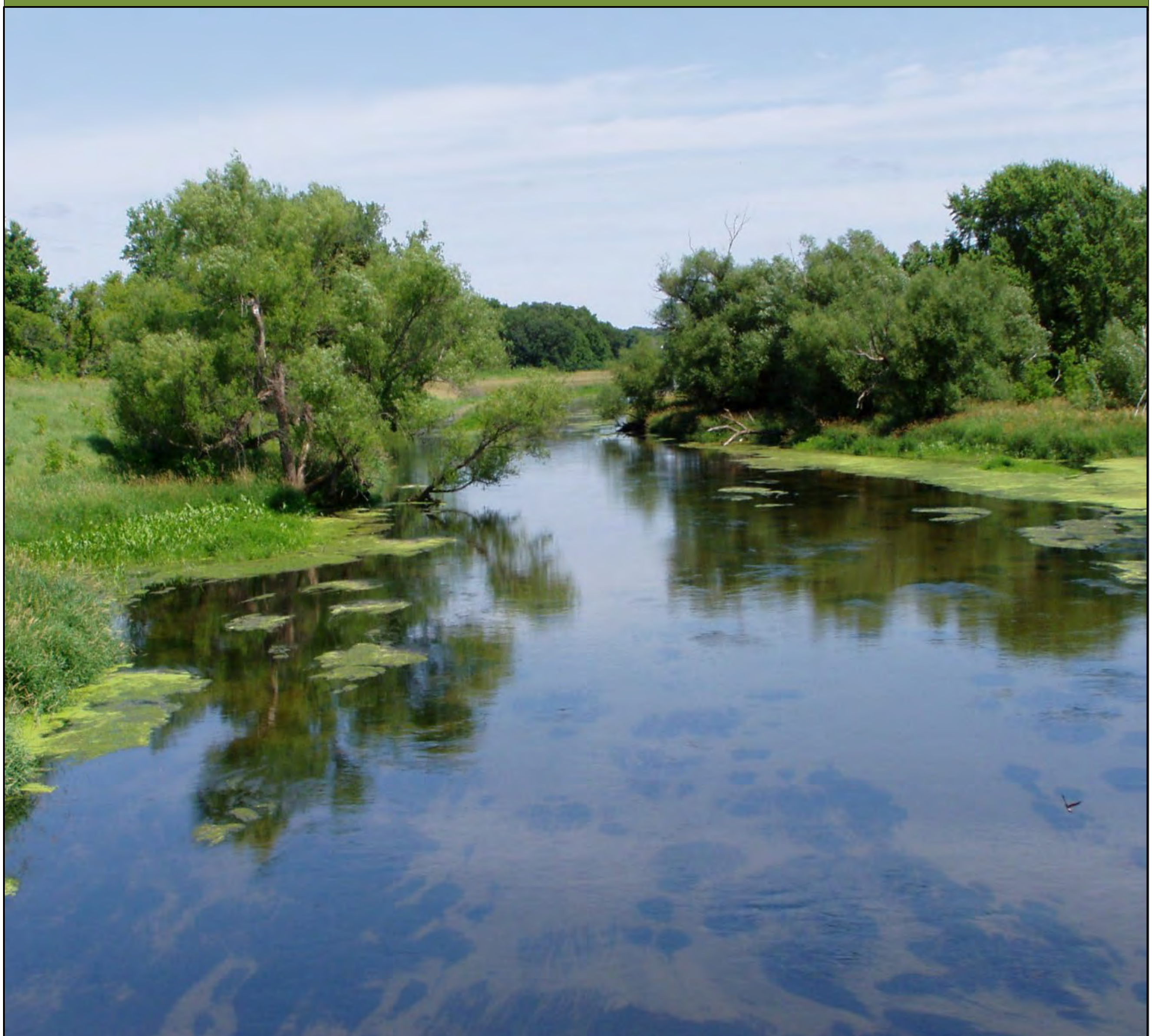
Shell Rock River Watershed Monitoring and Assessment Report



Minnesota Pollution Control Agency

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Contents

Executive Summary

This assessment report is the first in a series of reports for watershed work being conducted in the Shell Rock River watershed. The results of surface water monitoring activities in the Shell Rock River watershed are reported here. Subsequent reports will explain Stressor Identification, Total Maximum Daily Loads (TMDLs), and restoration and protection plans for the watershed.

The Shell Rock River Watershed (07080202) lies in southern rural Minnesota, encompassing a system of integrated lakes and streams, comprising 19 lakes and 37 stream assessment units (AUIDs). Since European settlement in the 1860s the Shell Rock River watershed has undergone dramatic land use modification; including the plowing of its native prairies, draining of its wetlands and modifications to its natural stream courses. Today, 78 percent of its landscape is utilized for agricultural production. Many of the headwater streams and tributaries have been ditched and straightened. The watershed's wealth of lakes and streams are a valuable resource for aquatic recreation and its health is essential to resident aquatic life.

In 2009 the Minnesota Pollution Control Agency (MPCA) undertook an intensive watershed monitoring effort of the Shell Rock River Watershed's surface waters. Nineteen sites were sampled for biology at the outlets of variable sized sub-watersheds. These locations included the mouth of the Shell Rock River, the outlet of its major tributaries and the outlets of headwater tributaries. As part of this effort, MPCA joined with the Shell Rock River Watershed District (SRRWD) to complete stream water chemistry sampling at the outlets of the Shell Rock River's three major subwatersheds. In 2011, a holistic approach was taken to assess all of the watershed's surface waterbodies for aquatic life, recreation and consumption use support, where data was available; five lakes and four streams 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 resource value waters.)

Lake assessments determined that three lakes are non-supporting aquatic consumption and five lakes are non-supporting of aquatic recreation. Lake water quality in the Shell Rock Watershed is modest to poor. Nutrient eutrophication is a common concern across the watershed, although recently completed lake reclamation and stream stabilization projects are demonstrating improvements in phosphorus external and internal loading and water clarity.

Stream assessments determined that and no AUIDs are fully supporting aquatic life or aquatic recreation. Aquatic biological impairments occur along the mainstem Shell Rock River and an unnamed creek to Fountain Lake. Aquatic recreation impairments due to high bacteria levels occur along the Shell Rock River and two AUIDs in the Fountain Lake watershed.

Two AUIDs were not assessed due to their classification as limited resource waters. Sixteen AUIDs were not assessed for aquatic biology because the reach or AUID is >50 percent channelized. Channelized reaches are currently not being assessed until standards are developed. Biological quality at channelized streams ranged from good to poor for fish and generally fair to poor for macroinvertebrates.

Despite past improvements to point source discharges, individual sewage treatment systems, urban stormwater, and general land conservation for water quality, both point and non-point sources of pollution continue to impact surface water quality in the watershed. Land use modification, hydrologic alteration, sediment and excess nutrients are contributing factors to the observed poor water quality conditions.

Watershed projects planned and completed may improve the water quality in some of the impaired lakes and streams. Additional monitoring and protection strategies will still be needed to improve conditions in order to attain water quality standards across the watershed.

Introduction

Water is one of Minnesota's most abundant and precious resources. 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 Shell Rock River Watershed beginning in the summer of 2009. This report provides a summary of all water quality assessment results in the Shell Rock River watershed and incorporates all data available for the assessment process including MPCA 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).

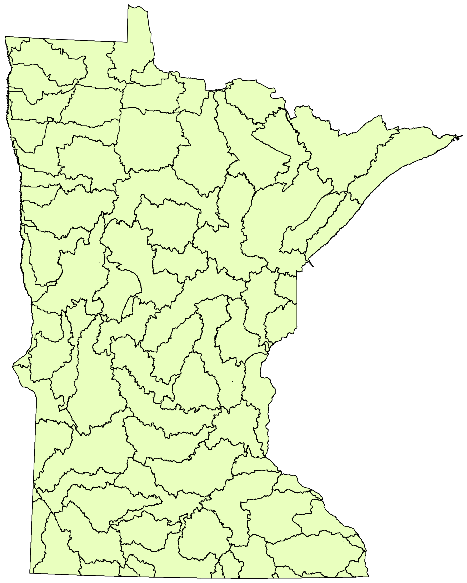

Figure 1. Major watersheds within Minnesota (8-Digit HUC)

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 WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (DNR) flow gauging 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.

Intensive water quality sampling occurs year round at all WPLMN sites. Approximately thirty-five mid-stream stream grab samples are collected per 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).

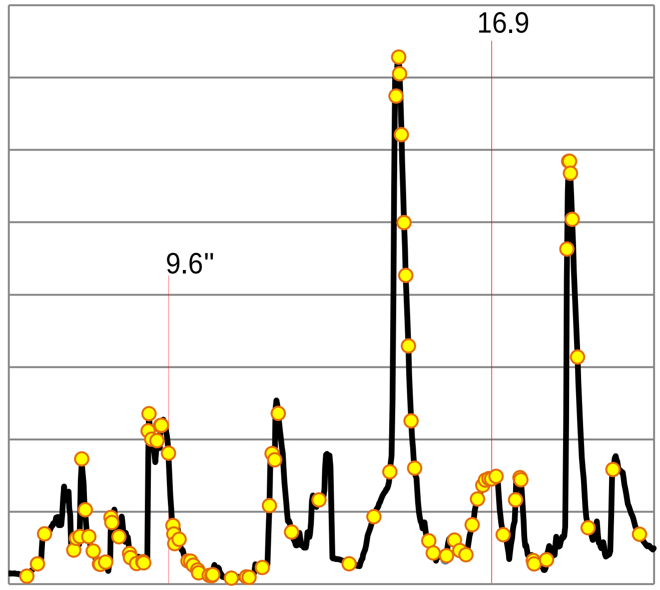

Figure 2. Hydrograph, sampling regime and annual runoff for the Shell Rock River near Gordonsville (2009-2010)

Intensive watershed monitoring

Stream monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale (Figure 3). 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 Shell Rock River Watershed).

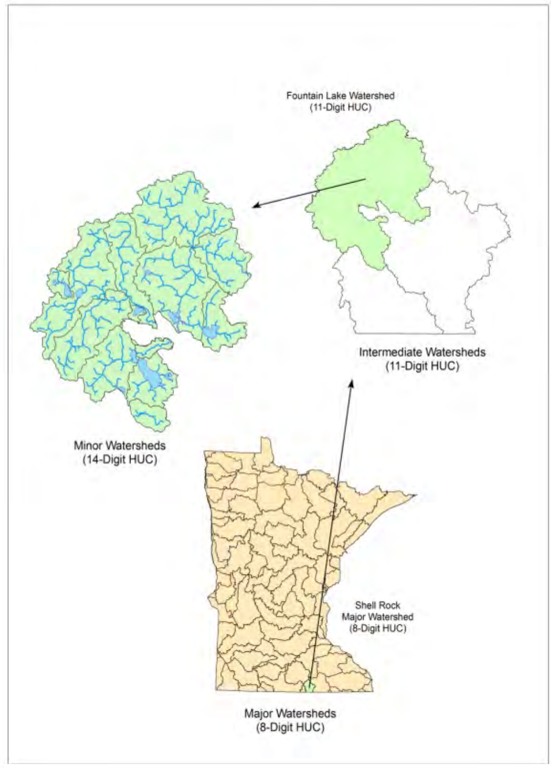

Figure 3. The intensive watershed monitoring design

The outlet of the major watershed (purple dot in Figure 4) 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 4) 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 4). Specific locations for sites sampled as part of the intensive monitoring effort in the Shell Rock River Watershed can be found in Appendices 4 and 5.

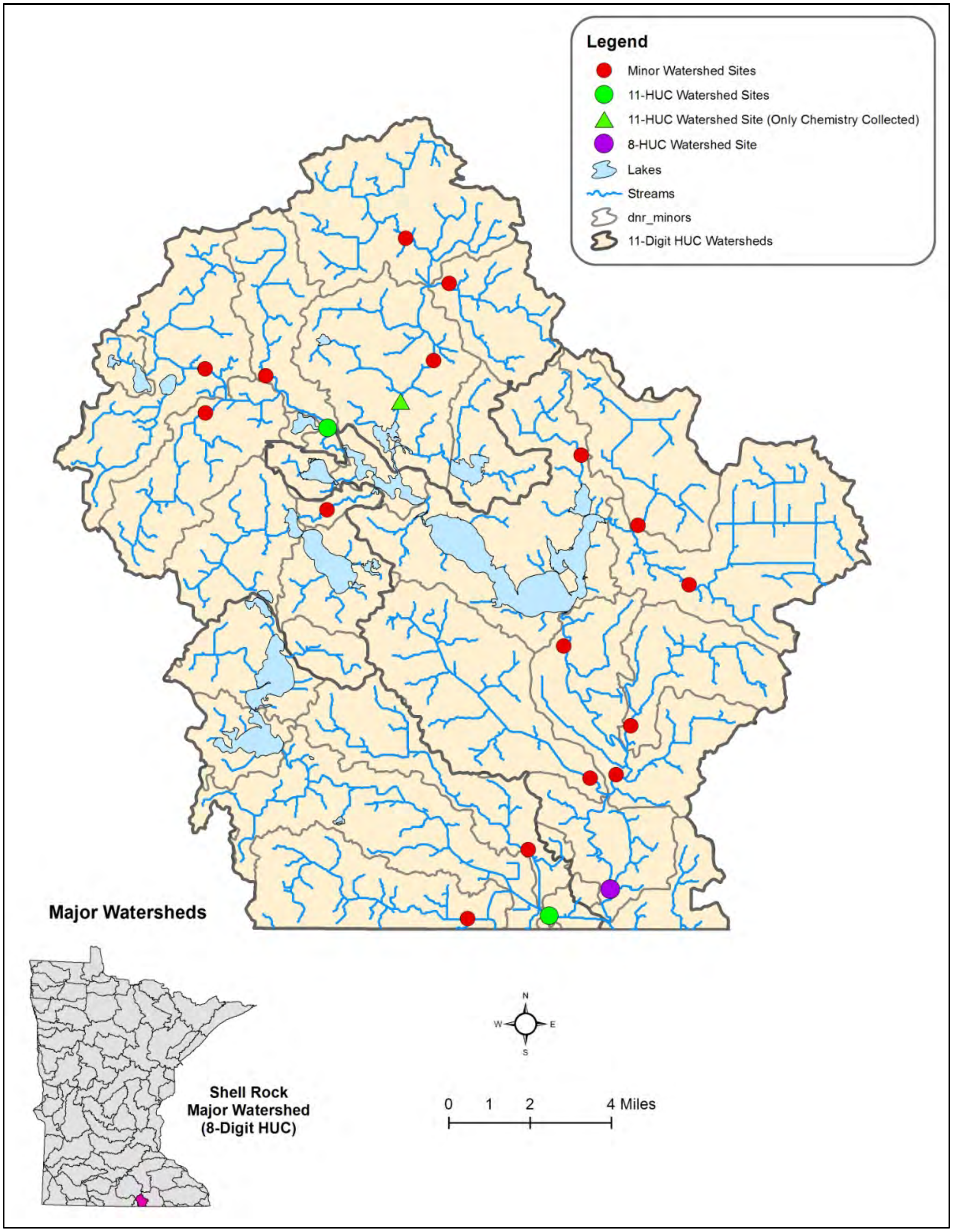

Figure 4. Intensive watershed monitoring stations for streams in the Shell Rock River Watershed

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 Shell Rock River Watershed currently have enough information for assessment.

Even when pooling MPCA and local resources, the MPCA is not able to monitor all lakes in Minnesota. The primary focus of MPCA monitoring is lakes ≥500 acres in size ("large lakes"). These resources typically have public access points, they generally provide the greatest aquatic recreational opportunity to Minnesota's citizens, and these lakes collectively represent 72 percent of the total lake area (greater than 10 acres) within Minnesota. Though the primary focus is on monitoring and assessing larger lakes, the MPCA is also committed to directly monitoring, or supporting the monitoring of, the majority of lakes between 100-499 acres ("small lakes") for assessment purposes.

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 (CSMP). 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 agency 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 .

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.

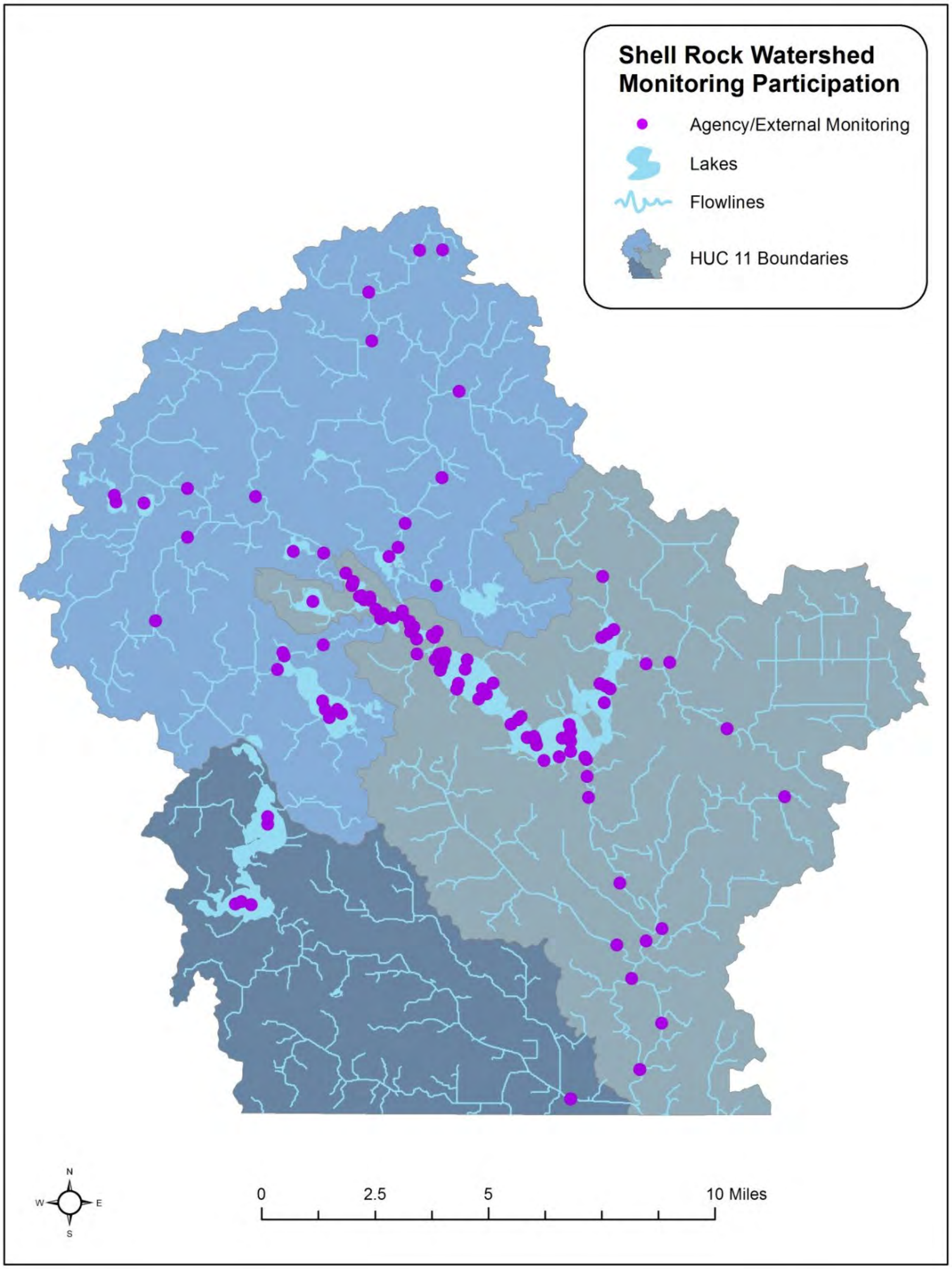

Figure 5. Citizen, local and MPCA lake and stream monitoring locations in the Shell Rock River Watershed. There are currently no citizen volunteers in the watershed.

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 use 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 Minnesota Department of Natural Resources (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 6.

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) .

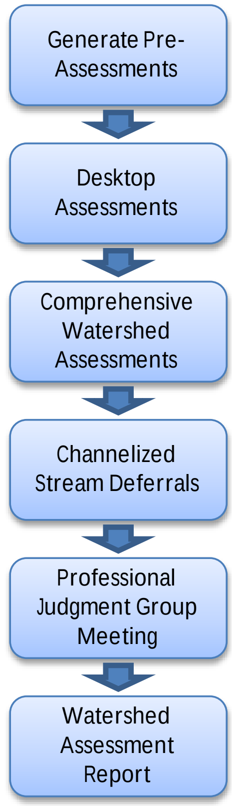

Figure 6. Flowchart of aquatic life uses assessment process

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 V).

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 EQuIS (Environmental Quality Information System), MPCA's data system. MPCA uploads the data from EQuIS to U.S. Enviornmetnal Protection Agency's (EPA) STORET data warehouse. Water quality monitoring projects required to store data in EQuIS are those with federal or state funding under CWP, 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 Shell Rock River watershed is located in Freeborn County, Minnesota and Iowa. Twenty-three percent of the entire Shell Rock River watershed lies in Minnesota, the focus of this report, and drains 254 square miles. The Shell Rock River watershed begins in the small headwaters and drainage ditches that flow first into a series of lakes north of Albert Lea which then drain into Albert Lea Lake. From there the Shell Rock River flows out of Albert Lea Lake and travels south where it is joined by the outflow of Upper and Lower Twin Lake and Goose Creek before crossing the border into Iowa. In Iowa, the Shell Rock River travels south easterly and joins the Cedar River. From there, the waters of the Shell Rock, Cedar, and Iowa Rivers flow together to the Mississippi River.

The Shell Rock River Watershed (Figure 7) lies in the south-eastern portion of Minnesota's Western Corn Belt Plains (WCBP) Ecoregion (Omernik, 1988). The soils in the WCBP are comprised of glacial tills of the Central Iowa and Minnesota Till Prairies and Eastern Iowa and Minnesota Till Prairies (NRCS 2008). Albert Lea Lake and smaller lakes near it were formed by glacial drift deposits and dammed depressions (Waters, 1977).

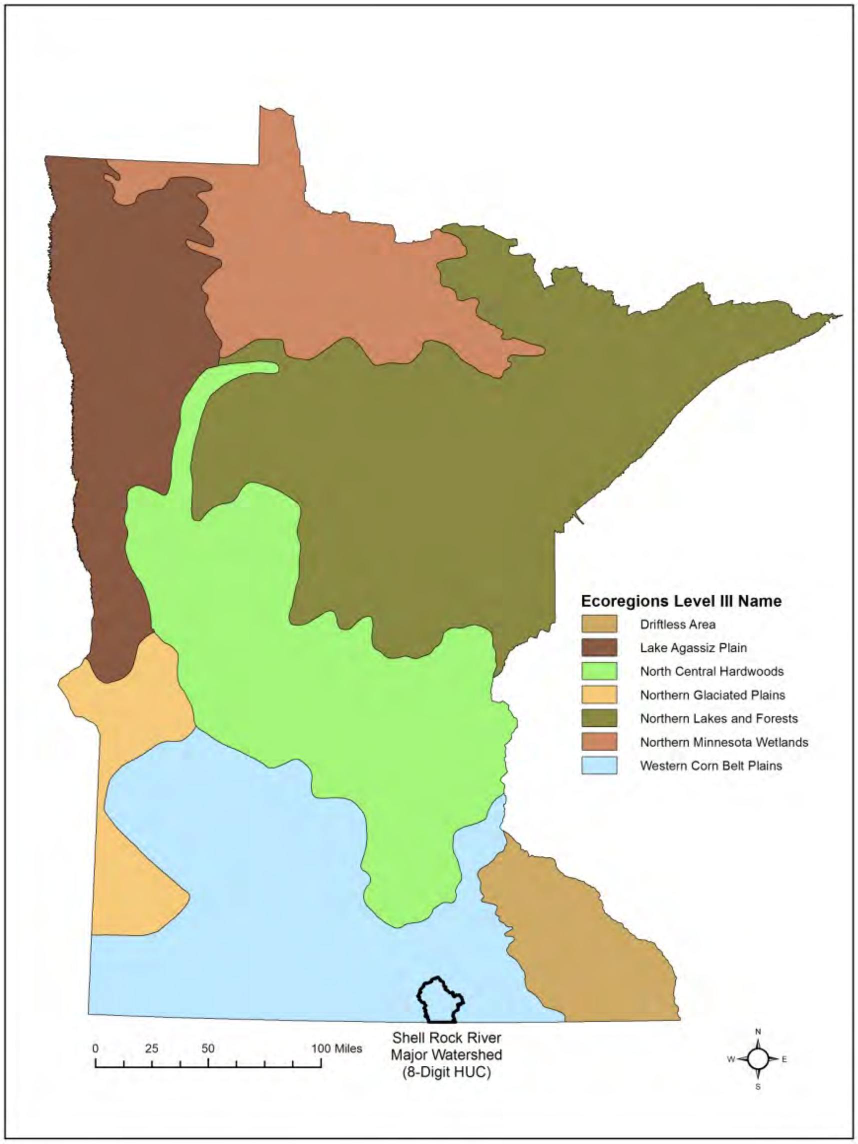

Figure 7. The Shell Rock River Watershed within the Western Corn Belt Plains ecoregion of Southern Minnesota

Land use summary

Before the early 1800s, the land cover in the WCBP was a mix of tall-grass prairie, oak savanna, wooded riverbanks, and wetlands (Dinsmore 1994). Myer-Big Island State Park on the north side of Albert Lea Lake may represent what much of the area may have looked like during that time period. During the early 1900s, much of the wetlands and smaller lakes within the WCBP were ditched and tile-drained for agricultural production (Timmerman 2001). Today, the thick prairie and drained wetland soils of the WCBP are considered some the most productive farmland in the world (EPA 2000). However, pollution to surface and groundwater related to fertilizer and nutrient applications, livestock production and manure management (EPA 2000), outdated septic systems, and flooding are major concerns throughout much of the region.

Presently, land cover in the watershed is distributed as follows: 69.7 percent cropland, 11.4 percent developed, 8.6 percent rangeland, 2.1 percent forest/shrub, 3.7 percent open water, 4.4 percent wetland and 0.1 percent barren/mining (Figure 7). Developed land includes impervious surfaces in urban areas, buildings on residential lots and farms, and roads throughout the watershed.

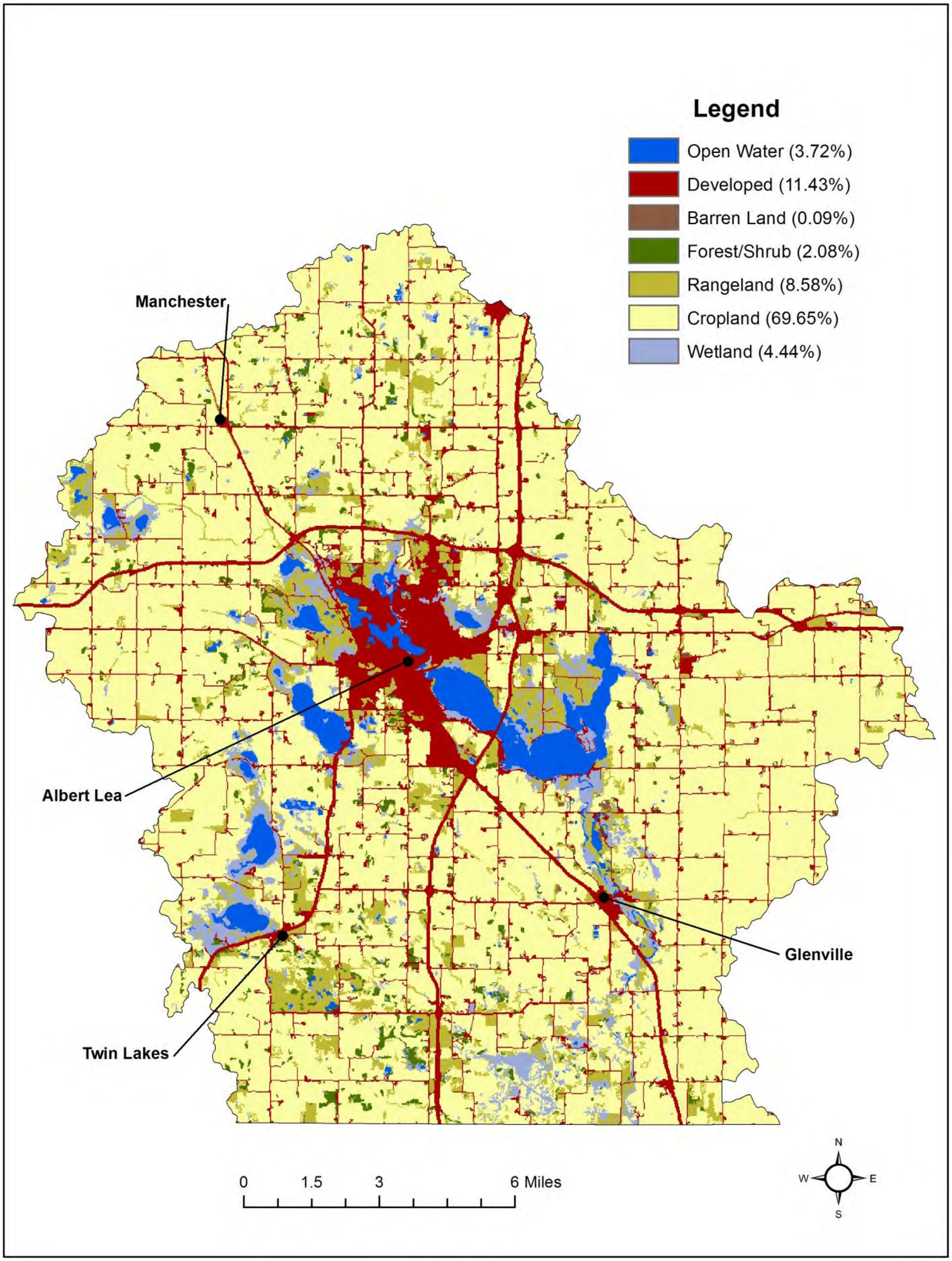

Figure 8. Land use in the Shell Rock River Watershed

Surface water hydrology

The Shell Rock River originates from the outlet of Albert Lea Lake in the center of Freeborn County and continues its course flowing down to the Iowa border. Gradually meandering in a southerly direction, the river travels by the community of Glenville before exiting the state of Minnesota.

Dams impede the natural flow of the Shell Rock River and tributaries. Today, most dams serve to maintain stable water levels on the river and lakes; two of the largest are located on Fountain and Albert Lea Lake. These are the only large two dams located in the Shell Rock River Watershed. In 1864 a fixed-crest dam was constructed on the south side of Albert Lea Lake to enlarge and deepen the lake (Albert Lea Lake Technical Committee 2000). There is a fish pond located on Lake Val Halla, and according to MDNR there is a dam on this lake and the outlet flows into Mud Lake which is north of Pickeral. There was also a small low-head dam placed on Wedge Creek to prevent carp migration.

The watershed is not lake rich, only holding 19 lakes, 16 of which are greater than 10 acres in size. There are several smaller tributaries that flow in to the Shell Rock River. The Shell Rock's 3 HUC-11 subwatersheds are comprised of 18 minor watersheds.

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 Shell Rock River watershed averages 33.15 inches each year (Midwest Regional Climate Center). The October 2008 -September 2009 water year precipitation summary shows conditions were near normal to slightly drier than normal (Figure 9).

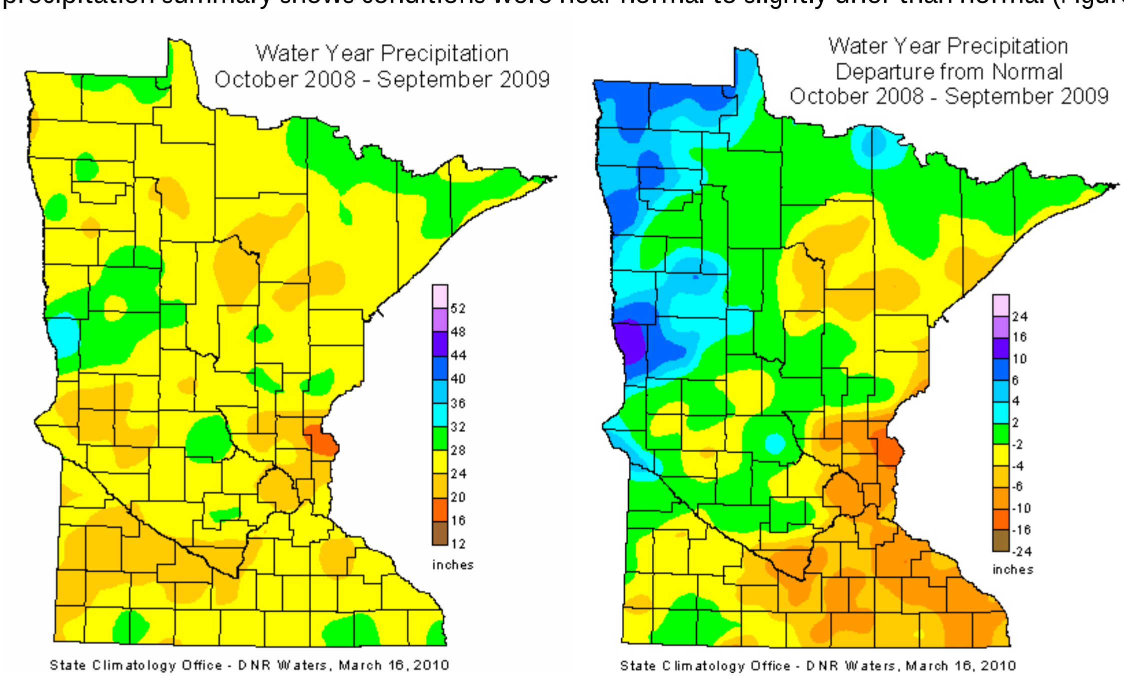

Figure 9. State-wide precipitation levels during the 2009 year

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.

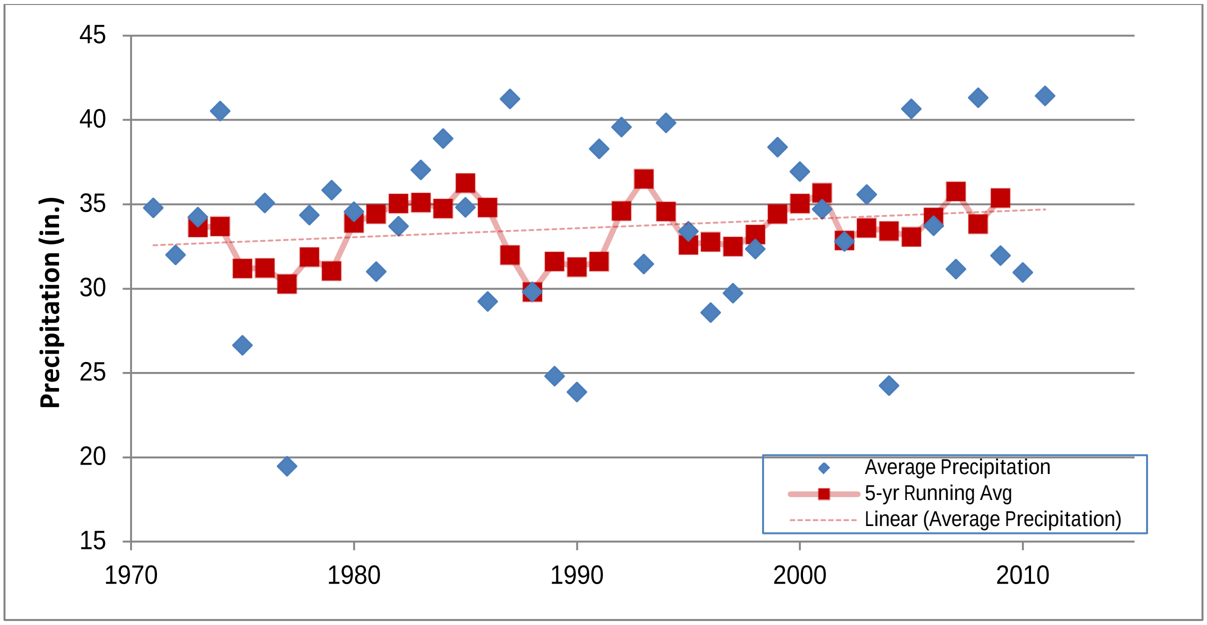

Figure 10. Precipitation trends in Southeast Minnesota (1970-2010) with five year running average

Rainfall in the Central region did not display a statistical trend 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 (see Figure 11). The Shell Rock Watershed is located in the western edge of Minnesota's Karst territory, 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.

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. No sites within the Shell Rock Watershed have been continuously monitored by the MPCA's Ambient Groundwater Program. Results from sites in the Cedar River Watershed to the east indicate the presence of high concentrations of naturally-occurring elements but the quality of groundwater is generally good.

The Monitoring and Assessment Unit of the Minnesota Department of Agriculture (MDA) monitors surface and groundwater in residential and agricultural areas that are most susceptible to elevated levels in nitrate-nitrogen and pesticide contamination (MDA 2010). Currently, there is no MDA groundwater monitoring station in the Shell Rock watershed (MDA 2009, 2010). The closest MDA well monitoring station is in Faribault County.

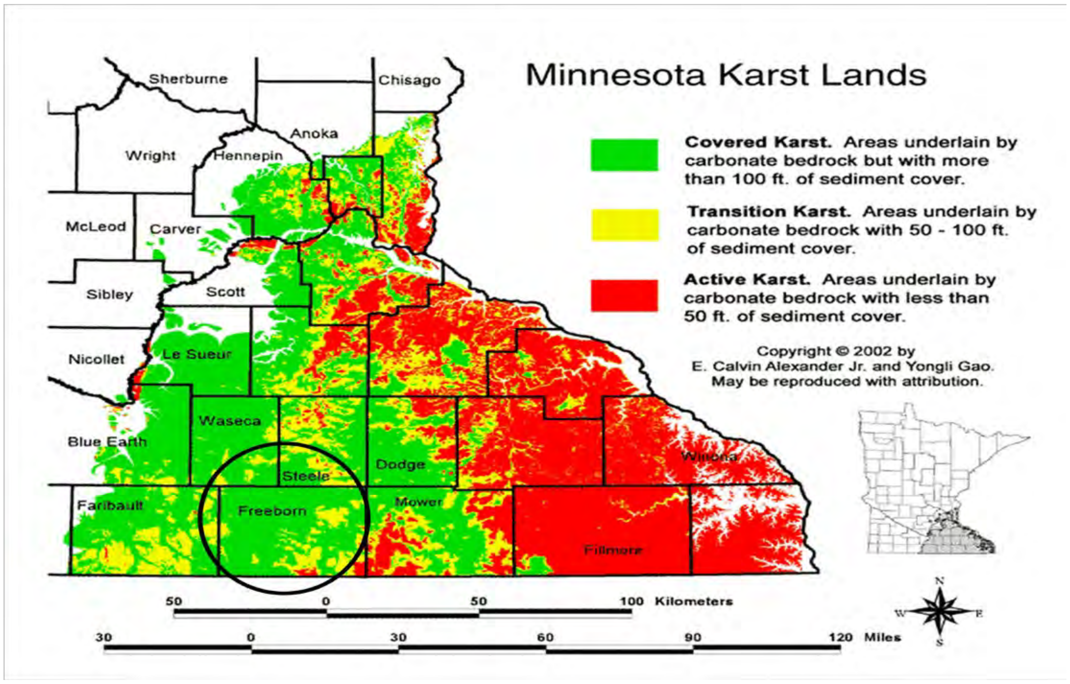

Figure 11. Minnesota Karst Lands (figure from Alexander et al. 2002)

High capacity withdrawals

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

The three largest permitted consumers of water in the state (in order) are municipalities, industry and irrigation. This is also the order of Shell Rock watershed withdrawals, which are over 85 percent municipal, 13 percent industrial, and only two percent irrigation.

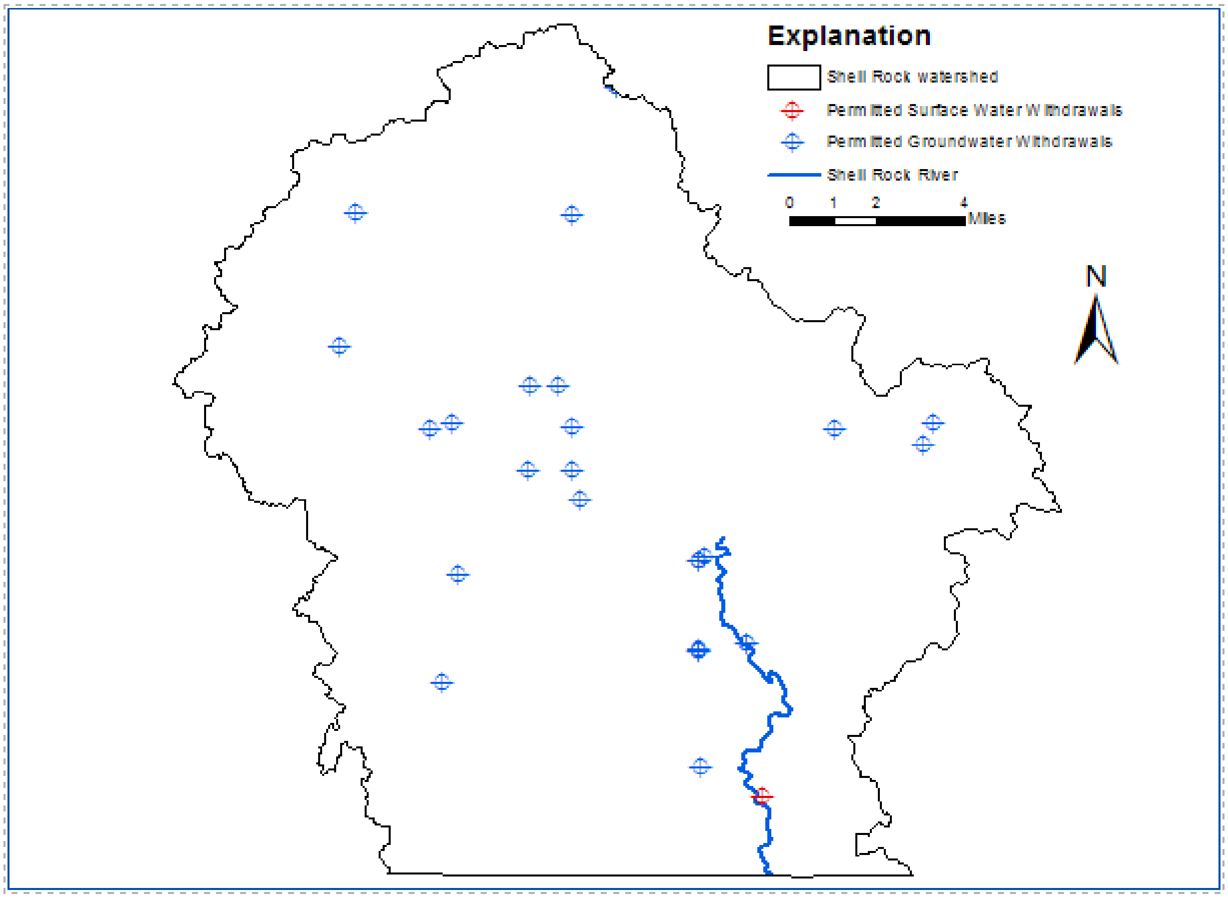

Figure 12. Locations of permitted groundwater withdrawals in the Shell Rock River Watershed

Data from the DNR SWUDS database indicate that total groundwater withdrawals for the watershed over the last 20 year show a declining trend in use that is not statistically significant (Figure 13). However, this is a departure from most other watersheds in the state that have seen a statistically significant rising trend in groundwater use. There have been no new permitted surface water withdrawals in the watershed in the last 20 years. The single surface water withdrawal permitted for the watershed, as shown in Figure 12, has been inactive since 1989.

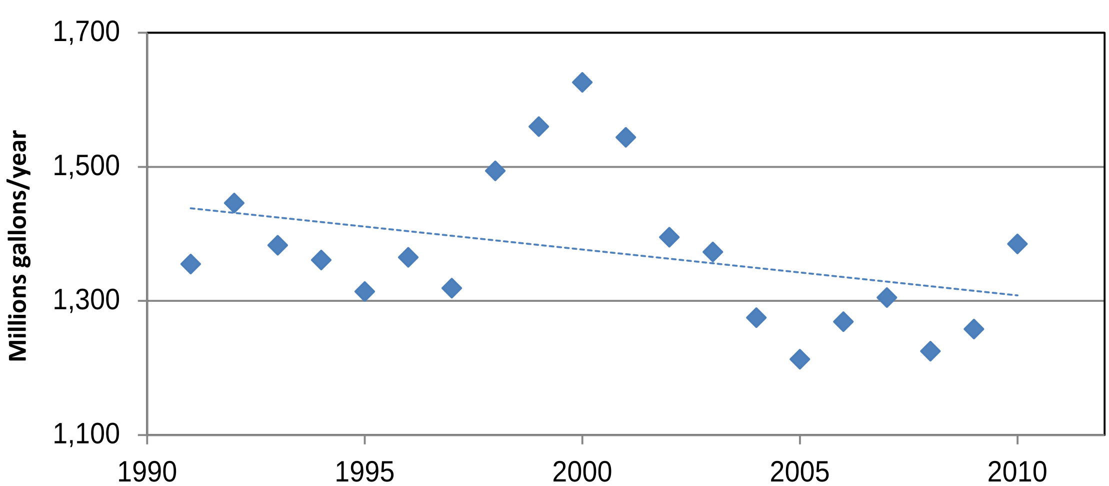

Figure 13. Total annual groundwater withdrawals in the Shell Rock River Watershed (1990-2010)

IV. Watershed-wide data collection methodology

Load monitoring

A load monitoring station is located on the Shell Rock River near Gordonsville on CR 1 just 1 mile north of the Iowa border. 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

Four stations were sampled from May thru September in 2009 and again June thru August of 2010 to provide sufficient water chemistry data for assessing aquatic life and aquatic recreation designated uses in the 11-HUC subwatersheds (purple and green dots in Figure 4). A Surface Water Assessment Grant (SWAG) was awarded to the Shell Rock Watershed District to complete the monitoring at two of the stations. Following the IWM design, sampling locations were established near the outlets of these subwatersheds. Water chemistry monitoring stations were not placed in sub watersheds that were smaller than 40 mi^2 HUC-11 drainage area in size or where less than 40 mi^2 of the 11-HUC was within Minnesota. This threshold was chosen to provide general guidance for when to establish water monitoring stations within the IWM design. Due to their small size or portion of the watershed in Minnesota, the following 11-HUC watersheds did not have a water chemistry stations placed at the outlet: Deer Creek, West Beaver Creek, and Otter Creek. However, three water quality samples were collected a t the outlet of Otter Creek during 2009 to record nutrient levels that could indicate a biological stressor. See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study.

Stream biological sampling

The biological monitoring component of intensive watershed monitoring in the Shell Rock River Watershed was completed during the summer of 2009. A total of eighteen biological monitoring sites were 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, one existing biological monitoring station was revisited in 2009. This monitoring station was established as part of a 2007 investigation into the quality of channelized streams with intact riparian zones. While data from the last ten years contributed to the watershed assessments, the majority of data utilized for the 2011 assessment was collected in 2009. A total of seventeen stream assessment units were sampled for biology in the Shell Rock River Watershed and aquatic life assessments were currently conducted for only one of these. In anticipation of transitioning to a TALU framework, biological monitoring data was not assessed on channelized stream segments due to their potential to qualify for a 'modified' aquatic life use classification and its associated water quality criteria. 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 to investigate trends in water quality condition 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 nine distinct classes, with each class having its own unique Fish IBI and Invert IBI. The classification factors used to produce the nine 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 Appendix 5.

Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) were analyzed in fish tissue samples collected from the Shell Rock 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: Albert Lea (24-0014) and Fountain (24-0018). Albert Lea Lake was sampled in 1992, 2000, and 2010; Fountain was sampled in 1990, 1996, 1999, and 2006.

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 (MDH) fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if 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 MDH. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of

PCBs, the MPCA considers the lake or river impaired. The threshold concentration for impairment is 0.22 mg/kg PCBs and more restrictive advice is recommended for consumption (one meal per month).

Lake water sampling

A Surface Water Assessment Grant (SWAG) was awarded over two years (2007 – 2008) to the Shell Rock Watershed District to complete the monitoring for seven lakes in the watershed: Albert Lea Lake (3 basins); Fountain Lake, East Bay; Fountain Lake, West Bay; Upper Twin Lake; Lower Twin Lake; Pickerel Lake; and White (Chapeau) Lake. The Shell Rock River Watershed District has also been monitoring the condition of select lakes in the watershed annually since 2003. This data also was included in the assessment since it was less than 10 years old.

Lake water chemistry and Secchi data used in this report was taken from the MPCA's STORET database. This data was collected by both MPCA staff and local partners such as the Shell Rock River Watershed District. 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 ten 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 Shell Rock 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 2012 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 channel stability 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 assessment

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 6). 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, 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 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 3 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

Water chemistry 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.

Fountain Lake Watershed Unit HUC 07080202010

The Fountain Lake Watershed Unit is second largest subwatershed draining 95 square miles within Freeborn County. The watershed is located on the northwestern side of Albert Lea and includes the city of Manchester. There are nine lakes within the watershed (Goose, Sugar, Halls, School Section, Mud, Pickeral, North Bay of Fountain, and two that are unnamed). The headwaters of the Fountain Lake Watershed Unit begin as a series of channelized streams and wetlands that drain into a number of small lakes. The outflows of these lakes travel within a string of natural and channelized tributaries that eventually pour into Fountain Lake. Agricultural land use dominates the watershed (79.8 percent), 72.6 percent is planted in crops while 7.2 percent is utilized as pasture. Developed land covers 12 percent of the watershed. Intensive water chemistry was collected on two of the larger tributaries to Fountain Lake. These two stations are collocated with water chemistry stations established by SRRWD: Swc01 is represented by MPCA STORET station S004-121 and biological stations 09CD072, and Sbc01 with MPCA STORET S004-120 and biological station 09CD075. SRRWD was awarded a SWAG grant to collect the water chemistry samples at these two stations while MPCA staff collected the bacteria samples.

Table 1. Aquatic life and recreation assessments on stream reaches in the Fountain Lake 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.
07080202-507 ***Bancroft Creek (County Ditch 63),*** *CD 63 to Fountain Lk*	6.6	2C	09CD082 09CD075	Upstream of 270th St, 2 mi. SW of Clarks Grove Downstream of Plaza St, 2.5 mi. N of Albert Lea	MTS	EXS	IF	EXP	--	MTS	--	--	EX	IF*	NS
07080202-531 ***Unnamed creek,*** *T103 R22W S36, north line to Unnamed ditch*	1.5	2B	--	---	--	--	MTS	EXP	--	MTS	--	--	EX	IF	NS
07080202-516 ***Unnamed creek,*** *Mud Lk to Fountain Lk*	3.1	2B	--	---	--	--	IF	EXS	--	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.

Table 2. Non-assessed biological stations on channelized AUIDs in the Fountain Lake 11-HUC

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07080202-529 ***County Ditch 65,*** *Unnamed ditch to CD 63*	1	2B	09CD085	Downstream of 760th Ave, 2.5 mi. SW of Clarks Grove	Fair	Poor
07080202-507 ***Bancroft Creek (County Ditch 63),*** *CD 63 to Fountain Lk*	6.6	2C	09CD082 09CD093 09CD075	Upstream of 270th St, 2 mi. SW of Clarks Grove Downstream of 240th St, 3.5 mi. N of Albert Lea Downstream of Plaza St, 2.5 mi. N of Albert Lea	Poor (3)	Poor (3)
07080202-527 ***Unnamed ditch,*** *CD 66 to CD 9*	1.6	2B	09CD084	Downstream of CR 14, 4.5 mi. NW of Albert Lea	Fair (2)	Fair
07080202-526 ***County Ditch 9,*** *Unnamed ditch to Unnamed ditch*	2	2B	09CD073	Downstream of 700th Ave, 4.5 mi. W of Albert Lea	Poor (2)	Poor
07080202-536 ***County Ditch 66,*** *Headwaters to Unnamed ditch*	4.0	2B	09CD072	Adjacent to Hwy 13, 1.5 mi. NW of Albert Lea	Fair	Good
07080202-516 ***Unnamed creek,*** *Mud Lk to Fountain Lk*	3.1	2B	09CD074	Downstream of Lake Chapeau Dr, 1 mi. W of Albert Lea	Fair	Fair
07080202-524 ***County Ditch 11,*** *Headwaters to Unnamed cr*	5.5	7	09CD090	Upstream of 715th Ave, 3.5 mi. W of Albert Lea	Poor	Fair

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and 5.3 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 annually for quality control purposes)

Table 3. Minnesota stream habitat assessment (MSHA) for the Foundation Lake 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	09CD085	County Ditch 65	1.3	9	18.3	6	22	56.6	fair
2	09CD082	Bancroft Creek (County Ditch 63)	1.1	10	22.3	12	31	76.4	good
1	09CD093	Bancroft Creek (County Ditch 10)	0	7.5	11.1	6	14	38.6	poor
1	09CD090	County Ditch 11	0	8.5	13.6	7	15	44.1	poor
2	09CD084	County Ditch 66	1.2	9.5	17.1	8.8	21.8	58.3	fair
2	09CD073	County Ditch 9	1.3	9	11.9	5.5	12.5	40.1	poor
1	09CD072	Trib. to Fountain Lake	3	7.5	14.3	12	24	60.8	fair
1	09CD074	Trib. to Fountain Lake	0	8	17.7	7	21	53.7	fair
Average Habitat Results: *Fountain Lake 11 HUC Watershed*			**1**	**8.6**	**15.8**	**8**	**20.2**	**53.5**	**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 4. Channel Condition and Stability Assessment (CCSI) for Fountain Lake 11-HUC

# Visits	Biological Station ID	Reach Name	Upper Banks (43-4)	Lower Banks (46-5)	Bottom Substrate (47-4)	Channel Evolution (11-1)	CCSI Score (147-14)	CCSI Rating
1	09CD085	County Ditch 65	29	9	3	1	42	fairly stable
1	09CD082	Bancroft Creek (County Ditch 63)	16	17	12	5	50	moderately unstable
1	09CD093	Bancroft Creek (County Ditch 10)	21	16	21	7	65	moderately unstable
1	09CD090	County Ditch 11	26	14	11	5	56	moderately unstable
1	09CD084	County Ditch 66	22	8	9	5	44	fairly stable
1	09CD073	County Ditch 9	23	13	13	3	52	moderately unstable
1	09CD072	Trib. to Fountain Lake	17	18	8	5	48	moderately unstable
1	09CD074	Trib. to Fountain Lake	8	16	14	7	45	moderately unstable
Average Channel Stability Results: *Fountain Lake HUC*			**20.3**	**13.9**	**11.4**	**4.8**	**50.3**	**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 5. Outlet water chemistry results for the Fountain Lake 11-HUC on Bancroft Creek

Station location:	**Bancroft Creek at Plaza St, in Albert lea**								
STORET ID:	**S004-120**								
Station #:	**09CD075**								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCBP 75th Percentile[3]**
Ammonia-nitrogen	mg/L	N/A	N/A	N/A	N/A	N/A			0.2
Chloride	mg/L	N/A	N/A	N/A	N/A	N/A	230		
Chlorophyll-a, Corrected	ug/L	19	1.86	34.9	9.16	6.1			
Dissolved Oxygen (DO)	mg/L	44	5.2	23.5	9.2	8.0	5	0/44	
Escherichia coli	MPN/100ml	15	46	>2400	618	320	1260	2/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	11	0.9	24.3	7.8	4.6			6.5
Kjeldahl nitrogen	mg/L	10	0.6	2.9	1.3	1.1			
Orthophosphate	ug/L	20	11	386	88	67			
pH		35	6.9	8.5	7.8	7.8	6.5 - 9	0/35	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	30	35	448	118	83			350
Specific Conductance	uS/cm	35	225	856	664	670			530
Temperature, water	deg °C	44	9.9	23.1	16.7	17.1			
Total suspended solids	mg/L	30	3.2	200	23.9	15			
Total volatile solids	mg/L	12	0.6	15	3.2	2.4			
Transparency tube	100 cm	11	50	>100	80.9	82	>20	0/11	
Transparency tube	60 cm	25	5	>60	43.2	48	>20	3/25	
Turbidity	FNU	21	0.5	335.6	36.1	7.5	25	5/21	
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 Fountain Lake 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 6. Outlet water chemistry results for the Fountain Lake 11-HUC on Unnamed creek (Wedges Creek)

Station location:	**Unnamed creek (Wedges Creek), W of Hwy 13, near Albert Lea**								
STORET ID:	**S004-121**								
Station #:	**09CD072**								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCBP 75th Percentile[3]**
Ammonia-nitrogen	mg/L	N/A	N/A	N/A	N/A	N/A			0.2
Chloride	mg/L	N/A	N/A	N/A	N/A	N/A	230		
Chlorophyll-a, Corrected	ug/L	25	0.94	20.2	6.13	4.5			
Dissolved Oxygen (DO)	mg/L	43	5.3	20.5	8.7	7.8	5	0/43	
Escherichia coli	MPN/100ml	15	88	2400	464	270	1260	1/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	0.2	21.4	6.9	3.0			6.5
Kjeldahl nitrogen	mg/L	9	0.4	2.8	1.3	1.2			
Orthophosphate	ug/L	18	12	530	118	775			
pH		34	7.2	8.5	7.9	7.9	6.5 - 9	0/34	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	29	36	733	151	96			350
Specific Conductance	uS/cm	34	225	875	628	638			530
Temperature, water	deg °C	43	9.9	23.1	17.9	18.3			
Total suspended solids	mg/L	19	2.8	210	38.6	8.8			
Total volatile solids	mg/L	21	1.2	63	8.8	3.2			
Transparency tube	100 cm	15	48	>100	88.7	100	>20	0/15	
Transparency tube	60 cm	21	5	>60	49.9	60	>20	3/21	
Turbidity	FNU	24	0.6	322.2	41.0	7.2	25	5/24	
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 Fountain Lake 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 7. Lake water aquatic recreation assessments for the Fountain Lake 11 HUC

Name	DOW#	Lake Area (ha)	Trophic Status	% Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Goose	24-0017-00	32.17	---	---	---	---	---	---	---	---	N/A
Pickeral	24-0025-00	201.51	H	100.0	1.22	0.96	---	332	194	0.3	NS
Sugar	24-0037-00	24.89	---	100.0	0.46	*0.25	---	---	---	---	IF
Halls	24-0038-00	21.69	---	100.0	0.91	*0.50	---	---	---	---	IF
School Section	24-0040-00	6.96	---	---	---	0.59	---	---	---	---	IF
Mud	24-0068-00	6.8	---	---	---	---	---	---	---	---	IF

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
N/A – Not Assessed

***These depths were created by MPCA Staff**

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

Summary

North Fountain Lake was listed in 2008 as impaired for aquatic consumption. Pickeral Lake was listed in 2008 as not supporting aquatic recreation and the current assessment agrees with the listing. However, watershed projects completed toward the end of the 10-year assessment data window may now be demonstrating significant improvements in water clarity in Pickeral Lake. These projects focused on the removal of rough fish such as carp that stir up bottom sediment and resuspend nutrients that fuel algal blooms. In 2008, a fish barrier on Mud Lake was installed and in 2009 a rough fish removal project was completed on Pickeral Lake and stream tributaries (SSRWD 2012). Additional years of monitoring data are needed to determine if Pickeral Lake is now regularly meeting aquatic recreation standards.

For streams, an unnamed creek (AUID 07080202-516) which flows from Mud Lake to Fountain Lake was listed in 2010 as having impaired aquatic life due to high levels of sediment (turbidity) and the current assessment supports the listing (Image 1). During this assessment cycle, Bancroft Creek (AUID 07080202-507) and unnamed creek (AUID 07080202-531) were determined to be impaired for aquatic recreation due to high bacteria levels.

Across the watershed, there are several channelized streams that are low to moderate gradient of fair to poor habitat quality and biological integrity. In contrast, one section of Bankroft Creek (County Ditch 63) of moderate gradient had clear, cool water and good habitat quality. This reach had an extensive riparian zone with trees and grasses that shade the stream, overhanging vegetation that provide cover for fish, and unembedded riffle and pool substrates that provide habitat for clinging aquatic insects and fish species such as Southern Redbelly Dace and Blacknose Dace (Image 2). The transformation of a section of Bancroft Creek from wetlands to an artificially drained system in the 1970s was documented with photographs by a local resident (Morreim, 1972).

Dissolved oxygen levels in Bancroft Creek (09CD082) and other channelized reaches in the subwatershed (09CD072, 09CD073, 09CD084, 09CD085, 09CD093) were high (>12 mg/l) during afternoon hours. High DO measurements in the afternoon may indicate supersaturated conditions that occur when a nutrient enriched system fuels the growth of plants that photosynthesize during the day and add dissolved oxygen to the water. However, during the nighttime, the abundant plants respire and use up oxygen, potentially contributing to low-dissolved oxygen readings (<5 mg/L) in the early morning. In order to determine if low DO conditions are occurring during the nighttime, sondes with continuous DO meters should be deployed during late summer when low DO conditions are more likely. Over enriched lakes in the area could be impacting downstream reaches. Excessive bacteria levels may also indicate a manure management issue.

High bedload sediment comprised mostly of sand was observed at channelized and incised biological station 09CD072. The sand is carried by high flows and transported in downstream eventually to Fountain Lake which is filling in with sediment. Fountain Lake has been dredged in the past, and currently, another dredging project has been proposed for Fountain Lake. A stream channel restoration project has also been recently completed on Wedge Creek in order to reconnect the floodplain, stabilize stream banks, and consequently reduce excess sediment transport to Fountain Lake.

Image 1 (left) Unnamed Creek-notice the fine sediment occurring along the banks. This AUID is impaired for turbidity
Image 2 (right): Section of Bancroft Creek (09CD082) with good riparian shade and instream habitat quality

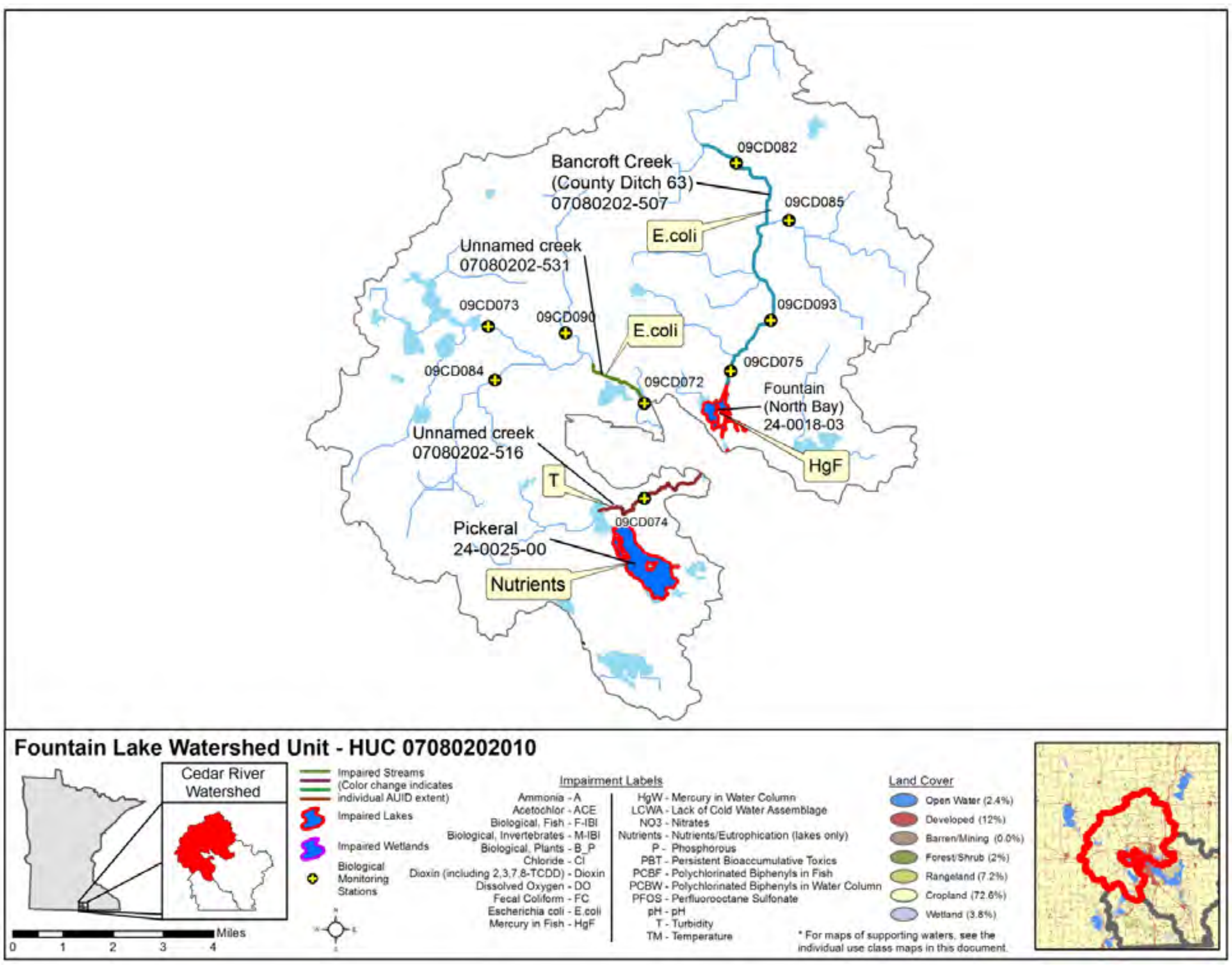

Figure 14. Currently listed impaired waters by parameter and land use characteristics in the Fountain Lake Watershed Unit

Shell Rock River Watershed Unit HUC 07080202020

The Shell Rock River Watershed Unit is located at the center of Freeborn County and includes the cities of Albert Lea and Glenville. It is the largest of the three subwatersheds, draining 103 square miles. There are three lakes within the watershed: Fountain (East and West Bays), White, and Albert Lea. Fountain East Bay drains into Albert Lea Lake through the Shell Rock River. Peter Lund Creek and the outflow of Fountain Lake feed into Albert Lea Lake. Albert Lea Lake is the largest lake in the watershed at over 2,600 acres of surface area and 20 miles of shoreline (MnDNR 2011). The outflow of the Albert Lea Lake Dam feeds into the Shell Rock River. As it meanders south, the Shell Rock River receives the waters of a number of channelized streams along its course to the Iowa border. The Shell Rock River Watershed is dominated by row-crop agriculture (68.4 percent), development (12.9 percent), and pasture (7.9 percent). Only five percent of the watershed is undeveloped land (1.3 percent forest, 3.8 percent wetland), while 5.5 percent is classified as open water. Much of the undeveloped land is associated with the 2,028 acre Myre-Big Island State Park on the north side of Albert Lea Lake. The intensive water chemistry collection station on the Shell Rock River is located 1 mile north of the Iowa border on CR 1. This sampling station is represented by MPCA STORET station S000-084 and biological station 09CD089. SRRWD provided continuous monitoring data from two locations on the Shell Rock River for continuous dissolved oxygen measurements collected with deployable sondes in 2010.

Table 8. Aquatic life and recreation assessments on stream reaches in the Shell Rock River Watershed Unit. Reaches are organized upstream to downstream in the table.

					Aquatic Life Indicators:										
AUID ***Reach Name,*** *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
07080202-508 ***County Ditch 16,*** *Unnamed ditch to Shell Rock R*	5.9	2B	09CD078	Downstream of CSAH 5, 1 mi. S of Glenville	NA	NA	EXP	MTS	--	MTS	--	--	--	IF*	NA
07080202-501 ***Shell Rock River,*** *Albert Lea Lk to Goose Cr*	12.1	2B	04CD037 09CD087 04CD017 09CD088 04CD015 09CD089	~1 mi. downstream of Albert Lea Lake Upstream of 170th St, 1.5 mi. S of Albert Lea At Hwy 13 bridge in Glenville Downstream of Hwy 65, 2 mi. SE of Glenville Downstream of Hwy 7, 2 mi. S of Glenville Upstream of CSAH 1 (110th St), 1 mi. W of Gordonsville	EXS	EXS	EXP	EXP	MTS	EXP	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 9. Non-assessed biological stations on channelized AUIDs in the Shell Rock River 11-HUC

AUID ***Reach Name,*** *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
07080202-513 ***County Ditch 16,*** *Unnamed ditch to Albert Lea Lk*	2.5	2B	09CD086	Downstream of I-90, 3.5 mi. E of Albert Lea	Good	Fair
07080202-534 ***Peter Lund Creek,*** *CD 12/47 to CD 32*	2.8	2B	09CD079	Upstream of 185th St, 1.5 mi. S of Hayward	Good	Fair
07080202-535 ***County Ditch 32,*** *Unnamed ditch to Peter Lund Cr*	4	2B	09CD076	Downstream of CR 112, 0.5 mi. W of Hayward	Fair	Poor (2)
07080202-533 ***Judicial Ditch 20,*** *Headwaters to Shell Rock R*	6.1	2B	09CD077	Upstream of CSAH 13, 1 mi. E of Glenville	Good	Fair
07080202-511 ***Unnamed ditch (County Ditch 16),*** *Headwaters to Unnamed ditch*	1.3	2B	04CD004	Downstream of Hwy 18, 2 mi. S of Albert Lea	Poor	Poor (2)
07080202-508 ***County Ditch 16,*** *Unnamed ditch to Shell Rock R*	5.9	2B	09CD078	Downstream of CSAH 5, 1 mi. S of Glenville	Poor	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and 5.3 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 10. Minnesota Stream Habitat Assessment (MSHA) for the Shell Rock 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	09CD086	County Ditch 16	0	9.5	18.4	13	25	65.9	Fair
1	09CD079	Peter Lund Creek	0	9	9	10	12	40	Poor
1	09CD076	County Ditch 32	0	9.5	9	11	13	42.5	Poor
1	09CD077	Judicial Ditch 20	0.5	11	11.7	11	26	60.2	Fair
1	04CD004	County Ditch 16	0	10.5	10	7	10	37.5	Poor
1	09CD078	County Ditch 16	0	8	15	1	7	31	Poor
1	04CD037	Shell Rock River	2.5	9.5	12	8	13	45	Fair
1	09CD087	Shell Rock River	2.5	9.5	10.4	12	14	48.4	Fair
1	04CD017	Shell Rock River	3.5	7	20	8	12	50.5	Fair
1	09CD088	Shell Rock River	2.5	11.5	13.4	12	17	56.4	Fair
1	04CD015	Shell Rock River	0	8	17	6	13	44	Poor
1	09CD089	Shell Rock River	0	8.5	8	13	13	42.5	Poor
Average Habitat Results: *Shell Rock River 11 HUC Watershed*			**1**	**9.3**	**12.8**	**9.3**	**14.6**	**47**	**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 11. Channel Condition and Stability Assessment (CCSI) for Shell Rock River 11-HUC

# Visits	Biological Station ID	Reach Name	Upper Banks (43-4)	Lower Banks (46-5)	Bottom Substrate (47-4)	Channel Evolution (11-1)	CCSI Score (137-14)	CCSI Rating
1	09CD086	County Ditch 16	16	15	3	1	35	fairly stable
1	09CD079	Peter Lund Creek	21	11	9	5	46	moderately unstable
1	09CD076	County Ditch 32	12	13	9	5	39	fairly stable
1	09CD077	Judicial Ditch 20	8	13	9	3	33	fairly stable
0	04CD004	County Ditch 16	NA	NA	NA	NA	NA	NA
1	09CD078	County Ditch 16	29	9	17	3	58	moderately unstable
1	04CD037	Shell Rock River	NA	NA	NA	NA	NA	NA
1	09CD087	Shell Rock River	4	5	10	1	20	stable
0	04CD017	Shell Rock River	NA	NA	NA	NA	NA	NA
1	09CD088	Shell Rock River	4	9	5	1	19	stable
0	04CD015	Shell Rock River	NA	NA	NA	NA	NA	NA
1	09CD089	Shell Rock River	19	15	19	5	58	moderately unstable
Average Channel Stability Results: *Shell Rock River HUC*			**14**	**9.5**	**12.8**	**2.5**	**38.8**	**fairly stable**

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

Table 12. Outlet water chemistry results for the Shell Rock River 11-HUC

Station location:	**Shell Rock River on CSAH-1, 1 mi. W of Gordonsville**								
STORET ID:	**S000-084**								
Station #:	**09CD089**								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard[1]**	**# of WQ Exceedances[2]**	**WCBP 75th Percentile[3]**
Ammonia-nitrogen	mg/L	14	<0.05	0.42	0.07	0.03			0.2
Chloride	mg/L	15	27.5	134	57.4	45.6	230	0/15	
Chlorophyll-a, Corrected	ug/L	11	1.36	20.6	10.2	9.7			
Dissolved Oxygen (DO)	mg/L	38	0.3	12.8	7.2	7.5	5	10/38	
Escherichia coli	MPN/100ml	15	17	650	133	65	1260	0/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	15	0.82	6.6	2.15	1.7			6.5
Kjeldahl nitrogen	mg/L	10	0.85	2.37	1.32	1.05			
Orthophosphate	ug/L	15	175	1520	487	381			
pH		38	7.09	9.15	8.01	8.03	6.5 - 9	2/38	
Pheophytin-a	ug/L	4	<1.17	5.37	2.70	2.43			
Phosphorus	ug/L	31	274	1720	550	400			350
Specific Conductance	uS/cm	37	355	1089	554	502			530
Temperature, water	deg °C	38	13.1	27.0	21.6	22.5			
Total suspended solids	mg/L	30	1.2	61	10.6	4.6			
Total volatile solids	mg/L	26	1.2	180	35.3	5.5			
Transparency tube	100 cm	16	26	>100	89.4	100	>20	0/16	
Transparency tube	60 cm	22	17	>60	48.5	60	>20	1/22	
Turbidity	FNU	36	0.2	173	16.6	5.6	25	6/36	
Sulfate	mg/L	15	22.4	46.1	34.9	33.8			
Hardness	mg/L	10	215	319	274.9	288.5			

[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 Shell Rock 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 13. Lake water aquatic recreation assessments for the Shell Rock 11-HUC

Name	DOW#	Lake Area (ha)	Trophic Status	% Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Albert Lea	24-0014-00	1074.69	H	100.0	1.83	0.53	---	254	125	0.4	NS
Fountain (East Bay)	24-0018-01	94.68	H	100.0	4.27	1.72	---	227	111	0.4	NS
Fountain (West Bay)	24-0018-02	57.54	H	100.0	2.44	1.57	---	205	89	0.6	NS
White	24-0024-00	63.82	H	0.35	1.07	0.35	---	287	173	0.5	NS

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
N/A – Not Assessed

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

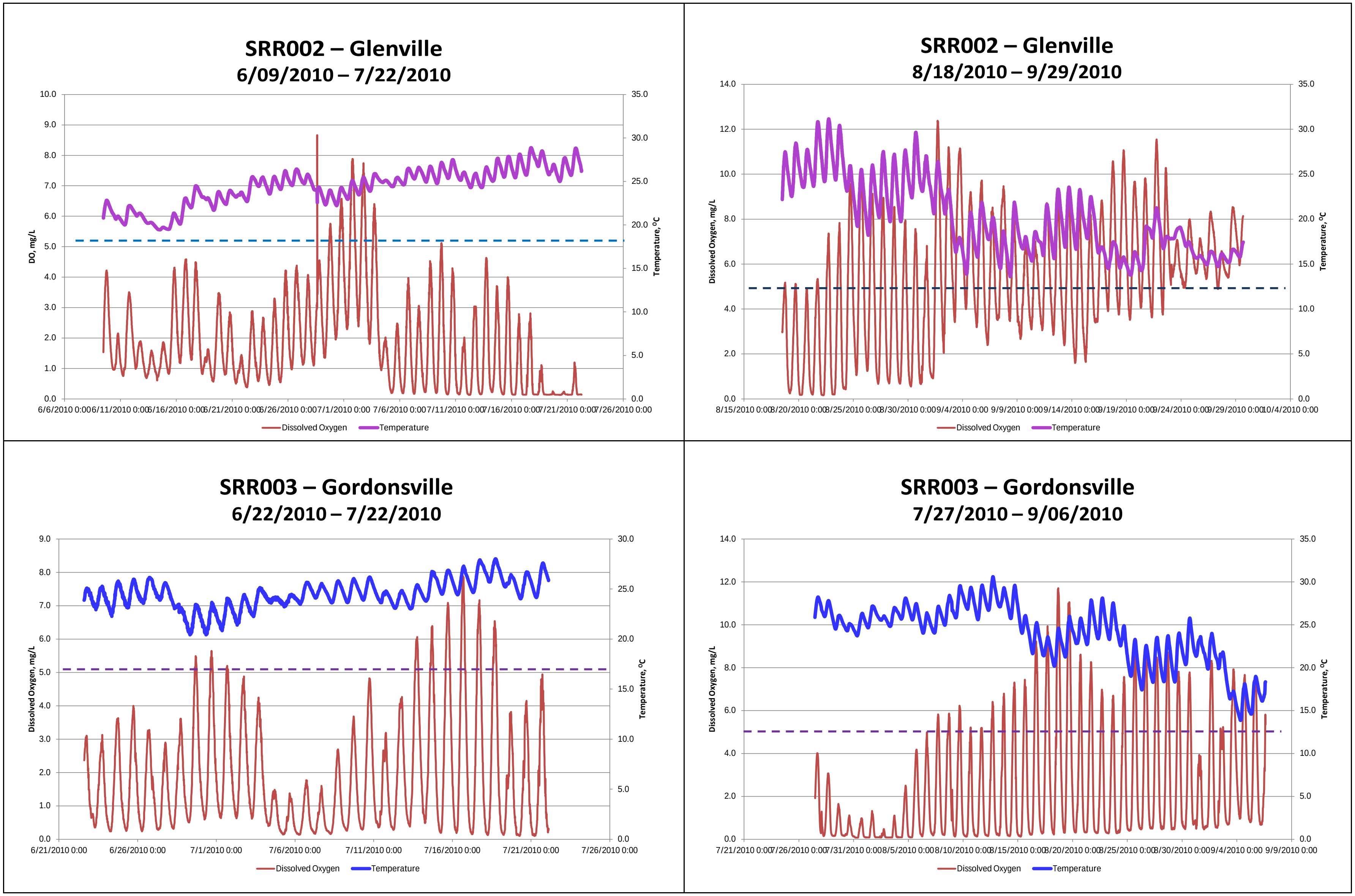

Figure 15. Continuous deployable Sonde data provided by SWWRD demonstrating low-dissolved oxygen reading (red line) seasonally and daily below the 5.0 Mg/L standard (dotted line) at two SWWR monitoring stations on the Shell Rock River. Purple and blue lines are water temperature.

Summary

Fountain Lake's North, East and West Bays are impaired for aquatic consumption due to high levels of mercury in fish tissue. The North Bay was added to the impaired waters list in 2008 while East and West Bays were added to the impaired waters list in 2012.

Albert Lea Lake was added to the list of impaired waters in 2008 for impaired aquatic recreation due to excess nutrients and the current assessment data support the 2008 listing. Other lakes upstream of Albert Lea Lake were also listed due to excess nutrients in 2008 (North, East, and West Bays of Fountain Lake; Pickeral Lake). White Lake was assessed as impaired for aquatic recreation during this assessment cycle. The total phosphorus and chlorophyll-a samples reviewed were well over the Western Corn Belt Plains shallow lake standards. External loading of phosphorus can also occur when dissolved phosphorus enters the drainage network and moves to downstream lakes. In addition to these external watershed inputs of phosphorus, shallow lakes can also experience internal loading. The phosphorus is released from the sediment when lake bottom conditions become anoxic (devoid of oxygen). Rough fish can also stir up the bottom sediments and release phosphorus that fuel algal blooms.

Numerous watershed projects have recently been completed or are planned. In 2009, a rough fish removal project was completed for Pickeral Lake and a fish barrier was placed on White Lake. The dam on Albert Lea Lake is scheduled to be replaced with a new dam that will lower the water table of the lake and allow shoreland plants to re-establish and anchor sediment. In addition, excess sediment that has accumulated on the bottom of Albert Lea Lake and Fountain Lake are proposed to be dredged and removed. Other watershed projects can be found on SRRWD's website: http://www.shellrock.org/index.php?option=com_content&view=category&layout=blog&id=35and Itemid=70.

Watershed projects recently completed may be starting to demonstrate improvements in water quality that were not captured during this 10 year assessment cycle. For example, lake restoration projects were completed for Pickeral Lake and White Lake which may be improving water clarity in downstream Fountain Lake; however, while water clarity has improved, phosphorus and chlorophyll a levels in Fountain Lake remain high (SRRWD 2012).

For streams, only one AUID was assessed for aquatic life and aquatic recreation. The 12 mile AUID of the Shell Rock River, which runs from Albert Lea Lake to Goose Creek, is impaired for aquatic recreation due to high bacteria counts. This AUID is also not supporting aquatic life standards for fish and invertebrates, dissolved oxygen, pH, and turbidity. Turbidity can be caused by excess suspended solids that cloud water clarity and/or excess algal growth that can cause water to be green (Lenhart 2010). Partitioning the fraction of total suspended sediment (TSS) from total suspended volatile solids (TSVS) would aid in determining the nature of high turbidity on the Shell Rock River. The degree to which TSS or TSVS dominates the fraction of particles can also vary with flow and seasonal conditions. Continuous dissolved oxygen readings from 2010 provided by SRRWD demonstrated that dissolved oxygen remained below the 5 mg/L water quality standard consistently in June, and late summer readings indicated more fluctuation in dissolved oxygen, where daily readings were above the standards during the day and below the standard during the nighttime (Figure 15). SRRWD staff observed excess growth of curly leaf pondweed in the early spring but then the plants died off in June. Microbial decomposition of plant material could have caused an increase in biological oxygen demand (BOD) indicated by the consistently low dissolved oxygen readings during June. After that time, phosphorus is released by decaying plants and anoxic sediment which could have fueled the excess aquatic plant growth that was observed in mid-to late summer. These dense beds of aquatic vegetation photosynthesize and increase dissolved oxygen during the daytime, while during the night the plants and aquatic organisms respire and use up the available dissolved oxygen, causing daily sags in dissolved oxygen below the standard. Additionally, the Shell Rock River receives much of its surface water from Albert Lea Lake which is high in phosphorus (SRRWD 2012). Additional monitoring of dissolved oxygen, biological oxygen demand, and phosphorus is recommended to characterize annual and seasonal variability, the extent of the impairment, and identify the cause and source of the impairment.

Six AUIDs had biological stations that were channelized. These streams will not be assessed for aquatic life until tired aquatic life standards are implemented; however, conditions at sites may indicate potential water quality issues that should be considered when downstream waterbodies are impaired. At two channelized reaches, fish and invertebrate communities were both rated poor and habitat quality was also rated poor. Only four fish were collected at a station on County Ditch 16 (09CD078) and all fish collected are considered tolerant to pollution. Dissolved oxygen was 1.24 mg/L at 8:00 a.m. which is well below the standard. During sampling, excessive growth of instream vegetation was observed which may indicate a nutrient issue that may be fueling the growth of aquatic plants that respire and use up oxygen during the nighttime. Peter Lund Creek (09CD079) recorded high dissolved oxygen (15.6 mg/L at 3:30 PM). Continuous dissolved oxygen monitoring using a deployable sonde should be considered at this location to determine if excess plant growth and consequent low-dissolved oxygen levels during the nighttime are a regular and pervasive stress to the biological community.

Prior to the 1980s, the Shell Rock River below Albert Lea was once considered a dead river where no fish could live due to the high phosphorus load coming from Albert Lea Lake. Minimally treated sewage from an older waste water treatment plant (WWTP) and waste from a meat packing plant raised phosphorus levels in Albert Lea Lake (SRRWD 2010) and the Shell Rock River which fueled excess plant growth and algae and caused low-dissolved oxygen levels that rendered the waters largely uninhabitable for fish and other aquatic life. A new waste water treatment plant was built in the 1980s that removed high levels of excess phosphorus from sewage and meat packing waste, while rerouting the treated water around Albert Lea Lake to the Shell Rock River. Phosphorus levels in Albert Lea Lake and the Shell Rock River have gradually improved since the building of the new WWTP (SRRWD 2010). Numerous fish species once again inhabit the Shell Rock River, including game fish such as Walleye, Northern Pike, Largemouth Bass and Black Crappie as well as many smaller native fish species of chubs, minnows, and darters. The Banded Darter in particular was not collected for many years but was collected in 2009. Its return to the Shell Rock River in Minnesota is potentially due to improved water quality conditions since the 1980s (Konrad Schmidt, MnDNR, personal communication).

While historical efforts to reduce phosphorus have made measurable improvements, more improvements are needed in order to bring Albert Lea Lake and the Shell Rock River up to water quality standards. Phosphorus levels remain high in Albert Lea Lake and are thought to be partially responsible for the currently observed low-dissolved oxygen levels in the Shell Rock River. Nitrate-N concentrations have also increased in the Shell Rock River in recent years (Table 20, Table 24).

Projects aimed at reducing nutrient inputs to waterbodies (e.g., application of phosphorus free lawn fertilizers, rain gardens, rain barrels, managing animal manure and pet waste, protecting water bodies from runoff using buffer strips and grass swales, tile-drainage controls, and general agricultural and urban stormwater BMPs) as well as minimize internal loading of phosphorus (e.g., removal of rough fish, stocking with desirable game fish that control rough fish populations, reestablishing near shore plants) have been completed or are planned. These projects have the potential to significantly improve water clarity and recreational quality. Improving the quality of lakes is of monumental importance for recreation and tourism in the area.

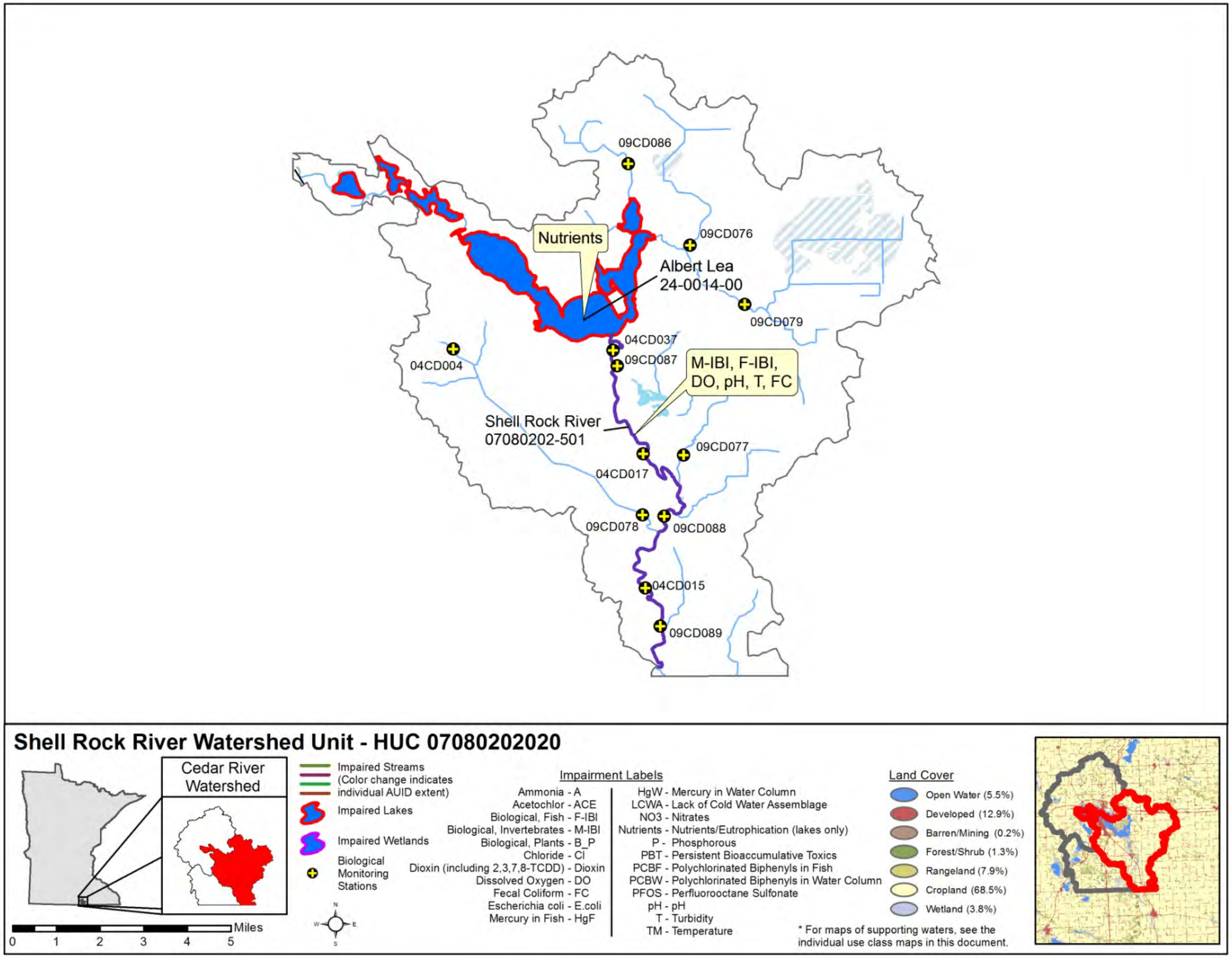

Figure 16. Currently listed impaired waters by parameter and land use characteristics in the Shell Rock River Watershed Unit

Goose Creek Watershed Unit HUC 07080202030

The Goose Creek Watershed Unit is the smallest subwatershed which drains only 48 square miles of southern Freeborn County. Goose Creek runs 11 miles before flowing into the Shell Rock River one mile north of the Minnesota-Iowa border. There are five lakes within the watershed (Lower Twin, Upper Twin, Church, and two small unnamed lakes). Another historical lake in the lower portion of the watershed has been ditched and drained (Grass 24-0016-00, see Figure 16). The Goose Creek Watershed is dominated by row-crop agriculture (65.7 percent) and pasture (12.9 percent). Developed land is at 7.4 percent. Wetland, forest, and open water make up the remaining 14 percent. A stream water chemistry station was placed near the outlet of the watershed before it flows into the Shell Rock River. This location is represented by MPCA STORET station S005-615 and biological station 09CD071.

Table 14. Aquatic life and class 7 assessments on stream reaches in the Goose 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	Class 7
07080202-510 *Goose Creek (County Ditch 10), Headwaters to Shell Rock River*	11	7	09CD071	Downstream of CR 79, 5 mi. S of Glenville	NA	NA	--	--	MTS	--	MTS	--	MTS	NA	IF

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 15. Non-assessed biological station on channelized AUIDs in the Goose Creek 11-HUC

AUID ***Reach Name,*** *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
07080202-510 ***County Ditch 17,*** *Unnamed ditch to Goose Cr*	1.6	2B	07CD002 04CD028	Downstream of Twp Rd 9, 9 mi. S of Albert Lea Downstream of I-35, 3 mi. SW of Gordonsville	Good (3)	Poor (3)
s07080202-532 ***County Ditch 40,*** *Unnamed ditch to Goose Cr*	6.1	2B	09CD081	Downstream of Twp Rd 17 (770th Ave), 3 mi. SW of Glenville	Good	Fair (2)
07080202-510 *Goose Creek (County Ditch 10), Headwaters to Shell Rock River*	11	7	09CD071	Downstream of CR 79, 5 mi. S of Glenville	Good	Poor

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and 5.3 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 16. Minnesota Stream Habitat Assessment (MSHA) for Goose 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	04CD028	County Ditch 17	0	8.5	9	6	4	27.5	Poor
3	07CD002	County Ditch 17	0	6.8	13	4	7	30.8	Poor
1	09CD081	County Ditch 40	1.5	9	13.5	3	12	39	Poor
1	09CD071	Goose Creek	0	6.5	3	13	4	26.5	Poor
Average Habitat Results: *Goose Creek 11 HUC Watershed*			**0.4**	**7.7**	**9.6**	**6.5**	**6.8**	**31**	**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 17. Channel Condition and Stability Assessment (CCI) for Goose Creek 11-HUC

# Visits	Biological Station ID	Reach Name	Upper Banks (43-4)	Lower Banks (46-5)	Bottom Substrate (47-4)	Channel Evolution (11-1)	CCSI Score (147-14)	CCSI Rating
0	04CD028	County Ditch 17	NA	NA	NA	NA	NA	NA
1	07CD002	County Ditch 17	25	8	20	5	58	moderately unstable
1	09CD081	County Ditch 40	24	4	9	1	38	fairly stable
1	09CD071	Goose Creek	29	7	20	3	59	moderately unstable
Average Channel Stability Results: *Goose Creek 11 HUC*			**26**	**6.3**	**16.3**	**3**	**51.7**	**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 18. Outlet water chemistry results for the Goose Creek 11-HUC. This station is a Class 7 reach; hence, a more limited set of water quality standards apply.

Station location:	Goose Creek (County Ditch 10) at 790th Ave, 5 mi. SW of Glenville								
STORET ID:	S000-084								
Station #:	09CD089								
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**Median**	**WQ Standard**	**# of WQ Exceedances[1]**	**WCBP 75th Percentile[2]**
Ammonia-nitrogen	mg/L	9	<0.05	0.19	0.06	0.03			0.2
Chloride	mg/L	10	9.03	19.5	15.8	16.2			
Chlorophyll-a, Corrected	ug/L	N/A	N/A	N/A	N/A	N/A			
Dissolved Oxygen (DO)	mg/L	18	0.18	13.58	5.74	6.38	1	2/18	
Escherichia coli	MPN/100ml	15	18	2200	255	107	1260	1/15	
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	<0.05	8.3	3.0	2.9			6.5
Kjeldahl nitrogen	mg/L	10	0.67	1.61	1.23	1.22			
Orthophosphate	ug/L	N/A	N/A	N/A	N/A	N/A			
pH		18	7.09	8.43	7.62	7.52	6 - 9	0/18	
Pheophytin-a	ug/L	N/A	N/A	N/A	N/A	N/A			
Phosphorus	ug/L	10	86	378	200	141			350
Specific Conductance	uS/cm	18	417	630	548	558			530
Temperature, water	deg °C	18	11.9	24.0	19.7	21.3			
Total suspended solids	mg/L	10	1.4	68	18.4	4			
Total volatile solids	mg/L	8	1.2	11	4.7	4			
Transparency tube	100 cm	13	43	>100	89.9	100			
Transparency tube	60 cm	8	6	>60	40.1	42.5			
Turbidity	FNU	12	4	141	27	8.3			
Sulfate	mg/L	10	11.4	38.3	28.3	29.9			
Hardness	mg/L	10	210	322	306.2	317			

[1]Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.
[2]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 Goose 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 19. Lake water aquatic recreation assessments for the Goose Creek 11-HUC

Name	DOW#	Lake Area (ha)	Trophic Status	% Littoral	Max. Depth (M)	Avg. Depth (M)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (M)	Support Status
Lower Twin	24-0027-00	111.55	H	100.0	0.76	0.29	---	164	54	0.3	IF
Upper Twin	24-0031-00	33.87	H	100.0	0.76	*0.29	---	253	176	0.4	IF

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
N/A – Not Assessed

*These depths were created by MPCA Staff.

Summary

Only Upper and Lower Twin Lakes have sufficient data for assessment, but due to their shallow depth and wetland-like characteristics, they were not assessed against the lake recreation standards. Both lakes are designated wildlife lakes, managed by the Department of Natural Resources and may undergo draw-downs to facilitate waterfowl habitat.

All AUIDs within this watershed are channelized; consequently, no AUIDs with biological data were currently assessed for aquatic life. Fish communities were rated good while invertebrate ratings were poor. Habitat conditions were consistently rated poor. Many of these channelized reaches were low-gradient and silt or sand bottomed. Wetlands have been extensively drained and agricultural land use dominates the watershed. High dissolved oxygen readings in the afternoon were recorded at 07CD002, which may indicate a diel DO flux where DO is high during the day due to excess photosynthetic activity but drop below the standard during the nighttime when plants and organisms respire and use oxygen. Cool ground water may be minimizing late summer water quality stress to fish communities while poor habitat conditions and water quality issues may be stressors to invertebrate communities.

Goose Creek is designated a Limited Resource Value water (Class 7). While the current dataset indicates that Goose Creek is meeting some of its Class 7 water quality standards, the assessment was given an "IF" for "insufficient information" since data on some standards were not available for assessment. One bacteria sample collected exceeded the standard for bacteria (1260 colonies/ml); however, more than one exceedence in two years is needed to be assessed as impaired for aquatic recreation. The Class 7 standard for dissolved oxygen concentration is 1 mg/L. Two measurements were below the standard. Dense macrophyte mats and filamentous algae were observed at the outlet station. Nitrogen concentrations above ecoregion expectations were also reported, which together with excess phosphorus may be fueling the growth of plants causing and contributing to the low-dissolved oxygen concentrations observed. Additional monitoring of early morning dissolved oxygen is recommended to determine whether or not this Class 7 reach is regularly meeting water quality standards.

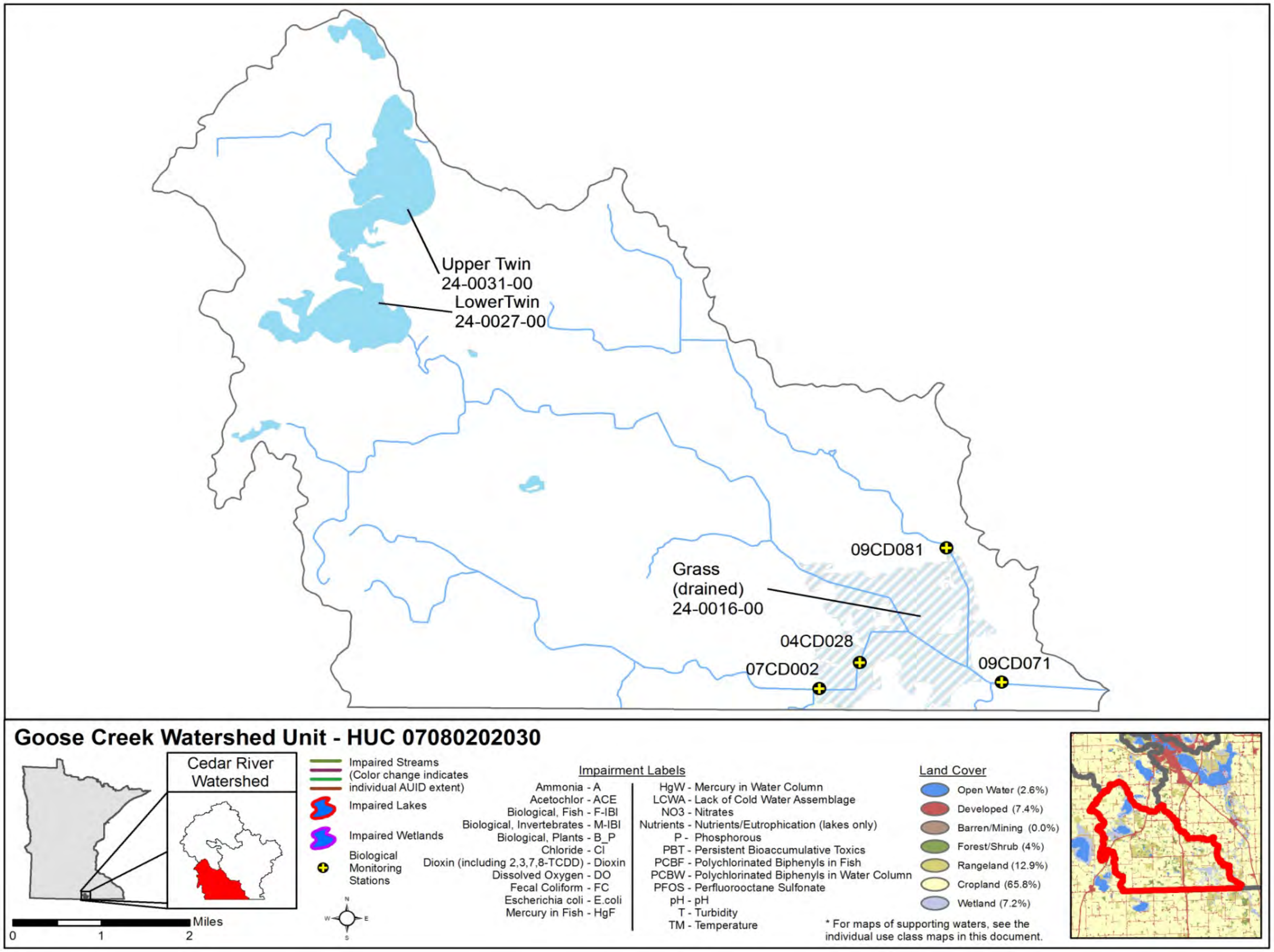

Figure 17. Location of biological monitoring stations and land use characteristics in the Goose Creek Watershed Unit. There are currently no listed impaired waters.

VI. Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed unit of the Shell Rock 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 Shell Rock River Watershed.

Pollutant load monitoring

The Shellrock River is monitored at Hwy 1 near Gordonsville approximately one and a half miles before it enters Iowa. 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 Shellrock River's load monitoring station is located within the South RNR. Annual Flow Weighted Mean Concentrations (FWMCs) were calculated and compared for years 2007-2009 (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 a 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 ten year period and not based on comparisons with FWMC's. 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 both "non-point" as well as "point" sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

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 and land use/management 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 draft standards until approved. 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 in 2009 and 2010 showed only one sample exceeding the 65 mg/L draft standard, this individual sample was taken during on the rising limb of an intense early June rainfall event. In addition, the computed FWMC's for the two sample years were well below the 65 mg/L draft standard (24.7, and 8.42 mg/L, respectively) (Figure 18). Although the data may not reflect long-term trends, both TSS FWMC's and annual loads showed decline from 2009 to 2010 (Figure 18 and Table 20). While there is often a strong correlation between pollutant loads and annual runoff volume, this is not evidenced during 2009 and 2010. Between year differences in annual TSS loads and FWMC's may be strictly a function of climatic variability i.e. high intensity or low intensity rain events as dominant storm types. More sources of sediment are typically active during high intensity rain events, additional data will help better determine the effects of climate on water quality within this watershed.

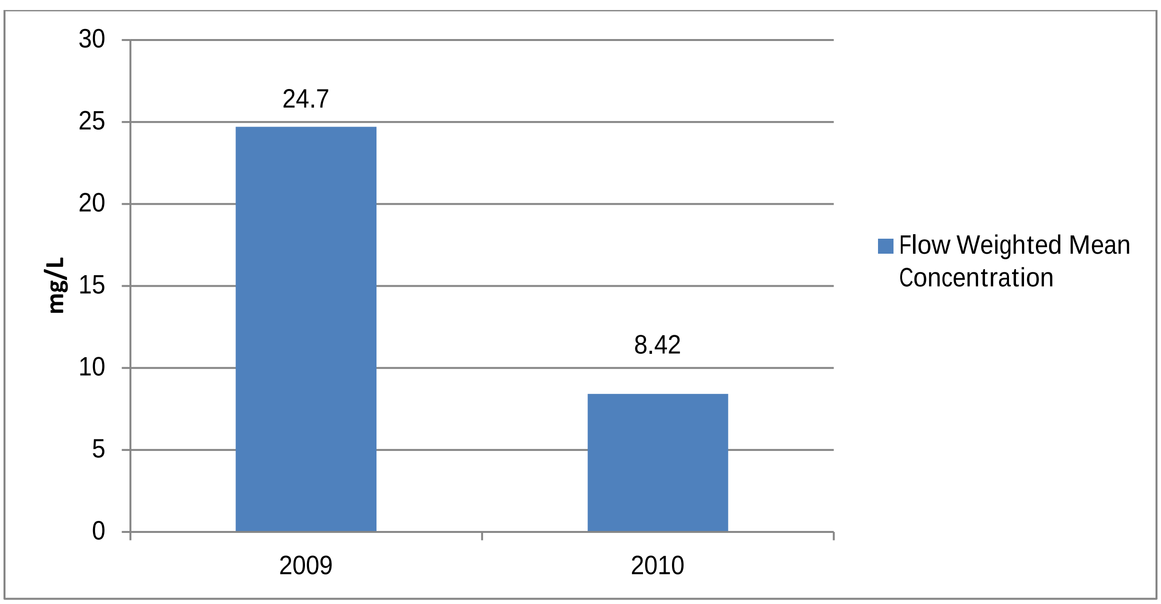

Figure 18. Total Suspended Solids (TSS) flow weighted mean concentrations for the Shell Rock River

Table 20. Annual pollutant loads by parameter calculated for the Shell River

	2009	2010
Parameter	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	2,981,373	1,787,074
Total Phosphorus	48,502	74,663
Ortho Phosphorus	34,805	56,218
Nitrate + Nitrite Nitrogen	362,989	691,314

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 over stimulate 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 0.150 mg/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 2009 and 2010 show that 100 and 99 percent of the individual TP samples exceeded the 0.150 mg/L draft standard, respectively. Observation of Figure 19 shows that all of the FWMC's from 2009 to 2010 are over double that of the draft standard at 0.402 and 0.352 mg/L, respectively. Table 20 shows an increase in annual TP loads from 2009 to 2010 as should be expected with the near doubling of annual runoff in 2010 (Figure 18).

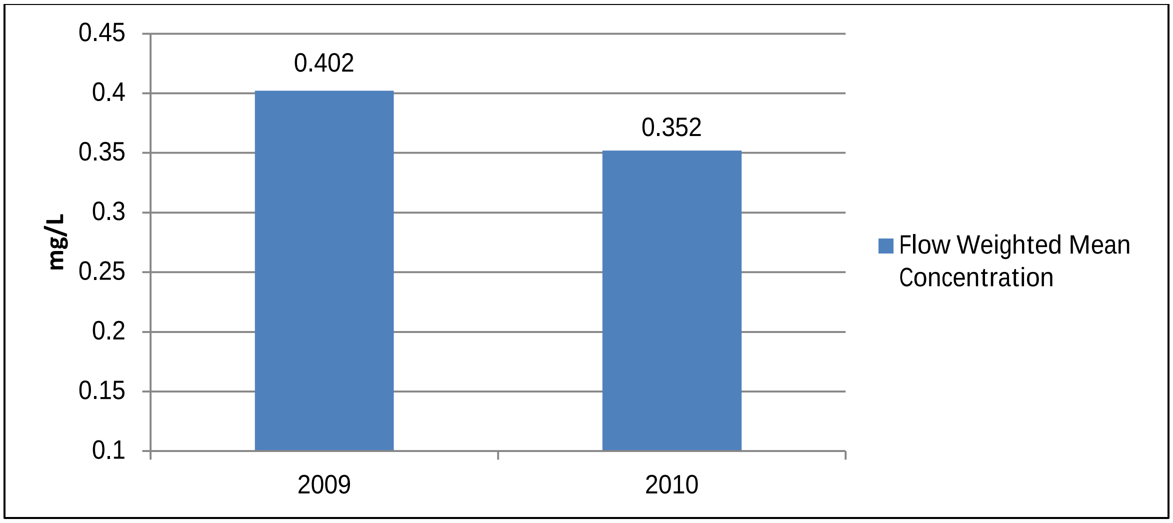

Figure 19. Total Phosphorous (TP) flow weighted mean concentrations for the Shell Rock River

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 2009 and 2010 FWMC ratios of DOP to TP show 66 and 23 percent of TP is in the orthophosphate form (Figure 20). Table 20 indicates a between year increase in DOP loads, similar to TP and nitrate plus nitrite – nitrogen.

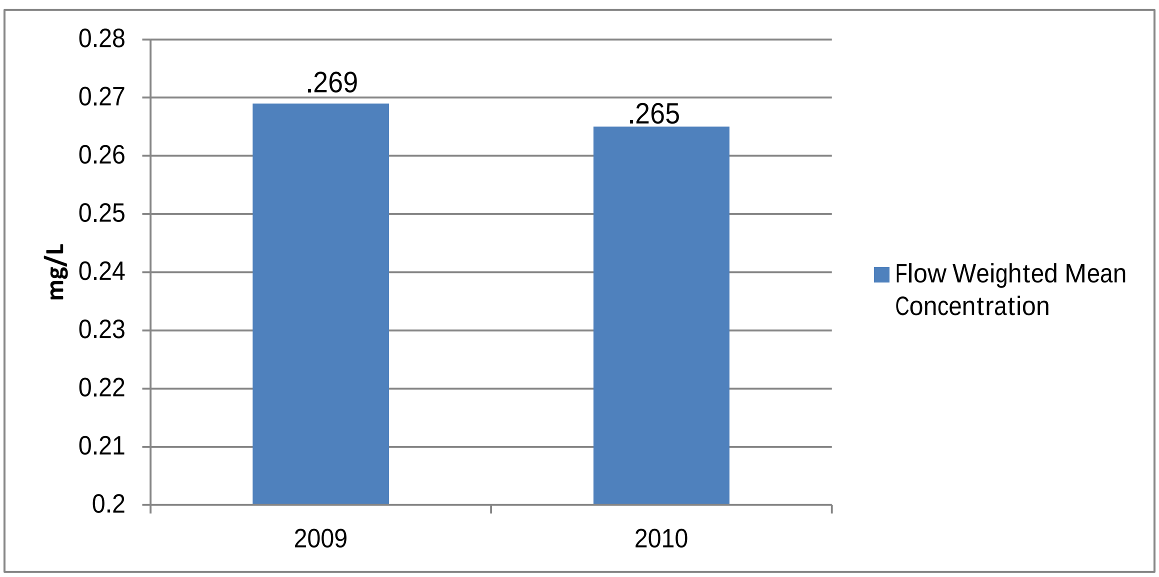

Figure 20. Orthophosphate (OP) flow weighted mean concentrations for the Shell Rock River

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 2009 to 2010 for the Shellrock River Watershed were 3.01, and 3.26 mg/L, respectively (Figure 21). Calculations of the Shellrock River's annual nitrate-N loads show an increase over the two year sampling period (Table 20), very much in line with the between-year increase measured in annual runoff. If flow weighted mean concentrations are similar across time, annual differences in loads are strictly a function of total runoff volume (the volume of water passing through the watershed).

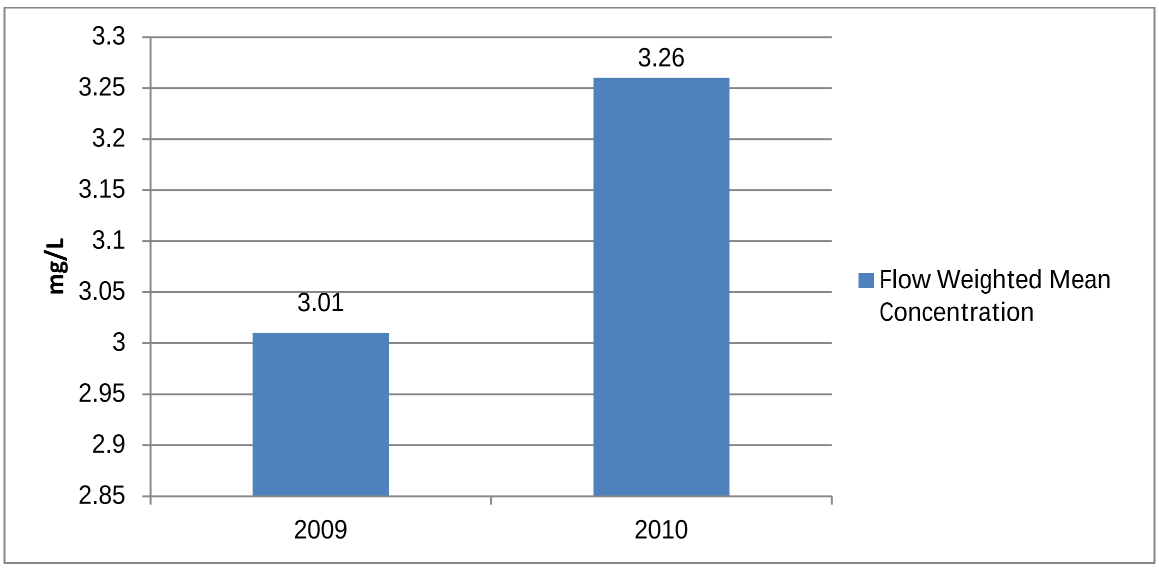

Figure 21. Nitrate + nitrite (Nitrate-N) flow weighted mean concentrations for the Shell Rock River

Stream water quality

Five of the 24 watershed-wide stream AUIDs were assessed (Table 21). Of the assessed AUIDs, two AUIDs were impaired for aquatic life, and 3 AUIDs were impaired for aquatic recreation. One AUID was assessed as a "limited resource value water" (Class 7). The result of the assessment was "insufficient information" since data on all applicable water quality standards was not available.

Aquatic recreation impairments due to high bacteria counts include the Shell Rock River, Bancroft Creek, and an unnamed creek north-west of Albert Lea. Aquatic biological impairments currently only include the main stem of the Shell Rock River and an unnamed creek north-west of Albert Lea. Water chemistry impairments on the Shell Rock River include low dissolved oxygen, pH, and turbidity.

Fifteen 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. Currently, channelized reaches and AUIDs are not assessed until standards are developed. These streams are included in the number for "insufficient data" in Table 21.

Two other AUIDs were not assessed due to nature of the location for stream sampling. One sampling station was close to a lake where the samples were likely influenced by lake water and the other station was a short connector between two lakes. These conditions mean that the water resource in that location is not assessable using water quality standards developed for streams.

Overall, biological quality in the watershed for both assessed and unassessed channelized streams is fair to poor. Turbidity violations were also reported which may indicate excess sediment entering streams from overland erosion or unstable stream banks. Excess sediment can negatively impact habitat quality and be a source of excess phosphorus. Nitrogen concentrations were also exceeding ecoregion expectations across much of the watershed. Excess nutrients may fuel the growth of plants and lower dissolved oxygen during the nighttime and when plants senesce. Low-dissolved oxygen concentrations were reported for a number of channelized tributaries and the Shell Rock River which may be a stress to the biological communities.

Table 21. Assessment summary for stream water quality in the Shell Rock River Watershed

				Supporting		Non-supporting		
Waterbody	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**
Shell Rock River HUC 8	157, 312	**53**	**5**	**0**	**0**	**2**	**3**	**48**
Fountain Lake	60, 928	24	3	0	0	1	2	21
Shell Rock River	65, 792	21	2	0	0	1	1	19
Goose Creek	30, 592	8	0	0	0	0	0	8

Lake water quality

For lakes, aquatic consumption impairments are limited to Fountain Lake (North, East & West Bays). Aquatic recreation impairments include Albert Lea Lake, Fountain Lake (East & West Bays), Pickeral, and White. Many of the lakes in the watershed are shallow lakes. 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 internal release of phosphorus into the water column.

Numerous improvement projects are currently underway which are aimed at restoring lake quality. Projects include stream bank restoration in unstable stream tributaries, water storage, sewage treatment system upgrades, urban stormwater management, and erosion control. The primary focus of these projects is to reduce phosphorus contributions from non-point sources. There are ongoing efforts to control of invasive rough fish through fish barriers and chemical removal. There are also plans for dredging larger areas of Fountain Lake, as well as some “spot” dredging in Albert Lea Lake.

Table 22. Assessment summary for lake water chemistry in the Shell Rock River Watershed

Waterbody	**Area (acres)**	**Total Lakes**	**Lakes < 10 Acres**	**Lake > 10 Acres**	**Full Support**	**Non-support**	**Insufficient Data**
Shell Rock River HUC 8	157, 312	**19**	**2**	**17**	**0**	**4**	**14**
Fountain Lake	60, 928	11	1	10	0	1	9
Shell Rock River	65, 792	3	0	3	0	3	0
Goose Creek	30, 592	5	1	4	0	0	5

Fish contaminant results

A summary of descriptive statistics for mercury and PCBs (Table 23) shows that the Shell Rock River and two lakes did not exceed the impairment threshold at the 90th percentile for mercury (0.2 mg/Kg) in fish tissue or the impairment threshold for PCBs (0.22 mg/Kg). However, North Bay of Fountain Lake was previously listed in 2008 for aquatic consumption due to mercury in fish tissue because the impairment assessment used only results from 2006 and not an earlier set of mercury results from 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). West and East Bays of Fountain Lake were added as impaired for mercury in fish tissue in the most recent assessment due to the likelihood of fish migration between the bays.

Table 23. Descriptive statistics of mercury and PCB concentrations in fish samples collected since 1998 by waterway in the Shell Rock River Watershed

					Length (in)				Mercury (mg/kg)					PCBs (mg/kg)			
Waterway	**AUID**	**EPA Category**	**Species**	**N**	**Mean**	**Min**	**Max**		**Mean**	**Min**	**Max**	**90th Pctl**		**N**	**Mean**	**Min**	**Max**
Shell Rock River	07080202-501, -502, -503, -504		Common Carp	5	19.8	15.6	25.5		0.118	0.086	0.174	0.174		1	0.080		
			Northern pike	5	20.9	18.7	22.6		0.135	0.096	0.177	0.177		3	0.083	0.025	0.200
Albert Lea Lake	24001400		Black crappie	1	8.5	8.5	8.5		0.050			NA		1	< 0.010		
			Common Carp	1	19.8	19.8	19.8		0.020			NA					
			Channel catfish	1	19.3	19.3	19.3		0.090			NA		1	0.013		
			Largemouth bass	2	13.3	12.4	14.1		0.075	0.060	0.090	0.090		1	< 0.010		
			Northern pike	5	26.7	22.2	32.2		0.065	0.030	0.138	0.138		1	< 0.010		
			Smallmouth buffalo	1	21.9	21.9	21.9		0.050			NA		1	0.019		
			Walleye	11	19.1	16.0	24.0		0.106	0.040	0.188	0.177		1	< 0.010		
			Yellow perch	2	8.4	8.0	8.8		0.011	0.010	0.012	0.012					
Fountain Lake	24001800		Walleye	18	14.9	9.9	28.1		0.106	0.048	0.522	0.141		1	< 0.010		
			Yellow perch	3	8.2	8.0	8.6		0.029	0.026	0.035	0.035					

NA - not available

Ground water monitoring

There is one currently functioning DNR observation well in the watershed (Observation Well 24007) which is located near Albert Lea. The well record between 2001 and 2012 reveals unusual behavior in the groundwater surface (Figure 22). MNDNR informed that while attempting to seal this well, they discovered that the pump valve was actually at 80 ft when the actual depth was 200+ ft but the remainder of the well was not accessible. Therefore, the data from 2007 to present is suspect and not to be used. Plans are to seal this well in the near future. A second observation well (24008), completed in the unconsolidated material overlying the carbonate bedrock, shows only a flat trend. This well is located just outside the watershed boundary to the northwest. There are no Ambient Groundwater Monitoring stations or MDA groundwater monitoring stations in the Stations in the Shell Rock River watershed.

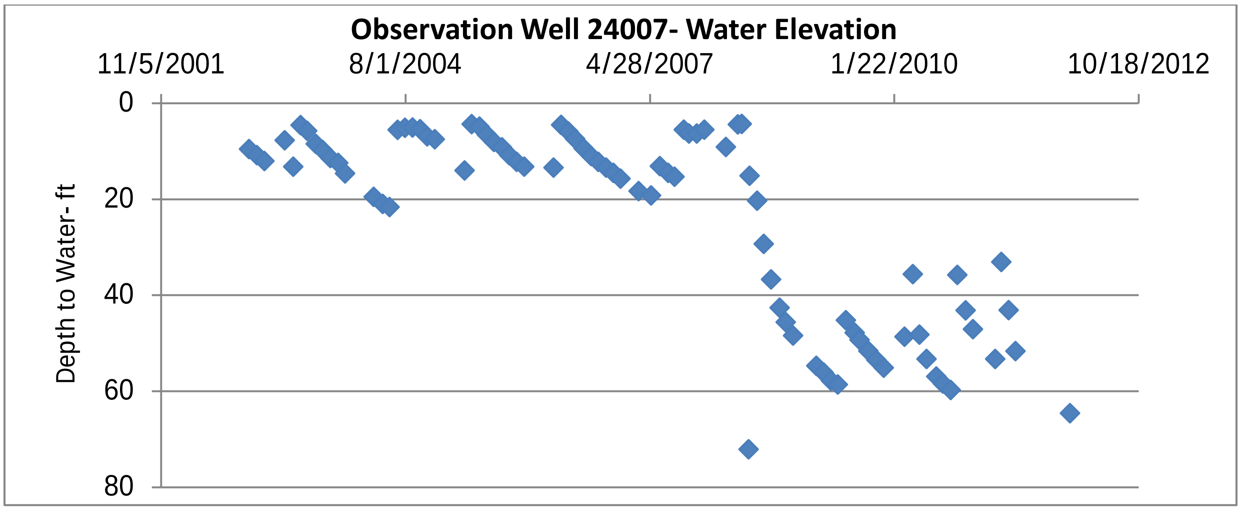

Figure 22. Water elevation at Observation Well 24007 (2001-2012)

Stream water levels

There are no long-term stream discharge measurements available for the Shell Rock River in Minnesota. The Load Monitoring station on the Shell Rock River at Gordonsville was only recently installed in 2008. Due to natural variability in annual stream discharge, more than 20 years of discharge measurements are needed in order to analyze groundwater/surface water interactions and whether or not stream discharges are trending overall as increasing, decreasing, or staying the same. There are two USGS gages on the Shell Rock River further downstream in Iowa. One station is at Rockford, which is ~40 miles downstream of Gordonsville, and the other station is at Shell Rock, which is ~80 miles downstream of Gordonsville. The USGS station at Rockford (USGS 05460400) was recently installed in 2010, while the station at Shell Rock (USGS 0546200) has discharge data from 1953. An analysis of the discharge data from the Shell Rock station may indicate whether or not stream flows have changed on the Shell Rock River over time. Since many streams across the state are showing dramatic summer time declines in flow, lacking such data on the Shell Rock River in Minnesota currently denies us an important measure of the stream health.

Lake water levels

Precipitation, surface water withdrawals and groundwater pumping for industry and residential use can have an impact on lake water levels. Water elevation data was reviewed to see if there was an overall increase or decrease in lake water level. The data indicates that there is a small, statistically insignificant rising trend in water level of Albert Lea Lake (Figure 23), a statistically insignificant rising trend for Lower Twin Lake (Figure 24), and a statistically insignificant decreasing trend in water level for Fountain Lake

(Figure 25). However, data collection changed from collecting over 18 levels a year in 1992, to collecting only one level a year in the last decade which renders a trend analysis less reliable.

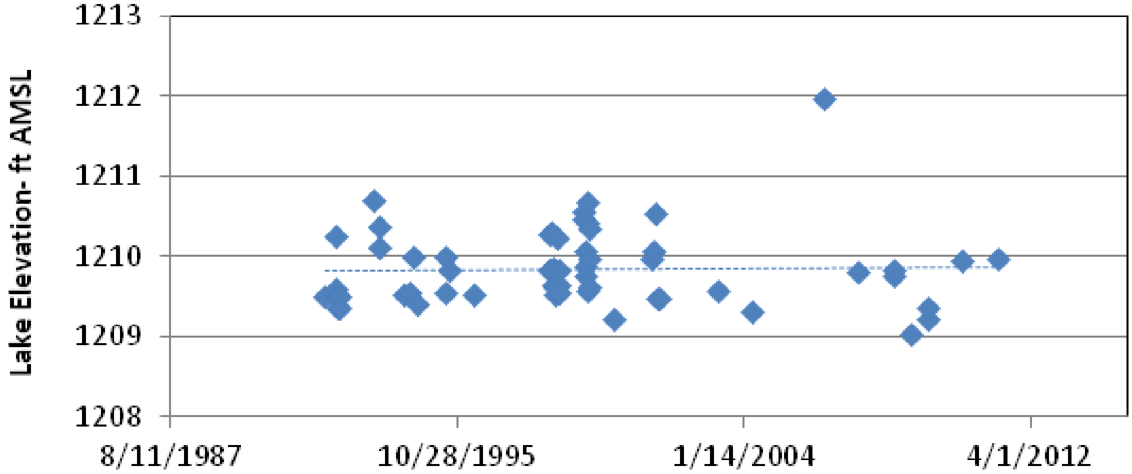

Figure 23. Water elevation for Albert Lea Lake (1987-2012)

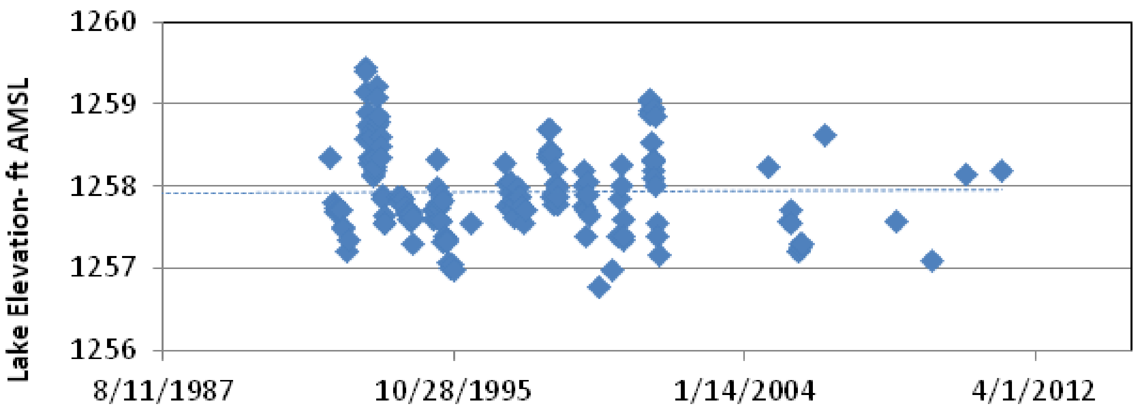

Figure 24. Water elevation level for Lower Twin Lake (1987-2012)

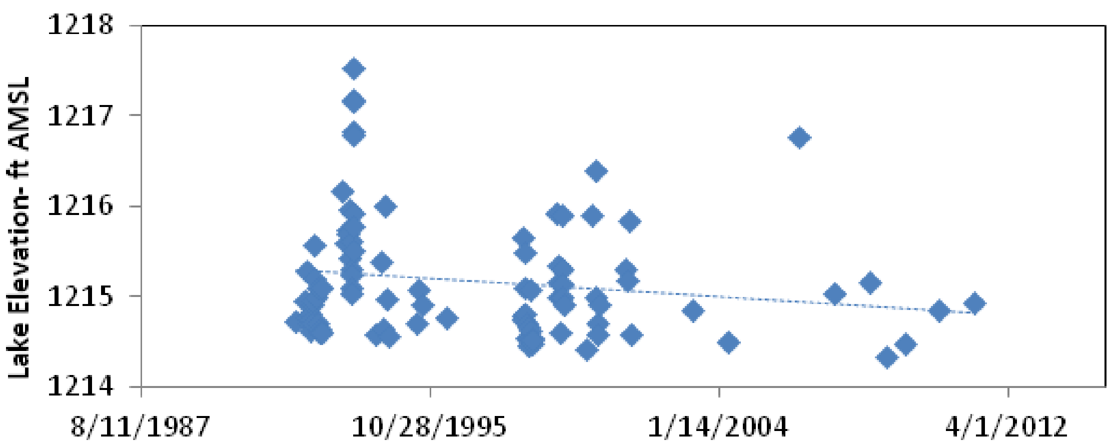

Figure 25. Water elevation level for Fountain Lake (1987-2012)

Pollutant trends for the Shell Rock River

Water quality trends at long-term monitoring stations

Analysis of long-term water quality trends in the watershed was limited to one location on the Shell Rock River. Overall, nitrite/nitrate and chloride increased over the long term while there was not trend during the short term (Table 24). Conversely, significant decreases were observed for total suspended solids, total phosphorus, ammonia, and biochemical oxygen demand over the long term record but not the short term.

Table 24. Trends in the Shell Rock River Watershed

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
At Br on CSAH-1, 1 Mi W of Gordonsville (SR-1.2) (period of record 1961 - 2009)						
overall trend (1961-2009)	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**increase**
average annual change	-1.9%	-1.0%	4.6%	-0.9%	-2.9%	1.5%
total change	**-60%**	**-38%**	**563%**	**-37%**	**-77%**	**106%**
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	99	0.5	1	0.10	14.5	35
median concentrations most recent 10 years	54	0.4	2	<.05	6.6	43

Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90 percent 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

There are currently no CSMP or CLMP monitors in this watershed. The MPCA encourages volunteers to sign up in these programs to provide annual data for trend evaluation in the future.

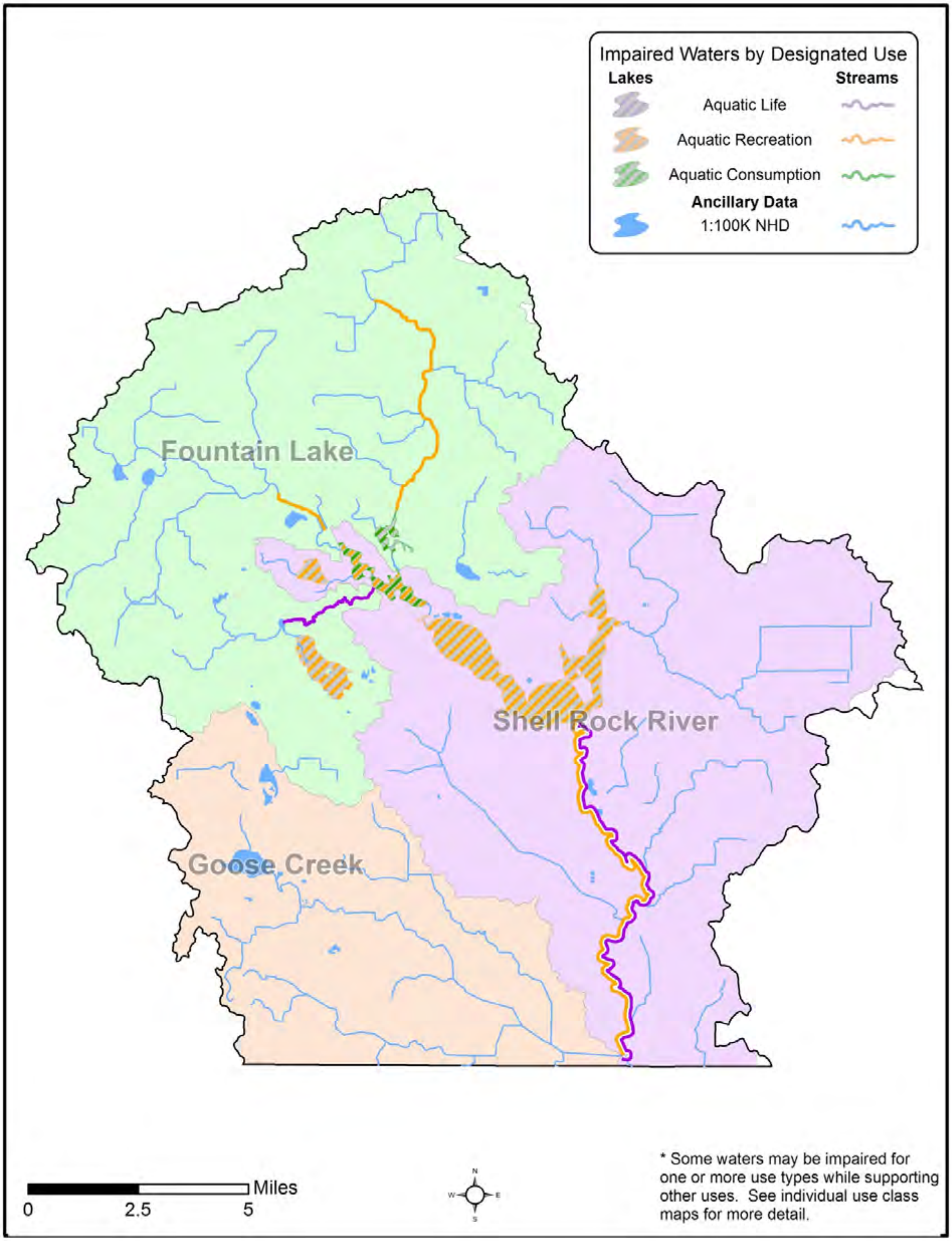

Figure 26. Impaired waters by designated use in the Shell Rock River Watershed

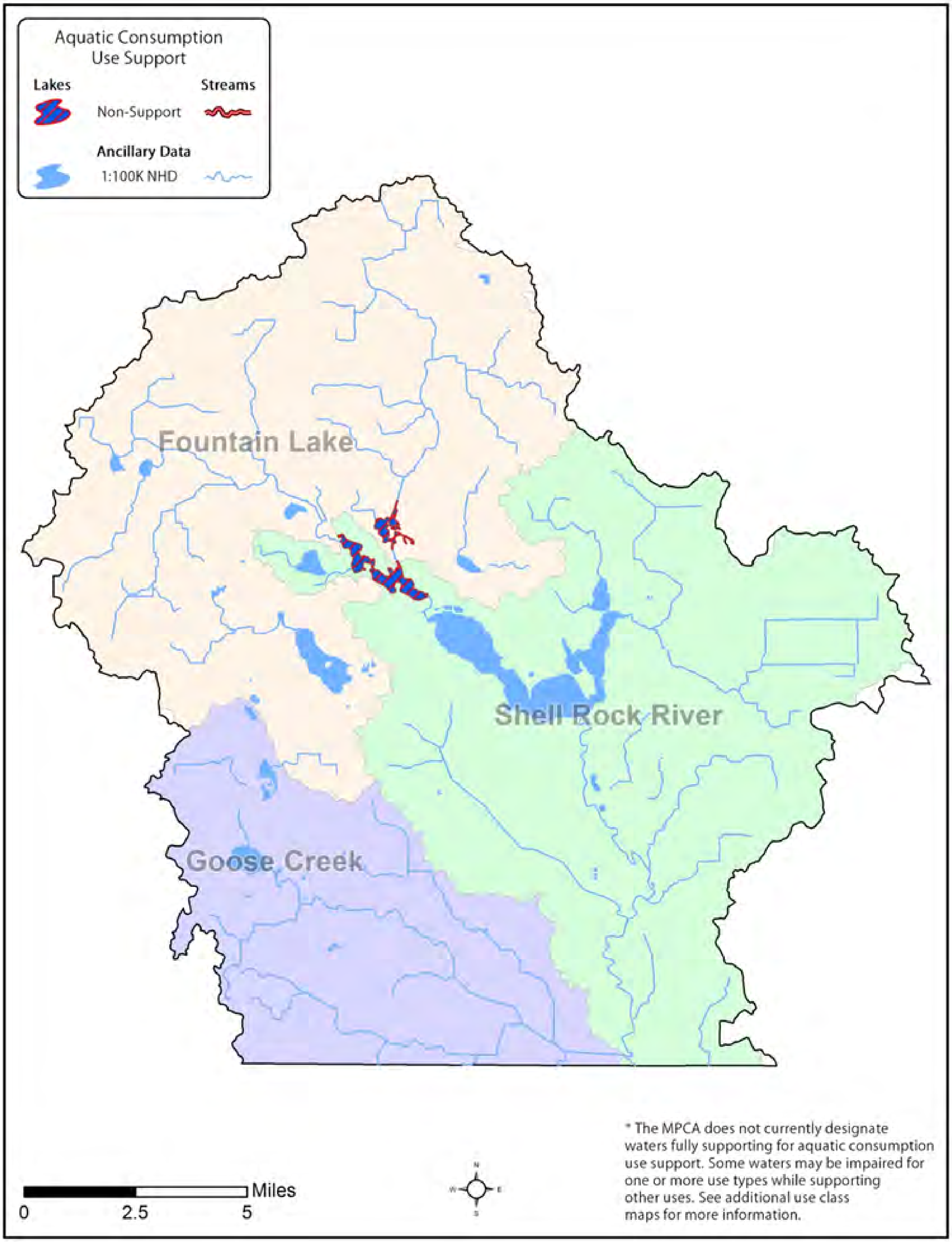

Figure 27. Aquatic consumption use support in the Shell Rock River Watershed

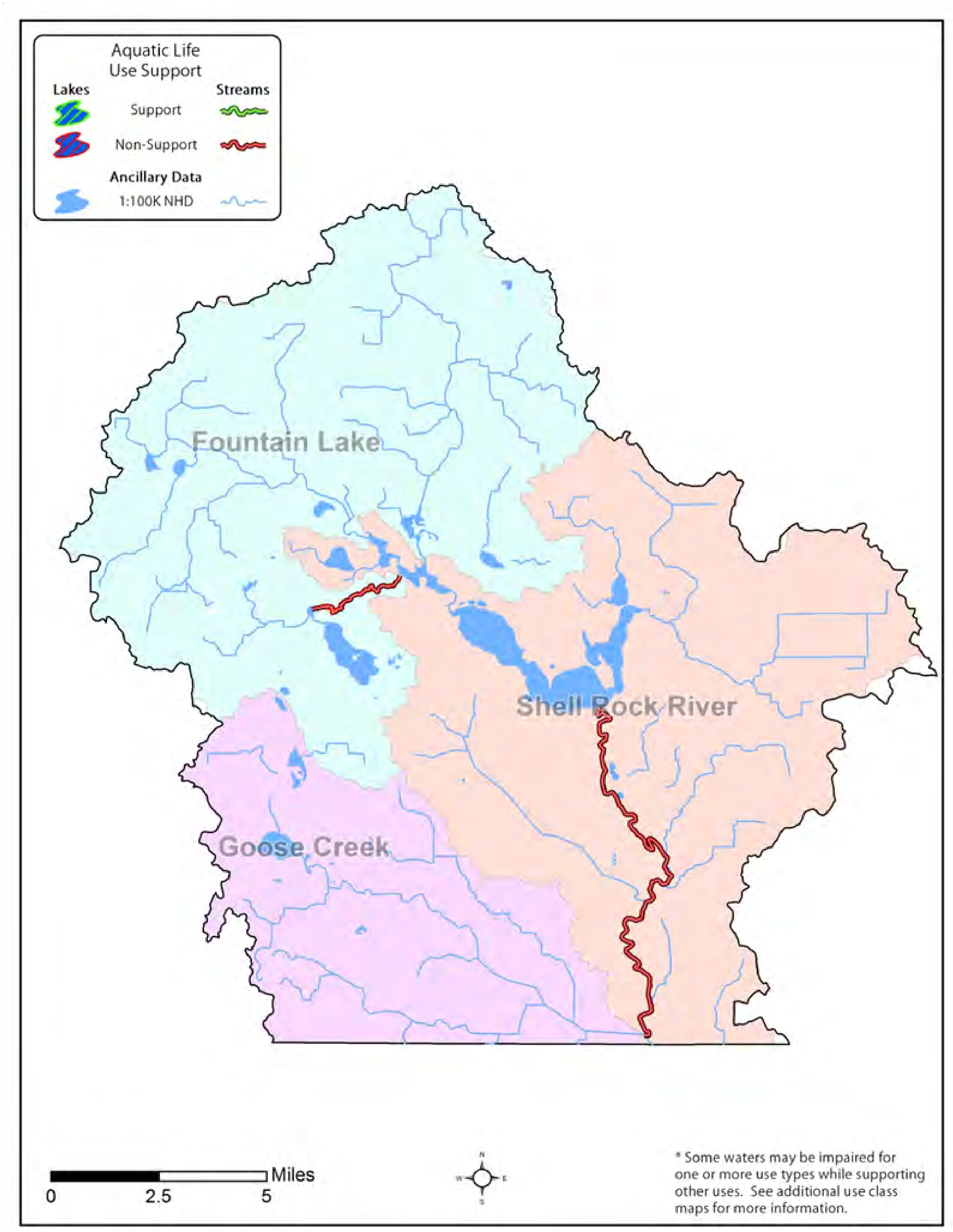

Figure 28. Aquatic life use support in the Shell Rock River Watershed

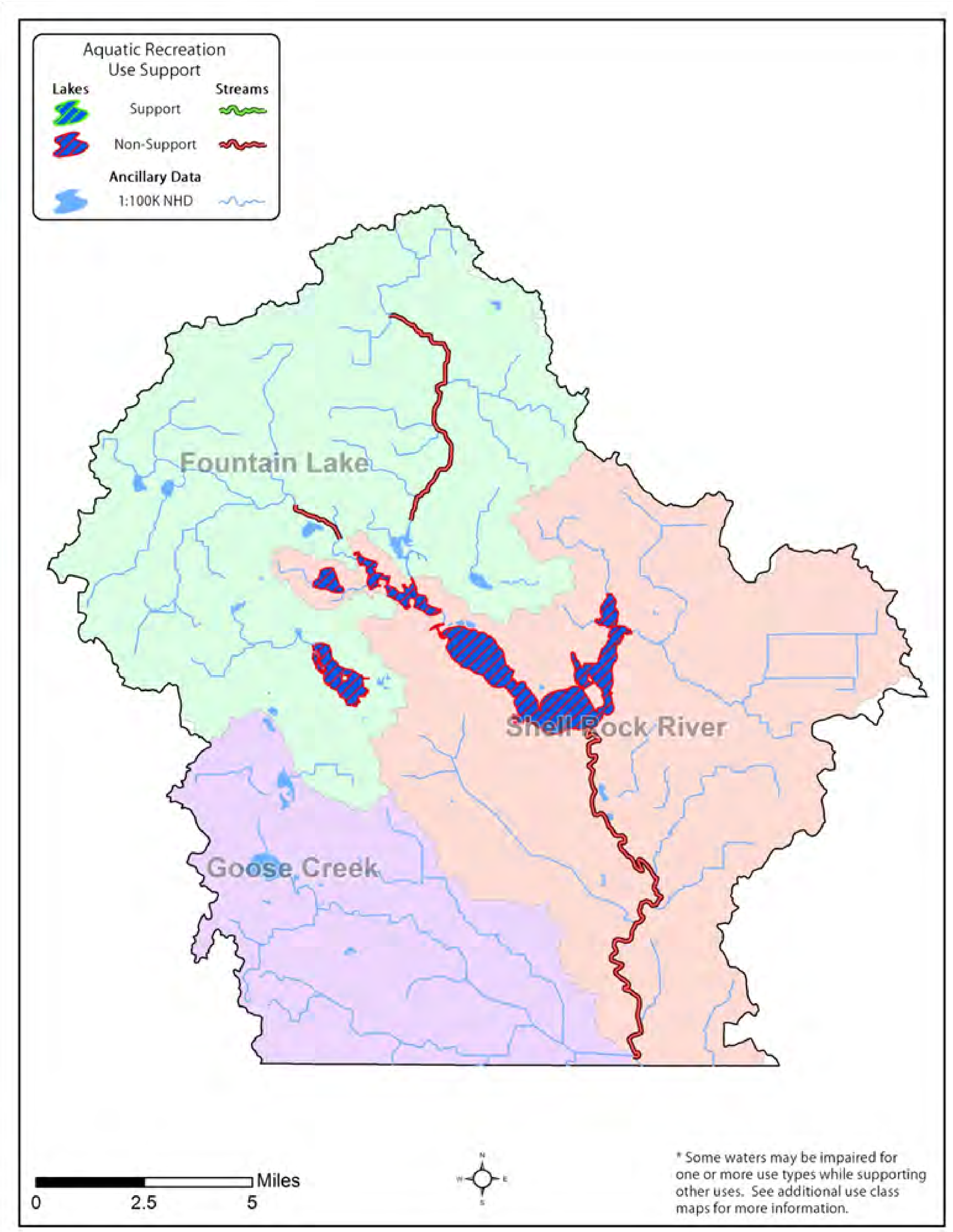

Figure 29. Aquatic recreation use support in the Shell Rock River Watershed

VII. Summaries and recommendations

The Shell Rock River was once considered a dead river where no fish could live (SRRWD 2010). A new wastewater treatment plant was built in the 1980s that greatly reduced point-sources of excess phosphorus entering Albert Lea Lake and the Shell Rock River. The reduction in phosphorus and turbidity has improved water quality and as a result, numerous fish species once again inhabitat the Shell Rock River. However, phosphorus levels today still remain above water quality standards in Albert Lea Lake and other lakes in the watershed. In addition, many of the shallow lakes in the watershed are susceptible to mixing throughout the open water season. This lake mixing resuspends bottom sediments, which when combined with high temperatures and pH can result in continued release of phosphorus into the water column. High levels of phosphorus in lakes and rivers can cause toxic algae blooms that are dangerous to people, pets, cattle, and wildlife. Some of the extremely low-dissolved oxygen levels observed in the Shell Rock River, which may be contributing to the biological impairment, may be in part related to high phosphorus levels leaving Albert Lea Lake.

Non-point sources of phosphorus include lawn fertilizer, animal manures from feedlots and pastures, grass and leaf clippings entering stormwater drains, outdated septic systems, and pet waste that is not collected and disposed of properly. Phosphorus can also be re-suspended from lake sediment by rough fish, such as carp, that stir up the sediment while feeding. Phosphorus can also enter waterbodies attached to sediment coming from overland erosion and unstable stream banks, or from subsurface drainage system flows.

In addition, Nitrate-N levels have been increasing in the Shell Rock River. Higher levels of Nitrate-N can fuel the growth of algae (MPCA 2010b) and can also be toxic to eggs and small fry of fish and aquatic invertebrates (Camargo et al. 2005). Nitrate-N is typically derived from the oxidation of ammonia nitrogen by nitrifying bacteria. Anthropogenic sources of ammonia nitrogen include fertilizers, septic systems, and animal waste. The transport of ammonia nitrogen from fields is enhanced through tile drainage.

The Shell Rock River Watershed District (SRRWD) was created in 2003 at the request of local citizens to improve water quality in the watershed. SRRWD has been working on multiple projects to reduce the two main sources of poor water quality: sediment and phosphorus. Projects implemented or planned have included: upgrading septic systems; a stormwater pollution prevention program; the building of stormwater retention ponds; a stream restoration project on Wedge Creek to stabilize stream banks; and lowering the dam on Albert Lea Lake to improve shoreland vegetation, stabilize bottom sediments, and reduce phosphorus. Rough fish removal (Pickerel Lake system) and fish barrier projects (Fountain Lake tributaries) have also been implemented to reduce the re-suspension of phosphorus from fish feeding on lake bottoms.

Additional efforts to improve water quality in the watershed have also included working with landowners on the state buffer and shoreland setback laws on ditches and streams. Freeborn County has over 350 miles of public ditches and a reported 100 percent compliance of the 16.5 ft vegetative buffer requirement for open public drainage ditches (Albert Lea Tribune, 2011). The buffer strips trap overland runoff of sediment and nutrients that would otherwise enter ditches and further degrade water quality in downstream lakes and streams.

Together, these watershed efforts will help to improve water quality related to sediments and nutrients. Additional measures will be needed in order to reduce phosphorus, sediment, and bacteria levels in order to bring impaired waters back into compliance with state and federal water quality standards.

Continued lake monitoring should target lakes where insufficient or no assessment level data is present for publicly accessible lakes. More targeted stream chemistry monitoring is also needed to determine the extent and identify the sources and mechanisms of chemical and biological impairments as well as to gage the effect of BMP implementation.

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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 Shell Rock River Watershed

Biological Station ID	STORET ID	Waterbody Name	Location	11-digit HUC
09CD072	S004-121	Trib. to Fountain Lake	At Hwy 13, 1.5 mi. NW of Albert Lea	07080202010
09CD075	S004-120	Bancroft Creek (County Ditch 63)	At plaza St, 2.5 mi. N of Albert Lea	07080202010
09CD089	S000-084	Shell Rock River	At CSAH 1 (110th St), 1 mi. W of Gordonsville	07080202020
09CD071	S005-615	Goose Creek (County Ditch 10)	At CR 79, 5 mi. S of Glenville	07080202030

Appendix 3.1 – AUID table of assessment results for streams (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)	Dissolved Oxygen	pH	Turbidity/T-Tube/TSS	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07080202010 (Fountain Lake Watershed)																						
07080202-509	County Ditch 63	Headwaters to Bancroft Cr	4.5	2C	NA	NA														EXN	MTN	
07080202-528	Judicial Ditch 21	Unnamed ditch to CD 63	0.8	2B	NA	NA														EXN	MTN	
07080202-529	County Ditch 65	Unnamed ditch to CD 63	1	2B	NA	NA			NA	NA										EXN	MTN	
07080202-536	County Ditch 66	Headwaters to Unnamed ditch	4	2B	NA	NA			NA													
07080202-507	Bancroft Creek (County Ditch 63)	CD 63 to Fountain Lk	6.6	2C	IF*	NS			MTS	EXS					EX	IF	MTS	EXP		EXN	MTN	EXP
07080202-527	Unnamed ditch	CD 66 to CD 9	1.6	2B	NA	NA			NA	NA										EXN	EXN	
07080202-526	County Ditch 9	Unnamed ditch to Unnamed ditch	2	2B	NA	NA			NA	NA										EXN	MTN	
07080202-524	County Ditch 11	Headwaters to Unnamed cr	5.5	7	NA	NA		NA	NA	NA												
07080202-531	Unnamed creek	T103 R22W S36, north line to Unnamed ditch	1.5	2B	IF*	NS			NA	NA					EX	MTS	MTS	EXP		EXN	MTN	EXP
07080202-514	County Ditch 68	Unnamed ditch to Mud Lk	1.3	2B	IF	NA										IF	MTS	MTS		EXN	MTN	MTS
07080202-516	Unnamed creek	Mud Lk to Fountain Lk	3.1	2B	NS	NA										IF	MTS	EXS			EXN	EXS
07080202-537	Unnamed creek	Goose Lk to Fountain Lk	1.9	2B	NA	NA										NA†	NA†	NA†			EXN	MTS

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. *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. † The condition of the waterbody where sampled was not appropriate for stream assessment (e.g., wetland flowage, lake effect).

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)	Dissolved Oxygen	pH	Turbidity/T-Tube/TSS	Un-ionized ammonia	Nitrite/Nitrate	Total Phosphorous	Suspended Solids
HUC 11: 07080202020 (Shell Rock River Watershed)																						
07080202-504	Shell Rock River	Fountain Lk to Albert Lea Lk	0.3	2B	NA	NA										IF	EXP	EXP			EXN	EXP
07080202-513	County Ditch 16	Unnamed ditch to Albert Lea Lk	2.5	2B	IF*	NA			NA	NA						IF	MTS	MTS		EXN	MTN	MTS
07080202-534	Peter Lund Creek	CD 12/47 to CD 32	2.8	2B	NA*	NA			NA	NA											EXN	
07080202-535	County Ditch 32	Unnamed ditch to Peter Lund Cr	4	2B	NA*	NA			NA	NA											MTN	
07080202-512	Peter Lund Creek	CD 32 to Albert Lea Lk	0.9	2B	NA*	NA										IF	MTS	EXP			EXN	EXP
07080202-533	Judicial Ditch 20	Headwaters to Shell Rock R	6.1	2B	NA*	NA			NA	NA												
07080202-511	Unnamed ditch (County Ditch 16)	Headwaters to Unnamed ditch	1.3	2B	NA*	NA			NA	NA												
07080202-508	County Ditch 16	Unnamed ditch to Shell Rock R	5.9	2B	IF*	NA			NA	NA						EXP	MTS	MTS		MTN	EXN	MTS
07080202-501	Shell Rock River	Albert Lea Lk to Goose Cr	12.1	2B	NS	NS			EXS	EXS					EX	IF	EXP	EXP		MTN	EXN	EXP
HUC 11: 07080202030 (Goose Creek Watershed)																						
07080202-510	County Ditch 17	Unnamed ditch to Goose Cr	1.6	2B	NA*	NA			NA	NA												
07080202-532	County Ditch 40	Unnamed ditch to Goose Cr	6.1	2B	NA*	NA			NA	NA												
07080202-505	Goose Creek (County Ditch 10)	Headwaters to Shell Rock R	11	7	NA*	NA		IF	NA	NA				MTS	MTS				MTS			

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. *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.

Appendix 3.2 – Assessment results for lakes in the Shell Rock 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
24-0017-00	Goose	Freeborn	07080202010	WCBP	32.17	---	1343	---	---	N/A
24-0025-00	Pickeral	Freeborn	07080202010	WCBP	201.51	1.22	1498	100.0	0.96	NS
24-0037-00	Sugar	Freeborn	07080202010	WCBP	24.89	0.46	4149	100.0	0.25*	IF
24-0038-00	Halls	Freeborn	07080202010	WCBP	21.69	0.91	412	100.0	0.50*	IF
24-0040-00	School Section	Freeborn	07080202010	WCBP	6.96	---	143	---	0.59	IF
24-0068-00	Mud	Freeborn	07080202010	WCBP	6.8	---	3645	---	---	IF
24-0014-00	Albert Lea	Freeborn	07080202020	WCBP	1074.69	1.83	38047	100.0	0.53	NS
24-0018-01	Fountain (East Bay)	Freeborn	07080202020	WCBP	94.68	4.27	10058	100.0	1.72	NS
24-0018-02	Fountain (West Bay)	Freeborn	07080202020	WCBP	57.54	2.44	21261	100.0	1.57	NS
24-0024-00	White	Freeborn	07080202020	WCBP	63.82	1.07	468	100.0	0.35	NS
24-0027-00	Lower Twin	Freeborn	07080202030	WCBP	111.55	0.76	3320	100.0	0.29	IF
24-0031-00	Upper Twin	Freeborn	07080202030	WCBP	33.87	0.76	2325	100.0	0.29*	IF

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.

*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	39	±11	50	28
2	Southern Streams	2B	45	±9	54	36
3	Southern Headwaters	2B	51	±7	58	44
4	Northern Rivers	2B	35	±9	44	26
5	Northern Streams	2B	50	±9	59	41
6	Northern Headwaters	2B	40	±16	56	24
7	Low Gradient	2B	40	±10	50	30
Invertebrates						
1	Northern Forest Rivers	2B	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B	52.4	±13.6	66	38.8
5	Southern Streams RR	2B	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B	38.3	±13.6	51.9	24.7

Appendix 4.3 – 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: 07080202010 (Fountain Lake Watershed)							
07080202-507	09CD082	Bancroft Creek (County Ditch 63)	10.9	3	51	59	10-Aug-09
07080202-507	09CD082	Bancroft Creek (County Ditch 63)	10.9	3	51	58	09-Jun-09
HUC 11: 07080202020 (Shell Rock River Watershed)							
07080202-501	04CD037	Shell Rock River	147.7	2	45	42	24-Aug-04
07080202-501	09CD087	Shell Rock River	147.9	2	45	48	28-Jul-09
07080202-501	04CD017	Shell Rock River	152.3	2	45	40	18-Aug-04
07080202-501	09CD088	Shell Rock River	167.9	2	45	51	29-Jul-09
07080202-501	04CD015	Shell Rock River	187.1	2	45	33	24-Aug-04
07080202-501	09CD089	Shell Rock River	188.0	2	45	34	29-Jul-09
HUC 11: 07080202030 (Goose Creek Watershed)							
NONE							

Appendix 4.4 – 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: 07080202010 (Fountain Lake Watershed)							
07080202-507	09CD082	Bancroft Creek (County Ditch 63)	10.9	5	35.9	33.81	11-Aug-09
07080202-507	09CD075	Bancroft Creek (County Ditch 63)	33.8	6	46.8	31.13	19-Aug-09
HUC 11: 07080202020 (Shell Rock River Watershed)							
07080202-501	04CD037	Shell Rock River	147.72	6	46.8	33.12	31-Aug-04
07080202-501	09CD087	Shell Rock River	147.89	6	46.8	36.24	19-Aug-09
07080202-501	04CD017	Shell Rock River	152.30	6	46.8	29.54	31-Aug-04
07080202-501	04CD017	Shell Rock River	152.30	6	46.8	47.65	09-Sep-04
07080202-501	09CD088	Shell Rock River	167.88	6	46.8	38.05	19-Aug-09
07080202-501	04CD015	Shell Rock River	187.08	6	46.8	49.09	31-Aug-04
07080202-501	09CD089	Shell Rock River	187.97	6	46.8	43.07	11-Aug-09
HUC 11: 07080202030 (Goose Creek Watershed)							
NONE							

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 (un-assessed)

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: 07080202010 (Fountain Lake)									
07080202-529	09CD085	County Ditch 65	7.1	3	100-51	50-36	35-0	36	15-Jun-09
07080202-527	09CD084	Unnamed ditch	7.7	3	100-51	50-36	35-0	35	10-Aug-09
07080202-527	09CD084	Unnamed ditch	7.7	3	100-51	50-36	35-0	42	16-Jun-09
07080202-526	09CD073	County Ditch 9	14.5	7	100-40	39-25	24-0	22	29-Jul-09
07080202-526	09CD073	County Ditch 9	14.5	7	100-40	39-25	24-0	14	16-Jun-09
07080202-516	09CD074	Unnamed creek	14.6	3	100-51	50-36	35-0	44	29-Jul-09
07080202-507	09CD093	Bancroft Creek (County Ditch 63)	29.4	7	100-40	39-25	24-0	15	28-Jul-09
07080202-531	09CD072	Unnamed creek	34.1	2	10-45	44-30	29-0	32	28-Jul-09
HUC 11: 07080202020 (Shell Rock River Watershed)									
07080202-511	04CD004	Unnamed ditch (County Ditch 16)	1.9	3	100-51	50-36	35-0	2	12-Jul-04
07080202-513	09CD086	County Ditch 16	3.5	3	100-51	50-36	35-0	60	01-Jul-09
07080202-533	09CD077	Judicial Ditch 20	7.9	3	100-51	50-36	35-0	52	28-Jul-09
07080202-535	09CD076	County Ditch 32	10.1	3	100-51	50-36	35-0	46	27-Jul-09
07080202-534	09CD079	Peter Lund Creek	15.3	3	100-51	50-36	35-0	57	27-Jul-09
07080202-508	09CD078	County Ditch 16	15.5	3	100-51	50-36	35-0	1	28-Jul-09
HUC 11: 07080202030 (Goose Creek Watershed)									
07080202-532	09CD081	County Ditch 40	8.8	3	100-51	50-36	35-0	59	28-Jul-09
07080202-510	07CD002	County Ditch 17	21.1	7	100-40	39-25	24-0	44	11-Aug-09
07080202-510	07CD002	County Ditch 17	21.1	7	100-40	39-25	24-0	50	16-Aug-07
07080202-510	04CD028	County Ditch 17	21.9	7	100-40	39-25	24-0	32	25-Aug-04
07080202-505	07CD071	Goose Creek (County Ditch 10)	61.5	2	100-45	44-30	29-0	57	27-Jul-09

Appendix 5.3 - Channelized stream reach and AUID IBI scores - macroinvertbrates (un-assessed)

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: 07080202010 (Fountain Lake)									
07080202-507	09CD093	Bancroft Creek (County Ditch 63)	29.37	6	100-48	47-32	31-0	27.29	05-Aug-09
07080202-531	09CD072	Unnamed creek	34.10	5	100-37	36-21	20-0	43.42	05-Aug-09
07080202-527	09CD084	Unnamed ditch	7.75	5	100-37	36-21	20-0	22.50	05-Aug-09
07080202-516	09CD074	Unnamed creek	14.61	6	100-48	47-32	31-0	29.69	05-Aug-09
07080202-526	09CD073	County Ditch 9	14.47	6	100-48	47-32	31-0	23.69	05-Aug-09
07080202-529	09CD085	County Ditch 65	7.06	6	100-48	47-32	31-0	30.16	05-Aug-09
HUC 11: 07080202020 (Shell Rock River Watershed)									
07080202-511	04CD004	Unnamed ditch (County Ditch 16)	1.86	6	100-48	47-32	31-0	17.94	09-Sep-04
07080202-511	04CD004	Unnamed ditch (County Ditch 16)	1.86	6	100-48	47-32	31-0	18.82	31-Aug-04
07080202-535	09CD076	County Ditch 32	10.11	6	100-48	47-32	31-0	33.96	18-Aug-09
07080202-535	09CD076	County Ditch 32	10.11	6	100-48	47-32	31-0	15.28	18-Aug-09
07080202-534	09CD079	Peter Lund Creek	15.26	6	100-48	47-32	31-0	47.03	18-Aug-09
07080202-508	09CD078	County Ditch 16	15.54	6	100-48	47-32	31-0	15.22	11-Aug-09
07080202-513	09CD086	County Ditch 16	3.50	5	100-37	36-21	20-0	33.93	18-Aug-09
07080202-533	09CD077	Judicial Ditch 20	7.90	6	100-48	47-32	31-0	41.93	19-Aug-09
HUC 11: 07080202030 (Goose Creek Watershed)									
07080202-532	09CD081	County Ditch 40	8.81	6	100-48	47-32	31-0	30.44	19-Aug-09
07080202-532	09CD081	County Ditch 40	8.81	6	100-48	47-32	31-0	33.50	19-Aug-09
07080202-510	07CD002	County Ditch 17	21.10	6	100-48	47-32	31-0	26.68	11-Aug-09
07080202-510	04CD028	County Ditch 17	21.92	6	100-48	47-32	31-0	30.37	31-Aug-04
07080202-510	04CD028	County Ditch 17	21.92	6	100-48	47-32	31-0	32.05	09-Sep-04
07080202-505	09CD071	Goose Creek (County Ditch 10)	61.49	6	100-48	47-32	31-0	21.00	11-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 Shell Rock 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
24-0014-00	Albert Lea	254	298	125	271	0.4	0.3	569	28515	---	48	50.11	0.4	4.66	H
24-0017-00	Goose	---	---	---	---	---	---	---	---	---	---	---	---	---	---
24-0018-01	Fountain (East Bay)	227	291	111	261.9	0.4	0.3	570	7481	---	49	13.13	0.1	13.87	H
24-0018-02	Fountain (West Bay)	205	389	89	400.1	0.6	0.2	570	15772	---	32	27.67	0	48.09	H
24-0024-00	White	287	213	173	165.5	0.5	0.4	566	366	---	62	0.65	0.3	1.01	H
24-0025-00	Pickeral	332	147	194	96.6	0.3	0.5	566	1170	---	74	2.07	0.9	1.03	H
24-0027-00	Lower Twin	164	331	54	315.1	0.3	0.3	569	2494	---	42	4.38	0.1	3.93	H
24-0031-00	Upper Twin	253	390	176	400.9	0.4	0.2	570	1733	---	32	3.04	0	8.98	H
24-0037-00	Sugar	---	---	---	---	---	---	---	---	---	---	---	---	---	---
24-0038-00	Halls	---	---	---	---	---	---	---	---	---	---	---	---	---	---
24-0040-00	School Section	---	---	---	---	---	---	---	---	---	---	---	---	---	---
24-0068-00	Mud	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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

*These depths were created by MPCA Staff.