Watershed health

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Blue Earth River Watershed Monitoring and Assessment Report

MINNESOTA POLLUTION CONTROL AGENCY

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List of acronyms

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

DNR Minnesota Department of Natural Resources

DOP Dissolved Orthophosphate

E Eutrophic

E. coli *Escherichia coli*

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

MCL maximum contaminant level

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

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

NH_3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

ppm parts per million

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 phosphorous

TSS total suspended solids

USGS United States Geological Survey

WID Waterbody Identification Number

WPLMN Watershed Pollutant Load Monitoring Network

Executive summary

The Blue Earth River Watershed (HUC 07020009) covers an area of more than 1,500 square miles (1,001,805 acres) in south central Minnesota and north central Iowa. Approximately 80% of the Blue Earth River Watershed lies within portions of Minnesota's Martin, Faribault, and Blue Earth counties, spanning an area from the Iowa border to its confluence with the Minnesota River in the city of Mankato.

In 2017, the Minnesota Pollution Control Agency (MPCA) began a two-year, intensive watershed monitoring (IWM) project in Blue Earth River Watershed. This project was designed to assess the quality of the lakes and streams in the watershed through both biological and water chemistry monitoring. MPCA biomonitoring staff evaluated fish and macroinvertebrate communities at 71 unique monitoring stations across 66 assessment reaches of stream. Minnesota Department of Natural Resources (DNR) staff evaluated fish communities in 10 lakes in the watershed. MPCA surface water quality staff in partnership with Faribault County Soil and Water Conservation District (SWCD) and Martin County SWCD completed lake and stream chemistry sampling at 18 stream locations: 16 of which were at the outlets of each major subwatershed and additional locations were sampled on tributaries entering the state from Iowa. MPCA surface water quality staff, in partnership with Faribault and Martin County SWCDs, collected water chemistry samples from 24 lakes to assess the aquatic life and aquatic recreation potential of each lake and stream where sufficient data was available.

Results presented in this report indicate significantly degraded water quality and biological communities throughout much of the watershed, as less than a third of streams are fully supporting aquatic life use. Despite significant alterations to hydrologic and ecological function, many reaches of stream were found to harbor diverse and balanced communities that met thresholds.

Stream and river fish communities throughout the Blue Earth River Watershed were characterized by a lack of diversity and near absence of species that are sensitive to declines in water quality. Fish communities were frequently dominated by species that are capable of persisting in degraded and sub-marginal habitats. The most commonly collected species of fish were generalist species that are particularly tolerant of disturbed conditions: fathead minnow, sand shiner, and white sucker. Fish communities were diverse and balanced in some stream reaches, however only five reaches of streams met the general aquatic life use expectations (modified use streams have lower biological expectations than general use waters).

Overall, macroinvertebrate communities in the Blue Earth River Watershed scored better than fish communities. Macroinvertebrate communities met aquatic life use standards in 65% of 66 assessed reaches. Of these 43 stream reaches that supported aquatic life use for macroinvertebrate communities, 17 were general use waters. The most commonly collected invertebrate taxa were midges of the genus *Polypedilum* in terms of the number of sites where present, and the tolerant snail genus *Physella* in terms of the number of overall individuals.

Stream water chemistry data collected during the IWM process indicate that surface water quality in the Blue Earth River Watershed is poor; results presented in this report detail widespread bacterial contamination and elevated nutrients. Of the 73 reaches of stream assessed for aquatic life using water chemistry parameters, 53 stream reaches (73%) were determined to be not meeting aquatic life use support standards and were listed as impaired. Of the 27 stream reaches that were assessed for aquatic recreation, not a single stream met permissible standards due to elevated levels of *Escherichia coli* (*E. Coli)* bacteria. Similarly, of the nine lakes in the Blue Earth River Watershed that were assessed for aquatic recreation, eight (89%) failed to meet applicable standards due to elevated nutrients and bacteria in their water. The sole lake meeting these standards was an unnamed lake in Faribault County

(Lake ID: 22-0088-00) near the town of Guckeen. Aquatic life use assessments were made on nine lakes based on fish community data; all nine lakes failed to meet aquatic life use standards as determined by sampling conducted by DNR. Fish communities in lakes in this watershed were characterized by a dominance of species that are tolerant of poor water quality, homogenous habitats, and low dissolved oxygen (DO): common carp, black bullhead, green sunfish, and bigmouth buffalo.

Chemical contaminants were examined in fish tissues from 11 assessment reaches of the Blue Earth River and from 11 lakes in the watershed. Mercury concentrations in fish tissues from the Blue Earth River were above permissible standards and all 11 sampled reaches are listed as impaired. Mercury concentrations in fish tissues from lakes within this watershed were generally low, however walleye from Independence and Big Twin Lakes tested high for mercury and both lakes are listed as impaired for fish consumption.

Groundwater monitoring in the Blue Earth River Watershed indicates the presence of naturally-occurring minerals such as iron, manganese and arsenic. Of these naturally-occurring minerals, arsenic is of particular concern as it is harmful to humans in concentrations above 10 micrograms per liter. Natural levels of arsenic vary across the counties in this watershed; 10-27% of newly constructed drinking water wells surpass this maximum permissible level of arsenic. Human activity has introduced high concentrations of chloride and nitrate into groundwater in this region.

The overall area covered by wetlands in this watershed has been reduced to approximately 6% of the acreage that existed prior to non-indigenous settlement. Plant and macroinvertebrate conditions range from fair to poor. Wetland plant communities exhibit moderate to extreme changes (e.g., complete replacement of native species by non-native invasives) in their expected species composition and abundance distributions.

The water quality and biological communities in the Blue Earth River Watershed reflect the land use, hydrologic modification, and discharge of pollutants (point and non-point) within this watershed. Changes in land use beginning in the mid-19th century have resulted in a near-wholesale conversion of the landscape from tall grass prairie, wetland and forest vegetation to row crop agriculture in this watershed. Such a dramatic shift in land cover, coupled with widespread modification of stream channels and wetland complexes has had severe consequences for surface water quality. The prevalence of stream channelization and artificial drainage (i.e. tiling) has created an engineered surficial hydrology that does not retain water from precipitation in the same manner as an unaltered landscape; rain events result in a rapid spike in discharge volumes, while intervening periods of low precipitation result in exceptionally low flows. High discharge events destabilize and erode stream banks, which generate high sediment loads and progressively wider, shallower channels. The loss of riparian tree cover and rooted, perennial vegetation can greatly exacerbate these issues by further destabilizing banks and increasing water temperatures from lack of shade and cover. Streams impacted by these processes are characterized by uniform depths, homogenous fine substrates and lack of well-developed riffle-pool-run sequences; they provide little habitat for diverse and healthy aquatic communities. The adoption of best land management practices such as an implementation of perennial vegetation buffers along stream reaches, improved control of waste runoff at livestock operations, installation of exclusion fencing to limit animal access to streams, and novel manners to mitigate nutrient loading to surface waters from fertilizer application would have profound benefits to water quality and biological communities throughout the region.

Introduction

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

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

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

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

This watershed-wide monitoring approach was implemented in the Blue Earth River Watershed beginning in the summer of 2017. This report provides a summary of all water quality assessment results in the Blue Earth River Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

The watershed monitoring approach

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

Watershed pollutant load monitoring

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

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

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

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

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

Intensive watershed monitoring

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

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

Figure 1. The intensive watershed monitoring design.

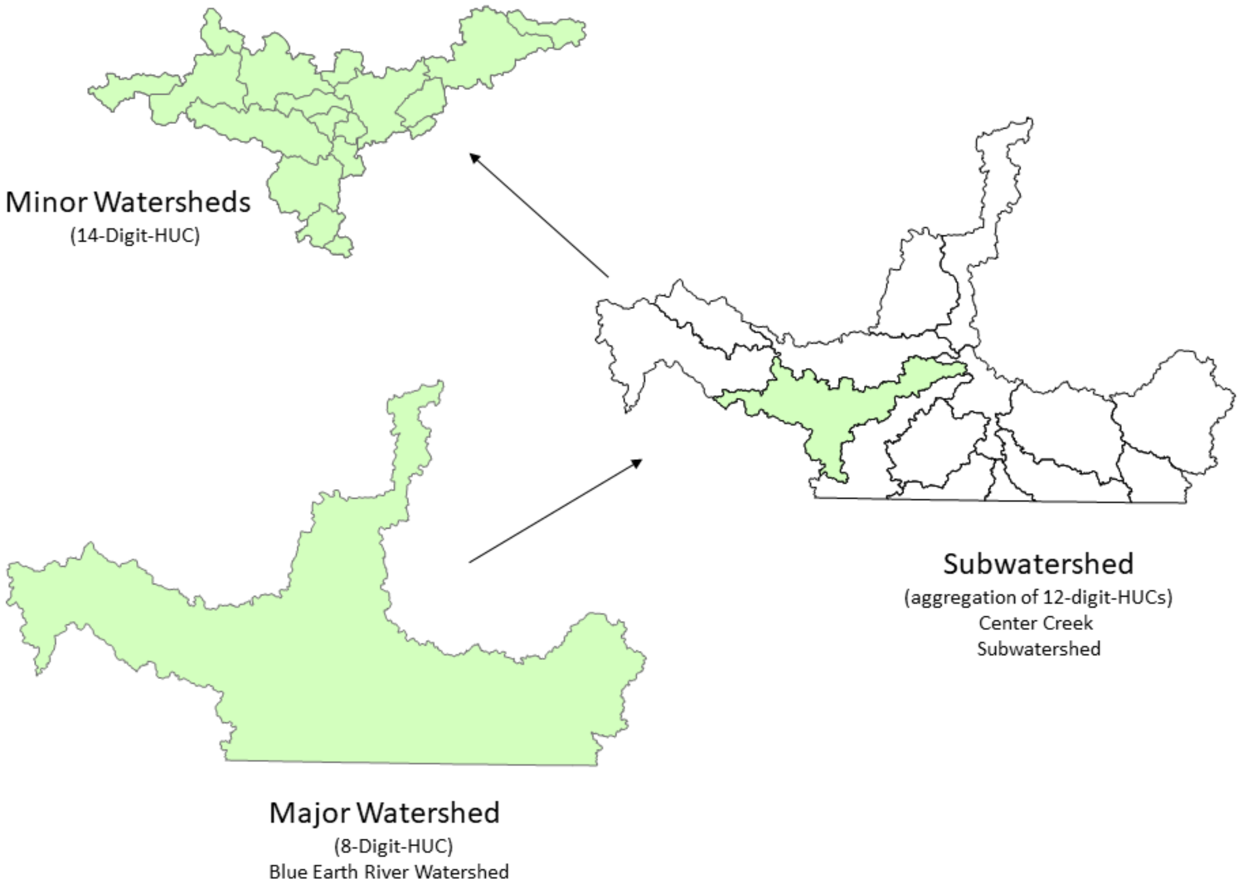
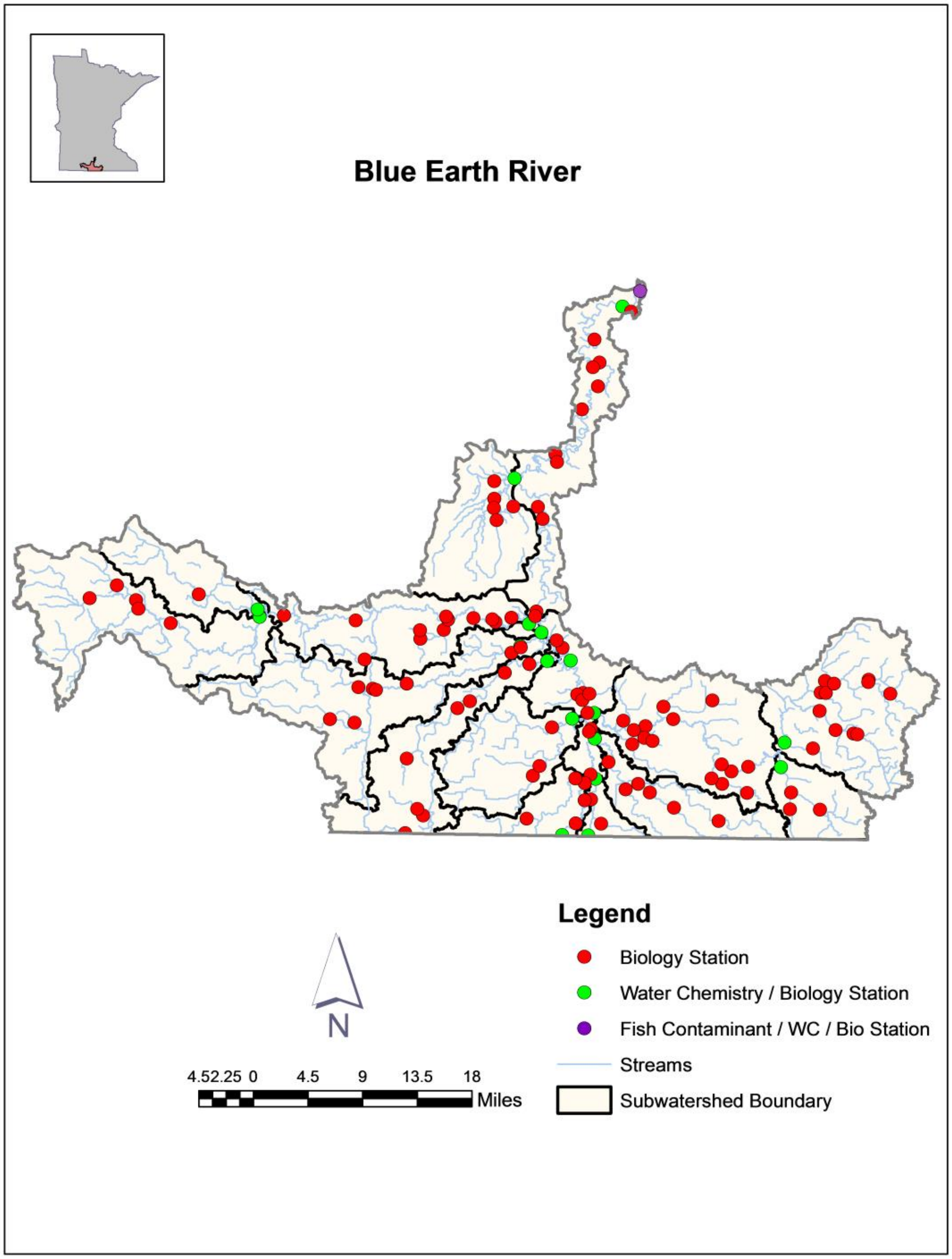


Figure 2. Intensive watershed monitoring sites for streams in the Blue Earth River Watershed.



Lake monitoring

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

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

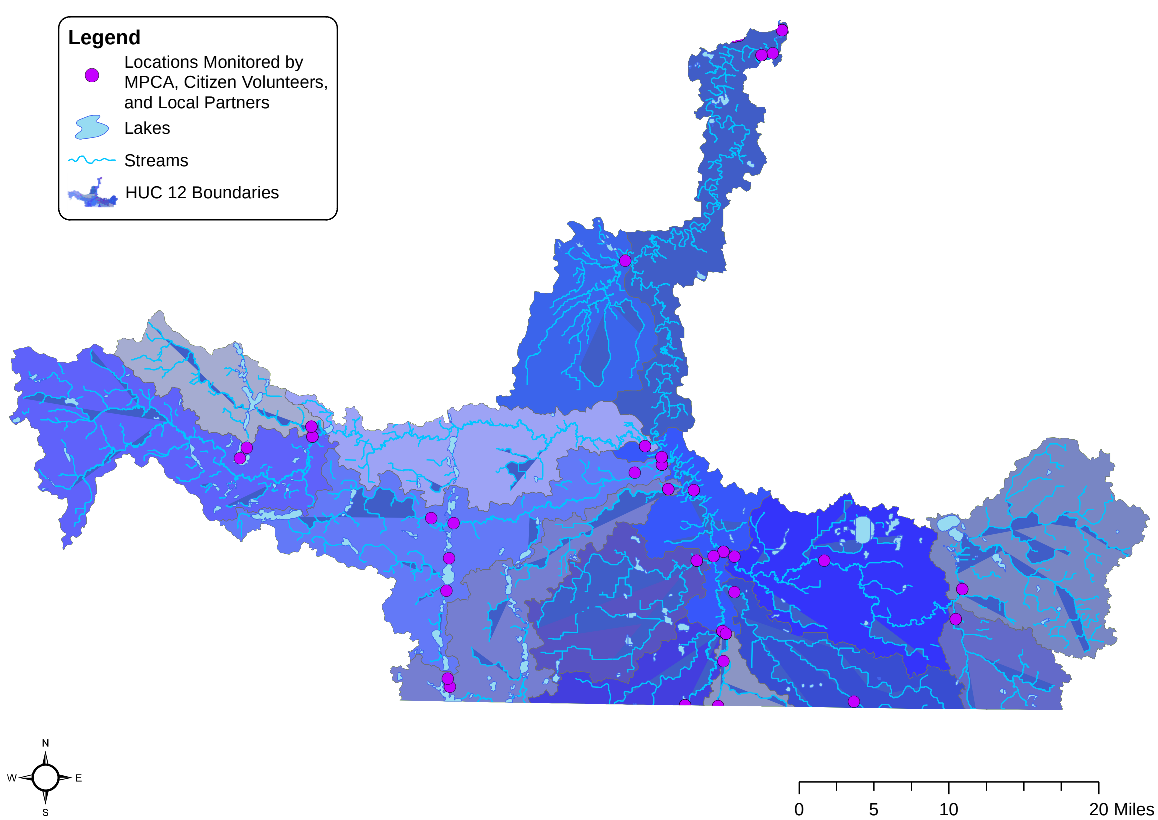
Citizen and local monitoring

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

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

Figure 3 provides an illustration of the locations where citizen-monitoring data were used for assessment in the Blue Earth River Watershed.

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



Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012)*. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04.pdf.

Water quality standards

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

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

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

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, macroinvertebrates, and plants. Biological monitoring, the sampling of aquatic organisms, is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI). This index is a scientifically validated combination of measurements of the biological community (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a site. The MPCA has developed stream IBIs for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. The MPCA also uses a lake fish IBI developed by the DNR to determine if lakes are meeting aquatic life use.

Because the lakes, rivers, and streams in Minnesota are physically, chemically, and biologically diverse, IBI's are developed separately for different stream classes and lake class groups to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life. For streams these include pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride, total suspended solids, pesticides, and river eutrophication. For lakes, pesticides and chlorides contribute to the overall aquatic life use assessment.

Protection for aquatic life uses in streams and rivers are divided into three tiers: Exceptional, General, and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that can be characterized as having an overall balanced distribution of the assemblages and with the ecosystem functions largely maintained through redundant attributes. Modified Use waters have been extensively altered through legacy physical modifications which limit the ability of the biological communities to attain the General Use. Currently the Modified Use is only applied to streams with channels that have been directly altered by humans (e.g., maintained for drainage). These tiered aquatic life uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat (MPCA 2015). For additional information, see https://www.pca.state.mn.us/water/tiered-aquatic-life-uses-talu-framework .

Table 1. Tiered aquatic life use standards.

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

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, 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 WID), comprised of the United States Geological Survey (USGS) eight-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the DNR. The Protected Waters Inventory provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the WID and are composed of an eight-digit number indicating county, lake and bay for each basin.

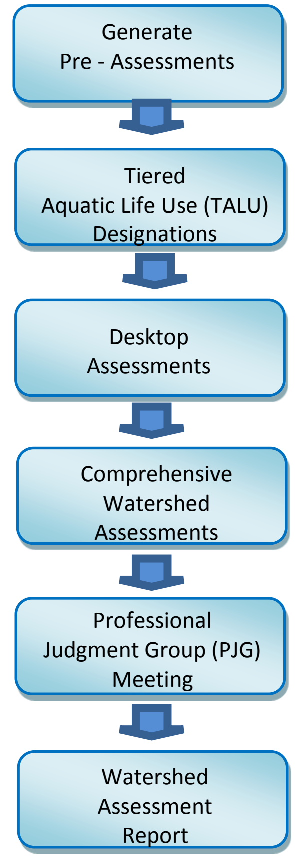
It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption).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

Determining use attainment

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

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

Figure 4. Flowchart of aquatic life use assessment process.



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

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2016) https://www.pca.state.mn.us/sites/default/files/wq-iw1-04j.pdf for guidelines and factors considered when making such determinations.

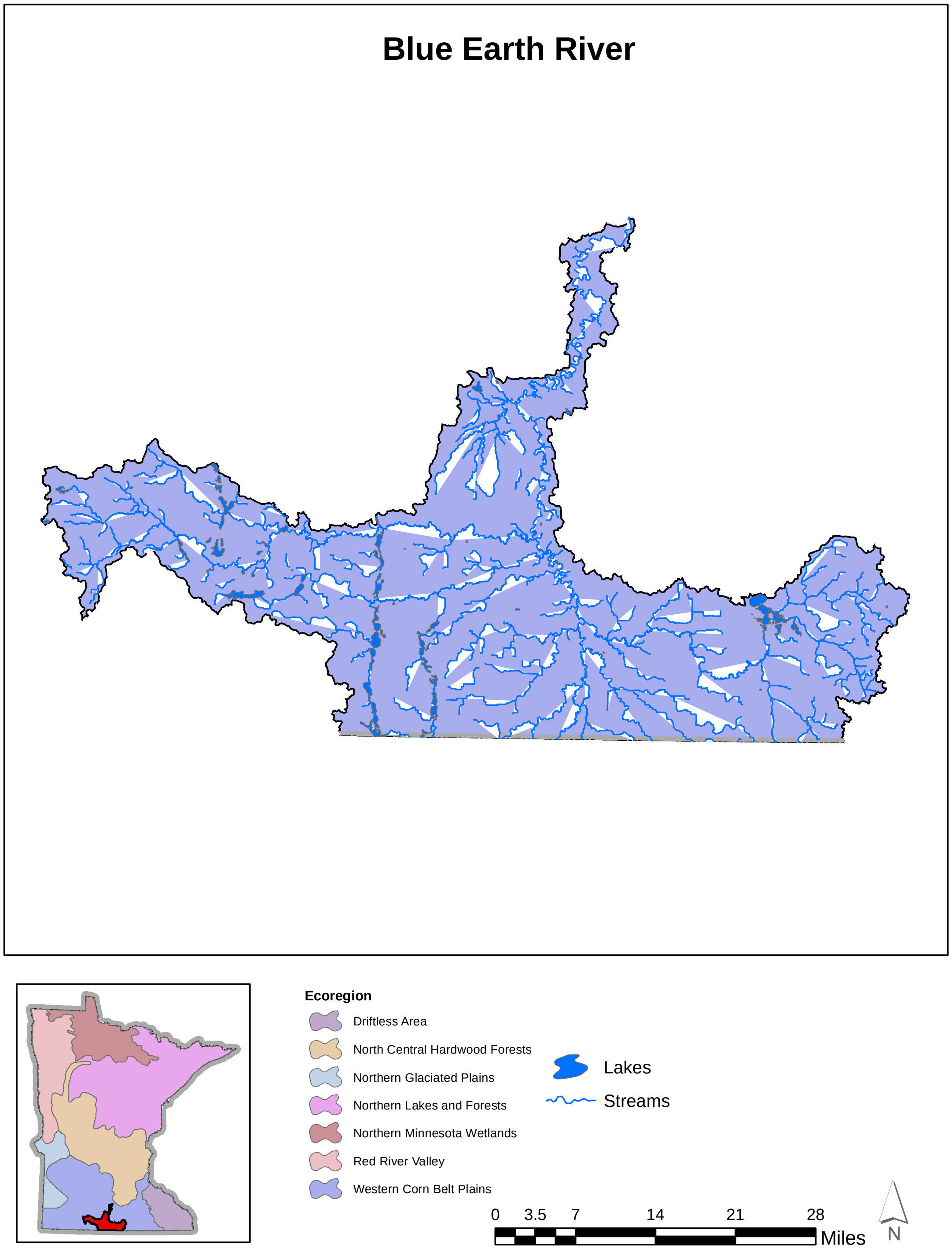
The last step in the assessment process is the Professional Judgment Group meeting. At this meeting, results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information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

Watershed overview

The Blue Earth River Watershed (HUC 07020009) covers an area of more than 1,500 square miles (1,001,805 acres) in south central Minnesota and north central Iowa. Before its confluence with the Minnesota River in the city of Mankato, the Blue Earth River receives the outlets of two other major watersheds, the Le Sueur River, and the Watonwan River, bringing the total drainage area of the Blue Earth Basin to over 3,500 square miles. This monitoring and assessment report will be restricted to the HUC 8 boundaries of the Blue Earth River within Minnesota; the Watonwan and Le Sueur River watersheds are detailed in separate reports.

Approximately 80% of the Blue Earth River Watershed lies within portions of Minnesota's Martin, Faribault, and Blue Earth counties, spanning an area from the town of Trimont in the western end of the watershed to the town of Alden in the east. Headwater portions of the West and Middle Branches of the Blue Earth River, and Coon Creek are in Iowa accounting for roughly 20% of the watershed. This watershed is divided into 15 subwatersheds (Figure 2). These subwatersheds are aggregations of individual 12 digit HUC drainages, containing anywhere from one to many 12 digit HUC units. For example, the Brush Creek and Cedar Creek subwatersheds consist of a single 12-digit HUC unit, while the South Creek and Center Creek subwatersheds consist of four. This watershed lies entirely within the Western Corn Belt Plains ecoregion (Figure 5).

Figure 5. The Blue Earth River Watershed within the Western Corn Belt Plains ecoregion of southern Minnesota.



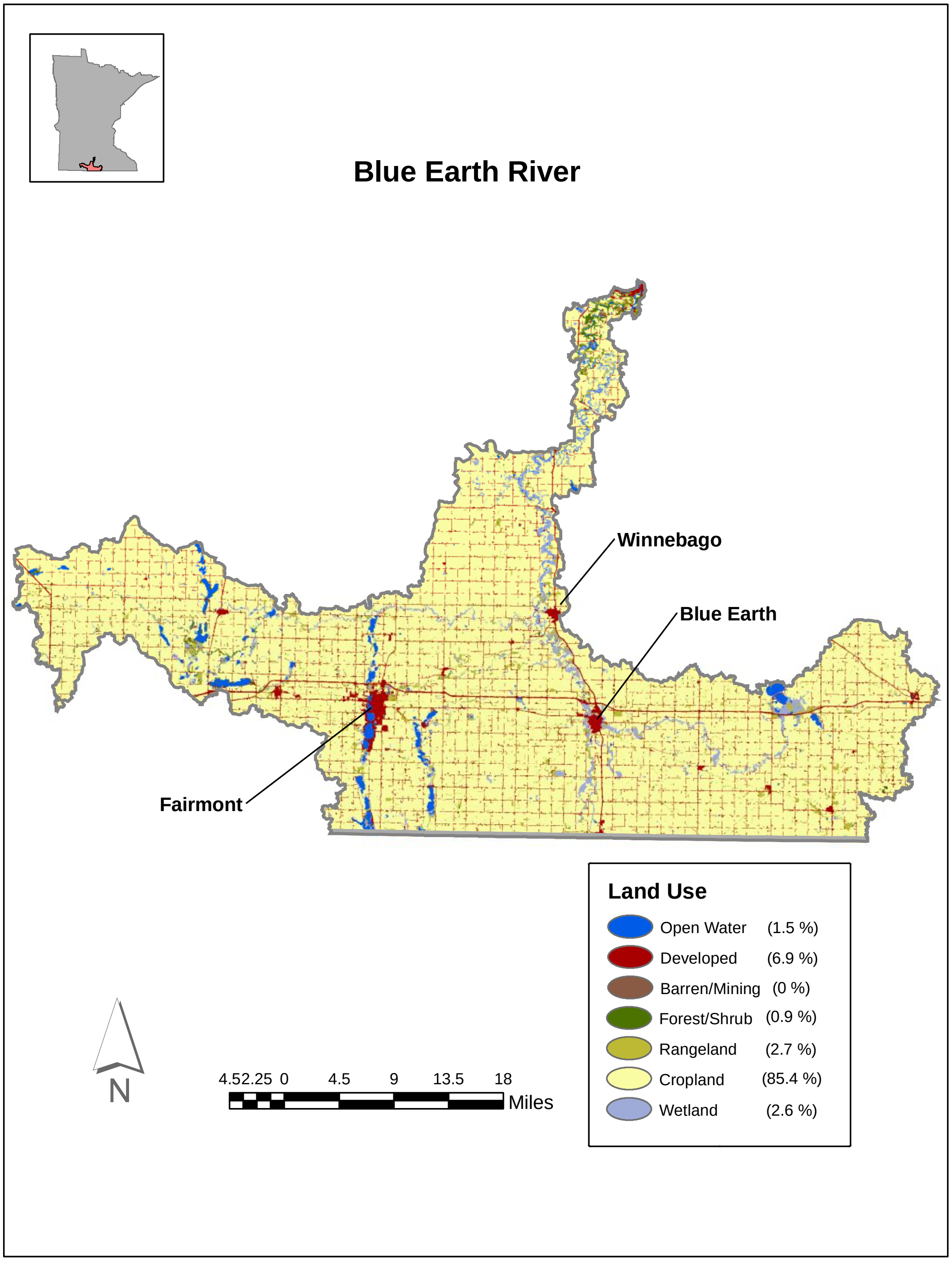
Land use summary

Lands within the Blue Earth River Watershed were opened to non-indigenous settlement in the mid-19th century. Over the following century and a half, the landscape underwent a near wholesale conversion from native tall grass prairie vegetation to agricultural uses. To increase arable land surface, wetlands and free-flowing streams were converted to networks of agricultural drainage ditches. Today, the landscape in this watershed is dominated by agriculture, with over 85% of the land coverage dedicated to row crop farming. Corn and soybeans account for nearly 92% of cropped lands (Figure 6).

Commercial/residential is the second most prevalent land use type at 7% of land use. The remaining land use types are split amongst, forest/shrub (< 1%), open water (<2%) and wetlands (<3%). Nearly all the land (98%) in the Blue Earth River Watershed is privately owned, and the region is predominantly rural. The most sizable towns in this watershed are Fairmont (10,666), Blue Earth (3,135), and Winnebago (1,351). The remaining towns and communities throughout the watershed have less than 1,000 inhabitants.

Soils within this watershed are predominantly loamy glacial till with scattered lacustrine areas. Most of the wet soils have been artificially drained. Prior to development and land use changes beginning in the 1850s, the native vegetation was predominantly tall grass prairie.

Figure 6. Land use in the Blue Earth River Watershed.



Surface water hydrology

The Middle and West Branches of the Blue Earth River flow 8 and 11 miles respectively from the Iowa border to their confluence just south of the city of Blue Earth. They are joined approximately 10 miles later by the East Branch Blue Earth River, which drains the majority of the eastern lobe of the watershed. From that confluence on the north side of the city of Blue Earth, the mainstem of the Blue Earth River flows in a general northerly direction. Along the 22 miles between the towns of Blue Earth and Winnebago, the Blue Earth River accumulates its principal tributaries that drain the western lobe of the watershed: South, Center, Elm, and Cedar creeks. Roughly 67 river miles north of Winnebago, the Blue Earth River meets its confluence with the Watonwan River, which is its own major watershed (HUC 07020010) and adds another 850 miles of drainage area. Four miles downstream of this confluence, the river is impounded by the Rapidan Dam. This impoundment creates a more than 6 mile long reservoir of 318 acres and contains an estimated 11 million cubic yards of accumulated sediment. Approximately 9 miles downstream of the dam, the Blue Earth River receives waters from another major watershed, the Le Sueur River (HUC 07020011), a basin of over 1,100 square miles. Approximately 3 miles downstream of this confluence, the Blue Earth River meets the Minnesota River in the city of Mankato.

Nearly 65% of stream reaches in this watershed have been channelized, rerouted, dredged or otherwise altered from their natural channel condition (Figure 7, Figure 8). Long reaches of unaltered, natural-channel stream are almost exclusively limited to higher order streams; nearly all of the low order streams and small tributaries in this watershed have been altered in some manner.

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

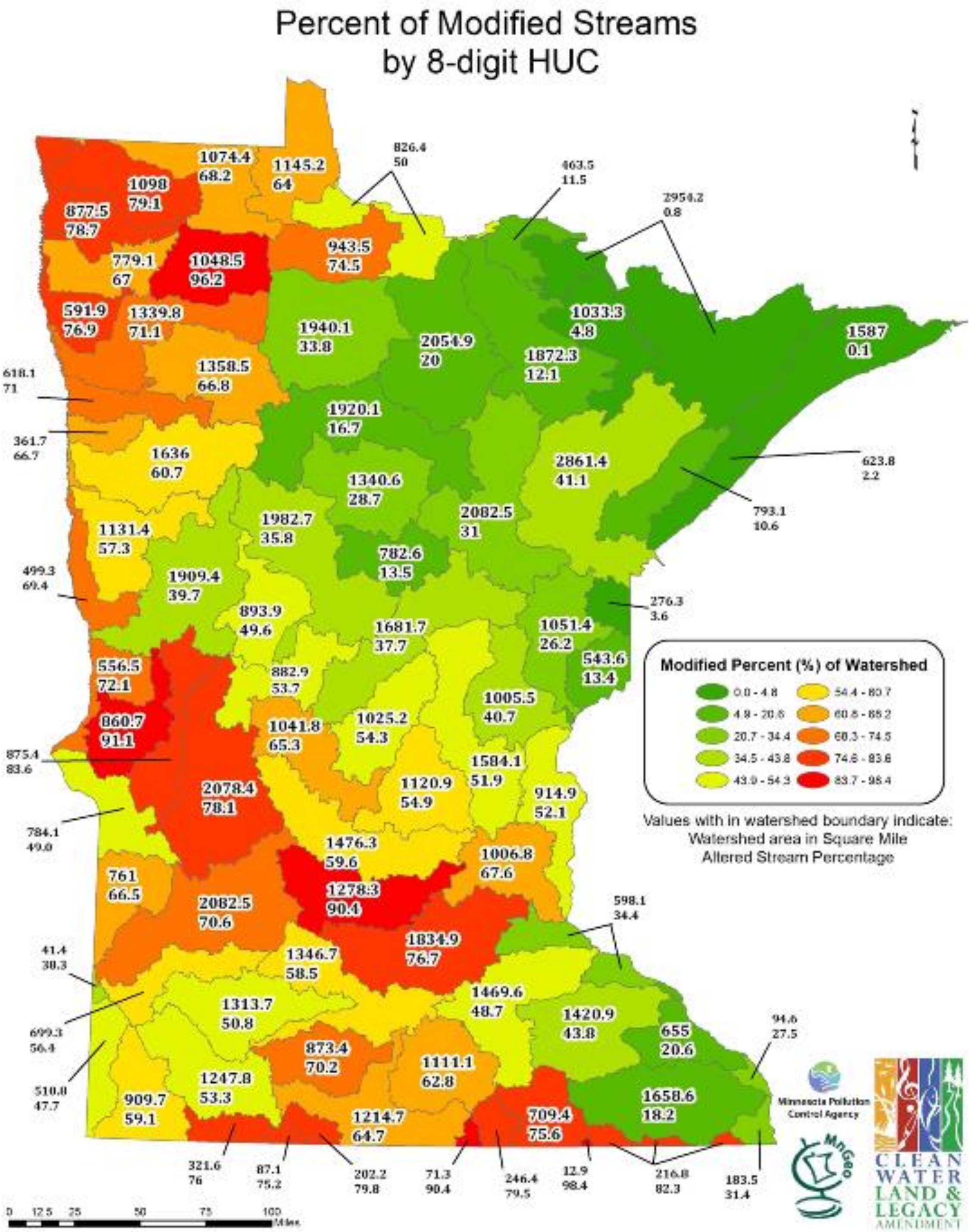
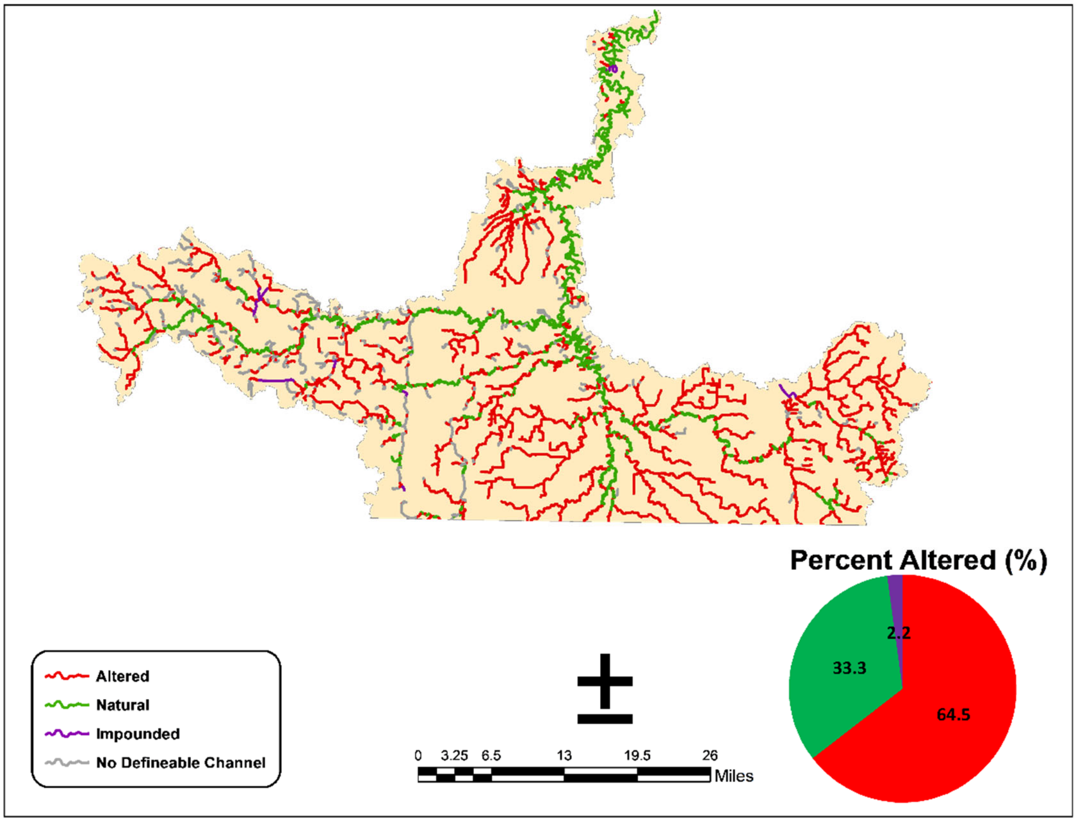


Figure 8. Comparison of natural to altered streams in the Blue Earth River Watershed (percentages derived from the State-wide Altered Water Course project).

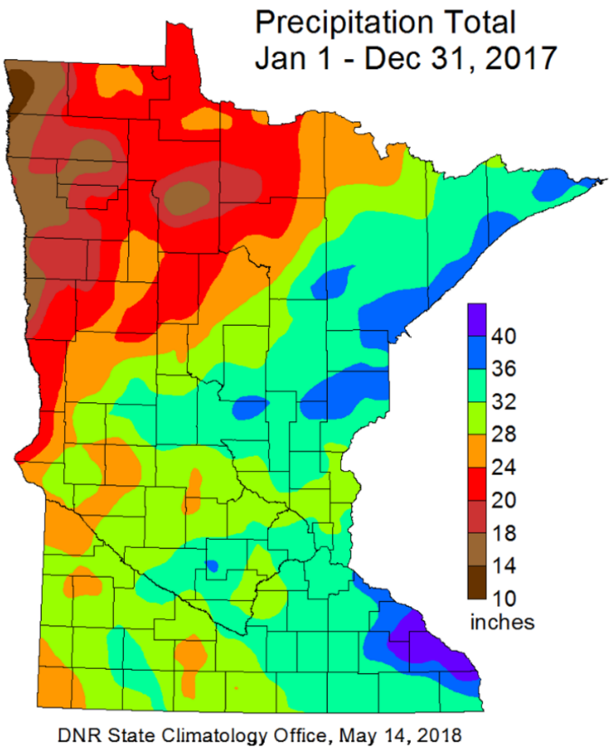


Climate and precipitation

The average annual temperature for the State of Minnesota is 41.6˚F. For the Blue Earth River Watershed, the annual average is 45.6 ˚F, the average summer (June-August) temperature is 70.3˚F and the average winter (December-February) temperature is 18.0˚F (DNR: Minnesota State Climatology Office, 2020).

Precipitation is an important source of water input to a watershed. Figure 9 displays two representations of precipitation for calendar year 2017. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the southeastern portion of the state. According to this figure, the Blue Earth River Watershed received 28.65 inches of precipitation in 2017. The display on the right shows the amount that precipitation levels departed from normal. The watershed experienced total precipitation about 4 inches below normal that year (Figure 10, Figure 11).

Figure 9. State-wide precipitation levels during the 2017 water year.



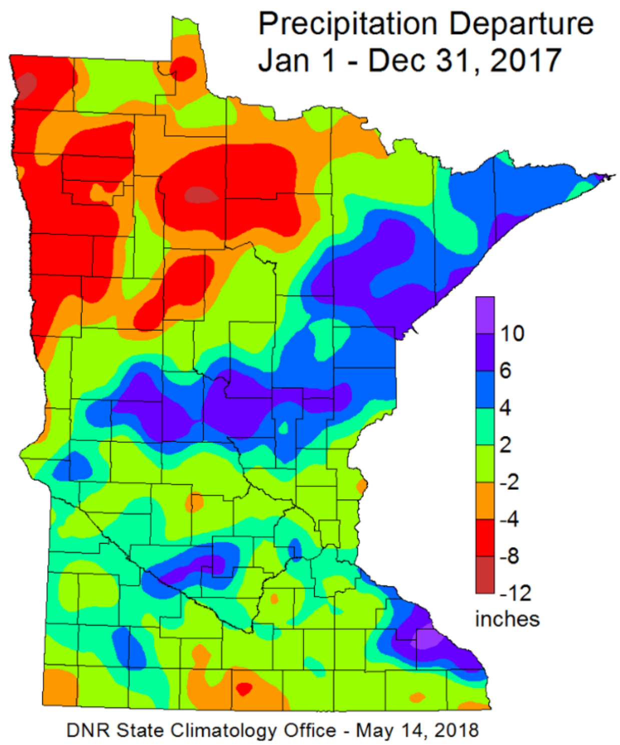


Figure 10. Precipitation trends in south central Minnesota (1997-2017) with 5-year running average.

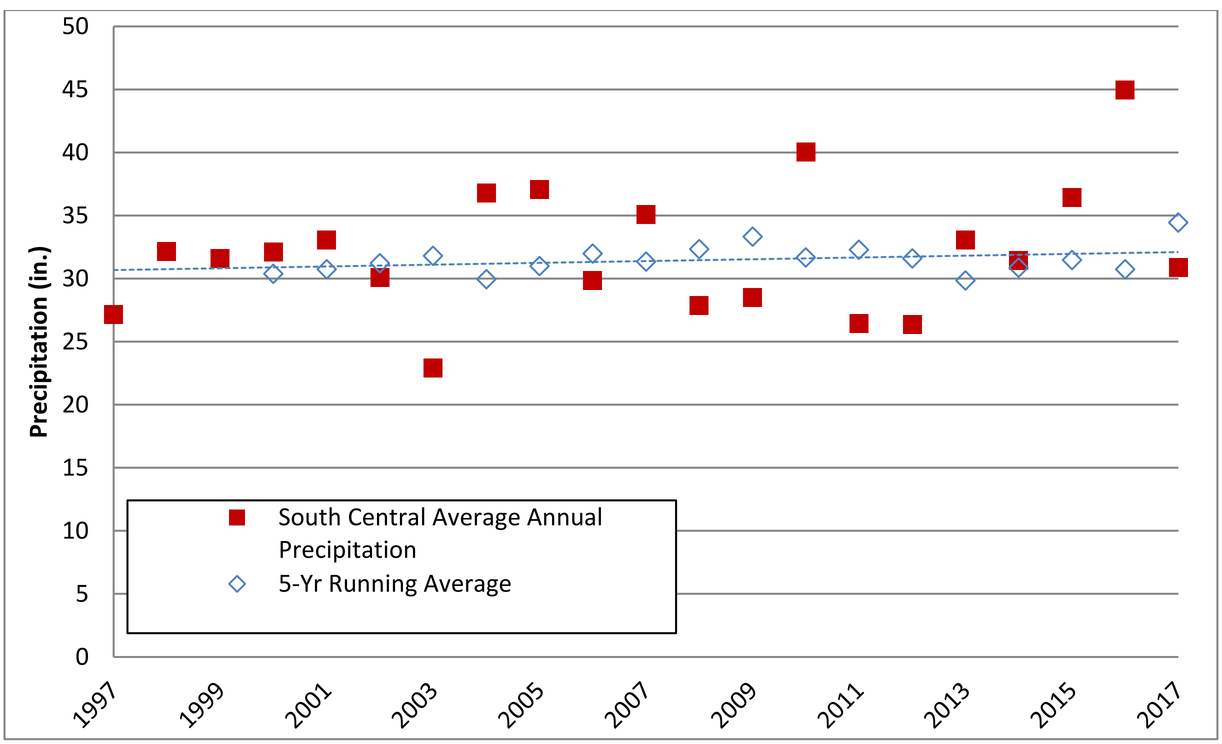
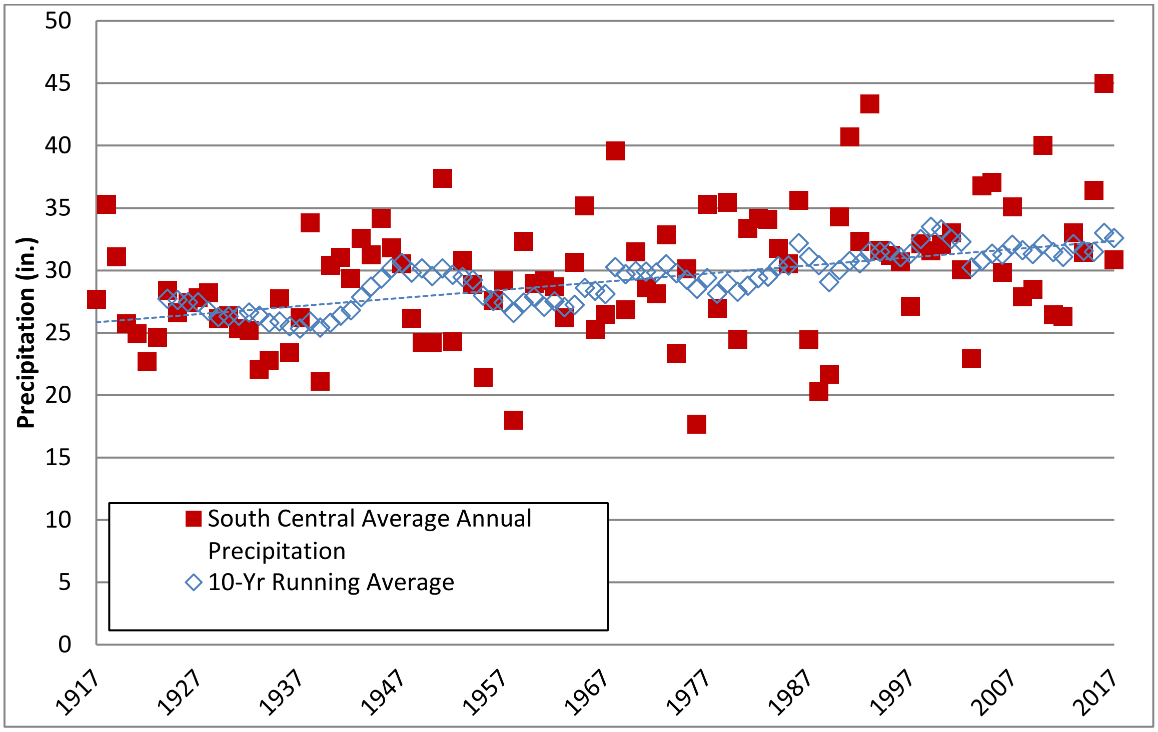


Figure 11. Precipitation trends in south central Minnesota (1917-2017) with 10-year running average (source: WRCC, 2020)



Hydrogeology

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

The Blue Earth River Watershed contains features of two of Minnesota's groundwater provinces: the South-Central and Western provinces. The South-Central province is characterized by clayey drift at the surface with sandy aquifers of limited extent over top of Paleozoic bedrock aquifers of sandstone, limestone and dolostone. The Western Province is characterized by clayey drift overlying Cretaceous and Precambrian bedrock. The drift and Cretaceous bedrock contain sand and sandstone aquifers of limited extent (DNR, 2017).

Groundwater potential recharge

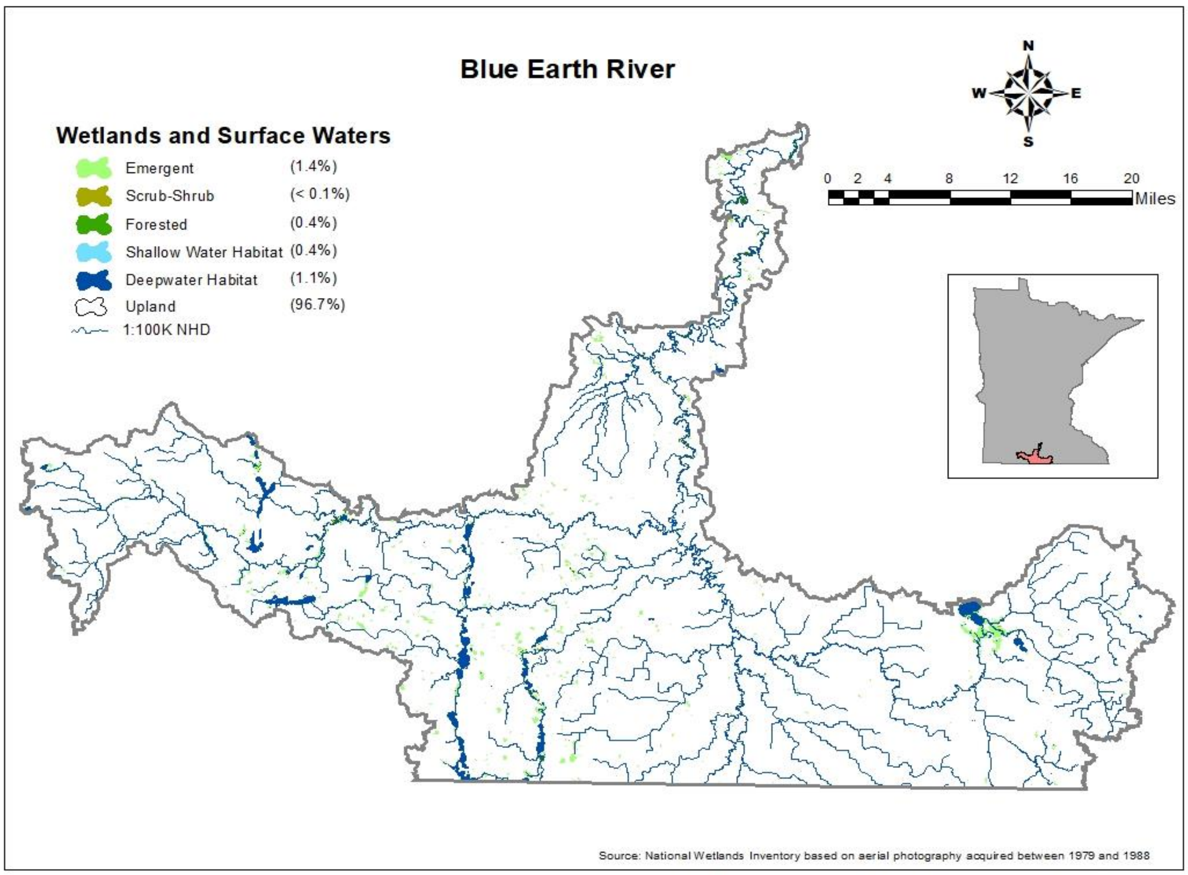
Groundwater recharge is one of the most important parameters in the calculation of water budgets, which are used in general hydrologic assessments, aquifer recharge studies, groundwater models, and water quality protection. Recharge is a highly variable parameter, both spatially and temporally, making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

Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock-surficial deposit interface. Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). For the Blue Earth River Watershed, the average annual potential recharge rate to surficial materials ranges from 2.1 to 9.7 inches per year, with a mean of 4.9 inches per year. The statewide average potential recharge is estimated to be 4 inches per year with 85%of all recharge ranging from 3 to 8 inches per year (USGS, 2015).

Wetlands

Wetlands are uncommon in the Blue Earth River Watershed. National Wetlands Inventory (NWI) data estimate 17,230 acres of wetlands—which covers approximately 3% of the watershed (Figure 12). This coverage rate is well below the statewide rate of 19% and less than the 6% rate for the broader Temperate Prairies ecoregion (Kloiber and Norris 2013, Bourdaghs et al. 2015). The most prevalent type in the watershed are emergent wetlands that are dominated by grasses, sedges, bulrushes, and/or cattails. Floodplain forest wetlands also occur along the Blue Earth River and its major tributaries.

Figure 12. Wetlands and surface water in the Blue Earth River Watershed. Watershed coverage by general wetland type is provided in the legend.



Prior to non-indigenous settlement, wetlands were much more prevalent throughout the watershed. As wetland soil features typically persist after artificial drainage, soil survey data can be used to estimate historical wetland extent. Mapped poorly and very poorly drained soil units (which would typically support wetlands in the absence of drainage) total 424,973 acres—or approximately 54% of the watershed. Comparing that total to the NWI estimate reveals that approximately 96% of the historical wetland extent has been lost in the Blue Earth River Watershed, with little variation in wetland loss rates between the 15 sub-watersheds (loss rates range from 91% - 99%).

A variety of glacial landforms are present in the watershed (MNGS 1997) that have broadly determined the historical and present day hydrogeomorphic (HGM) wetland types (Smith et al. 1995). The northern lobe of the watershed was once covered by glacial Lake Minnesota—leaving behind relatively flat lake modified till. Associated outwash swales (which have similar flat topography) extend up the valleys of the present day Blue Earth River and Elm Creek. This flat topography has limited capacity to naturally drain surface water—promoting large areas where soils are saturated at or near the surface in absence of artificial drainage. Mineral flat HGM type wetlands in the form of wet prairie plant communities were likely prevalent here prior to drainage and have been essentially eradicated due to agricultural development. The remainder of the watershed primarily consists of ground moraine landform that has gently rolling topography. Depressional HGM wetland complexes of wet prairie, wet meadow, marsh, and open water were once widespread in the topographic low areas. Only a relative few of these depressional wetlands remain (though they make up the largest portion of today's wetlands) in the watershed. The largest example is the Walnut Lake Wildlife Management Area west of Alden, Minnesota. The water storage that these depressional wetlands historically provided higher within the minor watersheds is now largely lost. Finally, riverine HGM wetlands are prevalent along the Blue Earth River and its major tributaries in the form of floodplain forest wetlands dominated by cottonwood and/or silver maple. Riverine wetlands are maintained by temporary/seasonal flooding from adjacent streams and typically provide only short-term water storage.

Watershed-wide data collection methodology

Lake water sampling

The MPCA sampled 11 lakes between 2017 and 2018 for the purpose of enhancing the dataset for lake assessment of aquatic recreation. Additionally, Martin SWCD sampled 7 lakes. There are currently six volunteers enrolled in the MPCA's CLMP that are conducting lake monitoring within the watershed. Sampling methods are similar among monitoring groups and are described in the document entitled "*MPCA Standard Operating Procedure for Lake Water Quality*" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake recreation use assessment requires eight observations/samples within a 10-year period (June to September) for phosphorus, chlorophyll-a and Secchi depth.

Stream water sampling

Nineteen water chemistry stations were sampled from May thru September in 2017, and again June thru August of 2018, to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12 HUC subwatershed that was >40 square miles in area (purple circles and green circles/triangles in (Figure 2). A SWAG was awarded to the Martin Soil and Water Conservation District to intensively collect water chemistry at these 19 outlet stations. (See Appendix 2.1 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study). In addition, there are currently 14 volunteers enrolled in the MPCA's CSMP that are conducting stream monitoring within the watershed.

Stream flow methodology

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

Lake biological sampling

A total of 12 lakes were monitored for fish community health in the Blue Earth River Watershed. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2019 assessment was collected in the last four years. Waterbody assessments to determine aquatic life use support were completed for nine WIDs.

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

Stream biological sampling

The biological monitoring component of the IWM in the Blue Earth River Watershed was completed during the summer of 2017. A total of 71 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, 12 existing biological monitoring stations within the watershed were revisited in 2017. These monitoring stations were initially established as part of a random Minnesota River Basin wide survey, or as parts of other monitoring projects in the region dating back as far as 1990. While only data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2019 assessment was collected in 2017. A total of 69 WIDs were sampled for biology in the Blue Earth River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 66 WIDs. Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

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

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Blue Earth River in 2017, by the MPCA biomonitoring staff. Samples had previously been collected by DNR fisheries staff ranging from 1975 to 2017. Seven lakes in the watershed have been tested for mercury and PCBs in fish: Fox (46-0109-00), Cedar (46-0121-00), Big Twin (46-0133-00), and Fish (46-0145-00).

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 (MDA) Laboratory performed all mercury and PCBs analyses of fish tissue.

Prior to 2006, mean mercury fish tissue concentrations were assessed for water quality impairment based on the Minnesota Department of Health's (MDH) 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 90th percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples are required per species to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters Inventory includes waterways that were assessed as impaired prior to 2006, as well as more recently.

Polychlorinated biphenyls 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 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. This implied that it was not necessary to continue widespread frequent monitoring of smaller river systems as is done with mercury. However, limited PCB monitoring was included in the watershed sampling design to ensure that this conclusion is still accurate. Impairment assessment for PCBs in fish tissue is based on the fish consumption advisories prepared by the MDH. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs, the MPCA considers the lake or river impaired. The threshold concentration for impairment is 0.22 mg/kg PCBs and more restrictive advice is recommended for consumption (one meal per month).

Pollutant load monitoring

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

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

More information can be found at the WPLMN website.

Groundwater monitoring

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

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 quantity

Monitoring wells from the DNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. Data from these wells and others are available at:
http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html

Groundwater/surface water withdrawals

The DNR 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 DNR yearly. Information on the program and the program database are found at:
http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Wetland monitoring

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

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

Individual aggregated 12-HUC subwatershed results

Aggregated 12-HUC subwatersheds

Assessment results for aquatic life and recreation use are presented for each aggregated HUC-12 subwatershed within the Blue Earth River Watershed. The primary objective is to portray all the full support and impairment listings within an aggregated 12-HUC subwatershed resulting from the complex and multi-step assessment and listing process. This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated HUC-12 subwatersheds contain the assessment results from the 2019 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2017 IWM effort, but also considers available data from the last 10 years.

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

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the aggregated HUC-12 subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2019 assessment process (2014 U.S. Environmental Protection Agency [EPA] reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessment process (see Figure 4). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), DO, TSS, chloride, pH, TP, chlorophyll-a, biochemical oxygen demand and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*E.coli)* data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A) or cool or warm water community (2B). Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated HUC-12 subwatershed as well as in the watershed-wide results and discussion section.

Lake assessments

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

West Branch Blue Earth River Aggregated 12-HUC   HUC 0702000902-01

The West Branch Blue Earth River drains an area of approximately 102 square miles along the Iowa/Minnesota border in Martin and Faribault counties; roughly half of this subwatershed lies in the state of Iowa. The two principal streams in this subwatershed, Judicial Ditch 7 and West Branch Blue Earth River, flow 13 and 11 miles respectively from the Iowa border to their confluence, approximately 5 miles south of Blue Earth. Judicial Ditch 7 is entirely channelized while the West Branch Blue Earth River has a natural channel for approximately 60% of its length. Land use in this subwatershed is more than 90% row crop agriculture.

Table 2. Aquatic life and recreation assessments on stream reaches: West Branch Blue Earth River Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	**Biological Station ID**	**Reach length (miles)**	**Use class***	**Aquatic life indicators:**									**Aquatic life**	**Aquatic rec. (Bacteria)**
				Fish IBI	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Eutrophication**		
07020009-611 **Judicial Ditch 7,** MN/IA border to W Br Blue Earth R	17MN344, 17MN372	13.02	2Bm, 3C	EXS	EXS	IF	IF	IF		IF	IF	--	IMP	
07020009-643 **Blue Earth River, West Branch,** MN/IA border to 15th St	17MN312	0.66	2Bm, 3C	EXS	MTS	IC	IF	MTS	MTS	MTS	MTS	--	IMP	IMP
07020009-644 **Blue Earth River, West Branch,** 15th St to Blue Earth R	10EM028, 90MN073	10.40	2Bg, 3C	EXS	MTS	IF	IF	IF		IF	IF	--	IMP	

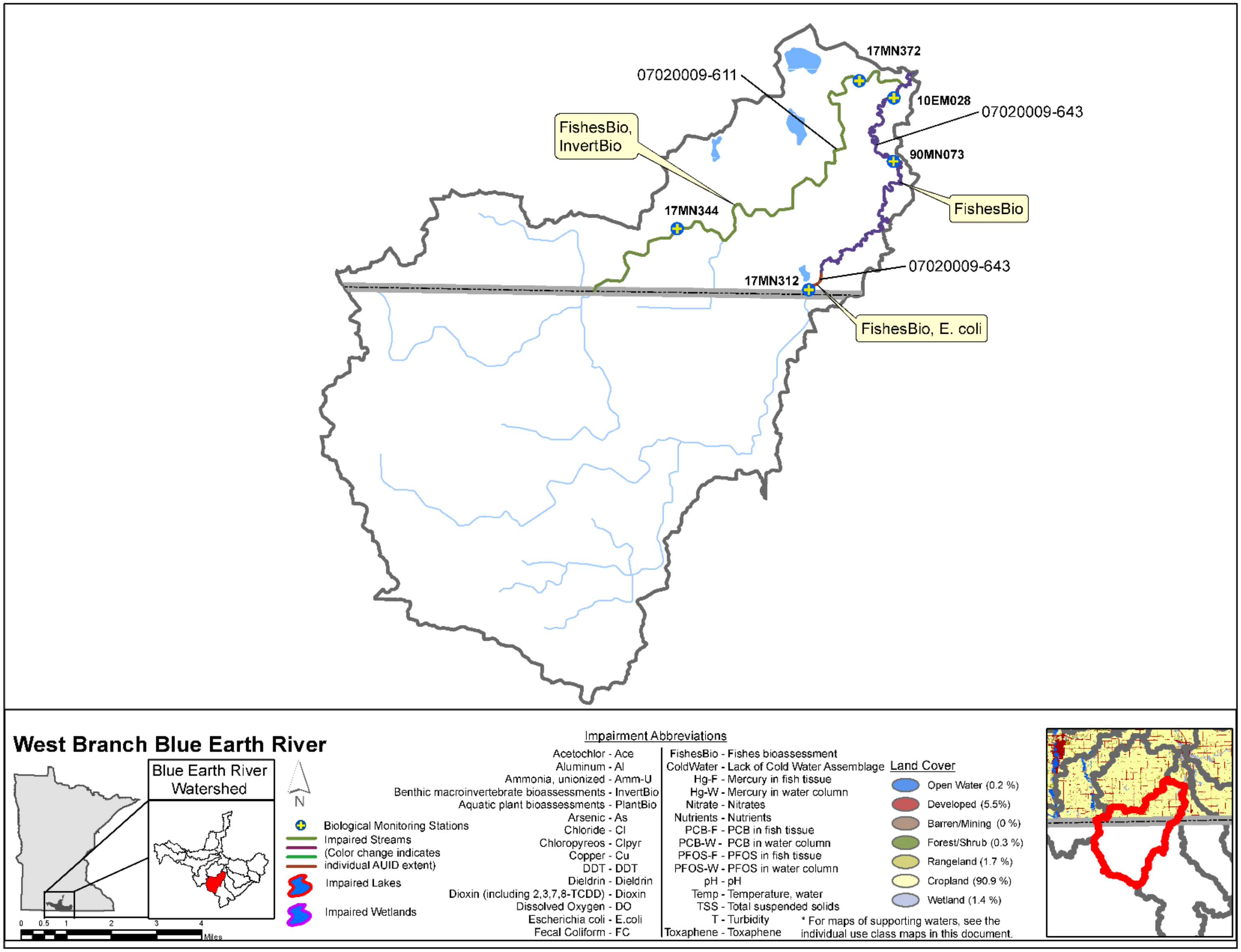
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **IC** = Inconclusive, **SUP** = Full Support (Meets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

Summary

Fish and macroinvertebrate communities were sampled at five biological stations on three reaches of stream in this subwatershed: Judicial Ditch 7, and two separate reaches of the West Branch Blue Earth River. Fish and macroinvertebrate communities monitored at two stations on Judicial Ditch 7 did not meet the modified use threshold and are impaired for aquatic life; fish communities at both stations were characterized by a dominance of species that are tolerant of human disturbance. Biological communities were monitored on two reaches of the West Branch Blue Earth River: an upstream, modified use (channelized) reach, and a downstream reach with a natural channel. Macroinvertebrate communities met aquatic life use standards on both of these reaches, while fish communities scored poorly and did not meet the standards. Habitat scores on these reaches were poor, particularly on the upstream reach, which was characterized by homogenous depth and a lack of habitat.

Available water quality data for the West Branch Blue Earth River (WID -643) include chloride, unionized ammonia, pH, and Secchi tube, which are all meeting water quality standards. Bacteria concentrations on this reach indicate poor water quality and resulted in a new listing for aquatic recreation on this reach. There were not sufficient chemistry data on the other reaches in this subwatershed to make an aquatic life use or aquatic recreation assessment.

Figure 13. Currently listed impaired waters by parameter and land use characteristics in the West Branch Blue Earth River Aggregated 12-HUC.



Middle Branch Blue Earth River Aggregated 12-HUC

HUC 0702000903-01

The Middle Branch Blue Earth River drains an area of approximately 110 square miles, more than two thirds of which are in Iowa. The stream enters Minnesota in southern Faribault County and flows about 9 miles to its confluence with the West Branch Blue Earth River, approximately 5 miles south of Blue Earth. The majority of channel along this reach is natural, with a few channelized segments. Land use in this subwatershed is more than 90% agricultural.

Table 3. Aquatic life and recreation assessments on stream reaches: Middle Branch Blue Earth River Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-551, **Unnamed Ditch,** Headwaters to Blue Earth R	17MN351	5.42	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-645, **Blue Earth River, Middle Branch,** MN/IA border to -94.104 43.514	17MN311	1.01	2Bm, 3C	MTS	MTS	IC	IF	MTS	MTS	MTS	MTS		--	SUP	IMP
07020009-646 **Blue Earth River, Middle Branch,** -94.104 43.514 to W Br Blue Earth R	17MN310	7.56	2Bg, 3C	EXS	MTS	IC	IF	MTS	MTS	MTS	MTS		--	IMP	IMP

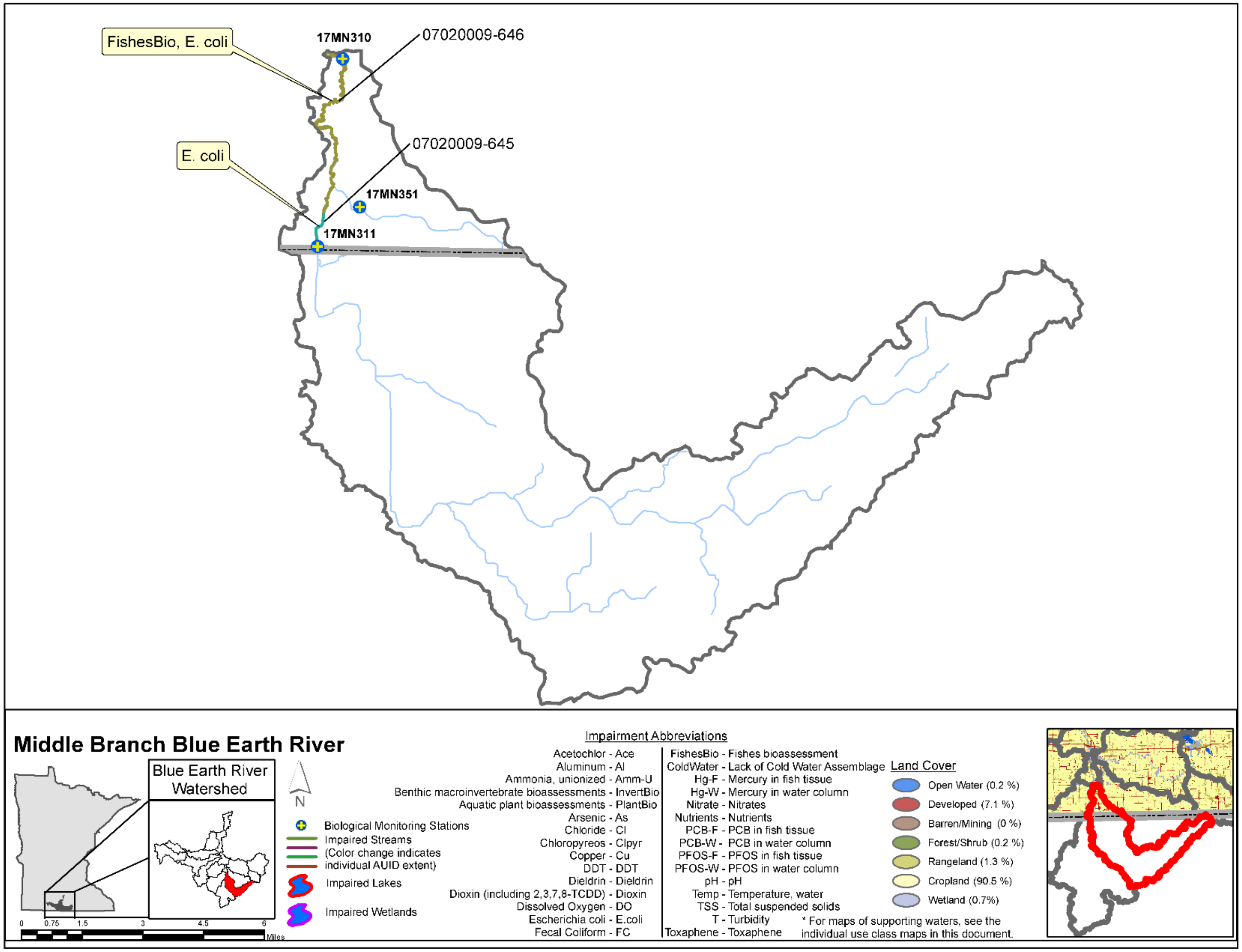
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired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

Summary

Fish and macroinvertebrate communities were sampled at three biological monitoring stations on three reaches of stream in this subwatershed: an unnamed ditch, and two separate reaches of the Middle Branch Blue Earth River (a modified use, upstream reach, and a general use downstream reach). Fish and macroinvertebrate community scores met aquatic life use thresholds on both modified use reaches. Fish communities at stations 17MN351 and 17MN311 had reasonable diversity for a channelized stream (10 and 16 species respectively) and exhibited balance among the taxa present. In contrast, the fish community on the downstream, general use reach was composed of more than 90% tolerant individuals and failed to meet the standard.

Aquatic life use water chemistry parameters chloride, unionized ammonia, pH, and Secchi tube are meeting water quality standards on both reaches of the Middle Branch Blue Earth River. Both reaches were also found to have high concentrations of bacteria, resulting in new aquatic recreation use impairments. There was not enough water chemistry data to make an assessment for the unnamed ditch.

Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Middle Branch Blue Earth River Aggregated 12-HUC.



Coon Creek Aggregated 12-HUC

HUC 0702000904-01

Coon Creek drains an area of approximately 100 square miles spanning the Iowa border in central Faribault County; roughly one third of this watershed lies within the state of Iowa. Three principal tributaries of Coon Creek (County Ditch (CD) 31 and two branches of Judicial Ditch 13) flow in a northwesterly direction from the headwaters in Iowa to their eventual confluence approximately 10 miles upstream of the confluence with the Blue Earth River just south of Blue Earth. With the exception of a few segments of the lower reaches of Coon Creek, nearly the entirety of this subwatershed is channelized. Land use in this subwatershed is more than 90% agricultural.

Table 4. Aquatic life and recreation assessments on stream reaches: Coon Creek Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-571 **Judicial Ditch 13 Branch A,** MN/IA border to JD 13	17MN356	8.05	2Bm, 3C	MTS	MTS	IF	IF	MTS		IF	IF		--	SUP	
07020009-612 **County Ditch 31,** MN/IA border to Coon Cr	17MN353	8.18	2Bm, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-647 **Coon Creek,** Headwaters to T101 R27W S4, north line	17MN355	9.23	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-648 **Coon Creek,** T102 R27W S33, south line to Blue	17MN313, 92MN074	6.41	2Bg, 3C	EXS	EXS	IF	IF	MTS	MTS	MTS	MTS		IF	IMP	IMP
07020009-665 **Judicial Ditch 13,** 20th St to 480th Ave	10EM156	2.50	2Bg, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	

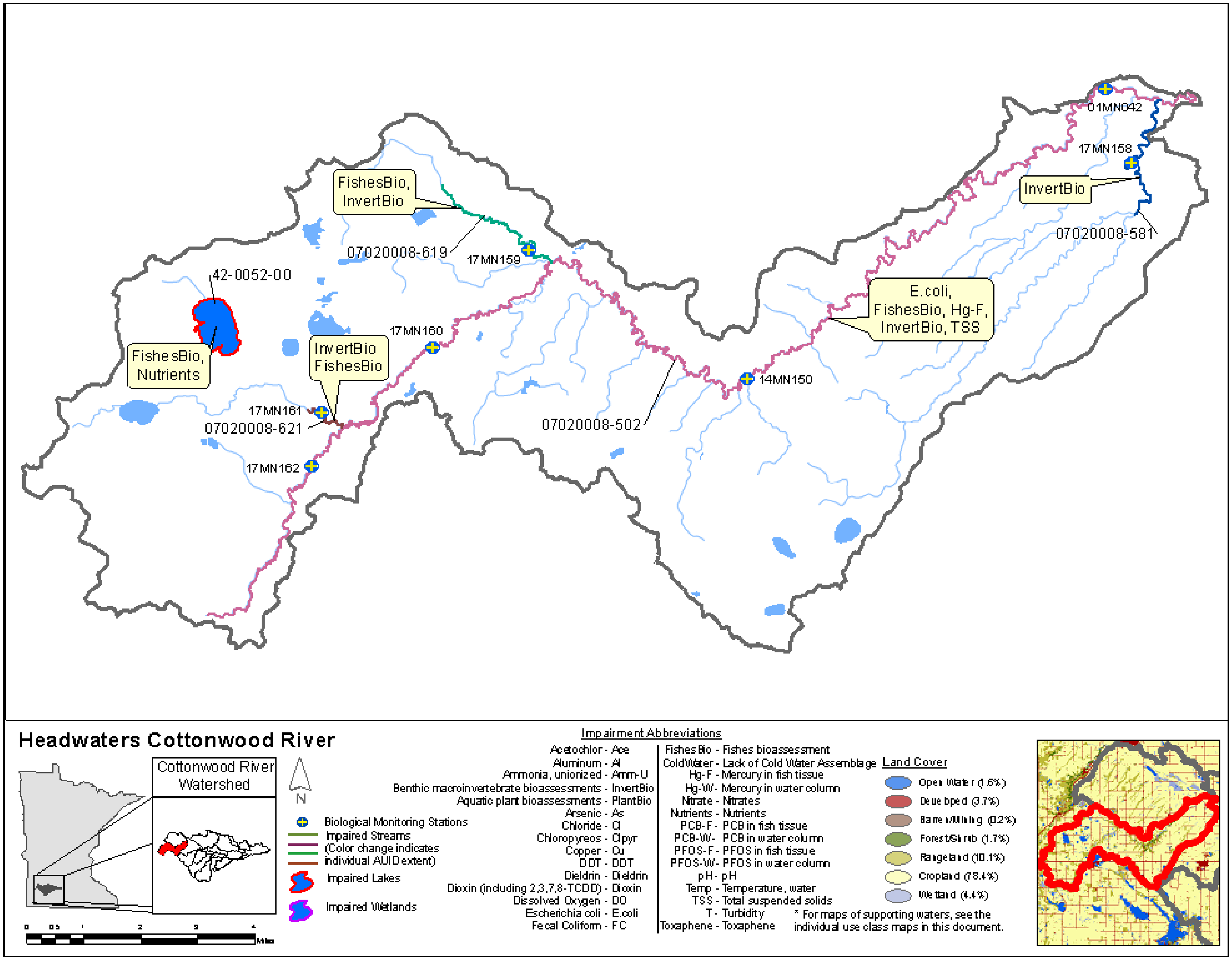
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: ☐ = existing impairment, listed prior to 2016 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water

Summary

Fish and macroinvertebrate communities were sampled at six biological monitoring stations on five reaches of stream in this subwatershed. Fish and invertebrate community scores both met their respective modified use standards on Judicial Ditch 13 Branch A, and the upstream reach of Coon Creek. However, in the downstream reach of Coon Creek both fish and macroinvertebrate communities failed to meet general use standards. In CD 31 both biological communities exhibited very poor IBI scores. The fish sample scores were indicative of major changes to community structure/ecosystem function, and the macroinvertebrate community consisted of an astonishingly low nine species. In Judicial Ditch 13, the fish community met the general use standard, while the macroinvertebrate community lacked species diversity and scored below the standard.

Judicial Ditch 13 Branch A was previously listed as impaired for turbidity in 2008. Secchi tube data was collected quite extensively over the 10-year assessment period, and appears to be meeting applicable water quality standards. After a closer review of the data used in listing this reach, it appears that the data from 2004-2005 are biased towards rain events. Consequently, MPCA is requesting that this reach no longer be listed as impaired for turbidity. The most downstream reach of Coon Creek (-648) had available data on chloride, unionized ammonia, pH, and Secchi tube, all of which meet their respective water quality standards for aquatic life use. This reach was also found to have high levels of bacteria and is considered impaired for aquatic recreation. The remaining reaches had insufficient water chemistry data to make an assessment on both aquatic life use and aquatic recreation use.

Figure 15. Currently listed impaired waters by parameter and land use characteristics in the Coon Creek Aggregated 12-HUC.



Lower East Branch Blue Earth River Aggregated 12-HUC   HUC 0702000905-01

The lower East Branch Blue Earth River drains an area of approximately 117 square miles in central Faribault County. The East Branch Blue Earth River enters this subwatershed about 3 miles north of Bricelyn and flows approximately 37 miles in a westerly direction to its confluence with the Blue Earth River in the City of Blue Earth. The mainstem of this river alternates between channelized and natural reaches throughout this subwatershed, while virtually all of the tributaries that flow into it have been channelized. Land use in this subwatershed is dominated by agriculture.

Table 5. Aquatic life and recreation assessments on stream reaches: Lower East Branch Blue Earth River Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-513 **County Ditch 44,** T101 R25W S16, east line to E Br Blue Earth R		7.46	LRVW							IF	IF		--		
07020009-553 **Blue Earth River, East Branch,** Brush Cr to Blue Earth R	15EM120, 17MN314, 17MN359, 17MN362	36.85	2Bg, 3C	EXS	MTS	IF	EXS	IC	MTS	MTS	MTS		IF	IMP	IMP
07020009-603 **County Ditch 25,** Headwaters to CD 5	17MN360	3.31	2Bm, 3C	EXS	EXS	IF	IF	IF		IF	IF		IF	IMP	
07020009-605 **County Ditch 5,** JD 6 to E Br Blue Earth R	17MN358	1.64	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-615 **County Ditch 14,** CD 14 to E Br Blue Earth R	17MN352	2.77	2Bm, 3C	MTS	MTS	IF	IF	IF		IF			--	SUP	

07020009-628 **County Ditch 26,** Headwaters to CSAH 13	17MN357	1.74	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	
0720009-669 **County Ditch 8,** Headwaters to -94.054 43.618	17MN354	7.34	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	

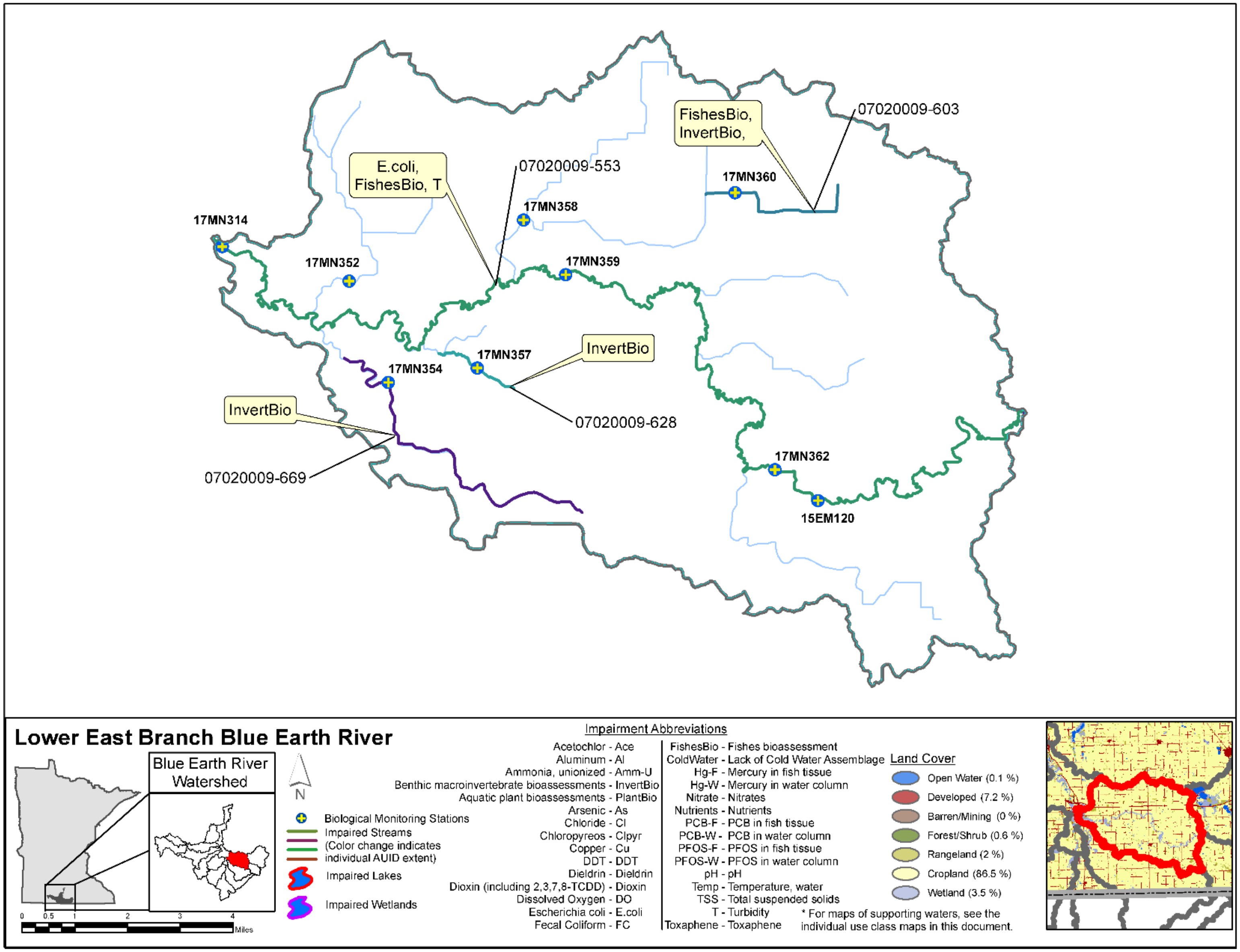
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support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

Summary

A robust biological dataset was collected to assess aquatic life use in the Lower East Branch Blue Earth River; fish and macroinvertebrate communities were sampled at nine stations on six separate reaches of stream. Biological communities sampled on CD 25 scored poorly and indicate that this reach is not meeting modified aquatic life use standards. The fish community lacked diversity and consisted of few individuals. Similarly, the macroinvertebrate community was composed almost entirely of species that are tolerant of poor water quality. Sampling crews noted poor habitat conditions, excessive filamentous algae growth, and choking macrophytes. This stream is likely being impacted by excessive nutrient input. Biological communities in CD 5 and 14 indicate that these streams are meeting modified use standards. In CD 8, the fish community was reasonably diverse (14 species) for a stream of this size and is meeting the modified use standard, whereas the macroinvertebrate community lacked diversity, was dominated by tolerant taxa and failed to meet the standard. Along the mainstem of the East Branch Blue Earth River that runs the length of this subwatershed, fish and macroinvertebrate communities were sampled at four stations across three years. This reach was determined to be impaired for aquatic life use based on fish data in 2004. Sampling during this assessment period indicate that fish communities are still not meeting the general use standard. Fish communities at these stations were suitably diverse for a stream of this size and character, however the high proportion of fish species that are highly tolerant to poor water quality indicate community imbalance and a high level of disturbance in the watershed. Though macroinvertebrate communities scored at or below the threshold at two stations, overall across the three years of sampling it appears that this reach of stream is supporting general aquatic life use for macroinvertebrate communities.

The East Branch Blue Earth River was previously listed in 2008 for turbidity. Recent TSS data exceed water quality standards, while Secchi tube is inconclusive; as a result, this reach will continue to be listed as impaired for turbidity. Total phosphorus on this reach was elevated, while response variables chlorophyll-a and pH were meeting the standards. Chloride and unionized ammonia are meeting water quality standards. Additionally, the East Branch Blue Earth River was found to be impaired for aquatic recreation due to high levels of bacteria. All other stream reaches had insufficient water chemistry data to make an assessment on both aquatic life use and aquatic recreation use.

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Lower East Branch Blue Earth River Aggregated 12-HUC.



Brush Creek Aggregated 12-HUC

HUC 0702000905-02

Brush Creek drains an area of approximately 47 miles in the southeast corner of Faribault County. A small portion of the headwaters of this watershed lies in Iowa, from which tributary streams flow in a general northwesterly direction. The named portion of Brush Creek flows approximately 13 miles until its confluence with the East Branch Blue Earth River 3 miles north of Bricelyn. With the exception of a few miles of stream sections, the entirety of this subwatershed has been channelized. Land use in this subwatershed is dominated by row crop agriculture.

Table 6. Aquatic life and recreation assessments on stream reaches: Brush Creek Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name,*** ***Reach Description***	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-624 **Unnamed Creek,** MN/IA border to Brush Cr	17MN363	4.63	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF			SUP	
07020009-654 **Brush Creek,** Headwaters to Unnamed Cr	17MN374	8.85	2Bg, 3C	MTS	MTS	IF	IF	IF		IF	IF			IMP	
07020009-655 **Brush Creek,** Unnamed Cr to E Br Blue Earth R	17MN300	4.50	2Bm, 3C	MTS	MTS	IC	IF	MTS	MTS	MTS	MTS		IF	SUP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards), **IC** = Inconclusive
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

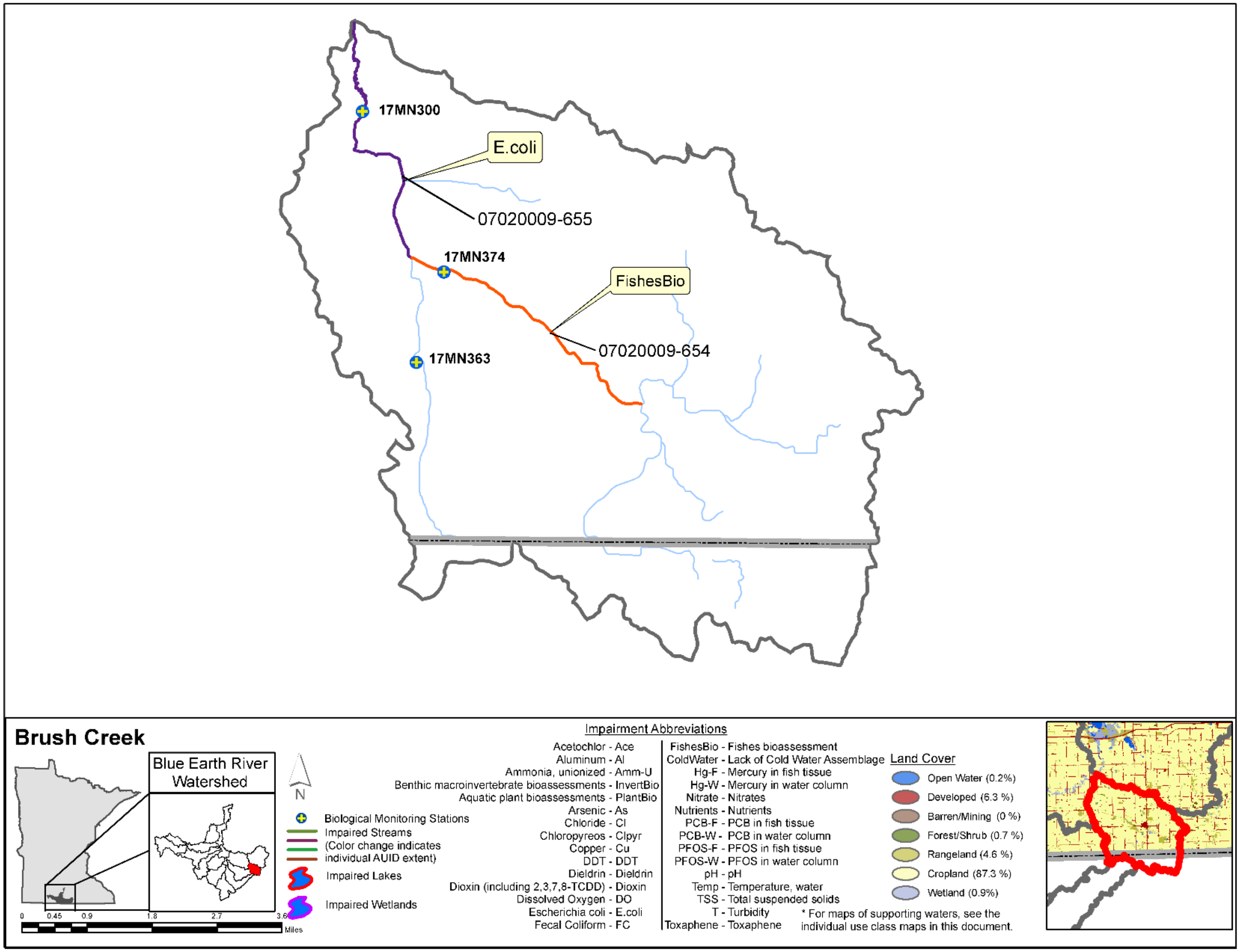
Summary

Fish and macroinvertebrate communities were sampled at three biological monitoring stations on three separate reaches of stream including an unnamed, channelized tributary to Brush Creek, and two separate reaches of Brush Creek: a general use segment (upstream), and a modified use segment (downstream). Biological communities met the modified use standard on the unnamed tributary to Brush Creek. Both monitored communities met modified aquatic life use goals on the downstream reach, if only barely. On the upstream, general use portion of Brush Creek macroinvertebrate communities were sampled at two different stations in 2001 and 2017. Both samples met the standard and suggest that macroinvertebrate communities are stable in that system.

The upstream reach of Brush Creek was listed as impaired for fish in 2004. A repeat sample in 2007 at the same station, also scored well below the general use threshold. Fishes were sampled at a new biological monitoring station (17MN374) in 2017 and the community scored well above the general use standard and suggest that this portion of Brush Creek may be supporting aquatic life use for fish. Habitat scores were slightly better at the new station and the fish community likely benefits from a small rock dam just upstream of the new site that appears to add some flow variability and habitat diversity at this location. However, as the existing impairment is based on samples from a different station, it is not possible to de-list this reach without a passing sample from the original station that triggered the listing. It is recommended that additional data be collected at the original station to pursue a removal from the impaired waters list.

The most downstream portion of Brush Creek had data available on aquatic life parameters such as unionized ammonia, chloride, pH and Secchi tube, all of which were meeting their respective water quality standard. Dissolved oxygen (DO) data were also available and showed minor exceedances. However, more monitoring of pre-9 am dissolved oxygen is recommend to evaluate potential DO issues on this reach. This same portion of Brush Creek was also found to have high concentrations of bacteria and is now considered impaired for aquatic recreation. The remaining stream segments did not have enough water chemistry data available to make an assessment of aquatic life or aquatic recreation.

Figure 17. Currently listed impaired waters by parameter and land use characteristics in the Brush Creek Aggregated 12-HUC.



Upper East Branch Blue Earth River Aggregated 12-HUC HUC 0702000905-03

The Upper East Brach Blue Earth River occupies an area of approximately 130 square miles spanning the border between Faribault and Freeborn counties. It is the eastern-most portion of the Blue Earth Watershed and is bordered by the Winnebago and Le Sueur Watersheds. The East Branch Blue Earth River flows from its headwaters in western Freeborn County in a general westerly direction. With the exception of a few short reaches of the East Branch Blue Earth River, the entirety of this watershed is channelized. Land use in this watershed is dominated by row crop agriculture.

Table 7. Aquatic life and recreation assessments on stream reaches: Upper East Branch Blue Earth River Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name, Reach description***	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-556 **Foster Creek** T103 R24W S35, east line to T102 R24W S6, west line	17MN367, 92MN076	6.71	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-557 **Foster Creek** T102 R23W S4, south line to Unnamed ditch		2.91	2Bg, 3C							IF	IF		--		
07020009-569 **Foster Creek** Unnamed ditch to T103 R24W S36, west line		3.18	2Bg, 3C							IF	IF		--		
07020009-599 **Unnamed Ditch** Unnamed Cr to E Br Blue Earth R	10EM119	4.61	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-621 **Unnamed Creek** Headwaters to Foster Cr	17MN366	7.46	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	

07020009-622 **Thisius Branch** CD 1 to Foster Cr	17MN365	1.94	2Bm, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-623 **Judicial Ditch 14** Unnamed Cr to Foster Cr	17MN368	1.07	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	
7020009-649 **Blue Earth River, East Branch,** Headwaters to -93.663 43.624		6.65	2Bg, 3C										--	IMP	
07020009-650 **Blue Earth River, East Branch,** -93.663 43.624 to -93.73 43.654	17MN364, 17MN373	4.49	2Bm, 3C	MTS	MTS	IF	IF	IC		IF	IF		--	SUP	
07020009-651 **Blue Earth River, East Branch,** -93.73 43.624 to T102 R24W S14, south line		8.47	2Bg, 3C										--	IMP	
07020009-652 **Blue Earth River, East Branch,** Unnamed Ditch to Brush Cr	17MN301	1.97	2Bm, 3C	MTS	EXS	EXS	IF	MTS	MTS	MTS	MTS		IF	IMP	IMP
07020009-653 **Blue Earth River, East Branch,** Unnamed Ditch to Brush Cr		1.35	2Bg, 3C										--	IMP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 8. Lake assessments: Upper East Branch Blue Earth River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation Use
							Fish IBI	Chloride	Pesticides ***	Total Phosphorus	Chlorophyll-a	Secchi		
Rice	22-0007-00	257	10	Shallow Water	WCBP	--	--	MTS	--	EXS	EXS	IC	IF	NS
South Walnut	22-0022-00	340	2	Shallow Water	WCBP	--	--	MTS	--	IF	IF	IF	IF	IF
Walnut	22-0023-00	683	2	Shallow Water	WCBP	--	--	MTS	--	IF	IF	IF	IF	IF

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

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

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

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

Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

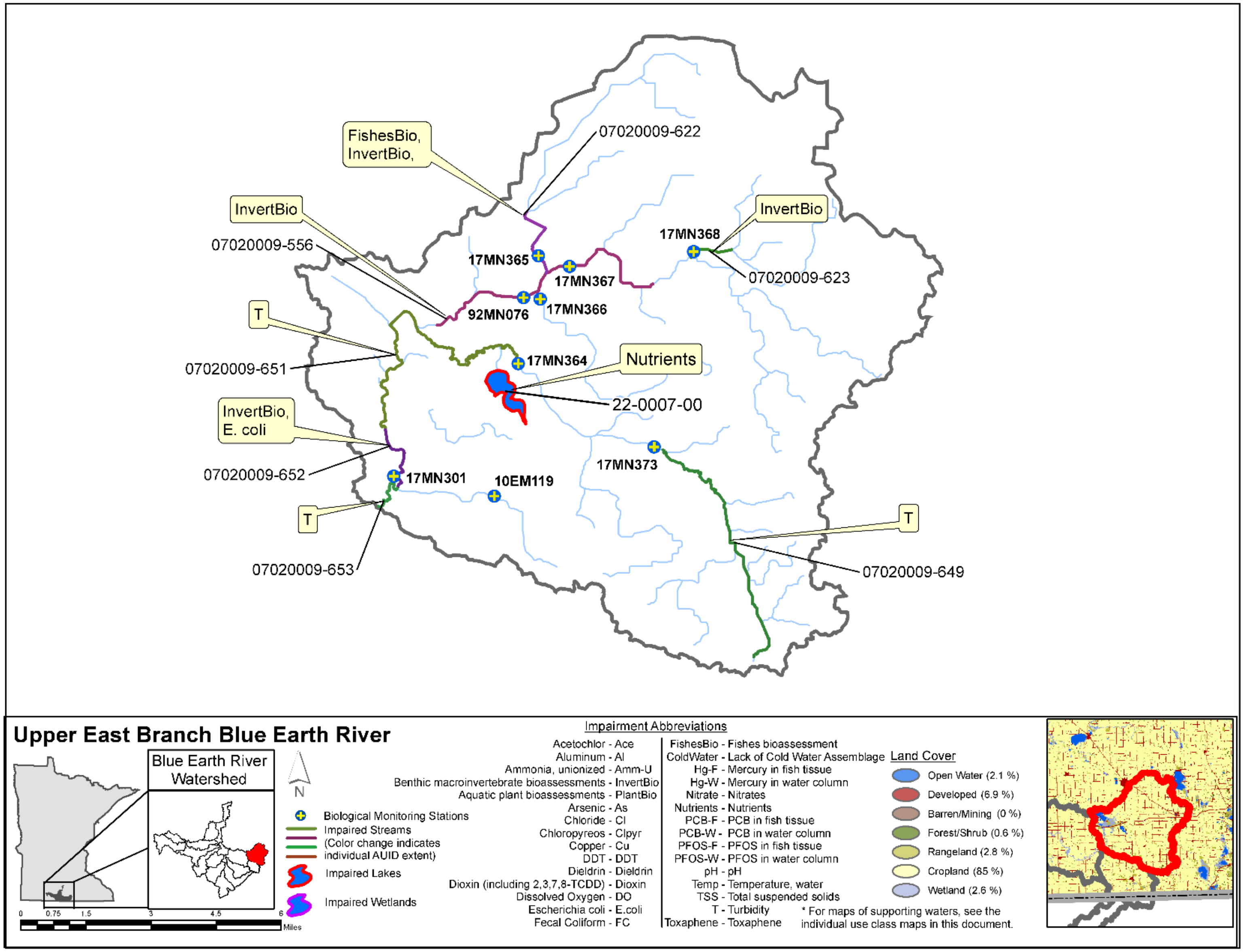
Summary

A large dataset was collected to assess aquatic life use in the Upper East Branch Blue Earth River Watershed. Fish and macroinvertebrate populations were sampled at nine biological monitoring stations on seven reaches of stream. Biological communities indicate support of modified aquatic life use on an unnamed tributary to Foster Creek, and an unnamed tributary to the East Branch Blue Earth River. On Foster Creek, fish communities at two stations indicate support of modified use despite barely meeting the standard; the species diversity was good for a channelized stream of this size and some sensitive taxa were present in low numbers. Macroinvertebrate communities were indicative of major changes to community composition and ecosystem function and are not supporting modified use. Fish and macroinvertebrate communities were indicative of non-support on Thisius Branch; the fish community was dominated by the tolerant generalist fathead minnow, and the invertebrate community scored poorly and did not meet the standard. Though a fairly simple fish community was sampled in two visits to a station on Judicial Ditch 14, the community did not exhibit imbalance and scores met the modified use threshold. In contrast, the macroinvertebrate community at this station lacked diversity, was dominated by highly tolerant taxa and scored very poorly. A similar pattern was observed at the biological station on the East Branch Blue Earth River at the outlet of this subwatershed: the fish community met the standard, while the reach was utterly devoid of macroinvertebrate habitat and is not supporting aquatic life use for that community.

Stream reach 07020009-554 of the East Branch Blue Earth River was listed as impaired for turbidity in 2008. This reach has now been retired and split into new “child” reaches. Its child reaches (-649, -650, -651, -652, and -653) will bear the existing turbidity impairment. Water quality indicators for a portion of the East Branch Blue Earth River (WID -652) were found to not support aquatic recreation based on high levels of bacteria in exceedance of the standard. Other water quality data on this reach met their respective standards.

Three lakes within the subwatershed were assessed for aquatic recreation. South Walnut and Walnut Lake lacked sufficient data to make a use support determination. Rice Lake was found to be impaired for aquatic recreation due to excess nutrients. Rice Lake has high concentrations of phosphorus, which in turn causes high chlorophyll-a concentrations and nuisance algal blooms. Additionally, its shallow depth allows mixing to occur throughout the water column during wind events. This mixing distributes nutrients throughout the water column and supports algal production. Rice, South Walnut, and Walnut Lakes also had chloride data, which were meeting water quality standards for aquatic life use. Additionally, data collected on plant floristic quality on South Walnut and Walnut Lakes indicate a poor plant community is present on these lakes.

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Upper East Branch Blue Earth River Aggregated 12-HUC.



South Creek Aggregated 12-HUC

HUC 0702000906-01

South Creek drains an area of roughly 112 square miles, predominantly in southeastern Martin County. A small portion of the headwaters lies in Iowa. A number of small channelized streams and ditches drain to a chain of lakes (East Chain, Sager, and Rose Lakes) from which South Creek emerges about 4 miles southeast of the city of Fairmont. From the outlet at Rose Lake, South Creek flows in a northeasterly direction for about 28 miles to its confluence with the Blue Earth River, approximately 4 miles south of Blue Earth. Some lengths of channel along this reach retain a natural, unaltered channel, but more than 70% of the subwatershed and nearly all of the lower order tributaries have been channelized. Land use in this subwatershed is more than 80% row crop agriculture.

Table 9. Aquatic life and recreation assessments on stream reaches: South Creek Aggregated 12-HUC.

WID ***Reach name***, *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:**											**Aquatic life**	**Aquatic rec. (Bacteria)**
				Fish IBI	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**			
07020009-610 **Judicial Ditch 98,** Headwaters to Sager Lk	17MN332	4.24	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--		IMP	
07020009-639 **South Creek,** -94.337 43.642 to -94.300 43.661	15EM040, 17MN338	3.77	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--		IMP	
07020009-640 **South Creek,** -94.300 43.661 to Blue Earth R	17MN303	17.89	2Bg, 3C	MTS	MTS	IC	IF	MTS	MTS	MTS	MTS		-IF		SUP	IMP
07020009-660 **Judicial Ditch 38,** Headwaters to 245th Ave	17MN334	4.82	2Bm, 3C	EXS		IF	IF	IF		IF	IF		--		IMP	
07020009-663 **Unnamed Creek** T101 R30W S35, west line to MN/IA border	17MN333	0.20	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--		SUP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 10. Lake assessments: South Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
East Chain	46-0010-00	480	5	Shallow Water	WCBP	--	--	IF	--	EXS	EXS	EXS	IF	NS
South Silver	46-0020-00	248	22	Deep Water	WCBP	NT	EXS	IF	--	MTS	EXS	MTS	NS	IF
Iowa	46-0049-00	681	9	Shallow Water	WCBP	--	--	MTS	--	EXS	EXS	EXS	IF	NS

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

Summary

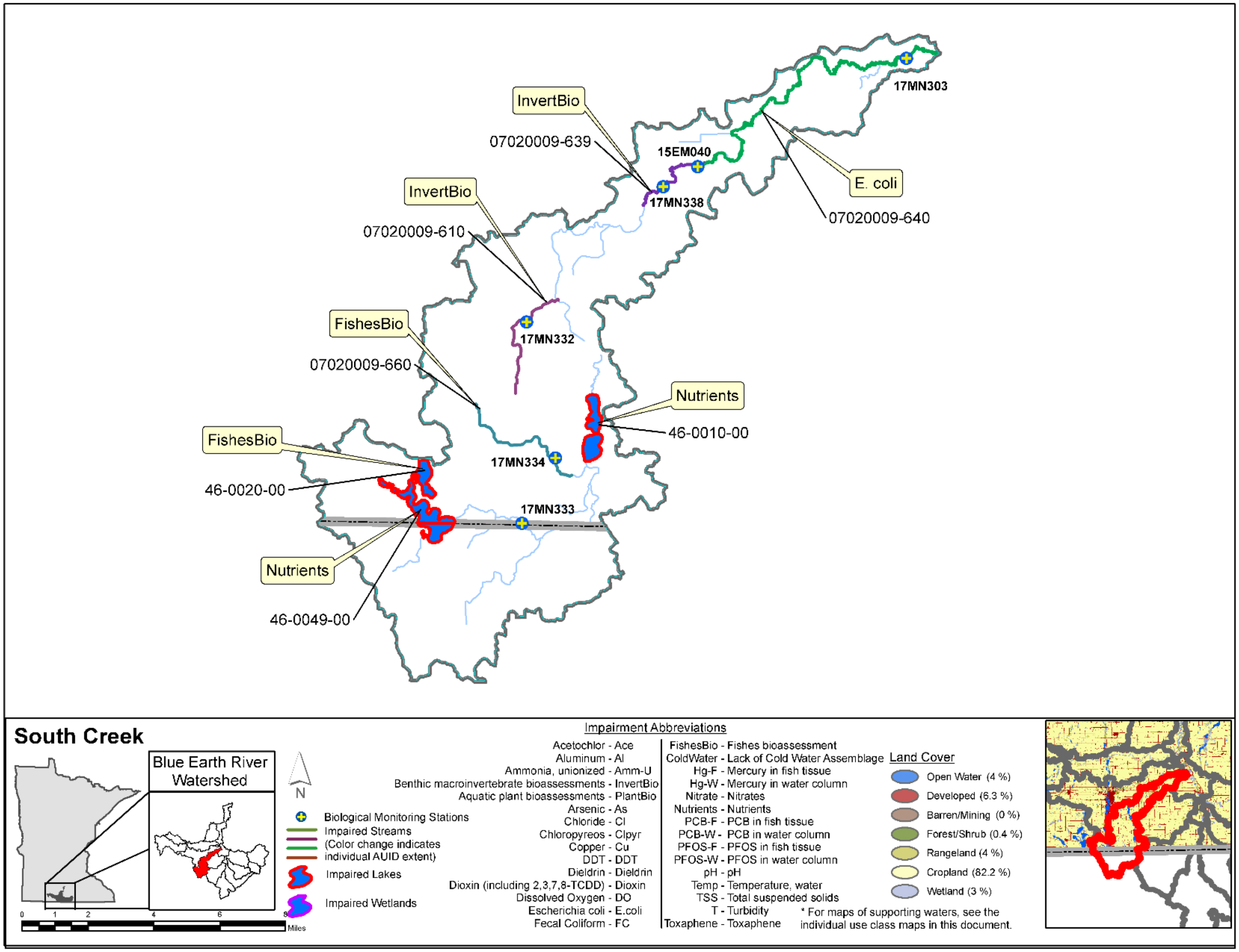
Biological communities were monitored at six stations on five reaches of stream in this subwatershed: three channelized tributaries to South Creek, and modified use (upstream) and general use (downstream) reaches of South Creek. Fish community scores indicate support of modified life use on Judicial Ditch 98, while the macroinvertebrate community was dominated by tolerant midge and snail species and did not meet the modified use standard. Dissolved oxygen readings and high levels of filamentous algae are indicative of eutrophication due to excess nutrients in this reach. Habitat scores were poor on Judicial Ditch 38, and the impaired fish community at this site reflected the deep silt and filamentous algae observed by the samplers.

Fish communities exhibited a presence of some sensitive taxa on the upstream reach of South Creek and IBI scores indicate support of modified use. The macroinvertebrate community on this reach was indicative of major disturbance in the watershed and is not supporting modified use for macroinvertebrate life. The downstream reach of South Creek exhibits a natural channel and habitat scores were above average for the region. Consequently, both biological communities were diverse, some sensitive species were present in the samples, and IBI scores indicated support of general aquatic life use.

The most downstream reach of South Creek in this subwatershed was assessed for chloride, ammonia, pH and Secchi tube, all of which are meeting water quality standards. However, recent *E. coli* data collected in this assessment window indicate poor recreational water quality on this reach.

Three lakes were assessed for aquatic recreation use. East Chain and Iowa lakes were found to be impaired for aquatic recreation due to excess nutrients. South Silver was found to be inconclusive for aquatic recreation due to contradictions between the causative variable, phosphorus, and response variable, chlorophyll-a. Phosphorus meets water quality standards, while chlorophyll-a exceeds it. For this reason, South Silver is considered vulnerable to future aquatic recreation impairment and should be considered a priority for protection efforts. Additionally, the fish community was used to assess aquatic life on South Silver Lake. It was found to not support aquatic life based on IBI scores below the impairment threshold. The score was most negatively influenced by the low proportion of top carnivores, high proportion of tolerant species, and lack of intolerant species captured. Data collected on plant floristic quality indicate a poor plant community is present in the lake. Iowa Lake also had chloride data, which were meeting water quality standards for aquatic life use.

Figure 19. Currently listed impaired waters by parameter and land use characteristics in the South Creek Aggregated 12-HUC.



Center Creek Aggregated 12-HUC

HUC 0702000907-01

The Center Creek subwatershed drains an area of approximately 137 square miles in central Martin County. Lily Creek flows from Fox Lake on the west end of the subwatershed that abuts the Des Moines River drainage. From the outlet of Fox Lake, Lily Creek flows roughly 16 miles in an easterly direction to its confluence with Center Creek just outside of Fairmont. A network of small ditches flow from the area west of Fairmont to Dutch Creek, which flows roughly 5 miles east to its inlet to Hall Lake. Center Creek flows out of the chain of lakes south of and within the city of Fairmont (North Silver, Wilmert, Amber, Hall, Budd, Sisseton, and George Lakes). From the outlet of George Lake, Center Creek joins Lily Creek and flows east from Fairmont approximately 30 miles to its confluence with the Blue Earth River just south of the town of Blue Earth. Over 65% of stream reaches are channelized in this subwatershed. Land use is dominated by row crop agriculture.

Table 11. Aquatic life and recreation assessments on stream reaches: Center Creek Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name*****,** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-503 **Center Creek,** Lily Cr to Blue Earth R	17MN304, 17MN331, 92MN083, 92MN084	29.36	2Bg, 3C	EXS	EXS	IF	EXS	IC	MTS	MTS	EXS		IF	IMP	IMP
07020009-535 **Unnamed Creek,** Unnamed Lk (Mud Lk 46-0035-00) to Amber Lk		0.17	2Bg, 3C				NA						NA	NA	
07020009-632 **Lily Creek,** Headwaters (Fox Lk 46-0109-00) to N Bixby Rd		14.70	2Bg, 3C				IF	MTS					--	IMP	IMP
07020009-633 **Lily Creek,** N Bixby Rd to Center Cr	17MN329	1.53	2Bg, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	IMP

07020009-634 **Dutch Creek,** Headwaters to -94.507 43.626		1.90	2Bm, 3C										--	IMP	IMP
07020009-635 **Dutch Creek,** -94.507 43.626 to T102 R31W S24, north line		0.79	2Bg, 3C			IF	EXS	MTS		MTS	IF	EXS	IF	IMP	IMP
07020009-636 **Dutch Creek** T102 R31W S13, south line to T102 R31W, south line	17MN328	0.97	2Bm, 3C	EXS	MTS	IF	IF	IF		IF	IF		--	IMP	IMP
07020009-637 **Dutch Creek** T102 R30W S19, north line to Hall Lk		1.76	2Bg, 3C										--	IMP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 12. Lake assessments: Center Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic Recreation Indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Imogene	46-0012-00	188	6.5	Shallow Water	WCBP	--	IF	IF	--	IC	EXS	EXS	IF	IF
Willmert	46-0014-01	320	9	Shallow Water	WCBP	--	IF	MTS	--	IC	EXS	EXS	NA	IF
George	46-0024-00	85	12	Shallow Water	WCBP	NT	--	MTS	--	MTS	EXS	MTS	IF	IF
Sisseton	46-0025-00	139	18.5	Shallow Water	WCBP	--	EXS	MTS	--	MTS	EXS	MTS	NS	IF
Budd	46-0030-00	221	20.5	Shallow Water	WCBP	NT	EXS	MTS	??	MTS	EXS	MTS	NS	IF
Hall	46-0031-00	549	25	Shallow Water	WCBP	NT	EXS	MTS	--	MTS	EXS	MTS	NS	IF
Amber	46-0034-00	182	16.5	Shallow Water	WCBP	NT	EXS	MTS	--	IC	EXS	IC	NS	IF
Fox	46-0109-00	906	20	Shallow Water	WCBP	NT	EXS	MTS	--	EXS	EXS	MTS	NS	NS

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

Summary

Fish and macroinvertebrate communities were sampled at six monitoring stations on three reaches of stream in this subwatershed: Dutch Creek, Lily Creek, and four stations on Center Creek. On Dutch Creek, sampling crews noted severe erosion due to hydrologic alteration and bank trampling from open livestock access to the stream. Consequently, habitat and fish community scores were very poor and very few fish were present in the sample. The macroinvertebrate community did score well enough to meet the standard in this stream, likely due in part to riparian shade cover and the presence of some coarse substrates. Similarly on Lily Creek, samplers noted symptoms of hydrologic alterations in heavily eroded banks, an incised channel, and siltation over coarse substrates. The fish sample was indicative of major alteration to community structure, ecosystem function, and was dominated by highly tolerant species (green sunfish, fathead minnow, and orangespotted sunfish). Macroinvertebrate scores did not meet the general use standard on Lily Creek. Biological communities along Center Creek are poor and likely have been for some time. Both communities have shown low IBI scores in visits as far back as 2001 (prior to this assessment period). Of a total of 10 assessable fish and macroinvertebrate samples on this reach, none of them meet the general use standard. Communities are characterized by a lack of overall diversity for a stream of this size and character and populations are primarily composed of tolerant taxa.

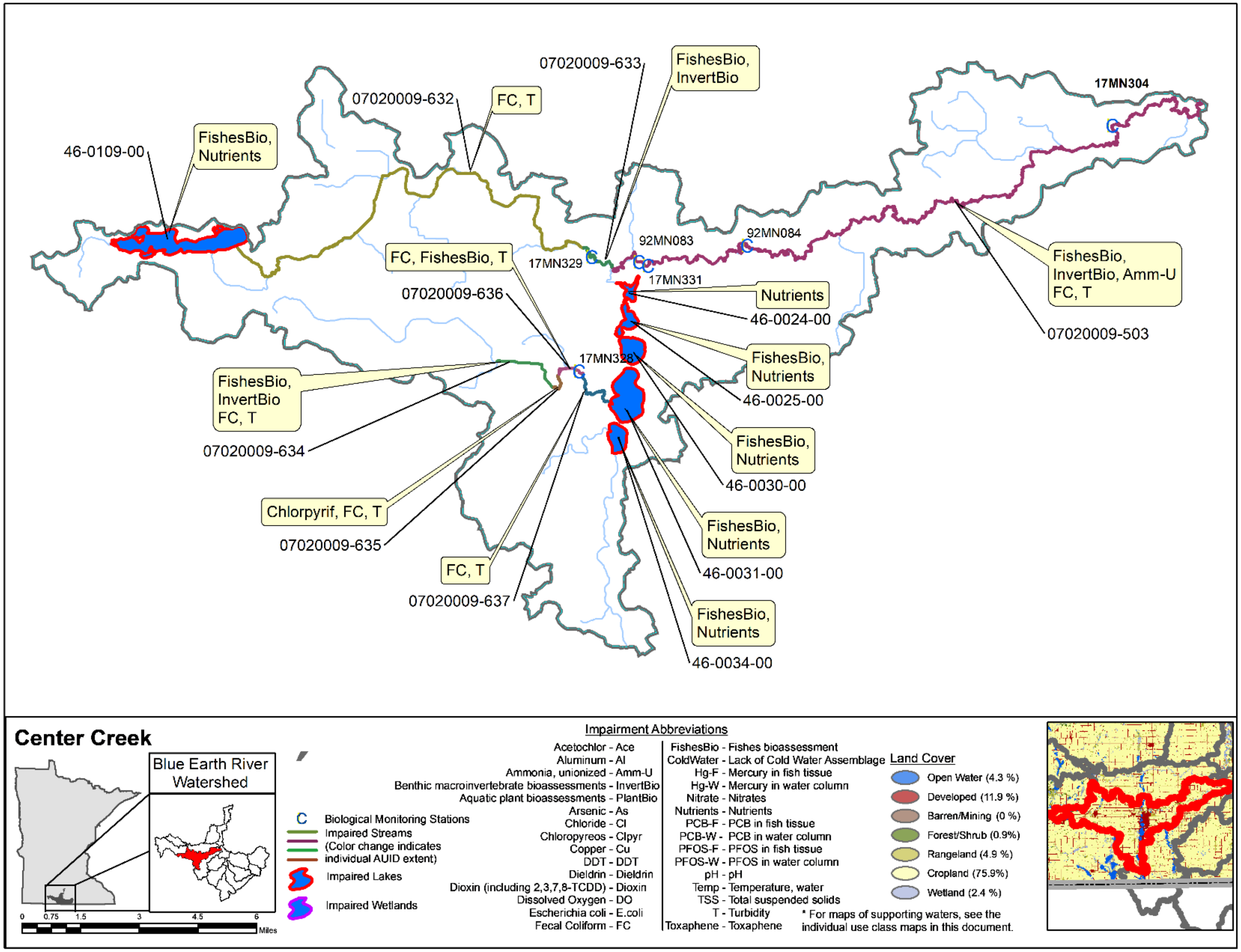
Stream reach 07020009-525 of Lily Creek was listed as impaired for turbidity in 2006. This reach has now been retired and split into two child WIDs. Its child reaches (-632 and -633) will be carrying forward this impairment. Reach 07020009-527 of Dutch creek was previously listed for turbidity and fecal coliform in 2006, and has been retired and split into four child WIDs. Its child reaches (-634, -635, -636, and -637) will be carrying forward both of these impairments.

Center Creek was previously listed as impaired for aquatic life use based on unionized ammonia data in 1996 and turbidity data in 2002. New data show two unionized ammonia exceedances, confirming that the impairment still exists. Total suspended solids data exceed standards, while surrogate Secchi tube data are inconclusive; the turbidity listing will remain as there is no evidence to support a delisting. A large TP dataset has a seasonal average that does not meet criteria. The chlorophyll-a and pH datasets were adequate and do not clearly show a response to the elevated TP concentrations. This reach was also previously listed as impaired for aquatic recreation use based on fecal coliform data in 1996. More recent *E. coli* data collected over the current assessment window indicate that poor recreational water quality persists.

Aquatic recreation was assessed on seven lakes. Fox Lake was previously listed for nutrients in 2010. Newer data show Fox Lake has excess nutrients, confirming that the impairment still exists. Phosphorus levels on Imogene and Willmert Lakes were hovering around the standard, while chlorophyll-a and Secchi measurements were exceeding water quality standards. The current data are inconclusive. Though data minimums were met for these two lakes, more robust datasets would be beneficial in determining each lake's aquatic recreation suitability. George, Sisseton, Budd, Hall, and Amber Lakes were all previously listed for nutrients in 2006. Recent data show that phosphorus levels are low and meeting water quality standards. However, the response variables are contradicting the low phosphorus levels; chlorophyll-a was still exceeding water quality standards, while water clarity measurements were either meeting standards or hovering at the standard. It appears these lakes are making an improvement, as phosphorus levels have decreased; however, these lakes will remain listed as impaired until there is more conclusive data to assess. Any efforts in place on these five lakes should remain in order to improve water quality and potentially remove them from the impaired waters list.

Six lakes were assessed for aquatic life using the fish community: Imogene, Sisseton, Budd, Hall, Amber, and Fox Lakes. Imogene Lake had a low fish IBI (FIBI) score, however due to the unknown effects of a winterkill event during the winter of 2013-2014, Imogene is being listed as insufficient information to assess for aquatic life use. Lakes Sisseton, Budd, Hall, Amber, and Fox were all found to not support aquatic life based on FIBI scores below the impairment threshold. These lakes' FIBI scores, except Sisseton, were negatively influenced by the high proportion of tolerant species captured and a lack of diversity of vegetative dwelling species. Sisseton's score was most negatively influenced by a low proportion of top carnivores and lack of vegetative-dwelling individuals captured. Additionally, Willmert, George, Sisseton, Budd, Hall, Amber, and Fox Lakes all had chloride data collected which were meeting water quality standards for aquatic life use. Finally, data collected on plant floristic quality indicated a poor plant community is present on Willmert, George, Sisseton, Budd, and Hall Lakes, and a healthy plant community is present on Fox Lake.

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Center Creek Aggregated 12-HUC.



Upper Blue Earth River Aggregated 12-HUC

HUC 0702000908-01

The Upper Blue Earth River subwatershed occupies an area of approximately 54 square miles in west-central Faribault County. This subwatershed contains the central reaches of the Blue Earth River mainstem from the confluence of the West and Middle Branches south of the town of Blue Earth to the town of Winnebago. Along this reach the Blue Earth River receives several higher order tributaries of relatively large drainage areas: Badger, South and Center Creeks from the west end of the watershed, and Coon Creek and the East Branch Blue Earth River from the east portion of the watershed. By the point where the Blue Earth River flows out of this subwatershed just southwest of Winnebago, it is draining an area of over 1,000 square miles. The majority of the Blue Earth River mainstem exhibits a natural, unaltered channel condition along its course through this subwatershed, although there are a few reaches where its course has been altered or channelized. Most of the low order tributaries along this reach are channelized streams or ditches. Row crop agriculture is the principal land use with over 75% of land area in this subwatershed.

Table 13. Aquatic life and recreation assessments on stream reaches: Upper Blue Earth River Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name***, *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-504 **Blue Earth River,** W Br Blue Earth R to Coon Cr	00MN001	6.31	2Bg, 3C	EXS	MTS	IC	IF	MTS	MTS	MTS	MTS		--	IMP	NS
07020009-508 **Blue Earth River,** E Br Blue Earth to South Cr	17MN316	10.85	2Bg, 3C	EXS	MTS	IF	IF	IC	MTS	MTS	MTS		IF	IMP	IMP
07020009-511 **County Ditch 60,** Headwaters to Blue Earth R		4.20	2Bg, 3C			IF		IF		IF			--	IF	
07020009-514 **Blue Earth River,** Center Cr to Elm Cr	17MN308	2.34	2Bg, 3C	EXS	MTS	IF	IF	EXS	MTS	MTS	MTS		IF	IMP	IMP

07020009-516 **Blue Earth River,** South Cr to Center Cr	17MN348	8.54	2Bg, 3C	EXS	MTS	IF	IF	IF		IF	IF		--	IMP	
07020009-518 **Blue Earth River,** Coon Cr to Badger Cr	10EM163, 92MN088	3.28	2Bg, 3C	EXS	MTS	MTS	EXS	IC		MTS	IF		--	IMP	
07020009-565 **Blue Earth River,** Badger Cr to E Br Blue Earth R	17MN349	1.46	2Bg, 3C	EXS	MTS	IF	IF	IC		IF	IF		--	IMP	
07020009-616 **County Ditch 17,** Headwaters to Blue Earth R	17MN350	3.17	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	

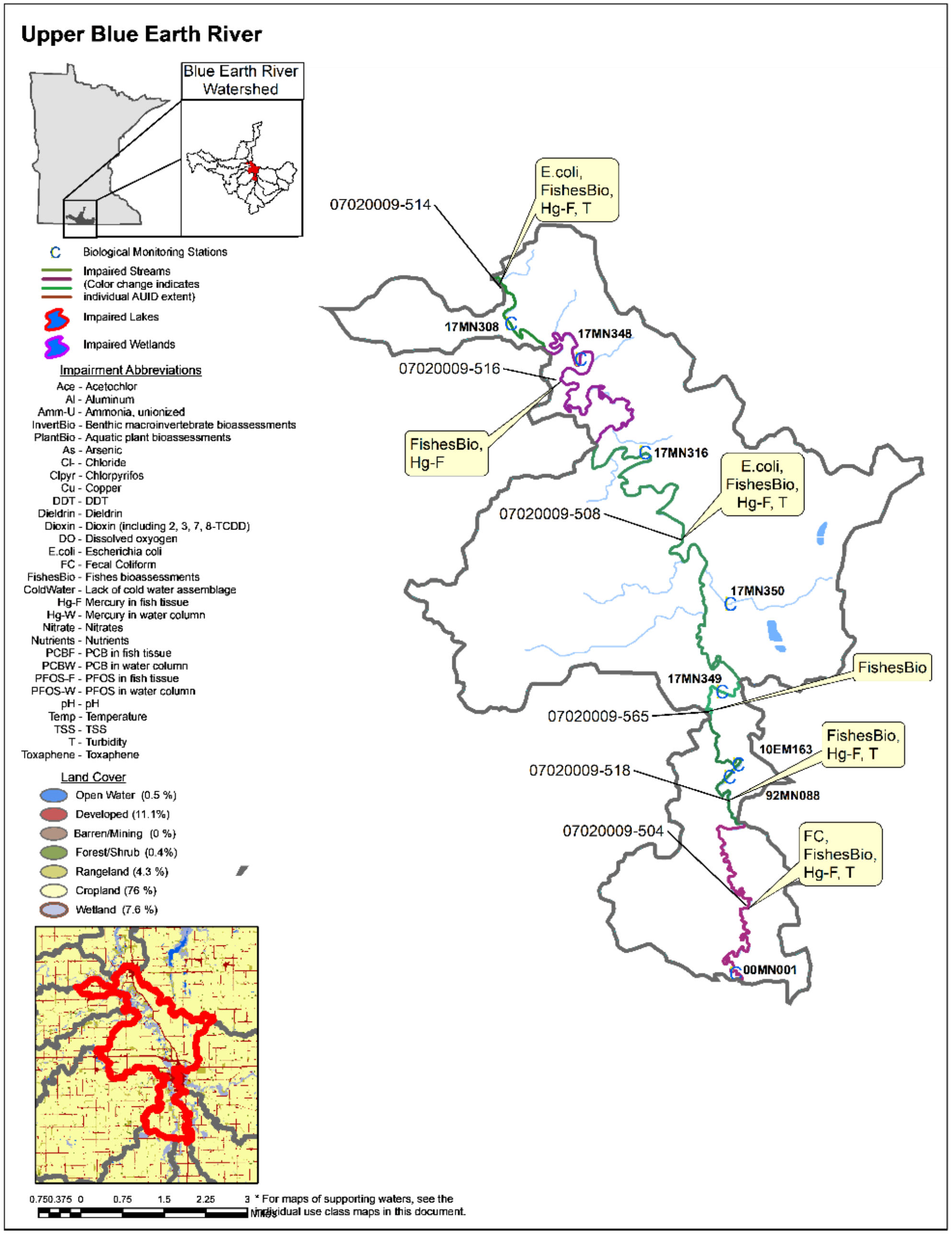
Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

Fish and macroinvertebrate communities were sampled at eight biological stations on seven separate assessment reaches along the mainstem Blue Earth River in this watershed. Fish community scores are sharply contrasted by macroinvertebrates along this reach of the river; not a single fish sample meets the general use threshold, while macroinvertebrate scores meet the standard at every station. Differing impacts of human disturbance on varied riverine habitats and the biological communities they support are a sound rationale for not limiting water quality assessment decisions to a single community. These results may be driven by the large amounts of woody debris and downed trees in the river. At most stations along this reach, there are heavily eroded and destabilized banks that result in trees falling into the channel. These downed trees and logjams provide ample habitat for aquatic insect communities that are likely contributing the higher scores along the river mainstem.

Reaches -508 and -514 of the Blue Earth River both had chlorophyll-a and pH data that were meeting water quality standards; however, TP (causative variable) data are within the standard error of the mean and confidence does not exist in determining whether these reaches meet or exceed river eutrophication standards. Extensive phosphorus data were collected on reach -518 over the assessment window and show an elevated seasonal average. No response data were available to support a complete river eutrophication assessment. This reach also had extensive data on dissolved oxygen, which was meeting water quality standards. Reaches -504, -508, -514, -518, -565 were all previously listed as impaired for turbidity. There either was not enough data or the data were inconclusive between Secchi tube and TSS samples to make a complete assessment of the water quality in regards to turbidity, therefore the turbidity impairments will remain on all four reaches. Reaches -504, -508, and -518 were meeting water quality standards for chloride and unionized ammonia, however these reaches exhibited high levels of bacteria and were not supporting aquatic recreation.

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Upper Blue Earth River Aggregated 12-HUC.



Badger Creek Aggregated 12-HUC

HUC 0702000908-02

Badger Creek drains an area of about 78 square miles along the border of Martin and Freeborn counties between the towns of Fairmont and Blue Earth. The principal streams in this subwatershed are Judicial Ditch 14, Little Badger Creek, and Badger Creek. These streams and their channelized tributaries flow in a general west to east direction to the confluence with the Blue Earth River just west of the town of Blue Earth. Streams in this watershed are virtually entirely channelized. Land use in this subwatershed is 90% row crop agriculture.

Table 14. Aquatic life and recreation assessments on stream reaches: Badger Creek Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:**										**Aquatic life**	**Aquatic rec. (Bacteria)**
				Fish IBI	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**		
07020009-568 **Judicial Ditch 14 (Badger Creek),** T101 R28W S18, west line to Little Badger Cr	17MN345	11.76	2Bm, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-614 **Judicial Ditch 14,** Headwaters to JD 14	17MN346	10.51	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-642 **Little Badger Creek,** 345th Ave to badger Cr	17MN347	2.99	2Bg, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-658 **Badger Creek,** Little Badger Cr to -94.136 43.64	17MN302	1.35	2Bm, 3C	MTS	MTS	IF	IF	IC	MTS	MTS	MTS		IF	SUP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information

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

Key for Cell Shading: ☐ = existing impairment, listed prior to 2014 reporting cycle; ☐ = new impairment; ☐ = full support of designated use; ☐ = insufficient information.

Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water

*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 15. Lake assessments: Badger Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Unnamed	22-0088-00	28	21	Deep Water	WCBP	--	--	IF	--	MTS	MTS	MTS	IF	FS

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

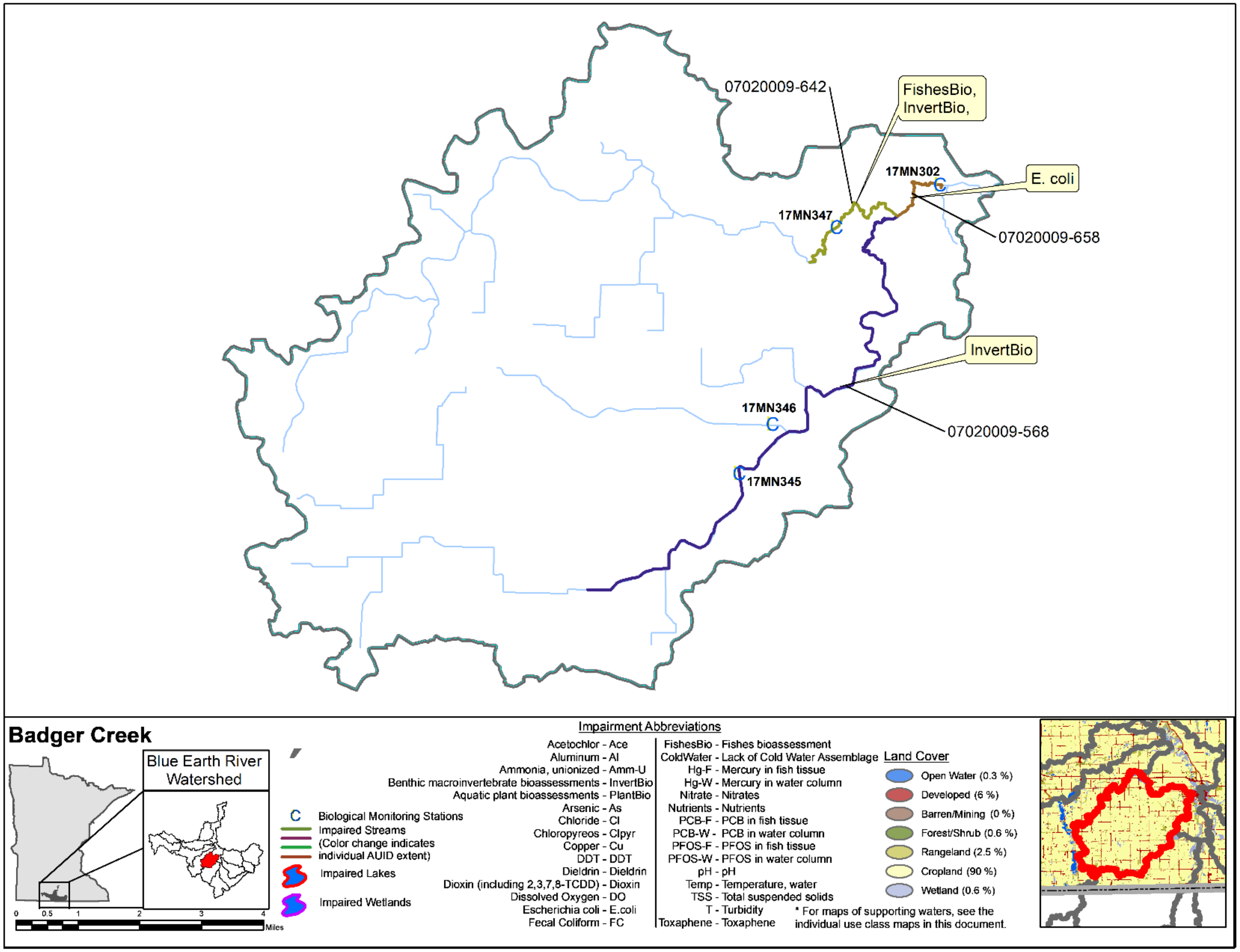
Summary

Fish and macroinvertebrate communities were monitored at four biological stations on four assessment reaches of stream. Two stations were sampled on two branches of Badger Creek: a modified use segment and a general use segment. Fish and macroinvertebrate communities were both determined to be meeting the modified use standard on that reach, while on the general use segment (which is also channelized) the fish community met the standard but the macroinvertebrate community did not due to low diversity and high numbers of tolerant species. Neither biological community meets the general use standard on Little Badger Creek, where samples indicated a substantial shift in population structure and ecosystem function. Samples from the station near the subwatershed outlet on the lower reach of Badger Creek indicate full support for aquatic life use.

Data on toxic pollutants, chloride and unionized ammonia, are meeting water quality standards for aquatic life use on Badger Creek. This reach was also found to be impaired for aquatic recreation based on high levels of bacteria. All other stream reaches had insufficient water chemistry data to make an assessment on both aquatic life use and aquatic recreation use.

One lake was assessed for aquatic recreation use in this subwatershed. Unnamed lake (22-0088-00) near Guckeen has good water quality and fully supports aquatic recreation. This lake also had chloride data collected, which were meeting water quality standards for aquatic life use.

Figure 22. Currently listed impaired waters by parameter and land use characteristics in the Badger Creek Aggregated 12-HUC.



Lower Elm Creek Aggregated 12-HUC

HUC 0702000909-01

The Lower Elm Creek subwatershed occupies an area of approximately 98 square miles in northeastern Martin County and contains the lower reach of Elm Creek and its minor tributaries. Elm Creek flows from its confluence with Cedar Creek on the west end of the subwatershed about 48 miles in an easterly direction to its confluence with the Blue Earth River just southwest of the town of Winnebago. At a total drainage area of more than 280 miles, Elm Creek represents one of the larger tributaries of the Blue Earth River. The majority of Elm Creek's lower reach in this subwatershed remains in a natural, unaltered channel, though nearly all of its minor tributaries are ditches or channelized streams. More than 86% of the land area in this subwatershed is dedicated to row crop agriculture.

Table 16. Aquatic life and recreation assessments on stream reaches: Lower Elm Creek Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-502 **Elm Creek,** Cedar Cr to Blue Earth R	03MN063, 12MN004, 12MN005, 13MN171, 13MN172, 17MN305, 17MN327	47.79	2Bg, 3C	MTS	EXS	IF	EXS	IC	MTS	MTS	MTS		IF	IMP	IMP
07020009-545 **Judicial Ditch 8,** Headwaters to JD 3	17MN335	2.91	2Bm, 3C		IC	IF		IF		IF			--	IC	
07020009-627 **Judicial Ditch 3,** -94.351 43.739 to Elm Cr	17MN336	1.85	2Bg, 3C	EXS	MTS	IF	IF	IF		IF	IF		--	IMP	IMP
07020009-667 **County Ditch 72,** Unnamed Ditch to 196th Ave	17MN330	2.33	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **IC** = Inconclusive Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards), **IC =** Inconclusive
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

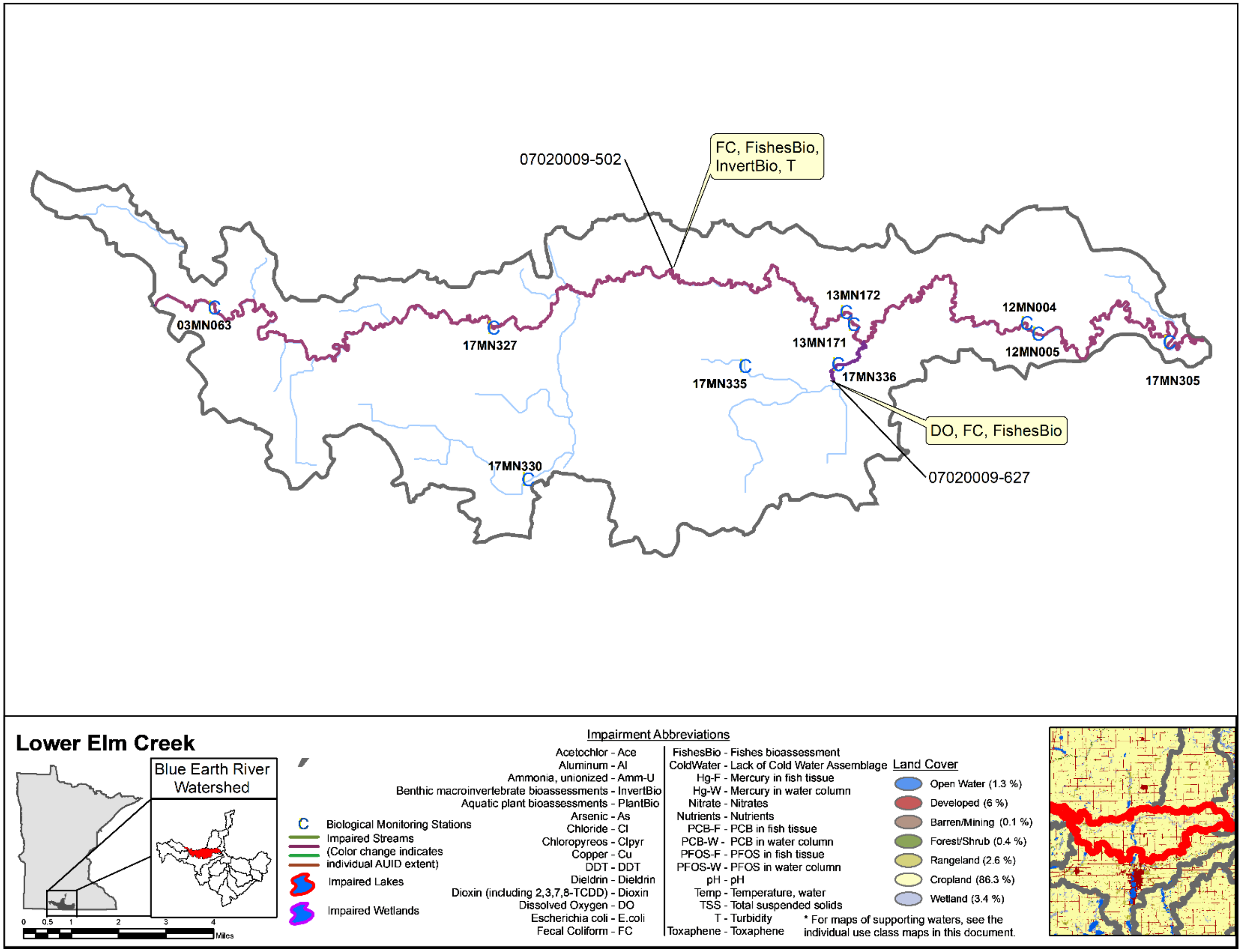
Summary

An extensive biological dataset was collected to assess aquatic life use support in this subwatershed. Fish and macroinvertebrate communities were monitored at 10 biological stations on four reaches of stream. Both communities met the modified use standard in CD 72. Macroinvertebrate community data indicate support of general aquatic life use in Judicial Ditch 3, while the fish community consisted of only eight species and did not meet the standard. Likely due in part to hydrologic alteration, water levels were too low to sample for fish on Judicial Ditch 8 at a visit in August 2017. The macroinvertebrate community had already been sampled but the data were not assessed over concerns that water levels were outside of base flow conditions for the time period.

Among the seven biological monitoring stations along the 48-mile assessment reach of Elm Creek, results were mixed for both communities. Some stations surpass the general use standard while others do not. Among stations that pass or fail, there is no discernable longitudinal pattern along the reach length, though there is some evidence to suggest that conditions for fish are improving in this system, as scores are higher in general than samples from before this assessment period that triggered the 2006 impairment for fish biology. Further fish sampling is recommended on this reach in pursuit of removing this reach from the impaired waters list, but at present time data from this assessment period indicate that general aquatic life use goals are not being met for fish. Similarly, macroinvertebrate communities had mixed results in that communities at some stations scored above the threshold while others did not. However, stations in the upstream portion of this reach exhibit lower scores, suggesting that conditions for macroinvertebrate life may improve moving downstream along this reach. Overall, macroinvertebrate community data indicate non-support for general aquatic life use.

Water chemistry data were available on Elm Creek. Elm Creek was previously listed for turbidity in 1996. TSS data clearly exceeds the standards, while surrogate Secchi tube data is inconclusive. This reach will remain listed as impaired for turbidity. Chloride and unionized ammonia are meeting water quality standards on this reach. Additionally, this reach has a large TP dataset that does not meet criteria. The chlorophyll-a and pH dataset clearly do not show a response to the elevated TP concentrations. Elm Creek was also previously listed for fecal coliform in 1994. More recent bacteria data confirms that bacteria concentrations are still high and above the standard.

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Lower Elm Creek Aggregated 12-HUC.



Upper Elm Creek Aggregated 12-HUC

HUC 0702000909-02

The Upper Elm Creek subwatershed drains an area of 134 square miles in Jackson and Martin counties. It is the westernmost portion of the Blue Earth Watershed and abuts the Des Moines River Basin to the west. The headwaters of Elm Creek and its South Branch lie in eastern Jackson county. The two streams flow in an easterly direction until their confluence just east of the Martin County border. From the confluence, Elm Creek flows about 27 miles to where it is joined by Cedar Creek four miles east of Trimont. The majority of Elm Creek's channel is natural, but is frequently interrupted by short reaches of channelization. Nearly all of the lower order tributaries are channelized streams or ditches. Land use in this subwatershed is dominated by row crop agriculture.

Table 17. Aquatic life and recreation assessments on stream reaches: Upper Elm Creek Aggregated 12-HUC.

WID *Reach name*, *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Aquatic life indicators:** Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-522 **Elm Creek,** S Fk Elm Cr to Cedar Cr	17MN306, 17MN325	26.82	2Bg, 3C	EXS	EXS	IF	IF	MTS	MTS	MTS	MTS		IF	IMP	IMP
07020009-561 **Elm Creek, South Fork,** T104 R34W S36, south line to Elm Cr	17MN323	1.83	2Bg, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-567 **Elm Creek, North Fork,** Headwaters to Elm Cr	17MN321	6.27	2Bm, 3C	MTS		IF	IF	IF		IF	IF		--	SUP	
07020009-597 **Unnamed Creek,** Tile line to Tile line		1.76	2Bg, 3C			IF	IF	IF		IF			--	IF	
07020009-630 **Elm Creek,** Headwaters to 570th Ave		7.15	2Bg, 3C										--	IMP	
07020009-631 **Elm Creek,** 570th Ave to S Fk Elm Cr	17MN320, 17MN322	7.81	2Bg, 3C	EXS	IF	IF	IF	IF		IF	IF		--	IMP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 18. Lake assessments: Upper Elm Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Independence	32-0017-00	81	10	Shallow Water	WCBP		--	IF	--	EXS	IC	MTS	IF	IF
Clam	46-0111-00	67	8	Shallow Water	WCBP		--	--	--	IF	--	--	--	IF
Round	46-0116-00	45	--	Shallow Water	WCBP		--	IF	--	IF	IF	IF	IF	IF
Watkins	46-0132-00	187	3	Shallow Water	WCBP		--	--	--	IF	--	IF	--	IF
Big Twin	46-0133-00	421	18.5	Shallow Water	WCBP		EXS	MTS	--	MTS	IC	MTS	NS	IF

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

Summary

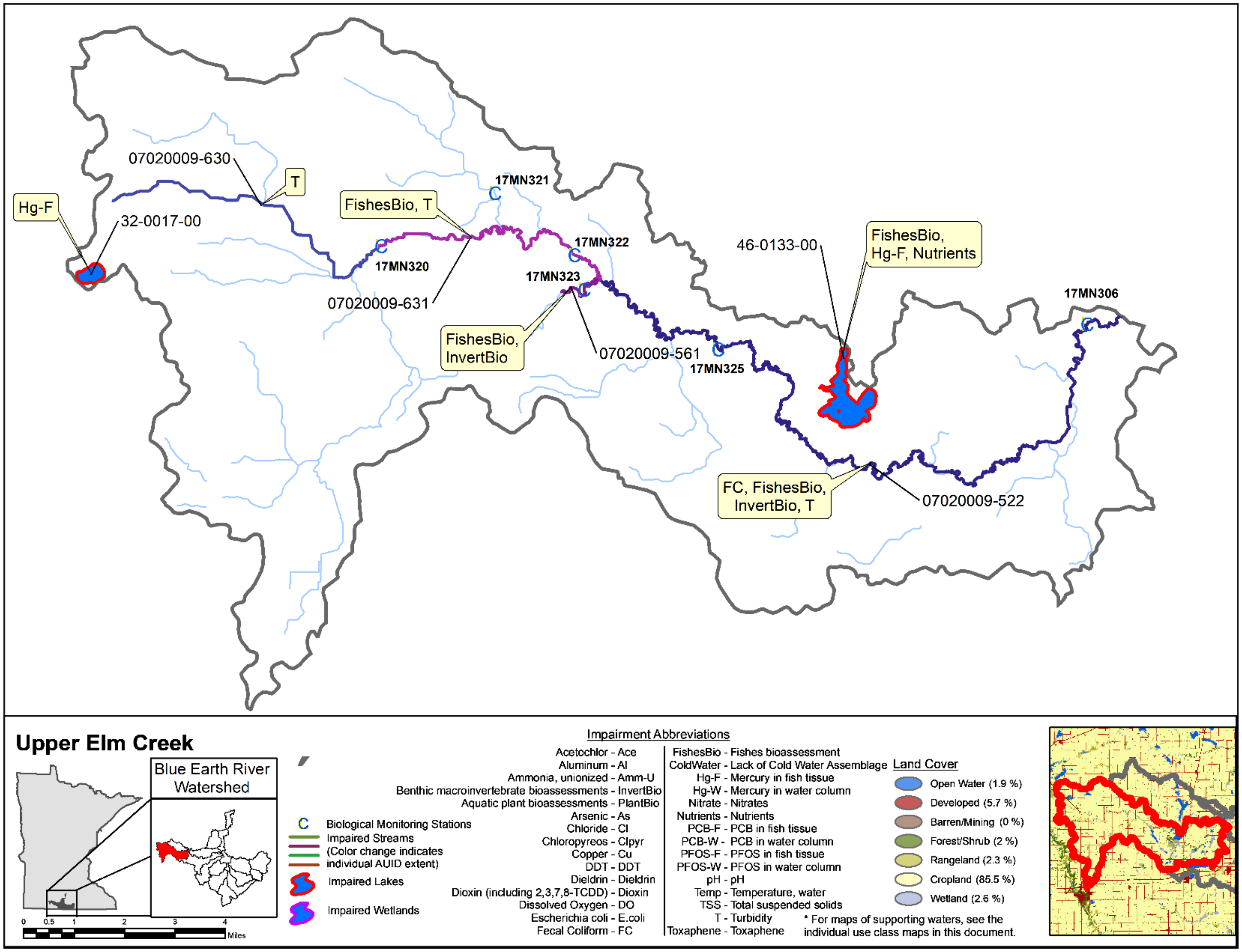
Fish and macroinvertebrate communities were sampled at six stations on four reaches of Elm Creek. On the reach of Elm Creek upstream of the confluence with the South Fork Elm Creek, fish communities were sampled at two stations, neither of which met the general use standard. Macroinvertebrates were sampled at these stations but the data were not used to make an assessment decision due to low flows at time of sample that were not representative of typical conditions for the time period. The fish community at the station on the North Fork of Elm Creek was not particularly speciose, but did not exhibit dominance of tolerant taxa and met the standard for modified use. On the South Fork of Elm Creek, habitat conditions were poor due to severely eroded banks and excess siltation. Both biological communities failed to meet the general use standard and were dominated by taxa that are tolerant to siltation. Two stations were sampled on the lower reach of Elm Creek in this subwatershed. Again, symptoms of hydrologic alteration were evident in poor habitat scores, bank erosion and excess siltation. Both communities indicate non-support of general aquatic life use.

Reach 07020009-522 was previously listed for turbidity in 2006. Secchi tube data appeared to meet water quality standards, however there wasn’t enough TSS data to fully assess the status of the turbidity impairment. The turbidity impairment will remain on this reach. This reach was also previously listed for fecal coliform in 2006. Recent data show high concentrations of bacteria, confirming the bacteria impairment still exists. 07020009-523 of Elm Creek was previously listed for turbidity. However, this reach has now been retired and split into child WIDs. One of its child WIDS, -631, will be carrying forward the existing turbidity impairment. The remaining stream reaches had limited water chemistry data to make an assessment of aquatic life use and aquatic recreation use.

Two lakes within the subwatershed had enough information to assess for aquatic recreation. Independence Lake’s TP levels were found to greatly exceed water quality standards, while chlorophyll-a and Secchi were meeting standards. The causative variable exceeds, but there is no response at this time. Independence should be a priority for protection in order to prevent this lake from becoming impaired. Big Twin was listed for nutrients in 2010. Recent TP and Secchi data appear to be meeting water quality criteria, but chlorophyll-a is hovering at the standard. The data are inconclusive at this time; Twin Lake will remain listed for nutrients.

Big Twin Lake was assessed for aquatic life using fish community data. It was found to not support aquatic life based on low FIBI scores. The FIBI score was most negatively influenced by the low proportion of biomass from insectivores, and lack of vegetative-dwelling species and benthic-dwelling species. Big Twin Lake also had chloride data available that were meeting water quality criteria in regards to aquatic life. Additionally, data collected on plant floristic quality indicated a poor plant community is present on Clam and Watkins Lakes, and a healthy plant community is present on Independence Lake.

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Elm Creek Aggregated 12-HUC.



Cedar Creek Aggregated 12-HUC HUC 0702000909-03

The Cedar Creek subwatershed drains an area of approximately 53 square miles located predominantly in Martin County. Cedar Creek flows approximately 11 miles in a generally northwest to southeast direction from its first order tributaries southeast of Windom to its inlet to Cedar Lake. From the outlet of Cedar Lake, it continues another 9 miles to the confluence with Elm Creek approximately 4 miles east of Trimont. Excluding a couple of short segments both upstream and downstream of the lake, nearly this entire subwatershed consists of channelized streams. Land use in the subwatershed is predominantly agricultural.

Table 19. Aquatic life and recreation assessments on stream reaches: Cedar Creek Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name*,** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-521 **Cedar Creek (Cedar Run Creek),** Cedar Lk to Elm Cr	17MN307	8.86	2Bg, 3C	MTS	EXS	IF	IF	MTS	MTS	MTS	MTS		IF	IMP	IMP
07020009-656 **Cedar Creek (Cedar Run Creek),** T104 R33W S6, west line to 60th Ave		9.98	2Bg, 3C			IF	IF	IF		IF	IF		--	IMP	IMP
07020009-657 **Cedar Creek (Cedar Run Creek)** 60th Ave to Cedar Lk	17MN326	1.24	2Bm, 3C	MTS	MTS								--	IMP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 20. Lake assessments: Cedar Creek Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Cedar	46-0121-00	713	6	Shallow Water	WCBP	--	EXS	MTS	--	EXS	EXS	EXS	NS	NS
Little Twin	46-0130-00	72	9	Shallow Water	WCBP	--	--	--	--	--	--	IF	--	IF
Fish	46-0145-00	149	5	Shallow Water	WCBP	--	EXS	IF	--	EXS	EXS	EXS	NS	NS

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

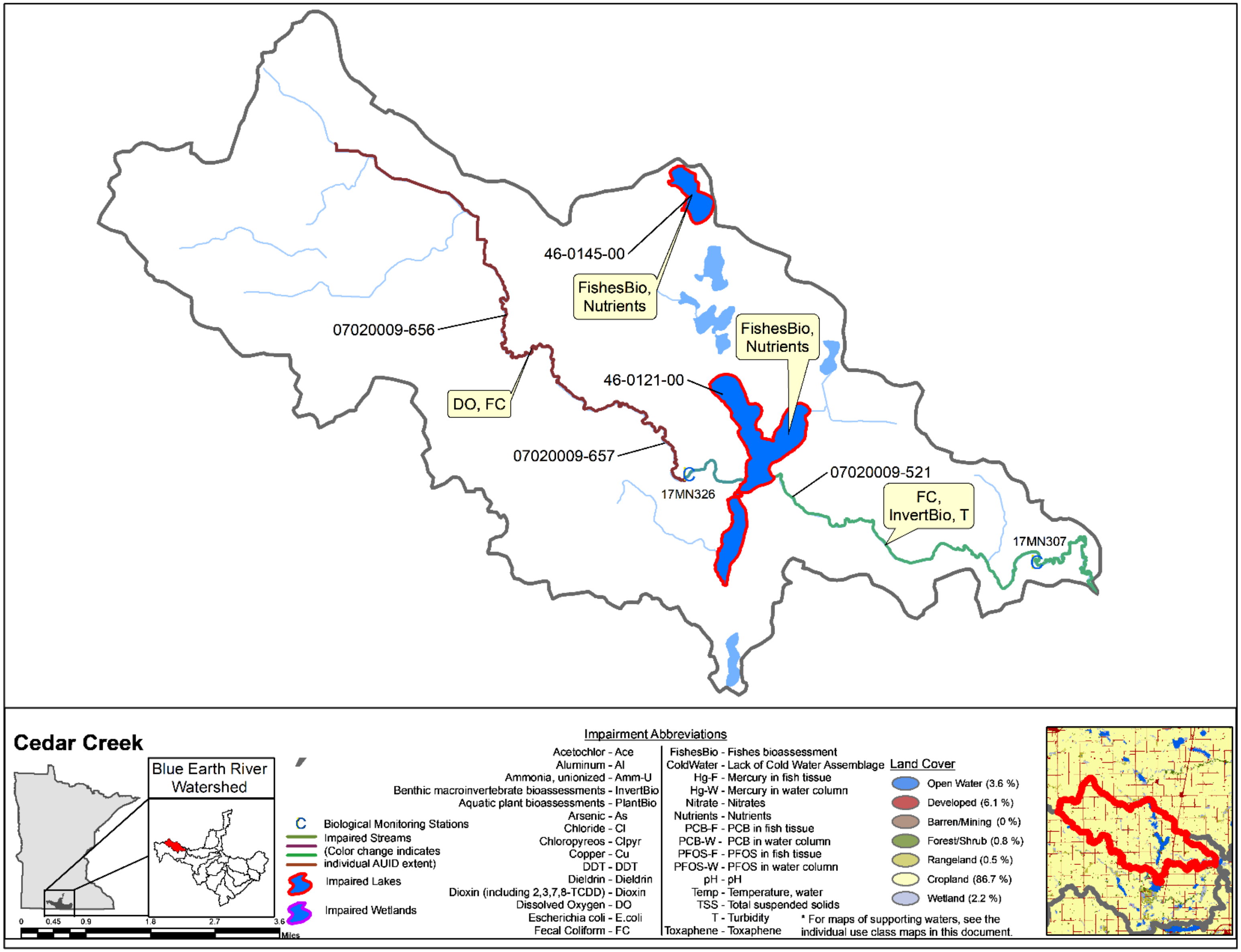
Summary

Fish and macroinvertebrate communities were monitored on a modified aquatic life use section of Cedar Creek upstream of Cedar Lake and a general use section of Cedar Creek downstream of Cedar Lake. The modified use section was determined to be supporting both aquatic life communities and had relatively good habitat for a channelized reach. The general use section further downstream exhibited a fish community that was reasonably diverse (22 species) and some sensitive taxa were present in low numbers. However, the reach was impaired for macroinvertebrates with a predominance of tolerant taxa (93%), low taxa richness (30 species), and low Ephemera, Plecoptera and Trichoptera (8) for a riffle-run stream. The habitat in the monitored reach was in good condition overall but was heavily embedded with fines.

Limited water chemistry data were available on streams within this subwatershed. Available parameters, chloride and unionized ammonia, meet their respective water quality standards on the most downstream reach of Cedar Creek (-521). Reach (-555) of Cedar Creek was previously listed as impaired for DO and fecal coliform bacteria. However, this reach has now been retired and split into two new reaches. The new reaches (-656) and (-657), will carry forward the existing dissolved oxygen and fecal coliform impairments. Reach (-521) of Cedar Creek was previously listed as impaired for fecal coliform bacteria in 2006. Newer data show elevated bacteria concentrations, confirming the bacteria impairment still exists.

Two lakes, Cedar and Fish, had sufficient information to assess in this subwatershed. Both lakes were found to have poor water quality due to excess nutrients and are impaired for aquatic recreation use. This also affected the fish community, with poor FIBI scores. Both Cedar and Fish Lake had low proportion of biomass from top carnivores and high proportion of tolerant species, leading to impairments for aquatic life use.

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



Willow Creek Aggregated 12-HUC — HUC 0702000910-01

Willow Creek drains an area of approximately 84 square miles in northeast Martin and southwest Blue Earth counties. It is the last subwatershed in the Blue Earth River Watershed to contribute to the Blue Earth River mainstem before it meets the Minnesota River at Mankato. Streams in this subwatershed generally flow from the south to north. Most of the tributaries that Willow Creek accumulates along its path to its confluence with the Blue Earth River southwest of Vernon Center are unnamed channelized streams or numbered ditches. More than 80% of stream reaches in this subwatershed have been channelized and land use is nearly entirely devoted to row crop agriculture.

Table 21. Aquatic life and recreation assessments on stream reaches: Willow Creek Aggregated 12-HUC.

WID ***Reach name,*** *Reach description*	Biological station ID	Reach length (miles)	Use class	Aquatic life indicators: Fish IBI	Invert IBI	Dissolved oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides ***	Eutrophication	Aquatic life	Aquatic rec. (Bacteria)
07020009-566 **Unnamed Creek,** Unnamed Cr to Willow Cr	17MN341	2.78	2Bg, 3C	MTS	EXS	IF	IF	IF		IF	IF		--	IMP	
07020009-577 **Willow Creek,** Unnamed Cr to Blue Earth R	17MN309	1.73	2Bg, 3C	EXS	MTS	IF	IF	IF	MTS	IF	MTS		IF	IMP	IMP
07020009-617 **Unnamed Creek,** Unnamed Cr to Willow Cr	17MN340	1.96	2Bg, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-619 **Judicial Ditch 116,** Headwaters to Willow Cr	17MN342	8.41	2Bm, 3C	MTS	MTS	IF	IF	IF		IF	IF		--	SUP	
07020009-620 **County Ditch 89/Judicial Ditch 24,** Headwaters to Willow Cr	17MN343	4.81	2Bm, 3C	EXS	MTS	IF	IF	IF		IF	IF		--	IMP	
07020009-625 **Unnamed Creek,** Unnamed Cr to Willow Cr	17MN339	1.74	2Bg, 3C	EXS	EXS	IF	IF	IF		IF	IF		--	IMP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information

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

Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water

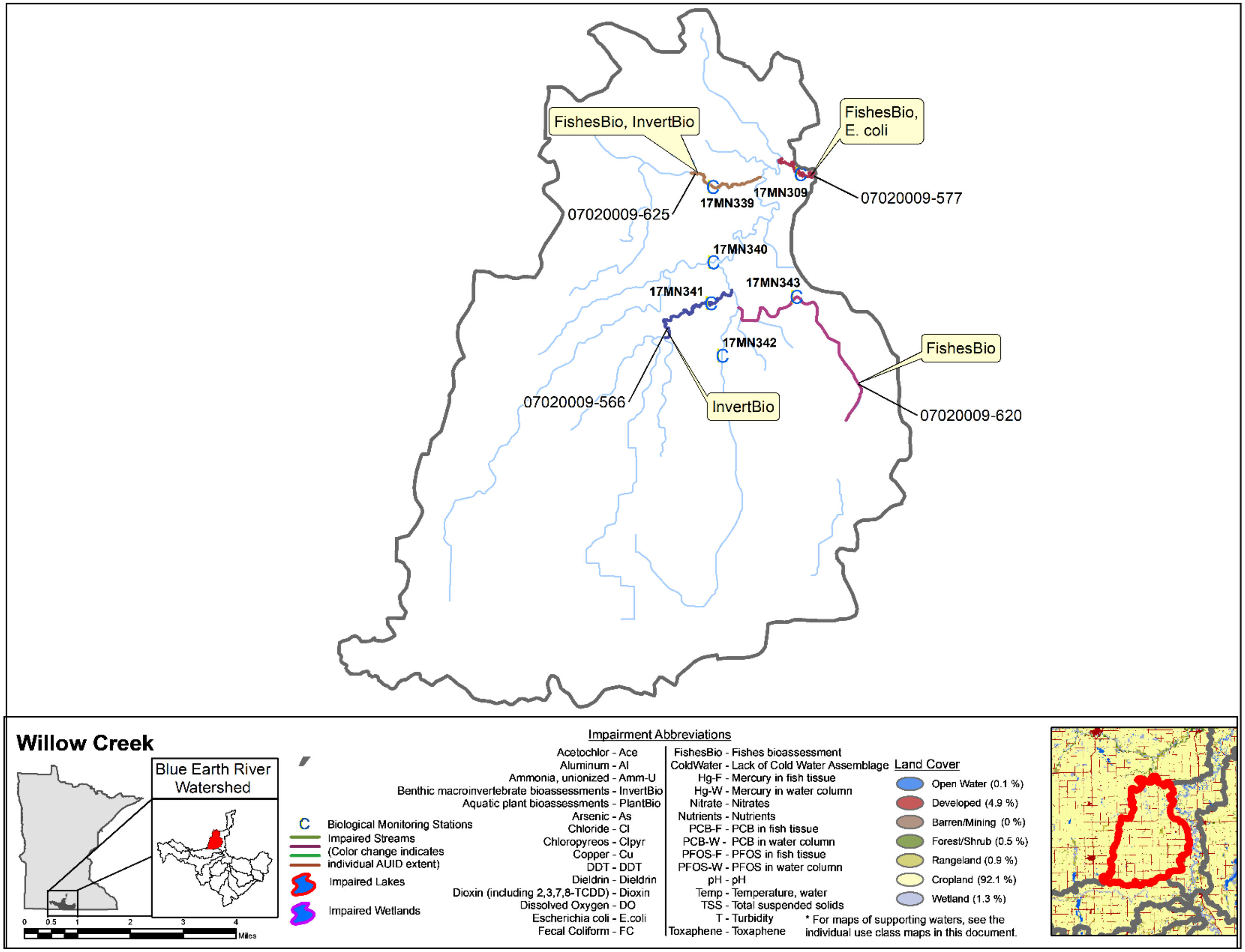
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Summary

Fish and macroinvertebrate communities were monitored at six stations on six reaches of stream in this subwatershed: one on Willow Creek and on five separate tributaries. An unnamed, general use tributary to Willow Creek was determined to be supporting aquatic life for both communities. Both communities also met the modified use standard on Judicial Ditch 116. Results were mixed across the two communities on CD 89/Judicial Ditch 24, as the fish community scored poorly, was dominated by tolerant taxa, and failed to meet the modified use standard. Despite very poor habitat scores and evidence of excessive nutrient enrichment, the macroinvertebrate community was reasonably diverse (33 species) for a channelized stream of this size and character and was determined to be meeting the modified use standard. At another station (17MN341) on an unnamed, general use reach of stream, the fish community was balanced and met life use expectations, while the invertebrate samples were indicative of major alterations to community structure and did not meet general use expectations. At the station on Willow Creek near the outlet of this subwatershed, sampling crews noted bank erosion issues and excess siltation. The fish community was composed of over 40% highly tolerant individuals and failed to meet the general use standard. Despite obvious stressors to this assessment reach, macroinvertebrate samples were somewhat surprisingly composed of nearly 70% mayfly, stonefly and caddisfly individuals and met general use scoring expectations.

Limited water chemistry data were available for all stream reaches. Willow Creek had the most data. Chloride and unionized ammonia are both meeting water quality standards in regards to aquatic life use. This reach was also found to have high concentrations of bacteria, resulting in a new aquatic recreation use impairment.

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Willow Creek Aggregated 12-HUC.



Lower Blue Earth River Aggregated 12-HUC HUC 0702000911-01

The Lower Blue Earth River subwatershed contains the lowermost reaches of the Blue Earth River before its confluence with the Minnesota River. It occupies an area of approximately 97 square miles along the river mainstem from Winnebago to Mankato. Two other major drainages (HUC 8) contribute to the Blue Earth River along this reach: the Watonwan River and the Le Sueur River. Most of the other tributaries along this route are small, low order streams and ditches. Upstream of its confluence with the Watonwan River, the Blue Earth is already a large river, draining an area of over 1,500 square miles. The Watonwan contributes another 850 miles of drainage area, and the Le Sueur River adds another 1,200 square miles at its confluence just upstream of Mankato. At the Blue Earth River's confluence at Mankato, it is draining a total area of over 3,500 square miles and represents the largest tributary to the Minnesota River.

Table 22. Aquatic life and recreation assessments on stream reaches: Lower Blue Earth River Aggregated 12-HUC.

				Aquatic life indicators:											
WID ***Reach name,*** *Reach description*	**Biological station ID**	**Reach length (miles)**	**Use class**	**Fish IBI**	**Invert IBI**	**Dissolved oxygen**	**TSS**	**Secchi Tube**	**Chloride**	**pH**	**Ammonia -NH_3**	**Pesticides *****	**Eutrophication**	**Aquatic life**	**Aquatic rec. (Bacteria)**
07020009-501 **Blue Earth River,** Le Sueur R to Minnesota R	17MN317	3.31	2Bg, 3C	EXS		IF	EXS	EXS	MTS	MTS	MTS		IF	IMP	IMP
07020009-507 **Blue Earth River,** Willow Cr to Watonwan R	00MN005, 10EM051, 92MN093	37.09	2Bg, 3C	EXS	MTS	IF	IF	EXS		IF	IF		--	IMP	
07020009-509 **Blue Earth River,** Rapidan Dam to Le Sueur R	17MN315	8.87	2Bg, 3C	EXS	MTS	IF	EXS	EXS	MTS	MTS	IC		EXS	IMP	IF
07020009-515 **Blue Earth River,** Elm Cr to Willow Cr	00MN003, 00MN004	25.79	2Bg, 3C	EXS	MTS	IF	EXS	EXS		MTS	IF		IF	IMP	

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warm water general, **WWm** = Warm water modified, **WWe** = Warm water exceptional, **CWg** = Cold water general, **CWe** = Cold water exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.

Table 23. Lake assessments: Lower Blue Earth River Aggregated 12-HUC.

Lake name	DNR ID	Area (acres)	Max depth (ft)	Assessment method	Ecoregion	Secchi Trend	Aquatic life indicators:			Aquatic recreation indicators:			Aquatic life use	Aquatic recreation use
							Fish IBI	Chloride	Pesticides ***	Total phosphorus	Chlorophyll-a	Secchi		
Ida	07-0090-00	111	8	Shallow Water	WCBP	--	--	IF	--	EXS	EXS	EXS	IF	NS

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

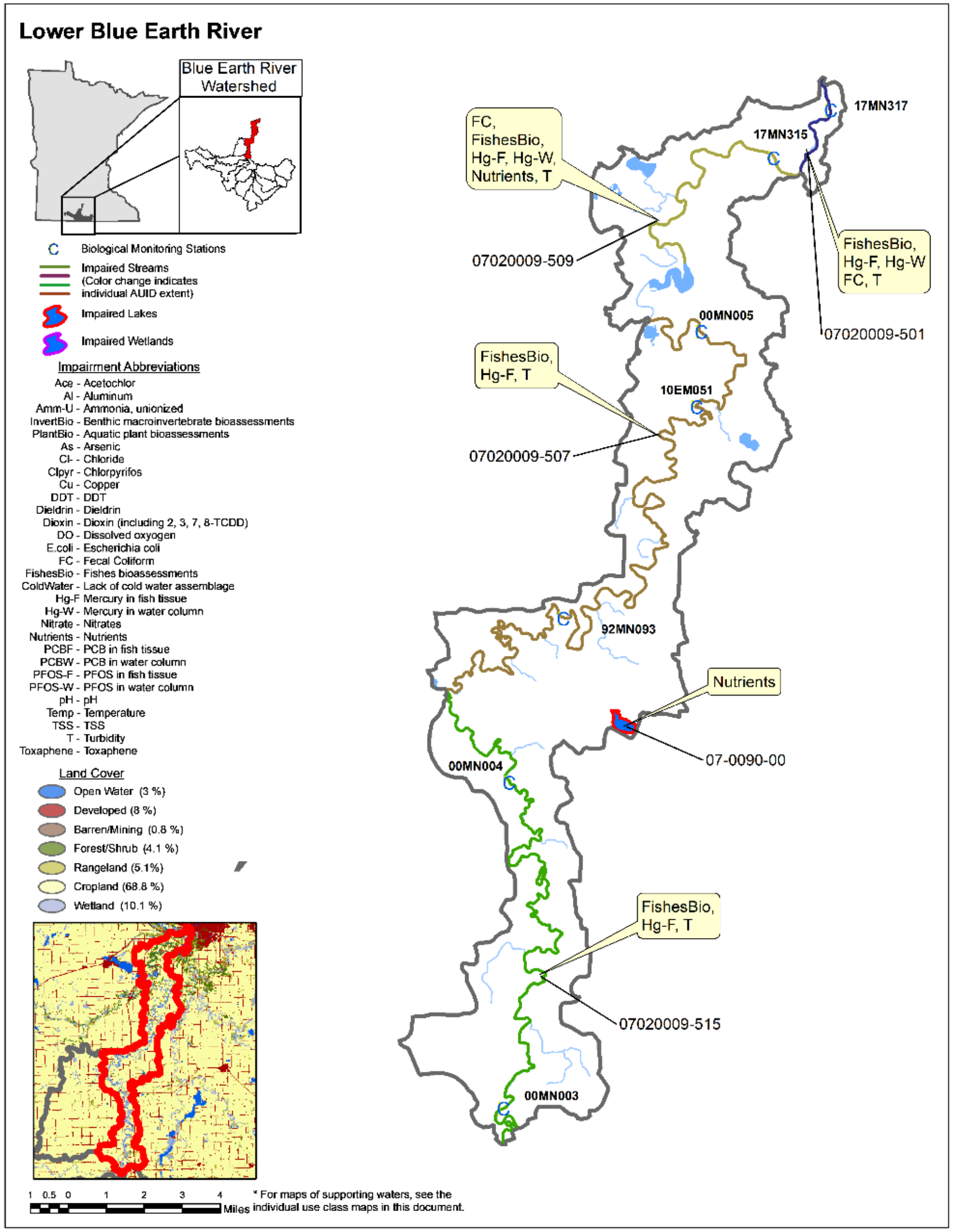
Summary

Fish and macroinvertebrate communities were monitored at seven stations on four separate assessment reaches of the Blue Earth River mainstem. As with the reaches immediately upstream of this subwatershed in the Upper Blue Earth River (see above), fish and macroinvertebrate communities exhibit discrepant results. Not a single assessment reach is supporting general aquatic life use for fish. Fish communities exhibit a general lack of sensitive taxa and a shift in balance towards species that are tolerant to human generated disturbance. In particular, excess sedimentation and lack of available coarse substrate are especially detrimental to the fish community. These issues are exacerbated by severe erosion and widespread bank instability that is driven in part by extensive hydrologic modifications in subwatersheds that drain into these lower assessment reaches. Interestingly, the macroinvertebrate community may actually benefit in some ways from the large amounts of deadfalls and woody debris that are deposited into the channel during erosive, high flow events. Macroinvertebrates were determined to be meeting the general use standard on all reaches of the Blue Earth River mainstem. It is noteworthy that MPCA's longitudinal survey of biological condition for the Blue Earth River has demonstrated a healthy macroinvertebrate community across its entire length. A total of eleven sites were monitored for macroinvertebrates in 2017, including three upper stations that were assessed using the Prairie Streams (Glide/Pool Habitats) macroinvertebrates IBI (MIBI) and eight lower stations (i.e., drainage area > 500 mi^2) that were assessed using the Prairie Forest Rivers MIBI. MIBI scores ranged from a few points above their respective impairment thresholds to greater than 20 points above the threshold. A similar, though less-intensive, survey of macroinvertebrates was conducted in 2000, which yielded much different results. At that time, four out of five stations did not meet general use expectations and a distinct declining trend in condition was evident in the downstream direction. The reason for the dramatic improvement in macroinvertebrate condition is not clear at this time, although climatic differences between the two periods does not seem to be a factor as rainfall amounts were approximately normal in both 2000 and 2017.

Reaches -501, -509, and -515 of the Blue Earth River were previously listed for turbidity. Recent total suspended solids (TSS) and Secchi tube data are exceeding water quality standards, confirming the turbidity impairment still exists. Reach -507 was also previously listed for turbidity in 2008. Secchi tube data for the reach are exceeding, however there was not enough TSS data to assess. The turbidity impairment will remain for this reach as well. Reach-509 was previously listed for nutrients in 2016. Recent phosphorus data were elevated, and chlorophyll-a responded by also exceeding standards; confirming the nutrient impairment still exists. This reach was also listed for fecal coliform in 2008. More recent data from two sampling stations show that bacteria concentrations are meeting water quality standards. However, not enough data were collected at the original listing's sampling site (S001-231) to be able to make a full support use determination and subsequently delist this reach. More monitoring at S001-231 is recommended to better determine the status of this reach. The most downstream reach of the Blue Earth River (-501) was listed for fecal coliform in 1994. Recent bacteria data confirm levels are still high and that an impairment still exists. Reach-509 of the Blue Earth River was also listed for fecal coliform in 2008.

Ida Lake was the only lake monitored and assessed for aquatic recreation use in this subwatershed. It was found to have poor water quality due to excess nutrients and is impaired for aquatic recreation use.

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



Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Blue Earth River Watershed, grouped by sample type. Summaries are provided for lakes, streams, and rivers in the watershed for the following: aquatic life and recreation uses, aquatic consumption results, load monitoring data results, and transparency trends. Waters identified as priorities for protection or restoration work were also identified. Additionally, groundwater and wetland monitoring results are included where applicable.

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

Stream water quality

Eighty stream WIDs were assessed in the Blue Earth River Watershed (Table 24). Of the assessed streams, only 20 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Three WIDs were classified as limited resource waters and assessed accordingly.

Throughout the watersheds, 57 WIDs are non-supporting for aquatic life and/or recreation. Of those WIDs, 53 are non-supporting for aquatic life and 27 are non-supporting for aquatic recreation.

Table 24. Assessment summary for stream water quality in the Blue Earth River Watershed.

				Supporting		Non-supporting			
Watershed	**Area (acres)**	**# Total WIDs**	**# Assessed WIDs**	**# Aquatic life**	**# Aquatic recreation**	**# Aquatic life**	**# Aquatic recreation**	**Insufficient data**	**# Delistings**
07020009 **HUC 8**	**1,001,805**	**147**	**80**	**20**	**0**	**53**	**27**	**4 AL, 1 AR, 3 LRV**	
0702000902-01	65,249	3	3	0	0	3	1	0	
0702000903-01	70,670	3	3	2	0	1	2	0	
0702000904-01	63,668	5	5	2	0	3	1	0	
0702000905-01	75,002	14	7	2	0	4	1	1 LRV	
0702000905-02	30,378	3	3	2	0	0	1	1 AL	
0702000905-03	83,316	14	12	3	0	7	1	2 LRV	
0702000906-01	71,820	20	5	2	0	3	1	0	
0702000907-01	87,489	27	7	0	0	7	7	0	
0702000908-01	34,067	7	8	1	0	6	3	1 AL	
0702000908-02	50,264	6	4	2	0	2	1	0	

Watershed	Area (acres)	# Total WIDs	# Assessed WIDs	Supporting: # Aquatic life	Supporting: # Aquatic recreation	Non-supporting: # Aquatic life	Non-supporting: # Aquatic recreation	Insufficient data	# Delistings
0702000909-01	60,186	10	4	1	0	2	2	1 AL	
0702000909-02	85,737	12	6	1	0	4	1	1 AL	
0702000909-03	34,066	6	3	0	0	3	3	0	
0702000910-01	54,016	12	6	2	0	4	1	0	
0702000911-01	62,249	5	4	0	0	4	1	1 AR	

Lake water quality

Twenty-four lakes greater than 10 acres were assessed. No lakes were fully supporting aquatic life and only one lake was considered to fully support aquatic recreation. Nine lakes did not support aquatic life and seven did not support aquatic recreation. Additionally, 11 lakes had insufficient data to make an assessment of aquatic life, while 16 had insufficient data to make an assessment of aquatic recreation.

Table 25. Assessment summary for lake water chemistry in the Blue Earth River Watershed.

Watershed	Area (acres)	Lakes >10 acres (assessed)	Supporting: # Aquatic life	Supporting: # Aquatic recreation	Non-supporting: # Aquatic life	Non-supporting: # Aquatic recreation	Insufficient data	# Delistings
07020009 HUC 8	**777,243**	**24**	**0**	**1**	**9**	**7**	**11 AL, 16 AR**	**0**
0702000902-01	22,366	0	--	--	--	--	--	--
0702000903-01	8,537	0	--	--	--	--	--	--
0702000904-01	38,649	0	--	--	--	--	--	--
0702000905-01	75,002	0	--	--	--	--	--	--
0702000905-02	26,353	0	--	--	--	--	--	--
0702000905-03	83,316	3	0	0	0	1	3 AL, 2 AR	0
0702000906-01	54,946	3	0	0	1	2	2 AL, 1 AR	0
0702000907-01	87,489	8	0	0	5	1	2 AL, 7 AR	0
0702000908-01	34,067	--	--	--	--	--	--	0
0702000908-02	50,264	1	0	1	0	0	1 AL	0
0702000909-01	60,186	0	--	--	--	--	--	--
0702000909-02	85,737	5	0	0	1	0	2 AL, 5 AR	0

			Supporting		Non-supporting			
Watershed	Area (acres)	Lakes >10 acres (assessed)	# Aquatic life	# Aquatic recreation	# Aquatic life	# Aquatic recreation	Insufficient data	# Delistings
0702000909-03	34,066	3	0	0	2	2	1 AR	0
0702000910-01	54,016	0	--	--	--	--	--	--
0702000911-01	62,249	1	0	0	0	1	1 AL	0

Fish contaminant results

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Blue Earth River from 1975 to 2017 and from 11 lakes in the watershed from 1969 to 2018 (Table 22). All 11 WIDs of the Blue Earth River are listed as impaired for mercury in fish tissue and are covered under the Minnesota Statewide Mercury TMDL. The most recent fish collections from the Blue Earth River in 2017 show mercury concentrations were low in common carp but high in walleye and flathead catfish: 10 common carp ranged from 0.022 parts per million (ppm) to 0.200 ppm, 10 walleye ranged from 0.159 ppm to 0.505 ppm, and 4 flathead catfish ranged from 0.068 ppm to 0.410 ppm. Mercury concentrations in the lakes were generally very low, with the exceptions of Independence Lake and Big Twin Lake both having Walleye with maximum mercury concentrations of 0.38 ppm, putting both lakes on the Impaired Waters List for mercury in fish tissue and covered by the Minnesota Statewide Mercury TMDL. The high concentration in Big Twin walleye was in 2000 and a more recent analysis in 2008 had a maximum concentration of 0.119 ppm. Big Twin should be resampled and if the mercury concentrations remain below 0.2 ppm the lake will be a candidate for delisting from the Impaired Waters List.

Multiple years of testing PCBs in the Blue Earth River confirmed concentrations near the reporting limit or below. Rice, Walnut, Hall, and Fox lakes had been tested at least once for PCBs and PCBs were near or below the reporting limit in all samples. Budd Lake is unusual in that it is listed as impaired for PCBs in fish tissue. There were samples from three walleye in 1969 having a mean PCBs concentration of 0.547 ppm. In 1993, 22 common carp were composited into 5 samples and the highest PCBs concentration was 0.25 ppm, which exceeds the threshold of 0.22 ppm for impairment. Unfortunately, fish collected in 2009—the last year of collection—were not analyzed for PCBs. Given the long period since the last test of PCBS, Budd Lake fish should be retested for PCBs at the next available fish collection.

Table 26. Fish contaminants: Summary of fish length, mercury, PCBs and PFOS by waterway-species-year.

					Total	Number	Length (in)			Mercury (mg/kg)			PCBs (mg/kg)			
WID	**Waterway**	**Species**	**Year**	**Anatomy[1]**	**Fish**	**Samples**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**N**	**Mean**	**Max**	**< RL**
07020009-501, 504, 507, 508, 509, 510, 514, 515, 516, 518, 565	BLUE EARTH R.*	Common Carp	1978	PLUG	3	1	19.2	19.2	19.2	0.120	0.120	0.120	1	0.02	0.02	Y
				WHORG	10	2	16.6	14.0	19.2	0.045	0.040	0.050	2	0.015	0.02	Y
			1979	WHORG	10	2	17.5	16.8	18.1	0.070	0.070	0.070				
			1985	FILSK	5	1	21.4	21.4	21.4				1	0.46	0.46	
			1990	FILSK	3	3	17.8	16.6	19.0	0.170	0.140	0.210	3	0.124	0.21	
			2017	FILSK	10	10	19.3	13.8	23.2	0.105	0.022	0.200	2	0.047	0.0517	
			1980	FILSK	15	3	20.0	13.6	27.5	0.107	0.050	0.150	3	0.05	0.05	Y
			1975	FILSK	5	5	22.0	18.6	26.2				5	0.042	0.05	
		Channel Catfish	1978	PLUG	3	1	17.0	17.0	17.0	0.180	0.180	0.180	1	0.02	0.02	Y
				WHORG	3	1	17.0	17.0	17.0	0.150	0.150	0.150	1	0.08	0.08	
			1985	FILET	5	1	18.2	18.2	18.2				1	0.42	0.42	
			1990	FILET	1	1	14.9	14.9	14.9	0.320	0.320	0.320	1	0.24	0.24	
			1975	FILET	3	3	18.2	16.1	19.4				3	0.05	0.05	
			1983	FILET	5	1	26.6	26.6	26.6	0.420	0.420	0.420	1	0.06	0.06	
		Northern Pike	1978	WHORG	1	1	21.0	21.0	21.0	0.080	0.080	0.080	1	0.01	0.01	Y
		Quillback	1990	FILSK	2	2	12.4	12.1	12.7	0.200	0.200	0.200	2	0.051	0.073	
			1983	FILSK	5	1	12.8	12.8	12.8	0.190	0.190	0.190	1	0.06	0.06	
		Redhorse sp.	1975	FILSK	2	2	11.7	11.1	12.2				2	0.05	0.05	Y
		Sauger	1990	FILSK	2	2	14.6	13.9	15.2	0.335	0.310	0.360	2	0.051	0.068	
		Smallmouth Bass	1978	WHORG	1	1	9.4	9.4	9.4	0.060	0.060	0.060	1	0.01	0.01	Y
			1990	FILSK	2	2	11.8	11.2	12.4	0.215	0.170	0.260	2	0.024	0.027	
		Walleye	1985	FILSK	4	2	18.1	15.1	21.1				2	0.05	0.05	
			2017	FILSK	10	10	17.6	12.6	20.9	0.310	0.159	0.505	2	0.025	0.025	
		Flathead Catfish	2017	FILSK	4	4	19.4	12.5	23.1	0.261	0.098	0.410	2	0.045	0.057	
22-0007-00	RICE	Black Bullhead	1990	FILET	8	1	11.3	11.3	11.3	0.029	0.029	0.029	1	0.01	0.01	Y
		Common Carp	1990	FILSK	7	1	17.7	17.7	17.7	0.020	0.020	0.020	1	0.014	0.014	
		Yellow Perch	1990	FILSK	8	1	9.6	9.6	9.6	0.025	0.025	0.025	1	0.01	0.01	Y
22-0023-00	WALNUT	Common Carp	1990	FILSK	2	1	13.9	13.9	13.9	0.020	0.020	0.020	1	0.01	0.01	Y
		Yellow Perch	1990	FILSK	8	1	9.6	9.6	9.6	0.050	0.050	0.050	1	0.01	0.01	Y

		Crappie sp.	1990	FILSK	4	1	8.3	8.3	8.3	0.026	0.026	0.026				
32-0017-00	INDEPENDENCE*	Black Bullhead	2015	FILET	8	1	11.1	11.1	11.1	0.063	0.063	0.063	1	0.01	0.01	Y
		Walleye	2015	FILSK	8	8	16.4	13.1	21.5	0.281	0.218	0.382				
		Yellow Perch	2015	FILSK	9	1	7.6	7.6	7.6	0.084	0.084	0.084				
46-0012-00	IMOGENE	Common Carp	2015	FILSK	5	1	21.5	21.5	21.5	0.019	0.019	0.019				
		Northern Pike	2015	FILSK	5	5	19.4	18.6	20.0	0.015	0.013	0.018				
		Yellow Perch	2015	FILSK	10	1	9.1	9.1	9.1	0.014	0.014	0.014				
46-0024-00	GEORGE	Black Crappie	2009	FILSK	10	2	8.8	8.3	9.3	0.019	0.019	0.019				
		Common Carp	2009	FILSK	3	1	24.2	24.2	24.2	0.029	0.029	0.029				
		Channel Catfish	2009	FILET	8	8	16.2	13.9	22.1	0.018	0.010	0.043				
46-0030-00	BUDD**	Common Carp	1993	FILSK	22	5	21.9	13.6	30.0	0.015	0.010	0.037	5	0.161	0.25	
			2001	FILSK	4	1	23.8	23.8	23.8	0.055	0.055	0.055	1	0.1	0.1	
			2009	FILSK	5	1	22.9	22.9	22.9	0.019	0.019	0.019				
		Channel Catfish	2001	FILET	8	8	17.9	12.9	22.8	0.024	0.006	0.045	7	0.027	0.06	
			2009	FILSK	8	8	14.6	11.8	16.5							
		Walleye	1993	FILSK	8	1	11.9	11.9	11.9	0.026	0.026	0.026	1	0.01	0.01	Y
			1969	PLUG	3	3	15.1	14.4	16.5				3	0.547	0.9	
		White Crappie	2001	FILSK	10	1	8.2	8.2	8.2	0.015	0.015	0.015				
		White Sucker	1969	FILET	2	2							2	0.001	0.001	Y
		Yellow Perch	1993	FILSK	10	1	9.0	9.0	9.0	0.010	0.010	0.010	1	0.01	0.01	Y
			2009	FILSK	8	1	7.4	7.4	7.4	0.026	0.026	0.026				
		Largemouth Bass	1969	FILET	1	1							1	0.001	0.001	Y
46-0031-00	HALL	Black Bullhead	1986	FILET	9	1	9.8	9.8	9.8	0.040	0.040	0.040				
		Black Crappie	2001	FILSK	9	1	7.8	7.8	7.8	0.010	0.010	0.010				
			2018	BIOPSYSK	10	1	9.2	9.2	9.2	0.032	0.032	0.032	1	0.025	0.025	Y
		Common Carp	1986	FILSK	5	1	20.7	20.7	20.7	0.040	0.040	0.040	1	0.109	0.109	
			2001	FILSK	4	1	20.3	20.3	20.3	0.047	0.047	0.047	1	0.09	0.09	
			2011	FILSK	5	1	18.2	18.2	18.2	0.025	0.025	0.025				
			2018	BIOPSYSK	1	1	10.7	10.7	10.7	0.010	0.010	0.010	1	0.025	0.025	
		Channel Catfish	2001	FILET	6	6	19.6	13.1	25.3	0.026	0.008	0.053	1	0.05	0.05	Y
			2011	FILET	8	8	19.3	15.6	23.8	0.015	0.010	0.031	2	0.09	0.155	
		Northern Pike	1984	FILSK	4	1	22.8	22.8	22.8	0.060	0.060	0.060	1	0.05	0.05	
		Quillback	2018	BIOPSYSK	1	1	18.6	18.6	18.6	0.014	0.014	0.014	1	0.049	0.049	Y

		Walleye	1970	PLUG	2	2	15.1	14.7	15.5	0.050	0.020	0.080				
			1984	FILSK	5	1	18.6	18.6	18.6	0.100	0.100	0.100	1	0.05	0.05	Y
			2018	BIOPSYSK	6	4	16.8	14.7	17.9	0.049	0.034	0.064	4	0.025	0.025	Y
		White Crappie	2001	FILSK	4	1	7.7	7.7	7.7	0.014	0.014	0.014				
		White Sucker	2018	BIOPSYSK	1	1	18.2	18.2	18.2	0.030	0.030	0.030	1	0.025	0.025	Y
		Yellow Perch	2011	FILSK	8	2	9.6	8.9	10.2	0.012	0.010	0.013				
		Bluegill sunfish	1970	PLUG	2	2	8.5	8.3	8.6	0.025	0.020	0.030				
			1984	FILSK	10	1	7.7	7.7	7.7	0.030	0.030	0.030	1	0.05	0.05	Y
		Bigmouth Buffalo	2018	BIOPSYSK	2	2	16.9	14.1	19.6	0.016	0.014	0.018	2	0.025	0.026	
46-0109-00	FOX	Black Crappie	2007	FILSK	10	1	9.1	9.1	9.1	0.046	0.046	0.046				
			1996	FILSK	10	1	9.5	9.5	9.5	0.050	0.050	0.050				
		Common Carp	1996	FILSK	13	4	21.2	17.3	26.9	0.040	0.020	0.060	3	0.05	0.08	
		Channel Catfish	2007	FILET	6	6	19.4	16.5	23.5	0.036	0.027	0.068	1	0.01	0.01	Y
		Walleye	2017	FILSK	8	8	15.2	12.0	19.5	0.045	0.033	0.054				
			1996	FILSK	15	3	17.4	13.6	20.3	0.103	0.060	0.130	1	0.01	0.01	Y
		White Crappie	2007	FILSK	10	1	9.5	9.5	9.5	0.075	0.075	0.075				
		Yellow Perch	2017	FILSK	8	1	7.1	7.1	7.1	0.019	0.019	0.019				
		Bluegill Sunfish	2007	FILSK	7	1	7.4	7.4	7.4	0.026	0.026	0.026				
		Bigmouth Buffalo	2017	FILSK	5	1	12.9	12.9	12.9	0.026	0.026	0.026				
46-0121-00	CEDAR	Common Carp	2010	FILSK	8	1	23.2	23.2	23.2	0.010	0.010	0.010				
		Yellow Perch	2010	FILSK	8	2	8.5	8.0	9.0	0.010	0.010	0.010				
46-0133-00	BIG TWIN*	Black Crappie	2000	WHORG	10	10	7.3	6.6	8.3	0.082	0.010	0.210				
			2008	FILSK	8	1	9.7	9.7	9.7	0.060	0.060	0.060				
		Common Carp	2008	FILSK	3	1	21.1	21.1	21.1	0.052	0.052	0.052				
		Walleye	2000	FILSK	23	23	15.3	6.4	25.8	0.097	0.010	0.380				
			2008	FILSK	3	3	16.4	13.7	20.3	0.080	0.052	0.119				
46-0145-00	FISH	Black Crappie	2015	FILSK	10	1	6.4	6.4	6.4	0.010	0.010	0.010				
		Common Carp	2015	FILSK	4	1	22.1	22.1	22.1	0.041	0.041	0.041				
		Channel Catfish	2015	FILET	8	8	14.3	11.7	19.4	0.016	0.010	0.039				
		Walleye	2015	FILSK	8	8	11.8	10.9	13.0	0.013	0.010	0.016				

* Impaired for mercury in fish tissue as of 2020 Draft Impaired Waters Inventory; categorized as EPA Category 4a for waters covered by the Statewide Mercury TMDL.

** Impaired for PCBs in fish tissue as of 2020 Draft Impaired Waters Inventory; categorized as EPA Category 5 for waters needing a TMDL.

1 Anatomy codes: BIOPSYSK—dorsal muscle plug using biopsy sampler or scalpel, with skin, PLUG—dorsal muscle plug without skin; FILSK – fillet with skin; FILET—fillet without skin; WHORG—whole organism.

Pollutant load monitoring

The WPLMN has three major watershed sites within the Blue Earth River Watershed as shown in Table 23. The Watonwan and Le Sueur Rivers are tributaries of the Blue Earth River and because of their size are classified as 8 digit HUC watersheds along with the Blue Earth River. In combination, the Blue Earth, Watonwan, and Le Sueur Rivers are often referred to as the Greater Blue Earth River basin or watershed. The Blue Earth River gaging station used by the WPLMN is the Blue Earth River near Rapidan (USGS), which is located below the confluence of the Watonwan River and includes the waters draining both the upper Blue Earth and Watonwan River watersheds. The WPLMN also uses the Watonwan River near Garden City (USGS) gage to compute pollutant loads for the Watonwan River. For this report, the Watonwan River pollutant loads were not subtracted from the Blue Earth River near Rapidan loads but were included in the maps and graphs below. Several subwatershed sites also exist throughout the Greater Blue Earth River Watershed but are not included in the report.

Table 27. Waste pollutant load monitoring sites for the Blue Earth River Watershed.

Site Type	Stream Name	USGS ID	DNR/MPCA ID	EQuIS ID
Major Watershed	Watonwan River nr Garden City, CSAH13	05319500	E31051001	S000-163
Major Watershed	Blue Earth River nr Rapidan, MN	05320000	E30092001	S001-231
Major Watershed	Le Sueur River nr Rapidan	05320500	E32077001	S000-340

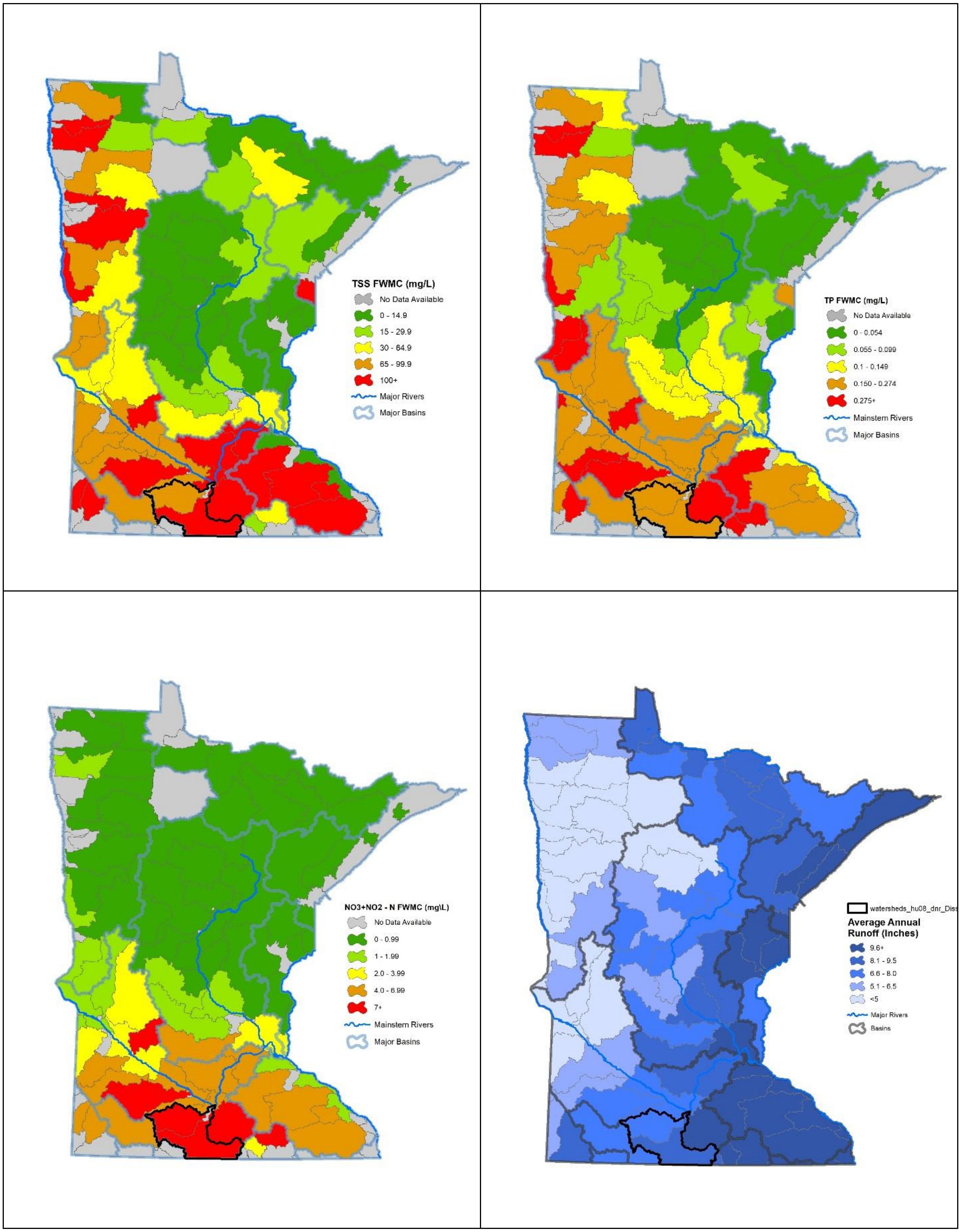
Average annual FWMCs of TSS, TP, and NO3+NO2-N for major watershed stations statewide are presented below, with the Blue Earth and Watonwan River watersheds highlighted. Water runoff, a significant factor in pollutant loading, is also shown. Water runoff is the portion of annual precipitation that makes it to a river or stream; this can be expressed in inches.

As a general rule, elevated levels of TSS and NO3+NO2-N are regarded as nonpoint source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess TP can be attributed to both non-point as well as point sources of pollution such as industrial or wastewater treatment plants. Major nonpoint sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Excessive TSS, TP, and NO3+NO2-N in surface waters impacts fish and other aquatic life, as well as fishing, swimming and other recreational uses. High levels of NO3+NO2-N is a concern for drinking water.

When compared with other major watersheds throughout the state, the average annual TSS, TP, and NO3+NO2-N FWMCs for the Blue Earth River is among the highest levels recorded in Minnesota (Figure 28).

Figure 28. 2007-2015 Average annual TSS, TP, and NO3-NO2-N flow weighted mean concentrations, and runoff by major watershed.



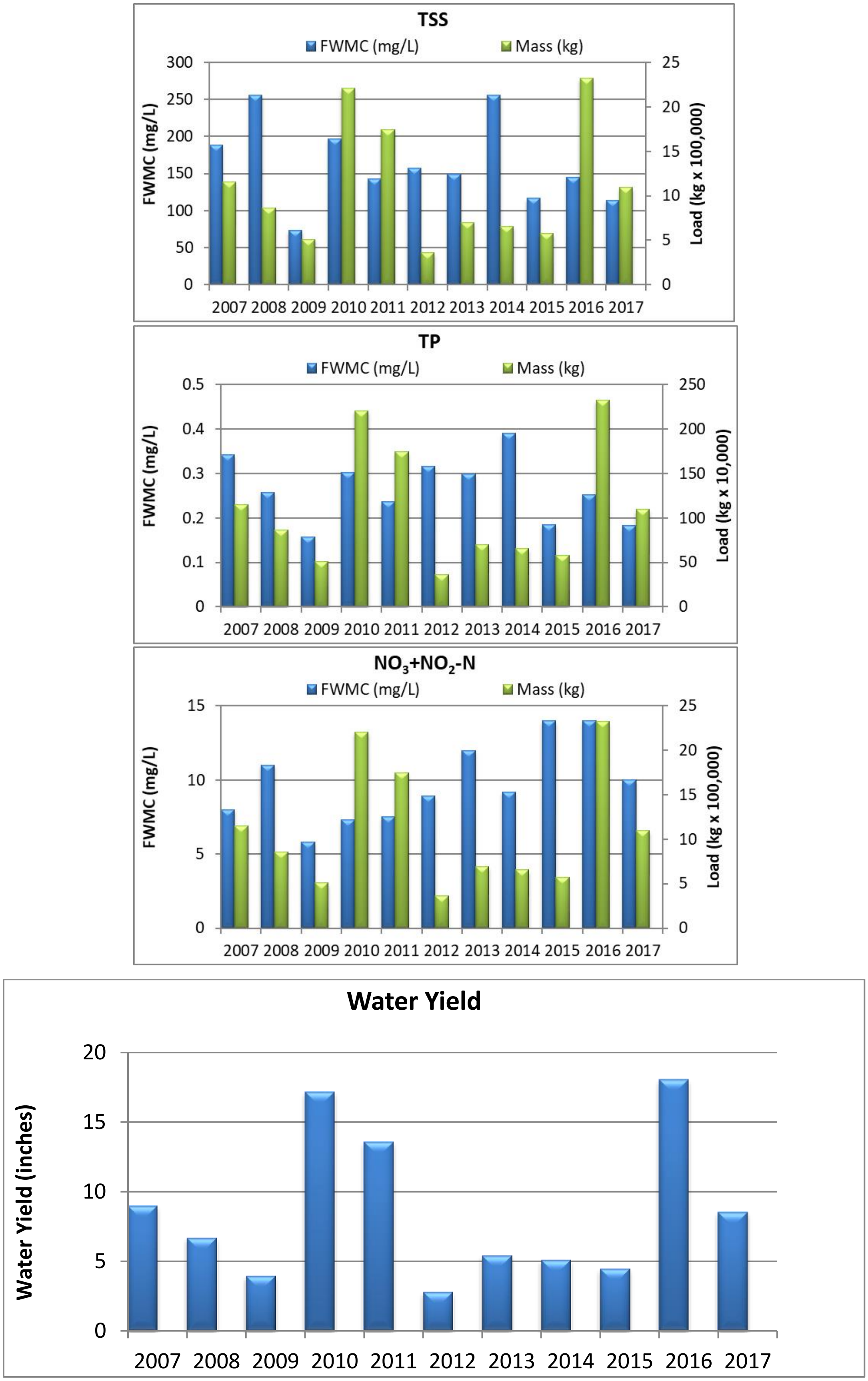
More information, including results for subwatershed stations, can be found at the WPLMN website.

Substantial year-to-year variability in water quality occurs for most rivers and streams, including the Blue Earth River. Results for individual years are shown in Figure 29.

The disproportionate pollution loading effects of the Minnesota River basin on the upper Mississippi River are well documented. Average TSS, NO_3-NO_2-N, and TP loads (2007-2016) measured at the furthest downstream site on the Minnesota River (Minnesota River at Fort Snelling) are the equivalent of 91%, 75%, and 57%, respectively, of the loads measured at the Mississippi River site closest to the inlet of Lake Pepin (Mississippi River at Lock and Dam #3 - LD #3). The Minnesota River basin accounts for 36% of the total drainage area of above Lock and Dam #3.

Within the Minnesota River basin, the effects of the Greater Blue Earth River alone are the equivalent of 60% of the TSS, 34% of the NO_3-NO_2-N, and 24% of the TP loads measured at LD#3. The Blue Earth and Le Sueur rivers account for the vast majority of these pollutants while only accounting for 5% of the drainage area above Lock and Dam #3.

Figure 29. Total suspended solids (TSS), total phosphorous (TP), and NO3+NO2-N flow weighted mean concentrations (FWMC), loads and water yields for the Blue Earth River near Rapidan, Minnesota.



Groundwater monitoring

Groundwater quality

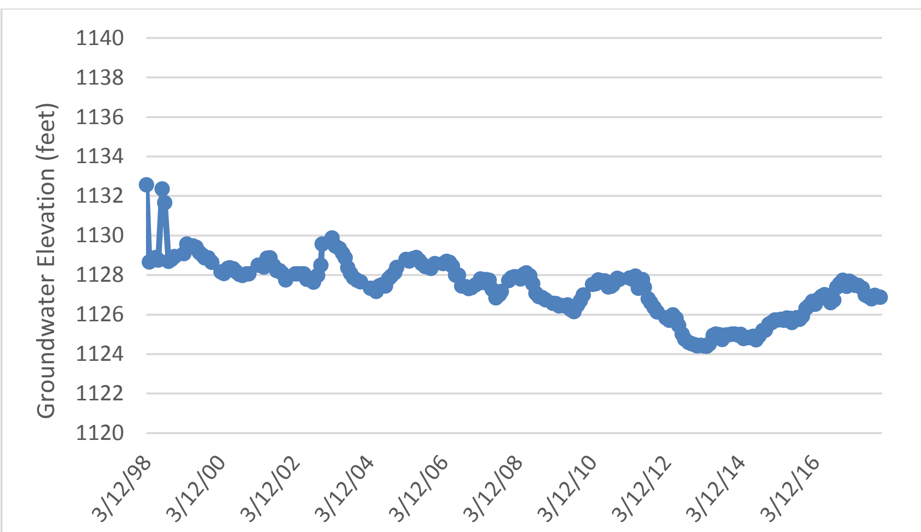
Currently, there is one MPCA Ambient Groundwater Monitoring well actively monitored within the Blue Earth River Watershed. Data from this well and past sampling of others indicate the presence of naturally-occurring minerals like iron and manganese as well as some elevated arsenic levels.

Another source of information on groundwater quality comes from the MDH. Mandatory testing for arsenic, a naturally occurring but potentially harmful contaminant for humans, of all newly constructed wells has found that an average of 10% of all wells installed from 2008 to 2016 have arsenic levels above the maximum contaminant level (MCL) for drinking water of 10 micrograms per liter (MDH, 2019a). The Blue Earth River Watershed is largely within Faribault and Martin counties and contains portions of Blue Earth, Jackson and Freeborn counties. The frequency of arsenic levels above the MCL in new wells in these counties ranged from 10.9% (Jackson) to 27.1% (Faribault and Blue Earth). (MDH 2020)

Groundwater quantity

The DNR maintains a statewide network of water level wells to assess groundwater resources, evaluate trends and plan for the future. There are a number of deep wells monitored within the Blue Earth River Watershed, but a shallow well is more reactive to recharge and withdrawals. However, many of the shallow aquifers in this watershed are buried aquifers, which recharge much more slowly. Groundwater elevations since 1998 from well #168351 are displayed below. While levels appear to have fluctuated within just a few feet of one another, the decreasing trend is statistically significant.

Figure 30. Water table elevations in Well #168351 near Elmore 1998-2018.



The DNR also permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons per day or 1 million gallons per year. Permit holders are required to track water use and report back to the DNR annually. The changes in withdrawal volume detailed in this groundwater report are a representation of water use and demand in the watershed and are taken into consideration when the DNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

The three largest permitted consumers of water in the state for 2017 were (in order) power generation, public water supply (municipals), and irrigation (DNR, 2019). According to the most recent DNR Permitting and Reporting System (MPARS), in 2017 the two largest use categories for withdrawals within the Blue Earth River Watershed were livestock watering (43%) and sand and water supply (25%).

Figure 31 displays total high capacity withdrawal locations within the watershed with active permit status in 2017. Permitted groundwater withdrawals are displayed below as blue squares and surface water withdrawals as red triangles. During 1997 to 2017, groundwater and surface water withdrawals within the Blue Earth River Watershed exhibit no significant trend (Figure 32).

Figure 31. Locations of active status permitted high capacity withdrawals in 2017 within the Blue Earth River Watershed (DNR, 2019).

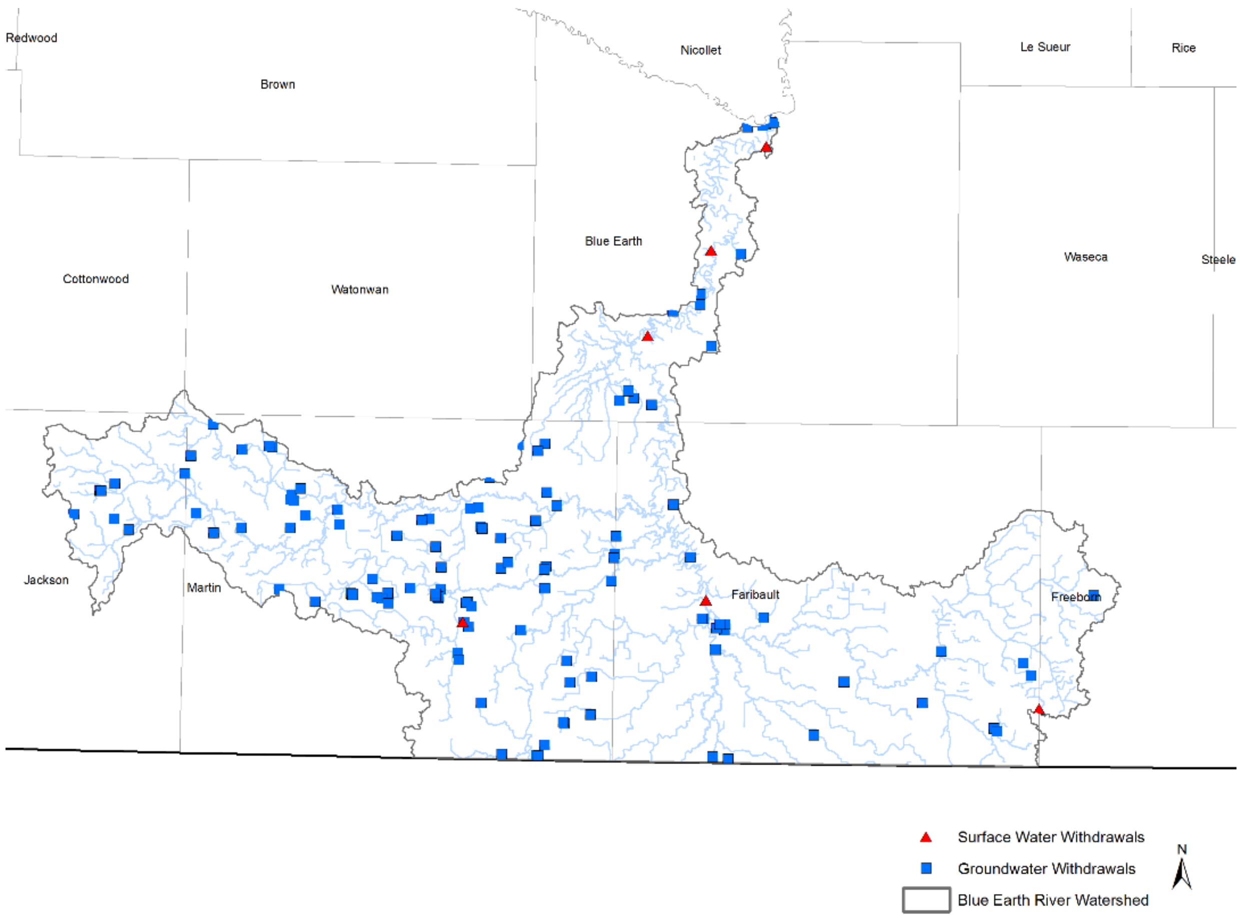
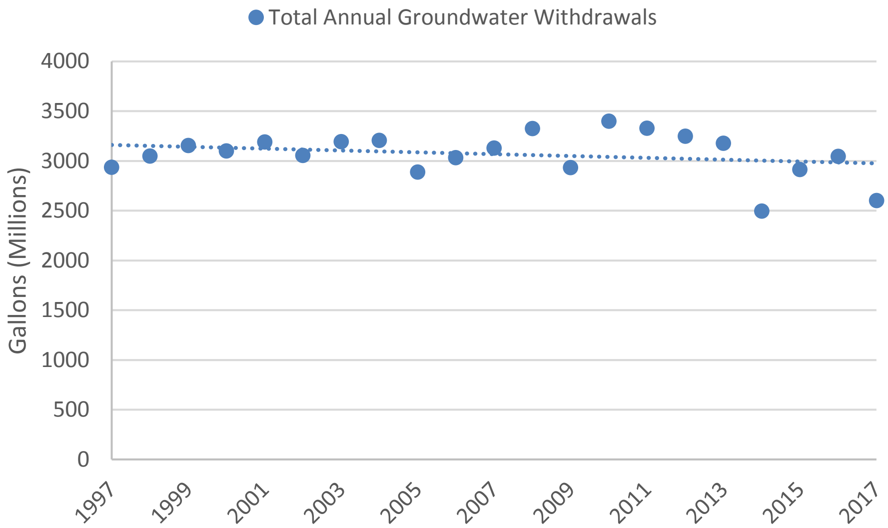
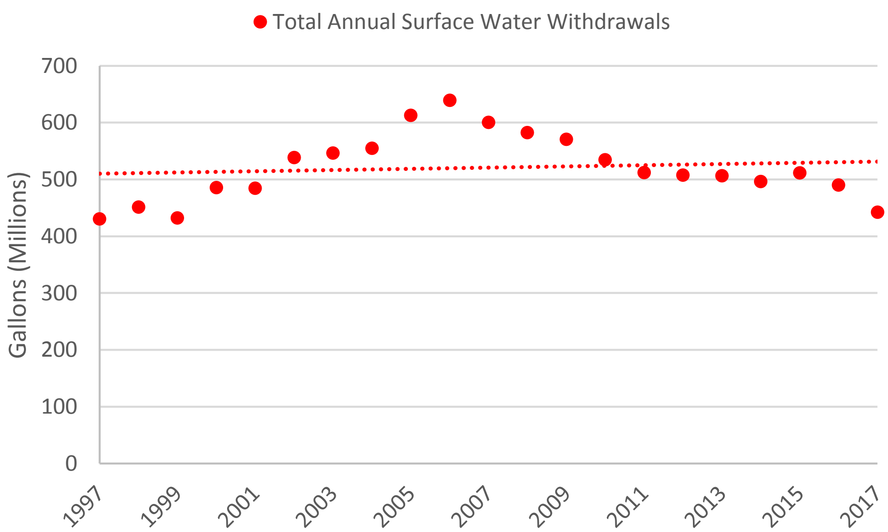


Figure 32. Total annual groundwater (top) and surface water (bottom) withdrawals in the Blue Earth River Watershed (1997-2017).

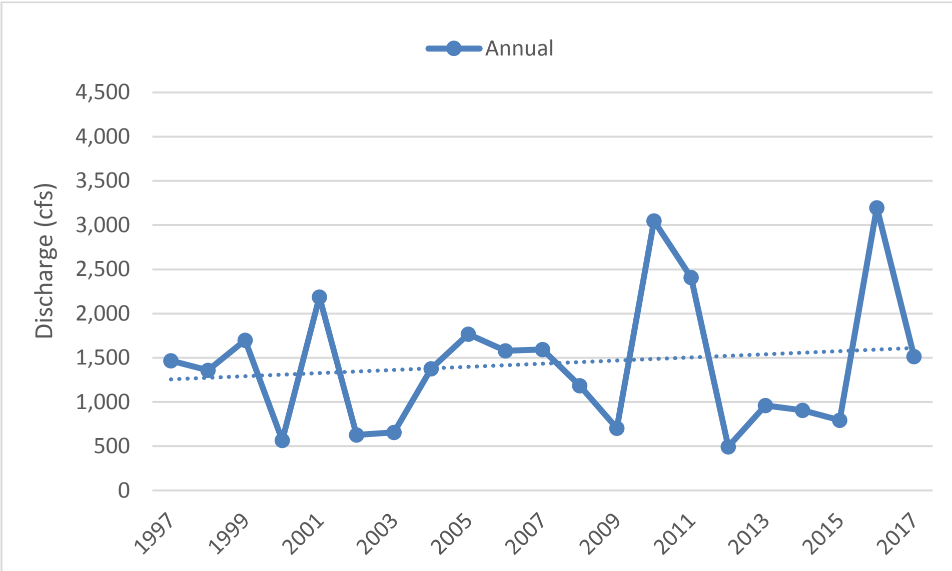


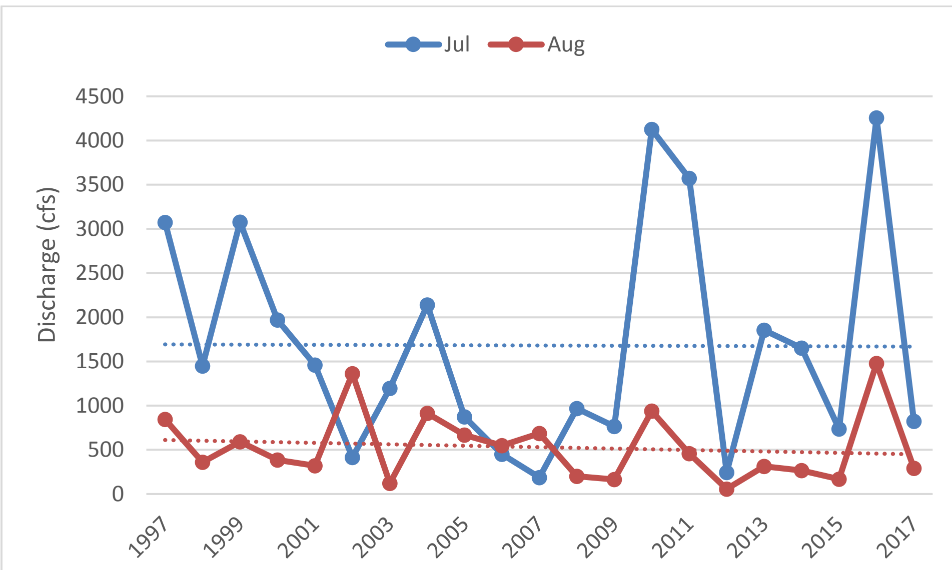


Stream flow

Stream flow data from the USGS's real-time streamflow gaging station on the Blue Earth River near Rapidan were analyzed for average annual discharge and summer (July and August) monthly average discharge from 1997-2017 (Figure 33). The data fluctuate, but these changes illustrate seasonality of flow and responses to precipitation and are not statistically significant. By way of comparison at a state level, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends (Streitz, 2011).

Figure 33. Average annual (top) and average summer (bottom) discharge of the Blue Earth River near Rapidan, Minnesota (1997-2017).





Wetland condition

Wetland vegetation quality is generally high in Minnesota. This is driven by the large share of wetlands located in Mixed Wood Shield (i.e., northern forest) ecoregion where development and resulting stressors are much less widespread (and wetland condition is largely intact) compared to the rest of the state. Wetlands in exceptional or good biological condition have few (if any) changes in their expected native species composition or abundance distribution. Wetland vegetation quality is largely degraded in the remainder of the state, where non-native invasive plant species (most notably Reed canary grass and Narrow leaf/Hybrid cattail) have replaced native wetland plant communities over the majority of the remaining wetland extent (Bourdaghs et al. 2019). High abundance of non-native invasive plant species is associated with a broad spectrum of wetland stressors and may also occur in the absence of stressors.

As the Blue Earth River Watershed is located entirely in the Temperate Prairies ecoregion, the few remaining wetlands are expected to have fair to poor (or degraded) vegetation quality. An estimated 84% of the wetland acreage in the Temperate Prairies has fair-poor vegetation quality and the few sites that were sampled in the ecoregion with good to exceptional vegetation quality are located in far northwestern Minnesota (Bourdaghs et al. 2019). Plant communities assessed as fair-poor condition have had moderate to extreme changes (e.g., complete replacement of native species by non-native invasives) in their expected species composition and abundance distributions. Vegetation community changes where non-native invasive species take over typically are not self-correcting and can persist even if the human caused stressors are reduced or managed.

Depressional wetlands with open water in the Blue Earth River Watershed are likely in somewhat better quality in terms of macroinvertebrate condition. Fair to poor macroinvertebrate quality was present at an estimated 68% of the depressional wetland basins in the Temperate Prairies ecoregion, with a corresponding 32% in good condition (Genet et al. 2019). The difference in quality between macroinvertebrates and vegetation is likely due to there not being a non-native invasive issue in the macroinvertebrate community and that the macroinvertebrates likely have a better ability to recover if stressors are removed.

Figure 34. Stream tiered aquatic life use designations in the Blue Earth River Watershed.

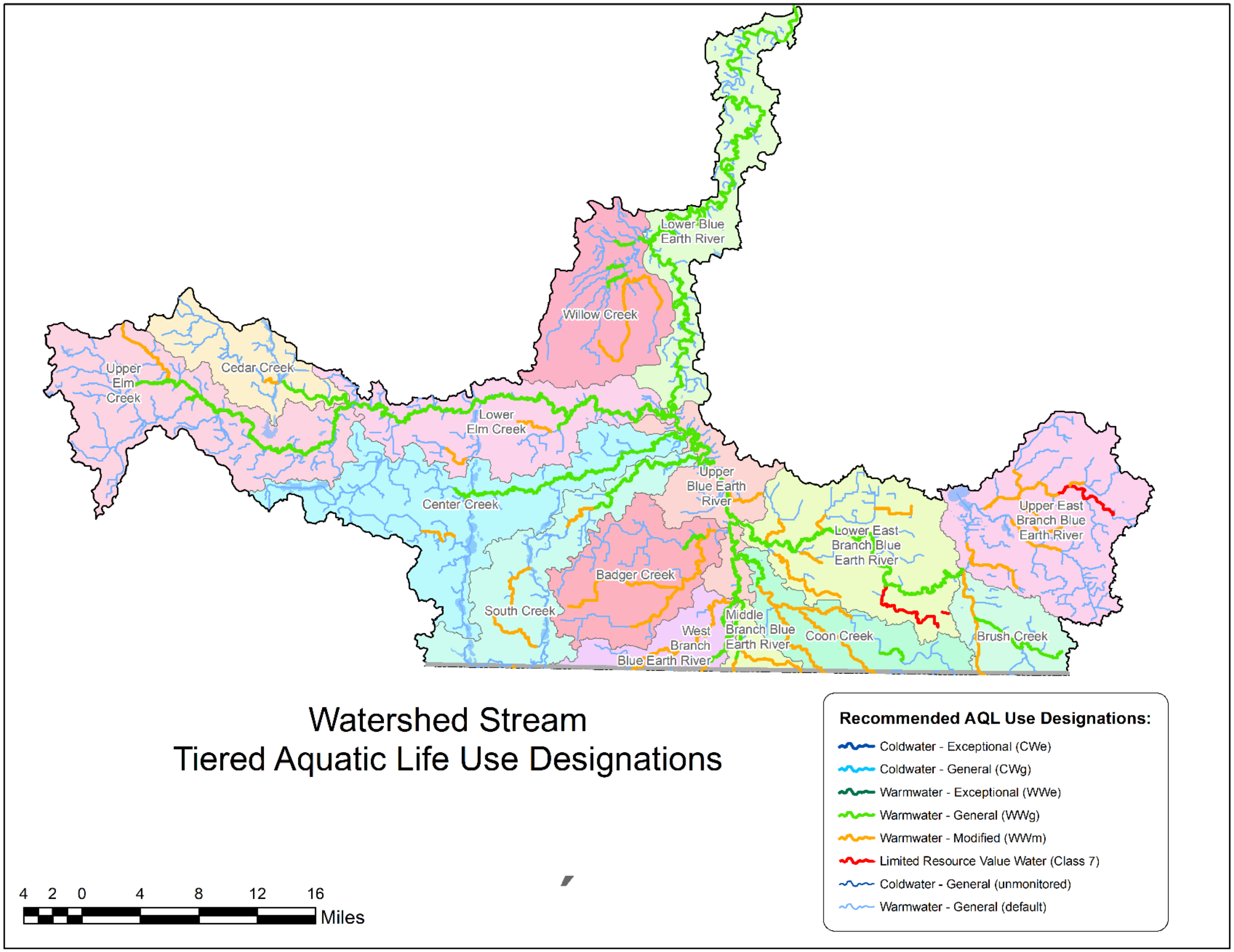


Figure 35. Fully supporting waters by designated use in the Blue Earth River Watershed.

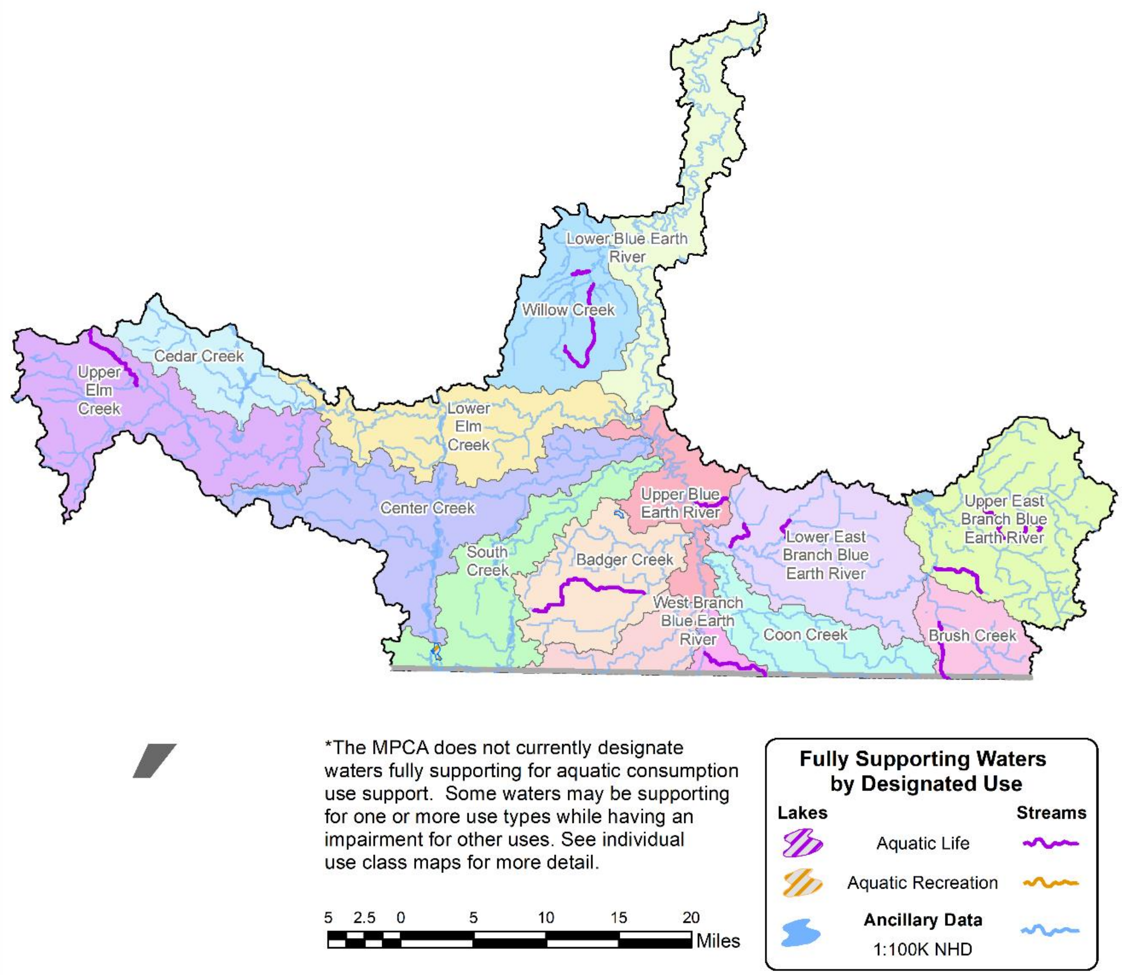


Figure 36. Impaired waters by designated use in the Blue Earth River Watershed.

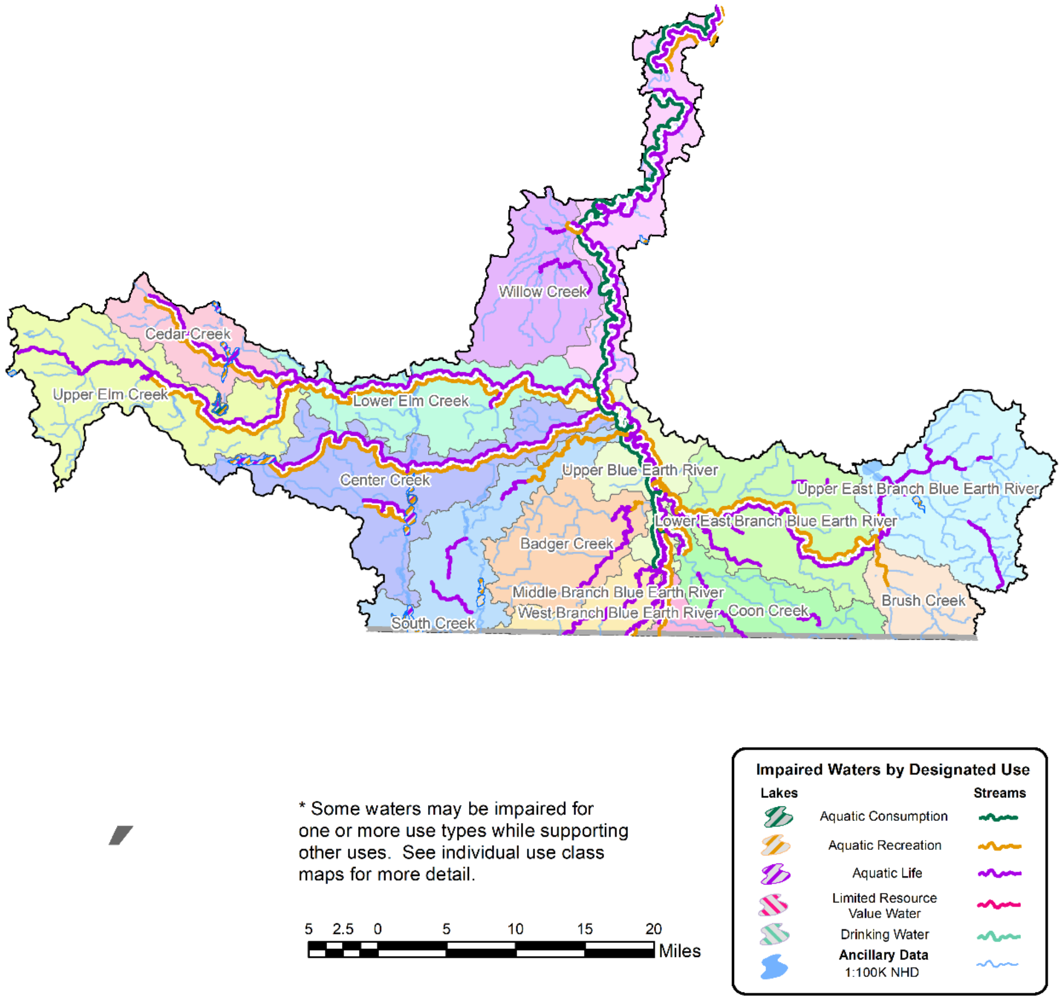


Figure 37. Aquatic consumption use support in the Blue Earth River Watershed.

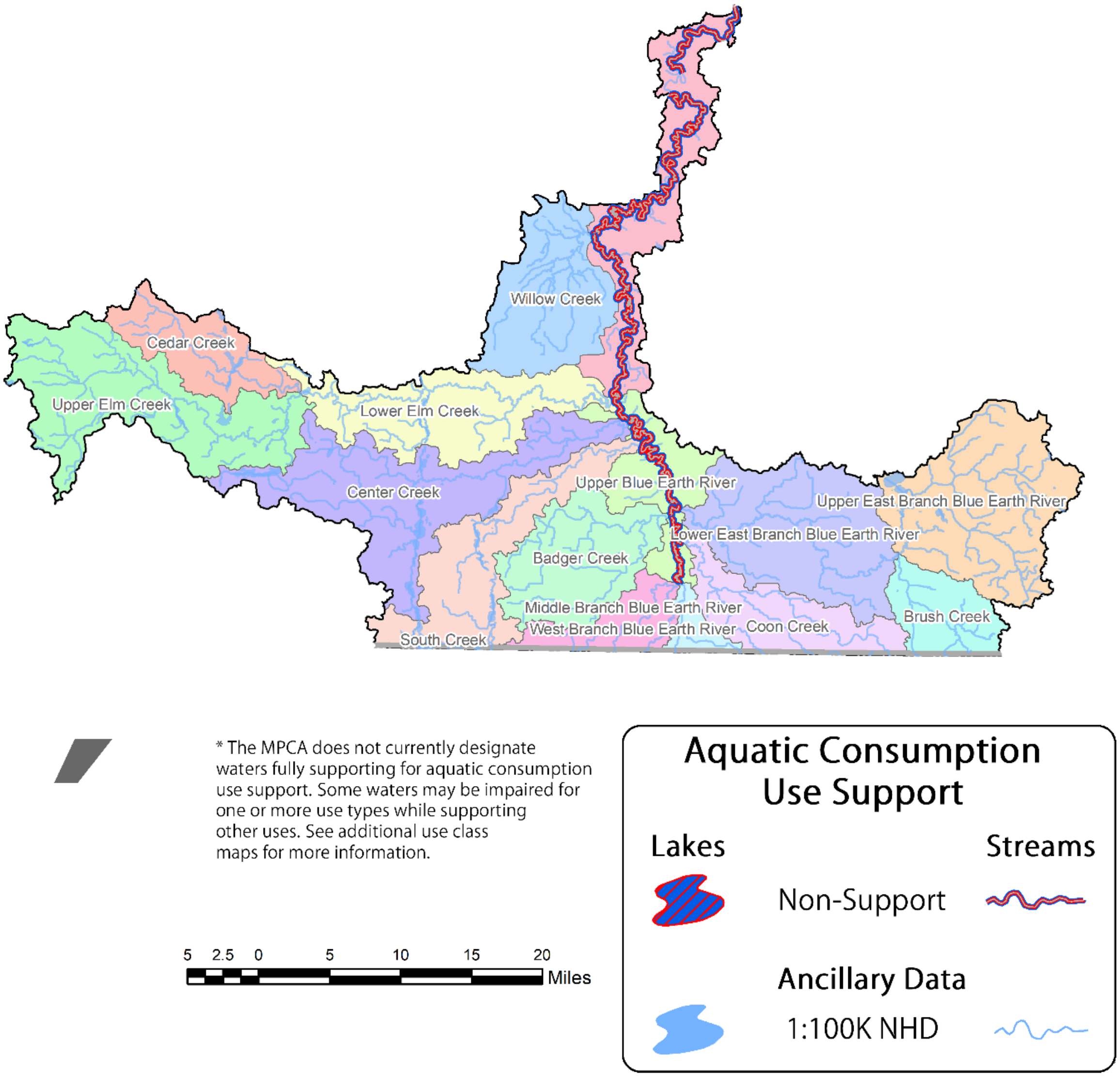


Figure 38. Aquatic life use support in the Blue Earth River Watershed.

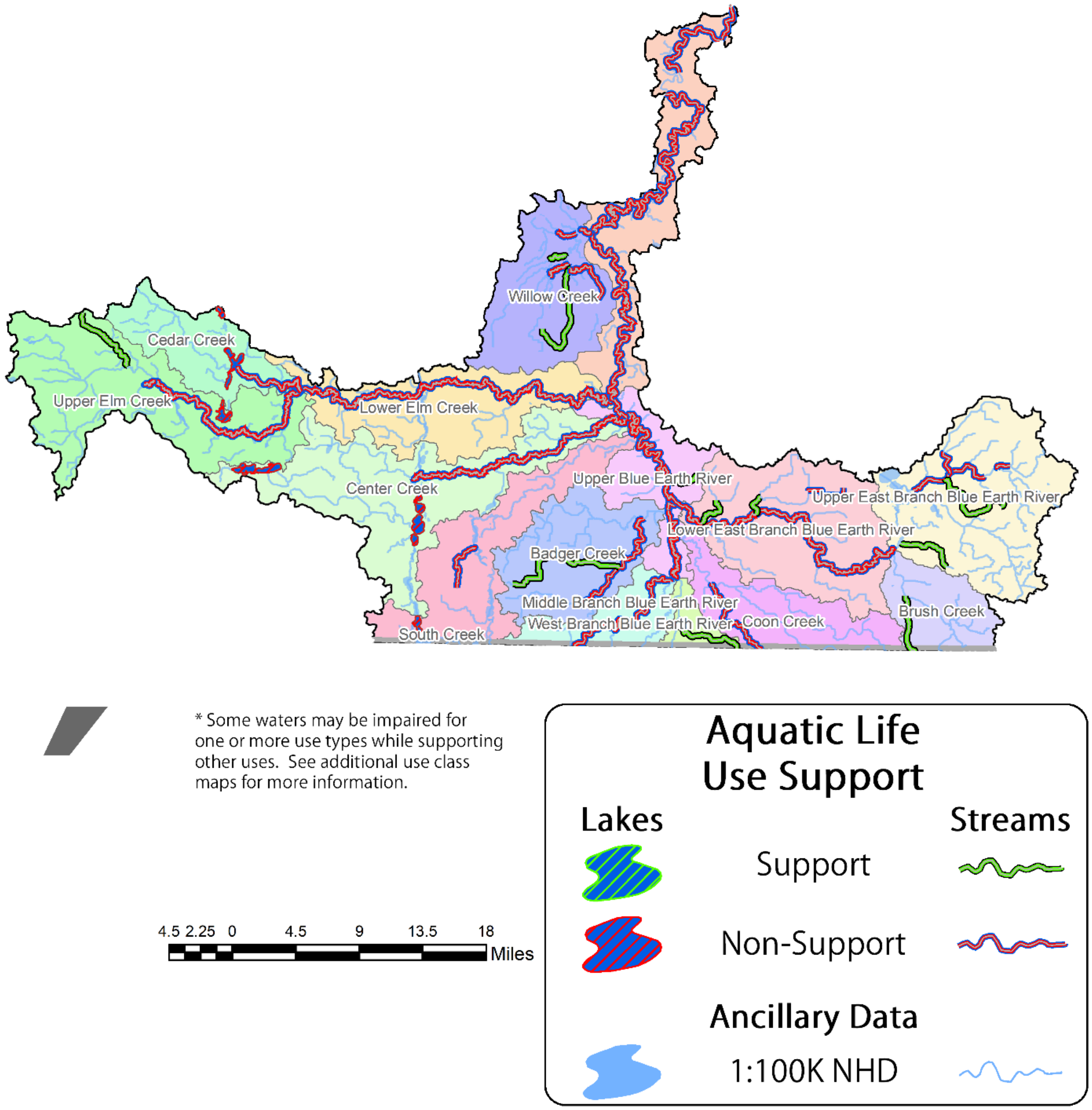
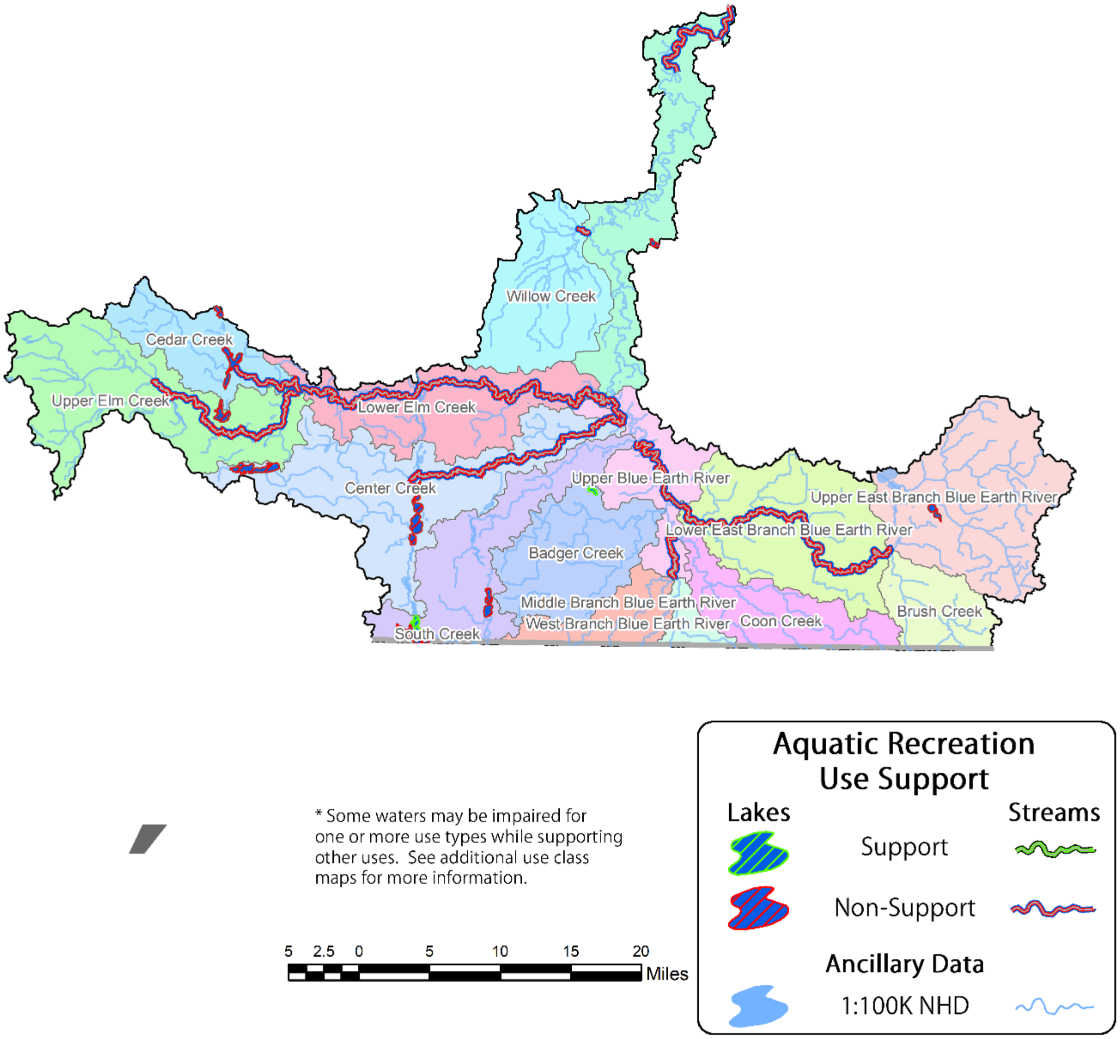


Figure 39. Aquatic recreation use support in the Blue Earth River Watershed.



Transparency trends for the Blue Earth River Watershed

MPCA completes annual trend analysis on lakes and streams across the state based on long-term transparency measurements. The data collection for this work relies heavily on volunteers across the state and also incorporates any agency and partner data submitted to EQuIS.

The trends are calculated using a Seasonal Kendall statistical test for waters with a minimum of eight years of transparency data; Secchi disk measurements in lakes and Secchi tube measurements in streams.

Citizen volunteer monitoring occurs at 14 streams and 6 lakes in the watershed. Recent data analysis indicate increasing water clarity trends on 15 stream reaches, and decreasing water clarity trends on 14 streams. No lakes or streams have been identified as having an increasing or decreasing water clarity trend, however six lakes were found to show no change in water clarity. Extensive datasets are required for developing accurate long-term trend in water quality. Maintaining current citizen monitoring programs, adding more volunteers, and expanding monitoring activities throughout the watershed will be ideal for tracking water quality changes over time.

Table 28. Water clarity trends.

Blue Earth River HUC 07020009	Streams	Lakes
Number of sites w/increasing trend	15	0
Number of sites w/decreasing trend	14	0
Number of sites w/no trend	24	6

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

Priority waters for protection and restoration in the Blue Earth River Watershed

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

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

The results for selected indicators and the risk priority ranking for each lake are shown in Appendix 6. Protection priority should be given to lakes that are particularly sensitive to an increase in phosphorus with a documented decline in water quality (measured by Secchi transparency), a comparatively high percentage of developed land use in the area, or monitored phosphorus concentrations close to the water quality standard. In the Blue Earth River Watershed, highest protection priority is suggested for South Silver Lake.

The results for selected indicators and risk priority ranking for each stream are shown in Appendix 7. Stream protection is driven by how close the stream is to having an impaired biological community, density of roads and disturbed land use in the immediate and larger drainage area, and how much land is protected in the watershed. In the Blue Earth River Watershed, 18 modified use streams were identified as high priority. In addition, two General Use streams, South Creek (07020009-640) and Unnamed Creek (07020009-617), scored as high priority for protection efforts. While these streams currently meet standards, work done to maintain current condition is important to prevent impairment in the future.

Summaries and recommendations

Water quality conditions in the Blue Earth River Watershed reflect the land use, hydrologic modifications, and discharge of pollutants (point and nonpoint) upstream of each monitoring location. Beginning in the middle 19th century and continuing through present day, dramatic alterations to stream channels, aquatic habitats, and surficial hydrology have had profound impacts to water quality in the region. These alterations have brought about a stark shift in the biological communities that these waters are capable of supporting.

Large-scale modifications to stream channels and artificial drainage tiling throughout the landscape have resulted in a largely engineered surficial hydrology in which water from precipitation moves through the watershed much differently than through an unaltered landscape. The loss of wetlands and increased soil drainage come at a cost to water retention and storage. Rain events result in a rapid spike in discharge volumes, while intervening periods of low precipitation result in lower-than normal flows. High discharge events destabilize and erode stream banks, resulting in high sediment input and ever-wider, shallower channels. Bank destabilization contributes to the loss of riparian tree cover and rooted perennial vegetation that can render stream banks even more vulnerable to erosive flows. The loss of riparian vegetation reduces shade and can contribute to increasing water temperatures. Streams impacted by these processes are characterized by uniform depths, homogenous fine substrates, and a lack of well-developed riffle-pool-run sequences; they provide little habitat for diverse and healthy aquatic communities.

Overall scores of biological communities in the Blue Earth River Watershed were fair to poor. Of 66 streams that were assessed for aquatic life use support, only 29% (n=19) were determined to be supporting of their designated aquatic life use for both fish and invertebrate communities. Of these 19 streams, 17 were supporting for modified use (which holds biological communities to a lower threshold than general use waters), and only two streams met general use expectations for both fish and invertebrate communities.

Approximately half of the 65 reaches that were assessed for fish assemblage did not meet aquatic life use standards and were listed as impaired. Of the 32 reaches of stream that were determined to be supporting aquatic life for fish, only five of these reaches were General Use waters: the lower reach of South Creek, the lower reach of Cedar Creek, a reach of Judicial Ditch 13 in the Coon Creek subwatershed, and two unnamed tributaries to Willow Creek.

A total of 53 fish species were collected in the Blue Earth River Watershed. The most commonly collected and numerous fish were generally species that are tolerant to degradations to habitat and water quality, though some species that require some amount of course substrate and flow were common throughout the watershed. More individuals of fathead minnow, a generalist species that thrives in degraded habitats, were collected than any other fish species.

Macroinvertebrate communities scored better in general than fish communities throughout the Blue Earth River Watershed. Macroinvertebrate communities met aquatic life use standards in 65% (n=43) of 66 assessed reaches. Of these 43 stream reaches that supported aquatic life use for macroinvertebrate communities, 17 were general use waters. The most commonly collected invertebrate taxa were midges of the genus *Polypedilum* in terms of the number of sites where present, and the tolerant snail genus *Physella* in terms of the number of overall individuals.

Many of the tributaries to the Blue Earth River have symptoms of water quality problems that are directly contributing to poor water quality in downstream waterbodies (e.g. the Minnesota River, Lake Pepin). A number of water chemistry parameters were evaluated to assess aquatic life use and aquatic recreation use on 73 stream reaches in the Blue Earth River Watershed. Past assessment efforts resulted in numerous turbidity listings. Total suspended solids and/or Secchi tube data confirmed most of the previous listings for turbidity and therefore will remain listed. Elevated sediment concentrations carried by many of these tributaries on a consistent basis are not typical of good water quality, drastically impacting aquatic communities. High phosphorus concentrations were found throughout the watershed. Phosphorus and sediment concentrations will require work to reduce overland runoff in the watershed. Stream riparian buffers provide a source for water and nutrients to infiltrate naturally. Future investigation, implementation, and restoration work will be prudent in order to achieve any long-term water quality improvements in the Blue Earth River Watershed.

Not a single stream in the Blue Earth River Watershed was determined to be supporting aquatic recreation. Twenty-seven streams were assessed for aquatic recreation, and all 27 were found to not support the use. Past fecal coliform datasets triggered seven aquatic recreation use listings throughout this watershed; more recent bacteria data confirmed almost all of the initial listings during this assessment cycle. Further investigations into patterns of elevated bacteria concentrations may be helpful to target specific sources. Concentrated animal activity within the stream or immediately adjacent to the flood plain is typically associated with high bacteria levels. Limiting animal access to stream corridors could lower bacteria levels.

Twenty-four lakes had at least one water quality measurement available. Of these lakes, eight had enough water quality information to conduct a formal aquatic recreation use assessment, and nine had enough information to conduct aquatic life use assessments. One lake was found to be fully supporting for aquatic recreation use and seven were found to not support. This watershed consists mainly of shallow lakes. Shallow lakes typically have higher phosphorus concentrations because they are not capable of assimilating phosphorus. All of the lakes that do not support aquatic recreation are relatively shallow and likely mix during large wind events. Lakes that are shallow and have these mixing events are vulnerable to nuisance algal blooms. Increased algal blooms cause water clarity to drop, preventing sunlight penetration and native aquatic plant growth. In these instances, aquatic vegetation within these lakes needs to be prioritized and protected to aid in phosphorus removal and nutrient uptake. Highly connected watersheds can also be at increased risk of eutrophication as nutrient loads from land use or human activities increase, causing water quality to degrade. Poor recreational water quality is likely playing an indirect role in struggling fish communities, as all nine lakes assessed for aquatic life were found to be impaired. The fish community in many lakes included higher than expected numbers of fish species that are tolerant to poor water quality in lakes, such as the common carp, black bullhead, green sunfish, and bigmouth buffalo.

Groundwater protection should be considered both for quantity and quality. Concerns for quality are possible high levels of naturally-occurring elements in drinking water as well as chloride and nitrate from human activities. The concerns for quantity are based on comparing the amount of water withdrawn versus the amount of water being recharged to the aquifer. Recharge is slow in this area of the state and withdrawals in the watershed have not changed significantly. However, groundwater levels have changed significantly in monitored locations. Continued mindfulness of water users and additional monitoring of groundwater quantity will provide the information needed to conserve the resource in the watershed.

Literature cited

Bourdaghs, M., J. Genet, and M. Gernes. 2015. Status and Trends of Wetlands in Minnesota: Vegetation Quality Baseline. wq-bwm-1-09. Minnesota Pollution Control Agency, St. Paul, MN.

Bourdaghs, M., J. Genet, and M. Gernes. 2019. Status and trends of wetlands in Minnesota: Minnesota Wetland Condition Assessment (2011/12 – 2016). wq-bwm1-11. Minnesota Pollution Control Agency. St. Paul, MN.

Kloiber, S.M. and D.J. Norris. 2013. Status and trends of wetlands in Minnesota: wetland quantity trends from 2006 to 2011. Minnesota Department of Natural Resources. St. Paul, MN.

Midwest Regional Climate Center. Climate Summaries. Historical Climate Data. Precipitation Summary. Station: 210355 Austin 3 S, MN. 1971-2000 NCDC Normals. http://mrcc.isws.illinois.edu/climate_midwest/historical/precip/mn/210075_psum.html

Minnesota Department of Agriculture (MDA). 2009. 2009 Water Quality Monitoring Report. Pesticide and Fertilizer Management Division, Minnesota Department of Agriculture, St. Paul, Minnesota. http://www.mda.state.mn.us/~/media/Files/chemicals/reports/2009waterqualitymonrpt.ashx

Minnesota Department of Agriculture (MDA). 2010. 2010 Water Quality Monitoring Report. Pesticide and Fertilizer Management Division, Minnesota Department of Agriculture, St. Paul, Minnesota. http://www.mda.state.mn.us/chemicals/pesticides/~/media/Files/chemicals/maace/2010wqmreport.ashx.

Minnesota Department of Health (2020), Private Wells – Arsenic: MDPH Data Access. Retrieved from https://mndatamaps.web.health.state.mn.us/interactive/wells.html

Minnesota Department of Natural Resources (2017), Groundwater Provinces. Retrieved from http://dnr.state.mn.us/groundwater/provinces/index.html

Minnesota Department of Natural Resources: State Climatology Office (2019a), Annual Precipitation Maps. Retrieved from http://www.dnr.state.mn.us/climate/historical/annual_precipitation_maps.html

Minnesota Department of Natural Resources (2019b), Water use- Water Appropriations Permit Program. Retrieved from http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html

Minnesota Department of Natural Resources: State Climatology Office (2020), Minnesota Climate Trends. Retrieved from https://arcgis.dnr.state.mn.us/ewr/climatetrends/#

Minnesota Geological Survey (MNGS). 1997. Minnesota at a Glance—Quaternary Glacial Geology. Minnesota Geological Survey, University of Minnesota, St. Paul, MN. http://conservancy.umn.edu/handle/59427

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

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

Minnesota Pollution Control Agency (MPCA). 2010a. Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity). http://www.pca.state.mn.us/index.php/view-document.html?gid=14922.

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

Minnesota Pollution Control Agency (MPCA). 2010d. Minnesota Milestone River Monitoring Report. http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/streams-and-rivers/minnesota-milestone-river-monitoring-program.html.

Minnesota Pollution Control Agency (MPCA). 2010e. Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria. http://www.pca.state.mn.us/index.php/view-document.html?gid=6072.

Minnesota Pollution Control Agency (MPCA). 2015. Technical guidance for designating aquatic life uses in Minnesota streams and rivers. Minnesota Pollution Control Agency, St. Paul, MN (Available at: https://www.pca.state.mn.us/sites/default/files/wq-s6-34.pdf).

Minnesota Pollution Control Agency (MPCA). 2017. Incorporating Lake Protection Strategies into WRAPS Reports.

National Resource Conservation Service (NRCS). 2007. Rapid Watershed Assessment: Blue Earth Watershed (MN/IA) HUC: 07020009. NRCS. USDA. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_023174.pdf .

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

State Climatology Office - DNR Division of Ecological and Water Resources. 2010. http://www.climate.umn.edu/doc/hydro_yr_pre_maps.htm.

Smith, D.R., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Wetlands Research Technical Report WRP-DE-9. US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

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

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

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

United States Geological Survey (2020), National Water Information System: Web Interface. USGS 05320000 Blue Earth River near Rapidan, MN. Retrieved from https://waterdata.usgs.gov/nwis/inventory/?site_no=05320000

Western Regional Climate Center (WRCC) (2020), U.S.A. Divisional Climate Data. Retrieved from http://www.wrcc.dri.edu/spi/divplot1map.html

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 wastewater treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

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

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

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

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

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

Unionized ammonia (NH_3) - Ammonia is present in aquatic systems mainly as the dissociated ion NH_4^+, 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 NH_4^+ ions and ^-OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 2.1 – Intensive watershed monitoring water chemistry stations in the Blue Earth River Watershed

EQuIS ID	Biological station ID	WID	Waterbody name	Location	Aggregated 12-digit HUC
S000-036	17MN316	07020009-508	Blue Earth River	At 150th St, 5 mi. S of Winnebago	0702000908-01
S000-135	00MN001	07020009-504	Blue Earth River	At CSAH 4, 4 mi. S of Blue Earth	0702000908-01
S000-519	17MN302	07020009-658	Badger Creek	At 365th Ave. 1.5 mi. W of Blue Earth	0702000908-02
S000-523	17MN308	07020009-514	Blue Earth River	At CSAH 10, 1.5 mi. S of Winnebago	0702000908-01
S000-532	17MN304	07020009-503	Center Creek	At 340th St., 2 mi. S of Winnebago	0702000907-01
S000-534	17MN314	07020009-553	Blue Earth River, East Branch	At CSAH 6 (N Main St) in Blue Earth	0702000905-01
S000-535	17MN305	07020009-502	Elm Creek	At 330th Ave., 2 mi. SW of Winnebago	0702000909-01
S000-540	17MN303	07020009-640	South Creek	At 345th Ave., 3.5 mi. S of Winnebago	0702000906-01
S000-583	17MN311	07020009-645	Blue Earth River, Middle Branch	At Iowa Border, 1 mi. W of Elmore	0702000903-01
S000-584	17MN312	07020009-643	Blue Earth River, West Branch	DS of 10 St, 3 mi. W of Elmore	0702000902-01
S000-671	17MN307	07020009-521	Cedar Creek	At C.R. 123/ 110th Ave., 2.5 mi. E of Trimont	0702000909-03
S003-020	17MN306	07020009-522	Elm Creek	At 185th St., 2.5 mi. E of Trimont	0702000909-02
S005-389	17MN317	07020009-501	Blue Earth River	Underneath US 169 bridge at Mankato	0702000911-01
S008-082	17MN315	07020009-509	Blue Earth River	At CSAH 33, 3 mi. SW of Mankato	0702000911-01
S009-435	17MN300	07020009-553	Brush Creek	At 70th St., 1.5 mi. N of Bricelyn	0702000905-02
S009-436	17MN301	07020009-652	Blue Earth River, East Branch	At C.R. 126/ 90th St., 4.5 mi. W of Walters	0702000905-03
S009-437	17MN310	07020009-646	Blue Earth River, Middle Branch	At 385th Ave (Old Elmore Rd), 4 mi. S of Blue Earth	0702000903-01
S014-893	17MN309	07020009-577	Willow Creek	At 507th Ave (CR 20), 4 mi. SW of Vernon Center, MN	0702000910-01
S014-896	17MN313	07020009-648	Coon Creek	At USTH 169, 2 mi. S of Blue Earth, MN	0702000904-01

Appendix 2.2 – Intensive watershed monitoring biological monitoring stations in the Blue Earth River Watershed

WID 07020009	Biological station ID	Waterbody name	Biological station location	County	Subwatershed
-501	17MN317	Blue Earth River	Upstream of Hwy 169, in Mankato	Blue Earth	Lower Blue Earth River
-502	03MN063	Elm Creek	Downstream of CSAH 27 (130th Ave), 5 mi. E of Trimont	Martin	Lower Elm Creek
-502	13MN172	Elm Creek	Downstream of CSAH 53 (260th Ave), 4 mi. NE of Northrop	Martin	Lower Elm Creek
-502	17MN305	Elm Creek	Upstream of 330th Ave, 2 mi. SW of Winnebago	Faribault	Lower Elm Creek
-502	17MN327	Elm Creek	Upstream of CSAH 39 (190th Ave) 5 mi. NW of Fairmont	Martin	Lower Elm Creek
-503	17MN304	Center Creek	Downstream of 165th St, 4 mi. SW of Winnebago	Faribault	Center Creek
-503	17MN331	Center Creek	Upstream of 212th Ave (North Ave), 0.5 mi. N of Fairmont	Martin	Center Creek
-503	92MN084	Center Creek	Upstream of 230th Ave, 2 mi. E of Fairmont	Martin	Center Creek
-504	00MN001	Blue Earth River	Downstream of CSAH 4, 4 mi. S of Blue Earth	Faribault	Upper Blue Earth River
-507	00MN005	Blue Earth River	Upstream of CSAH 34 (Gopher Rd), 3 mi. NE of Garden City	Blue Earth	Lower Blue Earth River
-507	92MN093	Blue Earth River	Downstream of Hwy 169, 0.5 mi. S of Vernon Center	Blue Earth	Lower Blue Earth River
-508	17MN316	Blue Earth River	Upstream of 150th St, 5 mi. S of Winnebago	Faribault	Upper Blue Earth River
-509	17MN315	Blue Earth River	Upstream of CSAH 33, 3 mi. SW of Mankato	Blue Earth	Lower Blue Earth River
-513	17MN361	County Ditch 44	Upstream of 60th St, 1 mi. SE of Frost	Faribault	Lower East Branch Blue Earth River
-514	17MN308	Blue Earth River	Downstream of CSAH 10, 2 mi. SW of Winnebago	Faribault	Upper Blue Earth River
-515	00MN003	Blue Earth River	Upstream of CSAH 12, 1 mi. W of Winnebago	Faribault	Lower Blue Earth River
-515	00MN004	Blue Earth River	Upstream of State Hwy 30, 2 mi W of Amboy	Blue Earth	Lower Blue Earth River
-516	17MN348	Blue Earth River	Downstream of CSAH 5 (345th Ave), 2 mi. S of Winnebago	Faribault	Upper Blue Earth River
-518	92MN088	Blue Earth River	Upstream of CSAH 6 (W 14th St), in SW Blue Earth	Faribault	Upper Blue Earth River
-521	17MN307	Cedar Creek	Upstream of CR 123 (110th Ave), 2.5 mi. E of Trimont	Martin	Cedar Creek
-522	17MN306	Elm Creek	Downstream of 185th St, 2.5 mi. E of Trimont	Martin	Upper Elm Creek
-522	17MN325	Elm Creek	Downstream of 180th St, 5 mi. W of Trimont	Martin	Upper Elm Creek
-545	17MN335	Judicial Ditch 8	Upstream of 240th Ave, 2 mi. E of Northrop	Martin	Lower Elm Creek
-551	17MN351	Trib. to Blue Earth River, Middle Branch	Upstream of Hwy 169, 1 mi. N of Elmore	Faribault	Middle Branch Blue Earth River

WID 07020003	Biological station ID	Waterbody name	Biological station location	County	Subwatershed
-553	17MN314	Blue Earth River, East Branch	Upstream of CSAH 6 (N Main St) in Blue Earth	Faribault	Lower East Branch Blue Earth River
-553	17MN359	Blue Earth River, East Branch	Downstream of 450th Ave (CR 109), 6 mi. E of Blue Earth	Faribault	Lower East Branch Blue Earth River
-553	17MN362	Blue Earth River, East Branch	Downstream of CSAH 19 (490th Ave), 2 mi. E of Frost	Faribault	Lower East Branch Blue Earth River
-556	17MN367	Foster Creek	Upstream of 580th Ave, 3.5 mi. S of Wells	Faribault	Upper East Branch Blue Earth River
-556	92MN076	Foster Creek	Upstream of Hwy 22, 4 mi. S of Wells	Faribault	Upper East Branch Blue Earth River
-561	17MN323	Elm Creek, South Fork	Downstream of of 190th St, 6 mi. W of Trimont	Martin	Upper Elm Creek
-565	17MN349	Blue Earth River	Downstream of Dead End of Grant St (377th Ave), 0.5 mi. NW of Blue Earth	Faribault	Upper Blue Earth River
-566	17MN341	Trib. to Willow Creek (JD 82)	Upstream of CSAH 40 (499th Ave), 5 mi. W of Amboy	Blue Earth	Willow Creek
-567	17MN321	Elm Creek, North Fork	Downstream of CSAH 29, 8.5 mi. W of Trimont	Jackson	Upper Elm Creek
-568	17MN345	Judicial Ditch 14 (Badger Creek)	Upstream of CSAH 4 (60th St), 5 mi. SW of Blue Earth	Faribault	Badger Creek
-569	17MN369	Foster Creek	Downstream of intersection of 610th Ave and 230th St, 2 mi W of Alden	Faribault	Upper East Branch Blue Earth River
-569	17MN370	Foster Creek	Downstream of 220th St, 2 mi. W of Alden	Freeborn	Upper East Branch Blue Earth River
-571	17MN356	Judicial Ditch 13, Branch A	Upstream of CSAH 13 (430th Ave) 3.5 mi. NE of Elmore	Faribault	Coon Creek
-577	17MN309	Willow Creek	Downstream of CSAH 20, 4 mi. SW of Vernon Center	Blue Earth	Willow Creek
-603	17MN360	County Ditch 25	Upstream of 480th Ave, 5.5 mi. N of Frost	Faribault	Lower East Branch Blue Earth River
-605	17MN358	County Ditch 5	Adjacent to 120th St (Off Private Bridge), 6 mi. E of Blue Earth	Faribault	Lower East Branch Blue Earth River
-610	17MN332	Trib. to Lake Sager (JD 98)	Downstream of Min. Maint. Rd N of CSAH 18 (70th St), 3 mi. NW of East Chain	Martin	South Creek
-611	17MN344	Trib. to Blue Earth River, West Branch (JD 7)	Upstream of 330th Ave, 6 mi. W of Elmore	Faribault	West Branch Blue Earth River
-611	17MN372	Trib. to Blue Earth River, West Branch (JD 7)	Upstream of 370th Ave, 5.5 mi. NW of Elmore	Faribault	West Branch Blue Earth River
-612	17MN353	Trib. to Coon Creek (CD 80)	Upstream of 50th St, 3 mi. NE of Elmore	Faribault	Coon Creek

WID 07020003	Biological station ID	Waterbody name	Biological station location	County	Subwatershed
-614	17MN346	Trib. to Judicial Ditch 14 (Badger Creek)	Upstream of 340th Ave (Min. Maint. Road), 4.5 mi. SW of Blue Earth	Faribault	Badger Creek
-615	17MN352	Trib. to Blue Eart River, East Branch (CD 14)	Downstream of private drive, just N of CSAH 16 (110th St), 2 mi. E of Blue Earth	Faribault	Lower East Branch Blue Earth River
-616	17MN350	Trib. to Blue Earth River (CD 17)	Downstream of CSAH 6 (380th Ave), 2.5 mi. N of Blue Earth	Faribault	Upper Blue Earth River
-617	17MN340	Trib. to Willow Creek (JD 85)	Upstream of CR 146, 6.5 mi. SW of Vernon Center	Blue Earth	Willow Creek
-619	17MN342	Trib. to Willow Creek (JD 106)	Upstream of 111th St (CR 144), 5 mi. W of Amboy	Blue Earth	Willow Creek
-620	17MN343	Trib. to Willow Creek (JD 24)	Upstream of 507th Ave (CR 140), 4 mi. W of Amboy	Blue Earth	Willow Creek
-621	17MN366	Trib. to Foster Creek	Downstream of 130th St, 4.5 mi. S of Wells	Faribault	Upper East Branch Blue Earth River
-622	17MN365	Trib. to Foster Creek (Thisius Branch)	Upstream of 140th St, 3.5 mi. S of Wells	Faribault	Upper East Branch Blue Earth River
-623	17MN368	Trib. to Foster Creek	Downstream of 610th Ave, 4 mi NW of Alden	Faribault	Upper East Branch Blue Earth River
-624	17MN363	Trib. to Brush Creek	Upstream of CSAH 2 (35th St), 3.5 mi. W of Kiester	Faribault	Brush Creek
-625	17MN339	Trib. to Willow Creek (Marble Creek)	Upstream of CR 146, 5 mi. SW of Vernon Center	Blue Earth	Willow Creek
-627	17MN336	Judicial Ditch 3	Upstream of CSAH 53 (260th Ave), 4 mi. E of Northrop	Martin	Lower Elm Creek
-628	17MN357	County Ditch 26	Upstream of 90th St, 5 mi. SE of Blue Earth	Faribault	Lower East Branch Blue Earth River
-631	17MN320	Elm Creek	Downstream of 570th Ave, 4 mi. SE of Bergen	Jackson	Upper Elm Creek
-631	17MN322	Elm Creek	Upstream of 10th Ave, 5 mi. E of Bergen	Jackson	Upper Elm Creek
-633	17MN329	Lilly Creek	Downstream of private road E of CSAH 39 (North Bixby Rd.), 1.5 mi. W of Fairmont	Martin	Center Creek
-636	17MN328	Dutch Creek	Upstream of CSAH 39 (190th Ave), 1.5 mi. SW of Fairmont	Martin	Center Creek
-639	17MN338	South Creek	Upstream of CSAH 26 (115th St), 5 mi. E of Fairmont	Martin	South Creek
-640	17MN303	South Creek	Upstream of 345th Ave, 3.5 mi. S of Winnebago	Faribault	South Creek
-642	17MN347	Little Badger Creek	Upstream of 100th St, 3 mi. W of Blue Earth	Faribault	Badger Creek
-643	17MN312	Blue Earth River, West Branch	Downstream of 10 St, 3 mi. W of Elmore	Faribault	West Branch Blue Earth River
-644	90MN073	Blue Earth River, West Branch	Downstream of 40th St, 2.5 mi. NW of Elmore	Faribault	West Branch Blue Earth River

WID 07020003	Biological station ID	Waterbody name	Biological station location	County	Subwatershed
-645	17MN311	Blue Earth River, Middle Branch	Downstream of 10th St, 1 mi. W of Elmore	Faribault	Middle Branch Blue Earth River
-646	17MN310	Blue Earth River, Middle Branch	Upstream of 385th Ave (Old Elmore Rd), 4 mi. S of Blue Earth	Faribault	Middle Branch Blue Earth River
-647	17MN355	Coon Creek (Judicial Ditch 13)	Upstream of 420th Ave, 4 mi. NE of Elmore	Faribault	Coon Creek
-648	17MN313	Coon Creek	Downstream of 385th Ave (S Ramsey St), 1 mi. S of Blue Earth	Faribault	Coon Creek
-648	92MN074	Coon Creek	Downstream of CSAH 4, 3 mi. S of Blue Earth	Faribault	Coon Creek
-650	17MN364	Blue Earth River, East Branch	Downstream of CSAH 16 (110th St), 6 mi. S of Wells	Faribault	Upper East Branch Blue Earth River
-650	17MN373	Blue Earth River, East Branch	Upstream of CSAH 31 (600th Ave), 1 mi. N of Walters	Faribault	Upper East Branch Blue Earth River
-652	17MN301	Blue Earth River, East Branch	Downstream of CR 126 (90th St), 4.5 mi. W of Walters	Faribault	Upper East Branch Blue Earth River
-654	17MN374	Brush Creek	Downstream of CR 117 (550th Ave), 2 mi. E of Bricelyn	Faribault	Brush Creek
-655	17MN300	Brush Creek	Upstream of 70th St, 1.5 mi. N of Bricelyn	Faribault	Brush Creek
-657	17MN326	Cedar Creek	Downstream of 60th Ave, 2.5 mi. NW of Trimont	Martin	Cedar Creek
-658	17MN302	Badger Creek	Downstream of 365th Ave, 1.5 mi. W of Blue Earth	Faribault	Badger Creek
-660	17MN334	Judicial Ditch 38	Upstream of CSAH 8 (30th St), 2.25 mi. SW of East Chain	Martin	South Creek
-663	17MN333	Trib. to Swag Lake	Upstream of 10th St (510th S) 10 mi. SE of Fairmont	Martin	South Creek
-667	17MN330	County Ditch 72	Upstream of 196th Ave, 3 mi. NW of Fairmont	Martin	Lower Elm Creek
-669	17MN354	Trib. to Blue Earth River, East Branch (CD 8)	Upstream of 415th Ave, 3.5 mi. SE of Blue Earth	Faribault	Lower East Branch Blue Earth River

Appendix 3.1 – Minnesota statewide IBI thresholds and confidence limits

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

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

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
0702000902-01 (West Branch Blue Earth River)							
07020009-644	10EM028	Blue Earth River, West Branch	160.44	Southern Streams	50	28.87	13-Jul-15
07020009-644	10EM028	Blue Earth River, West Branch	160.44	Southern Streams	50	36.56	20-Jul-10
07020009-643	17MN312	Blue Earth River, West Branch	152.20	Southern Streams	35	26.48	02-Aug-17
07020009-644	90MN073	Blue Earth River, West Branch	158.75	Southern Streams	50	46.06	09-Aug-17
07020009-611	17MN344	Trib. to Blue Earth River, W Branch (JD 7)	36.81	Southern Streams	35	38.89	16-Aug-17
07020009-611	17MN372	Trib. to Blue Earth River, W Branch (JD 7)	55.52	Southern Streams	35	32.81	26-Jul-17
0702000903-01 (Middle Branch Blue Earth River)							
07020009-645	17MN311	Blue Earth River, Middle Branch	84.64	Southern Streams	35	33.67	19-Jul-17
07020009-646	17MN310	Blue Earth River, Middle Branch	110.42	Southern Streams	50	39.20	02-Aug-17
07020009-551	17MN351	Trib. to Blue Earth River, Middle Branch	12.91	Southern Headwaters	33	44.02	27-Jul-17
0702000904-01 (Coon Creek)							
07020009-571	17MN356	Judicial Ditch 13, Branch A	19.58	Southern Headwaters	33	41.65	15-Aug-17
07020009-648	17MN313	Coon Creek	99.45	Southern Streams	50	42.30	01-Aug-17
07020009-612	17MN353	Trib. to Coon Creek (CD 80)	37.68	Southern Streams	35	24.79	27-Jul-17
07020009-647	17MN355	Coon Creek (Judicial Ditch 13)	48.83	Southern Streams	35	37.14	17-Jul-17
07020009-665	10EM156	Judicial Ditch 13	13.90	Southern Headwaters	55	50.49	14-Jul-10
07020009-648	92MN074	Coon Creek	94.83	Southern Streams	50	43.05	26-Jul-17
0702000905-01 (Lower East Branch Blue Earth River)							
07020009-553	15EM120	Blue Earth River, East Branch	186.04	Southern Streams	50	32.94	27-Jul-15
07020009-553	17MN314	Blue Earth River, East Branch	295.06	Southern Streams	50	50.35	15-Aug-17
07020009-553	17MN362	Blue Earth River, East Branch	188.62	Southern Streams	50	50.72	19-Jul-17
07020009-603	17MN360	County Ditch 25	9.67	Southern Headwaters	33	31.86	24-Jul-17
07020009-553	17MN359	Blue Earth River, East Branch	224.42	Southern Streams	50	43.42	20-Jul-17
07020009-605	17MN358	County Ditch 5	26.10	Low Gradient	15	31.55	15-Aug-17
07020009-628	17MN357	County Ditch 26	7.84	Southern Headwaters	33	35.52	15-Aug-17
07020009-615	17MN352	Trib. to Blue Earth River, East Branch (CD 14)	12.44	Southern Headwaters	33	53.97	16-Aug-17
07020009-669	17MN354	Trib. to Blue Earth River, East Branch (CD 8)	10.61	Southern Headwaters	33	47.56	21-Jun-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
0702000905-02 (Brush Creek)							
07020009-654	17MN374	Brush Creek	26.30	Southern Headwaters	55	65.97	16-Aug-17
07020009-655	17MN300	Brush Creek	45.51	Southern Streams	35	38.00	18-Jul-17
07020009-624	17MN363	Trib. to Brush Creek	7.46	Southern Headwaters	33	36.90	25-Jul-17
0702000905-03 (Upper East Branch Blue Earth River)							
07020009-621	17MN366	Trib. to Foster Creek	8.54	Southern Headwaters	33	49.66	24-Jul-17
07020009-599	10EM119	Unnamed ditch	4.01	Southern Headwaters	33	49.21	13-Jul-10
07020009-622	17MN365	Trib. to Foster Creek (Thisius Branch)	16.76	Southern Headwaters	33	35.54	14-Aug-17
07020009-556	92MN076	Foster Creek	64.50	Southern Streams	35	40.72	18-Jul-17
07020009-650	17MN364	Blue Earth River, East Branch	32.10	Southern Streams	35	30.66	19-Jul-17
07020009-623	17MN368	Trib. to Foster Creek	10.68	Southern Headwaters	33	36.53	20-Jun-17
07020009-652	17MN301	Blue Earth River, East Branch	121.25	Southern Streams	35	49.63	22-Aug-17
07020009-652	17MN301	Blue Earth River, East Branch	121.25	Southern Streams	35	46.25	18-Jul-17
07020009-623	17MN368	Trib. to Foster Creek	10.68	Southern Headwaters	33	48.48	28-Aug-17
07020009-556	17MN367	Foster Creek	37.85	Southern Streams	35	34.20	14-Aug-17
07020009-650	17MN373	Blue Earth River, East Branch	21.49	Southern Headwaters	33	52.25	20-Jun-17
0702000906-01 (South Creek)							
07020009-640	17MN303	South Creek	111.44	Southern Streams	50	54.05	03-Aug-17
07020009-639	15EM040	South Creek	95.67	Southern Streams	35	32.71	28-Jul-15
07020009-639	17MN338	South Creek	91.16	Southern Streams	35	35.71	26-Jul-17
07020009-660	17MN334	Judicial Ditch 38	6.19	Southern Headwaters	33	27.15	19-Jun-17
07020009-663	17MN333	Trib. to Swag Lake	20.09	Southern Headwaters	33	46.09	18-Jul-17
07020009-610	17MN332	Trib. to Lake Sager (JD 98)	12.72	Southern Headwaters	33	49.82	18-Jul-17
0702000907-01 (Center Creek)							
07020009-633	17MN329	Lilly Creek	39.25	Southern Streams	50	33.72	25-Jul-17
07020009-636	17MN328	Dutch Creek	15.85	Southern Headwaters	33	26.63	26-Jul-17
07020009-503	17MN304	Center Creek	131.73	Southern Streams	50	37.63	23-Aug-17
07020009-503	92MN083	Center Creek	92.02	Southern Streams	50	32.40	16-Aug-10
07020009-503	17MN331	Center Creek	92.02	Southern Streams	50	32.94	25-Jul-17
07020009-503	92MN084	Center Creek	98.79	Southern Streams	50	36.02	18-Aug-10

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07020009-503	92MN084	Center Creek	98.79	Southern Streams	50	44.73	25-Jul-17
0702000908-01 (Upper Blue Earth River)							
07020009-516	17MN348	Blue Earth River	960.17	Southern Rivers	49	50.87	16-Aug-17
07020009-508	17MN316	Blue Earth River	838.84	Southern Rivers	49	48.02	07-Aug-17
07020009-565	17MN349	Blue Earth River	517.46	Southern Rivers	49	39.66	08-Aug-17
07020009-514	17MN308	Blue Earth River	1101.74	Southern Rivers	49	37.96	08-Aug-17
07020009-518	10EM163	Blue Earth River	435.35	Southern Rivers	49	28.03	24-Aug-10
07020009-518	92MN088	Blue Earth River	435.58	Southern Rivers	49	44.83	15-Aug-17
07020009-504	00MN001	Blue Earth River	327.61	Southern Rivers	49	35.34	22-Aug-17
07020009-504	00MN001	Blue Earth River	327.61	Southern Rivers	49	37.55	02-Aug-17
07020009-616	17MN350	Trib. to Blue Earth River (CD 17)	8.34	Southern Headwaters	33	38.21	26-Jul-17
0702000908-02 (Badger Creek)							
07020009-568	17MN345	Judicial Ditch 14 (Badger Creek)	20.13	Southern Headwaters	33	37.87	25-Jul-17
07020009-642	17MN347	Little Badger Creek	28.99	Southern Headwaters	55	45.00	12-Jul-17
07020009-614	17MN346	Trib. to Judicial Ditch 14 (Badger Creek)	12.50	Southern Headwaters	33	35.94	25-Jul-17
07020009-658	17MN302	Badger Creek	77.30	Southern Streams	35	34.47	27-Jul-17
0702000909-01 (Lower Elm Creek)							
07020009-502	13MN172	Elm Creek	238.77	Southern Streams	50	58.85	19-Jul-17
07020009-502	17MN327	Elm Creek	209.66	Southern Streams	50	58.14	18-Jul-17
07020009-502	03MN063	Elm Creek	191.44	Southern Streams	50	52.32	01-Aug-17
07020009-502	12MN004	Elm Creek	272.20	Southern Streams	50	58.00	31-Jul-13
07020009-502	12MN005	Elm Creek	272.31	Southern Streams	50	39.40	31-Jul-13
07020009-502	13MN172	Elm Creek	238.77	Southern Streams	50	53.24	31-Jul-13
07020009-627	17MN336	Judicial Ditch 3	21.75	Southern Headwaters	55	39.80	12-Jul-17
07020009-667	17MN330	County Ditch 72	6.47	Southern Headwaters	33	55.44	26-Jul-17
07020009-502	17MN305	Elm Creek	280.76	Southern Streams	50	63.81	20-Jul-17
07020009-502	13MN171	Elm Creek	238.91	Southern Streams	50	37.23	31-Jul-13
07020009-502	17MN305	Elm Creek	280.76	Southern Streams	50	46.50	30-Aug-17
0702000909-02 (Upper Elm Creek)							
07020009-567	17MN321	Elm Creek, North Fork	8.57	Southern Headwaters	33	28.99	17-Jul-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Fish class	Threshold	FIBI	Visit date
07020009-522	17MN325	Elm Creek	90.97	Southern Streams	50	25.63	18-Jul-17
07020009-561	17MN323	Elm Creek, South Fork	29.27	Southern Headwaters	55	53.09	24-Jul-17
07020009-631	17MN322	Elm Creek	45.22	Southern Streams	50	31.64	18-Jul-17
07020009-522	17MN306	Elm Creek	133.36	Southern Streams	50	43.61	31-Jul-17
07020009-631	17MN320	Elm Creek	22.68	Southern Headwaters	55	49.74	18-Jul-17
0702000909-03 (Cedar Creek)							
07020009-521	17MN307	Cedar Creek	52.47	Southern Streams	50	53.36	03-Aug-17
07020009-657	17MN326	Cedar Creek	23.43	Southern Headwaters	33	46.91	18-Jul-17
0702000910-01 (Willow Creek)							
07020009-620	17MN343	Trib. to Willow Creek (JD 24)	12.26	Southern Headwaters	33	16.48	17-Jul-17
07020009-617	17MN340	Trib. to Willow Creek (JD 85)	16.08	Southern Headwaters	55	52.12	17-Jul-17
07020009-577	17MN309	Willow Creek	84.09	Southern Streams	50	41.54	17-Jul-17
07020009-625	17MN339	Trib. to Willow Creek (Marble Creek)	13.61	Southern Headwaters	55	38.63	17-Jul-17
07020009-619	17MN342	Trib. to Willow Creek (JD 106)	8.16	Southern Headwaters	33	56.52	13-Jul-17
0702000910-01 (Willow Creek) cont.							
07020009-566	17MN341	Trib. to Willow Creek (JD 82)	21.11	Southern Headwaters	55	59.41	27-Jul-17
0702000911-01 (Lower Blue Earth River)							
07020009-507	10EM051	Blue Earth River	1531.31	Southern Rivers	49	26.64	15-Jul-15
07020009-515	00MN003	Blue Earth River	1385.36	Southern Rivers	49	45.20	09-Aug-17
07020009-515	00MN004	Blue Earth River	1409.18	Southern Rivers	49	37.49	24-Aug-17
07020009-507	00MN005	Blue Earth River	1539.25	Southern Rivers	49	28.74	10-Aug-17
07020009-507	10EM051	Blue Earth River	1531.31	Southern Rivers	49	27.94	25-Aug-10
07020009-509	17MN315	Blue Earth River	2436.18	Southern Rivers	49	37.47	31-Aug-17
07020009-501	17MN317	Blue Earth River	3551.46	Southern Rivers	49	39.03	29-Aug-17
07020009-507	92MN093	Blue Earth River	1508.27	Southern Rivers	49	49.45	14-Aug-17

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

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
West Branch Blue Earth River: 0702000902-01							
07020009-644	10EM028	Blue Earth River, West Branch	160.44	Prairie Streams GP	41	53.81	11-Aug-10
07020009-644	90MN073	Blue Earth River, West Branch	158.75	Prairie Streams GP	41	54.93	28-Sep-17
07020009-611	17MN372	Trib. to Blue Earth River, West Branch (JD 7)	55.52	Prairie Streams GP	22	35.30	10-Aug-17
07020009-644	10EM028	Blue Earth River, West Branch	160.44	Prairie Streams GP	41	57.17	25-Aug-15
07020009-611	17MN344	Trib. to Blue Earth River, West Branch (JD 7)	36.81	Southern Streams RR	24	23.39	07-Aug-17
07020009-643	17MN312	Blue Earth River, West Branch	152.20	Prairie Streams GP	22	27.51	07-Aug-17
Middle Branch Blue Earth River: 0702000903-01							
07020009-551	17MN351	Trib. to Blue Earth River, Middle Branch	12.91	Prairie Streams GP	22	27.54	08-Aug-17
07020009-645	17MN311	Blue Earth River, Middle Branch	84.64	Prairie Streams GP	22	45.82	07-Aug-17
07020009-646	17MN310	Blue Earth River, Middle Branch	110.42	Prairie Streams GP	41	61.52	08-Aug-17
Coon Creek: 0702000904-01							
07020009-648	92MN074	Coon Creek	94.83	Prairie Streams GP	41	31.52	08-Aug-17
07020009-648	17MN313	Coon Creek	99.45	Southern Streams RR	37	28.15	08-Aug-17
07020009-612	17MN353	Trib. to Coon Creek (CD 80)	37.68	Prairie Streams GP	22	3.70	08-Aug-17
07020009-647	17MN355	Coon Creek (Judicial Ditch 13)	48.83	Prairie Streams GP	22	34.22	08-Aug-17
07020009-665	10EM156	Judicial Ditch 13	13.90	Prairie Streams GP	41	30.58	10-Aug-10
07020009-571	17MN356	Judicial Ditch 13, Branch A	19.58	Prairie Streams GP	22	24.71	08-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
Lower East Branch Blue Earth River: 0702000905-01							
07020009-553	17MN362	Blue Earth River, East Branch	188.62	Prairie Streams GP	41	46.03	08-Aug-17
07020009-553	15EM120	Blue Earth River, East Branch	186.04	Prairie Streams GP	41	47.49	25-Aug-15
07020009-603	17MN360	County Ditch 25	9.67	Prairie Streams GP	22	23.87	08-Aug-17
07020009-553	17MN314	Blue Earth River, East Branch	295.06	Prairie Streams GP	41	57.20	09-Aug-17
07020009-553	17MN359	Blue Earth River, East Branch	224.42	Prairie Streams GP	41	43.48	09-Aug-17
07020009-615	17MN352	Trib. to Blue Earth River, E Br (CD 14)	12.44	Prairie Streams GP	22	23.19	09-Aug-17
07020009-615	17MN352	Trib. to Blue Earth River, E Br (CD 14)	12.44	Prairie Streams GP	22	28.04	09-Aug-17
07020009-628	17MN357	County Ditch 26	7.84	Prairie Streams GP	22	3.67	09-Aug-17
07020009-605	17MN358	County Ditch 5	26.10	Prairie Streams GP	22	29.76	09-Aug-17
07020009-669	17MN354	Trib. to Blue Earth River, East Branch	10.61	Prairie Streams GP	22	19.82	09-Aug-17
Brush Creek: 0702000905-02							
07020009-655	17MN300	Brush Creek	45.51	Prairie Streams GP	22	29.65	10-Aug-17
07020009-624	17MN363	Trib. to Brush Creek	7.46	Prairie Streams GP	22	22.35	10-Aug-17
07020009-654	17MN374	Brush Creek	26.30	Prairie Streams GP	41	55.10	10-Aug-17
Upper East Branch Blue Earth River: 0702000905-03							
07020009-556	17MN367	Foster Creek	37.85	Prairie Streams GP	22	40.48	17-Aug-17
07020009-623	17MN368	Trib. to Foster Creek	10.68	Prairie Streams GP	22	12.45	22-Aug-17
07020009-650	17MN364	Blue Earth River, East Branch	32.10	Prairie Streams GP	22	55.06	17-Aug-17
07020009-622	17MN365	Trib. to Foster Creek (Thisius Branch)	16.76	Prairie Streams GP	22	19.40	17-Aug-17
07020009-556	17MN367	Foster Creek	37.85	Prairie Streams GP	22	37.36	17-Aug-17
07020009-599	10EM119	Unnamed ditch	4.01	Prairie Streams GP	22	33.51	11-Aug-10
07020009-650	17MN373	Blue Earth River, East Branch	21.49	Prairie Streams GP	22	41.99	22-Aug-17
07020009-650	17MN373	Blue Earth River, East Branch	21.49	Prairie Streams GP	22	44.92	29-Aug-17
07020009-556	92MN076	Foster Creek	64.50	Prairie Streams GP	22	19.00	17-Aug-17
07020009-621	17MN366	Trib. to Foster Creek	8.54	Prairie Streams GP	22	24.70	17-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
South Creek: 0702000906-01							
07020009-663	17MN333	Trib. to Swag Lake	20.09	Prairie Streams GP	22	24.56	08-Aug-17
07020009-610	17MN332	Trib. to Lake Sager (JD 98)	12.72	Prairie Streams GP	22	18.20	08-Aug-17
07020009-640	17MN303	South Creek	111.44	Southern Streams RR	37	48.05	09-Aug-17
07020009-639	15EM040	South Creek	95.67	Southern Streams RR	24	25.07	25-Aug-15
07020009-639	17MN338	South Creek	91.16	Prairie Streams GP	22	21.42	08-Aug-17
Center Creek: 0702000907-01							
07020009-503	92MN084	Center Creek	98.79	Southern Streams RR	37	22.38	19-Aug-10
07020009-633	17MN329	Lilly Creek	39.25	Prairie Streams GP	41	38.47	09-Aug-17
07020009-636	17MN328	Dutch Creek	15.85	Prairie Streams GP	22	41.77	09-Aug-17
07020009-503	17MN331	Center Creek	92.02	Southern Streams RR	37	12.99	09-Aug-17
07020009-503	92MN084	Center Creek	98.79	Southern Streams RR	37	19.69	08-Aug-17
07020009-503	17MN304	Center Creek	131.73	Southern Streams RR	37	32.86	28-Sep-17
07020009-503	92MN083	Center Creek	92.02	Prairie Streams GP	41	38.56	19-Aug-10
Upper Blue Earth River: 0702000908-01							
07020009-516	17MN348	Blue Earth River	960.17	Prairie Forest Rivers	31	57.20	10-Aug-17
07020009-616	17MN350	Trib. to Blue Earth River (CD 17)	8.34	Prairie Streams GP	22	38.71	09-Aug-17
07020009-565	17MN349	Blue Earth River	517.46	Prairie Streams GP	41	51.29	09-Aug-17
07020009-514	17MN308	Blue Earth River	1101.74	Prairie Forest Rivers	31	60.81	10-Aug-17
07020009-508	17MN316	Blue Earth River	838.84	Prairie Forest Rivers	31	33.12	09-Aug-17
07020009-518	10EM163	Blue Earth River	435.35	Prairie Streams GP	41	56.14	24-Aug-10
07020009-518	92MN088	Blue Earth River	435.58	Prairie Streams GP	41	63.83	08-Aug-17
07020009-504	00MN001	Blue Earth River	327.61	Prairie Streams GP	41	69.86	08-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
Badger Creek: 0702000908-02							
07020009-642	17MN347	Little Badger Creek	28.99	Prairie Streams GP	41	33.30	07-Aug-17
07020009-568	17MN345	Judicial Ditch 14 (Badger Creek)	20.13	Prairie Streams GP	22	13.65	07-Aug-17
07020009-614	17MN346	Trib. to JD 14 (Badger Creek)	12.50	Prairie Streams GP	22	43.05	07-Aug-17
07020009-658	17MN302	Badger Creek	77.30	Prairie Streams GP	22	51.96	07-Aug-17
Lower Elm Creek: 0702000909-01							
07020009-502	17MN327	Elm Creek	209.66	Southern Streams RR	37	39.46	09-Aug-17
07020009-545	17MN335	Judicial Ditch 8	6.35	Prairie Streams GP	22	11.41	10-Aug-17
07020009-502	13MN172	Elm Creek	238.77	Prairie Streams GP	41	60.47	10-Aug-17
07020009-502	03MN063	Elm Creek	191.44	Prairie Streams GP	41	37.97	09-Aug-17
07020009-502	17MN327	Elm Creek	209.66	Southern Streams RR	37	46.32	09-Aug-17
07020009-667	17MN330	County Ditch 72	6.47	Prairie Streams GP	22	24.80	09-Aug-17
07020009-627	17MN336	Judicial Ditch 3	21.75	Prairie Streams GP	41	49.20	10-Aug-17
Upper Elm Creek: 0702000909-02							
07020009-522	17MN306	Elm Creek	133.36	Prairie Streams GP	41	39.96	09-Aug-17
07020009-561	17MN323	Elm Creek, South Fork	29.27	Prairie Streams GP	41	29.06	08-Aug-17
07020009-522	17MN325	Elm Creek	90.97	Prairie Streams GP	41	50.59	08-Aug-17
07020009-631	17MN322	Elm Creek	45.22	Prairie Streams GP	41	50.49	08-Aug-17
Cedar Creek: 0702000909-03							
07020009-657	17MN326	Cedar Creek	23.43	Prairie Streams GP	22	39.34	08-Aug-17
07020009-521	17MN307	Cedar Creek	52.47	Southern Streams RR	37	21.75	09-Aug-17
Willow Creek: 0702000910-01							
07020009-577	17MN309	Willow Creek	84.09	Southern Streams RR	37	48.06	07-Aug-17
07020009-617	17MN340	Trib. to Willow Creek (JD 85)	16.08	Prairie Streams GP	41	57.85	07-Aug-17
07020009-619	17MN342	Trib. to Willow Creek (JD 106)	8.16	Prairie Streams GP	22	34.76	07-Aug-17
07020009-566	17MN341	Trib. to Willow Creek (JD 82)	21.11	Prairie Streams GP	41	40.53	07-Aug-17
07020009-620	17MN343	Trib. to Willow Creek (JD 24)	12.26	Prairie Streams GP	22	29.28	07-Aug-17
07020009-625	17MN339	Trib. to Willow Creek (Marble Creek)	13.61	Prairie Streams GP	41	46.54	10-Aug-17

National Hydrography Dataset (NHD) Assessment Segment WID	Biological station ID	Stream segment name	Drainage area Mi^2	Invert class	Threshold	MIBI	Visit date
Lower Blue Earth River: 0702000911-01							
07020009-507	00MN005	Blue Earth River	1539.25	Prairie Forest Rivers	31	50.41	07-Aug-17
07020009-515	00MN004	Blue Earth River	1409.18	Prairie Forest Rivers	31	32.77	07-Aug-17
07020009-515	00MN003	Blue Earth River	1385.36	Prairie Forest Rivers	31	40.83	10-Aug-17
07020009-507	10EM051	Blue Earth River	1531.31	Prairie Forest Rivers	31	39.28	25-Aug-15
07020009-507	10EM051	Blue Earth River	1531.31	Prairie Forest Rivers	31	16.49	23-Aug-10
07020009-507	92MN093	Blue Earth River	1508.27	Prairie Forest Rivers	31	34.45	07-Aug-17
07020009-509	17MN315	Blue Earth River	2436.18	Prairie Forest Rivers	31	44.29	17-Aug-17

Appendix 4.1 – Fish species found during biological monitoring surveys

Common name	Quantity of individuals collected	Quantity of stations where present
white sucker	4344	88
creek chub	4442	83
johnny darter	1976	79
bluntnose minnow	4242	79
green sunfish	3657	78
fathead minnow	4274	77
orangespotted sunfish	1372	68
blacknose dace	3751	68
bigmouth shiner	1866	65
blackside darter	938	64
sand shiner	4693	58
spotfin shiner	5086	51
yellow bullhead	398	51
black bullhead	750	49
common carp	932	48
central stoneroller	1531	46
yellow perch	386	43
brassy minnow	388	42
shorthead redhorse	794	41
tadpole madtom	357	41
northern hogsucker	331	34
northern pike	101	34
slenderhead darter	243	27
brook stickleback	167	25
stonecat	72	24
walleye	90	24
silver redhorse	119	23
black crappie	174	22
golden shiner	57	19
Iowa darter	84	19
freshwater drum	46	19
bluegill	620	18
quillback	236	16
channel catfish	97	16
golden redhorse	136	16
largemouth bass	254	15
fantail darter	125	14
bigmouth buffalo	23	9
highfin carpsucker	26	6
Gen: redhorses (*Moxostoma*)	92	6

Common name	Quantity of individuals collected	Quantity of stations where present
river carpsucker	84	5
white crappie	5	4
gizzard shad	135	2
emerald shiner	341	2
bullhead minnow	2	2
common shiner	2	2
flathead catfish	6	2
smallmouth buffalo	4	1
hybrid sunfish	1	1
banded darter	4	1
sauger	2	1
Gen: carpsuckers (*Carpiodes*)	44	1
shortnose gar	1	1

Appendix 4.2 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Polypedilum	77	1549
Thienemannimyia Gr.	76	1124
Oligochaeta	69	699
Acari	66	629
Cheumatopsyche	66	2539
Physella	65	4410
Dubiraphia	57	644
Hydroptila	56	576
Cricotopus	54	434
Dicrotendipes	54	597
Labrundinia	52	417
Orconectes	50	81
Rheotanytarsus	47	538
Tanytarsus	47	217
Ceratopsyche morosa	44	895
Hyalella	44	1511
Ablabesmyia	43	138
Tanypodinae	43	98
Paratanytarsus	42	174
Caenis diminuta	41	906
Baetis intercalaris	40	986
Tricorythodes	39	750
Brillia	38	176
Cryptochironomus	38	75
Stenelmis	36	408

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Rheocricotopus	34	198
Coenagrionidae	33	376
Hydropsychidae	31	347
Nectopsyche diarina	31	213
Stenacron	31	123
Hemerodromia	30	92
Heptagenia	30	185
Maccaffertium	30	406
Nanocladius	30	84
Hirudinea	28	58
Zavrelimyia	27	206
Chironomini	26	48
Macronychus glabratus	26	183
Pisidiidae	26	116
Simulium	25	270
Ephydridae	24	61
Ferrissia	24	120
Parakiefferiella	24	165
Phaenopsectra	24	44
Stenochironomus	24	83
Fallceon	23	89
Hydroptilidae	23	77
Orthocladiinae	23	46
Belostoma flumineum	22	29
Chironomus	21	61
Calopterygidae	20	78
Nemata	20	42
Procladius	20	47
Pteronarcys	20	68
Tanytarsini	20	35
Thienemanniella	20	55
Conchapelopia	19	32
Hydropsyche simulans	19	100
Paratendipes	19	66
Corixidae	18	63
Empididae	18	31
Micropsectra	18	175
Lymnaeidae	15	35
Neoplasta	15	50

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Boyeria vinosa	14	39
Cladotanytarsus	14	47
Nectopsyche candida	14	110
Paralauterborniella nigrohalterale	14	29
Plauditus	14	175
Potamyia flava	14	361
Saetheria	14	35
Scirtidae	14	23
Thienemannimyia	14	101
Trepaxonemata	14	35
Argia	13	41
Branchiobdellida	13	50
Caenis hilaris	13	35
Glyptotendipes	13	134
Gyraulus	12	214
Isonychia	12	43
Labiobaetis propinquus	12	38
Acentrella parvula	11	114
Calopteryx	11	38
Corynoneura	11	14
Heptageniidae	11	125
Hydropsyche bidens	11	142
Limnophyes	11	15
Neoplea striola	11	13
Nilotanypus	11	13
Hydrozoa	10	21
Leptoceridae	10	12
Oecetis avara	10	21
Cambaridae	9	13
Ceratopsyche	9	51
Mayatrichia ayama	9	164
Mesovelia	9	12
Orthocladius	9	24
Baetis	8	133
Baetis longipalpus	8	200
Brachycentrus numerosus	8	16
Callibaetis	8	21
Ceratopsyche bronta	8	28
Fossaria rustica	8	35
Hydropsyche betteni	8	114
Peltodytes	8	11
Procloeon	8	26

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Atrichopogon	7	9
Cryptotendipes	7	18
Gomphidae	7	8
Helichus	7	12
Hydropsyche	7	28
Leucrocuta	7	10
Tipula	7	9
Aeshna	6	11
Caecidotea	6	47
Caenis	6	31
Nectopsyche	6	39
Nematomorpha	6	6
Parachironomus	6	15
Pseudosuccinea columella	6	7
Scirtes	6	8
Stagnicola	6	23
Acroneuria	5	8
Aeshna umbrosa	5	5
Atherix	5	18
Boyeria	5	9
Maccaffertium exiguum	5	7
Maccaffertium terminatum	5	7
Paracladopelma	5	5
Physa	5	155
Sciomyzidae	5	5
Tabanidae	5	8
Baetidae	4	48
Cambarus	4	4
Ceratopogonidae	4	6
Ceratopogoninae	4	5
Corydalidae	4	4
Culicidae	4	4
Gyrinus	4	9
Hydropsyche placoda	4	24
Labiobaetis dardanus	4	6
Paracloeodes	4	14
Pycnopsyche	4	8
Trichocorixa	4	7
Acentrella	3	3
Aeshnidae	3	3
Anopheles	3	4
Baetis brunneicolor	3	13

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Corydalus	3	6
Dytiscidae	3	7
Endochironomus	3	4
Ephoron	3	4
Gerridae	3	3
Haliplus	3	5
Kloosia/Harnischia	3	7
Labiobaetis frondalis	3	43
Liodessus	3	4
Ochrotrichia	3	5
Planorbella	3	5
Planorbidae	3	4
Ranatra	3	3
Rhagovelia	3	6
Rheumatobates	3	3
Somatochlora	3	11
Acroneuria abnormis	2	2
Baetis flavistriga	2	3
Baetisca	2	2
Calopteryx aequabilis	2	4
Calopteryx maculata	2	2
Cladopelma	2	2
Crambidae	2	2
Dasyhelea	2	2
Dolichopodidae	2	2
Gyrinidae	2	2
Hexagenia	2	3
Hydropsyche orris	2	21
Isonychia rufa	2	22
Leptophlebiidae	2	3
Limnephilidae	2	9
Parametriocnemus	2	2
Perlidae	2	3
Phryganeidae	2	2
Polycentropodidae	2	2
Sigara	2	12
Telopelopia okoboji	2	2
Trichoptera	2	3
Tropisternus	2	2
Acerpenna	1	1
Acilius	1	1
Agnetina	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Amphipoda	1	1
Anax junius	1	1
Anthopotamus	1	3
Apedilum	1	1
Atherix variegata	1	1
Belostoma	1	1
Berosus	1	1
Caenis youngi	1	3
Ceraclea	1	1
Cercobrachys	1	1
Cheumatopsyche lasia	1	36
Chironomidae	1	1
Corduliidae	1	1
Cricotopus trifascia	1	5
Dubiraphia robusta	1	5
Dytiscus	1	1
Enallagma	1	1
Enochrus	1	1
Erioptera	1	1
Eukiefferiella	1	1
Forcipomyiinae	1	1
Hayesomyia sonata	1	1
Helichus striatus	1	1
Hetaerina	1	33
Hetaerina americana	1	1
Hyalella azteca	1	8
Hydraena	1	1
Hydrobiidae	1	1
Hydropsyche incommoda	1	33
Hydroptila xera	1	17
Ilybius	1	1
Labiobaetis	1	8
Labrundinia becki	1	10
Larsia	1	1
Limonia	1	2
Merragata	1	1
Metrobates	1	1
Microtendipes	1	2
Muscidae	1	1
Neoplea	1	1
Nixe	1	2
Oecetis	1	1

Taxonomic name	Quantity of stations where present	Quantity of individuals collected
Orthocladius annectens	1	2
Oxyethira	1	1
Palmacorixa	1	1
Paragnetina media	1	1
Pentaneura	1	1
Perlesta	1	1
Physella integra	1	17
Physidae	1	1
Pilaria	1	1
Platambus	1	1
Polypedilum fuscipenne	1	19
Prodiamesa	1	1
Prostoma	1	1
Pseudochironomus	1	1
Psychoda	1	13
Pycnopsyche limbata	1	2
Radotanypus	1	3
Scirtes orbiculatus	1	1
Simulium aureum	1	1
Sparbarus	1	1
Sperchopsis tessellata	1	1
Sperchopsis tessellata	1	1
Stenacron interpunctatum	1	1
Stenacron minnetonka	1	1
Stenelmis cheryl	1	7
Stictochironomus	1	2
Tribelos	1	1
Turbellaria	1	1
Tvetenia	1	1
Valvata	1	2
Xenochironomus xenolabis	1	1

Appendix 5 – Minnesota Stream Habitat Assessment results

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

# Visits	Biological station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
3	10EM028	W br	0.83	10.33	11.13	11.33	16.33	49.97	Fair
2	17MN312	W br	0.00	6.50	9.40	6.50	8.00	30.40	Poor
2	17MN344	JD 7	0.00	7.50	17.95	12.00	20.00	57.45	Fair
2	17MN372	JD 7	0.00	9.00	15.80	8.00	16.50	49.30	Fair
2	90MN073	W br	0.00	8.00	12.70	10.50	15.50	46.70	Fair
Average Results: W. Br. Blue Earth			0.23	8.45	13.19	9.82	15.36	47.05	Fair
2	17MN310	Mid. Br.	1.25	6.25	10.80	9.50	12.50	40.30	Poor
2	17MN311	Mid. Br.	0.00	9.50	14.00	4.00	3.50	31.00	Poor
2	17MN351	Trib to	0.25	7.50	3.50	1.00	3.50	15.75	Poor
Average Results: M. Br. Blue Earth			0.50	7.75	9.43	4.83	6.50	29.02	Poor
2	15EM120	E. Br.	0.63	6.25	12.75	14.00	7.50	41.13	Poor
2	17MN314	E. Br.	1.50	9.00	11.95	11.50	13.00	46.95	Fair
2	17MN352	CD 14	0.00	7.75	8.20	7.50	5.50	28.95	Poor
2	17MN354	CD 8	0.00	8.50	6.80	11.50	8.00	34.80	Poor
2	17MN357	CD 26	0.00	12.00	5.03	10.50	7.50	35.02	Poor
2	17MN358	CD 5	0.00	7.50	11.00	8.00	7.00	33.50	Poor
2	17MN359	E. Br.	2.50	9.75	9.50	7.00	16.00	44.75	Poor
2	17MN360	CD 25	0.00	8.00	6.50	6.00	3.00	23.50	Poor
3	17MN361	CD 44	0.00	9.00	9.43	8.67	7.67	34.77	Poor
2	17MN362	E. Br.	1.25	9.25	14.65	9.00	16.00	50.15	Fair
Average Results: Lwr.E.Br. BER			0.56	8.71	9.57	9.33	9.05	37.23	Poor
2	17MN300	Brush	0.00	8.00	12.60	7.50	11.50	39.60	Poor
2	17MN363	Trib. to	0.00	8.25	10.45	9.00	8.00	35.70	Poor
2	17MN374	Brush	0.00	8.25	18.80	9.50	17.00	53.55	Fair
Average Results: Brush Creek			0.00	8.17	13.95	8.67	12.17	42.95	Poor

Qualitative habitat ratings

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

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

# Visit	Biological station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
1	10EM156	JD 13	0.00	12.00	20.00	13.00	22.00	67.00	Good
2	17MN313	Coon	1.25	9.75	12.03	10.50	18.00	51.52	Fair
2	17MN353	Trib. to	0.00	6.50	9.20	10.00	6.50	32.20	Poor
2	17MN355	Coon	0.00	8.00	17.40	7.50	5.50	38.40	Poor
2	17MN356	JD 13 br.	0.00	8.00	7.00	10.00	7.00	32.00	Poor
2	92MN074	Coon	1.25	9.50	8.55	10.00	15.00	44.30	Poor
Average Results: Coon Creek			0.45	8.68	11.67	9.91	11.45	42.17	Poor
1	10EM119	ditch	0.00	9.50	15.20	5.00	19.00	48.70	Fair
3	17MN301	E.Br. BER	0.00	6.50	10.73	2.67	10.67	30.57	Poor
2	17MN364	E.Br. BER	0.00	11.25	12.25	6.00	15.50	45.00	Fair
2	17MN365	Thisius	0.00	8.75	7.65	4.00	7.50	27.90	Poor
2	17MN366	Trib. to	0.00	8.50	5.50	8.50	6.50	29.00	Poor
2	17MN367	Foster	0.00	7.25	15.45	5.50	10.50	38.70	Poor
3	17MN368	Trib. to	0.00	9.67	12.33	7.33	9.33	38.67	Poor
2	17MN369	Foster	0.00	8.00	14.30	11.50	15.50	49.30	Fair
2	17MN370	Foster	0.00	10.50	13.77	11.00	12.50	47.78	Fair
2	17MN373	E.Br. BER	0.00	9.25	12.50	10.00	9.00	40.75	Poor
2	92MN076	Foster	0.00	8.50	14.50	5.00	7.50	35.50	Poor
Average Results: Upper E.Br. BER			0.00	8.78	12.01	6.87	10.78	38.45	Poor
2	15EM040	South Cr.	0.00	6.00	11.25	6.50	11.50	35.25	Poor
2	17MN303	South Cr.	1.25	10.00	13.65	10.00	20.00	54.90	Fair
2	17MN332	JD 98	0.00	12.00	15.85	11.50	9.50	48.85	Fair
2	17MN333	Trib. to	0.00	7.50	7.50	8.50	5.50	29.00	Poor
1	17MN334	JD 38	0.00	7.50	5.00	9.00	2.00	23.50	Poor
2	17MN338	South Cr.	0.50	4.50	11.28	8.00	12.50	36.77	Poor
Average Results: South Creek			0.32	7.95	11.28	8.91	10.91	39.37	Poor
2	17MN304	Center	0.00	6.75	18.70	14.50	23.00	62.95	Fair
2	17MN328	Dutch	0.00	3.00	9.45	11.00	12.50	35.95	Poor
2	17MN329	Lily Cr.	0.00	8.25	8.10	5.50	12.50	34.35	Poor
2	17MN331	Center	0.50	2.00	11.95	8.50	10.50	33.45	Poor
1	92MN083	Center	0.00	12.50	13.30	11.00	24.00	60.80	Fair
3	92MN084	Center	0.00	2.67	8.90	10.00	14.67	36.23	Poor
Average Results: Center Creek			0.08	5.04	11.37	10.00	15.42	41.91	Poor

Qualitative habitat ratings

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# Visits	Biological station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
3	00MN001	Blue Earth R.	0.83	9.33	9.43	10.33	16.00	45.93	Fair
1	10EM163	Blue Earth R.	1.25	6.50	9.00	6.00	14.00	36.75	Poor
2	17MN308	Blue Earth R.	1.25	4.25	13.90	9.00	19.50	47.90	Fair
2	17MN316	Blue Earth R.	1.25	6.00	18.48	11.00	21.00	57.72	Fair
2	17MN348	Blue Earth R.	1.25	5.75	11.90	6.50	14.00	39.40	Poor
2	17MN349	Blue Earth R.	1.25	8.75	11.05	11.00	16.50	48.55	Fair
2	17MN350	CD 17	0.00	8.00	4.50	10.50	7.00	30.00	Poor
2	92MN088	Blue Earth R.	1.50	8.50	11.45	10.50	12.50	44.45	Poor
Average Habitat Results: Upper BER			1.05	7.31	11.24	9.63	15.19	44.41	Poor
2	17MN302	Badger Cr.	0.00	4.50	6.25	7.50	12.00	30.25	Poor
2	17MN345	JD 14	0.00	8.00	6.50	10.00	8.00	32.50	Poor
2	17MN346	Trib. to JD 14	0.00	7.00	11.80	9.50	11.50	39.80	Poor
2	17MN347	Little Badger	0.00	6.50	13.60	10.50	16.00	46.60	Fair
Average Habitat Results: Badger Creek			0.00	6.50	9.54	9.38	11.88	37.29	Poor
2	03MN063	Elm Creek	0.00	10.00	9.65	11.50	17.00	48.15	Fair
2	12MN004	Elm Creek	0.00	6.75	16.55	7.00	19.00	49.30	Fair
2	12MN005	Elm Creek	0.50	4.00	19.45	7.00	16.00	46.95	Fair
1	13MN171	Elm Creek	2.50	9.00	17.40	9.00	21.00	58.90	Fair
3	13MN172	Elm Creek	0.42	6.50	13.92	9.33	18.00	48.17	Fair
2	17MN305	Elm Creek	0.00	7.50	15.47	8.50	15.50	46.98	Fair
2	17MN327	Elm Creek	0.00	9.00	14.65	10.50	18.50	52.65	Fair
2	17MN330	CD 72	0.00	10.00	14.20	11.00	12.50	47.70	Fair
1	17MN335	JD 8	0.00	10.00	6.00	11.00	11.00	38.00	Poor
2	17MN336	JD 3	0.00	9.00	8.55	11.00	12.00	40.55	Poor
Average Results: Lower Elm Creek			0.25	7.95	13.80	9.53	16.16	47.68	Fair
2	17MN306	Elm Creek	0.00	10.75	6.95	6.00	12.00	35.70	Poor
1	17MN320	Elm Creek	0.00	12.00	10.60	13.00	20.00	55.60	Fair
1	17MN321	N. Fk. Elm Cr.	0.00	6.00	8.30	13.00	12.00	39.30	Poor
2	17MN322	Elm Creek	0.00	5.00	11.80	10.50	10.00	37.30	Poor
2	17MN323	S. Fk. Elm Cr.	0.00	6.00	8.55	10.00	14.00	38.55	Poor
2	17MN325	Elm Creek	0.00	6.50	11.10	7.50	11.00	36.10	Poor
Average Habitat Results: Upper Elm Cr.			0.00	7.45	9.57	9.40	12.60	39.02	Poor

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# Visit	Biological station ID	Reach name	Land use	Riparian	Substrate	Fish cover	Channel morph.	MSHA score	MSHA rating
2	17MN307	Cedar	0.00	9.75	12.03	12.50	21.00	55.27	Fair
2	17MN326	Cedar	0.00	7.00	14.10	11.50	12.50	45.10	Fair
Average Habitat Results: Cedar			0.00	8.38	13.06	12.00	16.75	50.19	Fair
2	17MN309	Willow	0.00	7.00	11.95	11.50	16.00	46.45	Fair
2	17MN339	Marble	0.00	10.50	6.00	7.00	4.50	28.00	Poor
2	17MN340	JD 85	0.00	9.50	9.43	5.50	11.50	35.92	Poor
2	17MN341	JD 82	0.00	6.50	12.00	9.50	14.50	42.50	Poor
2	17MN342	JD 106	0.00	8.75	8.52	7.00	10.00	34.28	Poor
2	17MN343	JD 24	0.00	8.00	5.50	11.00	2.50	27.00	Poor
Average Habitat Results: Willow			0.00	8.38	8.90	8.58	9.83	35.69	Poor
2	00MN003	Blue	1.25	4.75	16.35	10.00	20.00	52.35	Fair
2	00MN004	Blue	0.00	8.00	12.00	9.00	10.00	39.00	Poor
2	00MN005	Blue	0.00	5.00	11.85	7.50	11.50	35.85	Poor
3	10EM051	Blue	0.83	6.17	16.05	8.67	17.33	49.05	Fair
1	17MN315	Blue	2.50	9.00	17.75	7.00	21.00	57.25	Fair
1	17MN317	Blue	0.00	6.00	16.00	8.00	14.00	44.00	Poor
2	92MN093	Blue	0.00	6.00	12.28	11.50	16.00	45.77	Fair

Qualitative habitat ratings

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Appendix 6 – Lake protection and prioritization results

Lake ID	Lake Name	Mean TP	Trend	% Disturbed Land Use	5% load reduction goal	Priority
07-0090-00	Ida	294.3	No data provided	58%	29	C
22-0007-00	Rice	165.0	No data provided	83%	44	C
22-0022-00	South Walnut	53.0	No data provided	95%	436	C
22-0023-00	Walnut	186.9	No data provided	82%	49	C
32-0017-00	Independence	258.8	No data provided	96%	20	C
46-0010-00	East Chain	174.8	No data provided	92%	998	C
46-0012-00	Imogene	87.9	No data provided	79%	16	B
46-0014-01	Wilmert (main bay)	93.0	No data provided	92%	76	C
46-0020-00	South Silver	58.4	No evidence of trend	78%	11	A
46-0024-00	George	149.8	No evidence of trend	96%	31	NA
46-0025-00	Sisseton	101.3	No data provided	93%	461	NA
46-0030-00	Budd	97.1	Decreasing trend	91%	293	NA
46-0031-00	Hall	123.7	No evidence of trend	91%	352	NA
46-0034-00	Amber	101.7	No evidence of trend	69%	20	NA
46-0049-00	Iowa	156.9	No data provided	93%	316	C
46-0109-00	Fox	127.1	Increasing trend	86%	126	NA
46-0111-00	Clam	184.0	No data provided	97%	39	C
46-0121-00	Cedar	167.8	No data provided	97%	718	C
46-0132-00	Watkins	888.0	No data provided	96%	690	C
46-0133-00	Big Twin	119.1	No data provided	71%	33	NA
46-0145-00	Fish	115.8	No data provided	99%	30	C

Appendix 7 – Stream protection and prioritization results

WID	Stream Name	TALU	Cold/Warm	Community Nearly Impaired	Riparian Risk	Watershed Risk	Current Protection Level	Protection Priority Class
07020009-551	Unnamed ditch	Modified	warm	one	med/high	med/high	low	A
07020009-567	Elm Creek, North Fork	Modified	warm	one	high	high	low	A
07020009-571	Judicial Ditch 13 Branch A	Modified	warm	one	high	med/high	low	A
07020009-599	Unnamed ditch	Modified	warm	neither	high	high	low	A
07020009-605	County Ditch 5	Modified	warm	neither	high	high	med/low	A
07020009-614	Judicial Ditch 14	Modified	warm	one	med/high	high	low	A
07020009-615	County Ditch 14	Modified	warm	one	high	high	low	A
07020009-616	County Ditch 17	Modified	warm	neither	high	high	low	A
07020009-617	Unnamed creek	General	warm	one	med/high	high	low	A
07020009-619	Judicial Ditch 116	Modified	warm	neither	high	high	low	A
07020009-621	Unnamed creek	Modified	warm	one	high	high	low	A
07020009-624	Unnamed creek	Modified	warm	both	med/high	med/high	low	A
07020009-640	South Creek	General	warm	one	high	med/high	low	A
07020009-645	Blue Earth River, Middle Branch	Modified	warm	one	high	low	med/low	A
07020009-647	Coon Creek	Modified	warm	one	med/high	med/high	low	A
07020009-650	Blue Earth River, East Branch	Modified	warm	neither	high	high	low	A
07020009-655	Brush Creek	Modified	warm	both	med/high	high	low	A
07020009-658	Badger Creek	Modified	warm	one	medium	high	med/low	A
07020009-663	Unnamed creek	Modified	warm	one	high	med/high	low	A
07020009-667	County Ditch 72	Modified	warm	one	high	high	low	A