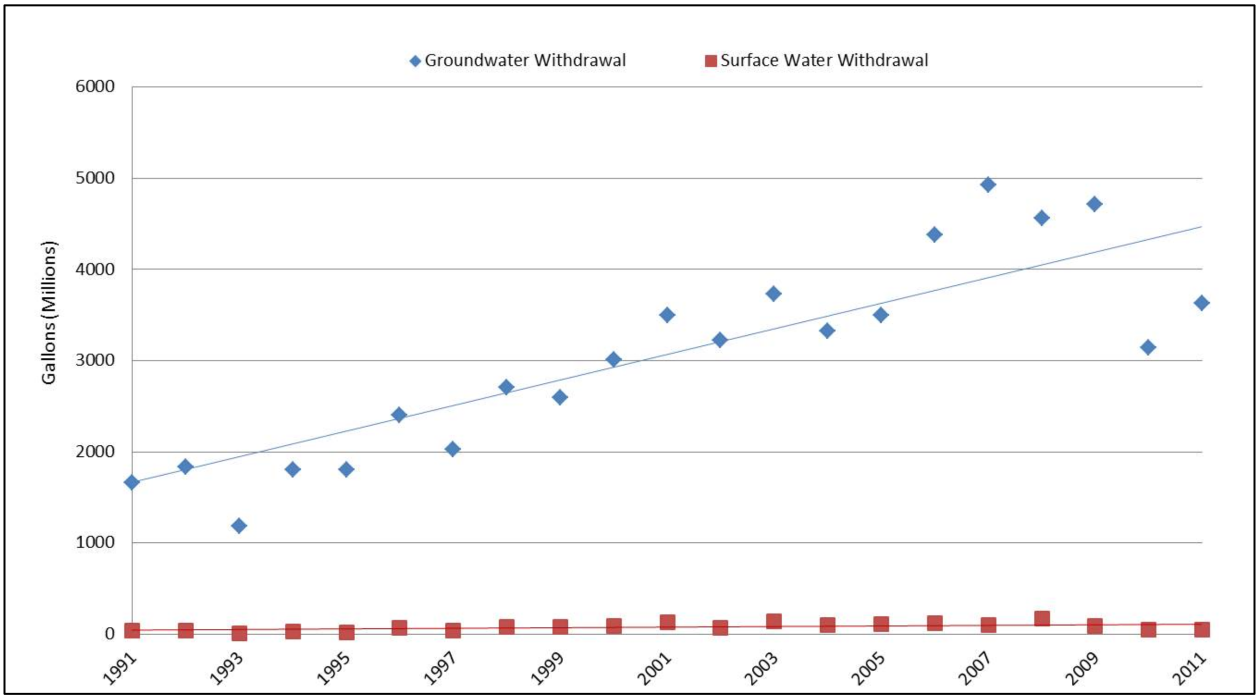

Figure 28. Total annual groundwater and surface water withdrawals in the Long Prairie River Watershed (1991-2011).

More specifically, groundwater withdrawals from the heavily-used quaternary water table aquifer within the watershed have increased significantly ($p=0.001$) over the same time period (1991-2011) (Figure 28 and Figure 29).

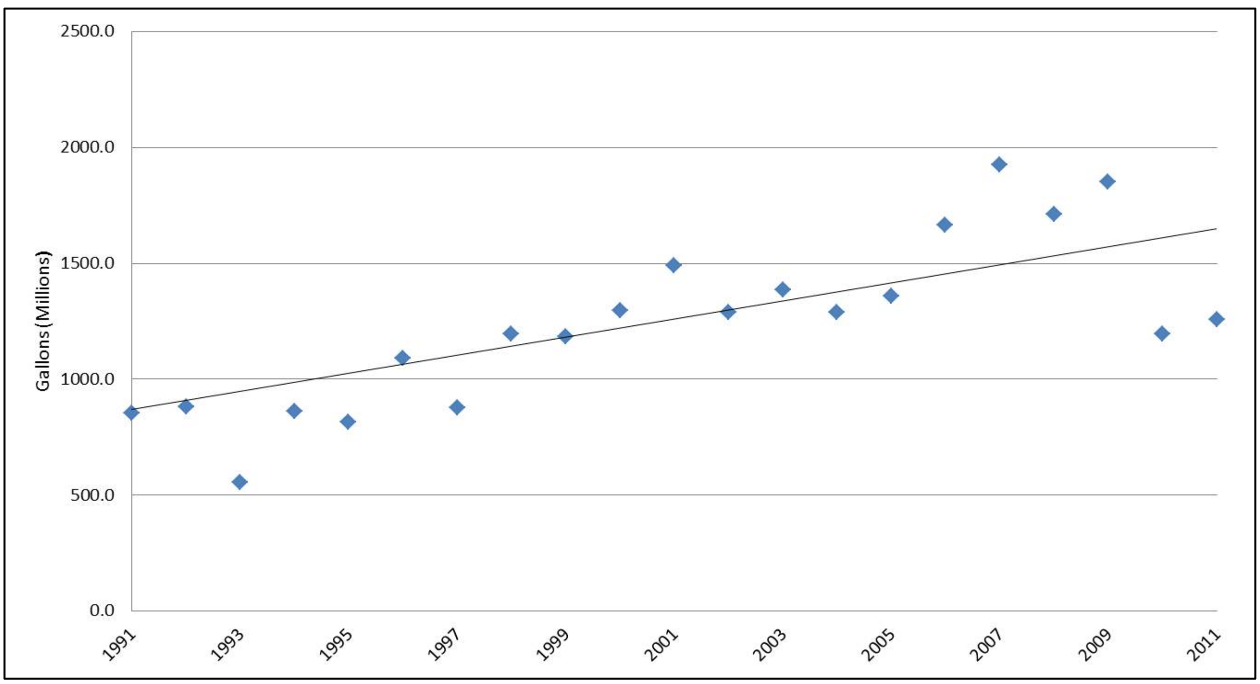

Figure 29. Total Quaternary Water Table Aquifer withdrawals in the Long Prairie River Watershed (1991-2011).

Stream flow

Figure 30 is a display of the annual mean discharge for Long Prairie River at Long Prairie, Minnesota from 1992 to 2012. The data shows that there is an increase in stream flow over time, but not at a level of statistical significance. Figure 31 displays July and August mean flows for the last 20 years for the same water body. Although July months appear to display a decreasing flow trend and August months appear to be increasing, neither months during this time period exhibit a statistically significant trend. By way of comparison, summer month flows have declined at a statistically significant rate at the majority of streams selected randomly for a study of statewide trends.

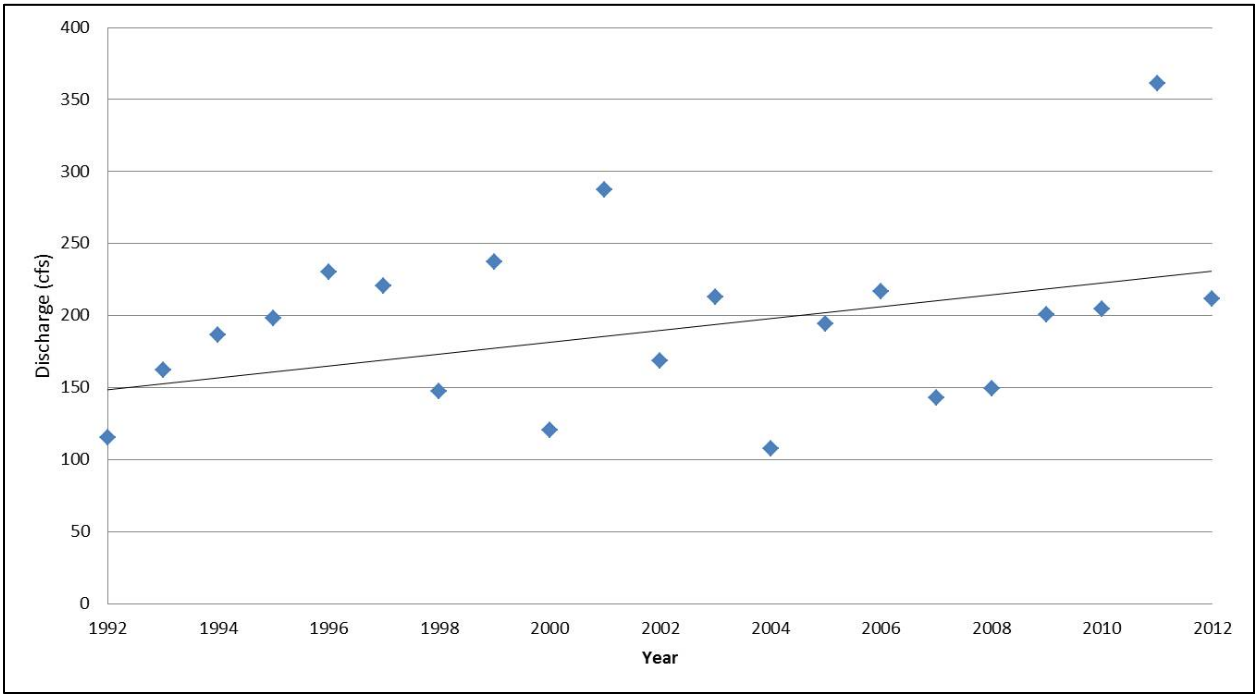

Figure 30. Annual Mean Discharge for Long Prairie River at Long Prairie, Minnesota (1992-2012).

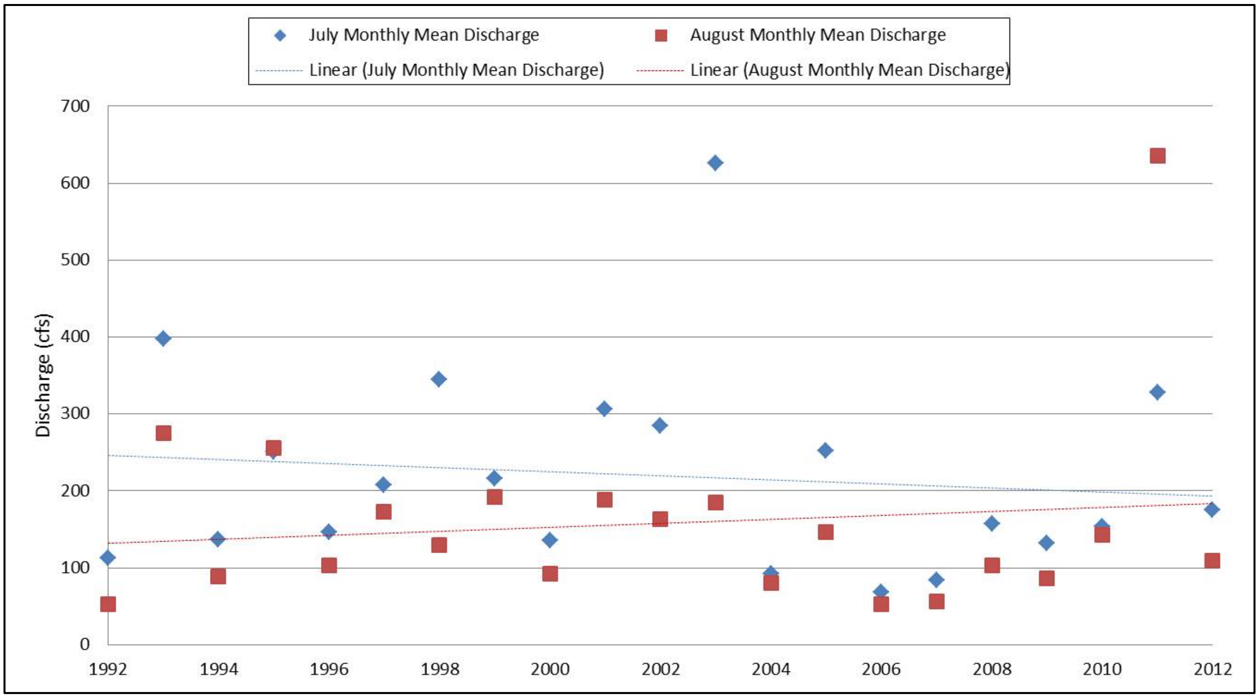

Figure 31. Mean monthly discharge measurements for July and August flows for Long Prairie River at Long Prairie, Minnesota (1992-2012).

Wetlands

Excluding open water portions of lakes, ponds, and rivers, the Long Prairie River Watershed currently supports approximately 104,424 acres of wetlands which is roughly equivalent to 18.25% of the watershed area. Emergent wetlands which are typically dominated by grasses, sedges, bulrushes or cattails are the most common wetland type comprising roughly 55,000 acres or about 9.7% of the watershed area; followed by scrub shrub wetlands which cover about 5.9% of the watershed or about 33,000 acres. Forested wetlands cover about 1.6% of the Long Prairie River Watershed and shallow open water wetlands comprise only 1.1% of the watershed (Figure 32). Moran Brook and Turtle Creek Subwatersheds support the most wetland among all Long Prairie subwatersheds containing 27.5% and 26.2% wetland respectively. These estimates and wetland distribution observations represent a snapshot of the location, type, and extent of wetlands occurring in the Long Prairie River Watershed around 1980, which is the year that aerial imagery was acquired to develop National Wetlands Inventory (NWI) maps in this part of Minnesota. Changes to wetlands have likely occurred in this watershed since the early 1980s, though the NWI remains the best data available to estimate current wetland extent. Minnesota natural resource agencies are cooperating to update the state NWI over a 10-year schedule which is slated for completion in 2019 with the north central and northwest regions of the state, including the Long Prairie Watershed being among the last regions to be updated.

Digital soils data can be used to estimate the historic wetland extent prior to European homesteading and settlement which initiated conversion of significant amounts of wetlands in much of Minnesota. Analysis of Natural Resources Conservation Service (NRCS) digital soil survey map (SSURGO) units which are classed as “all hydric” suggest approximately 147,000 acres of wetland, or 26% of the Long Prairie River Watershed, occurred prior to settlement. Comparing the area of all hydric SSURGO map units with contemporary national wetland inventory data for this watershed suggests approximately 8% of the historic wetland area present in the Long Prairie River Watershed have been converted to other land cover types, to improve agricultural cropping opportunities and other development enterprises including road and municipal development.

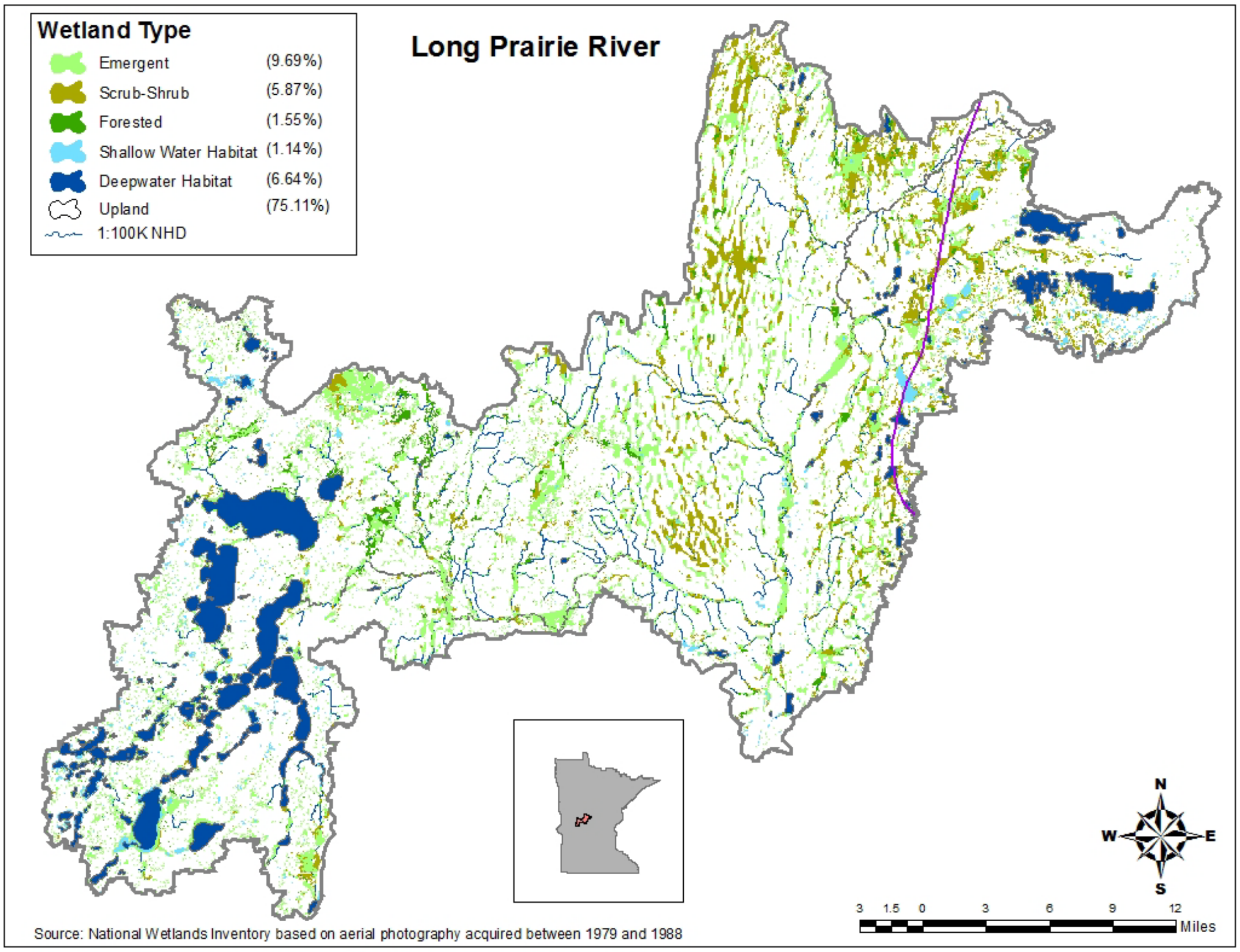

Figure 32. Distribution of wetlands by National Wetland Inventory type within the Long Prairie River HUC8 watershed.

Wetland loss rates are not consistent across the Long Prairie Watershed. Table 38 presents estimates of historic wetland as well as estimated percent wetland area converted to non-wetland in 11-digit subwatersheds of the Long Prairie Watershed. The upper half of the watershed, particularly in the Upper Long Prairie River, Eagle Creek and Harris Creek Subwatersheds is where most of the wetland conversion has occurred.

Table 38. Long Prairie River Watershed historic wetland extent based on hydric soil data for each 11-digit subwatershed.

11-digit Subwatershed Name	Area (acres) SSURGO 'all hydric' map units	Wetland area (NWI – acres)	Percent wetland loss
Eagle Creek	13,343	7,998	11.2
Long Prairie River	33,608	27,135	4.3
Moran Brook	15,349	12,580	6.1
Turtle Creek	14,017	13,048	2.0
Harris Creek	5,417	3,788	9.4
Upper Long Prairie River	65,329	39,971	9.7

Wetland condition

The MPCA began biological monitoring of wetlands in the early 1990s, focusing on wetlands with emergent vegetation (i.e., marshes) in a depressional geomorphic setting. This work resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, and crustaceans) indices of biological integrity (IBIs) for evaluating the ecological condition or "health" of depressional wetlands. Recently the MPCA wetland monitoring program has begun transitioning toward use of Floristic Quality Assessment to assess wetland condition based on the plant community. Future watershed wetland assessment reports will begin to use FQA wetland assessment approaches. One advantage to the FQA approach is the methods have been adapted to all wetland types which occur in Minnesota.

Both the macroinvertebrate and plant IBIs are scored on a 0 to 100 scale with higher scores indicating better condition. These indicators have been used in a survey of wetland condition where results can be summarized statewide and for each of Minnesota's ecoregions (Genet 2012). Approximately 88% of the Long Prairie River Watershed occurs in the Mixed Wood Plains Level II Ecoregion and 12% occurs in the Mixed Wood Shield Ecoregion in the eastern end of the Long Prairie River (Figure 32). As expected, statewide estimates have found wetlands in the Mixed Wood Plains Ecoregion to be in an intermediate condition compared with Minnesota's other two Level II Ecoregions. In the Mixed Wood Plain Ecoregion the invertebrate index results found 15% of depressional wetlands are in poor condition while 44% of these marsh-type wetlands are statistically estimated to be in good condition (Genet 2012). In contrast, plant index results show 18% of the depressional wetlands in this ecoregion are estimated to be in good condition and 61% in poor condition. Invasive plants, particularly narrow-leaf (*Typha angustifolia*) and hybrid cattails (*Typha* X *glauca*) as well as reed canary grass (*Phalaris arundinacea*) are important wetland stressors and can respond strongly to disturbed watershed conditions including nutrient enrichment, hydrologic alterations and toxic pollutants such as chloride loading (Galatowitsch 2012). Unfortunately, cattails and reed canary grass are very common, often dominating marshes within this region of the state and are detrimental to plant community health (Genet 2012). In contrast, statistical estimates of depressional wetland condition in the Mixed Wood Shield Ecoregion based on the invertebrate IBI found 60% of the wetlands in that region are in good condition, and the plant IBI for wetlands found 54% of the depressional wetlands to be in good condition.

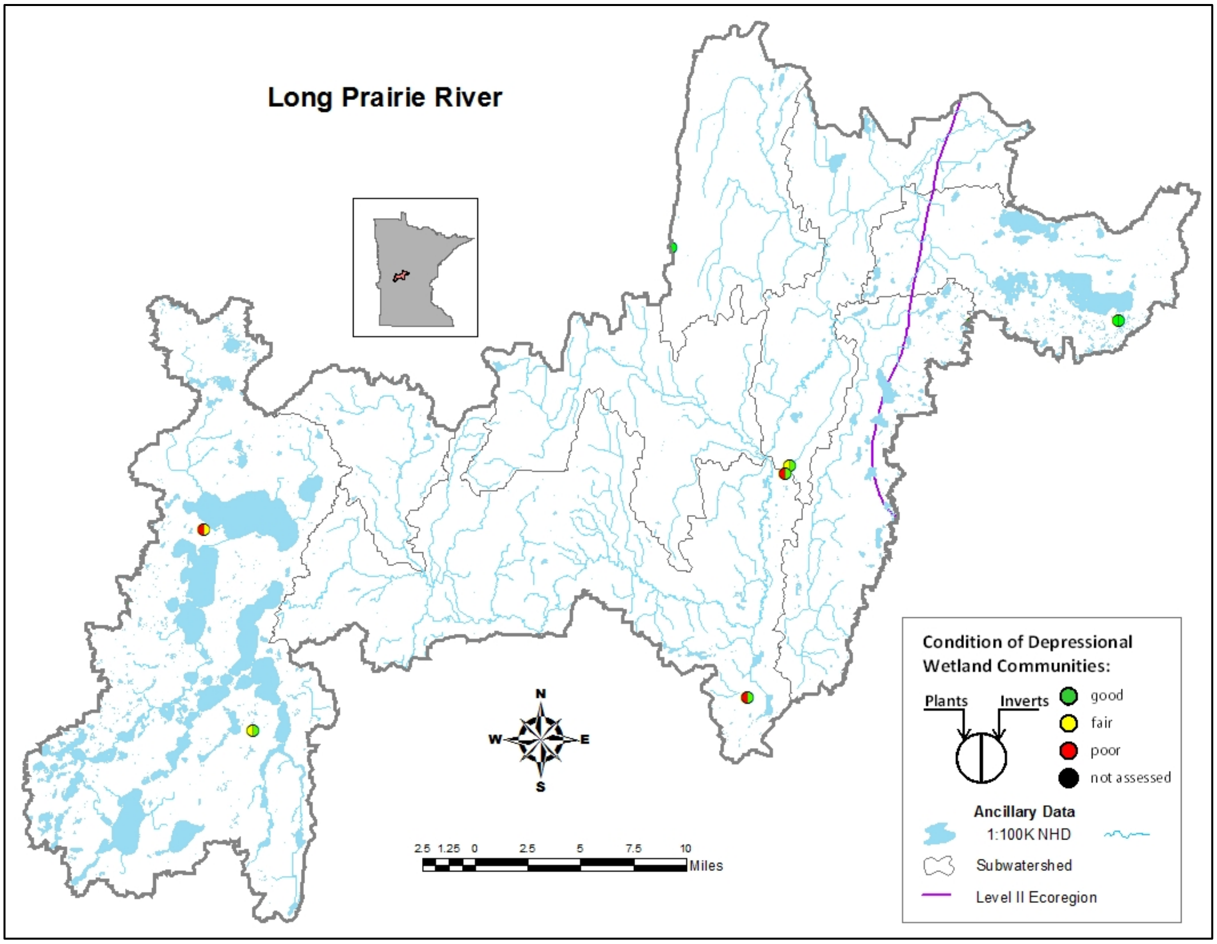

Figure 33. Depressional wetland IBI results (invertebrate and plant community indices) for the MPCA wetland biological study sites located in the Long Prairie River HUC-8 watershed.

MPCA ambient wetland biological condition data has been collected at seven depressional wetlands in the Long Prairie River Watershed. These sites are well distributed across the Long Prairie Watershed. Invertebrate and plant condition results for these sites are presented in Figure 33. Four of these wetland study sites (Lashier; Sheets Big; Sheets Small and 05Morr001) were targeted in their selection for development of wetland IBIs. The remaining three wetlands were randomly selected in 2007 as part of a probabilistic study to estimate wetland quality in the Mixed Wood Plains Ecoregion. Invertebrate community IBI scores at these seven sites range from 47 to 85 (0 to 100 scale with 100 being high integrity). Based on the invertebrate IBI, all of these sites, except one, were reported to be in 'Good' condition, where, the difference between Good and Fair is set at the 25th percentile reference site (i.e. least disturbed) scores within the Mixed Wood Plains Ecoregion (Genet 2012). The plant communities at these same seven wetlands was similarly sampled, where four of the sites were part of an IBI development effort and the remaining three wetlands were randomly selected to estimate wetland condition in the Mixed Wood Plains Ecoregion. The plant scores ranged from 25 to 82 with three of the sites considered to be in 'poor' condition, two of the wetlands were assessed as 'fair' condition and the remaining two wetlands were found to be in 'good' condition. The three wetlands in poor condition each were dominated by invasive plants including cattails and reed canary grass.

In general, wetlands in the eastern half or lower end of the watershed tended to be in better condition and wetlands in the Upper Long Prairie River tended toward lower condition. This pattern parallels the statistical condition estimates of depressional wetlands in the Mixed Wood Plains Level II Ecoregion where the invertebrate indicator found the majority of depressional wetlands were in good condition in contrast to the plant IBI results where most of the wetlands were found to be in poor condition (Genet 2012).

Pollutant trends

The Minnesota Milestone sites are a collection of 80 river and stream monitoring locations that provide the state's best long-term water quality data. As part of this group, monitoring data has been collected at the Long Prairie River site near Motley since the mid-1970s.

Concentrations for the majority of conventional pollutants have generally gone down over the overall period of record for the Milestone sites, and the Long Prairie River likewise shows significant long-term decreases for total suspended solids, ammonia, and biochemical oxygen demand. In addition, while changes in monitoring have precluded more recent trends analysis for bacterial pollution, previous trends work in 2000 showed significant long-term decreases there as well. These environmentally positive trends reflect the considerable progress made during the overall Milestone period in controlling municipal and industrial point sources of pollution in Minnesota.

Concentrations for nitrate and chloride, on the other hand, have generally gone up in the Long Prairie, consistent with a long-term pattern of increases in those two pollutants seen across much of the state. These environmentally negative trends likely reflect continuing, and in some ways more difficult, nonpoint source problems such as agricultural practices (nitrogen) and road salt application (chloride).

The more recent period, 1995 to 2010, has less evidence of continued trends, although at this point it is difficult to tell if this is because trends have leveled off or simply because reduced monitoring efforts have not provided enough data to discern trends over a shorter period.

Table 39. Pollutant trends through the Long Prairie River Watershed.

Data is from Minnesota Pollution Control Agency "Milestone" monitoring sites.

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
Long Prairie River at Bridge on US-10, South of Motley (S000-282)(LPR-3)(period of record 1974 -- 2010)						
Overall Trend	**decrease**	**no trend**	**increase**	**decrease**	**decrease**	**increase**
Estimated average annual change	-1.4%		0.8%	-3.6%	-0.7%	2.9%
Estimated total change	-40%		29%	-69%	-23%	178%
1995 - 2010 trend	no trend	no trend	no trend	no trend	decrease	little data
Estimated average annual change					-2.0%	
Estimated total change					-28%	
Median concentrations first 10 years	5	0.08	0.05	0.09	1	8
Median concentrations most recent 10 years	3	0.09	0.10	<0.03	1	25

(Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90% confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.)

(Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.)

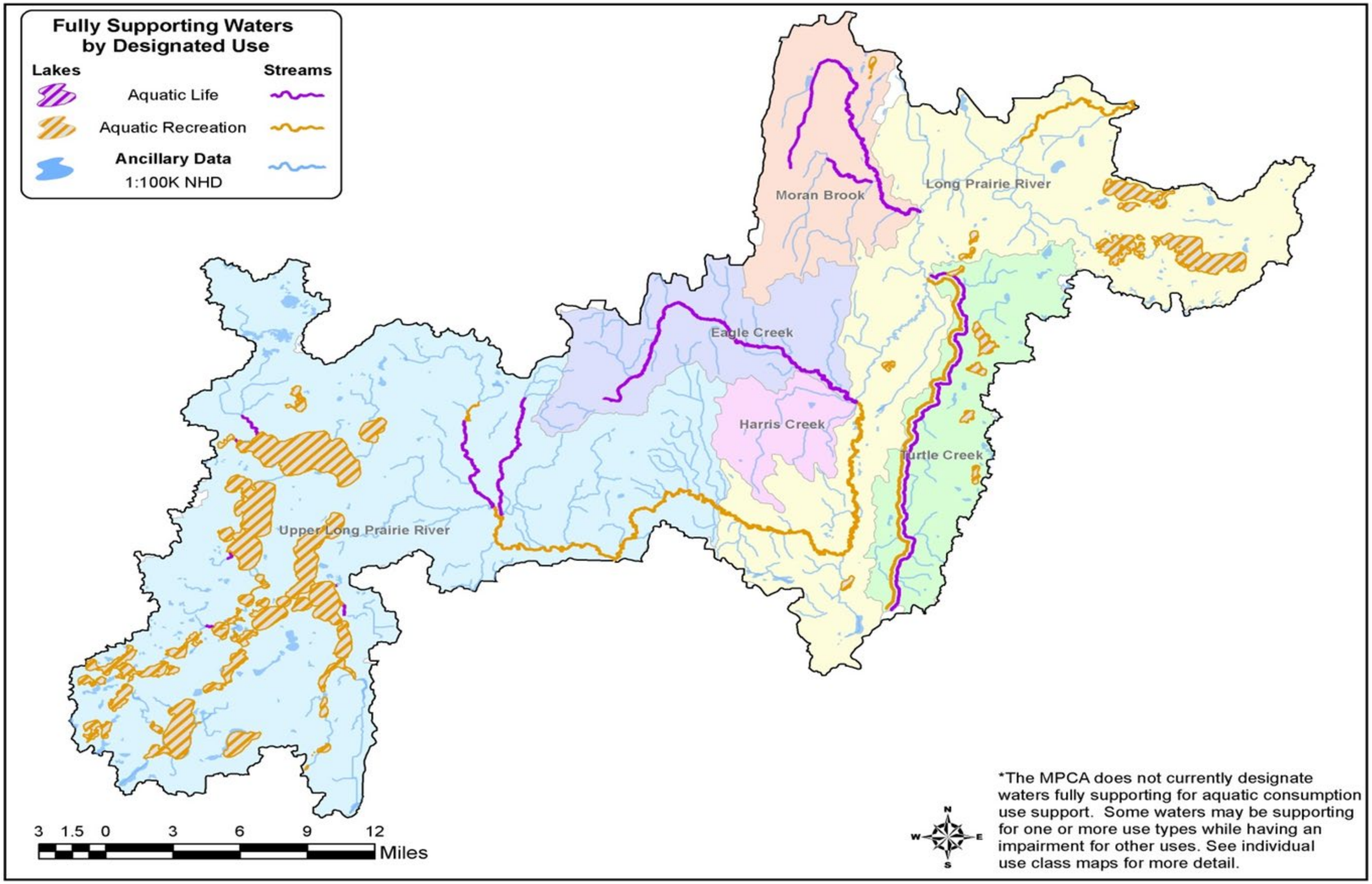

Figure 34. Fully supporting waters by designated use in the Long Prairie River Watershed.

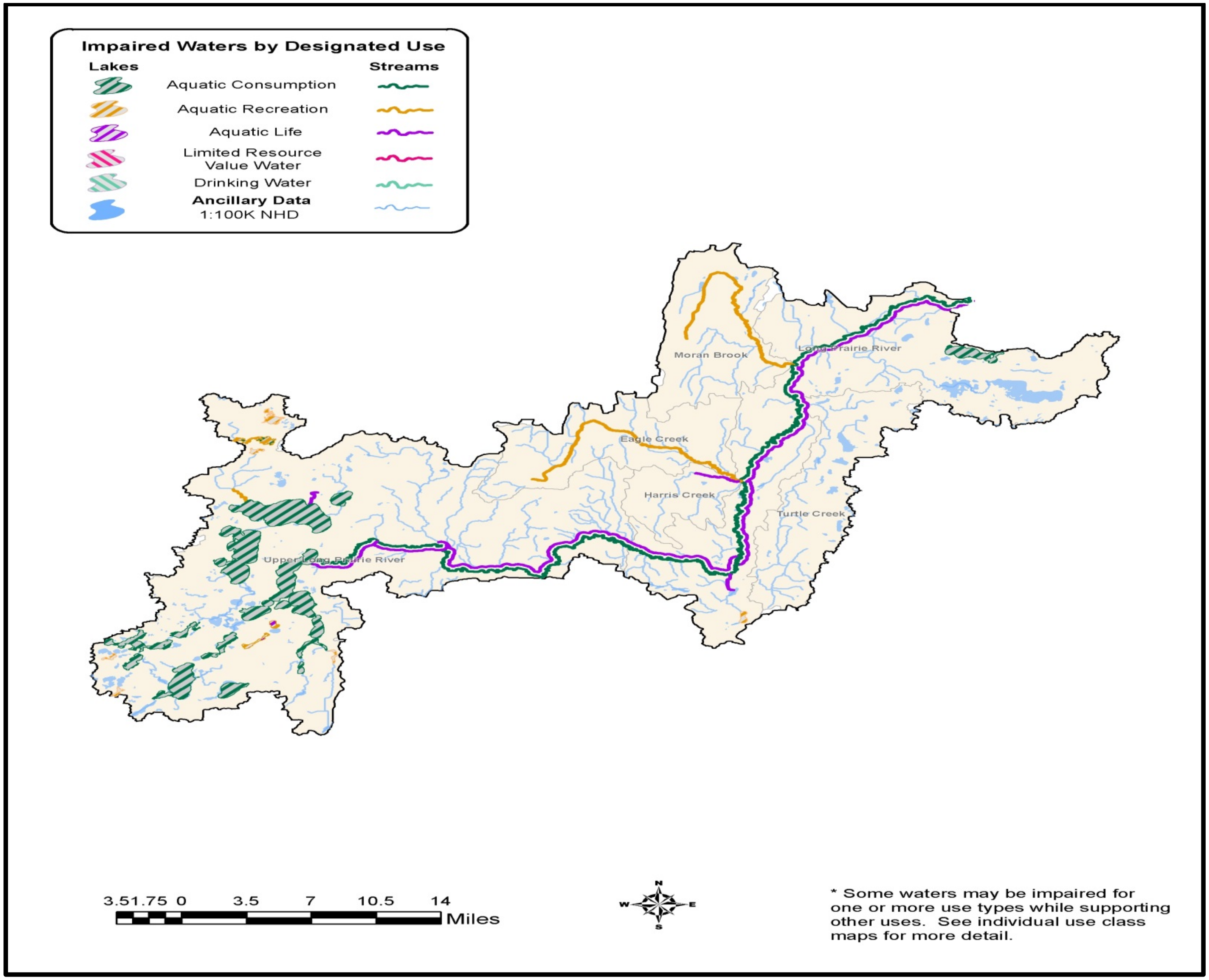

Figure 35. Impaired waters by designated use in the Long Prairie River.

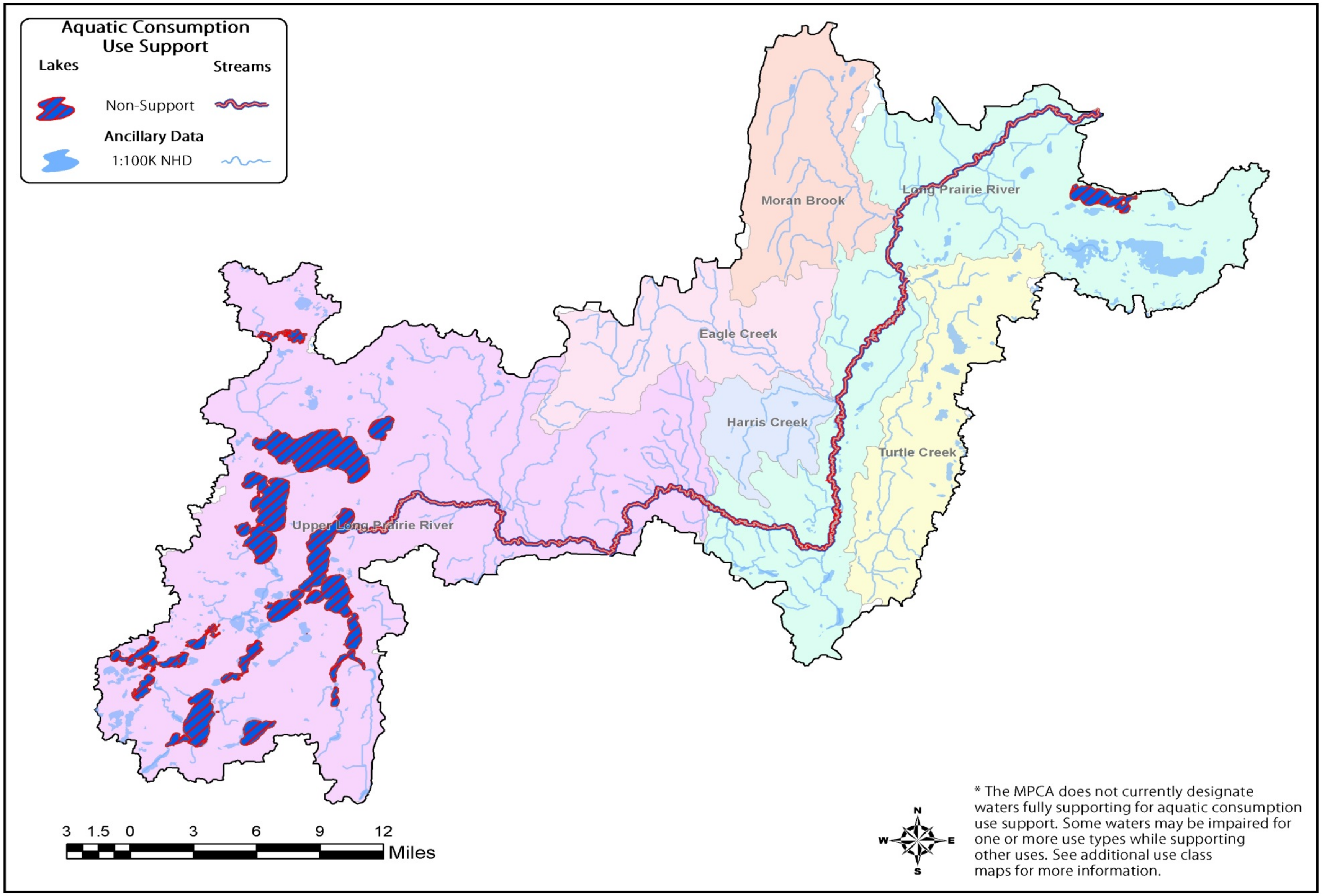

Figure 36. Aquatic consumption use support in the Long Prairie River Watershed.

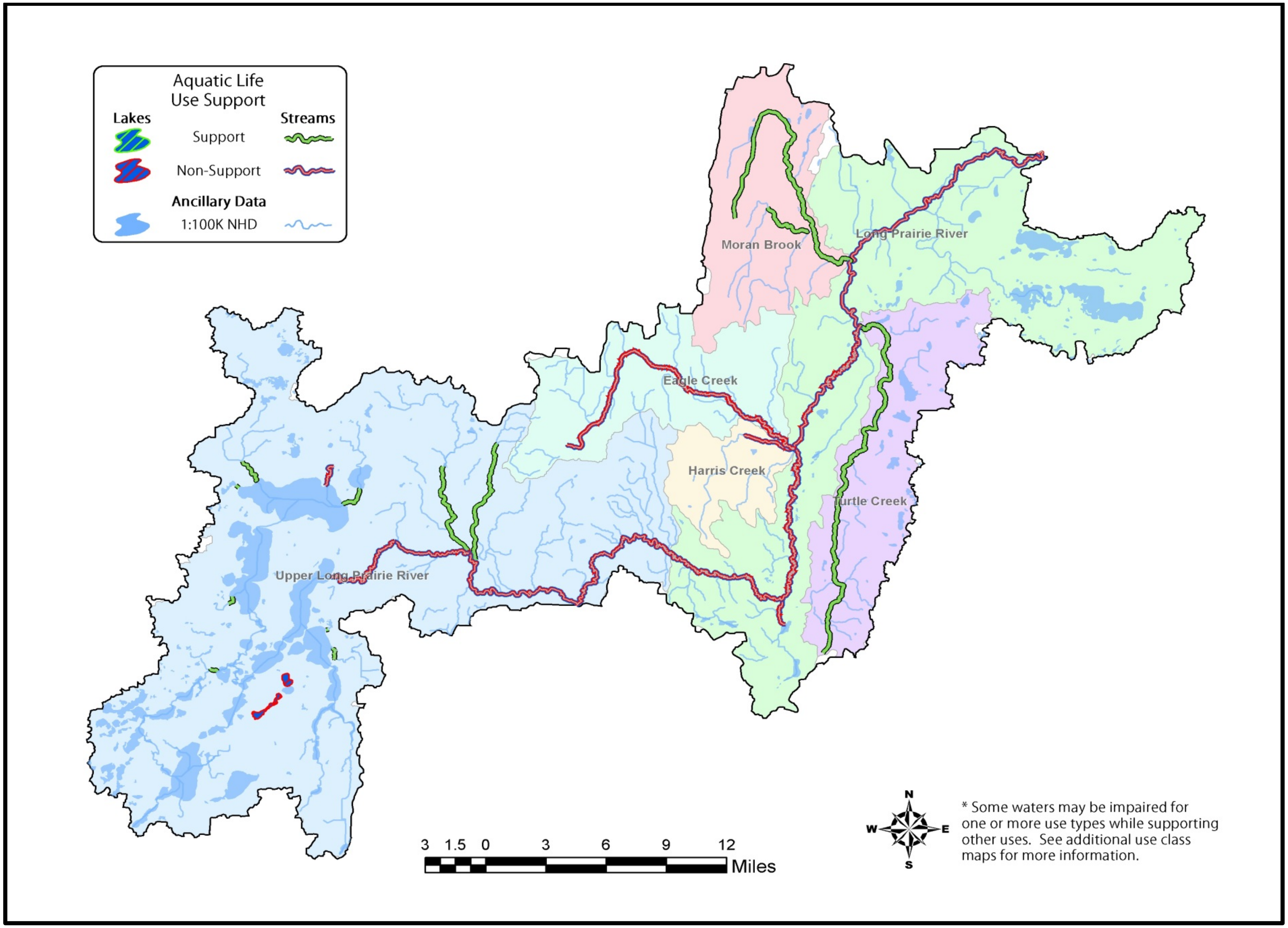

Figure 37. Aquatic life use support in the Long Prairie River Watershed.

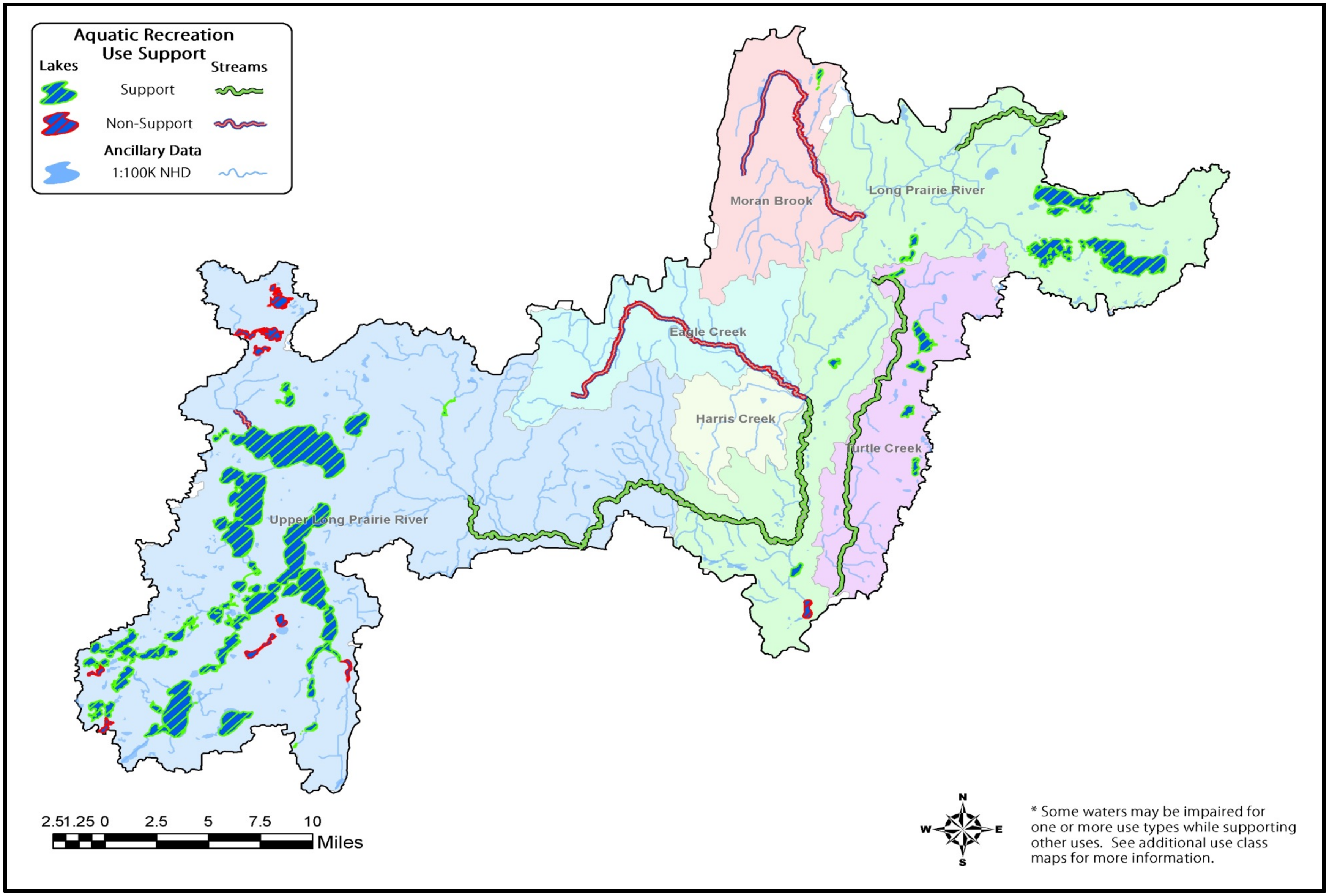

Figure 38. Aquatic recreation use support in the Long Prairie River Watershed.

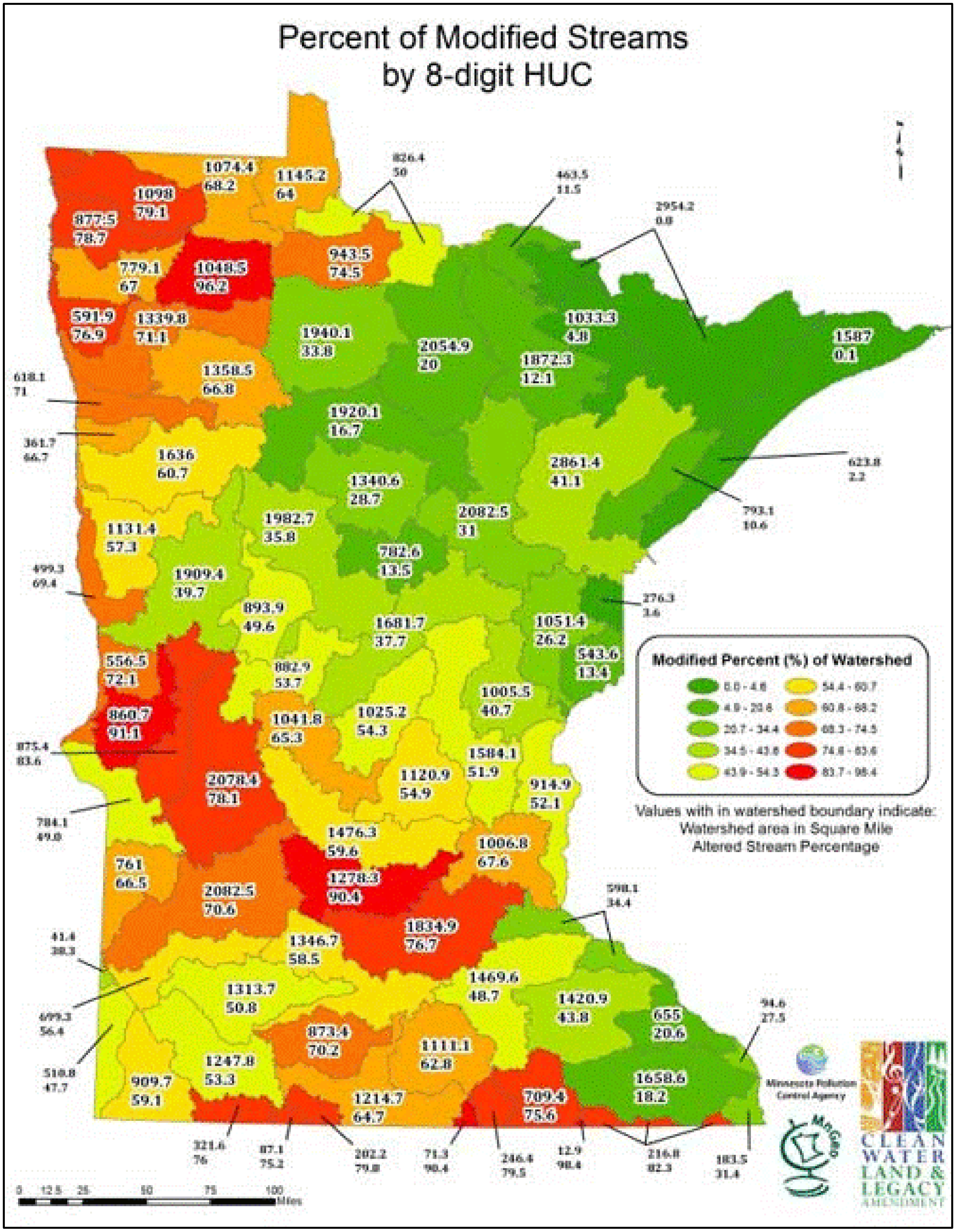

Figure 39. Map of percent modified streams by 8-digit HUC.

VII. Summaries and recommendations

Streams

Although the Long Prairie River Watershed begins in a lake-rich region of the state, the watershed makes a quick transition into a largely range and cropland-dominated landscape, before transitioning back into a mixed forested and lake landscape. Cropland and rangeland make up over half of the watershed's landscape, specifically in the middle portion of the watershed (Figure 7). Despite the high percentages of crop and rangeland there does not appear to be a large negative effect on the overall habitats in and around the streams. In turn, many of the streams showed benefits from the often intact riparian buffers. Although channelized streams are not abundant within this watershed, they are present. Eight out of 37 biological monitoring sites were on channelized streams.

Dissolved oxygen (DO) assessments were conducted on seven AUIDs with six exceeding the standard, resulting in aquatic life impairments (five on the Long Prairie River). The DO impairments on the Long Prairie River appear to fluctuate between sample locations, which is likely due to the river flowing in and out of landscapes with many wetlands. These varying DO levels appear to have an effect on the biological communities. Sites with higher DO concentrations resulted in a higher abundance of fish taxa than those locations with lower DO. Although all sites on the Long Prairie River had fair to good habitat ratings, the DO concentrations appear to play a larger role in fish abundance than the availability of suitable habitat (although still important). The lone other DO impairment occurred on Moran Creek but lower DO concentrations appeared to have little effect on the biological communites as both fish and macroinvertebrate IBI scores indicated full aquatic life use support at all monitoring sites. In total, there were eight AUIDs that fully supported aquatic life and 12 AUIDs where the aquatic life was impaired.

Bacteria impairments also occurred within the watershed although to a lesser extent than DO. Three of the seven assessed AUIDs were impaired due to bacteria and therefore do not support aquatic recreation. Four AUIDs supported aquatic recreation and three did not.

Habitat within this watershed was generally fair, although the MSHA average was within two points of the good range. MSHA metrics that most often influenced the poor overall MSHA scores (four sites) included the land use and substrate metrics. Low land use scores indicate a greater potential for in-stream disturbances due to poor land use practices, primarily in agricultural and urban areas. In addition, the in-stream substrate metric scores were low at many sites indicating that fine sediments are settling into streams and potentially impacting biological communities. The fine sediments cover coarse substrates and potential spawning and/or cover areas for aquatic fish and macroinvertebrates. At sites where the fine substrate material was most prevalent, fish species that spawn on gravel or coarse substrates were absent and more tolerant species dominated. Habitat ratings for riparian condition, channel morphology and fish cover were mostly high which is typical in watersheds where stream channelization is minimal. Overall, habitat within the watershed appears good. However, land use and/or land use practices should be improved to minimize sediment runoff that is detrimentally impacting coarse substrates, and consequently the aquatic life.

Within the Long Prairie River Watershed there are 20 dams, 19 of which are located at the outlets of lakes or wetlands. Dams create recreational opportunities for fishing and camping and also aid in water storage and flood control. However, dams can also restrict water flow to downstream areas, create impoundments upstream, alter stream flow, and prevent fish migration, among other impacts. Certain fish species migrate upstream to reach suitable spawning habitat; however some dams create barriers and prevent fish from reaching these areas. The lone dam on the Long Prairie River is located just downstream of Lake Carlos and acts as a discharge control structure as well as a fish barrier. Although not an actual dam, another example of a barrier to fish passage is the culvert under CSAH 14 on the

Tributary to Lake Miltona. The fish assemblages above versus below this small (but significant) elevation change show that dams, or in this case the perched culvert, do prohibit fish migration upstream.

Examples of actions that could help improve these issues:

- Establish or repair riparian zones using native vegetation and/or trees
- Protect any current riparian buffer zones and quality stream habitat
- Reduce the amount of agricultural, livestock, and urban runoff
- Evaluate dam/perched culvert locations (specifically the Tributary to Lake Miltona culvert) and possible negative effects on fish and/or macroinvertebrate communities
- Continued monitoring to evaluate and document declining or improving conditions

Lakes

Of the 65 assessed lakes in Long Prairie River Watershed, 50 had water quality suitable for aquatic recreation while 10 lakes did not meet standards and are considered impaired for aquatic recreation. Riparian areas around these lakes should be protected to ensure the quality of the lakes meeting thresholds. Three of the assessed lakes in the watershed were considered impaired for aquatic life due to elevated chloride levels.

Groundwater

Local conditions may vary, but due to the surficial geology and heavy agricultural use, nitrate is a potential contaminant of concern in the Long Prairie River Watershed. The MDA regularly samples groundwater across the region for nitrate. To protect human health, the Minnesota Department of Health encourages well owners to test their water supply for nitrate on a regular basis.

The MnDNR in 2010 concluded that the rate of groundwater withdrawals in this area was not detrimental to the aquifer, but cautioned that if withdrawals increased from the current levels (based on 2008 data) the water table could fall and subsequently decrease stream flow. However, the data does indicate a continued increase in groundwater withdrawals from the watershed and no apparent decrease in stream flow. Expanded and continued study of groundwater/surface water interactions should be a priority, due to the transmissive surficial geology and rising trend in groundwater use in this watershed as well as neighboring watersheds like the Crow Wing River and Redeye River.

Current/Future work

There is currently an ongoing TMDL strategy on the Long Prairie River to address the low dissolved oxygen within the river. In addition, several point sources have been addressed and the SWCD continues to work with landowners on Best Management Practices (BMPs) to reduce non-point runoff into the Long Prairie River. Lastly, progress is currently being made to complete additional watershed-wide TMDL and Watershed Restoration and Protection Strategies that will highlight the steps needed to restore and protect the water quality in the watershed.

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Appendix 1. Water chemistry definitions.

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

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

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

Orthophosphate – 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 waste water treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

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

Specific Conductance – The amount of ionic material dissolved in water. Specific conductance is influenced by the conductivity of rainwater, evaporation and by road salt and fertilizer application.

Temperature – Water temperature in streams varies over the course of the day similar to diurnal air temperature variation. Daily maximum temperature is typically several hours after noon, and the minimum is near sunrise. Water temperature also varies by season as doe's air temperature.

Total Kjehldahl 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 Phosphorus 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.

Total Suspended Volatile Solids (TSVS) – Volatile solids are solids lost during ignition (heating to 500 degrees C.) They provide an approximation of the amount of organic matter that was present in the water sample. ''Fixed solids'' is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called ''volatile solids.''

Unnionized 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. Intensive watershed monitoring water chemistry stations in the Long Prairie River Watershed.

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	11-digit HUC
00UM076	S002-905	Long Prairie River	At Miltona Carlos Rd NE, 1 mi. NW of Carlos	07010108010
00UM075	S000-723	Eagle Creek	At CR 89, 2 mi. E of Clarissa	07010108030
11UM010	S002-901	Turtle Creek	At Oak Ridge Rd, 8 mi. NE of Browerville	07010108040
11UM008	S002-903	Moran Creek	At 255th Ave., 8 mi. SW of Staples	07010108050
11UM019	S002-910	Long Prairie River	At CR 14, 0.5 mi. E of Browerville	07010108060
11UM001	S002-900	Long Prairie River	At Township Road 29 in Philbrook	07010108060

Appendix 3. AUID table of stream assessment results (by parameter and beneficial use)

AUID DESCRIPTIONS				USES						BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2013	Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
HUC-11: 07010108010 (Upper Long Prairie River)																		
07010108-595	*Unnamed Creek*	*Headwater to Lake Miltona*	1.62	2B, 3C	NS	NA	-	--	--	EXS	EXS	--	--	--	--	--	--	--
07010108-505	*Long Prairie River*	*Spruce Creek to Eagle Creek*	49.75	2B, 3C	NS	FS	-	--	B_F, DO, HGF	EXP	MTS	EXS	MTS	--	--	MTS	--	MTS
07010108-534	*Long Prairie River*	*Headwaters (Lake Carlos 21-0057-00) to end of Wetland (CSAH 65)*	6.92	2B, 3C	NS	IF	-	--	DO, HGF	NA	MTS	EXP	MTS	--	MTS	MTS	--	IF
07010108-522	*Stormy Creek*	*Unnamed Creek to Unnamed Creek*	7.4	2B, 3C	FS	NA	-	--	--	MTS	MTS	--	--	--	--	--	--	--
07010108-520	*Spruce Creek*	*Unnamed Lake (21-0034-00) to Long Prairie River*	6.16	2B, 3C	FS	NA	-	--	--	MTS	MTS	--	--	--	--	--	--	--
07010108-512	*Spruce Creek*	*T131 R36W S31, north line to Unnamed Lake (21-0034-00)*	7.4	1B, 2A, 3B	NS	NA	-	NA	--	EXP	EXP	--	--	--	--	--	--	--
07010108-535	*Long Prairie River*	*End of Wetland (CSAH 65) to Spruce Creek*	4.84	2B, 3C	NS	NA	-	--	DO, HGF	NA	MTS	EXS	MTS	--	MTS	MTS	--	--
07010108-587	*Freeman's Creek*	*County Ditch 4 to Long Prairie River*	6.88	2B, 3C	NS	NA	-	--	--	MTS	EXP	--	--	--	--	--	--	--
07010108-552*	*Unnamed Creek*	*County Ditch 11 to Lake Miltona*	1.61	2B, 3C	FS	NS	-	--	--	NA	NA	IF	MTS	--	MTS	MTS	--	EX

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedance (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Appendix 3. AUID table of stream assessment results (by parameter and beneficial use) continued

AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2013		Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
HUC-11: 07010108020 (Harris Creek)																			
07010108-592	*Harris Creek*	*Unnamed Creek to Eagle Creek*	3.09	2B, 3C	NS	NA	--	--	--		MTS	EXP	--	--	--	--	--	--	--
HUC-11: 07010108030 (Eagle Creek)																			
07010108-507	*Eagle Creek*	*Headwaters to Long Prairie River*	27.12	2B, 3C	FS	NS	--	--	B_F, B_I		MTS	MTS	IF	MTS	--	MTS	MTS	--	EX
HUC-11: 07010108040 (Turtle Creek)																			
07010108-513	*Turtle Creek*	*Headwaters to Long Prairie River*	28.23	2B, 3C	FS	FS	--	--	--		MTS	MTS	IF	MTS	--	MTS	MTS	--	MTS
HUC-11: 07010108050 (Moran Creek)																			
07010108-511	*Moran Creek*	*Headwaters to Long Prairie River*	23.17	2B, 3C	FS	NS	--	--	--		MTS	MTS	EXP	MTS	--	MTS	MTS	--	EX
07010108-603	*Unnamed Creek*	*Unnamed Creek to Unnamed Creek*	3.7	2B, 3C	FS	NA	--	--	--		MTS	MTS	--	--	--	--	--	--	--
HUC-11: 07010108060 (Long Prairie River)																			
07010108-568	*Venewitz Creek*	*Charlotte Lake to Long Prairie River*	2.05	2B, 3C	NS	NA	--	--	--		EXS	--	--	--	--	--	--	--	--
07010108-504	*Long Prairie River*	*Eagle Creek to Turtle Creek*	13.45	2B, 3C	NS	NA	--	--	--		MTS	NA	EXP	MTS	--	MTS	--	--	--
07010108-503	*Long Prairie River*	*Turtle Creek to Moran Creek*	5.01	2B, 3C	NS	NA	--	--	DO, HGF		MTS	MTS	--	--	--	--	--	--	--
07010108-502	*Long Prairie River*	*Moran Creek to Fish Trap Creek*	7.45	2B, 3C	NS	IF	--	--	DO, HGF		MTS	MTS	IF	MTS	--	MTS	MTS	--	IF
07010108-501	*Long Prairie River*	*Fish Trap Creek to Crow Wing River*	8.76	2B, 3C	FS	FS	--	--	DO, HGF		--	--	MTS	MTS	--	MTS	MTS	--	MTS
07010108-505	*Long Prairie River*	*Spruce Creek to Eagle Creek*	49.75	2B, 3C	NS	FS	-	--	B_F, DO, HGF		EXP	MTS	EXS	MTS	--	--	MTS	--	MTS

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedance (EXP), Exceeds standards or ecoregion expectations (EX/EXS).

Key for Cell Shading: ☐ = existing impairment, listed prior to 2012 reporting cycle; ☐ = new impairment; ☐ = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Appendix 4.1. Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Old Threshold	New Threshold	Confidence Limit	Upper CL	Lower CL
Fish							
1	Southern Rivers	2B, 2C	46	49	±11	60	38
2	Southern Streams	2B, 2C	45	50	±9	59	41
3	Southern Headwaters	2B, 2C	51	55	±7	62	48
10	Southern Coldwater	2A	45	50	±9	59	41
4	Northern Rivers	2B, 2C	35	38	±9	47	29
5	Northern Streams	2B, 2C	50	47	±9	56	38
6	Northern Headwaters	2B, 2C	40	42	±16	58	26
7	Low Gradient	2B, 2C	40	42	±10	52	32
11	Northern Coldwater	2A	37	35	±10	45	25
Invertebrates							
1	Northern Forest Rivers	2B, 2C	51.3	49	±10.8	59.8	38.2
2	Prairie Forest Rivers	2B, 2C	30.7	31	±10.8	41.8	20.2
3	Northern Forest Streams RR	2B, 2C	50.3	53	±12.6	65.6	41.4
4	Northern Forest Streams GP	2B, 2C	52.4	51	±13.6	64.6	37.4
5	Southern Streams RR	2B, 2C	35.9	37	±12.6	49.6	34.4
6	Southern Forest Streams GP	2B, 2C	46.8	43	±13.6	56.6	39.4
7	Prairie Streams GP	2B, 2C	38.3	41	±13.6	54.4	27.4
8	Northern Coldwater	2A	26	32	±12.4	34.4	19.6
9	Southern Coldwater	2A	46.1	43	±13.8	57.8	29.2

Appendix 4.2. Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC-11: 07010108010 (Upper Long Prairie River)							
07010108-595	11UM034	Trib. to Lake Miltona	6.38	6	42	0	07/10/2012
07010108-595	11UM034	Trib. to Lake Miltona	6.38	6	42	0	06/15/2011
07010108-595	13UM179	Trib. to Lake Miltona	6.38	6	42	33	7/25/2013
07010108-534	00UM076	Long Prairie River	247.57	5	47	46	08/09/2012
07010108-534	00UM076	Long Prairie River	247.57	5	47	45	07/06/2012
07010108-534	00UM076	Long Prairie River	247.57	5	47	44	7/24/2013
07010108-517	11UM031	Trib. to Long Prairie River	5.32	6	42	24	06/15/2011
07010108-535	11UM030	Long Prairie River	264.02	5	47	44	07/12/2012
07010108-535	11UM030	Long Prairie River	264.02	5	47	32	7/24/2013
07010108-535	10EM070	Long Prairie River	269.74	5	47	50	06/30/2010
07010108-535	13UM187	Long Prairie River	269.06	5	47	46	9/26/2013
07010108-512	09UM089	Spruce Creek	15.89	6	42	34	07/08/2010
07010108-512	09UM089	Spruce Creek	15.89	6	42	41	09/13/2011
07010108-520	11UM028	Spruce Creek	30.14	6	42	83	08/30/2011
07010108-522	11UM027	Trib. to Long Prairie River	11.70	6	42	52	06/16/2011
07010108-505	11UM025	Long Prairie River	340.78	5	47	36	08/06/2012
07010108-505	11UM025	Long Prairie River	340.78	5	47	47	9/25/2013
07010108-505	10EM042	Long Prairie River	345.32	5	47	55	06/30/2010
07010108-505	10EM042	Long Prairie River	345.32	5	47	38	9/26/2013
07010108-505	11UM024	Long Prairie River	375.29	5	47	30	08/08/2012
07010108-505	11UM024	Long Prairie River	375.29	5	47	43	07/05/2012
07010108-505	11UM024	Long Prairie River	375.29	5	47	46	8/1/2013
07010108-587	11UM022	Trib. to Long Prairie River	11.15	6	42	41	06/16/2011
07010108-552	11UM033	Unnamed Creek	32.91	6	42	58	6/15/2011
07010108-524	11UM032	Unnamed Ditch	8.33	6	42	48	6/15/2011
HUC-11: 07010108020 (Harris Creek)							
07010108-592	11UM013	Harris Creek	16.49	6	42	46	06/14/2011

Appendix 4.2. Biological monitoring results – fish IBI (assessable reaches) continued

National Hydrography Dataset (NHD Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC-11: 07010108030 (Eagle Creek)							
07010108-507	11UM017	Eagle Creek	32.09	6	42	48	07/26/2011
07010108-507	11UM015	Eagle Creek	46.33	6	42	45	6/26/2011
07010108-507	00UM075	Eagle Creek	55.58	5	47	57	07/25/2011
HUC-11: 07010108040 (Turtle Creek)							
07010108-513	11UM012	Unnamed Creek	6.77	6	40	58	6/14/2011
07010108-513	00UM078	Turtle Creek	40.13	7	40	42	09/13/2011
07010108-513	11UM010	Turtle Creek	76.33	5	50	48	08/13/2012
07010108-513	11UM010	Turtle Creek	76.33	5	50	42	09/28/2011
HUC-11: 07010108050 (Moran Creek)							
07010108-511	00UM077	Moran Creek	35.29	7	40	66	09/15/2008
07010108-511	00UM077	Moran Creek	35.29	7	40	76	08/18/2011
07010108-511	00UM077	Moran Creek	35.29	7	40	66	08/1/2013
07010108-603	11UM009	Unnamed Creek	19.87	6	40	60	07/25/2011
07010108-511	11UM008	Moran Creek	69.39	5	30	63	08/18/2011
HUC-11: 07010108060 (Long Prairie River)							
07010108-568	11UM020	Venewitz Creek	15.82	7	40	16	07/26/2011
07010108-504	11UM005	Long Prairie River	589.26	4	35	58	8/8/2012
07010108-504	00UM079	Long Prairie River	589.26	4	35	48	9/24/2013
07010108-594	11UM021	Trib to Long Prairie River	7.22	6	40	44	6/16/2011
07010108-503	11UM004	Long Prairie River	674.31	4	35	38	07/26/2012
07010108-503	11UM004	Long Prairie River	674.31	4	35	45	07/11/2012
07010108-502	11UM001	Long Prairie River	864.13	4	35	62	07/12/2012
07010108-514	11UM007	Fish trap Creek	69.20	5	50	27	8/31/2013
07010108-599	11UM006	Unnamed Creek	7.85	6	40	7	6/14/2013
07010108-505	00UM074	Long Prairie River	427.16	5	50	42	8/8/2012
07010108-505	11UM019	Long Prairie River	463.49	5	50	38	8/7/2012
07010108-505	11UM019	Long Prairie River	463.49	5	50	36	9/25/2013
07010108-505	13UM175	Long Prairie River	452.49	5	50	60	9/24/2013

Appendix 4.3. Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC-11: 07010108010 (Upper Long Prairie River)							
07010108-595	11UM034	Trib. to Lake Miltona	6.38	6	46.8	38	08/23/2011
07010108-534	00UM076	Long Prairie River	247.57	6	46.8	56	08/09/2012
07010108-534	00UM076	Long Prairie River	247.57	6	46.8	50.4	08/08/2012
07010108-517	11UM031	Trib. to Long Prairie River	5.32	6	46.8	53.9	08/23/2011
07010108-535	11UM030	Long Prairie River	264.02	6	46.8	56.4	08/08/2012
07010108-535	10EM070	Long Prairie River	269.74	6	46.8	49.7	09/20/2010
07010108-535	10EM070	Long Prairie River	269.74	6	46.8	51.7	09/20/2010
07010108-512	09UM089	Spruce Creek	15.89	6	46.8	46.1	09/23/2009
07010108-512	09UM089	Spruce Creek	15.89	6	46.8	43.2	09/13/2011
07010108-520	11UM028	Spruce Creek	30.14	6	46.8	61.2	08/23/2011
07010108-522	11UM027	Trib. to Long Prairie River	11.70	6	46.8	45.9	08/23/2011
07010108-524	11UM032	Unnamed Ditch	8.33	7	38.3	20.3	8/30/2011
07010108-552	11UM033	Unnamed Creek	32.91	5	35.9	43.39	8/23/2011
07010108-505	00UM074	Long Prairie River	427.16	6	46.8	62.19	8/8/2012
07010108-505	00UM074	Long Prairie River	427.16	6	46.8	67.03	8/7/2012
07010108-505	11UM025	Long Prairie River	340.78	6	46.8	56	08/06/2012
07010108-505	11UM024	Long Prairie River	375.29	6	46.8	56.5	08/07/2012
07010108-505	11UM024	Long Prairie River	375.29	6	46.8	45.7	08/08/2012
07010108-587	11UM022	Trib. to Long Prairie River	11.15	5	35.9	22.8	08/23/2011
07010108-595	13UM179	Trib. to Lake Miltona	6.38	6	46.8	33.7	9/5/2013
HUC-11: 07010108020 (Harris Creek)							
07010108-592	11UM013	Harris Creek	16.49	5	35.9	33.1	08/24/2011
HUC-11: 07010108030 (Eagle Creek)							
07010108-507	11UM017	Eagle Creek	32.09	6	46.8	53.6	08/24/2011
07010108-507	11UM015	Eagle Creek	46.33	5	35.9	42.87	8/24/2013
07010108-507	00UM075	Eagle Creek	55.58	6	46.8	70.1	09/12/2011

Appendix 4.3. Biological monitoring results-macroinvertebrate IBI (assessable reaches) continued.

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC-11: 07010108040 (Turtle Creek)							
07010108-600	11UM012	Unnamed Creek	6.77	5	35.9	29.4	8/23/2011
07010108-600	11UM012	Unnamed Creek	6.77	5	35.9	31.8	8/7/2012
07010108-513	00UM078	Turtle Creek	40.13	6	46.8	45.7	09/12/2011
07010108-513	11UM010	Turtle Creek	76.33	6	46.8	61.3	08/13/2012
07010108-513	11UM010	Turtle Creek	76.33	6	46.8	35	09/12/2011
HUC-11: 07010108050 (Moran Creek)							
07010108-511	00UM077	Moran Creek	35.29	6	46.8	64.9	08/30/2011
07010108-603	11UM009	County Ditch 25	19.87	5	35.9	45.1	08/30/2011
07010108-511	11UM008	Moran Creek	69.39	6	46.8	54.5	08/22/2011
HUC-11: 07010108060 (Long Prairie River)							
07010108-514	11UM007	Fish Trap Creek	69.20	4	52.4	9.98	8/22/2011
07010108-594	11UM021	Unnamed creek	7.22	5	35.9	52.99	8/23/2011
07010108-599	11UM006	Unnamed creek	7.85	6	46.8	31.37	8/22/2011
07010108-503	11UM004	Long Prairie River	674.31	2	30.7	25.6	09/12/2011
07010108-503	11UM004	Long Prairie River	674.31	2	30.7	64.1	08/08/2012
07010108-502	11UM001	Long Prairie River	864.13	1	43	43	08/22/2011
07010108-502	11UM001	Long Prairie River	864.13	1	43	64.4	08/08/2012
07010108-505	00UM074	Long Prairie River	427.16	6	43	67	08/07/2012
07010108-505	00UM074	Long Prairie River	427.16	6	43	62.2	08/08/2012

Appendix 5.1. Good/fair/poor thresholds for biological stations on non-assessed channelized AUIDs

Ratings of **Good** for channelized streams are based on Minnesota's general use threshold for aquatic life (Appendix 4.1). Stations with IBIs that score above this general use threshold would be given a rating of **Good**. The **Fair** rating is calculated as a 15 point drop from the general use threshold. Stations with IBI scores below the general use threshold, but above the **Fair** threshold would be given a rating of **Fair**. Stations scoring below the Fair threshold would be considered **Poor**.

Class #	Class Name	Good	Fair	Poor
Fish				
1	Southern Rivers	>38	38-24	<24
2	Southern Streams	>44	44-30	<30
3	Southern Headwaters	>50	50-36	<36
4	Northern Rivers	>34	34-20	<20
5	Northern Streams	>49	49-35	<35
6	Northern Headwaters	>39	39-25	<25
7	Low Gradient Streams	>39	39-25	<25
Invertebrates				
1	Northern Forest Rivers	>51	52-36	<36
2	Prairie Forest Rivers	>31	31-16	<16
3	Northern Forest Streams RR	>50	50-35	<35
4	Northern Forest Streams GP	>52	52-37	<37
5	Southern Streams RR	>36	36-21	<21
6	Southern Forest Streams GP	>47	47-32	<32
7	Prairie Streams GP	>38	38-23	<23

Appendix 5.2. Channelized stream reach and AUID IBI scores-FISH (non-assessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC-11: 07010108010 (Upper Long Prairie River)									
07010108-524	11UM032	Trib. To Lake Ida	8.33	6	>39	39-25	<25	48	06/15/2011
07010108-552	11UM033	County Ditch 11	32.91	6	>39	39-25	<25	58	06/15/2011
07010108-517	11UM031	Unnamed Creek	5.32	6	>39	39-25	<25	24	6/15/2011
HUC-11: 07010108020 (Harris Creek)									
None									
HUC-11: 07010108030 (Eagle Creek)									
07010108-507	11UM015	Eagle Creek	46.33	6	>39	39-25	<25	45	07/26/2011
HUC-11: 07010108040 (Turtle Creek)									
07010108-600	11UM012	Unnamed Creek	6.77	6	>39	39-25	<25	58	06/14/2011
HUC-11: 07010108050 (Moran Creek)									
None									
HUC-11: 07010108060 (Long Prairie River)									
07010108-594	11UM021	Trib. to Long Prairie River	7.22	6	>39	39-25	<25	44	06/16/2011
07010108-599	11UM006	Trib. to Long Prairie River	7.85	6	>39	39-25	<25	7	06/14/2011
07010108-514	11UM007	Fish Trap Creek	69.20	4	>34	34-20	<20	27	08/31/2011

Appendix 5.3. Channelized stream reach and AUID IBI scores-macroinverbrates (non-unassessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC-11: 07010108010 (Upper Long Prairie River)									
07010108-524	11UM032	Trib. To Lake Ida	8.33	7	>38	38-23	<23	20.3	08/30/2011
07010108-552	11UM033	County Ditch 11	32.91	5	>36	36-21	<21	43.4	08/23/2011
HUC-11: 07010108020 (Harris Creek)									
None									
HUC-11: 07010108030 (Eagle Creek)									
07010108-507	11UM015	Eagle Creek	46.33	5	>36	36-21	<21	42.9	08/24/2011
HUC-11: 07010108040 (Turtle Creek)									
07010108-600	11UM012	Unnamed Creek	6.77	5	>36	36-21	<21	29.4	08/23/2011
07010108-600	11UM012	Unnamed Creek	6.77	5	>36	36-21	<21	31.8	08/07/2012
HUC-11: 07010108050 (Moran Creek)									
None									
HUC-11: 07010108060 (Long Prairie River)									
07010108-594	11UM021	Trib. to Long Prairie River	7.22	5	>36	36-21	<21	53	08/23/2011
07010108-599	11UM006	Trib. to Long Prairie River	7.85	6	>47	47-32	<32	31.4	08/22/2011
07010108-514	11UM007	Fish Trap Creek	69.20	4	>52	52-37	<37	10	08/22/2011

Appendix 6. Minnesota's ecoregion-based lake eutrophication standards

Ecoregion	TP µg/L	Chl-a µg/L	Secchi meters
NLF – Lake Trout (Class 2A)	< 12	< 3	> 4.8
NLF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NLF – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
NCHF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NCHF – Aquatic Rec. Use (Class 2B)	< 40	< 14	> 1.4
NCHF – Aquatic Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
WCBP & NGP – Aquatic Rec. Use (Class 2B)	< 65	< 22	> 0.9
WCBP & NGP – Aquatic Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7

Appendix 7. MINLEAP model estimates of phosphorus loads for lakes in the Long Prairie River Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
21-0034-00	Mill Pond	40.1	118	15.1	70	2.0	0.6	149.0	1279.0	41.0	0.20	8.61	0.0	44.34	E
21-0041-00	Union	19.2	41	6.6	15	4.0	1.6	163.0	167.0	25.7	0.75	1.02	2.9	1.63	M
21-0049-00	Burgen	23.9	43	9.0	16	2.6	1.5	156.0	398.0	22.0	0.7	2.55	2.40	3.0	M
21-0051-00	Henry	55.8	59	19.3	25	1.7	1.2	154.0	405.0	20.4	0.62	2.63	1.0	4.28	E
21-0052-00	Geneva	26.4	41	9.1	15	3.1	1.6	159.0	950.0	21.9	0.74	5.98	2.8	2.23	E
21-0053-00	Agnes	94.8	52	30.0	21	1.4	1.3	155.0	349.0	18.2	0.66	2.25	1.4	3.44	E
21-0054-00	Victoria	22.5	36	8.1	13	3.1	1.7	158.0	692.0	19.6	0.77	4.38	3.7	2.42	M
21-0055-00	Jessie	55.2	41	30.3	15	1.5	1.6	169.0	104.0	21.0	0.76	0.61	3.0	1.13	E
21-0056-00	Le Homme Dieu	37.8	35	9.4	12	3.3	1.8	164.0	1854.0	22.4	0.79	11.28	4.2	1.47	E
21-0057-00	Carlos	15.3	39	4.6	14	3.4	1.6	153.0	91963.0	16.9	0.74	59.92	2.9	4.91	M
21-0073-00	Vermont	16.4	31	3.4	10	4.5	2.0	195.0	126.0	29.4	0.84	0.64	7.3	0.51	M
21-0076-00	Irene	26.9	34	12.7	11	2.3	1.9	167.0	590.0	20.1	0.80	3.53	4.8	1.26	E
21-0080-00	Darling	19.8	68	6.3	31	3.0	1.0	150.0	6668.0	23.2	0.55	44.32	0.6	9.73	M
21-0081-00	Winona	218.2	76	161.7	37	0.5	0.9	159.0	303.0	21.9	0.52	1.90	0.5	2.14	H
21-0083-00	Miltona	19.7	28	6.1	9	3.9	2.2	174.0	3839.0	22.5	0.84	22.04	7.8	0.92	M
21-0084-00	Skoglund Slough	31.6	106	13.1	60	1.5	0.7	150.0	1507.0	31.5	0.29	10.05	0.1	12.48	E
21-0085-00	Andrew	22.7	22	6.8	6	2.6	2.7	188.0	446.0	18.6	0.88	2.37	14.2	0.60	M
21-0092-00	Mary	28.6	36	10.8	12	1.8	1.8	173.0	1736.0	26.6	0.79	10.05	4.3	0.97	E
21-0093-00	Alvin	20.7	53	6.7	21	2.4	1.3	201.0	49.0	36.8	0.74	0.24	2.2	0.45	M
21-0094-00	Louise	18.2	99	8.0	54	2.7	0.7	149.0	4995.0	23.3	0.34	33.60	0.1	37.74	M
21-0095-00	North Union	19.4	117	6.5	69	3.0	0.6	148.0	6084.0	28.2	0.21	41.02	0.0	75.64	M
21-0101-00	Stony	16.5	114	4.5	67	3.9	0.7	148.0	6069.0	27.5	0.23	41.11	0.0	86.09	M
21-0102-00	Brophy	22.3	65	6.0	29	3.0	1.1	152.0	1080.0	24.3	0.57	7.11	0.7	6.25	M
21-0103-00	Cowdrey	21.7	94	5.5	50	3.6	0.8	149.0	6399.0	22.4	0.37	43.07	0.2	42.41	M
21-0105-00	Lottie	20.9	126	4.9	77	3.3	0.6	148.0	6107.0	33.6	0.15	41.20	0.0	103.88	M

Appendix 7. MINLEAP model estimates of phosphorus loads for lakes in the Long Prairie River Watershed continued

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
21-0106-01	LATOKA (North Bay)	14.9	20	4.0	5	4.2	2.9	185.0	272.0	18.7	0.89	1.47	16.7	0.66	M
21-0106-02	LATOKA (South Bay)	15.2	19	4.1	5	4.1	3.1	192.0	91.0	18.7	0.90	0.48	19.9	0.55	M
21-0108-00	Mina	15.1	36	3.3	12	3.7	1.8	157.0	731.0	19.9	0.77	4.65	3.8	2.57	M
21-0111-00	Cook	33.8	49	4.0	19	3.3	1.4	163.0	123.0	28.4	0.70	0.76	1.9	1.58	E
21-0120-00	Charley	21.9	114	6.0	66	2.5	0.7	148.0	4897.0	27.9	0.24	32.98	0.0	50.31	M
21-0123-00	Ida	17.9	33	5.0	11	4.0	1.9	161.0	5321.0	21.4	0.79	32.98	4.8	1.81	M
21-0130-00	Spring	22.0	34	9.9	11	2.9	1.9	171.0	76.0	22.9	0.80	0.44	4.9	1.04	M
21-0144-01	Lobster (East Bay)	21.6	37	7.2	13	2.8	1.7	168.0	593.0	25.2	0.78	3.54	3.9	1.22	M
21-0144-02	Lobster (West Bay)	25.7	31	9.7	10	2.3	2.0	191.0	269.0	26.3	0.84	1.41	6.9	0.56	E
21-0150-00	Grants	21.5	34	4.7	11	3.1	1.9	164.0	202.0	21.7	0.79	1.23	4.6	1.47	M
21-0151-00	Blackwell	23.1	32	5.4	11	2.8	1.9	186.0	146.0	24.7	0.83	0.78	6.2	0.63	M
21-0157-00	Echo	47.7	35	18.8	12	1.5	1.8	186.0	50.0	21.2	0.81	0.27	5.2	0.64	E
21-0180-00	Mill	37.4	63	12.5	28	2.5	1.1	152.0	1842.0	24.9	0.59	12.14	0.8	6.51	E
21-0197-00	Round	21.7	83	6.5	42	1.8	0.9	155.0	155.0	33.4	0.46	1.00	0.3	3.25	M
21-0199-01	Crooked (Northwest Bay)	19.3	34	3.9	12	2.6	1.8	193.0	68.0	26.3	0.82	0.35	5.6	0.53	M
21-0199-02	Crooked (East Crooked)	43.3	51	28.2	21	1.1	1.3	161.0	145.0	27.5	0.68	0.90	1.6	1.87	E
49-0079-00	Alexander	18.3	15	6.7	3	4.7	3.8	60.0	774.0	23.4	0.75	12.97	7.2	1.07	M
49-0127-00	Shamineau	14.5	20	4.5	5	4.5	2.9	56.0	687.0	25.5	0.64	12.28	2.7	2.09	M
49-0133-00	Crookneck	26.9	20	7.0	5	2.7	2.9	64.0	37.0	23.4	0.69	0.58	3.6	0.71	E
49-0136-00	Ham	16.3	28	6.2	9	3.5	2.2	62.0	13.0	41.6	0.55	0.20	1.3	0.79	M

Appendix 7. MINLEAP model estimates of phosphorus loads for lakes in the Long Prairie River Watershed continued

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
49-0137-00	Fish Trap	24.5	16	8.7	4	3.4	3.5	59.0	350.0	22.6	0.73	5.89	5.6	1.10	E
56-0065-00	Nelson	73.0	73	36.9	34	1.0	1.0	162.0	386.0	27.5	0.55	2.39	0.6	1.75	E
56-0066-00	Fish	83.1	60	52.5	26	1.1	1.1	162.0	566.0	30.6	0.63	3.49	1.0	1.73	E
56-0067-00	Twin	81.6	64	42.2	29	1.3	1.1	171.0	103.0	30.0	0.63	0.60	1.0	1.03	E
77-0046-00	Coal	17.6	32	11.1	10	2.6	2.0	182.0	93.0	17.0	0.83	0.51	6.3	0.71	M
77-0050-00	Mill	18.8	36	10.8	13	1.8	1.7	192.0	70.0	21.3	0.81	0.37	5.0	0.54	M
77-0061-00	Rice	49.8	35	11.8	12	1.3	1.8	55.0	442.0	33.8	0.36	8.08	0.3	2.96	E
77-0066-00	Thunder	29.1	46	19.0	17	1.2	1.4	175.0	145.0	28.0	0.74	0.83	2.5	0.88	E
77-0076-00	Fawn	17.4	36	3.0	13	3.6	1.7	219.0	43.0	33.4	0.83	0.19	5.9	0.34	M
77-0077-00	Pine Island	19.5	38	4.6	14	3.2	1.7	206.0	54.0	32.2	0.81	0.26	4.8	0.41	M
77-0088-00	Turtle	17.5	26	7.1	8	2.6	2.3	191.0	54.0	21.6	0.86	0.28	10.4	0.57	M
77-0105-00	Latimer	71.1	36	48.0	13	1.2	1.7	167.0	181.0	17.1	0.78	1.08	4.0	1.27	E
77-0120-00	Charlotte	15.1	46	4.2	18	3.6	1.4	152.0	631.0	19.6	0.70	4.15	1.9	5.66	M
77-0128-00	Horseshoe	14.5	47	5.1	18	3.1	1.4	168.0	100.0	25.3	0.72	0.60	2.1	1.21	M
77-0138-00	Dower	13.1	45	3.7	17	4.1	1.5	162.0	161.0	24.2	0.72	0.99	2.3	1.77	M

Abbreviations: **H – Hypereutrophic** **M – Mesotrophic** **--- No data**
E – Eutrophic **O – Oligotrophic**

Appendix 8. Fish species sampled during biological monitoring surveys

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
bigmouth shiner	9	83
black bullhead	16	255
black crappie	5	12
blacknose dace	24	1317
blacknose shiner	10	89
bluegill	16	426
bluntnose minnow	4	59
bowfin	11	47
brassy minnow	5	21
brook stickleback	13	178
brown bullhead	2	2
burbot	24	257
central mudminnow	36	2741
common carp	6	23
common shiner	28	4177
creek chub	29	579
fathead minnow	17	468
finescale dace	1	2
Gen: redhorses	3	53
golden shiner	10	135
greater redhorse	7	19
green sunfish	12	66
hornyhead chub	19	1556
hybrid sunfish	7	45
Iowa darter	13	114
johnny darter	25	1169
largemouth bass	18	249
logperch	11	51
longnose dace	5	11
mimic shiner	5	211
mottled sculpin	6	144
northern pike	31	377
northern redbelly dace	12	397
pearl dace	3	51
pumpkinseed	5	10
rock bass	20	217
sand shiner	3	5
shorthead redhorse	10	95
silver redhorse	1	1
smallmouth bass	3	4

Appendix 8. Fish species sampled during biological monitoring surveys continued

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
spottail shiner	3	5
tadpole madtom	18	296
walleye	7	12
white sucker	34	1529
yellow bullhead	12	44
yellow perch	18	446