Cedar River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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Executive Summary

The Cedar River Watershed (07080201) lies in southeastern Minnesota. Approximately 42 percent of the watershed lies in Minnesota and is addressed in this report, while the rest of the watershed lies across the border in Iowa. The watershed has 103 stream assessment units (AUIDs) and seven lakes. Drinking water quality and the recreational value of lakes and streams are assets to the health and wealth of local economies throughout the watershed.

The Cedar River provides local communities with drinking water for households and industry, habitat for aquatic life, riparian corridors for wildlife, and recreational opportunities such as fishing, swimming and canoeing. Today, 88 percent of its landscape is utilized for cropland and pasture and nine percent is developed land used for housing, business and industrial complexes, county roads and city streets. Woodlands and wetlands dot the landscape and riparian corridors for only three percent of the total land area. Only one percent of the watershed is classified as open water.

In 2009, Minnesota Pollution Control Agency (MPCA) undertook the intensive watershed monitoring effort of the Cedar River Watershed's surface waters. Sixty-five sites were sampled for biology at the outlets of variable sized sub-watersheds within the Cedar River watershed. These locations included the mouth of the Cedar River at the Iowa border, the upstream outlets of major tributaries, and the headwater outlets of smaller streams. As part of this effort, MPCA staff joined with the Cedar River Watershed District (CRWD) to complete stream water chemistry sampling at the outlets of seven of the Cedar River's major subwatersheds. In 2011, a holistic approach was taken to assess all of the watershed's surface waterbodies for support of aquatic life, recreation, and fish consumption, where sufficient data was available. Thirty-five streams and one lake were assessed in this effort. (Not all lake and stream AUIDs were able to be assessed due to insufficient data, modified channel condition or their status as limited resources waters.)

Lake Geneva is non-supporting of aquatic recreation due to low transparency. East Side Lake is on the impaired waters list for aquatic consumption. Other un-assessed lakes in the watershed are small in size and shallow. Shallow lakes are susceptible to mixing throughout the open water season. The mixing re-suspends bottom sediments, which when combined with high temperatures and pH, can result in continued release of phosphorus into the water column.

Throughout the watersheds, eleven stream AUIDs are fully supporting aquatic life and no streams are fully supporting aquatic recreation. Aquatic consumption impairments span the entire length of the Cedar River. Thirty AUIDs are non-supporting of aquatic life and/or recreation. Of those AUIDs, 21 are non-supporting of aquatic life and nine are non-supporting of aquatic recreation. Aquatic biological impairments occur along the mainstem Cedar River and many tributaries. Aquatic recreation impairments due to high bacteria levels occur throughout the watershed.

Two AUIDs were not assessed due to their classification as limited resource waters. Twenty-three AUIDS were not assessed for aquatic biology because the reach or AUID is >50 percent channelized. Channelized reaches are currently not being assessed until new biological standards are developed. Biological quality at channelized streams was generally rated good to fair for fish and fair to poor for macroinvertebrates. Three additional AUIDs were not assessed due to local factors that make conditions not appropriate for stream assessment.

Land use changes in vegetation, draining of wetlands and lakes, urban development, and unpermitted damming of streams have all likely contributed to reduced populations of sensitive aquatic species. Increased nutrients and flashy stream flows are threats to the quality of the water resources in much of the watershed today.

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) requiring states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of water bodies that do not meet established standards. Such waters are referred to as "impaired waters" and the state must take appropriate actions to restore these waters, including the development of Total Maximum Daily Loads (TMDLs). A TMDL is a comprehensive study identifying all pollution sources causing or contributing to impairment and the reductions needed to restore a water body so that it can support its designated use.

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

The passage of Minnesota's Clean Water Legacy Act (CWLA) of 2006, provided a policy framework and the initial resources to state and local governments to accelerate efforts to monitor, assess, restore and protect surface waters. Funding from the Clean Water Fund created by the passage of the Clean Water Land, and Legacy Amendment to the state constitution allows a continuation of this work. In response, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of water monitoring programs to provide a more comprehensive assessment of water quality and expedite the restoration and protection process. This has permitted the MPCA to establish a goal to assess the condition of Minnesota's surface waters via a 10-year cycle, and provides an opportunity to more fully integrate MPCA water resource management efforts in cooperation with local government and stakeholders to allow for coordinated development and implementation of water quality restoration and improvement projects.

The rationale behind the watershed monitoring approach is to intensively monitor the 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 efforts. The monitoring strategy was implemented in the Cedar River Watershed beginning in the summer of 2008. This report provides a summary of all water quality assessment results in the Cedar River watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units. Consequently, there is an 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. A 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, restoring, and preserving the quality of Minnesota's water resources.

I. The Watershed Monitoring Approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 81 major watersheds (Figure 1). The primary feature of the watershed approach is that it provides a unifying focus on the water resources within a watershed as the starting point for water quality assessment, planning, implementation, and result measures. 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 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).

Load monitoring network

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

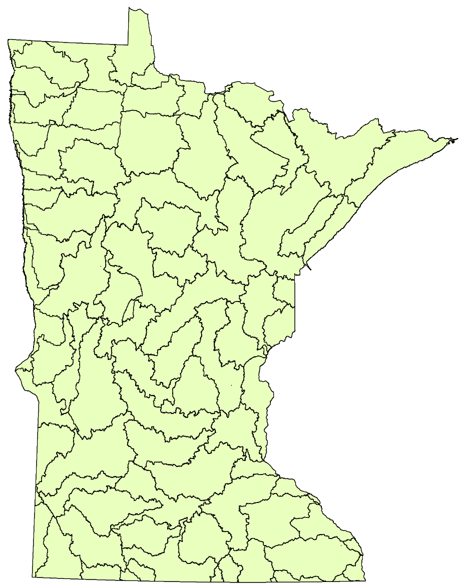

Figure 1. Major watersheds within Minnesota (8-Digit HUC)

Intensive water quality sampling occurs year round at all WPLMN sites. Thirty-five to fifty mid-stream grab samples were collected at this site per year with sampling frequency greatest during periods of moderate to high flow (Figure 2). Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

Annual water quality and daily average discharge data are coupled in the "Flux32," pollutant load model, originally developed by Dr. Bill Walker and upgraded in 2010, by the U.S. Army Corp of Engineers and MPCA, to create concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary output include annual and daily pollutant loads and flow weighted mean concentrations (pollutant load/total flow volume). Loads and flow weighted mean concentrations are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), nitrate plus nitrite nitrogen (nitrate-N) and total Kjeldahl nitrogen (TKN).

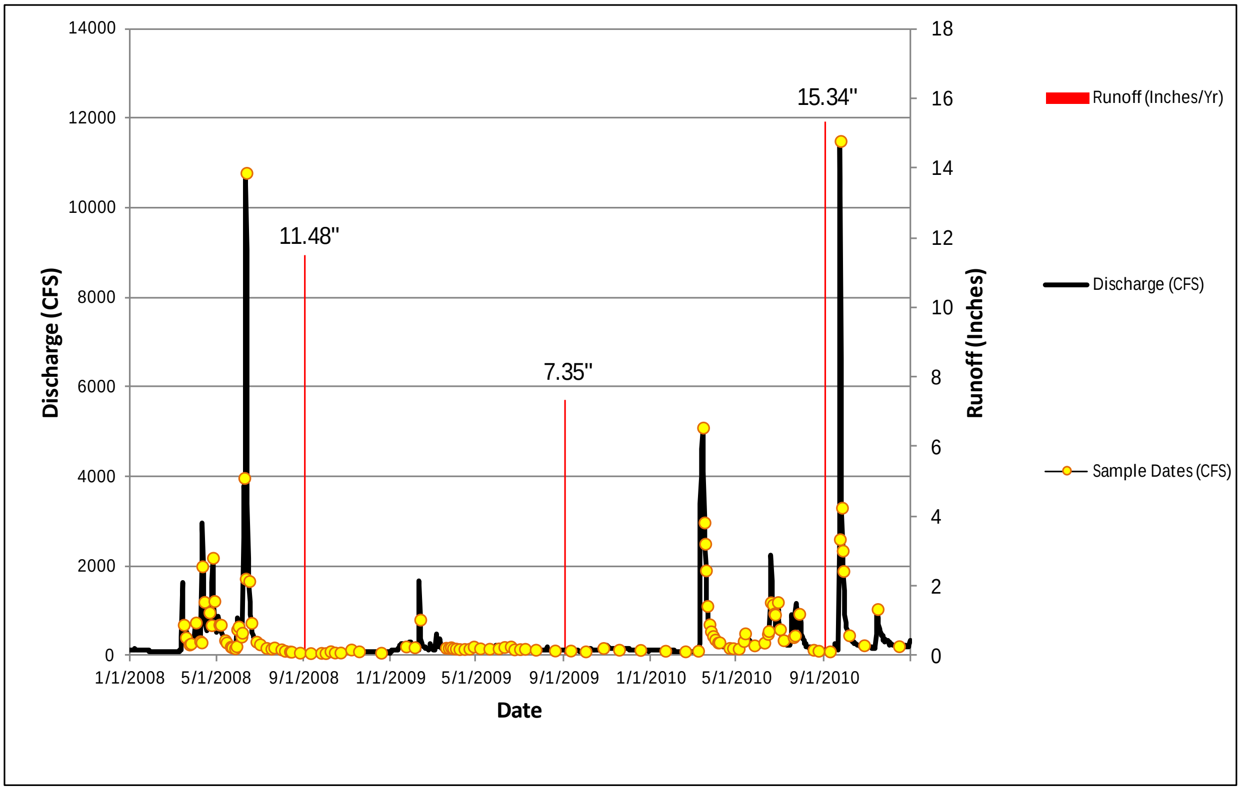

Figure 2. Hydrograph and annual runoff for the Cedar River near Austin (2008-2010)

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale (Figure 1). The foundation of this comprehensive approach is the 81 major watersheds within Minnesota. Streams are broken into segments by hydrologic unit codes (HUC) to define separate waterbodies within a watershed. Sampling occurs in each major watershed once every 10 years. In this approach, intermediate-sized (approx. 11-digit HUC) and “minor” (14-digit HUC) watersheds are sampled along with the major watershed outlet to provide a complete assessment of water quality (Figure 2). River/stream sites are selected near the outlet at all watershed scales. This approach provides holistic assessment coverage of rivers and streams without monitoring every single stream reach (See Figure 3 for an illustration of the monitoring site coverage within the Cedar River Watershed).

The outlet of the major watershed (purple dot in Figure 3) is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation, and aquatic consumption use support. Each 11-HUC outlet (green dots in Figure 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Watersheds at this scale generally consist of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Lastly, most minor watersheds (typically 10-20 mi^2) are sampled for biology (fish and macroinvertebrates) to assess aquatic life use support (red dots in Figure 3). Specific locations for sites sampled as part of the intensive monitoring effort in the Cedar River Watershed can be found in Appendix 4 and 5.

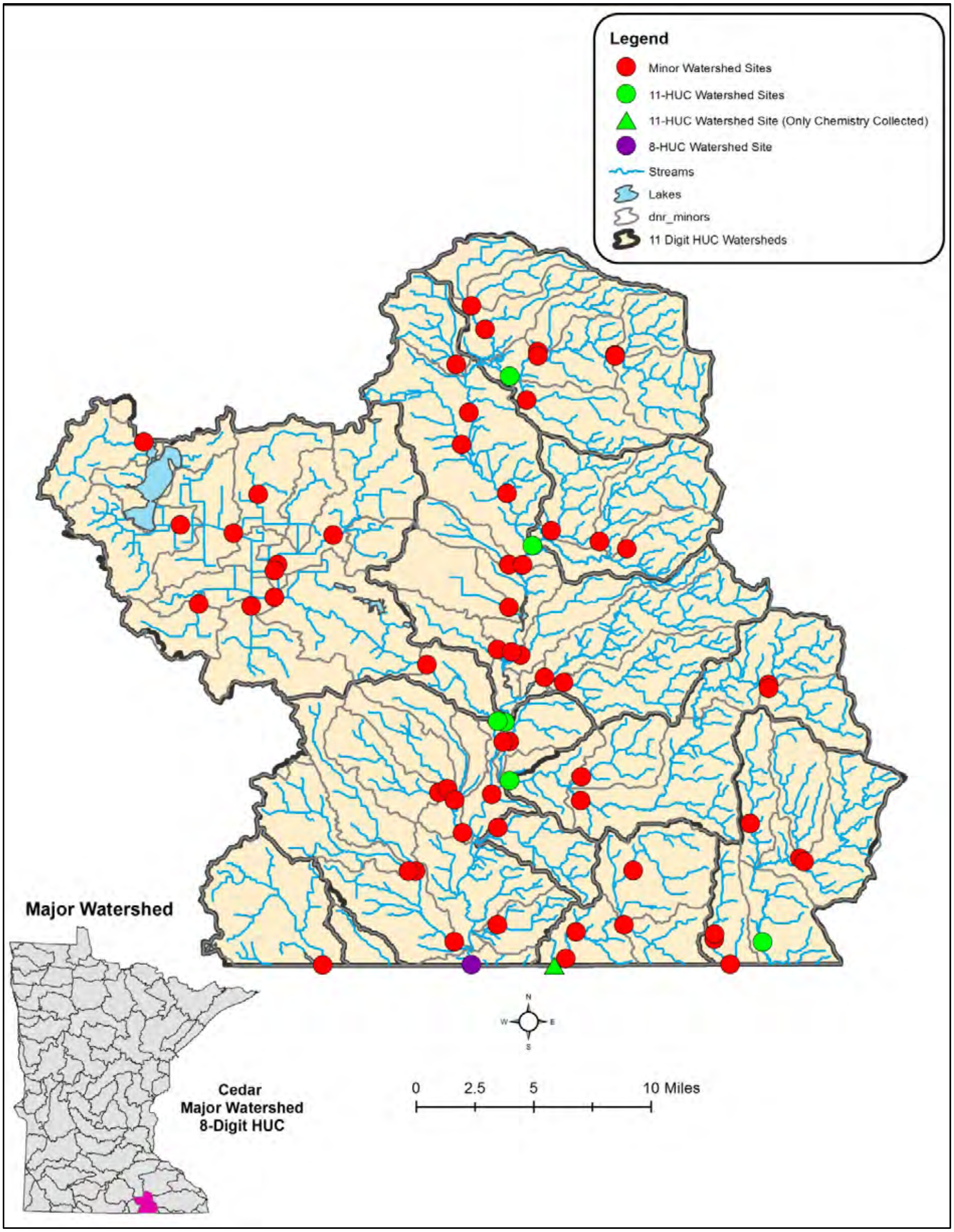

Figure 3. Intensive watershed monitoring sites for streams in the Cedar River Watershed

The second step of the intensive watershed monitoring effort consists of follow-up monitoring at areas determined to have impaired waters. This follow-up monitoring is designed to collect the information needed to initiate the stressor identification process, in order to identify the source(s) and cause(s) of impairment to be addressed in TMDL development and implementation.

Lake monitoring

The MPCA conducts and supports lake monitoring for a variety of objectives. Lake condition monitoring activities are focused on assessing the recreational use support of lakes and identifying trends over time. The MPCA also assesses lakes for aquatic consumption use support, based on fish-tissue and water-column concentrations of toxic pollutants. Lake monitoring was added to the watershed monitoring framework in 2009, so while there is some data available, not all of the lakes in the Cedar River Watershed currently have enough information for assessment.

Citizen and local monitoring

Citizen monitoring is an important component of the watershed monitoring approach. The MPCA coordinates two programs aimed at encouraging citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program. Like the permanent load monitoring network, sustained citizen monitoring can provide the long-term picture needed to help evaluate current status and trends. The advance identification of lake and stream sites that will be sampled by the MPCA staff provides an opportunity to actively recruit volunteers to monitor those sites, so that water quality data collected by volunteers are available for the years before and after the intensive monitoring effort by MPCA staff. This citizen-collected data helps agency staff interpret the results from the intensive monitoring effort, which only occurs one out of every ten years. It also allows interested parties to track any water quality changes that occur in the years between the intensive monitoring events. Coordinating with volunteers to focus monitoring efforts where it will be most effective for planning and tracking purposes will help local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change. Figure 4 provides an illustration of the locations where citizen monitoring data were used for assessment in the Cedar River Watershed.

The MPCA also passes through funding via Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits, and educational institutions to monitor lake and stream water quality. These local partners greatly expand our overall capacity to conduct sampling. Many SWAG grantees invite citizen participation in their monitoring projects.

The annual SWAG Request for Proposal (RFP) identifies the major watersheds that are scheduled for upcoming intensive monitoring activities. HUC-11 stream outlet chemistry sites and lakes less than 500 acres that need monitoring are identified in the RFP and local entities are invited to request funds to complete the sampling. SWAG grantees conduct detailed sampling efforts following the same established monitoring protocols and quality assurance procedures used by the MPCA. All of the lake and stream monitoring data from SWAG projects are combined with the MPCA's monitoring data to assess the condition of Minnesota lakes and streams.

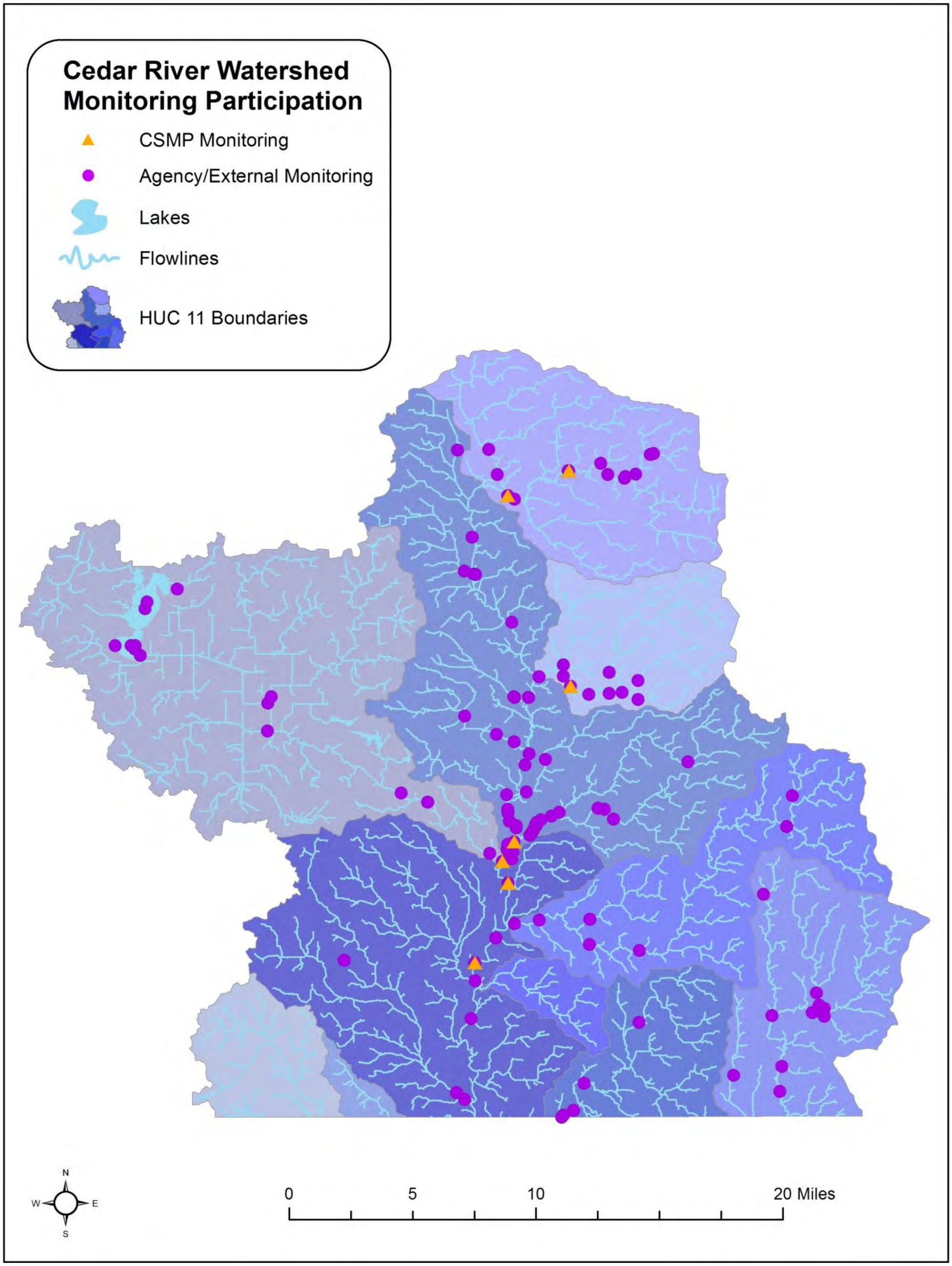

Figure 4. Monitoring locations of local groups, citizens, and the MPCA lake monitoring staff in the Cedar River Watershed

II. Assessment Methodology

The Clean Water Act requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses. 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 methodology 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). http://www.pca.state.mn.us/index.php/view-document.html?gid=8601.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. Use attainment status describes whether or not a waterbody is supporting its designated use 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). 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. Protection of aquatic life means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms, including fish and invertebrates. Protection of recreation means the maintenance of conditions suitable for swimming and other forms of water recreation. Protection of consumption means protecting citizens who eat fish inhabiting Minnesota waters or receive their drinking water from waterbodies protected for this use.

A small percentage of stream miles in the state (~1 percent 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, aesthetics and 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.

Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Ideally, if the standard is not exceeded, the use will be protected. However, nature is very complex and variable, therefore the MPCA uses a variety of tools to fully assess designated uses. Assessment methodologies often differ by parameter and designated use. Furthermore, pollutant concentrations may be expressed in different ways such as chronic value, maximum value, final acute value, magnitude, duration and frequency.

Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses. Interpretations of narrative criteria for aquatic life support in streams are based on multi-metric biological indices including the Fish Index of Biological Integrity (Fish IBI), which evaluates the health of the fish community, and the Macroinvertebrate Index of Biological Integrity (Invert IBI), which evaluates the health of the aquatic invertebrate community. Biological monitoring is a direct means to assess aquatic life support, as the aquatic community tends to integrate the effects of pollutants and stressors over time.

Assessment units

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

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

Determining use attainment status

Conceptually, the process for determining use attainment status of a waterbody is similar for each designated use: comparison of monitoring data to established water quality standards. However, the complexity of that process and the amount of information required to make accurate assessments varies between uses. In part, the level of complexity in the assessment process depends on the strength of the dose-response relationship; i.e., if chemical B exceeds water quality criterion X, how often is beneficial use Y truly not being attained. For beneficial uses related to human health, such as drinking water, the relationship is well understood and thus the assessment process is a relatively simple interpretation of numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA’s assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 5.

The first step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. This is largely an automated process performed by logic programmed into a database application and the results are referred to as ‘Pre-Assessments’. Pre-assessments are then reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are conducted at the workstation of each reviewer (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 attenuating circumstances that should be considered (e.g., flow, time/date of data collection, habitat).

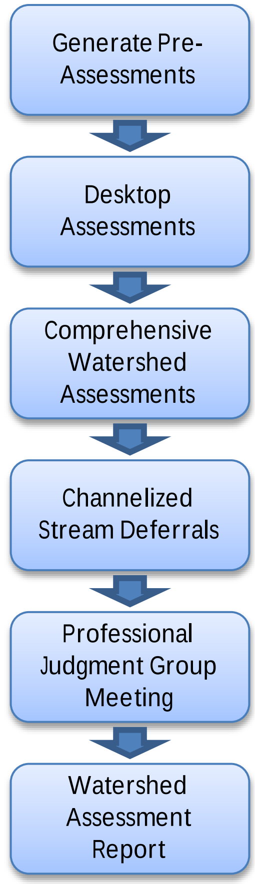

Figure 5. Flowchart of aquatic life use assessment process

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List* (MPCA 2012) http://www.pca.state.mn.us/index.php/view-document.html?gid=8601 for guidelines and factors to consider when making such determinations.

Any new impairment determination (i.e., waterbody not attaining its beneficial use) is reviewed using GIS to determine if greater than 50 percent of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use framework. For additional information see: Tiered Aquatic Life Use (TALU) Framework (http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/the-tiered-aquatic-life-use-talu-framework.html). Since large portions of a watershed may be channelized, reaches with biological data are evaluated on a "good-fair-poor" system to help evaluate their condition (see Section VI).

The last step in the assessment process is the Professional Judgement Group or PJG 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 have a vested interest in the outcomes of the assessment process. Information obtained during this meeting may be used to revise previous use attainment decisions. The result of this meeting is a compilation of the assessed waters which will be included in the watershed assessment report. 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.

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments, and volunteers. The data must meet rigorous quality-assurance protocols before being used. All monitoring data required or paid for by MPCA is entered into the EQuIS (Environmental Quality Information System), MPCA's data system. MPCA uploads the data from EQuIS to U.S. Enivornmental Protection Agency's STORET data warehouse. Water quality monitoring projects required to store data in EQuIS are those with federal or state funding under Clean Water Partnership, CWLA Surface Water Assessment Grants, and the TMDL program. Many local projects not funded by MPCA choose to submit their data to the MPCA in EQuIS-ready format so that it may be utilized in the assessment process. Prior to each assessment cycle, the MPCA requests data from local entities and partner organizations using the most effective methods, including direct contacts and GovDelivery distribution lists.

Period of record

The MPCA uses data collected over the most recent 10 year period for all water quality assessments. Generally, the most recent data from the 10 year assessment period is reviewed first when assessing toxic pollutants, eutrophication and fish contaminants. Also, the more recent data for all pollutant categories may be given more weight during the comprehensive watershed assessment or professional judgment group meetings. The goal is to use data from the 10 year period that best represents the current water quality conditions. Using data over a 10 year period provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data for the entire period is not required to make an assessment.

III. Watershed overview

The Cedar River begins in Minnesota and flows into Iowa. The total stream length of the Cedar River in Minnesota is 40 miles (Waters 1977). The Minnesota portion of the watershed drains 454,029 acres (70 square miles) (NRCS 2007, Waters 1977). The largest portions of the watershed encompass all of Mower County, half of Freeborn County, and small sections of Dodge and Steele counties.

The Cedar River watershed originates in the headwaters of the East, Middle, and West Forks of the Cedar River in Dodge County. From there, the mainstem of the Cedar River connects with Roberts, Wolf, and Dobbins Creeks before flowing through the city of Austin. Just south of Austin, the Cedar River connects with Turtle Creek and flows south, meeting with Orchard, Rose, and Wolf Creeks along the way to the Iowa border. Across the border, the waters of the Cedar River join the Shell Rock and Iowa Rivers which then flow into the Mississippi River.

The Cedar River Watershed lies in the south-east portion of Minnesota's Western Corn Belt Plains (WCBP) Ecoregion (Omernik, 1988). The WCBP is dominated by glacial sediments deposited by the Des Moines Lobe of the Wisconsin Glaciation approximately 12,000 years ago. The watershed is comprised of Glacial Till in much of the river valley (Figure 6).

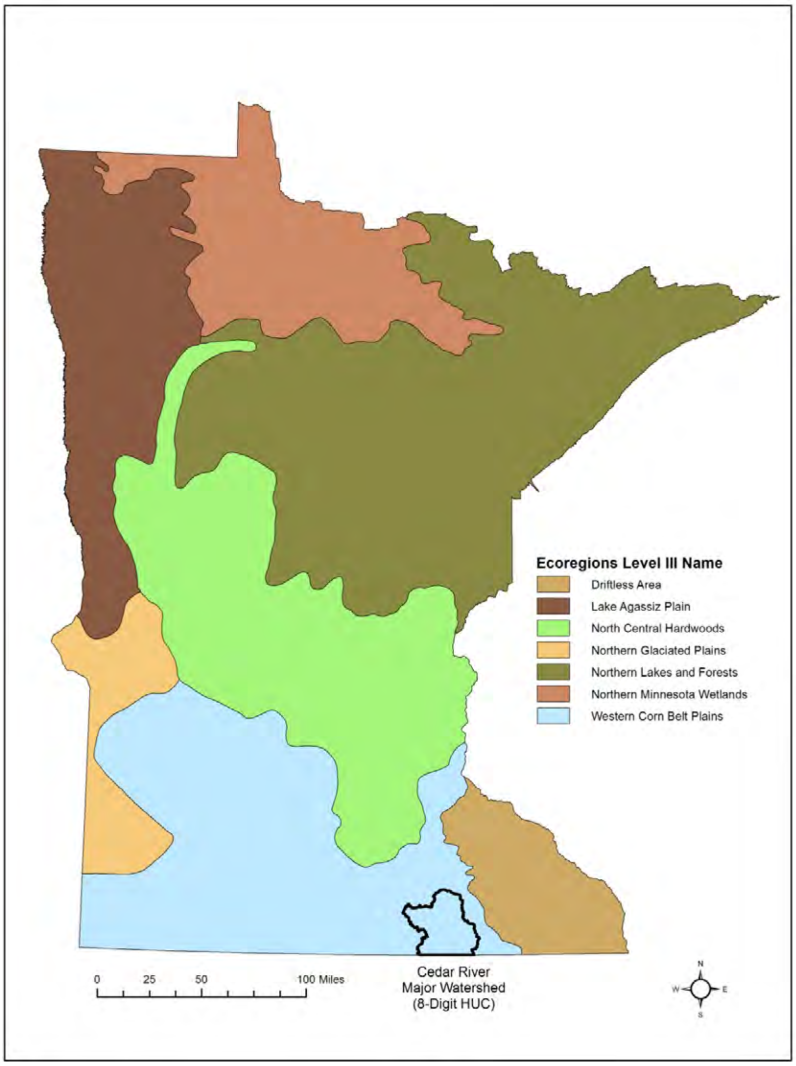

Figure 6. The Cedar River Watershed within the western corn belt plains ecoregion of southern Minnesota

The USDA Major Land Resource Areas (MLRA) for the Cedar River watershed includes two classifications: the western third of the watershed is classified as Central Iowa and Minnesota Till Prairies while the eastern two-thirds of the watershed are classified as Eastern Iowa and Minnesota Till Prairies (Figure 7). Soils in the area of the Turtle Creek watershed in the northwest limb of the watershed are loamy till and organic soil (NRCS 2007). The remainder of the watershed is comprised of soils described as "thin silty material over loamy till, underlain by sedimentary bedrock" (NRCS 2007). Exposed bedrock can be found along the lower reaches of the Cedar River below Austin.

The Cedar River provides local communities with: drinking water; recreational opportunities such as fishing, swimming and canoeing; and riparian corridors for wildlife. In 2011, the Cedar River was designated a State Water Trail by the Minnesota Legislature. Approximately 25 miles are easily navigable by canoe, passing through wooded riparian corridors and areas of exposed limestone bedrock.

Given the geologic history of the valley, Karst springs dot the central corridor of the Cedar River and many of its tributaries (Figure 7), such as Wolf Creek, Orchard Creek, Rose Creek, Roberts Creek, Little Cedar River, and Woodbury Creek. Historical records indicate that many of these spring-fed streams supported Brook Trout and other sensitive aquatic species. In the 1950s, the MDNR attempted to stock many of these steams with Brown Trout. Unfortunately, neither native Brook Trout nor introduced Brown Trout have been documented as captured in the watershed since 1982. Landuse changes in vegetation, draining of wetlands and lakes, urban development, extensive field tiling, excess nutrients, and unpermitted rock dams have likely contributed to the loss of trout and reduced populations of other sensitive species. However, sensitive fish, mussels, and aquatic invertebrate species in select tributaries of the Cedar River presently exist and indicate good water quality and habitat. These tributaries are worthy of additional protections in order to preserve these valuable aquatic resources.

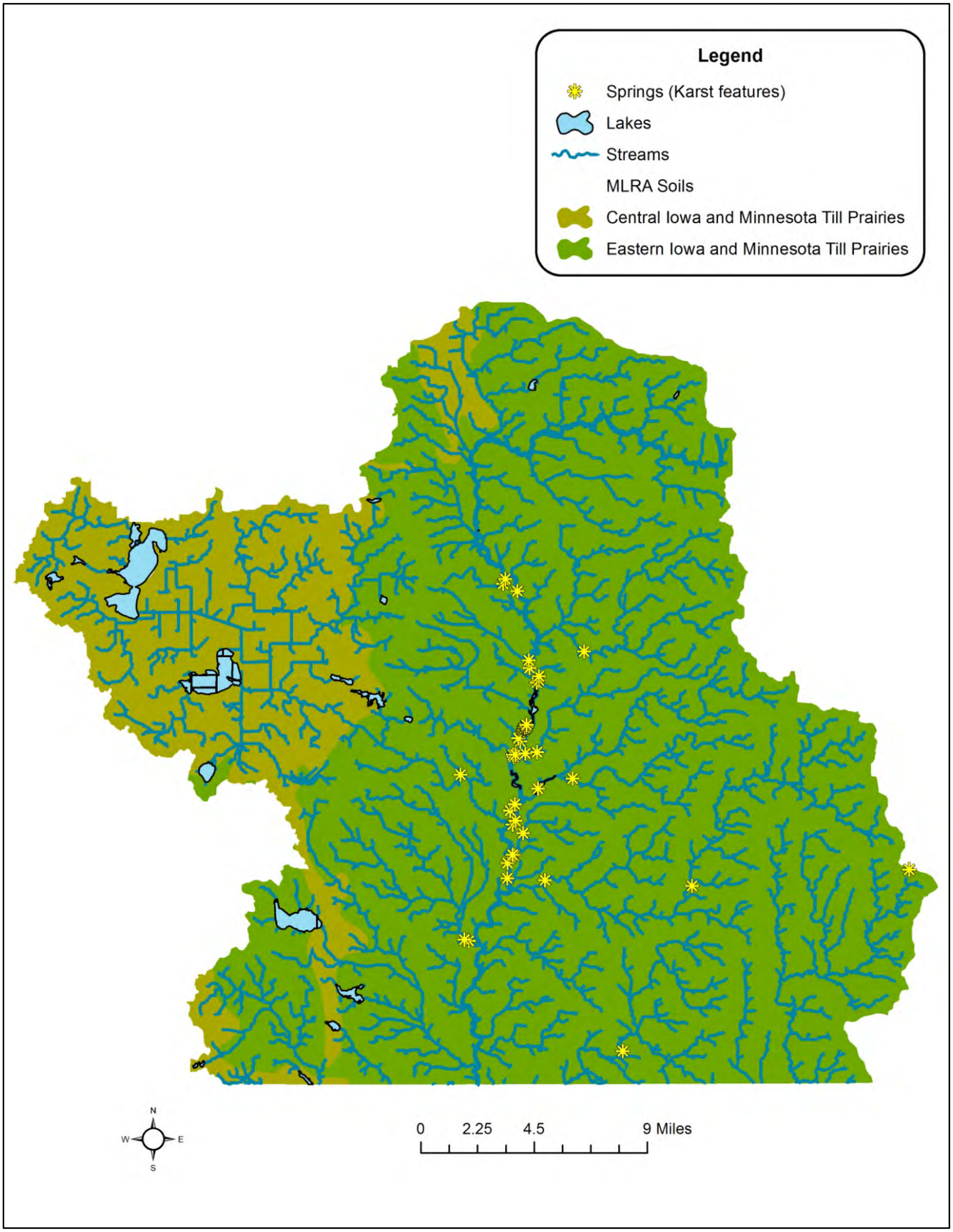

Figure 7. Major Land Resource Areas (MLRA) and springs in the Cedar River Watershed

Land use summary

Prior to western settlement, tall grasslands, wetlands, oak savanna, and maple-basswood woodlands, comprised land cover in much of the Cedar River watershed. Western expansion came to the Cedar River in the 1850s, as people were largely drawn to the area to farm the rich agricultural soils. The population grew dramatically in the 1860s and 1870s, with the westward expansion of the railroad. The city of Austin continued to grow along with the thriving agricultural economy and the founding of the George A. Hormel Company in 1891.

Historically, much of the Turtle Creek subwatershed was a large wetland complex. In 1919, the Albert Lea Farms Company purchased 15,000 acres of wetland and workers dug in a network of drainage ditches to drain the wetland, plowed the soil, and planted vegetable crops including celery, potatoes, onions, carrots, and cabbage (Albert Lea Farms Company and Payne Investment Company, http://www.turtlecreekwd.org/documents/HollandaletheWonderland.pdf).

Today, agriculture continues to thrive in the watershed comprising 88 percent of the watershed land area (Figure 8). Row-crops of corn and soybean are the predominant crops. The top animal commodities in the watershed are hogs and pigs (USDA 2007a, b).

The largest population centers are located along the Hwy 218 corridor (dividing the watershed in two from west to east) and include the cities of Blooming Prairie and Austin. Several smaller communities dot the watershed (Figure 8).

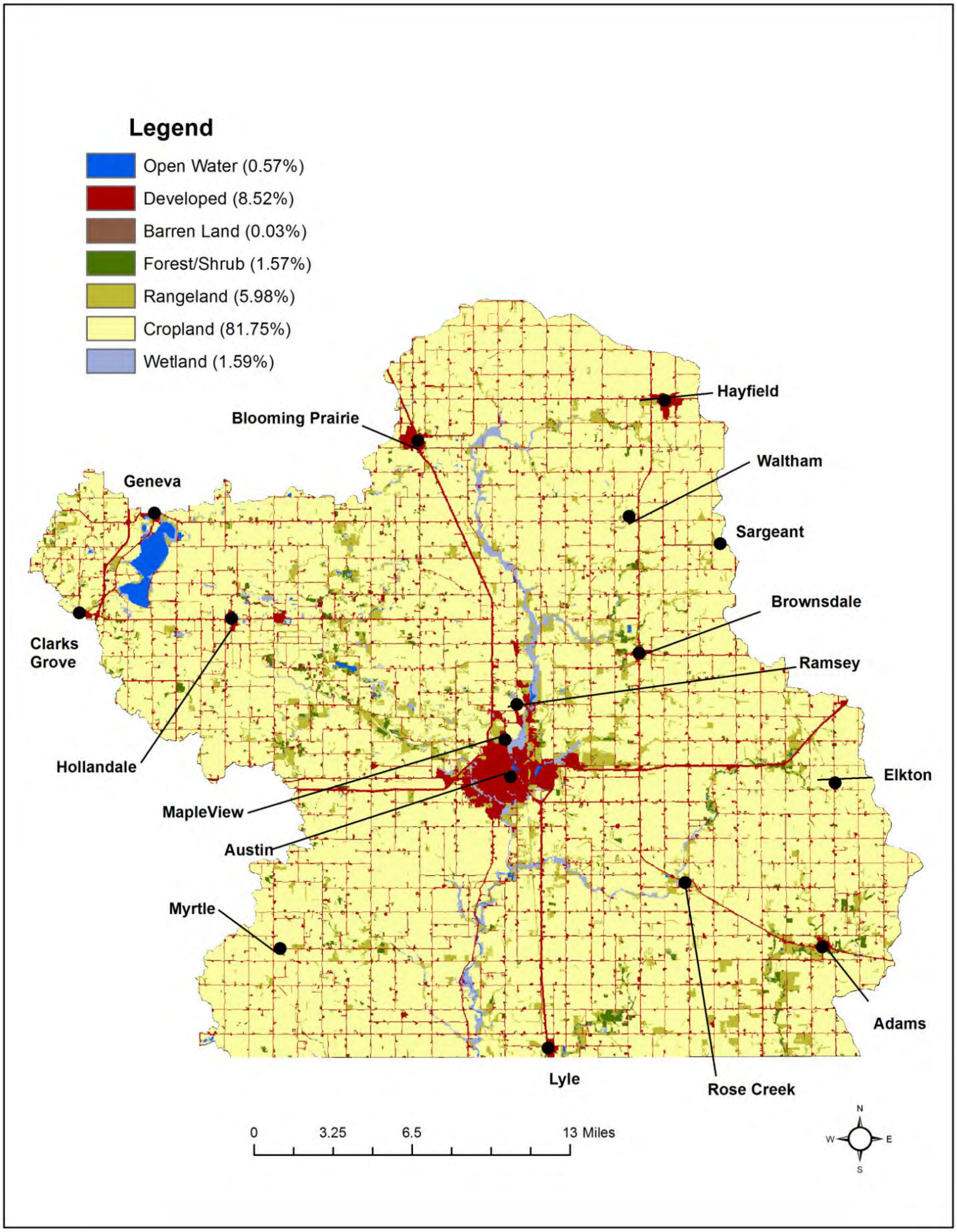

Figure 8. Land use in the Cedar River Watershed

Surface Water Hydrology

The Cedar River begins as three separate tributaries (West, Middle, East Forks) that join together just east of Blooming Prairie in Dodge County. From there the river meanders south through Mower County and flows into Ramsey Mill Pond just north of Austin. From there it travels through the city of Austin and meanders south 10 miles before crossing the Iowa border.

Several major tributaries feed into the Cedar River including Turtle Creek, Roberts Creek, Wolf Creek, Dobbins Creek, Rose Creek, Otter Creek, Mud Lake Creek, Deer Creek, and Woodbury Creek. The Cedar's 11 HUC-11 subwatersheds are comprised of 77 minor watersheds.

Geneva Lake is the only natural lake in the watershed greater than 10 acres in size. Other lakes in the watershed are reservoirs and ponds formed by dams. Historical records indicate that other natural lakes have since been ditched and drained.

Four dams restrict the natural flow of the Cedar River and its tributaries. Historically, dams in the watershed were constructed for milling, recreation, and power generation. Gregson's Mill was built on the Cedar River for grinding flour. This dam was rebuilt and creates the Ramsey Mill Pond reservoir north of Austin. In 1854, Austin Nichols built a dam on the Cedar River to operate a saw mill (http://www.blueplanetgreenliving.com/tag/austin-minnesota/). Today this dam is known as the Cedar River Dam and the 4th St Dam and creates Mill Pond in the city limits of Austin. Another dam on the Cedar River is located near Le Roy. A settler named Conrad Hambrecht built an earthen dam in the 1850s or 1860s to create a pond. This dam was later rebuilt by the city of Le Roy and created Lake Louise (Meyer 1991). A dam on Dobbins Creek was built in 1934 for flood control. This dam created the reservoir East Side Lake in Austin.

Flooding is a major concern, the largest flood on record occurring in September 2004, and causing crop losses of $7 million and property losses of $10 million (MPCA 2009). Historically, the Cedar River has flooded its banks in 1908, 1916, 1925, twice in 1978, 2000, 2004, and most recently in 2008. The most recent flooding events were worse than previous events (MPCA 2009).

Climate and precipitation

Precipitation is the source of almost all water inputs to a watershed. In southeastern Minnesota, deep bedrock aquifers also conduct water from recharge zones hundreds of miles distant, allowing discharge of groundwater into local watersheds. Precipitation in the Cedar River watershed averages 32 inches per year (Midwest Regional Climate Center). The Oct. 2008-Sept. 2009 water year precipitation summary shows conditions were near normal to slightly drier than normal (Figure 9).

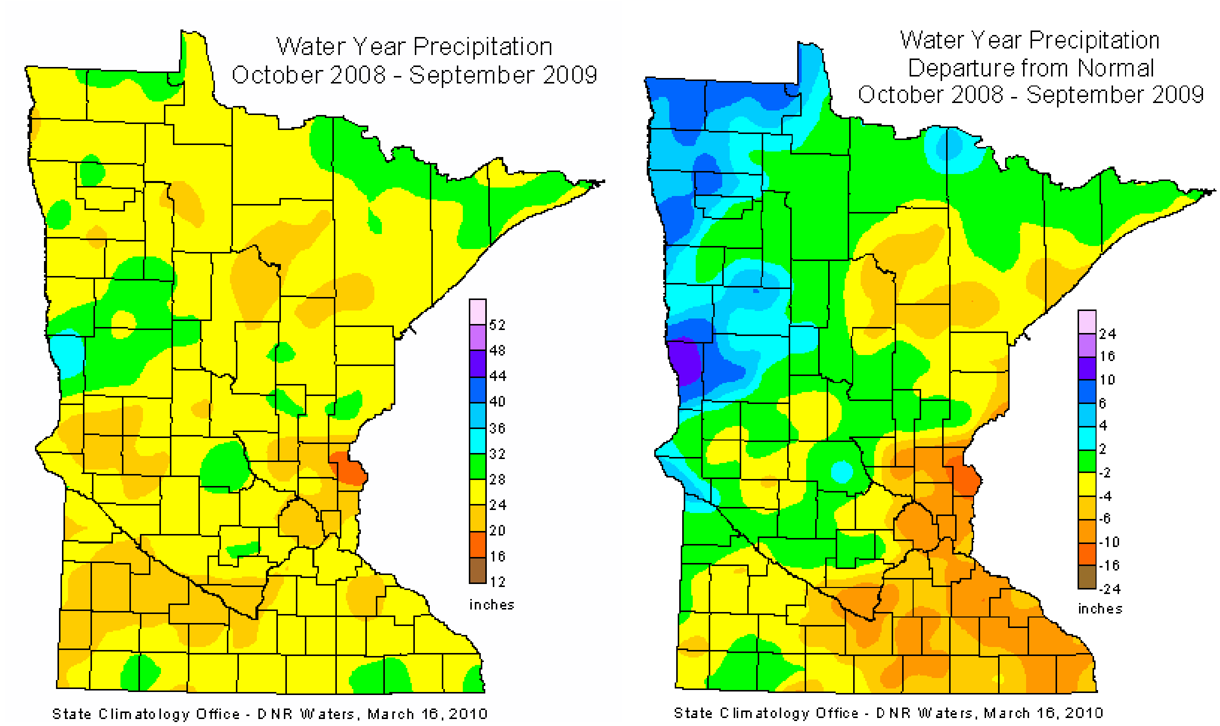

Figure 9. State-wide precipitation levels during the 2009 water year

Figure 10 displays the areal average representation of precipitation in Southeast Minnesota. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center, available as a link off of the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html.

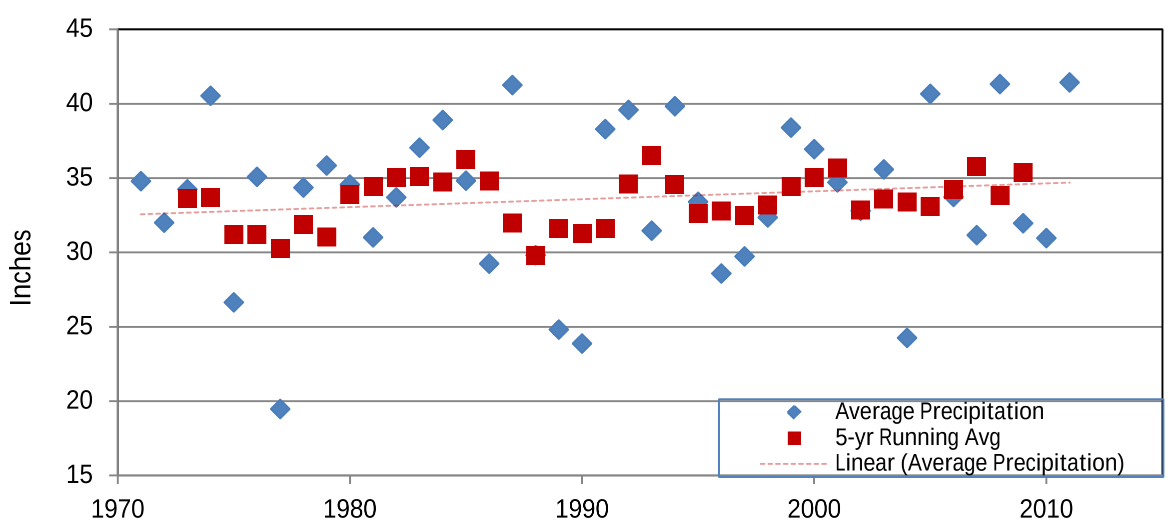

Figure 10. Precipitation trends in southeast Minnesota (1960-2010) with five year running average

Rainfall in the Central region has not risen over the last 40 years. This contrasts with a state-wide spatial average showing a statistically significant rising trend for the same time period. Though rainfall can vary in intensity and time of year, it would appear that southeast MN precipitation has not changed dramatically over this time period.

Hydrogeology and groundwater quality

Geology in Southeast Minnesota is characterized by karst features. The Cedar River Watershed is located in the western edge of Minnesota's Karst geography, in a transition zone ranging from covered Karst to active Karst. These geologic features occur where limestone is slowly dissolved by infiltrating rainwater, sometimes forming hidden, rapid pathways from pollution release points to drinking water wells or surface water.

Karst aquifers are very difficult to protect from activities at the ground surface. Pollutants are quickly transported to drinking water wells or surface water, thus conventional hydrogeologic tools such as monitoring wells are of limited usefulness. The best strategy is pollution prevention from common sources like septic systems, abandoned wells, and animal feedlot operations.

Bedrock in Mower County is covered by glacial sediments as thick as 275 feet, with bedrock exposed in only a few places such as along the Cedar River. The county is underlain by limestone and dolostone karst aquifers, which are formed by solution processes.

Figure 11 demonstrates that the water flowing into the Cedar River just south of Austin is young water, water with a short residence time in the aquifer. Younger water is more likely to be contaminated with salt, petroleum byproducts, agricultural chemicals, etc.

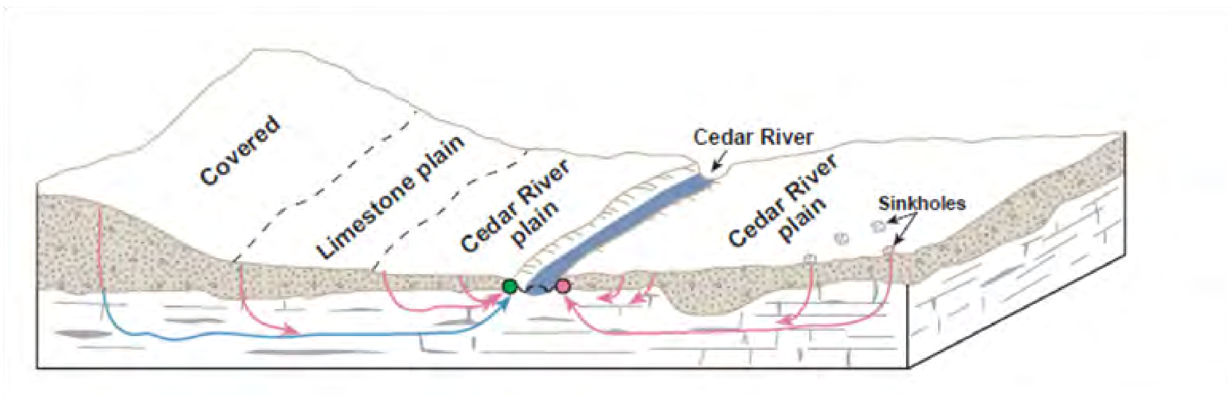

Figure 11. Diagrammatic depiction of groundwater flow in plains adjacent ot the Cedar River. Vintage groundwater (blue line) from the covered Karst unit mixes with recent groundwater (pink lines) from the Cedar River plain and limestone plain, some of which may enter via sinkholes (Mower County Atlas; Plate 10)

The Ambient Groundwater Monitoring Program at the MPCA tracks trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. Results from two monitoring sites near the city of Austin indicate high concentrations of naturally-occurring elements in groundwater. These results do not raise concern for impacts of widespread contamination from anthropogenic chemicals. Currently, there are no MDA groundwater's monitoring station in the Cedar River watershed (MDA 2009, 2010)

High capacity withdrawals

The DNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or one million gallons/year (See Figure 12 for locations of permitted groundwater and surface water withdrawals). 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.

Groundwater and surface water withdrawals are located across the watershed (Figure 12). The highest concentration of permitted withdrawals occurs along the Cedar River corridor. The three largest permitted consumers of water in the state (in order) are municipalities, industry and irrigation. The Cedar watershed withdrawals are mostly a mix of municipal and irrigation pumping.

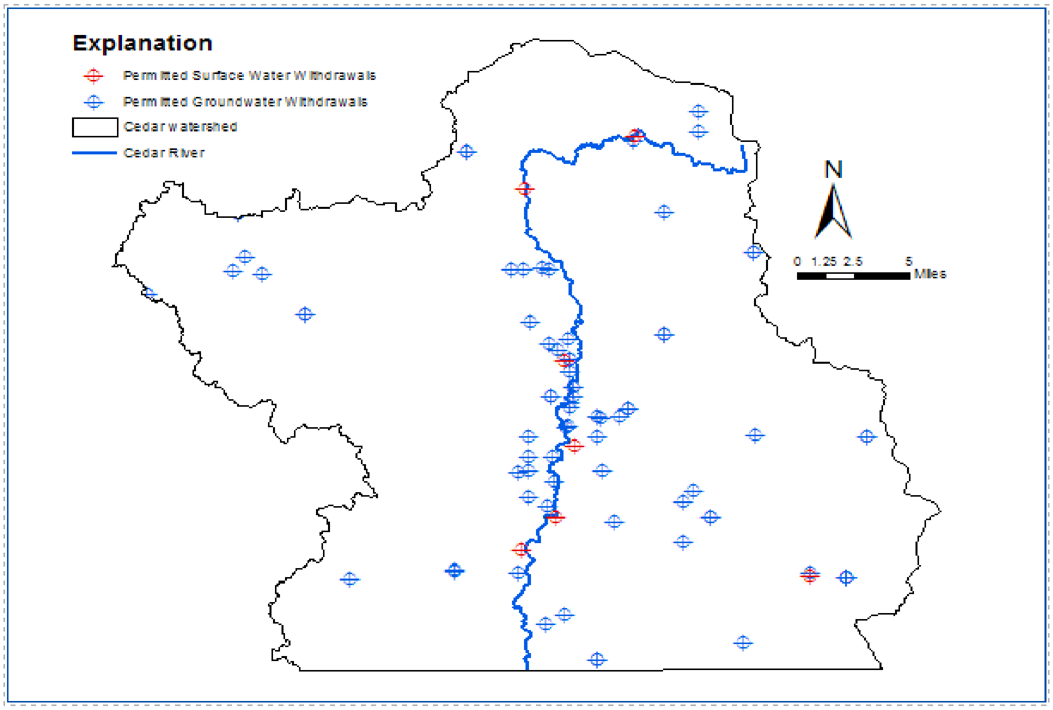

Figure 12. Locations of permitted groundwater withdrawals in the Cedar River Watershed

Data from the MDNR SWUDS database (Figure 13) indicate that total groundwater withdrawals for the watershed over the last 20 year show a show a statistically significant rising trend in both surface water and groundwater withdrawals ($p<0.10$). This is a trend observed in watersheds across the state. There have been no new permitted surface water withdrawals in the watershed in the last 20 years.

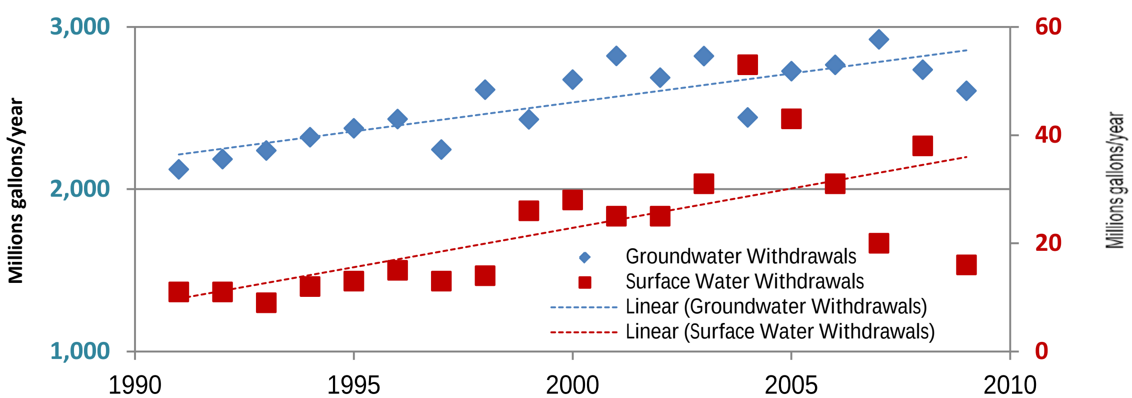

Figure 13. Total annual groundwater and surface water withdrawals in the Cedar River Watershed (1990-2010)

IV. Watershed-Wide Data Collection Methodology

Load monitoring

A load monitoring station is located on the Cedar River on CSAH 28 just downstream of the city of Austin. Intensive water quality sampling occurs year round at this site. Twenty to thirty-five grab samples are collected at the site per year with sampling frequency greatest during periods of moderate to high flow. Frequent sampling during major runoff events is required to capture the largest pollutant loads and to accurately characterize shifting concentration/flow dynamics. Low flow periods are also sampled and are well represented. This biased sampling methodology generally results in samples being well distributed over the entire range of flows.

Water chemistry and discharge data are input into the “Flux32” load estimation program to estimate pollutant concentrations and loads on days when samples are not collected. Primary outputs include: annual pollutant loads, defined as the amount (mass) of a pollutant passing a stream location over a defined period of time, and flow weighted mean concentrations (FWMCs). Flow weighted means concentrations are computed by dividing the pollutant load by the total seasonal flow volume. Annual pollutant loads and flow weighted means are calculated for total suspended solids (TSS), total phosphorus (TP), orthophosphate (OP), Total Kjeldahl Nitrogen (TKN) and nitrate plus nitrite nitrogen (nitrate-N).

Stream water sampling

Seven water chemistry stations were sampled from May thru September in 2009, and again June thru August of 2010, to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards in the 11 HUC subwatersheds that were >40 square miles in area (purple circles and green circles/triangles in Figure 3). A Surface Water Assessment Grant (SWAG) was awarded to the Cedar River Watershed District (CRWD) in partnership with Mower Soil and Water Conservation District for a turbidity TMDL monitoring project. Three of these stations collocated with the IWM design and water chemistry was collected by CRWD while MPCA staff collected water chemistry at four new stations. Following the IWM design, sampling locations were established near the outlets of the intermediate 11-HUC watersheds. See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study. Chemistry data on the Cedar River submitted by wastewater treatment plants as part of their discharge permit was also reviewed. Due to the small drainage area (<40 mi^2) of the West Beaver Creek subwatershed (11-HUC) an intensive chemistry collection station was not placed at the outlet; however, a biological station was placed at the outlet and assessed for aquatic life. Two 11-HUC subwatersheds begin in Minnesota and the outlets are located in Iowa (Little Cedar River and Elk River). Due to the small subwatershed areas that are located in Minnesota, no intensive chemistry collection stations were placed within these two 11-HUC subwatersheds. The MPCA assessed the outlet of the Little Cedar River subwatershed using biological data to assess for aquatic life. The Elk River watershed was too small for placement of a biological monitoring station (~2 square miles on Minnesota side of border with Iowa).

Stream biological sampling

The biological monitoring component of the intensive watershed monitoring in the Cedar River Watershed was completed during the summer of 2009. A total of 61 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds, selected following the sampling design. In addition, four existing biological monitoring stations within the watershed were revisited in 2009. These monitoring stations were initially established as part of a random Cedar River Basin wide survey in 2004, or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2011 assessment was collected in 2009. A total of 46 AUIDs were sampled for biology in the Cedar River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 25 AUIDs. Waterbody assessments were not conducted for 21 AUIDs because criteria for channelized reaches had not been developed prior to the assessments. Nonetheless, the biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically Fish and Invert IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure. Minnesota's streams and rivers were divided into seven distinct warm water classes and two cold water classes, with each class having its own unique Fish IBI and Invert IBI. The classification factors used to produce the seven classes were drainage area, gradient, water temperature and geographic region of the state. Fish and macroinvertebrate communities occurring at sites within each class are more similar to each other than those occurring in other classes. These classification factors are unaffected by human disturbance to ensure that the framework reflects natural variability and that the resulting IBIs reflect human-induced impacts to the waterbody. IBI development was stratified by class, with a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals identified for each. IBI scores higher than the impairment threshold indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold indicate that the stream reach does not support aquatic life. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of waterbody condition involves consideration of potential stressors, and draws upon additional information regarding water chemistry, physical habitat, land use activities, etc. For individual biological monitoring station IBI scores, thresholds and confidence intervals for all biological monitoring sites within the watershed refer to Appendices 4 and 5.

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Cedar River in 2009, by the MPCA biomonitoring staff. Samples had previously been collected by MDNR fisheries staff in 1978, 1979, 1980, 1987, 1999, and 2007. Two lakes in the watershed have been tested for mercury and PCBs in fish: East Side (50-0002) and Ramsey Mill Pond (50-0004). East Side was sampled only in 1992, and Ramsey Mill Pond was only sampled in 2000.

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

Prior to 2006, mean mercury fish tissue concentrations were assessed for water quality impairment based on the Minnesota Department of Health's 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 ten percent of the fish samples (measured as the 90^{th} percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples 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.

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These 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 Minnesota Department of Health. 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).

Lake water sampling

MPCA sampled Lake Geneva in 2008 and 2009, as part of the Clean Water Legacy Surface Water Monitoring project for the purpose of enhancing the dataset for lake assessment of aquatic recreation. There are currently no volunteers enrolled in the MPCA's Citizens Lake Monitoring Program (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 water quality assessment standard requires eight observations/samples within a 10 year period for Phosphorus, Chlorophyll-a and Secchi depth.

V. Individual watershed results

HUC-11 watershed units

Assessment results are presented for each of the HUC-11 watershed units within the Cedar River Watershed. This is intended to enable the assessment of all surface waters at one time and the ability to develop comprehensive TMDL studies on a watershed basis, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. This scale provides a robust assessment of water quality condition in the 11-digit watershed unit and is a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The primary objective is to portray all the impairments within a watershed resulting from the complex and multi-step assessment and listing process. The graphics presented for each of the HUC-11 watershed units contain the assessment results from the 2011 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2009 intensive watershed monitoring effort, but also considers available data from the last ten years.

Given all the potential sources of data and differing assessment methodologies for indicators and designated uses, it is not currently feasible to provide results or summary tables for every monitoring station by parameter. However, in the proceeding pages an individual account of each HUC-11 watershed is provided. Each account includes a brief description of the subwatershed, a table summarizing stream aquatic life and aquatic recreation assessments, a table summarizing the biological condition of channelized streams and ditches, a stream habitat results table, a summary of water chemistry results for the HUC-11 outlet, a summary of lake aquatic recreation assessments, and a narrative summary of the assessment results for the subwatershed. A brief description of each of these components 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 watershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2011 assessment process (2012 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 5). Assessment of aquatic life is derived from the analysis of biological (fish and invert IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*Escherichia coli*) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Stream reaches that do not have sufficient information for either an aquatic life or aquatic recreation assessment (from current or previous assessment cycles) are not included in these tables, but are included in Appendices 5.2 and 5.3. Where applicable and sufficient data exists, assessments of other designated uses (e.g., class 7, drinking water, aquatic consumption) are discussed in the summary section of each HUC-11 as well as in the Watershed-Wide Results and Discussion section.

Channelized stream evaluations

Biological criteria has not been developed yet for channelized streams and ditches, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible at some monitoring stations. A separate table provides a narrative rating of the condition of fish and macroinvertebrate communities at such stations based on IBI results. Evaluation criteria are based on aquatic life use assessment thresholds for each individual IBI class (see Appendix 5.1). IBI scores above this threshold are given a "good" rating, scores falling below this threshold by less than ~15 points (i.e., value varies slightly by IBI class) are given a "fair" rating, and scores falling below the threshold by more than ~15 points are given a "poor" rating. For more information regarding channelized stream evaluation criteria refer to Appendix 5.1.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each HUC-11 section. These tables 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 HUC-11 watershed.

Stream stability results

Stream channel stability information evaluated during each invert sampling visit is provided in each HUC-11 section. These tables display the results of the Channel Condition and Stability Index (CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates Three regions of the stream channel (upper banks, lower banks, and bottom) which may provide an indication of stream channel geomorphic changes and loss of habitat quality which may be related to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2008, and is collected once at each biological station. Consequently, the CCSI ratings are only available for the 2009 biological visits. The final row in each table displays the average CCSI scores and a rating for the HUC-11 watershed.

Watershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the HUC-11 watershed. This data along with other data collected within the 10 year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to the standards or expectations used for assessing aquatic life and recreation. While not all of the water chemistry parameters of interest have established water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of parameters that provide a basis for evaluating stream water quality data and estimating attainable conditions for an ecoregion. For comparative purposes, water chemistry results for the Cedar River Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams within each ecoregion.

Lake assessments

A summary of lake water quality is provided in the HUC-11 sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for all lakes in the watershed are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 6.2.

Middle Fork Cedar River Watershed Unit HUC 07080201010

The Middle Fork Cedar River Watershed Unit drains 72 square miles. The watershed begins as a series of channelized streams that flow together to become three tributaries to the Cedar River. The East Fork of the Cedar River begins near Hayfield and travels west until it connects with the Middle Fork of the Cedar River east of Blooming Prairie. The West Fork of the Cedar River begins north of Blooming Prairie and connects with the Cedar River just north of CSAH 2 near the Dodge/Mower County border. Over 90 percent of the land is used for agriculture of which 88 percent is planted in row- crops and 3.4 percent is utilized as pasture. Developed land is estimated at seven percent. Only 1.7 percent of the watershed is in forest and wetlands. There are no lakes in this watershed. The intensive water chemistry sampling station was collocated with CRWD's sampling station #11. This station is also represented by MPCA's STORET/EQuIS station S000-804 and biological station 09CD011.

Table 1. Aquatic life and recreation assessments on stream reach in the Middle Fork Cedar River Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-503† ***Cedar River,*** *Headwaters to Roberts Cr*	28.6	2B	09CD005 04CD003 09CD056 09CD011	Upstream of 180th Ave, 2 mi. SW of Hayfield Downstream of Hwy 5, 4 mi. SW of Hayfield Upstream of 150th Ave, 4.5 mi. W of Hayfield Downstream of CSAH 2, 3 mi. E of Blooming Prairie	MTS	EXP	IF	EXP	MTS	MTS	MTS	--	EX	NS	NS
07080201-529 ***Unnamed creek,*** *Unnamed cr to Cedar R*	2.3	2B	09CD004	Upstream of 180th Ave, 2 mi. SW of Hayfield	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07080201-592 ***Unnamed creek,*** *Unnamed cr to Cedar R*	4.4	2B	09CD041	Upstream of 150th Ave, 4.5 mi. W of Hayfield	EXP	NA	--	--	--	--	--	--	---	FS	NA
07080201-532 ***Unnamed creek,*** *Headwaters to Cedar R*	8.6	2B	09CD014	Upstream of Dodge Mower Rd, 4.5 mi. SE of Blooming Prairie	EXP	EXS	--	--	--	--	--	--	--	IF*	NA
07080201-549 ***Cedar River, Middle Fork,*** *Westfield-Ripley Ditch to Unnamed cr*	1.4	2B	04CD016	Upstream of Hwy 30, 3 mi. NE of Blooming Prairie	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-530 ***Cedar River, Middle Fork,*** *Unnamed cr to Cedar R*	3.1	2B	09CD002	Upstream of Hwy 30, 3.5 mi. NE of Blooming Prairie	MTS	EXP	IF	EXP	--	MTS	--	--	--	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50 percent) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
† This AUID crosses two subwatersheds. The results for this AUID are included in both the Middle Fork of the Cedar River and Upper Cedar River watershed units.

Table 2. Non-assessed biological stations on channelized AUIDs in the Middle Fork Cedar River 11-HUC

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07080201-550 ***Unnamed creek,*** *Unnamed cr to Unnamed cr*	2.9	2B	04CD036	Downstream of CR 5, 4.5 miles SE of Hayfield	Poor	--
07080201-532 ***Unnamed creek,*** *Headwaters to Cedar R*	8.6	2B	09CD014	Upstream of Dodge Mower Rd, 4.5 mi. SE of Blooming Prairie	Fair	Fair
07080201-549 **Cedar River, Middle Fork,** Westfield-Ripley Ditch to Unnamed cr	1.4	2B	09CD040	Downstream of 720th St, 3 mi. NE of Blooming Prairie	Poor	--

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results

Table 3. Minnesota Stream Habitat Assessment (MSHA) for the Middle Fork Cedar River 11-HUC

# Visits	Biological Station ID	Stream Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD004	Unnamed creek	0	11	12.8	12	15	50.8	Fair
1	09CD014	Unnamed creek	0	8	8.1	11	12	39.1	Poor
1	04CD036	Trib. to Cedar River, East Fork	0	5	10.3	5	12	32.3	Poor
1	09CD040	Cedar River, Middle Fork	0	6	6	5	7	24	Poor
1	04CD016	Cedar River, Middle Fork	0	11.5	16.8	13	24	65.3	Fair
1	09CD002	Cedar River, Middle Fork	0	9.5	9.5	8	15	42	Poor
1	09CD041	Trib. to Cedar River	0	11	18.1	11	22	62.1	Fair
1	09CD005	Cedar River	0	11.5	12.5	13	15	52	Fair
1	04CD003	Cedar River	0	8.5	17.6	8	29	63.1	Fair
1	09CD056	Cedar River	1.3	9	13.1	12	16	51.3	Fair
1	09CD011	Cedar River	0	11.5	17.2	10	27	65.7	Fair
Average Habitat Results: *Middle Fork Cedar River 11 HUC Watershed*			**0.1**	**9.3**	**12.9**	**9.8**	**17.6**	**49.8**	**Fair**

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

Table 4. Channel Condition and Stability Assessment (CCSI) for the Middle Fork Cedar River 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD004	Unnamed creek	15	18	25	5	63	moderately unstable
1	09CD014	Unnamed creek	15	13	12	3	43	fairly stable
0	04CD036	Trib. to Cedar River, East Fork	NA	NA	NA	NA	NA	NA
1	09CD040	Cedar River, Middle Fork	6	11	33	6	56	moderately unstable
0	04CD016	Cedar River, Middle Fork	NA	NA	NA	NA	NA	NA
1	09CD002	Cedar River, Middle Fork	23	18	17	7	65	moderately unstable
1	09CD041	Trib. to Cedar River	8	12	15	5	40	fairly stable
1	09CD005	Cedar River	15	20	19	5	59	moderately unstable
0	04CD003	Cedar River	NA	NA	NA	NA	NA	NA
1	09CD056	Cedar River	14	17	15	3	49	moderately unstable
1	09CD011	Cedar River	13	20	14	5	52	moderately unstable
Average Stream Stability Results: *Middle Fork Cedar River 11 HUC*			**13.6**	**16.1**	**18.8**	**4.9**	**53.4**	**moderately unstable**

Qualitative channel stability ratings
stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 5. Outlet water chemistry results for the Middle Fork Cedar River 11-HUC

Station location:	East Fork Cedar River, on CSAH-2, East of Blooming Prairie								
STORET/EQuIS ID:	S000-804								
Station #:	09CD011								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCBP 75th Percentile[3]**
Ammonia-nitrogen	mg/L	24	<0.16	0.29	N/A	N/A			0.2
Chloride	mg/L	15	17.3	34.2	28.33	27.8	230	0/15	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	35	3.4	10.7	7.5	7.6	5	1/35	
Escherichia coli	MPN/100ml	21	30	1600	420	255	1260	2/21	
Inorganic nitrogen (nitrate and nitrite)	mg/L	19	0.2	19.9	8.1	8.9			6.5
Kjeldahl nitrogen	mg/L	19	<0.2	2.8	1.1	0.9			
Orthophosphate	ug/L	19	10	463	110	71			
pH		35	7.3	8.6	8.0	8.0	6.5 - 9	0/35	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	19	30	847	190	133			350
Specfic Conductance	uS/cm	35	44	589	426	482			530
Temperature, water	deg °C	35	8.4	25.3	19.1	19.6			
Total suspended solids	mg/L	10	<2	54	10.4	5.5			
Total volatile solids	mg/L	N/A	N/A	N/A	N/A	N/A			
Transparency tube	100 cm	11	49	>100	80	80	>20	0/11	
Transparency tube	60 cm	26	4	>60	45	55	>20	5/26	
Turbidity	FNU	30	0.2	178.6	28.1	8.4	25	6/30	
Sulfate	mg/L	15	13.8	39.5	19.0	17.5			
Hardness	mg/L	N/A	N/A	N/A	N/A	N/A			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Cedar River 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

The Cedar River (AUID 07080201-503) was listed as impaired for aquatic recreation due to high bacteria counts in 2006. The current assessment supports the listing with 2 of 21 samples exceeding the individual maximum standard (1260/100ml). This same AUID was also listed for aquatic consumption for mercury in fish tissue in 1998 and for PCBs in 2002. No other fish tissue collections have been submitted for analysis since 2002.

Five AUIDs were assessed for aquatic life in the Middle Fork Cedar River watershed unit while one AUID was not assessed due to channelization. Of the assessed AUIDs, two reaches were fully supporting of aquatic life and three reaches were non-supporting due to low aquatic macroinvertebrate community scores. One of the impaired AUIDs on the Cedar River (07080201-503) is a 29 mile long AUID that begins in the Middle Fork Cedar River watershed unit (070802010) and continues into the Upper Cedar River watershed unit (070802030). Monitoring stations along this Cedar River AUID suggest that while fish performed well, there appears to be an upstream to downstream gradient in aquatic macroinvertebrate community condition where the headwater reaches rated poor while the downstream reaches rated fair to good. Habitat quality at the four reaches in the Middle Fork of the Cedar watershed was rated fair and channel stability was rated moderately unstable. Habitat loss due to altered hydrology and unstable stream channels may be a potential stress to the biological communities. In addition, nitrite-nitrate samples were high at 9 to 21 mg/L in the months of May and June, which could also be a potential stressor. Unnamed creeks in the watershed are also non-supporting of aquatic life due to low aquatic invertebrate community scores. Habitat quality was fair to poor and channel stability was moderately unstable at these stations as well. High nitrates and turbidity were noted as potential stressors.

For the channelized stations/AUIDs that were not assessed, two stations performed poorly for fish community condition (04CD036 and 09CD040). Macrointerbrates and channel stability assessments were not collected at these sites. Nitrate-nitrogen values were high at 22 mg/L and 11 mg/L, respectively, which could indicate a potential stress. Habitat quality was also rated poor for riparian width, percent cover, sinuosity, and riffle-pool development. At three biological stations (09CD040, 09CD041, 04CD016), mid-afternoon dissolved oxygen concentrations were high (14.93 mg/L) which may indicate a potential diel oxygen issue. Deployable sondes should be considered at these sites to determine if low-dissolved oxygen during the nighttime is a potential stressor.

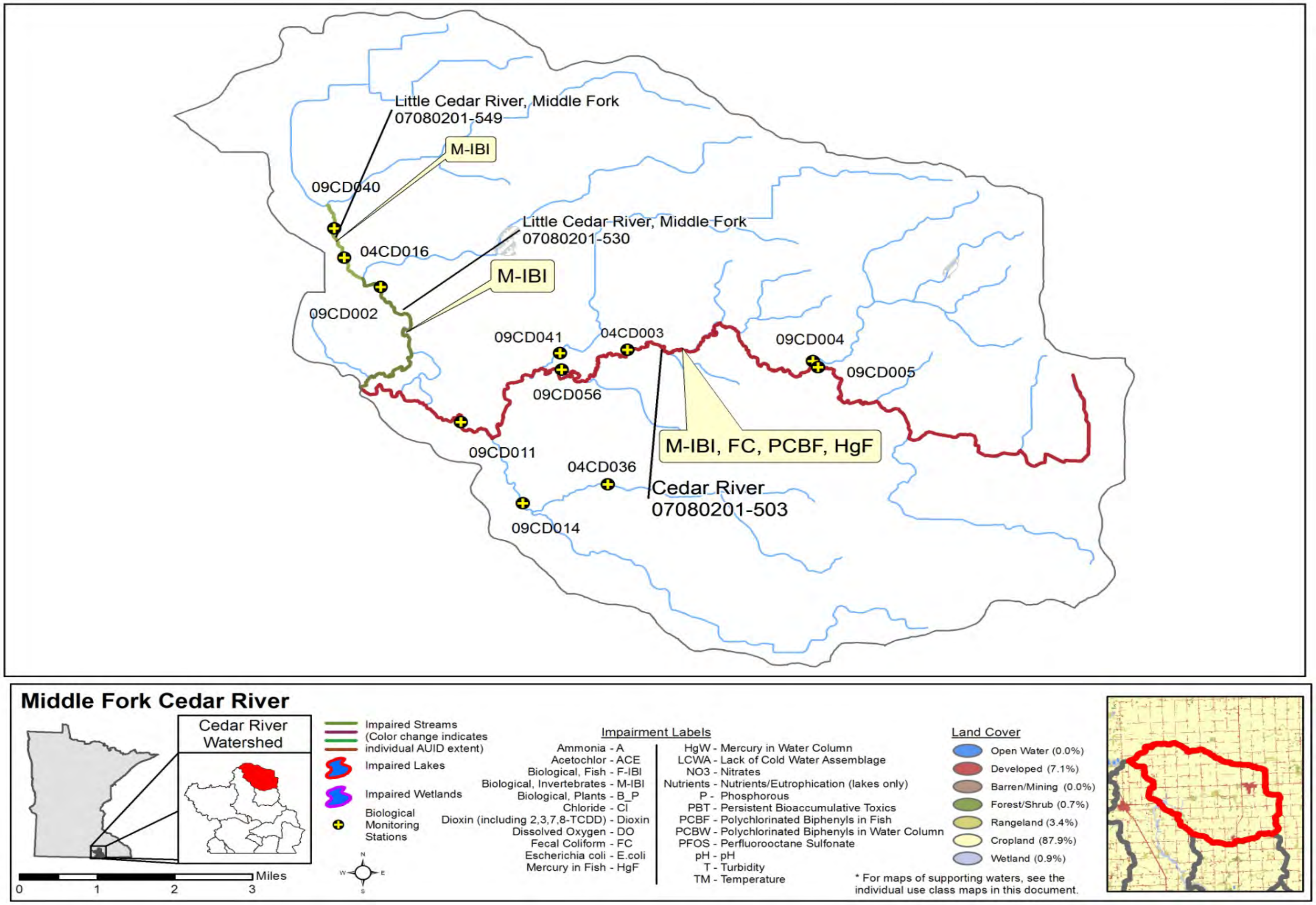

Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Middle Fork Cedar River Watershed Unit

Roberts Creek Watershed Unit HUC 07080201020

The Roberts Creek Watershed Unit is located in north central Mower County and drains 39 square miles. The headwaters of Roberts Creek begin just south of Sargeant and north of Brownsdale. Other unnamed creeks join Roberts Creek as it flows west to the Cedar River. The creeks are mostly natural and unchannelized with intact forest and wetland riparian vegetation. Forest and wetland comprise 3.2 percent of the watershed. Over 90 percent is use for agricultural production, of which, 81.1 percent is used for row-crop cultivation and 7 percent is in pasture. Of the remaining acreage, 6.7 percent is developed land. The outlet of Roberts Creek was sampled for water chemistry at 550th Avenue, 4 miles west of Brownsdale. This location is also represented by CRWD's station #8 and MPCA's STORET/EQuIS station S001-182 and biological station 09CD013.

Table 6. An aquatic life and recreation assessment on stream reaches in the Roberts Creek Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID *Reach Name,* *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07080201-505 ***Unnamed creek,*** *Headwaters to Roberts Cr*	9.3	2B	09CD016	Upstream of 280th St, 2 mi. NW of Brownsdale	MTS	MTS	--	--	--	--	--	--	--	FS	NA
07080201-534 ***Unnamed creek,*** *Unnamed cr to T103 R17W S10, west line*	0.5	2B	09CD051	Upstream of Hwy 56, 0.5 mi. N of Brownsdale	EXP	EXS	--	--	--	--	--	--	--	NS	NA
07080201-506 ***Roberts Creek,*** *Headwaters to Unnamed cr*	6.9	2C	09CD018	Upstream of Hwy 56, 1.5 mi. N of Brownsdale	EXS	EXS	--	--	--	--	--	--	--	NS	NA
07080201-593 ***Unnamed creek,*** *Unnamed cr to Unnamed cr*	1.6	2B	09CD017	Upstream of 285th St, 3 mil. NW of Brownsdale	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-504 ***Roberts Creek,*** *Unnamed cr to Cedar R*	5.8	2C	04CD033 09CD013	Downstream of 570th Ave, 2 mi. E of Lansing Upstream of 550th Ave, 3 mi. NE of Brownsdale	MTS	EXP	IF	EXP	MT	MTS	MT	--	EX	NS	NS

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

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

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

Table 7. Non-assessed biological stations on channelized AUIDs in the Roberts Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI Quality	M-IBI Quality
07080201-507 ***Unnamed creek,*** *T103 R17W S9, east line to Roberts Cr*	0.5	7	09CD052	Downstream of 271st St, 0.5 mi. N of Brownsdale	Fair	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses

Table 8. Minnesota Stream Habitat Assessment (MSHA) for the Roberts Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD017	Unnamed creek	0	12	15.2	12	22	61.2	Fair
1	09CD016	Unnamed creek	1.3	12	8.3	11	13	45.6	Fair
1	09CD051	Unnamed creek	0	11.5	15.7	12	29	68.2	Good
1	09CD052	Unnamed creek	1.3	6.5	15.1	8	16	46.8	Fair
1	09CD018	Roberts Creek	1	12	15.2	11	24	63.2	Fair
1	04CD033	Roberts Creek	0	11.5	16	9	30	66.5	Good
1	09CD013	Roberts Creek	0.8	12	18	11	23	64.8	Fair
Average Habitat Results: *Roberts Creek 11 HUC Watershed*			**0.6**	**11.1**	**14.8**	**10.6**	**22.4**	**59.5**	**Fair**

Qualitative habitat ratings

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

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

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

Table 9. Channel Condition and Stability Assessment (CCSI) for the Roberts Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD017	Unnamed creek	13	20	9	3	45	moderately unstable
1	09CD016	Unnamed creek	13	23	14	5	55	moderately unstable
1	09CD051	Unnamed creek	17	21	15	7	60	moderately unstable
1	09CD052	Unnamed creek	21	17	21	3	62	moderately unstable
1	09CD018	Roberts Creek	13	15	23	6	57	moderately unstable
1	04CD033	Roberts Creek	NA	NA	NA	NA	NA	NA
1	09CD013	Roberts Creek	7	17	9	5	38	fairly stable
Average Stream Stability Results: *Roberts Creek 11 HUC*			**14**	**18.8**	**15.2**	**4.8**	**52.8**	**moderately unstable**

Qualitative channel stability ratings:
stable: CCSI < 27   fairly stable: 27 < CCSI < 45   moderately unstable: 45 < CCSI < 80   severely unstable: 80 < CCSI < 115   extremely unstable: CCSI > 115

Table 10. Outlet water chemistry results for the Roberts Creek 11-HUC

Station location:	**Roberts Creek at Twp Rd, 4.2 mi. NW of Brownsdale**
STORET/EQuIS ID:	**S001-182**
Station #:	**09CD013**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	Median	WQ Standard[1]	# of WQ Exceedances[2]	WCBP 75th Percentile[3]
Ammonia-nitrogen	mg/L	16	< 0.16	0.29	N/A	N/A			0.2
Chloride	mg/L	15	12.3	40.2	19.4	19.6	230	0/15	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	34	6.3	11.4	8.5	8.5	5	0/34	
Escherichia coli	MPN/100ml	21	62	>2400	765	488	1260	3/21	
Inorganic nitrogen (nitrate and nitrite)	mg/L	19	0.7	17.9	6.2	6.3			6.5
Kjeldahl nitrogen	mg/L	19	0.4	2.9	1.1	0.8			
Orthophosphate	ug/L	19	10	270	80	62			
pH		34	7.4	8.5	8.1	8.2	6.5 - 9	0/34	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	19	0.05	0.70	0.18	0.10			350
Specific Conductance	uS/cm	34	44	571	436	457			530
Temperature, water	deg °C	40	8.5	24.1	18.1	18.9			
Total suspended solids	mg/L	10	<2	186	24.2	5.5			
Total volatile solids	mg/L	N/A	N/A	N/A	N/A	N/A			
Transparency tube	100 cm	12	46	>100	84	100	>20	0/12	
Transparency tube	60 cm	40	3.5	>60	42	48.5	>20	6/40	
Turbidity	FNU	29	0.7	399.5	38.1	5.6	25	6/29	
Sulfate	mg/L	15	14.8	51.4	21.0	18.9			
Hardness	mg/L	N/A	N/A	N/A	N/A	N/A			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Roberts Creek 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Roberts Creek (AUID 07080201-504) was listed in 2006, as impaired for aquatic recreation due to high bacteria counts. The current assessment supports the listing. The monthly standard was exceeded for all three samples with enough samples to calculate a geometric monthly mean. For a one time maximum, three of 21 samples recorded counts that exceeded the one time standard (1260 colonies/100 ml). A single sample was reported with over 2400 colonies. Recent upgrades to sanitary sewage treatment in the watershed may help in addressing the current bacteria impairment; however, other sources of bacteria may also include feedlots and land application of manure. These sources should also be reviewed to determine if additional control measures are needed.

Of the five AUIDs that were assessed for aquatic life, one was fully supporting and four were non-supporting of aquatic life. The fully supporting AUID had sensitive fish species present, but in low numbers. This biological station (09CD016) was rated moderately unstable for channel stability and only fair for habitat quality. Excessive bank erosion and cutting was observed along with severely embedded coarse substrates. In order to prevent this stream from becoming impaired in the future, attention should be given to address the geomorphic stream instability and improve habitat conditions.

For the AUIDs with impaired aquatic life, two were impaired for fish while all four were impaired for aquatic macroinvertebrates. The un-assessed channelized reach also rated poor for macroinvertebrates. Turbidity, excess bedded sediment, elevated nitrates and low dissolved oxygen may be stressors to the biological communities. High turbidity values were reported at the outlet monitoring station during high flows. Channel stability at a majority of the biological monitoring stations was rated moderately unstable and habitat quality was rated fair, with moderate to severe bank erosion and excess sedimentation observed. Nitrite -nitrate values exceeded ecoregion expectations during May and June of 2009 (9 to 18 mg/L). At biological station 09CD017, a onetime dissolved oxygen reading was near the standard at 5.4 mg/L at 10:00 a.m. (5.0 mg/L is the standard). Early morning measurements of dissolved oxygen as a series of one-time readings or continuous monitoring with a deployable sonde may indicate whether or not this reach is regularly meeting the dissolved oxygen standard.

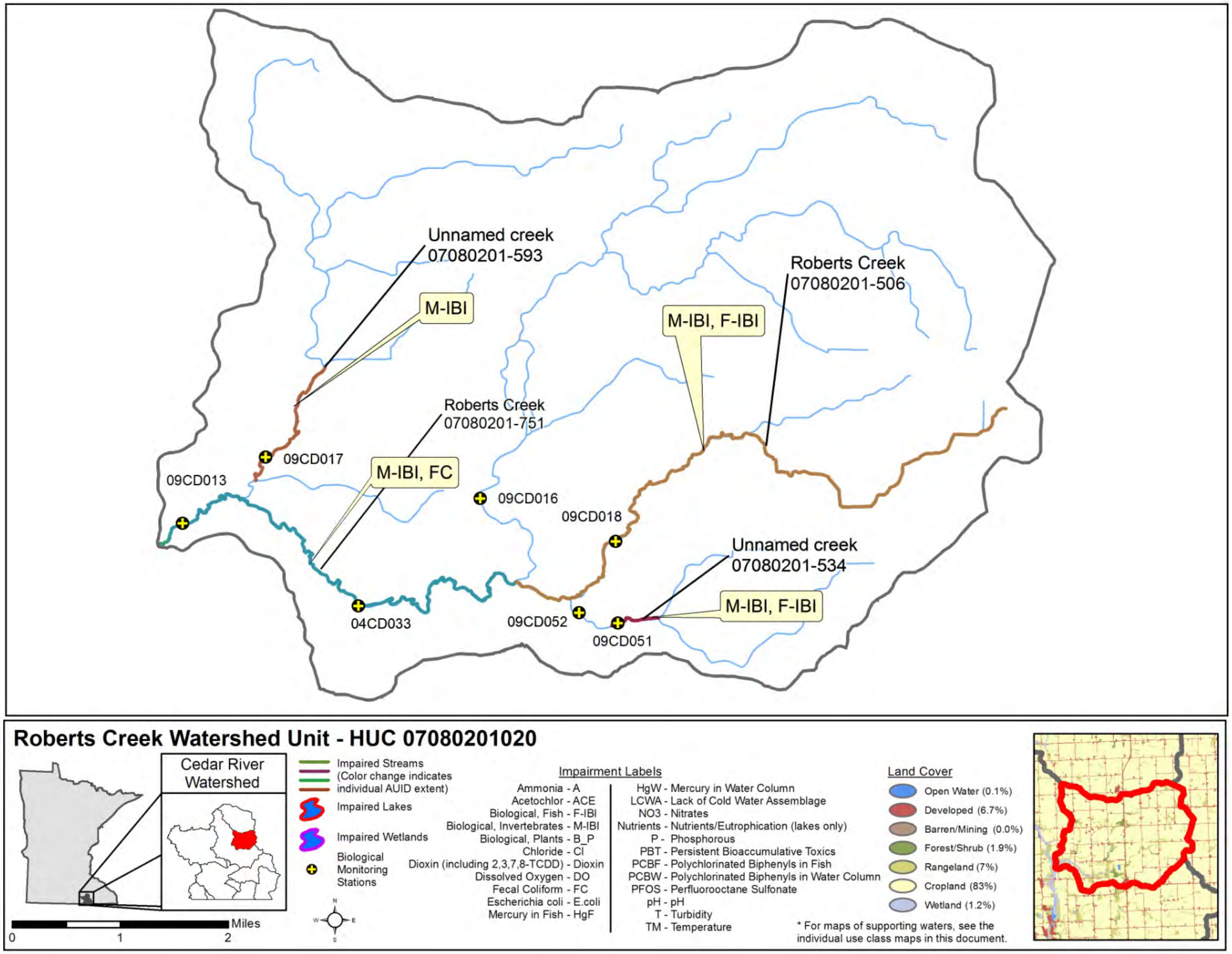

Figure 15. Currently listed impaired waters by parameter and land use characteristics in the Roberts Creek Watershed Unit

Upper Cedar River Watershed Unit HUC 0708201030

The Upper Cedar River Watershed is the second largest subwatershed and drains 131 square miles of Dodge, Freeborn, Mower, and Steele counties. The Upper Cedar River Watershed receives the flow from the Cedar River of the Middle Fork Cedar River Watershed just east of Blooming Prairie. From there, the Cedar River flows south along Hwy 218 through the city Ramsey where the flow is dammed by Ramsey Mill Pond. As it flows south out of the dam, the Cedar River joins Murphy creek and Wolf Creek just north of I-90 on the north side of Austin. Dobbins Creek flows in to Austin from the east, through the Jay C. Hormel Nature Center and into the East Side Lake Reservoir just south of I-90. The outflow of East Side Lake flows southwest and joins the Cedar River in Austin. There are two lakes within watershed (East Side and Ramsey Mill Pond). The watershed is dominated by row-crop agriculture (79.3 percent), developed land (9.9 percent), and pasture (7.0 percent). Only 0.9 percent is forest, 2.7 percent is wetland, and 0.2 percent is open water. The outlet of the watershed was collected just south of the Austin WWTP. Water chemistry data collected by Austin WWTP during low-flow conditions was also consulted during assessment. The outlet is represented by MPCA's STORET/EQuIS station S005-613 and biological station 09CD009.

Table 11. Aquatic life and recreation assessments n stream reaches in the Upper Cedar River Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-591 ***Unnamed creek (Cedar River, West Fork),*** *Unnamed cr to Cedar R*	1.1	2B	09CD023	Downstream of Hwy 30, 1.5 mi. E of Blooming Prairie	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-577 ***Unnamed creek,*** *Unnamed cr to Cedar R*	1.4	2B	04CD009	At SE end of 530th Ave, 6 mi. SE of Blooming Prairie	MTS	EXS	--	--	--	--	--	--	--	NS	NA
07080201-553 ***Murphy Creek,*** *Headwaters to Cedar R*	5.6	2C	09CD044	Upstream of CSAH 45, in Mapleview	NA	NA	IF	EXP	--	MTS	MTS	--	IF	NA*	IF
07080201-503† ***Cedar River,*** *Headwaters to Roberts Cr*	28.6	2B	04CD018 04CD023 09CD010 09CD032	Upstream of 335th St, 2mi. SE of Blooming Prairie 1.5 mi. upstream of CSAH 2, 1.5 mi. N of Lansing Upstream of 335th St, 2.5 mi. SE of Blooming Prairie Upstream of CSAH 25, 5 mi. SE of Blooming Prairie	MTS	EXP	IF	EXP	MTS	MTS	MTS	--	EX	NS	NS
07080201-533 ***Unnamed creek,*** *Unnamed cr to Cedar R*	2.7	2B	09CD042	Upstream of 540th Ave, in Lansing	MTS	EXP	IF	EXP	MTS	MTS	MTS	--	IF	NS	IF
07080201-573 ***Judicial Ditch 5*** *Headwaters to Cedar R*	4.3	2B	09CD043	Upstream of 540th Ave, 1.0 mi. N of Austin	MTS	EXP	IF	EXP	MTS	MTS	MTS	--	IF	IF*	IF

07080201-502 ***Cedar River,*** *Roberts Cr to Upper Austin Dam*	4.8	2B	09CD006	Upstream of 270th St, 2.5 mi. N of Ramsey	MTS	MTS	IF	EXP	MTS	MTS	MTS	--	EX	NS	NS
07080201-511 ***Cedar River,*** *Upper Austin Dam to Wolf Cr*	2.6	2B	04CD038	~1 mi. upstream of I-90, just N of Austin	MTS	EXP	--	--	--	--	--	--	--	FS	NA
07080201-563 ***Unnamed creek,*** *Unnamed cr to Dobbins Cr*	1.5	2B	09CD026	Upstream of CSAH 46, 1 mi. E of Austin	EXP	EXP	--	--	--	--	--	--	--	FS	NA
07080201-535 ***Dobbins Creek,*** *T103 R18W S36, east line to East Side Lk*	1.2	2B	09CD064	Upstream of CR 61, 0.5 mi. E of Austin	EXP	MTS	IF	EXP	--	MTS	--	--	--	NS	NA
07080201-537 ***Dobbins Creek,*** *East Side Lk to Cedar R*	0.7	2B	--	--	--	--	--	--	--	--	--	--	--	NA	NA
07080201-510 ***Wolf Creek,*** *Headwaters to Cedar R*	11.2	2C	--	--	--	--	--	--	--	--	--	--	--	NA	NA
07080201-514 ***Cedar River,*** *Dobbins Cr to Turtle Cr*	1.9	2B	09CD009	Adjacent to 1st Dr SE, in Austin	MTS	MTS	--	EXP	MTS	--	MTS	--	EX	FS	NS

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

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

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

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

† This AUID crosses two subwatersheds. The results for this AUID are included in both the Middle Fork of the Cedar River and Upper Cedar River watershed units.

Table 12. Non-assessed biological stations on channelized AUIDs in the Upper Cedar River 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-573 ***Judicial Ditch 5*** *Headwaters to Cedar R*	4.3	2B	09CD043	Upstream of 540th Ave, 1.0 mi. N of Austin	Good	Fair
07080201-553 ***Murphy Creek,*** *Headwaters to Cedar R*	5.6	2C	09CD044	Upstream of CSAH 45, in Mapleview	Fair	Fair
07080201-510 ***Wolf Creek,*** *Headwaters to Cedar R*	11.2	2B	09CD024	Upstream of CSAH 16, 1 mi. N of Austin	Good	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results.

Table 13. Minnesota Stream Habitat Assessment (MSHA) for Upper Cedar River 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD049	Unnamed creek	0	7.5	18.2	6	24	55.7	Fair
1	04CD009	Trib. to Cedar River	0	14	6.1	15	25	60.1	Fair
1	09CD042	Unnamed creek	0	10.5	17.2	10	24	61.7	Fair
1	09CD043	Judicial Ditch 5	1.3	10.5	16.1	13	19	59.8	Fair
1	09CD044	Murphy Creek	2.5	8.5	14	10	13	48	Fair
1	09CD024	Wolf Creek	2	5	9	14	7	37	Poor
1	09CD026	Unnamed creek	1	11.5	18	11	25	66.5	Good
1	09CD064	Dobbins Creek	5	11.5	19.4	11	26	72.9	Good
1	09CD023	Cedar River, West Fork	0	8.5	16.0	12	15	51.5	Fair
1	09CD010	Cedar River	1.3	10	8.6	13	7	39.9	Poor
1	04CD018	Cedar River	0	7.5	17.1	9	18	51.6	Fair
2	09CD032	Cedar River	1.9	10	19.8	9.5	22	63.2	Fair
1	04CD023	Cedar River	5	14	20	13	23	75	Good
1	09CD006	Cedar River	2.5	10	17.3	10	15	54.8	Fair
2	04CD038	Cedar River	1.8	11.3	14	14	26	67	Good
1	09CD009	Cedar River	2	13	19.6	12	27	73.6	Good
Average Habitat Results: *Upper Cedar River 11 HUC*			**1.6**	**10.2**	**15.7**	**11.4**	**19.8**	**58.6**	**Fair**

Qualitative habitat ratings

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

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

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

Table 14. Channel Condition and Stability Assessment (CCSI) for the Upper Cedar River 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD049	Unnamed creek	11	11	12	3	37	fairly stable
0	04CD009	Trib. to Cedar River	NA	NA	NA	NA	NA	NA
1	09CD042	Unnamed creek	8	5	14	3	30	fairly stable
1	09CD043	Judicial Ditch 5	10	14	19	3	46	moderately unstable
1	09CD044	Murphy Creek	15	9	14	1	39	fairly stable
1	09CD024	Wolf Creek	16	11	10	3	40	fairly stable
1	09CD026	Unnamed creek	17	13	15	3	48	moderately unstable
1	09CD064	Dobbins Creek	8	11	12	3	34	fairly stable
1	09CD023	Cedar River, West Fork	7	17	17	3	44	fairly stable
1	09CD010	Cedar River	9	14	19	5	47	moderately unstable
0	04CD018	Cedar River	NA	NA	NA	NA	NA	NA
1	09CD032	Cedar River	9	13	18	5	45	moderately unstable
0	04CD023	Cedar River	NA	NA	NA	NA	NA	NA
1	09CD006	Cedar River	15	17	25	5	62	moderately unstable
1	04CD038	Cedar River	18	38	37	11	104	Severely unstable
1	09CD009	Cedar River	26	9	5	5	45	moderately unstable
Average Stream Stability Results: *Upper Cedar River 11 HUC*			**13**	**14**	**16.7**	**4.1**	**47.8**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 15. Outlet water chemistry results for Upper Cedar River 11-HUC

Station location:	**Cedar River, Adjacent to 4th St SE, W of Austin Utility**								
STORET/EQuIS ID:	**S005-613**								
Station #:	**09CD009**								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCPB 75th Percentile[3]**
Ammonia-nitrogen	mg/L	10	<0.05	0.12	0.04	0.03			0.2
Chloride	mg/L	10	20.5	28.8	22.8	21.8	230	0/10	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	18	7.1	12.4	9.6	9.32	5	0/18	
Escherichia coli	MPN/100ml	15	21	1400	277	110	1260	1/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.32	18	4.65	2.75			6.5
Kjeldahl nitrogen	mg/L	10	0.44	1.23	0.71	0.66			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		18	7.8	8.9	8.3	8.3	6.5 - 9	0/18	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	10	68	233	120	108			350
Specific Conductance	uS/cm	18	363	551	451	452			530
Temperature, water	deg °C	18	15.9	27.1	21.9	22.0			
Total suspended solids	mg/L	10	3.6	100	20.5	10.5			
Total volatile solids	mg/L	10	1.6	14	4.2	3			
Transparency tube	100 cm	12	47	>100	85	92	>20	0/8	
Transparency tube	60 cm	8	9	>60	32	29	>20	1/12	
Turbidity	FNU	12	5.2	31	13.7	13.4	25	1/10	
Sulfate	mg/L	10	14.1	24.6	20.3	21.2			
Hardness	mg/L	10	182	248	229	239			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Cedar River 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 16. Lake water aquatic recreation assessments for the Upper Cedar River 11-HUC

Name	DOW#	Area (ha)	Trophic Status	percent Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	Support Status
East Side	50-0002-00	16	---	99.6	5.2	2.5*	---	---	---	---	NA
Ramsey Mill Pond	50-0004-00	37	---	99.1	5.5	2.5*	---	---	---	---	NA

Abbreviations:
↘ -- Decreasing/Declining Trend
↗ -- Increasing/Improving Trends
NT – No Trend
--- No data

H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O – Oligotrophic

FS – Full Support
NS – Non-Support
IF – Insufficient Information
NA – Not assessed

Summary

East Side Lake and the entire length of the Cedar River, which includes Mill Pond, were listed in 1998 for aquatic consumption due to high mercury in fish tissue. No lakes had enough data to assess for aquatic recreation.

For stream aquatic recreation, high bacteria counts were reported for Dobbins Creek, Wolf Creek and Cedar River. Dobbins Creek and Wolf Creek were listed in 2006 while Cedar River AUID 07080201-514 is a new impairment listing. Murphy Creek also reported high bacteria counts, but the number of samples was insufficient for assessment.

Ten AUIDs were assessed for aquatic life; three AUIDs are fully supporting and seven AUIDs are non-supporting. Of those that are impaired, two were existing turbidity impairments on the Cedar River with new data that supported previous listings, one is new turbidity impairment for Dobbins Creek, and four are new impairments due to low macroinvertebrate IBI scores. Potential stressors include: high nitrates, phosphorus, and turbidity. Nitrite-nitrate was high (6.5 to 25 mg/L) at many assessed reaches. Phosphorus was high (0.27 to 0.38 mg/L) at biological stations 09CD032, 09CD042, and 09CD049. Two unassessed channelized reaches (09CD024, 09CD044) may experience large diel oxygen swings.

For streams that were assessed as supporting aquatic life for both fish and invertebrates, high nitrates and turbidity were reported that may be a stress to the biological communities. These streams should be monitored and included in watershed management strategies that may maintain and improve stream conditions in order to prevent future listings.

Wolf Creek (07080201-510) was not assessed for aquatic life due to a localized groundwater seep that collocates with the biological monitoring station. This localized input of groundwater may create conditions that are atypical for the remainder of the AUID that is designated warmwater. A onetime water temperature reading was only 12.4C during fish sampling in July. Future monitoring should place a biological station upstream of the groundwater influence so that this AUID can be assessed for aquatic life using warmwater biological criteria. Longitudinal monitoring to better understand the thermal regime of Wolf Creek should also be considered.

Groundwater seeps occur along the Cedar River and tributaries such as Wolf Creek and Dobbins Creek with the potential to support coldwater species such as trout. MDNR fisheries management records state that a single brook trout was collected in Dobbins Creek in 1980, and surmised that this trout was a loner that migrated from Woodson Creek, a tributary to the Cedar two miles downstream. Other MDNR records indicate that brown trout were once stocked in Wolf Creek but that the introduction was not successful in part due to intensive agricultural land use in the watershed. No trout were collected in 2009. Extensive algal growth was noted at the biological station on Wolf Creek flowing through Todd Park, which may indicate a nutrient issue. Habitat quality was rated poor, in part due to lack of riparian width, canopy shading and depth variability. The current stream width may be overwidened due to the lack of deep rooted vegetation protecting the banks from erosion. Nitrogen samples collected during local watershed monitoring demonstrate that nitrite-nitrate values are high (9 to 14 mg/L). In addition, a few low dissolved oxygen measurements were also recorded in 2008 and 2010 which may be related to the high abundance of algae. With watershed activities that reduce nutrients and increase riparian shading and habitat quality, it may be possible for conditions to improve that would be supportive of a managed trout fishery.

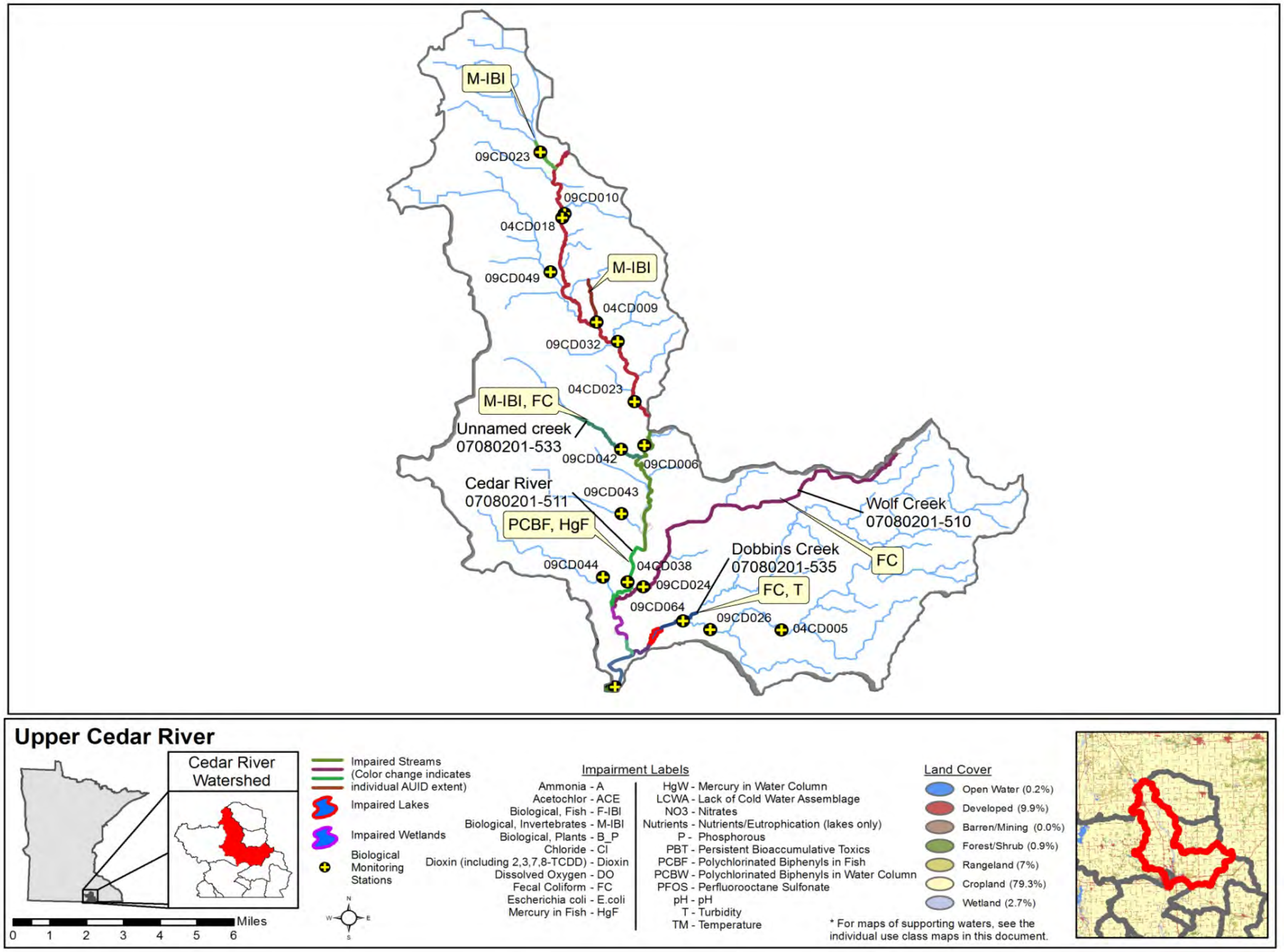

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Upper Cedar River Watershed Unit

Turtle Creek Watershed Unit HUC 07080201040

The Turtle Creek Watershed is the largest subwatershed, draining 154 square miles of Freeborn, Mower, and Steele counties. Historically, much of the Turtle Creek Watershed was a large wetland complex, covering over 15,000 acres near the city of Hollandale. In the 1920s area was ditched and the wetlands were drained for vegetable production (Albert Lea Farms Company and Payne Investment Company, undated). Additionally, some shallow lakes had also been ditched and drained. Currently, there are two lakes greater than 10 acres in size (Geneva, Hickory). Today, only 1.9 percent of the watershed remains as wetland, 2.2 percent is open water, and 2.3 percent remains as forest. Currently, the majority of the Turtle Creek Watershed is utilized for row-crop agriculture (76.8 percent) and pasture (7.4 percent) while 9.3 percent of the watershed is developed land. The outlet of the Turtle Creek watershed was sampled at CSAH 23 (4th Dr SW) and is represented by STORET/EQuIS station S000-230 and biological station 09CD062.

Table 17. Aquatic life and recreation assessments on stream reaches in the Turtle Creek Watershed Unit. Reaches are organized upstream to downstream in the table

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-547 ***Unnamed creek,*** *Unnamed cr to Turtle Cr*	1.4	2B	04CD041	Downstream of CSAH 25, 4.5 mi. NW of Austin	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-538 ***Turtle Creek,*** *T103 R20W S2, north line to T103 R18W S32, south line*	12.5	2C	04CD006 09CD063 09CD067	1 mi. S of Hwy 25, 1.5 mi. NW of Austin Upstream of 43rd St NW, 2 mi. W of Mapleview Downstream of 850th Ave, 2 mi. SE of Hollandale	NA	NA	--	EXP	--	MTS	--	--	--	IF*	NA
07080201-540 ***Turtle Creek****, T102 R18W S4, north line to Cedar R*	3.0	2B	04CD010 09CD062	Downstream of Hwy 105, in Austin Upstream of CSAH 23 (4th Dr SW), 0.5 mi. SW of Austin	EXP	EXP	IF	EXS	MTS	MTS	MTS	--	EX	NS	NS

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

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

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

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

Table 18. Non-assessed biological stations on channelized AUIDs in the Turtle Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07080201-525 ***Turtle Creek,*** *Headwaters (Geneva Lk 24-0015-00) to T104*	4.3	2B	09CD007 09CD019	Downstream of 810th Ave, 2.5 mi. NW of Hollandale Upstream of CSAH 28, 0.5 mi. N of Hollandale	Fair (2)	Fair (2)
07080201-528 ***Mud Creek,*** *Headwaters to Turtle Cr (JD 24)*	9.0	2B	09CD038	Downstream of 300th St, 2.5 mi. N of Hollandale	Fair	Poor
07080201-538 ***Turtle Creek,*** *T103 R20W S2, north line to T103 R18W S32, south line*	12.5	2C	04CD006 09CD063 09CD067	1 mi. S of Hwy 25, 1.5 mi. NW of Austin Upstream of 43rd St NW, 2 mi. W of Mapleview Downstream of 850th Ave, 2 mi. SE of Hollandale	Fair (5)	Good (3)
07080201-544 ***County Ditch 30****,* *Unnamed cr to Turtle Cr*	3.6	2B	04CD013	Upstream of CSAH 45, 1.5 mi. NE of Clarks Grove	Fair (2)	Poor (2)
07080201-545 ***Knotvold Branch****,* *Unnamed ditch to Turtle Cr*	2.3	2B	04CD034	At west end of 100th St, 2.5 mi. NW of Hollandale	Poor	Poor
07080201-546 ***Deer Creek,*** *Ditch to Turtle Cr*	2.8	2B	04CD027 07CD001 09CD055	Downstream of 860th St, 2.5 SE of Hollandale Downstream of 270th St, 1 mi. S of Maple Island Upstream of CSAH 34, 2 mi. E of Maple Island	Fair (5)	Fair (4)
07080201-572 ***Unnamed creek,*** *JD 24 to Turtle Cr*	1.1	2B	09CD061	Upstream of 850th Ave, 3 mi. SE of Hollandale	Fair	Poor
07080201-584 ***County Ditch 8,*** *Unnamed cr to Unnamed ditch*	2.9	2B	09CD035	Upstream of CSAH 35, 1 mi. W of Geneva	Fair	Fair
07080201-587 ***Judicial Ditch 24,*** *Unnamed ditch to JD 24*	1.8	2B	09CD039	Upstream of CSAH 25, 3 mi. SE of Hollandale	Fair	Poor
07080201-589 ***Judicial Ditch 18,*** *Unnamed ditch to JD 24*	1.7	2B	09CD068	Upstream of CSAH 25, 3 mi. SW of Hollandale	Fair	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits when >1, which may or may not occur in the same year.

Table 19. Minnesota Stream Habitat Assessment (MSHA) for the Turtle Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD035	County Ditch 8	0	9	18	8	22	57	Fair
1	04CD034	Knolvold Branch	0	7.5	4	9	10	30.5	Poor
1	09CD038	Mud Creek	0	8	15.9	7	11	41.9	Poor
1	09CD055	Deer Creek	0	8.5	16	6	14	44.5	Poor
2	04CD027	Deer Creek	0	8.5	12	7.5	12	40	Poor
2	07CD001	Deer Creek	0.3	8.3	12.8	11.0	17.3	49.7	Fair
1	09CD068	Judicial Ditch 18	0	8.5	18.4	6	22	54.9	Fair
1	09CD039	Judicial Ditch 24	0	8	12	4	10	34	Poor
1	09CD061	Unnamed ditch	0	7	7	4	1	19	Poor
2	04CD013	County Ditch 30	0	8	9	11	12.5	40.5	Poor
1	04CD041	Trib. to Turtle Creek	0	9	20.9	17	29	75.9	Good
1	09CD007	Turtle Creek	0	7.8	14.5	5.5	7.5	35.3	Poor
1	09CD019	Turtle Creek	1	6	9	6	4	26	Poor
2	09CD067	Turtle Creek	0	7.3	15.6	6	11	39.9	Poor
1	04CD006	Turtle Creek	0	7	9	5	11	32	Poor
2	09CD063	Turtle Creek	0	8.3	10.3	8	12.5	39.1	Poor
1	04CD010	Turtle Creek	2	9.5	18	9	15	53.5	Fair
1	09CD062	Turtle Creek	2	11.5	18.6	12	33	77.1	Good
Average Habitat Results: *Turtle Creek 11 HUC Watershed*			**0.3**	**8.2**	**13.7**	**7.9**	**13.9**	**43.9**	**Poor**

Qualitative habitat ratings

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

Table 20. Channel Condition and stability Assessment (CCI) for the Turtle Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD035	County Ditch 8	29	25	12	5	71	moderately unstable
0	04CD034	Knolvold Branch	NA	NA	NA	NA	NA	NA
1	09CD038	Mud Creek	21	8	12	5	46	moderately unstable
1	09CD055	Deer Creek	29	17	23	5	74	moderately unstable
0	04CD027	Deer Creek	NA	NA	NA	NA	NA	NA
1	07CD001	Deer Creek	28	17	11	5	61	moderately unstable
1	09CD068	Judicial Ditch 18	16	13	9	4	42	fairly stable
1	09CD039	Judicial Ditch 24	19	7	20	5	51	moderately unstable
1	09CD061	Unnamed ditch	19	5	25	5	54	moderately unstable
0	04CD013	County Ditch 30	NA	NA	NA	NA	NA	NA
0	04CD041	Trib. to Turtle Creek	NA	NA	NA	NA	NA	NA
1	09CD007	Turtle Creek	24	7	20	5	56	moderately unstable
1	09CD019	Turtle Creek	24	4	12	5	45	moderately unstable
1	09CD067	Turtle Creek	24	7	19	5	55	moderately unstable
0	04CD006	Turtle Creek	NA	NA	NA	NA	NA	NA
1	09CD063	Turtle Creek	24	7	12	3	46	moderately unstable
0	04CD010	Turtle Creek	NA	NA	NA	NA	NA	NA
1	09CD062	Turtle Creek	10	9	9	3	31	fairly stable
Average Stream Stability Results: *Turtle Creek 11 HUC*			**22.3**	**10.5**	**15.3**	**4.6**	**52.7**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 21. Outlet water chemistry results for Turtle Creek 11-HUC

Station location:	**Turtle Creek at CSAH-23 (4th Drive SW), in Austin**
STORET/EQuIS ID:	**S000-230**
Station #:	**09CD062**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	Median	WQ Standard[1]	# of WQ Exceedances[2]	WCPB 75th Percentile[3]
Ammonia-nitrogen	mg/L	10	<0.05	0.16	0.06	0.04			0.2
Chloride	mg/L	10	11.6	19.3	15.6	16.1	230	0/10	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	18	7.01	11.0	8.7	8.7	5	0/18	
Escherichia coli	MPN/100ml	14	31	>2400	420	200	126	1/14	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.13	12	2.45	1.26			6.5
Kjeldahl nitrogen	mg/L	10	0.5	1.48	0.87	0.87			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		18	7.6	8.5	8.1	8.1	6.5 - 9	0/18	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	10	85	252	130	94			350
Specific Conductance	uS/cm	18	383	715	570	593			530
Temperature, water	deg °C	68	10	26.7	20.1	20.4			
Total suspended solids	mg/L	10	4.4	110	34.3	16.5			
Total volatile solids	mg/L	10	2	17	6.3	3.8			
Transparency tube	100 cm	9	38	>100	63	60	>20	0/9	
Transparency tube	60 cm	61	6	>60	34	27	>20	16/61	
Turbidity	FNU	12	11.2	93.3	30.8	26.6	25	7/12	
Sulfate	mg/L	10	21	39.6	31.8	32.9			
Hardness	mg/L	10	230	358	302.3	317			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Turtle Creek 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 22. Lake water aquatic recreation assessments for the Turtle Creek 11-HUC

Lake Name	Lake ID	Lake Area (ha)	Trophic Status	percent Littoral	Max. Depth (F)	Avg. Depth (F)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (F)	Support Status
Geneva	24-0015-00	645.74	---	100.0	2.43	0.19	---	222	35	0.6	NS
Unnamed (Hickory)	24-0067-00	---	---	---	---	---	---	---	---	---	NA

Summary

Geneva Lake is fully supporting of aquatic life since chloride data was well below the standards. However, excess nutrients resulting in low transparency values resulted in Geneva Lake being assessed as impaired for aquatic recreation. Not enough data was available to assess Hickory Lake. Other historical lakes in the watershed have been ditched and drained (see Figure 17).

A recent lake reclamation project was completed on Geneva Lake which was a collaboration between Freeborn County, MDNR and Ducks Unlimited. Funds for the Geneva Lake project were provided through duck stamps, the Environment and Natural Resources Trust Fund, and a grant through the North American Wetlands Conservation Act (http://www.ducks.org/minnesota/minnesota-projects/geneva-lake-update). Through the project, a water control structure and fish barrier were installed. This allowed for a draw-down of lake levels to reset the ecological balance of the shallow lake system and reduce internal loading of phosphorus through the removal of rough fish that forage on the bottom and re-suspend phosphorus bound to sediment, which can fuel algal blooms and reduce water clarity. The project has already demonstrated improvements in lake quality though increased water clarity and the re-establishment of near shore native plants that provide habitat, spawning areas, and cover for game fish and other species.

For streams, the three mile section of Turtle Creek immediately upstream of the Cedar River was listed as impaired in 2006 for aquatic recreation due to high bacteria levels. The current assessment supports the listing. Only two of 12 AUIDs were assessed for aquatic life due to the extent of ditching in the watershed. The most downstream AUID on Turtle Creek was listed in 2006 as impaired for aquatic life due to high turbidity. The recent assessment found Turtle Creek is also non-supporting of aquatic life for fish and aquatic invertebrate communities. Nitrite-nitrate and phosphorus measurements were high at 04CD010 while dissolved oxygen in the afternoon was high at 09CD062. One tributary stream is also non-supporting of aquatic life for aquatic invertebrates. Of the 10 un-assessed reaches or channelized AUIDs, a majority of the reaches were rated fair for fish and poor for macroinvertebrates. Many of the channelized reaches were rated poor for habitat quality. Dense instream aquatic vegetation was also noted which could indicate nutrient issues. Nitrogen values were high at many stations, while phosphorus was high at 04CD027). Two stations (09CD007 and 04CD034) had abundant plant growth and low-dissolved oxygen readings in the morning.

Many pollution sensitive fish species were collected along Turtle Creek, including rainbow darter, fantail darter, and Ozark Minnow. These species need clean, coarse substrates to spawn. Ozark Minnow is listed as a special concern species in Minnesota which had not been previously found in Turtle Creek. The Redfin Shiner, a pollution tolerant minnow, was also found in Turtle Creek in 2009. This minnow had not been documented as collected in the Turtle Creek watershed since 1964. Sizeable game fish such as walleye and northern pike were also collected. Turtle Creek has good groundwater support which may keep water cool during summer and minimize stress to biological communities.

Other notable projects in the watershed include the 350 acre Riceland Wetland Restoration near Geneva Lake which was a collaboration with multiple partners including landowners, Turtle Creek Watershed District, Freeborn SWCD, Farm Service Agency, Board of Water and Soil Resources, and Natural Resource Conservation Service. It was intended as a flood reduction project, but has provided additional benefits such as improved water quality and wildlife habitat.

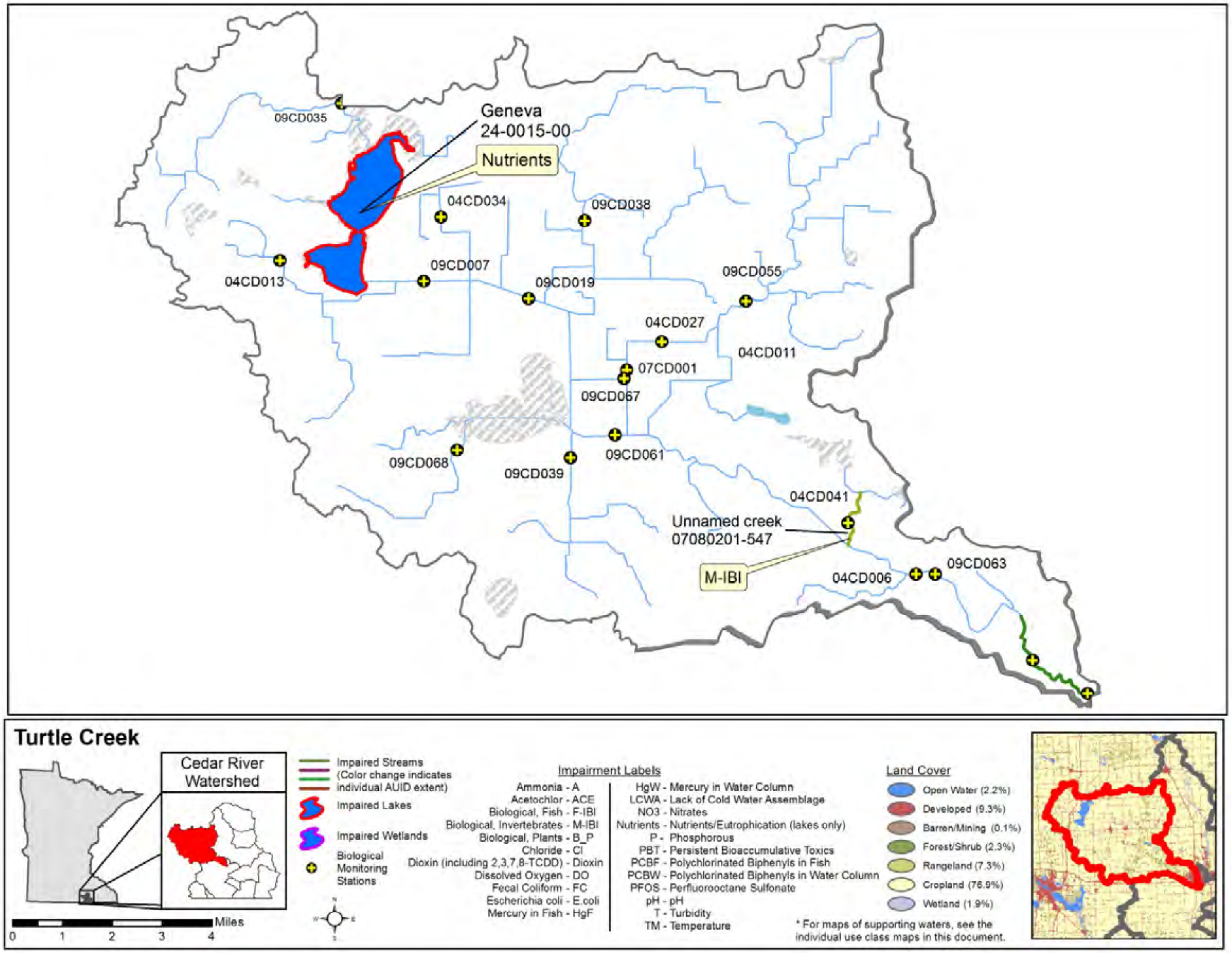

Figure 17. Currently listed impaired waters by parameter and land use characteristics in the Turtle Creek Watershed Unit. Polygons with grey has lines indicate lakes that have been drained.

Rose Creek Watershed Unit HUC07080201050

The Rose Creek Watershed Unit encompasses 66 mi^2 of Mower County. The headwaters of the watershed begin as Rose Creek just north of I-90 near Dexter and Schwerin Creek just south of I-90 near Elkton. Rose Creek travels a total of 27 miles winding first west along I-90, and then south through the city of Rose Creek, and then west until it meets the Cedar River just four miles south of Austin. Along its course, Rose Creek is surrounded by a fairly extensive riparian area of forest and wetland, although only three percent of the watershed is classified as wetland and forest. Land use in the watershed is dominated by row-crop cultivation (83.4 percent), developed land (7.5 percent), and pasture (5.9 percent). The outlet monitoring site of the watershed unit was collocated with MWCD's monitoring station, also represented by MPCA's STORET/EQUIS station S000-229 and biological monitoring station 09CD091.

Table 23. Aquatic life and recreation assessments on stream reaches in the Rose Creek Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-523 ***Schwerin Creek,*** *Headwaters to Rose Cr*	6.9	2B	09CD045	Upstream of 650th Ave, 5 mi. NE of Rose Creek	EXP	EXP	--	--	--	--	--	--	--	NS	NA
07080201-583 ***Unnamed creek,*** *Unnamed cr to Rose Cr*	1.4	2B	09CD021	Downstream of 575th Ave, 4 mi. SE of Austin	EXP	EXS	IF	EXP	--	MTS	--	--	--	NS	NA
07080201-522 ***Rose Creek,*** *Headwaters to Cedar R*	27	2C	09CD020 04CD001 09CD022 04CD012 09CD091	Upstream of 650th Ave, 5 mi. NW of Rose Creek Downstream of Hwy 3, 3 mi. NE of Rose Downstream of 570th Ave, 4.5 mi. SE of Austin Upstream of CSAH 4 (175th St), 3 mi. SE of Austin Upstream of CSAH 29, 3 mi. S of Austin	MTS	MTS	IF	EXP	MTS	MTS	MTS	--	EX	NS	NS

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

Table 24. Non-assessed biological stations on channelized AUIDs in the Rose Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-548 ***Unnamed creek,*** *Headwaters to Rose Cr*	4.0	2B	04CD035	Upstream of Hwy 7, 1 mi. S of Dexter	Poor	Poor
07080201-575 ***Unnamed creek,*** *Unnamed cr to Rose Cr*	2.6	2B	07CD004	Downstream of CR 19, 0.25 mi. S of Rose Creek	Fair	--

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results.

Table 25. Minnesota Stream Habitat Assessment (MSHA) for the Rose Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD045	Schwerin Creek	1	11	19.8	12	32	75.8	Good
1	04CD035	Unnamed trib. to Rose Creek	0	9.5	19.5	7	24	60	Fair
1	07CD004	Unnamed ditch to Rose Creek	0	10.5	13.9	6	19	49.4	Fair
1	09CD021	Trib. to Rose Creek	1.3	10	16	8	19	54.3	Fair
1	09CD020	Rose Creek	0	9.5	16.4	13	26	64.9	Fair
0	04CD001	Rose Creek	NA	NA	NA	NA	NA	NA	NA
1	09CD022	Rose Creek	2.5	14	18	8	27	69.5	Good
1	04CD012	Rose Creek	0	11.5	18.9	9	24	63.35	Fair
1	09CD091	Rose Creek	4.3	14	21.7	11	28	79	Good
Average Habitat Results: *Rose Creek 11 HUC Watershed*			**1.1**	**11.3**	**18.0**	**9.3**	**24.9**	**64.5**	**Fair**

Qualitative habitat ratings

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

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

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

Table 26. Channel Condition and Stability Assessment (CCSI) for the Rose Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD045	Schwerin Creek	25	36	22	9	92	severely unstable
1	04CD035	Unnamed trib. to Rose Creek	NA	NA	NA	NA	NA	NA
1	07CD004	Unnamed ditch to Rose Creek	NA	NA	NA	NA	NA	NA
1	09CD021	Trib. to Rose Creek	18	26	17	7	68	moderately unstable
1	09CD020	Rose Creek	18	30	29	11	88	severely unstable
0	04CD001	Rose Creek	NA	NA	NA	NA	NA	NA
1	09CD022	Rose Creek	14	26	25	7	72	moderately unstable
1	04CD012	Rose Creek	NA	NA	NA	NA	NA	NA
1	09CD091	Rose Creek	12	9	11	3	35	fairly stable
Average Stream Stability Results: *Rose Creek 11 HUC*			**17.4**	**25.4**	**20.8**	**7.4**	**71**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 27. Outlet water chemistry results for Rose Creek 11-HUC

Station location:	**Rose Creek at CSAH-29, 3 mi. S of Austin**								
STORET/EQuIS ID:	**S000-229**								
Station #:	**09CD091**								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard`**	**# of WQ Exceedances[2]**	**WCPB 75th Percentile[3]**
Ammonia-nitrogen	mg/L	17	0.15	<0.16	N/A	N/A			0.2
Chloride	mg/L	15	11.8	30.9	21.5	21.5	230	0/15	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	36	7.4	13.2	9.1	8.9	5	0/36	
Escherichia coli	MPN/100ml	21	33.1	>2400	565	240	1260	3/21	
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	2.03	16.40	6.45	6.54			6.5
Kjeldahl nitrogen	mg/L	20	<0.2	3.10	1.26	1.20			
Orthophosphate	ug/L	20	<0.05	630.0	100.0	60.0			
pH		36	7.3	8.8	8.2	8.3	6.5 - 9	0/36	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	20	29	782	170	74			350
Specfic Conductance	uS/cm	36	4	561	423	469			530
Temperature, water	deg °C	36	2.9	22.7	17.3	18.4			
Total suspended solids	mg/L	10	<2	250	36.6	1			
Total volatile solids	mg/L	N/A	N/A	N/A	N/A	N/A			
Transparency tube	100 cm	12	60	>100	94	100	>20	0/12	
Transparency tube	60 cm	24	3	>60	44	60	>20	7/24	
Turbidity	FNU	24	1.1	270.4	41.0	7.8	25	5/24	
Sulfate	mg/L	15	16.5	74.0	25.0	20.8			
Hardness	mg/L	NA	NA	NA	NA	NA			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Rose Creek 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Rose Creek, a 27 mile long AUID, was listed in 2004 for impaired aquatic recreation due to high bacteria levels. The current dataset agrees with the listing.

For aquatic life, Rose Creek was assessed as non-supporting of aquatic life use due to excess sediment (turbidity). The transparency readings were only taken at the lower reach of this 27 mile AUID. Therefore, additional longitudinal transparency monitoring is recommended in order to get a better picture of conditions along the entire length of Rose Creek. According to the MDNR, the biological station at the lower end of the AUID has sensitive mussel beds. While fish and invertebrate scores did not indicate impairment, excess sediment from eroding stream banks upstream is likely being transported downstream during high flow events where it has the potential to bury sensitive mussel beds and embed coarse substrates used for feeding and spawning by sensitive fish species. The sampling station near the outlet (09CD091) had bank cutting along both sides of the stream channel. This may indicate that the stream is attempting to widen in response to an increase in watershed hydrology. Nitrite-nitrogen values were also high (9 to 16 mg/L), indicating another potential biological stressor.

Two other headwater AUIDs were non-supporting of aquatic life due to low aquatic invertebrate ratings. The aquatic communities were dominated by tolerant individuals (>80 percent). The channel stability assessment suggests that these streams are unstable with excess cutting, bank erosion and unstable substrates. In addition, the nitrite-nitrate grab samples taken in early July at 09CD021 and 09CD045 were both above the 75^{th} percentile for the WCBP ecoregion (8.6 mg/L and 12 mg/L) which may indicate a potential biological stress related to excess nutrients. Additionally, low dissolved oxygen (DO) measurements were reported on an unnamed creek (07080201-583); however, the sampling station had a beaver dam at the site that may be ponding water resulting in the low dissolved oxygen conditions observed. Therefore, the assessment was recorded as “insufficient information” until additional monitoring is completed. Longitudinal DO monitoring is recommended along the length of the AUID in order to determine if the steam is meeting the 5.0 mg/L standard.

One other AUID was not assessed due to channelization. Fish and invertebrate communities were both rated poor. Nitrite-nitrate was reported at 23 mg/L in July 2004, which may indicate a nutrient issue. BMPs in the headwaters of the watershed may be needed in order to protect and preserve the sensitive aquatic species currently found in Rose Creek. Across the watershed, nitrite-nitrate values were above ecoregion expectations (8.3 to 17 mg/L). Additional monitoring should be conducted to identify whether excess nutrients and/or flashy hydrology are significant stressors to the biological communities in this watershed so that management plans can be designed and implemented to protect sensitive species and prevent future impairment listings.

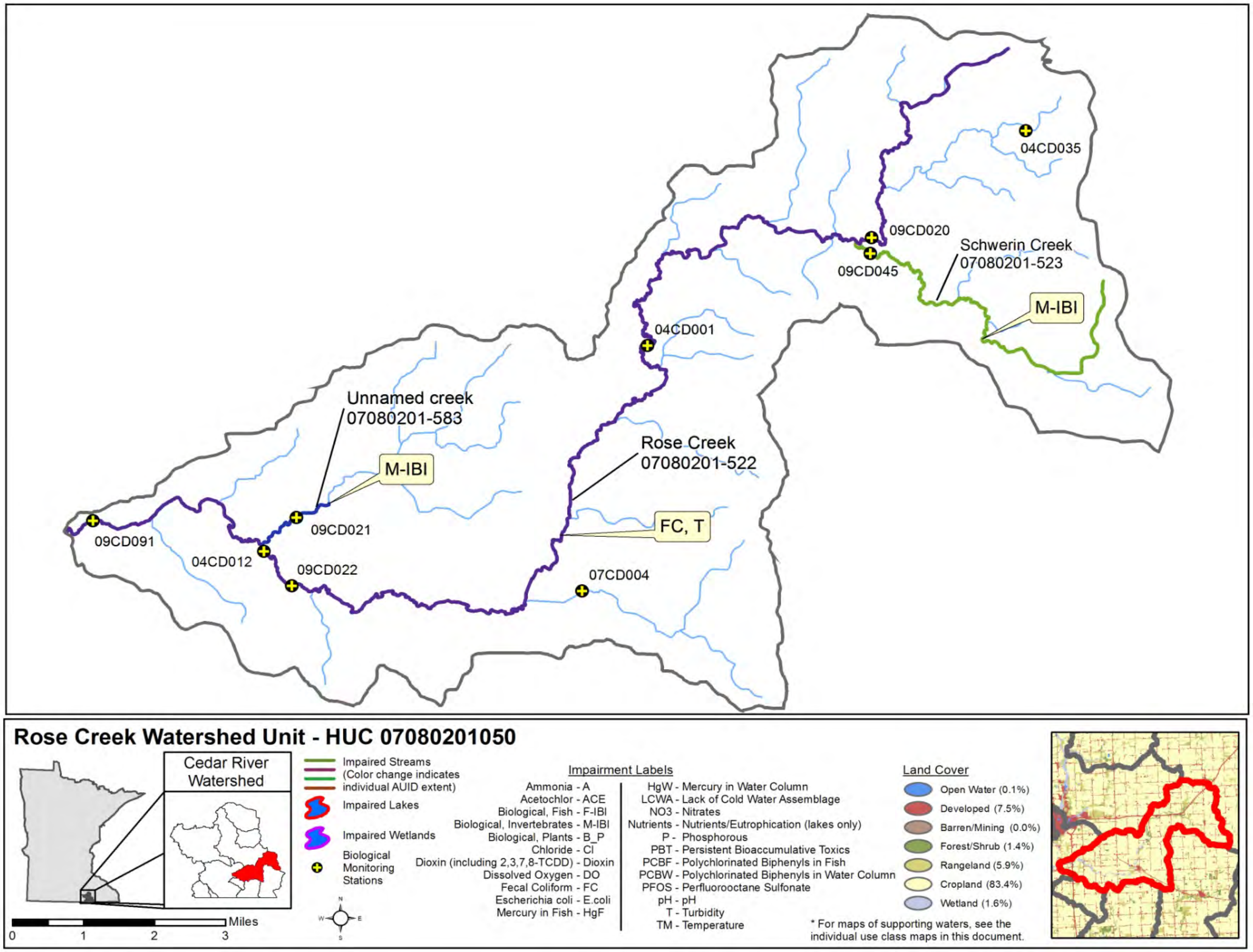

Figure 18. Currently listed impaired waters by parameter and land use characteristics in the Rose Creek Watershed Unit

West Beaver Creek Watershed Unit HUC 07080201060

At only at 11 square miles, the West Beaver Creek Watershed Unit is the smallest 11-HUC watershed in the Cedar River watershed that lies entirely in Minnesota. Land use in the Watershed Unit is dominated by row-crop cultivation (87.7 percent) and developed land (7.9 percent). Only 3.2 percent of the land is in pasture. There are no lakes in the watershed (0 percent open water) and few wetlands or forest land (1.2 percent). Due to its small watershed size, no water chemistry station was established; only a biological monitoring station was placed at the outlet.

Table 28. Aquatic life and recreation assessments on stream reaches in the West Beaver Creek Watershed Unit.

AUID ***Reach Name,*** *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07080201-556 ***Unnamed creek,*** *Unnamed cr to Cedar R*	2.9	2B	04CD025	Downstream of 535th Ave, 4 mi. S of Austin0020	MTS	MTS	--	--	--	--	--	--	--	FS	NA

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

Table 29. Non-assessed biological stations on channelized AUIDs in the West Beaver Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-556 ***Unnamed creek,*** *Unnamed cr to Cedar R*	2.9	2B	09CD001	Upstream of 535th Ave, 4.5 mi. S of Austin	Good	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results.

Table 30. Minnesota Stream Habitat Assessment (MSHA) for the West Beaver Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD001	Unnamed creek	0.5	9	19.4	8	15	51.9	Fair
1	04CD025	Unnamed trib. to Cedar River	0	11	19.5	14	26	70.5	Good
Average Habitat Results: *West Beaver Creek 11 HUC Watershed*			**0.3**	**10**	**19.4**	**11**	**20.5**	**61.2**	**Fair**

Qualitative habitat ratings

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

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

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

Table 31. Channel Condition and Stability Assessment (CCSI) for the West Beaver Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD001	Unnamed creek	17	9	15	1	42	fairly stable
0	04CD025	Unnamed trib. to Cedar River	NA	NA	NA	NA	NA	NA
Average Stream Stability Results: *West Beaver Creek 11 HUC*			**17**	**9**	**15**	**1**	**42**	**fairly stable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Summary

Only one AUID was assessed in the West Beaver Creek watershed. Unnamed creek (07080201-556) is fully supporting of aquatic life. Pollution sensitive fish (pearl dace, rainbow darter, fantail darter) and aquatic insects were collected at biological station 04CD025. Habitat quality was rated good for riparian shading, instream fish cover, and depth variability, but was rated moderately poor for channel stability and embeddedness. Nitrite-nitrogen was high (9 mg/L) which may indicate a potential nutrient issue that should be remediated in order to prevent a future impairment listing.

One other AUID was not assessed due to channelization at the biological station (09CD001). The fish community was rated good with presence of pollution sensitive species (rainbow darter, fantail darter) while the invertebrate community was rated poor with over 70 percent of individuals collected that were highly tolerant to pollution. High proportion of tolerant individuals may indicate a nutrient issue, or lack of suitable habitat. Habitat quality overall was rated fair but was rated poor for lack of variable water depth and amount of fish cover. Photos from sampling indicate that while the stream has a very narrow riparian zone of trees, the stream lacks suitable habitat for macroinvertebrates such as woody debris and overhanging vegetation in contact with water. The stream is also incised and over-widened for its size, which could be related to channelization and a flashy hydrology.

Image: Stream has cut banks and is over-widened; lacks vegetation in contact with water and areas of faster flow required for some sensitive macroinvertebrates

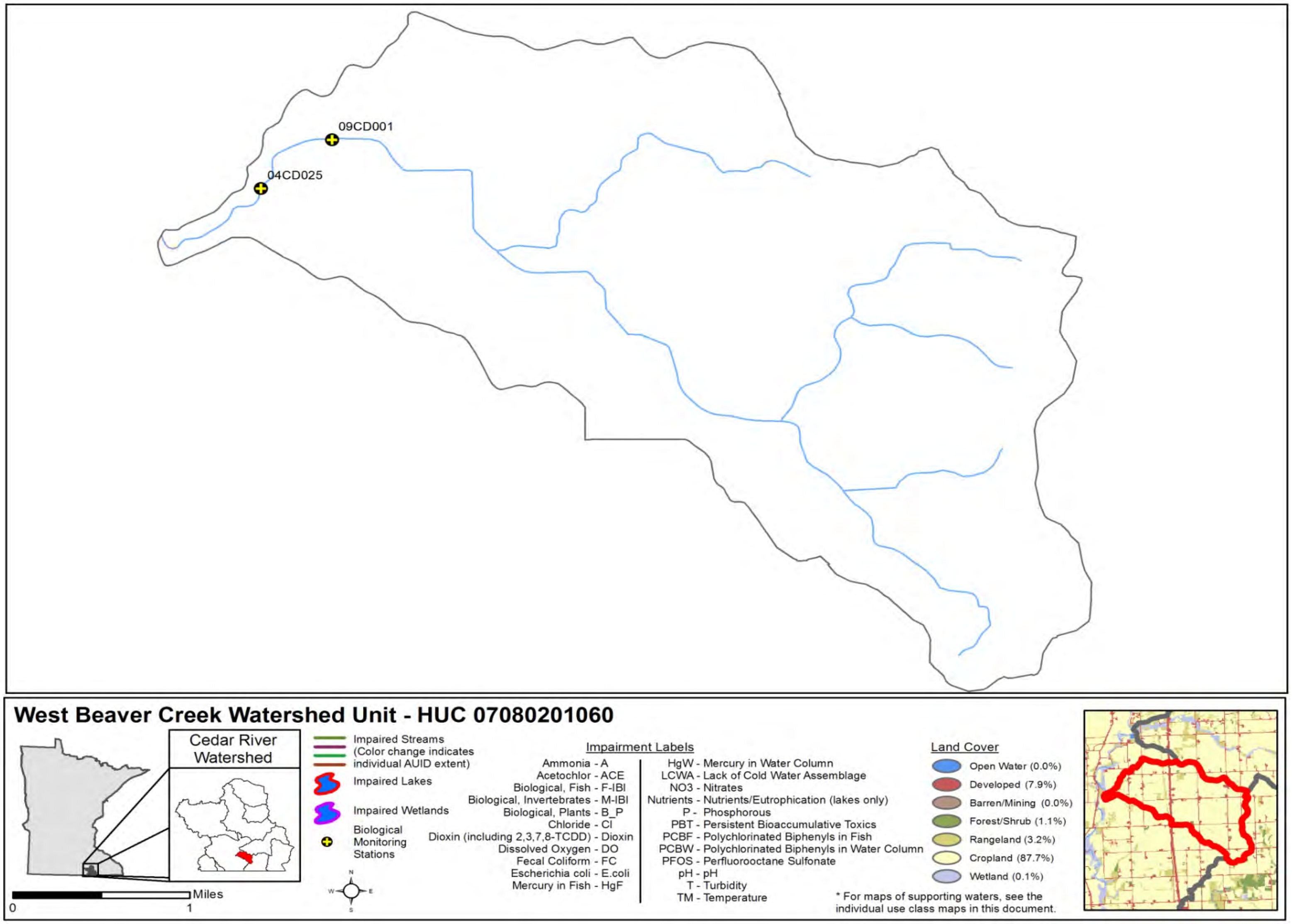

Figure 19. Biological monitoring station locations and land use characteristics in the West Beaver Creek Watershed Unit. There are no listed impairments in the watershed

Lower Cedar River Watershed Unit

HUC 07080201065

The Lower Cedar River Watershed is the third largest subwatershed within the Cedar River Watershed encompassing 117 mi^2 of Freeborn and Mower counties. Mill Pond is the only lake in the watershed, and exists artificially due to a dam. The watershed is dominated by agriculture (82.5 percent) and developed land (9.9 percent). Only 4.4 percent is used as pasture. Together, forest, wetland, and open water comprise only 3.2 percent of the watershed. The outlet monitoring station on the Cedar River is at State Line Rd on the border with Iowa. This location is represented by MPCA STORET/EQuIS station S000-059 and biological station 09CD012.

Table 32. Aquatic life and recreation assessments on stream reaches in the Lower Cedar River Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-512 ***Cedar River,*** *Wolf Cr to Lower Austin Dam*	1.3	2B	--	--	--	--	--	EXP	--	--	--	--	--	IF	NA
07080201-554 ***Unnamed creek (Woodson Creek),*** *T102 R18W S14, north line to Cedar R*	1.0	2A	09CD048	Upstream of CSAH 28 (29th St), E of 4th St SE, 1 mi. S of Austin	EXS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-515 ***Cedar River,*** *Turtle Cr to Rose Cr*	3.0	2B	09CD069	Upstream of 29th Ave NW, 2 mi. S of Austin	MTS	EXP	IF	EXS	MT	MTS	MTS	--	--	NS	NA
07080201-594 ***Unnamed creek,*** *Unnamed cr to Orchard Cr*	2.0	2B	09CD058	Downstream of 510th Ave, 3 mi. SW of Austin	EXP	EXS	--	--	--	--	--	--	--	IF*	NA
07080201-555 ***Unnamed creek,*** *Headwaters to Orchard Cr*	6.7	2B	09CD095	Upstream of 170th St, 4 mi. SW of Austin	MTS/NA	EXS/NA	--	--	--	--	--	--	--	IF*	NA
07080201-509 ***Orchard Creek,*** *Headwaters to T102 R18W S32, south line*	7.6	2C	09CD059	Upstream of 175th St, 2.5 mi. SW of Austin	EXP	EXS	--	--	--	--	--	--	--	IF*	NA
07080201-539 ***Orchard Creek,*** *T101 R18W S5, north line to Cedar R*	1.1	2B	09CD025	Upstream of 520th Ave, 6 mi. S of Austin	MTS	MTS	IF	EXP	MT	MTS	MTS	--	IF	FS	IF
07080201-501 ***Cedar River,*** *Rose Cr to Woodbury Cr*	10.3	2B	04CD002 04CD024 09CD065	E of Hwy 105, 6 mi. S of Austin 1 mi. upstream of CSAH 6, 3 mi. NW of Lyle Upstream of 170th St, 4.5 mi. S of Austin	EXS	EXP	IF	EXS	MT	MTS	MTS	--	EX	NS	NS
07080201-526 ***Woodbury Creek,*** *Headwaters to Cedar R*	15.1	2C	09CD028	Upstream of 110th St, 3.5 mi. W of Lyle	MTS	MTS	IF	EXP	MT	MTS	MTS	--	IF	FS	IF

07080201-590 ***Mud Lake Creek/County Ditch 25,*** *Unnamed cr to Woodbury Cr*	3.7	2B	09CD047	Upstream of CSAH 13, 6 mi. NW of Lyle	EXP	EXP	--	--	--	--	--	--	--	IF*	NA
07080201-516 ***Cedar River,*** *Woodbury Cr to MN/IA border*	0.7	2B	09CD012	Upstream of State Line Rd, 2.5 mi. W of Lyle	EXP	EXP	--	EXP	MT	--	MTS	--	EX	NS	NS

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

Table 33. Non-assessed biological stations on channelized AUIDs in the Lower Cedar River 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-509 ***Orchard Creek,*** *Headwaters to T102 R18W S32, south line*	7.6	2C	09CD059	Upstream of 175th St, 2.5 mi. SW of Austin	Good	Poor
07080201-594 ***Unnamed creek,*** *Unnamed cr to Orchard Cr*	2.0	2B	09CD058	Downstream of 510th Ave, 3 mi. SW of Austin	Good	Poor
07080201-555 ***Unnamed creek,*** *Headwaters to Orchard Cr*	6.7	2B	09CD095	Upstream of 170th St, 4 mi. SW of Austin	Good	Fair
07080201-590 ***Mud Lake Creek/County Ditch 25,*** *Unnamed cr to Woodbury Cr*	3.7	2B	09CD047	Upstream of CSAH 13, 6 mi. NW of Lyle	Good	Fair
07080201-526 ***Woodbury Creek,*** *Headwaters to Cedar R*	15.1	2C	09CD027	Upstream of CSAH 5, 6 mi. NW of Lyle	Good	Good
07080201-595 ***Unnamed creek,*** *Unnamed cr to Cedar R*	2.3	2B	09CD054	Upstream of 535th Ave, 2 mi. NW of Lyle	Good	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results.

Table 34. Minnesota Stream Habitat Assessment (MSHA) for the Lower Cedar River 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD048	Unnamed Creek (Woodson Creek)	2.3	9	16.5	12	23	64.8	Good
1	04CD042	Trib. to Orchard Creek	0	6	10	5	10	31	Poor
1	09CD058	Trib. to Orchard Creek	0	13	20	12	32	77	Good
1	09CD095	Trib. to Orchard Creek	0	11	20	11	30	72	Good
1	09CD059	Orchard Creek	2.5	10.5	20	12	28	73	Good
1	09CD025	Orchard Creek	2.3	9.5	19.8	14	24	69.6	Good
1	09CD047	Mud Lake Creek/ County Ditch 75	0	10	12.5	7	17	46.5	Fair
1	09CD027	Woodbury Creek	0	10	17.4	7	17	51.4	Fair
1	09CD028	Woodbury Creek	1.3	12	20.3	10	24	67.6	Good
1	09CD054	Trib. to Cedar River	0	9.5	15.2	12	16	52.7	Fair
2	09CD069	Cedar River	0.8	11.3	18.15	9.5	20	59.7	Fair
1	09CD065	Cedar River	0	12.5	18.2	7	19	56.7	Fair
1	04CD002	Cedar River	0	7.5	13.2	9	26	55.7	Fair
1	04CD024	Cedar River	0	10.5	19	12	20	61.5	Fair
1	09CD012	Cedar River	1.3	9.5	14	7	15	46.8	Fair
Average Habitat Results: *Lower Cedar River 11 HUC Watershed*			**0.7**	**10.1**	**17**	**9.8**	**21.4**	**59.1**	**Fair**

Qualitative habitat ratings

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

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

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

Table 35. Channel Condition and Stability Assessment (CCSI) for the Lower Cedar River 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD048	Unnamed Creek (Woodson Creek)	12	7	17	3	39	fairly stable
0	04CD042	Trib. to Orchard Creek	NA	NA	NA	NA	NA	NA
1	09CD058	Trib. to Orchard Creek	30	36	31	11	108	severely unstable
1	09CD095	Trib. to Orchard Creek	17	22	13	5	57	moderately unstable
1	09CD059	Orchard Creek	25	32	22	11	90	severely unstable
1	09CD025	Orchard Creek	13	11	9	3	36	fairly stable
1	09CD047	Mud Lake Creek/ County Ditch 75	17	20	25	5	67	moderately unstable
1	09CD027	Woodbury Creek	15	16	15	3	49	moderately unstable
1	09CD028	Woodbury Creek	6	11	5	3	25	fairly stable
1	09CD054	Trib. to Cedar River	16	18	27	7	68	moderately unstable
1	09CD069	Cedar River	12	7	5	3	27	fairly stable
1	09CD065	Cedar River	10	11	5	3	29	fairly stable
0	04CD002	Cedar River	NA	NA	NA	NA	NA	NA
0	04CD024	Cedar River	NA	NA	NA	NA	NA	NA
1	09CD012	Cedar River	13	16	23	5	57	moderately unstable
Average Stream Stability Results*: Lower Cedar River 11 HUC*			**15.5**	**17.3**	**16.4**	**5.2**	**54.3**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 36. Outlet water chemistry results for Lower Cedar River 11-HUC

Station location:	Cedar River at State Line Rd, 2.5 mi. W of Lyle								
STORET/EQuIS ID:	S000-059								
Station #:	09CD012								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCPB 75th Percentile[3]**
Ammonia-nitrogen	mg/L	9	<0.05	<0.05	<0.05	<0.05			0.2
Chloride	mg/L	9	21.5	45.9	32.88	29.5	230	0/9	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	17	6.8	11.8	8.7	8.6	5	0/17	
Escherichia coli	MPN/100ml	13	66	870	293	220	1260	0/13	
Inorganic nitrogen (nitrate and nitrite)	mg/L	9	5.2	16.0	7.6	6.6			6.5
Kjeldahl nitrogen	mg/L	9	0.42	1.19	0.74	0.65			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		17	7.8	8.6	8.2	8.2	6.5 - 9	0/17	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	9	158	608	338	331			350
Specfic Conductance	uS/cm	17	400	630	540	559			530
Temperature, water	deg °C	17	13.5	25.4	20.6	21.7			
Total suspended solids	mg/L	9	3.6	56.0	18.0	8.4			
Total volatile solids	mg/L	9	1.2	9.2	3.9	3.0			
Transparency tube	100 cm	11	52	>100	84	95	>20	0/11	
Transparency tube	60 cm	8	15	>60	36	27	>20	1/8	
Turbidity	FNU	11	2	51.7	16.2	15.7	25	1/11	
Sulfate	mg/L	9	19.1	26.6	24.1	25.6			
Hardness	mg/L	9	249	281	263.8	264			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Cedar River 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

There are currently no lakes in this watershed. Historically, there were natural lakes (e.g., Mud Lake DOW 2400-300, Unnamed Lake DOW 2400-100) but they have been ditched and drained (See Figure 20).

For streams, four AUIDs are fully supporting aquatic life for both fish and aquatic macroinvertebrates. The biological stations on Woodbury Creek (09CD028) and Orchard Creek (09CD025) had good quality habitat with a diversity of stream features and clean, coarse substrates of cobble and gravel. Channel stability was rated as fairly stable. Sensitive fish species were collected at these sites, including rainbow darter, fantail darter, Ozark minnow, stonecat, hornyhead chub, and northern hogsucker. Ozark minnow is also considered a special concern species by the MDNR. Nitrite-nitrogen values at both biological stations were high, which may indicate a potential nutrient issue that should be monitored and addressed to protect sensitive species.

Woodson Creek is the only MDNR designated coldwater stream in the Cedar River Watershed. The fish and invertebrate communities are impaired aquatic life. Historical MDNR survey records indicate that Brook Trout were once abundant in Woodbury Creek but have not been recorded as collected since 1984. Brook Trout require fast flowing water and clean, coarse substrates to successfully spawn. Brook Trout also utilize different regions of a stream course between spring, summer, and winter. The DNR survey indicates that well-intentioned landowners built a rock dam to increase pool volume in Woodson Creek. The rock dam likely interrupted the natural flow and migrational route of Brook Trout and caused excess sediment to bury coarse substrates. Restoration efforts to bring back the coldwater community will require habitat restoration and reintroduction of Brook Trout. Since the macroinvertebrate community was also poor, water quality issues should also be investigated.

One new AUID on the Cedar River near the Iowa border was assessed as impaired for aquatic recreation due to high bacteria counts. Other AUIDs on the Cedar River above this AUID had previously been listed as impaired in 1998 and in 2006. Pesticide data collected on Cedar River AUID 07080501-515 indicate that Acetochlor, Alachlor, and Atrazine levels met toxic standards for aquatic life. Three AUIDs on the Cedar River are not supporting aquatic life (impairment one fish, two macroinvertebrates, three turbidity). One of these AUIDs was previously listed for aquatic life impairment due to turbidity in 2002. Potential stressors may include poor habitat quality, low-dissolved oxygen, and elevated nutrients for both phosphorus and nitrogen. Geomorphic studies conducted by the DNR indicate that the Cedar River is incised and overwidened. Portions of the Cedar River have downcut to bedrock and so the river is adjusting to a change in watershed hydrology. The overwidened cross-section makes the river shallow with minimal depth and flow velocity variation, conditions that may be limiting to certain fish species.

Macroinvertebrate communities at an unassessed channelized upstream reach and tributaries of Orchard Creek were rated fair to poor. While habitat quality was rated as good, the channel stability rating was rated as severely unstable. Photographs during sampling suggest that these reaches are incised with unstable banks and over-widened cross-sections along portions of the reach where excess sedimentation has greatly reduced stream depth and pool volume. These unstable reaches may indicate a potential stress related to flashy watershed hydrology. Nitrate concentrations at both 09CD058 and 09CD059 were fairly high (14 and 11 mg/L, respectively) and may indicate a potential nutrient issue.

Due to the presence of special concern species and the high diversity of aquatic communities collected within the Orchard Creek watershed, this watershed could be considered a target for additional monitoring and land use protections in order to better preserve these valuable resource areas.

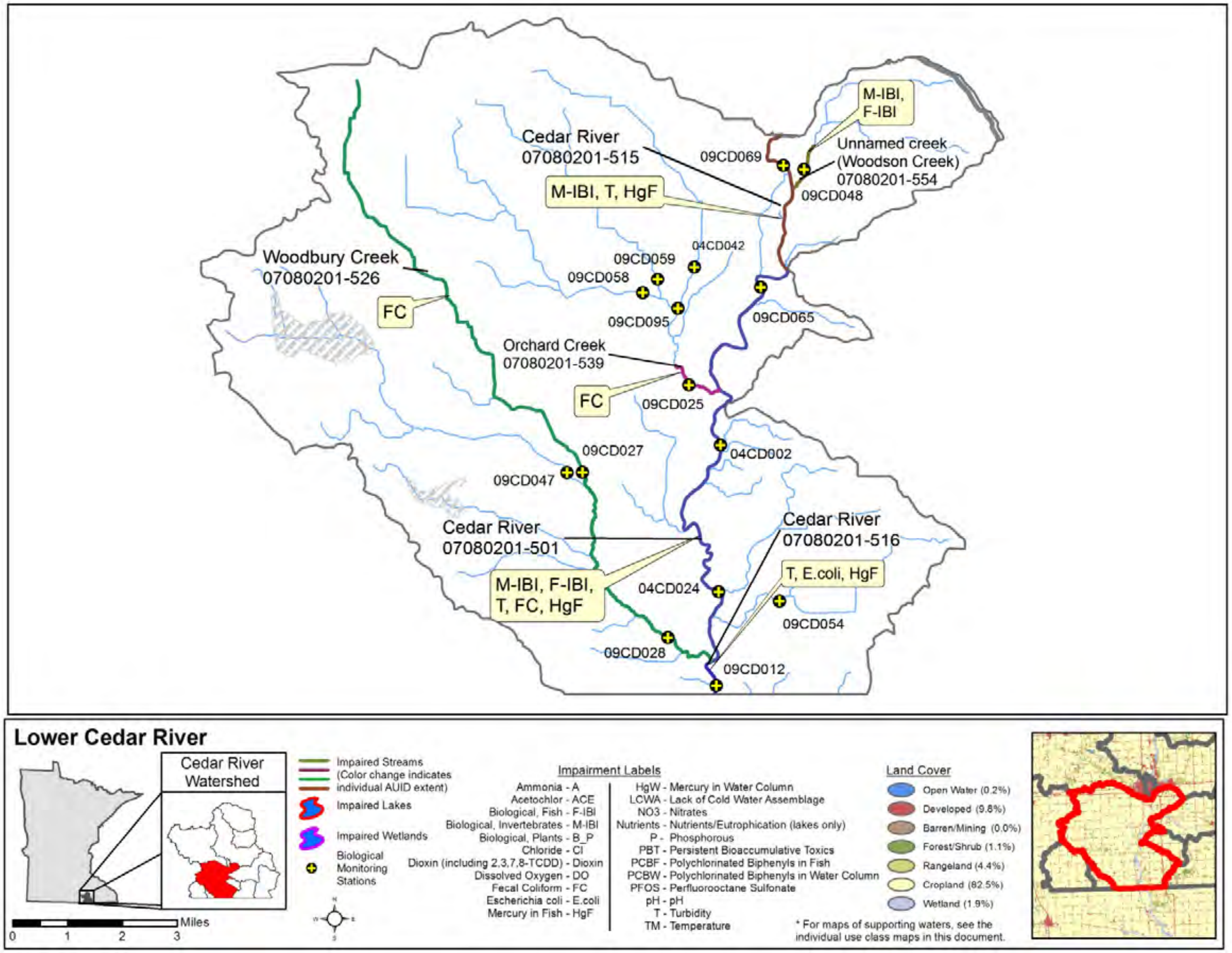

Figure 20. Currently listed impaired waters by parameter and land use characteristics in the Lower Cedar River Watershed Unit. Polygons with grey hash marks indicate lakes that have been drained

Otter Creek Watershed Unit HUC 07080201075

Otter Creek twists a total of 14.3 miles south before crossing into Iowa. The watershed area on the Minnesota side of the border drains 33 square miles of Mower County. The headwaters of Otter Creek begin south of the City of Rose Creek and meanders south west through the Larson State Wildlife Management Area. An unnamed tributary to Otter Creek begins just upstream of Rose Wildlife Management Area near CSAH 19 just north of the border with Iowa. Land use is dominated by row-crop production (82.6), developed land (7.3 percent) and pasture (6.7 percent). Wetlands and forests make up only 3.4 percent of the watershed. Due to its small size (<40 mi^2), MPCA did not establish an outlet water chemistry station for Otter Creek. However, a few water chemistry samples were collected at the outlet at State Line Rd just downstream of biological station 10EM092, given the presence of special concern species in the watershed. This location is represented by STORET/EQuIS station S005-787.

Table 37. Aquatic life and recreation assessments on stream reaches in the Otter Creek Watershed Unit.

AUID ***Reach Name,*** *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07080201-517 ***Otter Creek,*** *Headwaters to MN/IA border*	14.3	2B	04CD040 04CD031 10EM092	Downstream of 120th St, 3 mi. NE of Lyle Downstream of Hwy 6, 1 mi. of NE of Lyle Downstream of 105th St, 1.5 mi. E of Lyle	MTS	MTS	--	MTS	--	--	--	--	--	FS	NA

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

Table 38. Non-assessed biological stations on channelized AUIDs in the Otter Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-574 ***Unnamed creek,*** *Unnamed cr to Otter Cr*	1.9	2B	07CD003	Upstream of 118th St, 3 mi. NE of Lyle	Good (2)	Fair
07080201-517 ***Otter Creek,*** *Headwaters to MN/IA border*	14.3	2B	09CD008 07CD005	Downstream of 140th St, 3.5 mi. NE of Lyle Downstream of 590 Ave, 4 mi. NE of Lyle	Good (2)	Fair (2)

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits when >1, which may or may not occur in the same year.

Table 39. Minnesota Stream Habitat Assessment (MSHA) for the Otter Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	07CD003	Unnamed ditch to Otter Creek	2.5	8	15.2	6	24	55.7	Fair
1	09CD008	Otter Creek	0	10.5	15	11	22	58.5	Fair
1	07CD005	Otter Creek	0	11	18	11	22	62	Fair
1	04CD040	Otter Creek	2.5	13	20.2	14	30	79.7	Good
1	04CD031	Otter Creek	0	6.5	18.4	12	19	55.9	Fair
1	10EM092	Otter Creek	0	4	16.8	13	21	54.8	Fair
Average Habitat Results: *Otter Creek 11 HUC Watershed*			**0.8**	**8.8**	**17.3**	**11.2**	**23**	**61.1**	**Fair**

Qualitative habitat ratings

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

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

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

Table 40. Channel Condition and Stability Assessment (CCSI) for the Otter Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	07CD003	Unnamed ditch to Otter Creek	NA	NA	NA	NA	NA	NA
1	09CD008	Otter Creek	33	27	29	7	96	severely unstable
1	07CD005	Otter Creek	11	17	20	3	51	moderately unstable
1	04CD040	Otter Creek	NA	NA	NA	NA	NA	NA
1	04CD031	Otter Creek	NA	NA	NA	NA	NA	NA
1	10EM092	Otter Creek	16	21	23	5	65	moderately unstable
Average Stream Stability Results: *Otter Creek 11 HUC*			**20.0**	**21.7**	**24.0**	**5.0**	**70.7**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 41. Outlet water chemistry results for Otter Creek 11-HUC

Station location:	**Otter Creek at State Line Rd, 0.5 mi. SE of Lyle**
STORET/EQuIS ID:	**S005-787**
Station #:	--

Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCPB 75th Percentile[3]**
Ammonia-nitrogen	mg/L	3	<0.05	0.14	0.06	0.025			0.2
Chloride	mg/L	N/A	N/A	N/A	N/A	N/A	230		
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	4	6.1	12.2	8.6	8.1	5	0/5	
Escherichia coli	MPN/100ml	N/A	N/A	N/A	N/A	N/A	1260		
Inorganic nitrogen (nitrate and nitrite)	mg/L	3	2.5	12	6.8	5.8			6.5
Kjeldahl nitrogen	mg/L	N/A	N/A	N/A	N/A	N/A			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		4	7.0	8.2	7.8	7.7	6.5 - 9	0/4	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	3	65	454	201	84			350
Specfic Conductance	uS/cm	4	108	479	327	361			530
Temperature, water	deg °C	4	12.9	18.2	15.9	16.2			
Total suspended solids	mg/L	3	<1.0	82	29.0	4.4			
Total volatile solids	mg/L	3	<1.0	12	4.6	1.2			
Transparency tube	100 cm	4	20	>100	73	85.5	>20	0/4	
Transparency tube	60 cm	N/A	N/A	N/A	N/A	N/A	>20		
Turbidity	FNU	N/A	N/A	N/A	N/A	N/A	25		
Sulfate	mg/L	N/A	N/A	N/A	N/A	N/A			
Hardness	mg/L	N/A	N/A	N/A	N/A	N/A			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Otter Creek 11 HUC, a component of the IWM work conducted between May and September in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Otter Creek was listed for non-support for aquatic recreation in 2006 due to high bacteria counts. No new data within the last 10 years was available for this assessment cycle.

Otter Creek is fully supporting of aquatic life for fish, aquatic macroinvertebrates and turbidity. Two special concern species were collected in the watershed. Least Darter was collected in the headwaters of Otter Creek (09CD008) on the north end of the Larson State Wildlife Management Area. Ozark Minnow were collected on Otter Creek (10EM092) near the border with Iowa. Natural springs provide good groundwater support to maintain baseflow and regulate water temperature along Otter Creek. An artificial rock dam on Otter Creek may be limiting to fish migration during critical spawning times. A habitat improvement project may be needed in order to minimize potential biologically limiting effects of the dam. Nitrite-nitrogen values were high (7 to 16 mg/L) and algae was observed on shallow sections of Otter Creek which may indicate a potential nutrient issue.

While biological communities at the assessed reaches performed well, unassessed channelized reaches in the headwataters of Otter Creek were rated good for fish and only fair for aquatic macroinvertebrates. While habitat quality was fair, channel stability was rated moderately unstable to very unstable. The biological monitoring station 09CD008 indicates that historical channelization coupled with incision and overwidening is creating a shallow aggraded bed with poor pool development.

Additional protections and BMPs are recommended in order to maintain and improve habitat conditions and water quality to protect sensitive and special concern species in the watershed.

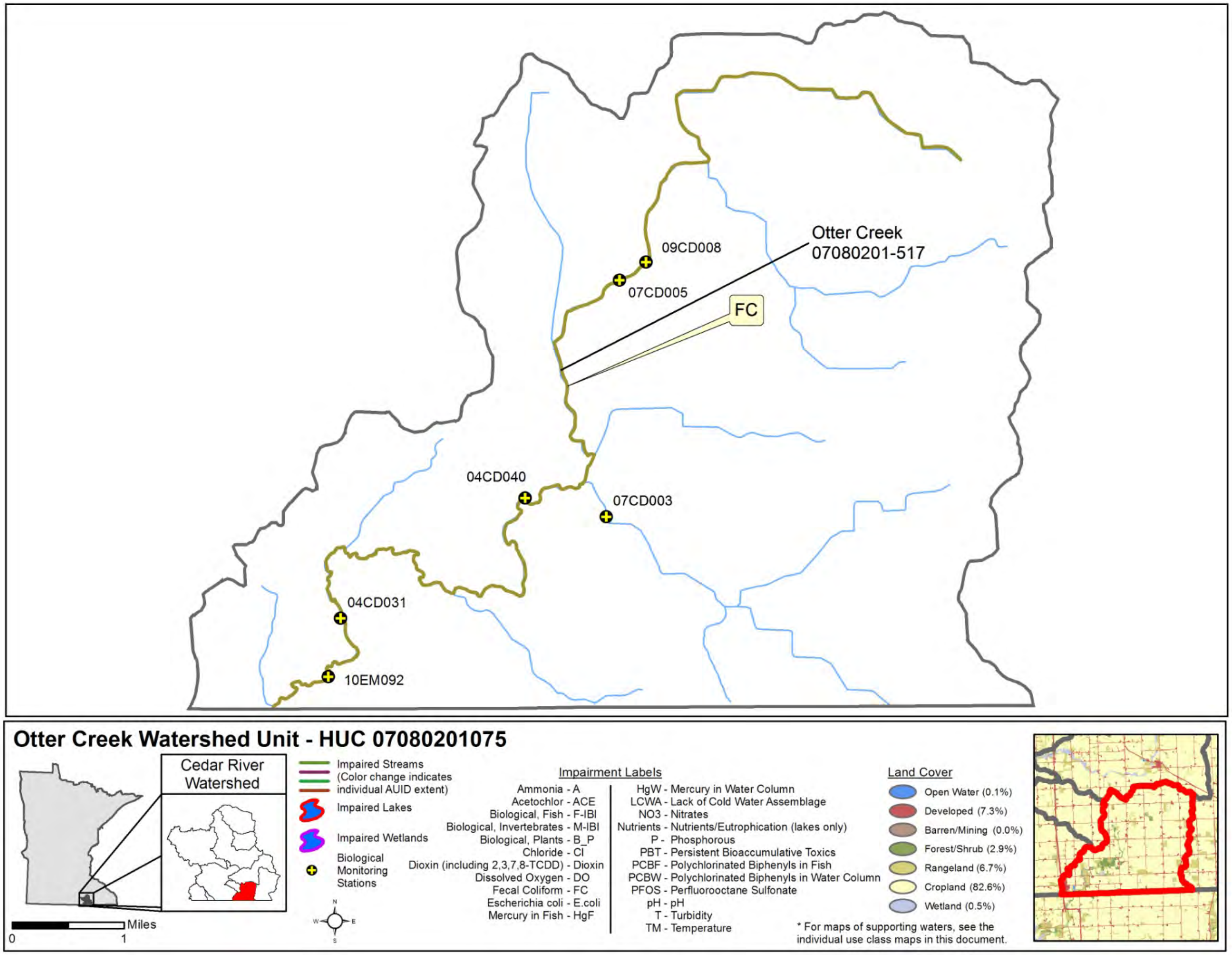

Figure 21. Currently listed impaired waters by parameter and land use characteristics in the Otter Creek Watershed Unit. Otter Creek was listed in 2006 for bacteria (FC)

Deer Creek Watershed Unit HUC 07080201095

The Deer Creek subwatershed drains only 25 square miles on the Minnesota side of the border with Iowa. The outlet of the watershed flows through the town of Deer Creek. There are three unnamed lakes in the watershed. A majority of stream miles are channelized with narrow riparian corridors surrounded by row-crops. However, the lower portion of Deer Creek is surrounded by a wider corridor of forest and wetland. The Deer Creek Watershed Unit has the smallest percent of uncultivated land. Only 1.1 percent is used for pasture, 1.1 percent of the watershed is in forest and wetland, 5.8 percent is developed land, and 92 percent of the watershed is in row-crop agriculture. Due to its small drainage area (<40 sqmi), a water chemistry monitoring station was not placed near the outlet.

Table 42. Aquatic life and recreation assessments on stream reaches in the Deer Creek Watershed Unit

AUID ***Reach Name,*** *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07080201-580 ***Deer Creek (County Ditch 71),*** *T101 R19W S19, north line to MN/IA border*	4.4	2C	09CD066	Upstream of State Line Rd, 5 mi. SE of Murtle	EXP	MTS	--	--	--	--	--	--	--	IF*	NA

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

Table 43. Non-assessed biological stations on channelized AUIDs in the Deer Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080201-580 *Deer Creek (County Ditch 71),* *T101 R19W S19, north line to MN/IA border*	4.4	2C	09CD066	Upstream of State Line Rd, 5 mi. SE of Murtle	Fair	Good

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results.

Table 44. Minnesota Stream Habitat Assessment (MSHA) for Deer Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	09CD066	Deer Creek	0	11.5	17.5	8	20	87	Fair
		Average Habitat Results: *Deer Creek 11 HUC Watershed*	**0**	**11.5**	**17.5**	**8**	**20**	**87**	**Fair**

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

Table 45. Channel Condition and Stability Assessment (CCSI) for Deer Creek 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD066	Deer Creek	25	28	23	7	83	severely unstable
		Average Stream Stability Results: *Deer Creek 11 HUC*	**25**	**28**	**23**	**7**	**83**	**severely unstable**

Qualitative channel stability ratings
stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Summary

Only one biological monitoring station was sampled on Deer Creek. This AUID was channelized and so will be assessed at a later time when TALU standards are developed. The biological community was rated fair for fish and good for aquatic macroinvertebrates using a lower baseline expectation for channelized reaches. The fish community was dominated by individuals of two taxa (~79 percent) and no sensitive species, which may indicate a water quality or habitat issue. The habitat at the sampling station was rated fair. While the reach had a fairly intact riparian zone of mature trees and contained a good portion of riffle habitat, the reach lacked pool habitat and fish cover. The channel stability was rated as very unstable. The reach has unstable, cut banks and appears to be overwidened in its cross-section along portions of the reach. The cutting along both banks and overwidened cross-section could contribute to the lack of overhanging vegetation and pool depth observed

For the three unnamed lakes in the watershed (DOW 24-0079-00, 24-0070-00, 24-0072-00), there was no data to assess for aquatic recreation. The two lakes on the south-western corner of the watershed are both less than 10 acres in size, which is the size criteria for assessment, and the other lake near the outlet has characteristics of a shallow lake or emergent wetland. Hence, no lakes in this watershed were assessed for aquatic recreation.

Image: cut banks within sampling reach 09CD066

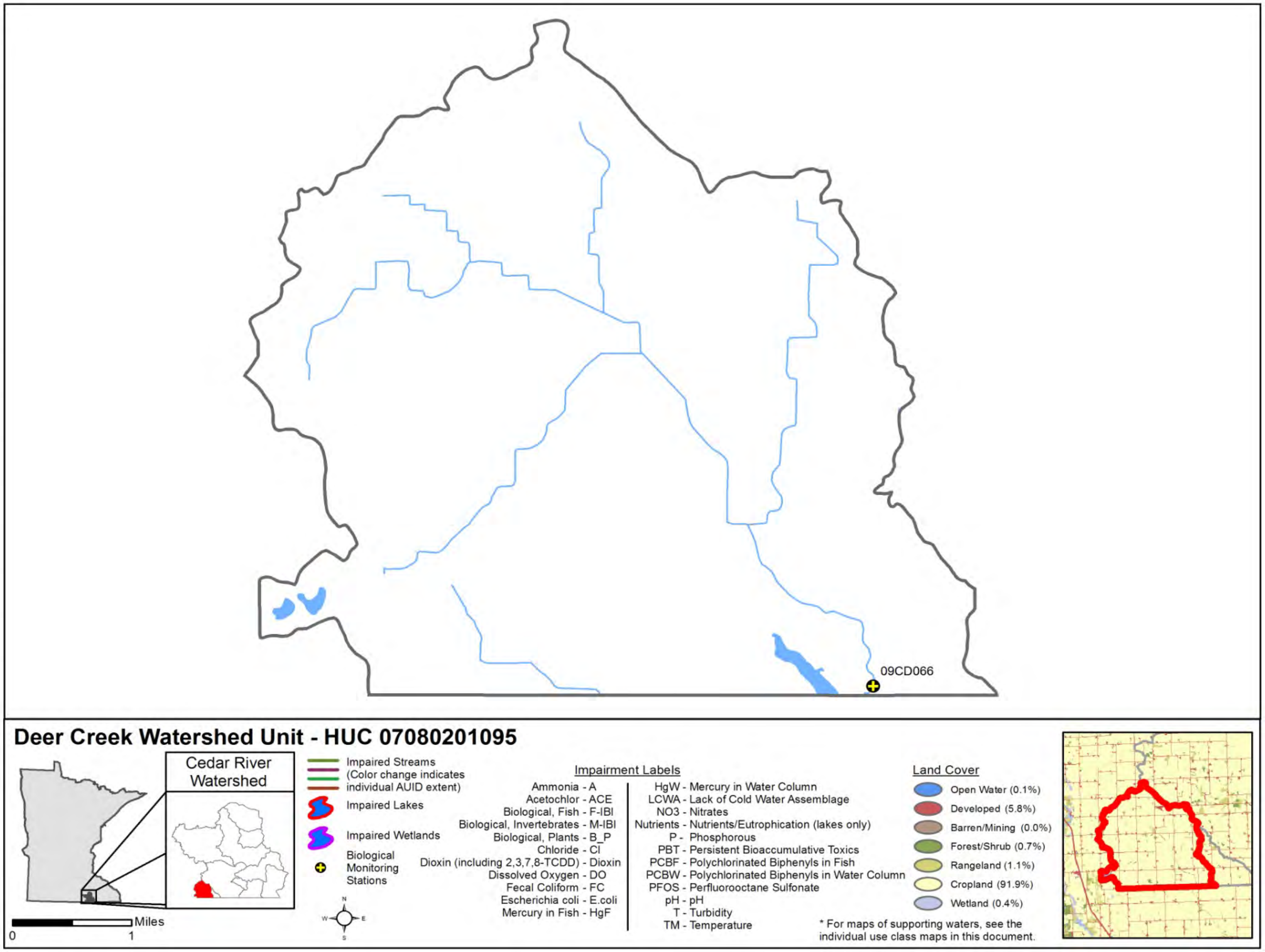

Figure 22. Biological monitoring station locations and land use characteristics in the Deer Creek Watershed Unit. There are currently no listed impairments in the watershed

Little Cedar River Watershed Unit HUC 07080201240

The Little Cedar River Watershed Unit drains 58.7 square miles in Mower County before crossing the border into Iowa. The headwaters of the Little Cedar River begin south of I-90 and north east of the city of Adams. An unnamed tributary to the Little Cedar River begins as a series of channelized ditches that flow south to the city of Adams, and then west two miles to the confluence with the Little Cedar River near Johnsburg. An additional unnamed creek flows from west of Adams to the Iowa border. A channelized section of this unnamed creek was redesigned into an experimental two-stage ditch that ideally will reduce maintenance costs. Over 90 percent of the watershed is used for agricultural production (81.7 percent cultivated for row-crop, 8.5 percent pasture). Only 0.1 percent is classified as wetland and 2.6 percent as forest land. Developed land comprises 7.1 percent. There are no lakes in the watershed. The outlet monitoring site of the watershed unit is represented by MPCA STORET/EQuIS station S005-614 and biological station 04CD008.

Table 46. Aquatic life and recreation assessments on streams reaches in the Little Cedar River Watershed Unit. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name,*** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
07080201-520 ***Unnamed creek,*** *Unnamed cr to Unnamed cr*	1.1	2B	09CD029	Upstream of W Main St, in Adams	EXP	EXP	--	--	--	--	--	--	--	NS	NA
07080201-519 ***Unnamed creek,*** *Unnamed cr to Little Cedar R*	4.3	2B	09CD030	Upstream of 4th St SW, in Adams	MTS	EXP	--	--	--	--	--	--	--	NS	NA
07080201-518 ***Little Cedar River,*** *Headwaters to MN/IA border*	15	2C	09CD046 04CD008	Upstream of 160th St, 2 mi. NW of Adams Downstream of Hwy 6, 4 mi. SW of Adams	MTS	MTS	IF	IF	MT	MTS	MT	--	EX	FS	NS

Abbreviations for Indicator Evaluations: -- = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

Table 47. Non-assessed biological stations on channelized AUIDs in the Little Cedar River 11-HUC

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07080201-596 **Unnamed creek,** *Unnamed cr to MN/IA border*	2.5	2B	09CD034 09CD050 09CD053	Upstream of State Line Rd, 4.5 mi. SW of Adams Upstream of 110th St, 2 mi. NW of Johnsburg Upstream of 110th St, 2 mi. NW of Johnsburg (Upstream of 09CD050)	Fair (3)	Poor (4)

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 4.3 for IBI results. Parentheses behind ratings indicate the quantity of site visits, which may or may not occur in the same year (10 percent of monitoring stations are repeated for quality control purposes).

Table 48. Minnesota Stream Habitat Assessment (MSHA) for the Little Cedar River 11-HUC

# Visits	**Biological Station ID**	**Reach Name**	**Land Use (0-5)**	**Riparian (0-15)**	**Substrate (0-27)**	**Fish Cover (0-17)**	**Channel Morph. (0-36)**	**MSHA Score (0-100)**	**MSHA Rating**
1	09CD053	Unnamed creek	0	7.5	12.5	5	12	37	Poor
1	09CD050	Unnamed creek	0	8	13.2	5	16	42.2	Poor
1	09CD034	Unnamed creek	0	6.5	16	5	11	38.5	Poor
1	09CD029	Unnamed creek	1	7	13.1	12	13	46.1	Fair
1	09CD030	Unnamed creek	1	8	15.4	6	16	46.4	Fair
2	09CD046	Little Cedar River	0.3	6.8	17.6	7.1	17.3	48.9	Fair
4	04CD008	Little Cedar River	0.5	7	19.1	9.3	23.5	59.4	Fair
Average Habitat Results: *Little Cedar River 11 HUC Watershed*			**0.4**	**7.3**	**15.3**	**7.1**	**15.5**	**45.5**	**Fair**

Qualitative habitat ratings

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

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

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

Table 49. Channel Condition and Stability Assessment (CCSI) for the Little Cedar River 11-HUC

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	09CD053	Unnamed creek	24	11	15	3	53	moderately unstable
1	09CD050	Unnamed creek	NA	NA	NA	NA	NA	NA
1	09CD034	Unnamed creek	17	11	13	3	44	severely unstable
1	09CD029	Unnamed creek	23	32	31	9	95	moderately unstable
1	09CD030	Unnamed creek	18	29	25	9	81	severely unstable
2	09CD046	Little Cedar River	17	17	13	4	51	fairly stable
4	04CD008	Little Cedar River	11	11	10	3	35	fairly stable
Average Stream Stability Results: *Little Cedar River 11 HUC*			**18.3**	**18.5**	**17.8**	**5.2**	**59.8**	**moderately unstable**

Qualitative channel stability ratings

stable: CCSI < 27 fairly stable: 27 < CCSI < 45 moderately unstable: 45 < CCSI < 80 severely unstable: 80 < CCSI < 115 extremely unstable: CCSI > 115

Table 50. Outlet water chemistry results Little Cedar River 11-HUC

Station location:	Little Cedar River at 100th St, 4 mi. SW of Adams								
STORET/EQuIS ID:	S005-614								
Station #:	09CD008								
Parameter	Units	# of Samples	Minimum	Maximum	Mean	Median	WQ Standard[1]	# of WQ Exceedances[2]	WCPB 75th Percentile[3]
Ammonia-nitrogen	mg/L	10	< 0.05	0.1	N/A	N/A			0.2
Chloride	mg/L	10	20.7	26.9	23.8	23.6	230	0/10	
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	18	7.1	11.8	9.0	8.7	5	0/18	
Escherichia coli	MPN/100ml	15	180	>2400	947.33	820	1260	4/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	2.3	480	54.4	5.3			6.5
Kjeldahl nitrogen	mg/L	9	0.31	0.83	0.58	0.54			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		18	7.2	8.5	8.1	8.2	6.5 - 9	0/18	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	10	65	138	90	88			350
Specfic Conductance	uS/cm	18	369	603	485	489			530
Temperature, water	deg °C	18	13.7	25.4	20.2	20.8			
Total suspended solids	mg/L	10	4.4	46	12.7	10.2			
Total volatile solids	mg/L	10	1.2	7.2	2.8	2.4			
Transparency tube	100 cm	12	47	>100	79	77.5	>20	0/12	
Transparency tube	60 cm	8	18	>60	39	35	>20	1/8	
Turbidity	FNU	12	8.6	51.3	17.8	14.8	25	1/12	
Sulfate	mg/L	10	12.4	21.7	18.0	18.6			
Hardness		10	212	261	234.2	232.5			

[1]Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25.
[2]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[3]Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCollor and Heiskary 1993).

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Little Cedar River 11 HUC, a component of the IWM work conducted in 2009 and 2010. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

For aquatic recreation use, only the Little Cedar River had sufficient data for assessment. The AUID was determined to be impaired for aquatic recreation use due to high bacteria counts with four samples from June and July 2010 above 1260 colonies per 100 ml.

For assessment of aquatic life use, the Little Cedar River mainstem was supporting for both fish and macroinvertebrates; however, nitrite-nitrate values were high (9 – 17 mg/l), which may indicate a potential stressor. Habitat quality at both reaches on the Little Cedar River was rated as fair and channel stability was rated as fairly stable. Two unnamed creeks near Adams were assessed as impaired due to low macroinvertebrate IBI scores. Habitat quality was fair, while channel stability was rated moderately unstable and very unstable. These reaches have downcut and are over widened, and are experiencing high rates of sedimentation. One AUID was not assessed due to channelization. The biological community at the channelized AUID was rated fair for fish and poor for macroinvertebrates. The habitat ratings were poor for all three biological monitoring stations. A research project was undertaken in fall 2009 to create a multi-stage ditch, which includes biological stations 09CD050 and 09CD053, with the intention of minimizing maintenance costs overtime. The design has also increased habitat diversity which may also benefit the biological community. Fish community samples from 2010 demonstrated some improvement in IBI scores.

Image1: Cut banks and excess sedimentation at 09CD029

Image2: Mullenbach two-stage ditch after construction in Spring 2010

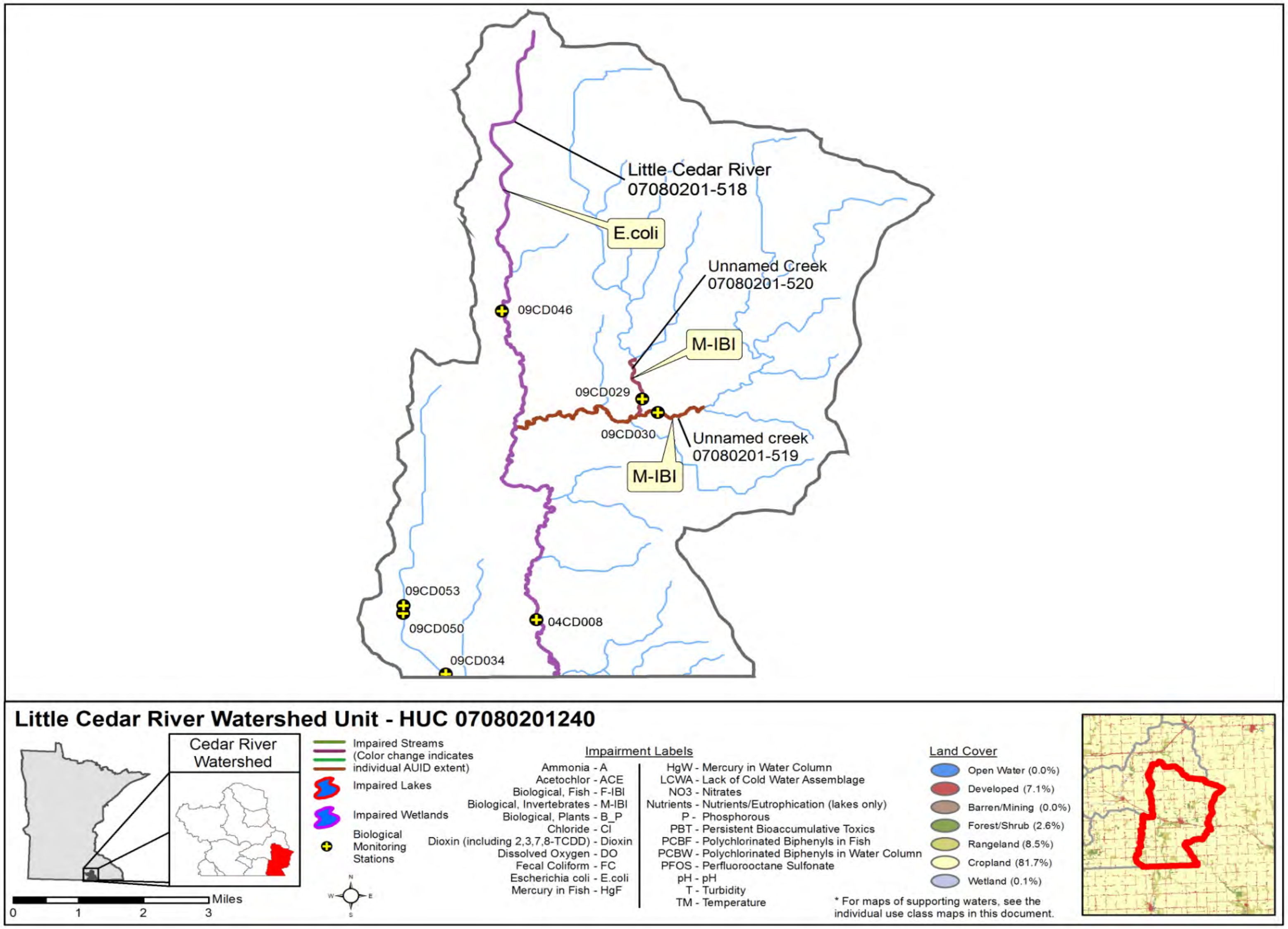

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Little Cedar River Watershed Unit

VI. Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Cedar River, grouped by sampling type. Summaries are provided for aquatic life and recreation uses in streams and lakes throughout the watershed, for aquatic consumption results at select river and lake locations along the watershed, and for load monitoring data results near the mouth of the river.

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 Cedar River Watershed.

Pollutant load monitoring

The Cedar River is monitored at Hwy 28 near Austin approximately 13 miles before it leaves Minnesota. Many years of water quality data from throughout Minnesota combined with previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR) (MPCA 2010a), each with unique nutrient standards. Of the state's three RNR's (North, Central, South), the Cedar River's load monitoring station is located within the South RNR. Annual FWMCs were calculated and compared for years 2008-2010 (Figures 12-15) and compared to the RNR standards (only TP and TSS draft standards are available for the South RNR). It should be noted that while a FWMC exceeding given water quality standard is generally a good indicator the water body is out of compliance with the River Nutrient Region standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10 percent and greater (MPCA 2010a), over the most recent 10 year period and not based on comparisons with FWMCs. A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10 percent of the individual samples collected over the assessment period were above the standard.

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

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

Total Suspended Solids (TSS)

Water clarity refers to the transparency of water. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter, and plankton or other microscopic organisms. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

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

Currently, the State of Minnesota's TSS standards are moving from the "development phase" into the "approval phase" and must be considered to be draft standards until complete approval. Within the South RNR, the TSS draft standard is 65 mg/L (MPCA 2010c), when greater than 10 percent of the individual samples exceed the draft standard, the river is out of compliance. Calculations from 2008 through 2010 show 10, 10, and 2 percent of the individual TSS samples exceeded the 65 mg/L draft standard, respectively. In addition, the computed FWMCs for the three sampling years, only 2008 exceeded the 65 mg/L draft standard while 2009 and 2010 were well below the 65 mg/L draft standard (Figure 24). In 2008, the sample with the highest measured TSS concentrations (635 mg/L) was collected on the rising limb of a high intensity rainfall event in June. In 2009, the highest individual concentrations coincided with back to back mid-June rain events where concentrations of individual samples ranged from 100 mg/L to 170 mg/L during the events. Although the data may not reflect long-term trends, both TSS FWMCs and annual loads showed a consistent decline in 2009 and 2010 (Figure 24 and Table 50). Because of the strong correlation that often exists between pollutant loads and annual runoff volume, annual load reductions may be due strictly to differences in annual runoff volume (Figure 2).

One possible explanation for the increase in annual TSS load for 2008, is that most of the runoff occurred early in the growing season. The soil is most vulnerable to erosion when it is directly exposed to rainfall due of the lack of plant canopy cover. At this time, the plants roots are not always full developed and do not provide the soil stabilization as they would later in the growing season.

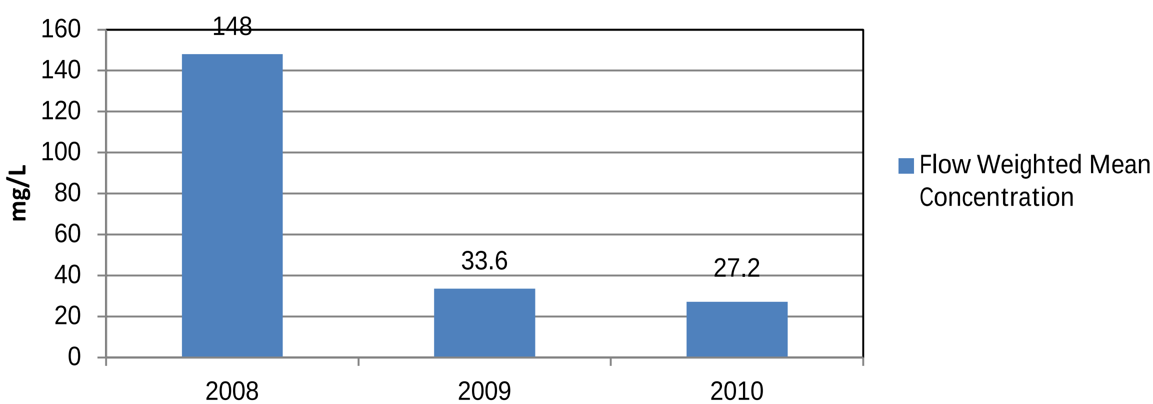

Figure 24. Total Suspended Solids (TSS) flow weighted mean concentrations in the Cedar River

Table 51. Annual pollutant loads by parameter calculated for the Cedar River

	2008	2009	2010
Parameter	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	44,578,161	6,473,101	10,965,056
Total Phosphorus	93,713	75,148	134,959
Ortho Phosphorus	70,425	60,533	104,418
Nitrate + Nitrite Nitrogen	2,673,598	1,773,250	3,578,311

Total Phosphorus

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

TP standards for Minnesota’s rivers are also in the final approval phase and must be considered draft standards until approved. Within the South RNR, the TP draft standard is 150 ug/L as a summer average. Summer average violations of one or more “response” variables (pH, biological oxygen demand (BOD), dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. Concentrations from 2008, 2009 and 2010 show that 94, 100, and 93 percent of the individual TP samples exceeded the 150 ug/L draft standard, respectively. Observation of Figure 13 shows that all of the FWMCs from 2008 to 2010 are more than double the draft standard at 311, 390, and 335 ug/L, respectively. At this site, TP concentrations are generally highest during low flow periods. This likely indicates a point source discharge upstream of the site that should be investigated.

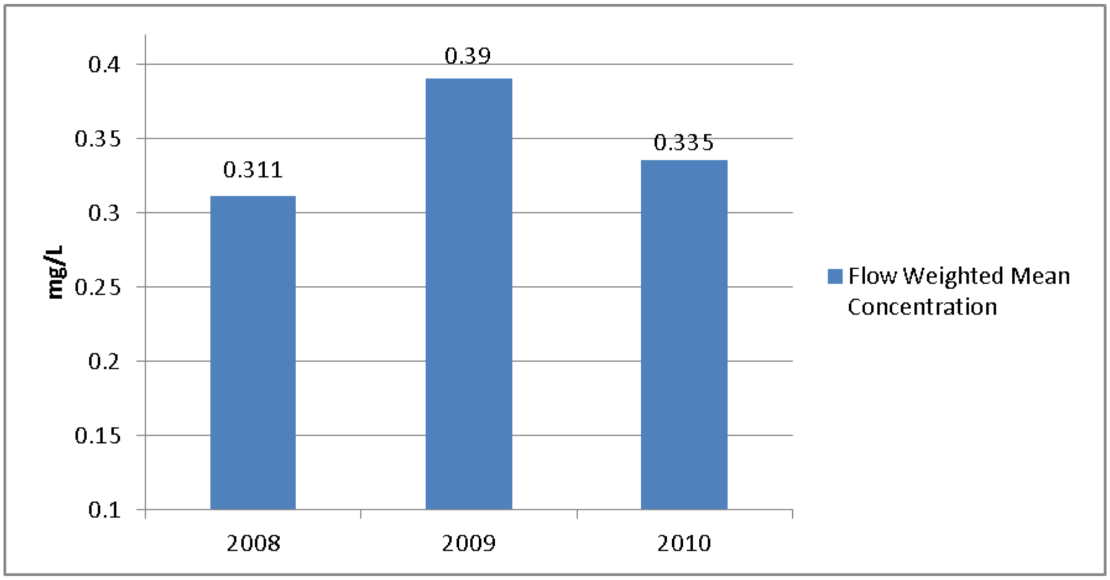

Figure 25. Total Phosphorus (TP) flow weighted mean concentrations for the Cedar River

Dissolved Orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The 2008 through 2010 FWMC ratio of DOP to TP shows that 75 to 80 percent of TP is in the orthophosphate form. Figure 14 indicates DOP FWMC was highest when the annual runoff volume was the lowest. This also indicates that a point source discharge may be the source.

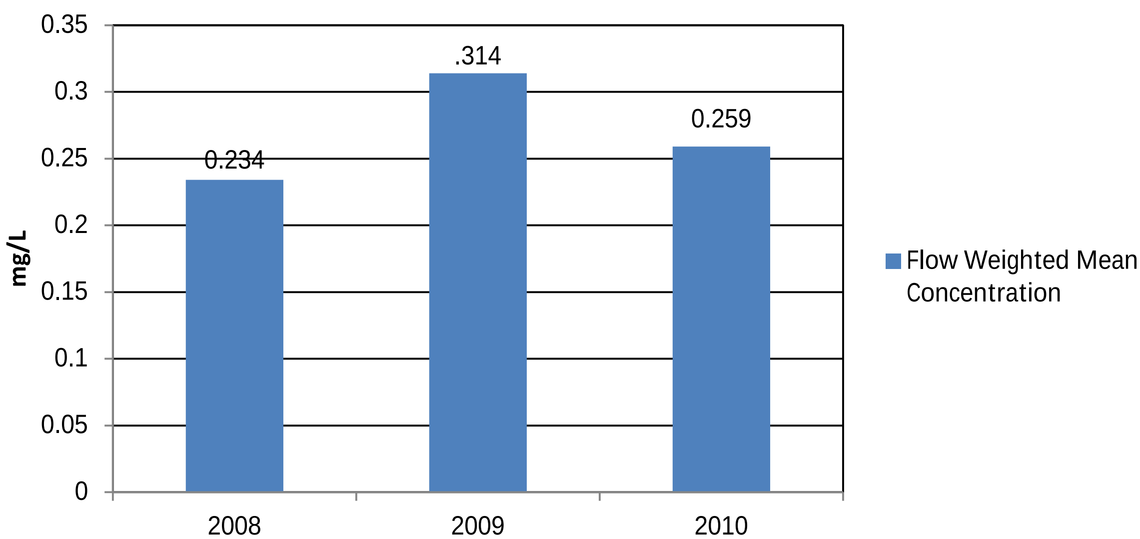

Figure 26. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the Cedar River

Nitrate plus Nitrite - Nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems, and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA 2010b). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-N to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen, with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

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

Nitrate-N FWMCs from 2008 through 2010 for the Cedar River Watershed were 8.87, 9.19, and 8.88 mg/L, respectively (Figure 15). Calculations of the Cedar River's annual nitrate-N loads show a consistent relationship to the annual runoff volume over the three year sampling period (Table 50).

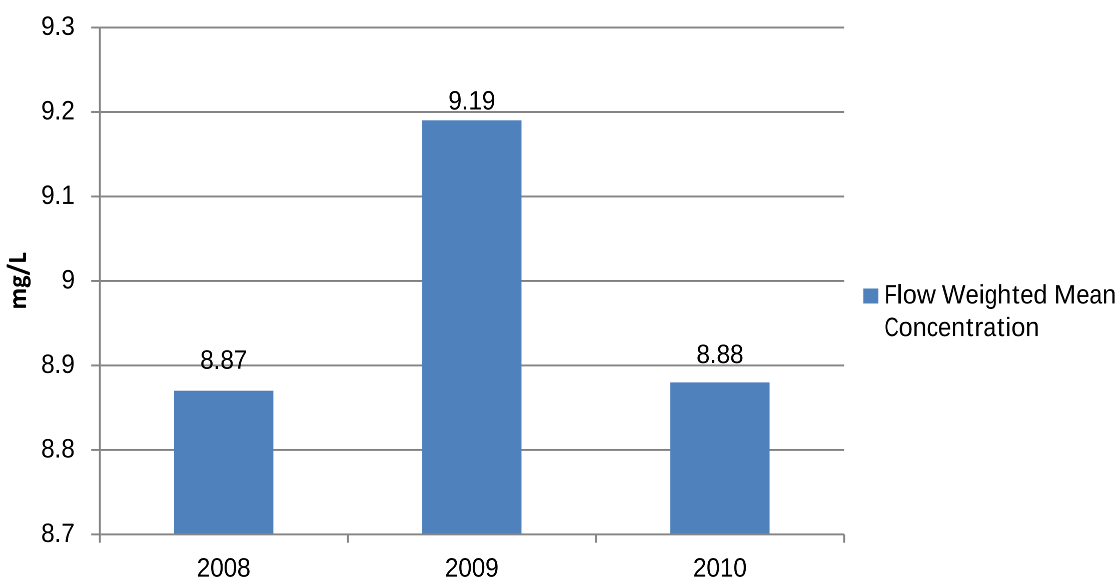

Figure 27. Nitrate + Nitrite Nitrogen (Nitrate-N) flow weighted mean concentrations for the Cedar River

Stream water quality

Thirty five of the 122 stream AUIDs were assessed (Table 55). Of the assessed streams, only 11 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Two AUIDs were not assessed due to their classification as limited resource waters. Twenty three AUIDS were not assessed for aquatic biology because greater than 50 percent of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID. One AUID was not assessed due to a localized spring where the sampling reach had a cold thermal regime that fell without the MPCA's coldwater classification criteria and so was not reflective of conditions representing a majority of the warmwater AUID.

Throughout the watersheds, 30 AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, 21 are non-supporting for aquatic life and 9 are non-supporting for aquatic recreation. Aquatic biological impairments (Figure 33) occur along the mainstem Cedar River and many tributaries (e.g., Dobbins Creek, Roberts Creek, Rose Creek, Turtle Creek, Woodson Creek). Six AUIDs were previously listed for turbidity. During this assessment cycle, 4 more AUIDs were assessed as impaired for turbidity - 2 AUIDs on the Cedar River, Dobbins Creek, and Rose Creek - for a total of 10 turbidity impairments.

High bacteria concentrations are a common concern across the watershed affecting almost the entire length of the Cedar River and tributaries (Turtle Creek, Rose Creek, Little Cedar River, Otter Creek, Orchard Creek, Roberts Creek, Wolf Creek, Woodbury Creek, and an unnamed creek). Nutrient concentrations of nitrite-nitrate across the watershed are not meeting ecoregion expectations, whereas, phosphorous concentrations are generally meeting ecoreregion expectations (except for a few locations the Turtle Creek and Rose Creek watersheds and the main stem of the Cedar River near the Iowa Border).

Table 52. Assessment summary for stream water quality in the Cedar River Watershed

				Supporting		Non-supporting		
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**
Cedar River **HUC 8**	416,064	**122**	**35**	**11**	**0**	**21**	**9**	**30**
Middle Fork Cedar River	6,720	12	5	2	0	3	1	2
Roberts Creek	16,000	13	5	1	0	4	1	1
Upper Cedar River	21,376	26	9	3	0	6	3	8
Turtle Creek	24,960	21	2	0	0	2	1	10
Rose Creek	30,592	7	3	0	0	3	0	1
West Beaver Creek	37,568	2	1	1	0	0	0	0
Lower Cedar River	42,304	24	6	2	0	4	2	4
Otter Creek	46,272	4	1	1	0	0	0	1
Deer Creek	60,928	6	0	0	0	0	0	1
Little Cedar River	63,552	6	3	1	0	2	1	1
Elk River	65,792	1	0	0	0	0	0	1

Lake water quality

Of a watershed total of seven lakes, only Geneva Lake had enough data for assessment. Geneva Lake is impaired for aquatic recreation due to low transparency. Other lakes in the watershed are small in size and shallow. Shallow lakes are susceptible to mixing throughout the open water season. The mixing resuspends bottom sediments, which when combined with high temperatures and pH, can result in continued release of phosphorus into the water column.

Table 53. Assessment summary for lake water chemistry in the Cedar River Watershed

Watershed	Area (acres)	Total Lakes or Reservoirs	Lakes >10 Acres	Lake <10 Acres	Full Support	Non-support	Insufficient Data
Cedar River **HUC 8**	416,064	**7**	**7**	**0**	**0**	**1**	**6**
Middle Fork Cedar River	6,720	0	0	0	0	0	0
Roberts Creek	16,000	0	0	0	0	0	0
Upper Cedar River	21,376	2	2	0	0	0	2
Turtle Creek	24,960	2	2	0	0	1	1
Rose Creek	30,592	0	0	0	0	0	0
West Beaver Creek	37,568	0	0	0	0	0	0
Lower Cedar River	42,304	0	0	0	0	0	0
Otter Creek	46,272	0	0	0	0	0	0
Deer Creek	60,928	3	3	0	0	0	3
Little Cedar River	63,552	0	0	0	0	0	0
Elk River	65,792	0	0	0	0	0	0

Fish contaminant results

All reaches (AUIDs) of the mainsteam Cedar River are on the Impaired Waters Inventory for mercury in fish tissue. In addition, the upper reaches of the mainstem Cedar River, from the headwaters to Lower Austin Dam, are on the Inventory for PCBs in fish tissue. East Side Lake is the only other waterway on the Inventory for mercury in fish tissue. The lake was added in 1998, because of a single largemouth bass with a mercury tissue concentration of 0.39 mg/Kg. If we used the assessment criteria that began in 2006 (see above), East Side Lake would not be assessed as impaired because at least five fish are required to make an assessment. Also, new assessments would not use data collected before 1999. All of the AUIDS with mercury impairments qualified for inclusion in the Minnesota Statewide Mercury TMDL (http://www.pca.state.mn.us/water/tmdl/tmdl-mercuryplan.html).

A summary of descriptive statistics for mercury and PCBs (Table 1) shows the upper four AUIDs of Cedar River continue to have fish that exceed the threshold for impairment because of mercury and PCBs. Golden redhorse and largemouth bass (collected since 1998) had a 90th percentile mercury concentrations of 0.22 mg/Kg and 0.49 mg/Kg, respectively. A common carp and a river carpsucker had PCB concentrations of 0.233 mg/Kg and 0.536 mg/Kg, respectively. Ramsey Mill Pond did not exceed the impairment thresholds for mercury or PCBs. East Side Lake should be targeted for another collection of fish to assess the current status of mercury concentrations in fish.

Waterway	AUID	EPA Category	Species	N	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)			
					Mean	Min	Max	Mean	Min	Max	90th Pctl	N	Mean	Min	Max
Cedar River	07080201-503, -502, -511, -512	4A-mercury; 5B-PCBs	Black bullhead	1	10.6			0.270			NA	1	< 0.010		
			Common Carp	2	24.8	23.0	26.5	0.130	0.130	0.130	0.130	2	0.128	0.023	0.233
			Golden redhorse	2	15.6	15.1	16.1	0.210	0.200	0.220	0.220	2	0.023	0.013	0.032
			Largemouth bass	6	13.0	9.2	18.9	0.255	0.099	0.490	0.490	3	0.015	0.013	0.018
			Northern pike	8	21.7	18.3	26.7	0.148	0.090	0.192	0.188	5	0.029	0.015	0.060
			River carpsucker	1	21.7			0.420			NA	1	0.536		
			Smallmouth bass	3	10.5	8.9	12.5	0.119	0.089	0.165	0.165				
			White sucker	3	14.5	12.9	15.7	0.143	0.120	0.170	0.170	3	0.034	0.010	0.054
	07080201-513, -514, -515, -501, -516	4A-mercury	Common Carp	7	18.5	13.3	25.5	0.091	0.013	0.166	0.166	3	0.064	0.045	0.090
			Smallmouth bass	7	10.2	8.6	12.8	0.111	0.079	0.180	0.172	3	0.036	0.027	0.050
Ramsey Mill Pond	50000400		Common Carp	1	22.6	22.6	22.6	0.160				1	< 0.010		
			Redhorse	1	14.8	14.8	14.8	0.170				1	< 0.010		

Note: East Side Lake is listed for mercury but is not in this table because the listing was for a largemouth bass caught in 1992 (0.390 mg/Kg).
NA - not available

Ground water monitoring

There are no currently functioning MDNR observation wells in the watershed. Existing wells were abandoned over 10 years ago. Results from Ambient Groundwater sites near the city of Austin indicate high concentrations of naturally-occurring elements in groundwater. These results do not raise concern for impacts of widespread contamination from anthropogenic chemicals. There are currently no MDA pesticide and nutrient monitoring wells currently in the watershed (MDA 2009, 2010).

Lake Levels

There are few lakes in the watershed. Within Freeborn, only Geneva Lake has an active record of elevation readings from 1987 to present (Figure 28). There is a small, statistically insignificant rising trend in water level.

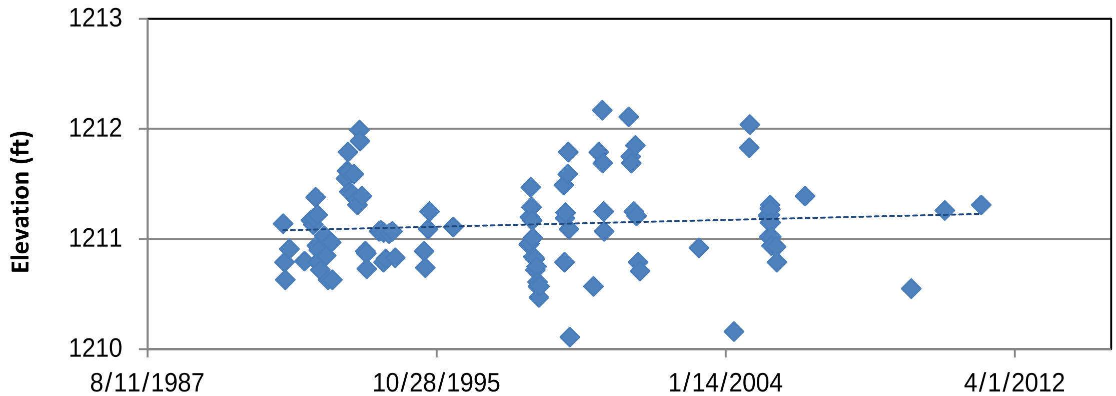

Figure 28. Water elevation for Geneva Lake (1987-2012)

Stream flow

Figure 29 is a display of July and August mean flows for the last 20 years. Both months show a decreasing flow trend, but the level of significance is not high. By way of comparison, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends.

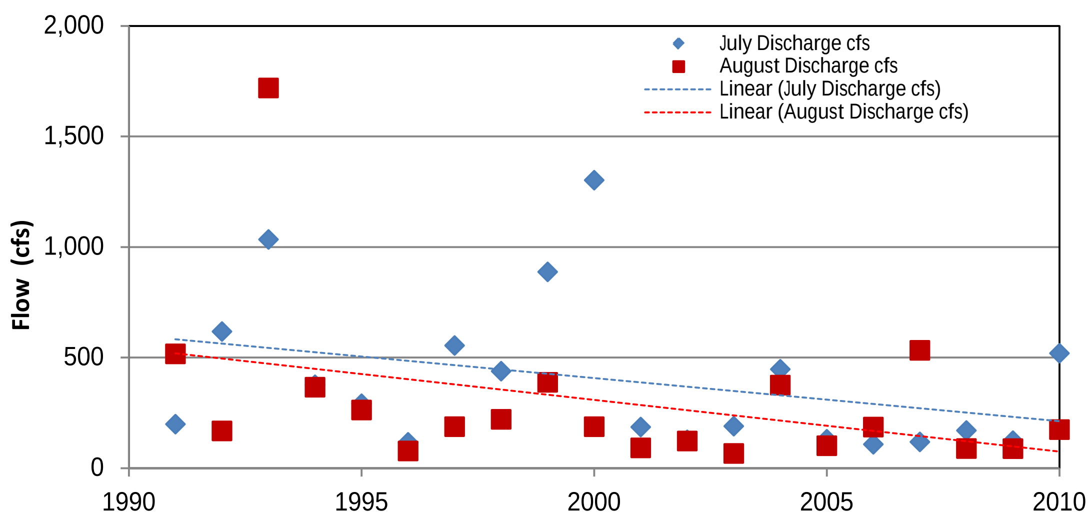

Figure 29. Mean monthly discharge measurements for July and August flows (1990-2010)

Pollutant trends for the Cedar River

Water quality trends at long-term monitoring stations

Water Chemistry data were analyzed for trends (Table 54) for the long term period of record (1967-2009) and near term period of record (1995-2009). There were significant increases in nitrite/nitrates during the long term period of record for both stations and additionally for the short term period for CD-10 which is south of Austin. Conversely, there were significant decreases in total suspended solids, total phosphorus, ammonia, and biological oxygen demand for the long term period of record while there was no trend with the near term period. No trend was observed for chloride; however, this may be the result of insufficient data, especially within the most recent time period.

Table 54. Trends in the Cedar River Watershed

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
At CSAH-2, 0.5 Miles E of Lansing (CD-24)						
overall trend (1967–2009)	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**no trend**
average annual change	-2.8%	-2.0%	3.2%	-1.6%	-4.1%	
total change	**-71%**	**-58%**	**294%**	**-50%**	**-83%**	
recent trend (1995 – 2009)	**no trend**	**no trend**	**no trend**	**no trend**	**no trend**	little data
average annual change						
total change						
median concentrations first 10 years	38	0.3	2	0.10	3.8	20
median concentrations most recent 10 years	11	0.2	8	<.05	0.8	20
At CSAH-4, 3 Miles S of Austin (CD-10)						
overall trend (1967–2009)	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**no trend**
average annual change	-2.9%	-2.9%	2.5%	-5.2%	-3.9%	
total change	**-71%**	**-72%**	**193%**	**-90%**	**-82%**	
recent trend (1995 – 2009)	**no trend**	**no trend**	**increase**	**no trend**	**no trend**	little data
average annual change			3.1%			
total change			**53%**			
median concentrations first 10 years	42	0.7	3	0.29	5.9	41
median concentrations most recent 10 years	34	0.2	9	<.05	1.7	28

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

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

Water clarity trends at citizen-monitoring sites

Citizen volunteer monitoring occurs at only two streams in the watershed. Water clarity has shown no trend.

Cedar HUC 08070201	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/ increasing trend	0	0
number of sites w/ decreasing trend	0	0
number of sites w/ no trend	2	0

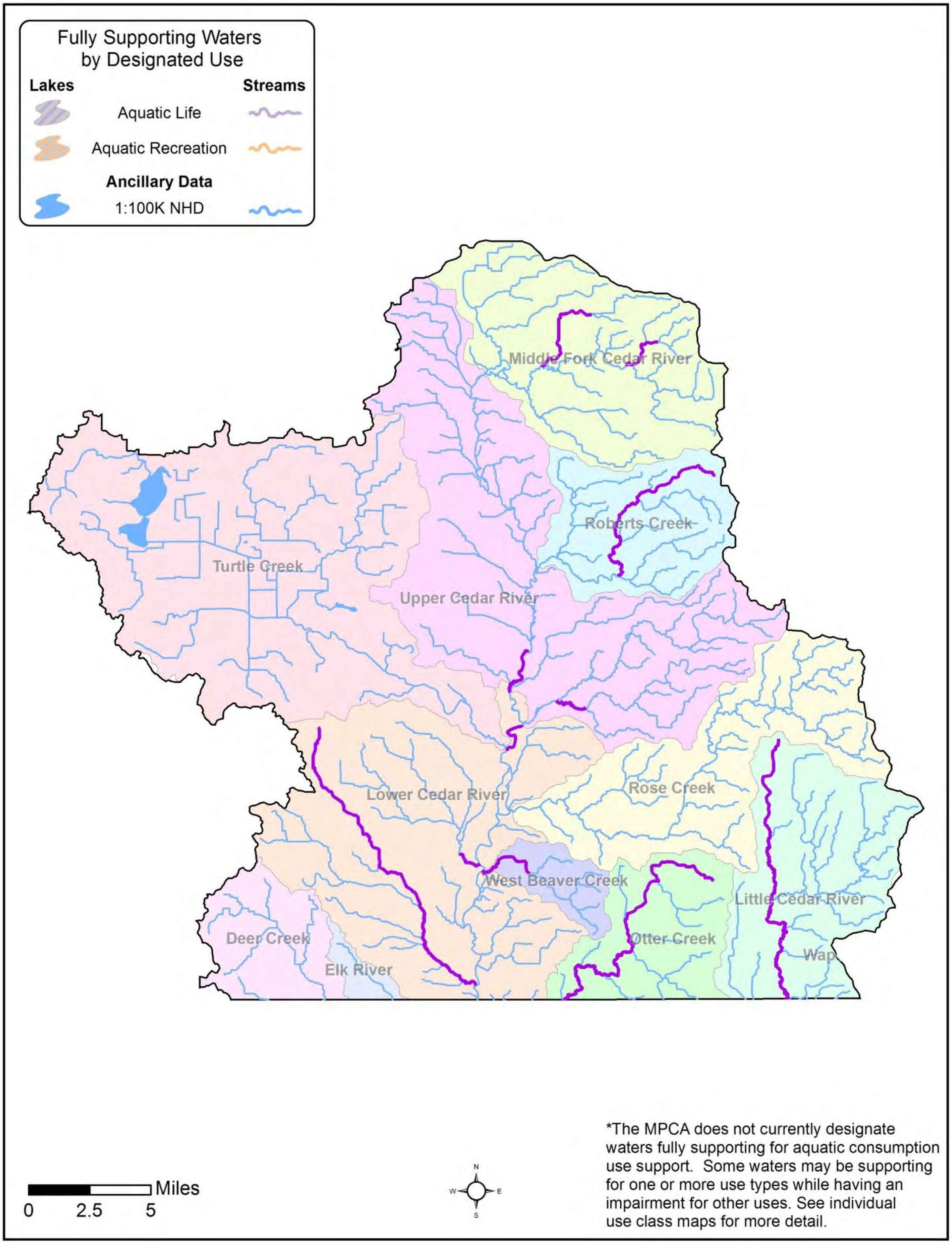

Figure 30. Fully supporting waters by designated use in the Cedar River Watershed

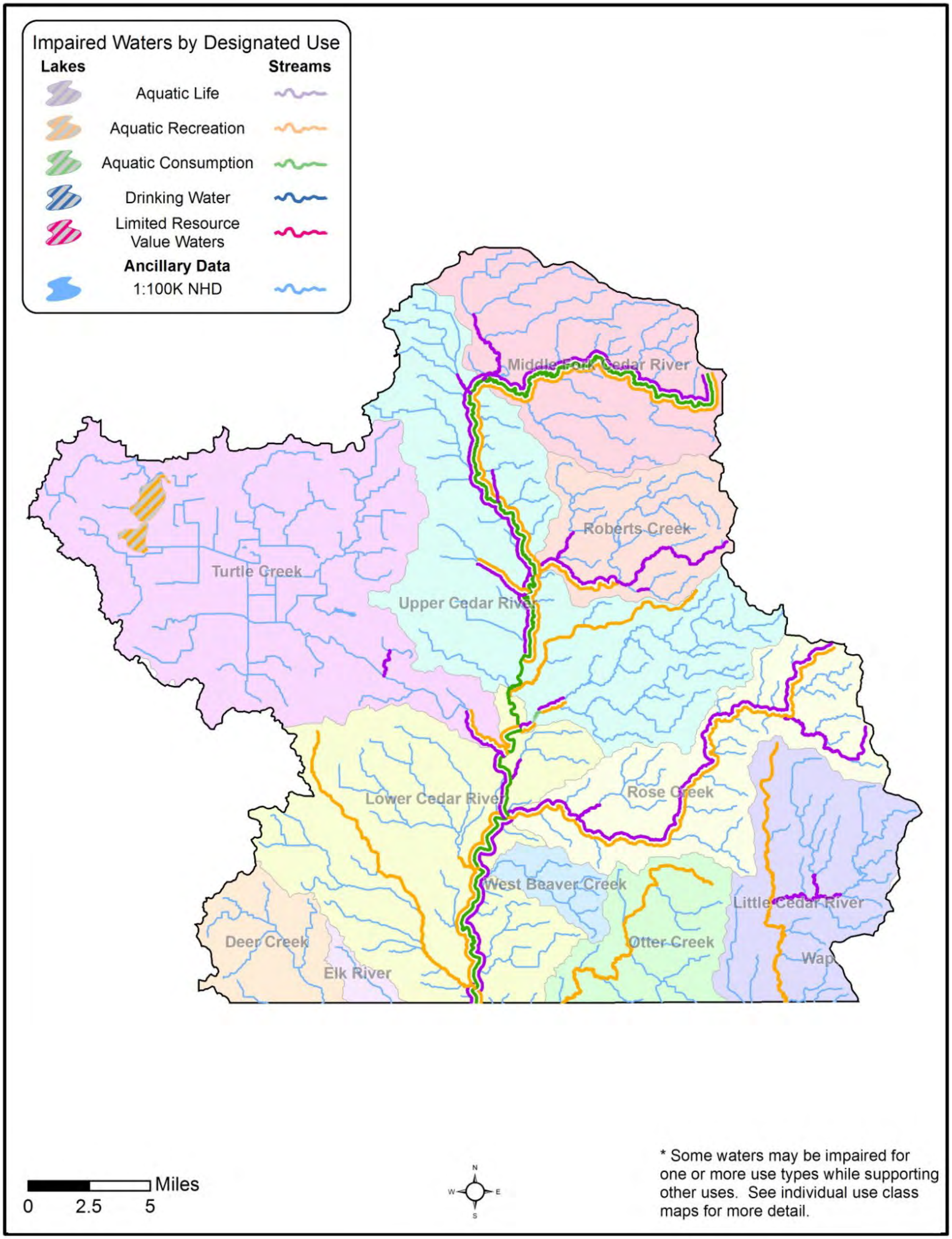

Figure 31. Impaired waters by designated use in the Cedar River Watershed

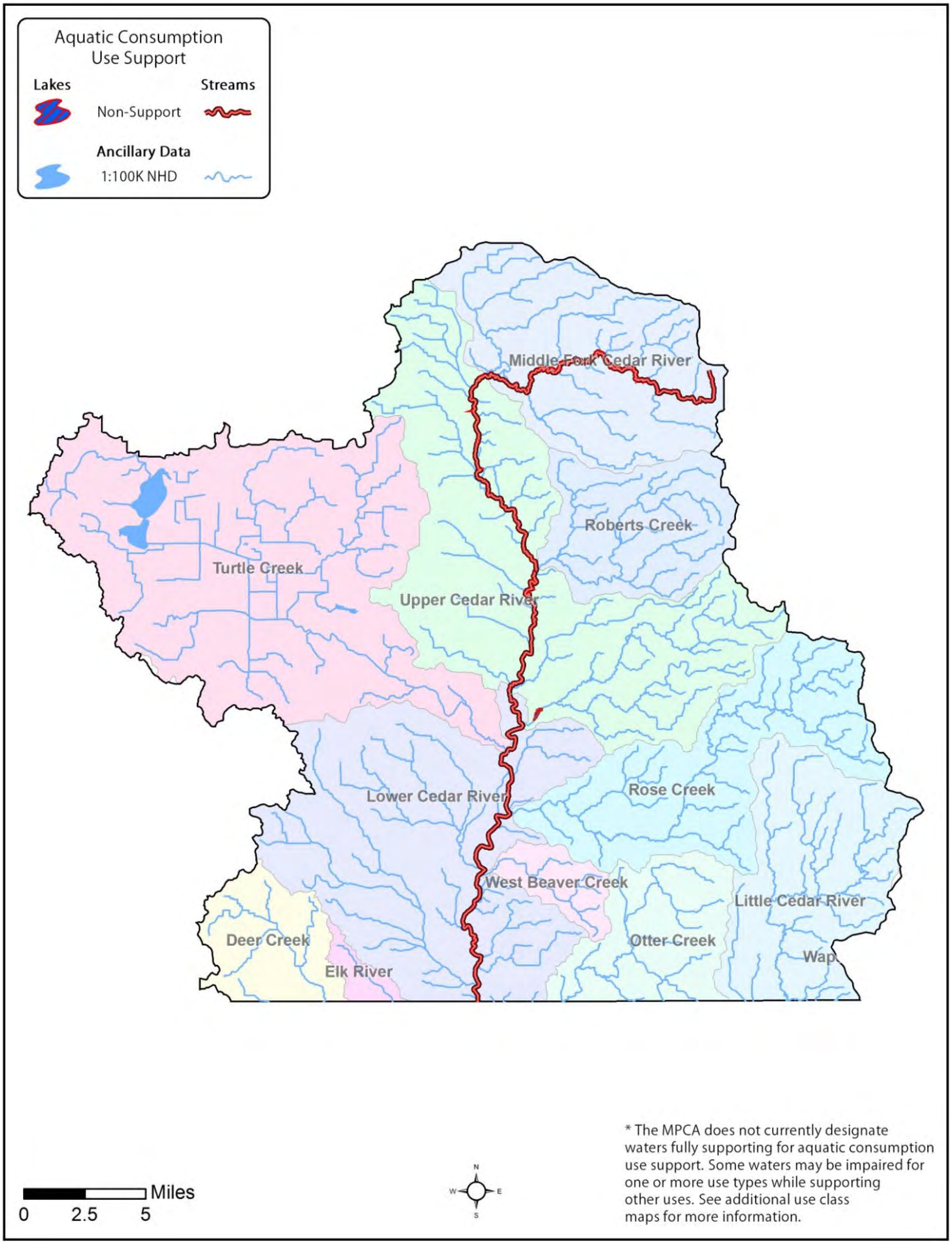

Figure 32. Aquatic consumption use support in the Cedar River Watershed

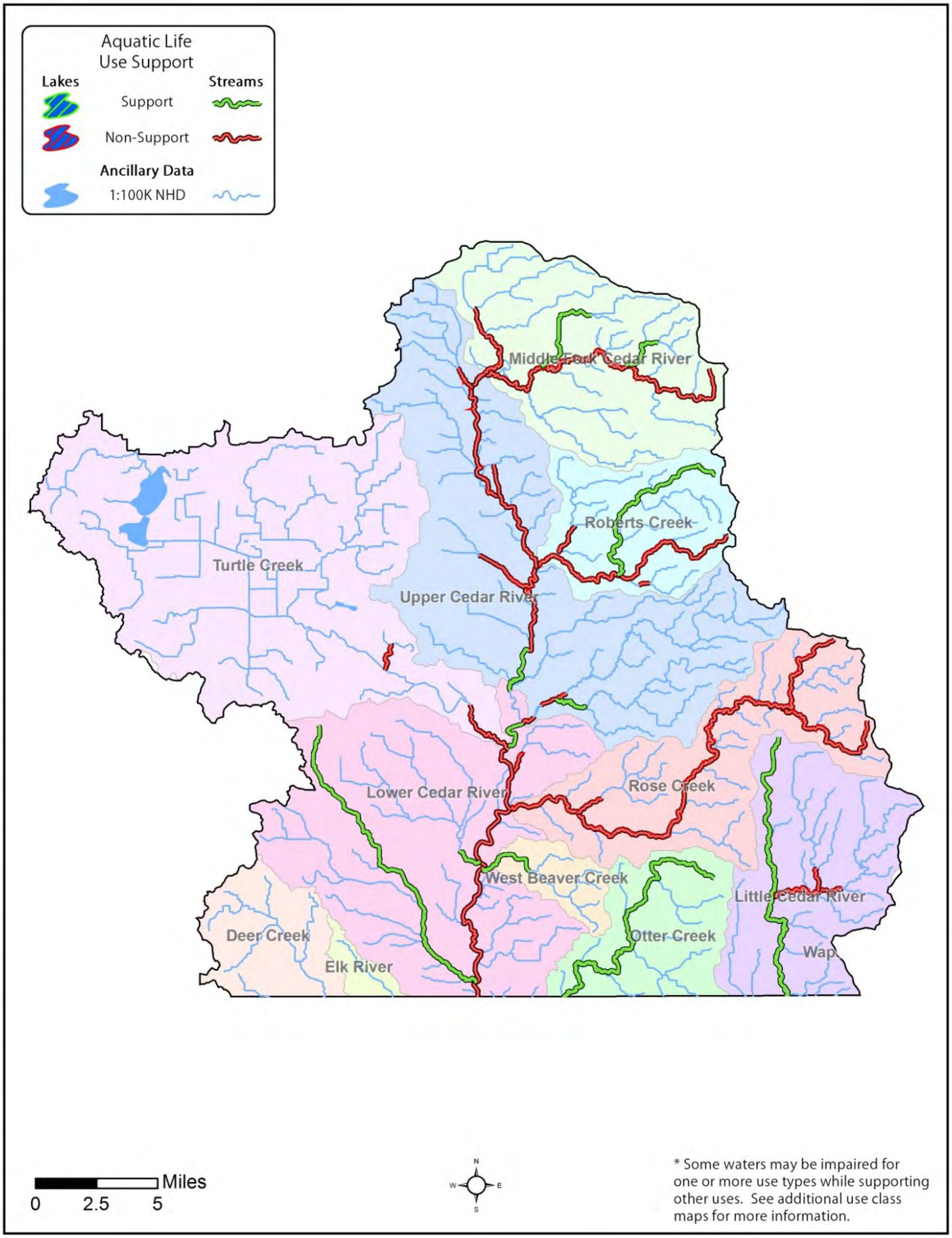

Figure 33. Aquatic life use support in the Cedar River Watershed

Figure 34. Aquatic recreation use support in the Cedar River Watershed

VII. Summaries and Recommendations

While improvements have been made to the water quality of the Cedar River watershed over the last 30 years with regards to point source discharges, many of its waterbodies struggle to attain water quality standards. In order to see measureable improvements in water quality, measures must be taken to address both point and non-point source pollution across the watershed.

Some potential biological stressors include excess nutrients, changes in watershed hydrology, and loss of habitat quality. Water quality grab samples collected at the outlet monitoring station and during summer biological sampling throughout the watershed indicate that Nitrite-Nitrate values are exceeding the 75^{th} percentile ecoregion expectation (6.5 mg/L). Two of the highest nitrite-nitrate values recorded at biological monitoring stations were 21 mg/L and 32 mg/L in the Middle Fork Cedar River Watershed. High nitrates in stream water can enter groundwater. Nitrate concentrations above 10 mg/L can be harmful to human health, farm animals, wildlife and sensitive aquatic life. High nitrates can fuel excessive growth of plants and algae which seasonally die and are decomposed by microbes. The process of decomposition can decrease dissolved oxygen levels which can be a stress to sensitive fish and aquatic insects. Nitrate sources include natural sources and anthropogenic sources such as septic systems, runoff from feedlots, land application of manure, and nitrogen based fertilizers. Nutrient and sediment management may include: the protection of stream corridors by maintaining and improving stream buffers and introducing native shoreland vegetation; proper fertilizer application; and incorporating cover crops and increasing lands in perennial vegetation and wetlands to reduce nutrient loading and high stream flows. Very high total and ortho phosphorus levels in the mainstem downstream of Austin indicate that there may be point sources that need to reduce discharges of this nutrient.

Changes in watershed hydrology can cause or exacerbate stream bank erosion and cause a loss of habitat quality. The Cedar River TMDL suggests that climate, change in cropping patterns, and ditching/tile drainage have increased stream flows in the Cedar River watershed (BARR 2011). An increase in stream flows provides more power to scour and erode stream banks and initiate gully erosion. The excess sediments can bury substrates used by fish and aquatic insects for spawning, feeding, and protection.

Efforts to reduce the severity of flooding are being investigated and implemented, including the building of berms, purchasing land to make wetlands and water retention sites, rain gardens, rain barrels, and controlled drainage practices. Improved watershed storage should also translate into improvements in water quality though reductions in stream bank erosion and turbidity which would also benefit aquatic habitat and aquatic life.

Projects aimed at the protection of sensitive species should be investigated. Restoration projects could include working with landowners to improve quality of riparian corridors, stream bank stabilization, bank grading to reconnect floodplains, and removal of illegal rock dams. These projects should help improve and maintain habitat quality required by sensitive species to survive.

Additional monitoring could include investigating the extent of existing and new impairments. More targeted stream chemistry monitoring is needed in areas where sufficient data for assessment is lacking and to determine the extent and stressors of known impairments.

Improvements in water quality will protect drinking water and provide scenic and recreational opportunities that enhance the quality of life and continued economic vitality of the watershed.

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Appendix 1 - Water chemistry definitions

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

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

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

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

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

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

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

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

Total Phosphorus (TP) - Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Increasing the amount of phosphorus entering the system therefore increases the growth of aquatic plants and other organisms. Excessive levels of 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.

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

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

Appendix 2 - Intensive watershed monitoring water chemistry stations in the Cedar River Watershed

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	11-digit HUC
09CD011	S000-804	Cedar River	At CSAH-2 (750th St), 3.5 mi. E of Blooming Prairie	07080201010
09CD013	S001-182	Roberts Creek	At 550th Ave, 3 mi. NE of Brownsdale	07080201020
09CD009	S005-613	Cedar River	Adjacent to 4th St SE, W of Austin Utility	07080201030
09CD062	S000-230	Turtle Creek	At CSAH 23 (4th Dr SW), 0.5 mi. SW of Austin	07080201040
09CD091	S000-229	Rose Creek	At CSAH 29, 3 mi. S of Austin	07080201050
09CD012	S000-059	Cedar River	At MN Hwy 105, 2.5 mi. W of Lyle	07080201065
04CD008	S005-614	Little Cedar River	At 110th St, 3.5 mi. SW of Adams	07080201240

Appendix 3.1 - AUID table of stream assessment results (by parameter and beneficial use)

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS			
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Oxygen Demand (BOD)	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07080201010 (Middle Fork Cedar River)																								
07080201-529	Unnamed creek	Unnamed cr to Cedar R	2.3	2B	FS	NA	NA		MTS	MTS														
07080201-592	Unnamed creek	Unnamed cr to Cedar R	4.4	2B	FS	NA	NA		EXP	NA														
07080201-550	Unnamed creek	Unnamed cr to Unnamed cr	2.9	2B	NA*	NA	NA		NA															
07080201-532	Unnamed creek	Headwaters to Cedar R	8.6	2B	IF*	NA	NA		EXP	EXS														
07080201-549	Little Cedar River, Middle Fk	Westfield-Ripley Ditch to Unnamed cr	1.4	2B	NS	NA	NA		MTS	EXP														
07080201-530	Little Cedar River, Middle Fk	Unnamed cr to Cedar R	3.1	2B	NS	NA	NA		MTS	EXP							IF	MTS	EXP			EXN	MTN	
07080201-503†	Cedar River	Headwaters to Roberts Cr	28.6	2B	NS	NS	NS		MTS	EXP				MTS	EX		IF	MTS	EXP	MT		EXN	MTN	
HUC 11: 07080201020 (Roberts Creek)																								
07080201-505	Unnamed creek	Headwaters to Roberts Cr	9.3	2B	FS	NA	NA		MTS	MTS														
07080201-507	Unnamed creek	T103 R17W S east line to Roberts Cr	0.5	7	NA*			NA	NA	NA														
07080201-534	Unnamed creek	Unnamed cr to T103 R17W S10, west line	0.5	2B	NS	NA	NA		EXP	EXS														
07080201-593	Unnamed creek	Unnamed cr to Unnamed cr	1.6	2B	NS	NA	NA		MTS	EXP														
07080201-506	Roberts Creek	Headwaters to Unnamed cr	6.9	2C	NS	NA	NA		EXS	EXS														
07080201-504	Roberts Creek	Unnamed cr to Cedar R	5.8	2C	NS	NS	NA		MTS	EXP				MTS	EX		IF	MTS	EXP	MT				

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
† AUID 07080201-503 is listed in the table twice since the 29 mile AUID spanned the length of two different HUCs (07080201010 and 07080201030)

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07080201030 (Upper Cedar River)																							
07080201-502	Cedar River	Roberts Cr to Upper Austin Dam	4.8	2B	NS	NS	NA		MTS	MTS				MT	EX		IF	MT	EXP	MT	EXN	MTN	EX
07080201-503†	Cedar River	Headwaters to Roberts Cr	28.6	2B	NS	NS	NA		MTS	EXP					EX		IF	MT	EXP	MT	EXN	MTN	EX
07080201-510	Wolf Creek	Headwaters to Cedar R	11.2	2C	NA*	IF	NA		NA	NA				MT	IF		IF	MT	EXP	MT			
07080201-511	Cedar River	Upper Austin Dam to Wolf Cr	2.6	2B	FS	NA	NA		MTS	EXP													
07080201-524	Dobbins Creek	Headwaters to T103 R17W S31, west line	16.2	2C	IF*	NA	NA										IF	MT	EXP		EXN	MTN	EX
07080201-531	Unnamed creek	Headwaters to Cedar R	4.6	7	NA*			IF	NA	NA				MT	IF		IF	MT		MT			
07080201-533	Unnamed creek	Headwaters to Cedar R	2.7	2B	NS	IF	NA		MTS	EXP				MT	IF		IF	MT	EXP	MT	EXN	MTN	EX
07080201-535	Dobbins Creek	T103 R18W S36, east line to East Side Lk	1.2	2B	NS	NA	NA		EXP	MTS					--		IF	MT	EXP		EXN	MTN	EX
07080201-553	Murphy Creek,	Headwaters to Cedar R	5.6	2C	IF*	IF	NA		NA	NA				MT	IF		IF	MT	EXP	MT	EXN	MTN	EX
07080201-563	Unnamed creek	Unnamed cr to Dobbins Cr	1.5	2B	FS	NA	NA		EXP	EXP													
07080201-573	Judicial Ditch 5	Headwaters to Cedar R	4.3	2B	IF*	IF	NA		MTS	EXP				MT	IF		IF	MT	EXP	MT	EXN	MTN	EX
07080201-577	Unnamed creek	Unnamed cr to Cedar R	1.4	2B	NS	NA	NA		MTS	EXS													
07080201-591	Unnamed creek (Cedar River, West Fork)	Unnamed cr to Cedar R	1.1	2B	NS	NA	NA		MTS	EXP													
07080201-512	Cedar River	Wolf Cr to Lower Austin Dam	1.3	2B	NA	NA	NA																

07080201-513	Cedar River	Lower Austin Dam to Dobbins Cr	0.6	2B	NA	NA	NA																		
07080201-514	Cedar River	Dobbins Cr to Turtle Cr	1.9	2B	FS	NS	NA			MTS	MTS				MT	EX				EXP	MT		EXN	MTN	MT
HUC 11: 07080201040 (Turtle Creek)																									
07080201-525	Turtle Creek	Headwaters (Geneva Lk 24-0015-00) to T104 R20W S35, south line	4.3	2B	NA*	NA	NA			NA	NA														
07080201-528	Mud Creek	Headwaters to Turtle Cr (JD 24)	9	2B	NA*	NA	NA			NA	NA														
07080201-538	Turtle Creek	T103 R20W S2, north line to T103 R18W S32, south line	12.5	2C	IF*	NA	NA			NA	NA								MT	EXP			EXN	MTN	EX
07080201-540	Turtle Creek	T102 R18W S4, north line to Cedar R	3	2B	NS	NS	NA			EXP	EXP				MT	EX		IF	MT	EXS	MT		MTN	MTN	EX
07080201-544	County Ditch 30	Unnamed cr to Turtle Cr	3.6	2B	NA*	NA	NA			NA	NA														
07080201-545	Knotvold Branch	Unnamed ditch to Turtle Cr	2.3	2B	NA*	NA	NA			NA	NA														
07080201-546	Deer Creek	Ditch to Turtle Cr	4.3	2B	IF	NA	NA												MT	EXP			EXN	EXN	EX
07080201-547	Unnamed creek	Unnamed cr to Turtle Cr	1.4	2B	NS	NA	NA			MTS	EXP														
07080201-572	Unnamed creek	JD 24 to Turtle Cr	1.1	2B	IF*	NA	NA			NA	NA								MT	EXP			EXN	EXN	EX
07080201-584	County Ditch 8	Unnamed cr to Unnamed ditch	2.9	2B	NA*	NA	NA			NA	NA														
07080201-587	Judicial Ditch 24	Unnamed ditch to JD 24	1.8	2B	NA*	NA	NA			NA	NA														
07080201-589	Judicial Ditch 18	Unnamed ditch to JD 24	1.7	2B	NA*	NA	NA			NA	NA														

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.
† AUID 07080201-503 is listed in the table twice since the 29 mile AUID spanned the length of two different HUCs (07080201010 and 07080201030)

AUID DESCRIPTIONS				USES					BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS		
National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Class 7	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07080201050 (Rose Creek																							
07080201-522	Rose Creek	Headwaters to Cedar R	27	2C	NS	NS	NA		MTS	MTS				MT	EX		IF	MT	EXP	MT	EXN	MTN	EX
07080201-523	Schwerin Creek	Headwaters to Rose Cr	6.9	2B	NS	NA	NA		EXP	EXP													
07080201-548	Unnamed creek	Headwaters to Rose Cr	4	2B	NA*	NA	NA		NA	NA													
07080201-575	Unnamed creek	Unnamed cr to Rose Cr	2.6	2B	NA*	NA	NA		NA														
07080201-583	Unnamed creek	Unnamed cr to Rose Cr	1.4	2B	NS	NA	NA		EXP	EXS							IF	MT	EXP		EXN	EXN	EX
HUC 11: 07080201060 (West Beaver Creek)																							
07080201-556	Unnamed creek	Unnamed cr to Cedar R	2.9	2B	FS	NA	NA		MTS	MTS													
HUC 11: 07080201065 (Lower Cedar River)																							
07080201-554	Unnamed creek (Woodson Creek)	T102 R18W S14, north line to Cedar R	1.0	2A	NS	NA	NA		EXS	EXP													
07080201-555	Unnamed creek	Headwaters to Orchard Cr	6.7	2B	IF*	NA	NA		MTS	EXS													
07080201-590	Mud Lake Creek/County Ditch 75	Unnamed cr to Woodbury Cr	3.7	2B	IF*	NA	NA		EXP	EXP													
07080201-595	Unnamed creek	Unnamed cr to Cedar R	2.5	2B	NA*	NA	NA		NA	NA													
07080201-594	Unnamed creek	Unnamed cr to Orchard Cr	2.0	2B	IF*	NA	NA		EXP	EXS													

07080201-526	Woodbury Creek	Headwaters to Cedar R	15.1	2C	FS	IF	NA			MTS	MTS				MT	IF		IF	MT	EXP	MT		EXN	MTN	EX
07080201-539	Orchard Creek	T101 R18W S5, north line to Cedar R	1.1	2B	FS	IF	NA			MTS	MTS				MT	IF		IF	MT	EXP	MT		EXN	MTN	EX
07080201-509	Orchard Creek	Headwaters to T102 R18W S32, south line	7.6	2C	IF*	NA	NA			EXP	EXS														
07080201-501	Cedar River	Rose Cr to Woodbury Cr	10.3	2B	NS	NS	NA			EXS	EXP				MT	EX		IF	MT	EXS	MT		EXN	EXN	EX
07080201-512	Cedar River	Wolf Cr to Lower Austin Dam	1.3	2B	IF*	NA	NA													EXP					
07080201-515	Cedar River	Turtle Cr to Rose Cr	3	2B	NS	NA	NA			MTS	EXP	MT	MT	MT	MT			IF	MT	EXS	MT		EXN	EXN	EX
07080201-516	Cedar River	Woodbury Cr to MN/IA border	0.7	2B	NS	NS	NA			EXP	EXP				MT	EX				EXP	MT		EXN	EXN	EX
HUC 11: 07080201075 (Otter Creek)																									
07080201-574	Unnamed creek	Unnamed cr to Otter Cr	1.9	2B	NA*	NA	NA			NA	NA														
07080201-517	Otter Creek	Headwaters to MN/IA border	14.3	2B	FS	NA	NA			MTS	MTS					--				MTS					
HUC 11: 07080201095 (Deer Creek)																									
07080201-580	Deer Creek (County Ditch 71)	T101 R19W S19, north line to MN/IA border	4.4	2C	IF*	NA	NA			EXP	MTS														
HUC 11: 07080201240 (Little Cedar River)																									
07080201-518	Little Cedar River	Headwaters to MN/IA border	15	2C	FS	NS	NA			MTS	MTS				MT	EX		IF	MT	IF	MT		EXN	MTN	MT
07080201-519	Unnamed creek	Unnamed cr to Little Cedar R	4.3	2B	NS	NA	NA			MTS	EXP														
07080201-520	Unnamed creek	Unnamed cr to Unnamed cr	1.1	2B	NS	NA	NA			EXP	EXP														
07080201-596	Unnamed creek	Unnamed cr to MN/IA border	2.5	2B	NA*	NA	NA			NA	NA														

Appendix 3.2 - Assessment results for lakes in the Cedar River Watershed

Lake ID	Lake Name	County	HUC-11	Ecoregion	Lake Area (ha)	Max Depth (m)	Watershed Area (ha)	% Littoral	Mean depth (m)	Support Status
50-0002-00	East Side	Mower	07080201030	WCBP	15.94	5.18	9949	99.6	*2.5	N/A
50-0004-00	Ramsey Mill Pond	Mower	07080201030	WCBP	36.87	5.49	49077	99.1	*2.5	N/A
24-0015-00	Geneva	Freeborn	07080201040	WCBP	645.74	2.43	5475	100.0	0.19	NS
50-0003-00	Mill Pond	Mower	07080201065	WCBP	15.58	5.18	50922	92.1	*2.5	N/A

Abbreviations:
FS – Full Support
NS – Non-Support
IF – Insufficient Information
N/A – Not Assessed

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

*These depths were created by MPCA Staff.

Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B, 2C	39	±11	50	28
2	Southern Streams	2B, 2C	45	±9	54	36
3	Southern Headwaters	2B, 2C	51	±7	58	44
10	Southern Coldwater	2A	45	±9	58	32
4	Northern Rivers	2B, 2C	35	±9	44	26
5	Northern Streams	2B, 2C	50	±9	59	41
6	Northern Headwaters	2B, 2C	40	±16	56	24
7	Low Gradient	2B, 2C	40	±10	50	30
11	Northern Coldwater	2A	37	±10	47	27
Invertebrates						
1	Northern Forest Rivers	2B, 2C	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B, 2C	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B, 2C	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B, 2C	52.4	±13.6	66	38.8
5	Southern Streams RR	2B, 2C	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B, 2C	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B, 2C	38.3	±13.6	51.9	24.7
8	Northern Coldwater	2A	26	±12.4	38.4	13.6
9	Southern Coldwater	2A	46.1	±13.8	59.9	32.3

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

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
HUC 11: 07080201010 (Middle Fork Cedar River Watershed)							
07080201-530	09CD002	Little Cedar River, Middle Fork	18.9	3	51	65	08-Jul-09
07080201-503	09CD005	Cedar River	12.2	3	51	62	30-Jun-09
07080201-503	09CD011	Cedar River	48.7	2	45	46	06-Jul-09
07080201-503	09CD056	Cedar River	27.2	3	51	60	13-Jul-09
07080201-503	04CD003	Cedar River	24.8	3	51	67	05-Aug-04
07080201-549	04CD016	Little Cedar River, Middle Fork	12.9	3	51	66	01-Sep-04
07080201-592	09CD041	Unnamed creek	6.6	3	51	56	30-Jun-09
07080201-532	09CD014	Unnamed creek	11.7	3	51	51	09-Jul-09
07080201-529	09CD004	Unnamed creek	6.8	3	51	59	30-Jun-09
HUC 11: 07080201020 (Roberts Creek Watershed)							
07080201-534	09CD051	Unnamed creek	2.7	3	51	46	30-Jun-09
07080201-504	04CD033	Roberts Creek	26.0	3	51	74	25-Aug-04
07080201-504	09CD013	Roberts Creek	39.1	2	45	49	22-Jul-09
07080201-505	09CD016	Unnamed creek	14.0	3	51	64	15-Jul-09
07080201-506	09CD018	Roberts Creek	5.5	3	51	39	01-Jul-09
07080201-593	09CD017	Unnamed creek	9.7	3	51	62	09-Jul-09
HUC 11: 07080201030 (Upper Cedar Watershed)							
07080201-563	09CD026	Unnamed creek	17.0	3	51	51	30-Jun-09
07080201-502	09CD006	Cedar River	159.7	2	45	56	14-Jul-09
07080201-533	09CD042	Unnamed creek	5.0	3	51	66	13-Jul-09
07080201-503	04CD023	Cedar River	118.3	2	45	58	25-Aug-04
07080201-503	09CD032	Cedar River	113.5	2	45	51	11-Aug-09
07080201-503	09CD032	Cedar River	113.5	2	45	54	08-Jul-09
07080201-503	04CD018	Cedar River	88.9	2	45	47	28-Jul-04
07080201-503	09CD010	Cedar River	89.0	2	45	41	14-Jul-09
07080201-511	04CD038	Cedar River	184.7	2	45	75	02-Sep-04

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
07080201-511	04CD038	Cedar River	184.7	2	45	66	01-Sep-09
07080201-573	09CD043	Judicial Ditch 5	11.5	3	51	70	22-Jul-09
07080201-591	09CD023	Unnamed creek (Cedar River, West Fork)	9.3	3	51	68	13-Jul-09
07080201-577	04CD009	Unnamed creek	1.0	3	51	65	13-Jul-04
07080201-531	09CD049	Unnamed creek	9.9	3	51	58	08-Jul-09
HUC 11: 07080201040 (Turtle Creek Watershed)							
07080201-547	04CD041	Unnamed creek	4.4	3	51	64	14-Jul-04
07080201-540	09CD062	Turtle Creek	152.9	2	45	67	20-Jul-09
07080201-540	04CD010	Turtle Creek	151.8	2	45	45	28-Jul-04
HUC 11: 07080201050 (Rose Creek Watershed)							
07080201-583	09CD021	Unnamed creek	9.0	3	51	53	15-Jul-09
07080201-522	04CD012	Rose Creek	50.0	2	45	59	27-Jul-04
07080201-522	09CD022	Rose Creek	49.5	2	45	61	07-Jul-09
07080201-522	09CD020	Rose Creek	8.9	3	51	60	30-Jun-09
07080201-522	09CD091	Rose Creek	65.8	2	45	53	07-Jul-09
07080201-523	09CD045	Schwerin Creek	9.3	3	51	57	01-Jul-09
HUC 11: 07080201060 (West Beaver Creek Watershed)							
07080201-556	04CD025	Unnamed creek	9.8	3	51	67	25-Aug-04
HUC 11: 07080201065 (Lower Cedar River Watershed)							
07080201-509	09CD059	Orchard Creek	8.1	3	51	54	30-Jun-09
07080201-590	09CD047	Mud Lake Creek/County Ditch 75	13.8	3	51	53	07-Jul-09
07080201-501	04CD002	Cedar River	521.7	1	39	35	02-Sep-04
07080201-501	09CD065	Cedar River	475.0	1	39	54	22-Jul-09
07080201-501	04CD024	Cedar River	530.8	1	39	35	09-Sep-04
07080201-514	09CD009	Cedar River	244.1	2	45	73	21-Jul-09
07080201-526	09CD028	Woodbury Creek	39.9	2	45	68	08-Jul-09
07080201-515	09CD069	Cedar River	397.8	1	39	45	21-Jul-09
07080201-515	09CD069	Cedar River	397.8	1	39	68	12-Aug-09
07080201-516	09CD012	Cedar River	585.6	1	39	46	22-Jul-09

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
07080201-539	09CD025	Orchard Creek	31.6	2	45	49	15-Jul-09
07080201-594	09CD058	Unnamed creek	10.6	3	51	54	30-Jun-09
07080201-554	09CD048	Unnamed creek (Woodson Creek)	6.5	10	45	19	29-Jun-09
07080201-555	09CD095	Unnamed creek	7.0	3	51	58	30-Jun-09
HUC 11: 07080201075 (Otter Creek Watershed)							
07080201-517	10EM092	Otter Creek	36.7	2	45	61	20-Jul-10
07080201-517	10EM092	Otter Creek	36.7	2	45	67	15-Jul-09
07080201-517	04CD031	Otter Creek	34.8	2	45	58	19-Jul-04
07080201-517	04CD040	Otter Creek	29.2	3	51	68	20-Jul-04
HUC 11: 07080201095 (Deer Creek Watershed)							
07080201-580	09CD066	Deer Creek	20.1	3	51	49	07-Jul-09
HUC 11: 07080201240 (Little Cedar River Watershed)							
07080201-518	04CD008	Little Cedar River	46.6	2	45	52	20-Jul-04
07080201-518	09CD046	Little Cedar River	7.0	3	51	57	01-Jul-09
07080201-518	09CD046	Little Cedar River	7.0	3	51	51	21-Jul-09
07080201-518	04CD008	Little Cedar River	46.6	2	45	79	11-Aug-09
07080201-518	04CD008	Little Cedar River	46.6	2	45	52	08-Sep-04
07080201-518	04CD008	Little Cedar River	46.6	2	45	75	06-Jul-09
07080201-520	09CD029	Unnamed creek	10.6	3	51	56	14-Jul-09
07080201-519	09CD030	Unnamed creek	13.0	3	51	70	14-Jul-09

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

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
HUC 11: 07080201010 (Middle Fork Cedar River)							
07080201-503	04CD003	Cedar River	24.8	5	35.9	25.71	01-Sep-04
07080201-549	04CD016	Cedar River, Middle Fork	13.0	6	46.8	36.71	02-Sep-04
07080201-530	09CD002	Cedar River, Middle Fork	18.9	6	46.8	43.53	04-Aug-09
07080201-529	09CD004	Unnamed creek	6.8	6	46.8	49.15	04-Aug-09
07080201-503	09CD005	Cedar River	12.3	6	46.8	30.99	04-Aug-09
07080201-503	09CD011	Cedar River	48.7	6	46.8	59.71	05-Aug-09
07080201-532	09CD014	Unnamed creek	11.7	6	46.8	33.00	05-Aug-09
07080201-503	09CD056	Cedar River	27.2	6	46.8	39.22	04-Aug-09
HUC 11: 07080201020 (Roberts Creek)							
07080201-504	04CD033	Roberts Creek	26.0	5	35.9	10.70	01-Sep-04
07080201-504	09CD013	Roberts Creek	39.1	6	46.8	65.15	05-Aug-09
07080201-505	09CD016	Unnamed creek	14.0	6	46.8	55.70	05-Aug-09
07080201-593	09CD017	Unnamed creek	9.7	6	46.8	45.91	05-Aug-09
07080201-506	09CD018	Roberts Creek	5.5	6	46.8	29.32	05-Aug-09
07080201-534	09CD051	Unnamed creek	2.8	6	46.8	16.96	05-Aug-09
07080201-507	09CD052	Unnamed creek	3.1	6	46.8	3.70	05-Aug-09
HUC 11: 07080201030 (Upper Cedar River)							
07080201-577	04CD009	Unnamed creek	1.0	6	46.8	33.10	02-Sep-04
07080201-503	04CD018	Cedar River	89.0	6	46.8	53.38	02-Sep-04
07080201-503	04CD023	Cedar River	118.3	6	46.8	52.10	02-Sep-04
07080201-511	04CD038	Cedar River	184.7	6	46.8	42.40	01-Sep-04
07080201-511	04CD038	Cedar River	184.7	6	46.8	54.50	13-Aug-09
07080201-502	09CD006	Cedar River	159.7	6	46.8	46.97	05-Aug-09
07080201-503	09CD010	Cedar River	89.0	6	46.8	38.81	05-Aug-09

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
07080201-591	09CD023	Unnamed creek (Cedar River, West Fork)	9.3	6	46.8	44.02	04-Aug-09
07080201-563	09CD026	Unnamed creek	17.0	6	46.8	51.25	06-Aug-09
07080201-563	09CD026	Unnamed creek	17.0	6	46.8	45.11	06-Aug-09
07080201-503	09CD032	Cedar River	113.5	6	46.8	74.35	05-Aug-09
07080201-533	09CD042	Unnamed creek	5.0	6	46.8	37.45	05-Aug-09
07080201-573	09CD043	Judicial Ditch 5	11.5	6	46.8	36.95	05-Aug-09
07080201-531	09CD049	Unnamed creek	9.9	6	46.8	43.70	05-Aug-09
HUC 11: 07080201040 (Turtle Creek)							
07080201-540	04CD010	Turtle Creek	151.8	6	46.8	31.39	26-Aug-04
07080201-547	04CD041	Unnamed creek	4.4	5	35.9	35.16	02-Sep-04
07080201-540	09CD062	Turtle Creek	152.9	5	35.9	34.71	06-Aug-09
HUC 11: 07080201050 (Rose Creek)							
07080201-522	04CD001	Rose Creek	26.5	6	46.8	51.50	26-Aug-04
07080201-522	04CD012	Rose Creek	50.0	5	35.9	52.93	26-Aug-04
07080201-522	09CD020	Rose Creek	8.9	5	35.9	27.44	06-Aug-09
07080201-583	09CD021	Unnamed creek	9.0	6	46.8	32.20	13-Aug-09
07080201-522	09CD022	Rose Creek	49.5	5	35.9	39.50	13-Aug-09
07080201-523	09CD045	Schwerin Creek	9.3	6	46.8	38.35	06-Aug-09
07080201-522	09CD091	Rose Creek	65.8	5	35.9	36.87	06-Aug-09
HUC 11: 07080201060 (West Beaver Creek)							
07080201-556	04CD025	Unnamed creek	9.8	5	35.9	50.64	01-Sep-04
HUC 11: 07080201065 (Lower Cedar River)							
07080201-501	04CD002	Cedar River	521.7	2	30.7	30.53	01-Sep-04
07080201-501	04CD024	Cedar River	530.8	2	30.7	28.87	01-Sep-04
07080201-514	09CD009	Cedar River	244.1	5	35.9	43.72	06-Aug-09
07080201-514	09CD009	Cedar River	244.1	5	35.9	29.84	06-Aug-09
07080201-516	09CD012	Cedar River	585.6	2	30.7	41.01	12-Aug-09
07080201-516	09CD012	Cedar River	585.6	2	30.7	37.61	12-Aug-09
07080201-539	09CD025	Orchard Creek	31.6	6	46.8	49.82	07-Aug-09

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
07080201-526	09CD028	Woodbury Creek	39.9	5	35.9	57.65	07-Aug-09
07080201-590	09CD047	Mud Lake Creek/County Ditch 75	13.8	6	46.8	39.59	12-Aug-09
07080201-554	09CD048	Unnamed creek (Woodson Creek)	6.5	9		34.52	06-Aug-09
07080201-594	09CD058	Unnamed creek	10.6	6	46.8	19.73	12-Aug-09
07080201-509	09CD059	Orchard Creek	8.1	5	35.9	21.44	12-Aug-09
07080201-501	09CD065	Cedar River	475.1	5	35.9	35.54	18-Aug-09
07080201-515	09CD069	Cedar River	397.8	6	46.8	22.22	06-Aug-09
07080201-555	09CD095	Unnamed creek	7.0	6	46.8	34.43	17-Aug-09
HUC 11: 07080201075 (Otter Creek)							
07080201-517	04CD031	Otter Creek	34.8	5	35.9	40.74	26-Aug-04
07080201-517	04CD040	Otter Creek	29.3	5	35.9	41.85	01-Sep-04
07080201-517	10EM092	Otter Creek	36.7	5	35.9	41.76	13-Aug-09
HUC 11: 07080201095 (Deer Creek)							
07080201-580	09CD066	Deer Creek (County Ditch 71)	20.1	5	35.9	39.81	12-Aug-09
HUC 11: 07080201240 (Little Cedar River)							
07080201-518	04CD008	Little Cedar River	46.7	5	35.9	39.88	26-Aug-04
07080201-518	04CD008	Little Cedar River	46.7	5	35.9	51.48	06-Aug-09
07080201-520	09CD029	Unnamed creek	10.6	6	46.8	29.58	06-Aug-09
07080201-519	09CD030	Unnamed creek	13.0	6	46.8	39.78	06-Aug-09
07080201-518	09CD046	Little Cedar River	7.0	6	46.8	42.31	06-Aug-09

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

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

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

Appendix 5.2 - Channelized stream reach and AUID IBI scores-FISH (unassessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: 07080201010 (Middle Fork Cedar River)									
07080201-550	04CD036	Unnamed creek	4.5	3	100 - 51	50 -36	35 - 0	31	01-Jul-04
07080201-549	09CD040	Cedar River, Middle Fork	12.6	3	100 - 51	50 - 36	35 - 0	32	06-Jul-09
HUC 11: 07080201020 (Roberts Creek)									
NONE									
HUC 11: 07080201030 (Upper Cedar River)									
07080201-510	09CD024	Wolf Creek	11.2	3	100 - 51	50 - 36	35 - 0	66	08-Jul-09
07080201-553	09CD044	Murphy Creek	6.4	3	100 - 51	50 - 36	35 - 0	40	29-Jun-09
HUC 11: 07080201040 (Turtle Creek)									
07080201-528	09CD038	Mud Creek	9.7	3	100 - 51	50 - 36	35 - 0	40	15-Jun-09
07080201-572	09CD061	Unnamed creek	29.0	7	100 - 40	39 - 25	24 - 0	31	08-Jul-09
07080201-525	09CD007	Turtle Creek	33.8	2	100 - 45	44 - 30	29 - 0	33	23-Jul-09
07080201-525	09CD019	Turtle Creek	46.9	2	100 - 45	44 - 30	29 - 0	45	22-Jul-09
07080201-538	09CD067	Turtle Creek	62.8	2	100 - 45	44 - 30	29 - 0	48	16-Jul-09
07080201-538	09CD067	Turtle Creek	62.8	2	100 - 45	44 - 30	29 - 0	47	10-Aug-09
07080201-538	09CD063	Turtle Creek	145.6	2	100 - 45	44 - 30	29 - 0	45	16-Jul-09
07080201-538	04CD006	Turtle Creek	145.2	2	100 - 45	44 - 30	29 - 0	19	01-Sep-04
07080201-538	09CD063	Turtle Creek	145.6	2	100 - 45	44 - 30	29 - 0	44	30-Jul-09
07080201-587	09CD039	Judicial Ditch 24	14.8	7	100 - 40	39 - 25	24 - 0	36	23-Jul-09
07080201-546	04CD027	Deer Creek	29.8	7	100 - 40	39 - 25	24 - 0	36	26-Aug-04
07080201-546	04CD027	Deer Creek	29.8	7	100 - 40	39 - 25	24 - 0	28	10-Sep-04
07080201-546	07CD001	Deer Creek	31.0	2	100 - 45	44 - 30	29 - 0	38	16-Jul-09
07080201-546	09CD055	Deer Creek	21.0	3	100 - 51	50 -36	35 - 0	52	15-Jul-09
07080201-546	07CD001	Deer Creek	31.0	2	100 - 45	44 - 30	29 - 0	42	13-Aug-07
07080201-544	04CD013	County Ditch 30	3.2	3	100 - 51	50 -36	35 - 0	42	31-Aug-04
07080201-544	04CD013	County Ditch 30	3.2	3	100 - 51	50 -36	35 - 0	42	17-Aug-04
07080201-545	04CD034	Knotvold Branch	3.4	7	100 - 40	39-25	24 - 0	0	26-Aug-04

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
07080201-584	09CD035	County Ditch 8	9.6	3	100 - 51	50 -36	35 - 0	25	16-Jun-09
07080201-589	09CD068	Judicial Ditch 18	6.7	3	100 - 51	50 -36	35 - 0	48	15-Jun-09
HUC 11: 07080201050 (Rose Creek)									
07080201-548	04CD035	Unnamed creek	1.0	3	100 - 51	50 -36	35 - 0	0	13-Jul-04
07080201-575	07CD004	Unnamed creek	4.8	3	100 - 51	50 -36	35 - 0	44	14-Aug-07
HUC 11: 07080201060 (West Beaver Creek)									
07080201-556	09CD001	Unnamed creek	9.6	3	100 - 51	50 -36	35 - 0	68	07-Jul-09
HUC 11: 07010201065 (Lower Cedar River)									
07080201-526	09CD027	Woodbury Creek	12.8	7	100 - 40	39-25	24 - 0	40	07-Jul-09
07080201-595	09CD054	Unnamed creek	5.1	3	100 - 51	50-36	35 - 0	60	07-Jul-09
07080201-555	04CD042	Unnamed creek	6.8	3	100 - 51	50-36	35 - 0	45	13-Jul-04
HUC 11: 07010201075 (Otter Creek)									
07080201-517	09CD008	Otter Creek	10.5	3	100 - 51	50-36	35 - 0	60	11-Aug-09
07080201-517	07CD005	Otter Creek	10.9	3	100 - 51	50-36	35 - 0	64	14-Aug-07
07080201-574	07CD003	Unnamed creek	10.7	3	100 - 51	50-36	35 - 0	66	14-Aug-07
07080201-574	07CD003	Unnamed creek	10.7	3	100 - 51	50-36	35 - 0	63	07-Jul-09
HUC 11: 07010201095 (Deer Creek)									
NONE									
HUC 11: 07010201240 (Little Cedar River)									
07080201-596	09CD034	Unnamed creek	6.3	3	100 - 51	50-36	35 - 0	26	21-Jul-09
07080201-596	09CD050	Unnamed creek	4.7	3	100 - 51	50-36	35 - 0	38	21-Jul-09
07080201-596	09CD053	Unnamed creek	4.7	3	100 - 51	50-36	35 - 0	50	02-Sep-09

Appendix 5.3 - Channelized stream reach and AUID IBI scores-macrinverbrates (unassessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 07080201010 (Middle Fork Cedar River)									
NONE									
HUC 11: 07080201020 (Roberts Creek)									
NONE									
HUC 11: 07080201030 (Upper Cedar River)									
07080201-510	09CD024	Wolf Creek	11.2	6	100-48	47-32	31-0	11	06-Aug-09
07080201-553	09CD044	Murphy Creek	6.4	6	100-48	47-32	31-0	35	06-Aug-09
HUC 11: 07080201040 (Turtle Creek)									
07080201-528	09CD038	Mud Creek	9.7	6	100-48	47-32	31-0	22	18-Aug-09
07080201-572	09CD061	Unnamed creek	29.0	6	100-48	47-32	31-0	18	18-Aug-09
07080201-525	09CD007	Turtle Creek	33.8	6	100-48	47-32	31-0	28	18-Aug-09
07080201-525	09CD019	Turtle Creek	46.9	6	100-48	47-32	31-0	43	18-Aug-09
07080201-538	09CD067	Turtle Creek	62.8	6	100-48	47-32	31-0	48	18-Aug-09
07080201-546	09CD063	Turtle Creek	145.6	6	100-48	47-32	31-0	41	18-Aug-09
07080201-546	04CD006	Turtle Creek	145.2	6	100-48	47-32	31-0	28	02-Sep-04
07080201-546	04CD027	Deer Creek	29.8	6	100-48	47-32	31-0	29	02-Sep-04
07080201-546	07CD001	Deer Creek	31.0	6	100-48	47-32	31-0	48	13-Aug-09
07080201-546	07CD001	Deer Creek	31.0	6	100-48	47-32	31-0	37	13-Aug-09
07080201-546	09CD055	Deer Creek	21.0	6	100-48	47-32	31-0	40	13-Aug-09
07080201-544	04CD013	County Ditch 30	3.2	6	100-48	47-32	31-0	26	25-Aug-04
07080201-544	04CD013	County Ditch 30	3.2	6	100-48	47-32	31-0	30	09-Sep-04
07080201-544	04CD034	Knolvold Branch	3.4	6	100-48	47-32	31-0	12	02-Sep-04
07080201-544	04CD034	Knolvold Branch	3.4	6	100-48	47-32	31-0	22	09-Sep-04
07080201-587	09CD039	Judicial Ditch 24	14.8	6	100-48	47-32	31-0	24	18-Aug-09
07080201-584	09CD035	County Ditch 8	9.6	6	100-48	47-32	31-0	40	11-Aug-09

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
07080201-589	09CD068	Judicial Ditch 18	6.7	6	100-48	47-32	31-0	44	18-Aug-09
HUC 11: 07080201050 (Rose Creek)									
07080201-548	04CD035	Unnamed creek	1.0	5	100-37	36-21	20-0	10	01-Sep-04
HUC 11: 07080201060 (West Beaver Creek)									
07080201-556	09CD001	Unnamed creek	9.6	6	100-48	47-32	31-0	28	06-Aug-09
HUC 11: 07010201065 (Lower Cedar River)									
07080201-595	09CD054	Unnamed creek	5.1	6	100-48	47-32	31-0	35	06-Aug-09
07080201-526	09CD027	Woodbury Creek	12.8	6	100-48	47-32	31-0	57	07-Aug-09
07080201-555	04CD042	Unnamed creek	6.8	6	100-48	47-32	31-0	47	26-Aug-04
HUC 11: 07010201075 (Otter Creek)									
07080201-517	09CD008	Otter Creek	10.5	6	100-48	47-32	31-0	35	12-Aug-09
07080201-574	07CD003	Unnamed creek	10.7	6	100-48	47-32	31-0	39	12-Aug-09

Appendix 6.1 - Minnesota's ecoregion-based lake eutrophication standards

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

Appendix 6.2 - MINLEAP model estimates of phosphorus loads for lakes in the Cedar River Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
24-0015-00	Geneva	222	269	35	232.9	0.6	0.3	566	4251	67	53	7.5	0.2	1.16	H
50-0002-00	East Side	---	---	---	---	---	---	---	---	---	---	---	---	---	---
50-0003-00	Mill Pond	---	---	---	---	---	---	---	---	---	---	---	---	---	---
50-0004-00	Ramsey Mill Pond	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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