

# Upper Red River of the North Watershed Monitoring and Assessment Report



Minnesota Pollution Control Agency

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## Authors

*MPCA Upper Red River Watershed Report Team:*

Nathan Mielke, Jessica Moore, Scott Niemela,  
Andy Butzer, Dave Christopherson,  
Kelly O'Hara, Bruce Monson, Kris Parson,  
Andrew Streitz, Steve Thompson, and  
Jack Frederick

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## Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 | [www.pca.state.mn.us](http://www.pca.state.mn.us) | 651-296-6300  
Toll free 800-657-3864 | TTY 651-282-5332

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# Executive summary

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The Upper Red River of the North Watershed (HUC-09020104) lies in the western portion of Minnesota. The watershed covers 371,689 acres and is comprised of seven lakes and 41 named stream assessment units (AUIDs). The primary land use is agricultural, accounting for over 80% of the landscape within the watershed.

In 2008, the Minnesota Pollution Control Agency (MPCA) conducted intensive watershed monitoring of the Upper Red River of the North Watershed's surface waters. Thirteen stations were sampled for biology at the outlets of variable sized subwatersheds within the Upper Red River of the North watershed. These locations included the mouth of Whiskey Creek, Comstock Coulee, and other outlets of major tributaries within the watershed. Due to the extensive modification and channelization in this watershed, many tributaries were non-assessable and will be deferred till a tiered aquatic life use (TALU) framework is developed. As part of this effort, MPCA also joined with the Buffalo-Red River Watershed District who completed stream water chemistry sampling at the outlets of Whiskey Creek and Wolverton Creek. Due to the watershed's limited natural ability for water retention there are no assessable lakes within the Upper Red River Watershed. Therefore, no lake water chemistry sampling was conducted.

Of the original 13 stations (11 AUIDs; multiple stations exist on two of the AUIDs) selected to be sampled for biology, only three AUIDs were assessable for either aquatic life or aquatic recreation. There are currently no stream AUIDs within this watershed that are fully supportive of aquatic life or aquatic recreation. Two AUIDs were found to be non-supportive of aquatic recreation and one was non-supportive of aquatic life use. Two stream AUIDs had insufficient information to make an assessment for aquatic life use and one AUID was not assessed for aquatic recreation due to the lack of information gathered. Aquatic biological impairments are isolated to specific reaches on the mainstem of Whiskey Creek. Due to the extensive modification and channelization in this watershed, many tributaries were not assessable and will be deferred until a tiered aquatic life use (TALU) standard is developed. However, channelized streams throughout the watershed are generally in fair to poor biological condition, with the exception of five sites with healthy fish communities. Water chemistry impairments involving turbidity and moderately high bacteria concentrations are common across the watershed's tributaries.

Overall, the results from the intensive watershed monitoring, and holistic assessment process, reveals that the Upper Red River of the North Watershed is in poor condition. The majority of streams in the watershed have been highly altered to promote farmland drainage. The highly altered landscape and stream channel characteristic have resulted in impaired conditions as measured with a broad suite of aquatic community, water chemistry, and stream habitat indicators. The main resource concerns within the watershed are wetland management, surface water quality, flood damage reduction, wildlife habitat, and soil erosion from wind and water (Natural Resources Conservation Service (NRCS) 2011). Many of the resource concerns relate directly to land use and development in the region (NRCS 2011). Land use modifications such as removal of buffers, tiling, and agricultural development result in increased sediment and pollutant loading to surface waters. In addition, hydrologic alteration, including channelization, ditching, and groundwater withdrawal may be contributing factors to the observed poor water quality conditions.

# I. Introduction

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Water is one of Minnesota's most abundant and precious resources. The MPCA is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) requiring states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption, and aquatic life. States are required to provide a summary of the status of the state's surface waters and to 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 be successful in preventing and addressing problems, decision makers need good information about the status of the resources, potential and actual threats, options for addressing the threats, and data on how effective management actions have been. 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 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 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. This monitoring strategy was implemented in the Upper Red River of the North Watershed beginning in the summer of 2008. This report provides a summary of all water quality assessment results, and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring, and monitoring conducted by local government units. Consequently, there is an opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at a 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.



## II. The watershed monitoring approach

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The watershed approach is a 10-year rotation for 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 results 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>).

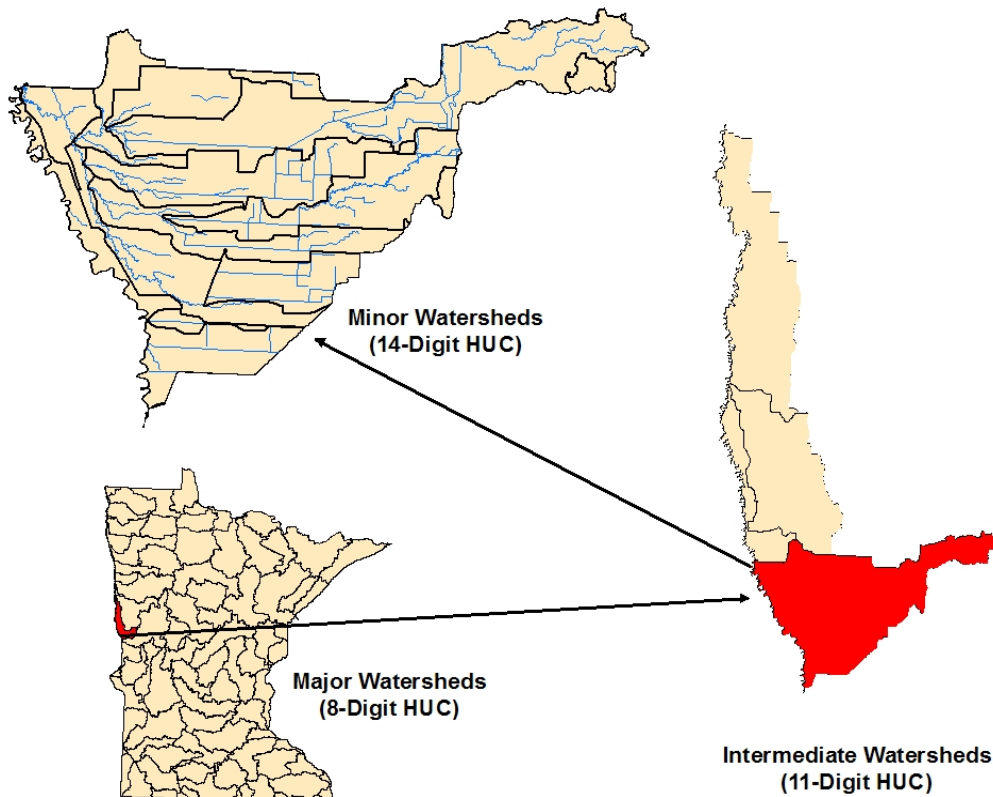


Figure 1: Minnesota's major watersheds (8-Digit HUC). Upper Red River of the North Watershed highlighted

### 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. The foundation of this comprehensive approach is the 81 major watersheds within Minnesota (Figure 1). Streams are broken into segments by hydrologic unit codes (HUC) to define separate water-bodies within a watershed. Sampling occurs in each major watershed once every 10 years. In this approach intermediate-sized (approximately HUC-11) 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 a good coverage of rivers and streams without monitoring every single stream reach (See Figure 3 for an illustration of the monitoring site coverage within the Upper Red River of the North Watershed).



**Figure 2: The intensive watershed monitoring design**

In most 8-digit HUC watersheds, the major outlet is sampled for biology, water chemistry, and fish contaminants to allow for the assessment of aquatic life, aquatic recreation, and aquatic consumption. However, this watershed includes a segment of the Red River mainstem as well as the smaller tributary streams that enter into it. This report will include only data collected from the tributary streams. The mainstem Red River will be sampled and the results published in a separate report following a future longitudinal survey of the Red River. Because the tributary streams entering the Red River in this watershed are relatively small and contain few game fish during the summer index period, there is no assessment of aquatic consumption. Biology (fish and macroinvertebrates) and water chemistry are sampled for the assessment of aquatic life and aquatic recreation use-support at each HUC-11 outlet (green dots in Figure 3). Watersheds at the 11-digit HUC scale typically have drainage areas ranging from 75 to 150 square miles. Lastly, most minor watersheds (typically 10-20 square miles) are sampled for biology only to assess aquatic life use-support (red dots in Figure 3). Specific locations for stations sampled as part of the intensive monitoring effort in the Upper Red River of the North Watershed can be found in Appendix 4.2 and 4.3.

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



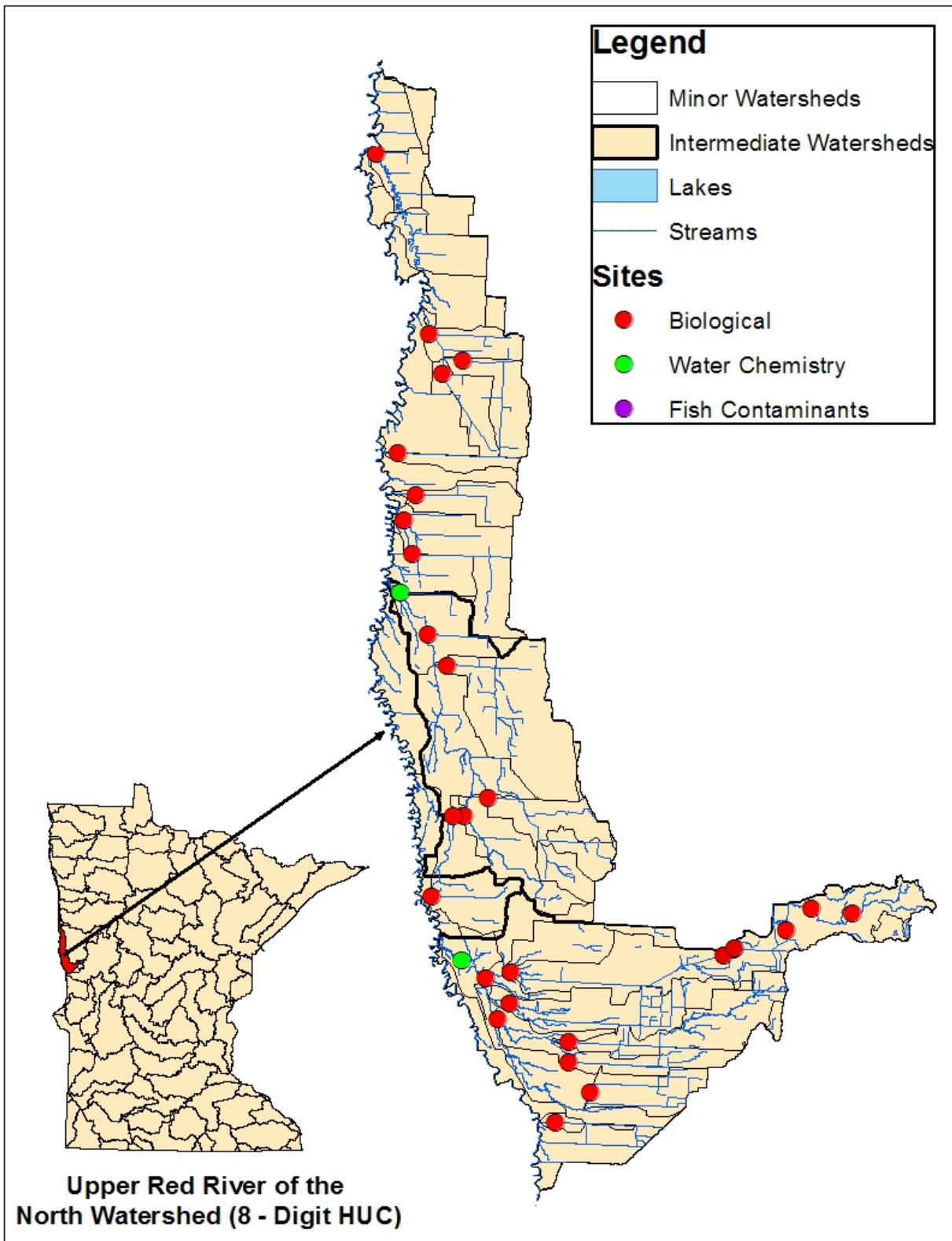


Figure 3: Intensive watershed monitoring stations in the Upper Red River of the North Watershed

## 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 advanced identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites too, so that water quality data collected by volunteers are available for the years before and after the intensive monitoring effort by MPCA staff. This citizen-collected data helps agency staff interpret the results from the intensive monitoring effort, which only occurs one out of every ten years. It also allows interested parties to track any water quality changes that occur in the years between the intensive monitoring events. Coordinating with volunteers to focus monitoring efforts where it will be most effective for planning and tracking purposes will help local citizens/governments see how their efforts are being used to inform water quality management decisions and affect change. Figure 4 provides an illustration of citizen monitoring data used for assessment in the Upper Red River of the North Watershed.

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

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

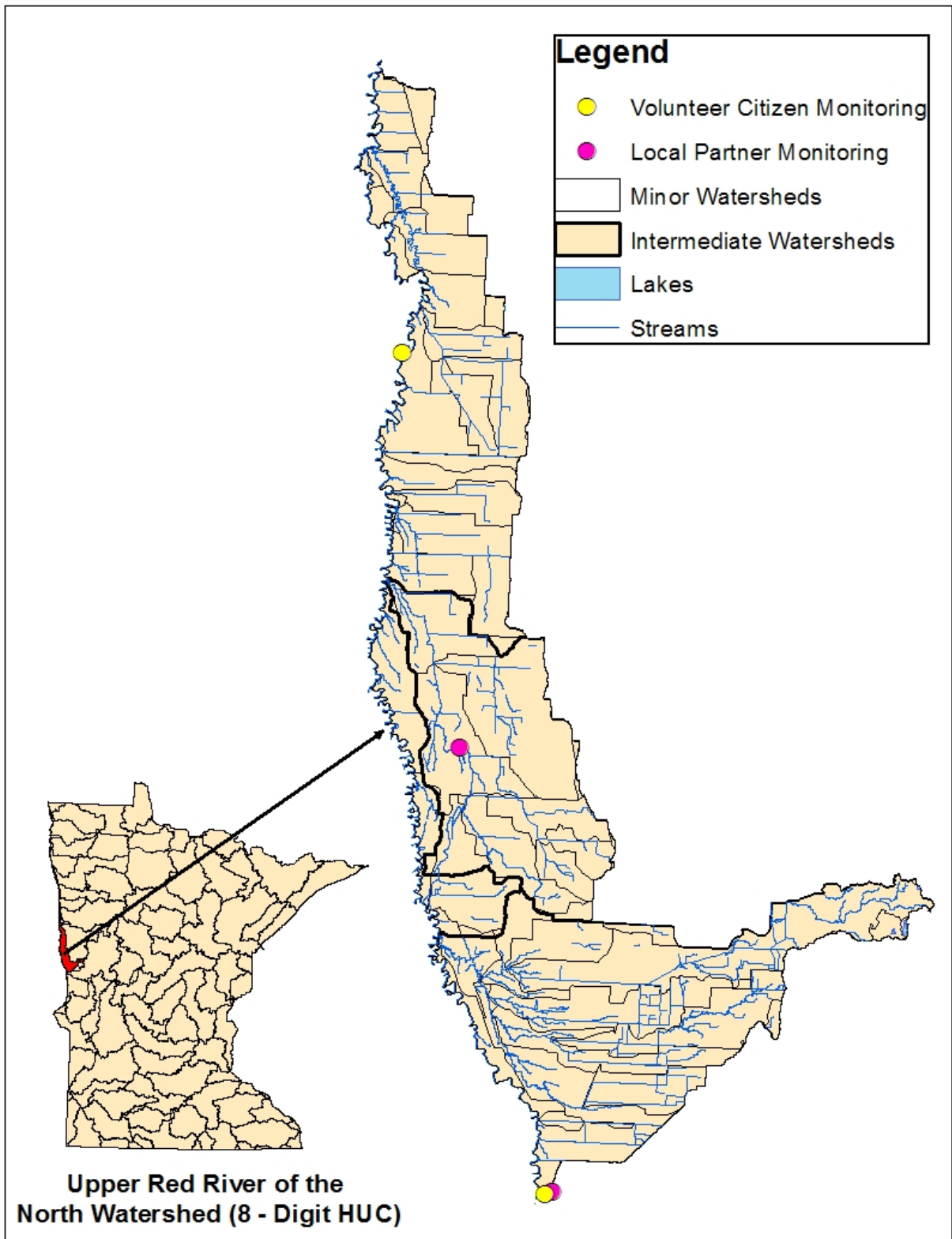


Figure 4: Monitoring locations of the local groups, citizens, and the MPCA lake monitoring staff in the Upper Red River of the North watershed

### III. Assessment methodology

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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=16988>).

#### 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 is a term describing the degree to which environmental indicators are either above or below criteria specified by Minnesota Water Quality Standards (Minn. R. 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.

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 (F-IBI), which evaluates the health of the fish community, and the macroinvertebrate index of biological integrity (M-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 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 5.

The first step in the aquatic life assessment process is a comparison of the monitoring data to 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).

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) for guidelines and factors to consider when making such determinations (<http://www.pca.state.mn.us/index.php/view-document.html?gid=16988>).

Any new impairment determination (i.e., waterbody not attaining its beneficial use) is reviewed using GIS to determine if greater than 50% of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the tiered aquatic life use 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 some watersheds may be channelized, as is the case in this watershed, reaches with biological data are evaluated on a “good-fair-poor” system and reported in tables for each HUC-11 as well as in Appendix 5.2 and 5.3.

The last step in the assessment process is the Professional Judgement Group or Professional Judgement Group meeting. At this meeting results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might 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 Environmental Quality Information System (EQiS), MPCA’s data system. MPCA uploads the data from EQiS to USEPA’s STORET data warehouse. Water quality monitoring projects required to store data in EQiS are those with federal or state funding under CWA Section 319, CWP, CWLA Surface Water Assessment Grants, and the Total Maximum Daily Load (TMDL) program. Many local projects not funded by MPCA choose to submit their data to the MPCA in EQiS-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.



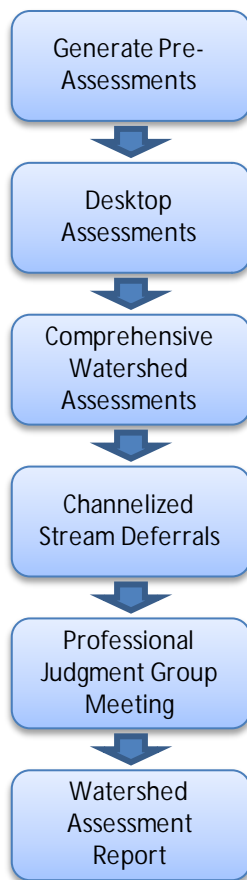


Figure 5: Flow chart of the aquatic life use assessment process

## IV. Watershed overview

Originating from the confluence of the Bois de Sioux and Otter Tail Rivers, the Upper Red River of the North flows north about 133 river miles before it meets the outlet of the Buffalo River. The watershed straddles the border between Minnesota and North Dakota. Unless noted otherwise statistics reported in the watershed overview section are for the entire watershed including that portion of the watershed lying within North Dakota. This watershed drains an area of 581 square miles and includes the cities of Breckenridge, Minnesota in the south and Fargo, North Dakota and Moorhead, Minnesota in the north. Major tributaries in Minnesota are Wolverton and Whiskey Creeks and in North Dakota there are many smaller streams that contribute to the Red River of the North. The United States Geological Survey hydrologic unit code (HUC) is 09020104.

The Minnesota portion of the Upper Red River of the North watershed includes parts of three Minnesota Counties: Clay, Otter Tail, and Wilkin (Figure 6). The drainage area in Minnesota is 441 mi<sup>2</sup> or 282,062 acres, which is 75.9% of the entire watershed. The majority of the watershed in Minnesota is in the Lake Agassiz Plain (LAP) ecoregion with only a very small portion of the North Central Hardwood Forest ecoregion occurring in the south eastern portion of the watershed (White and Omernik 2007) (Figure 6). The LAP is dominated by glacial sediments and glacial landforms deposited from the Des Moines Lobe of Wisconsin Glaciation approximately 12,000 year ago. There are three main landform types formed from Glacial Lake Agassiz; Lake Agassiz plain, Agassiz beach ridge, and Glacial Moraine. The Lake Agassiz Plain consists of glacial lake deposits of clay and silt from the ancient lake bed. The Agassiz Beach Ridge is characterized by glacial lakeshore deposits of delta sand and gravel, with the Glacial

Moraine being primarily deposits of clay, silt, sand, gravel, cobble, and boulders (NRCS, 2011). Soils in this watershed range from somewhat poorly drained to very poorly drained and are classified as Mollisols and Vertisols (Figure 7).

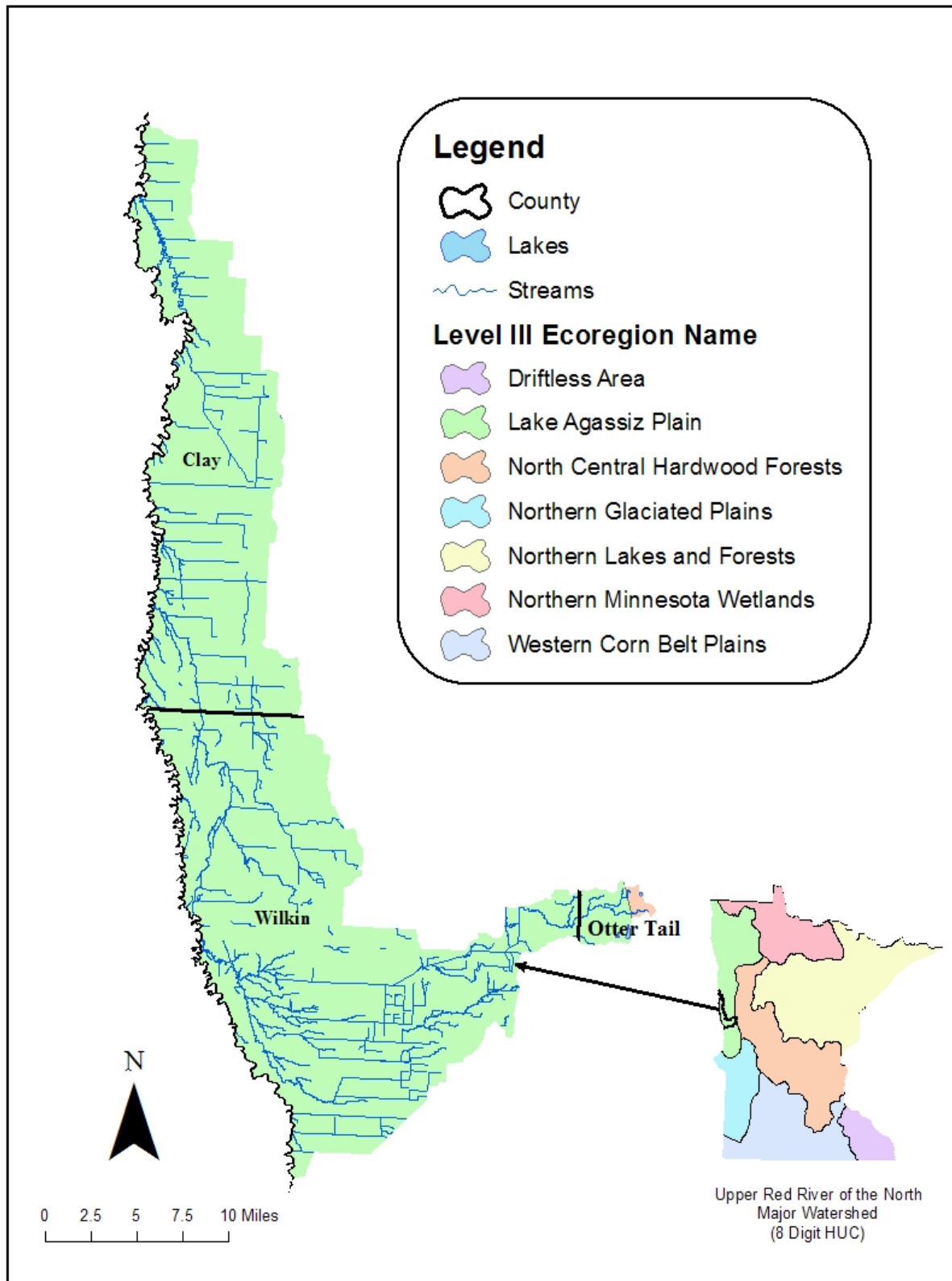


Figure 6: The Upper Red River of the North Watershed Level III Ecoregions

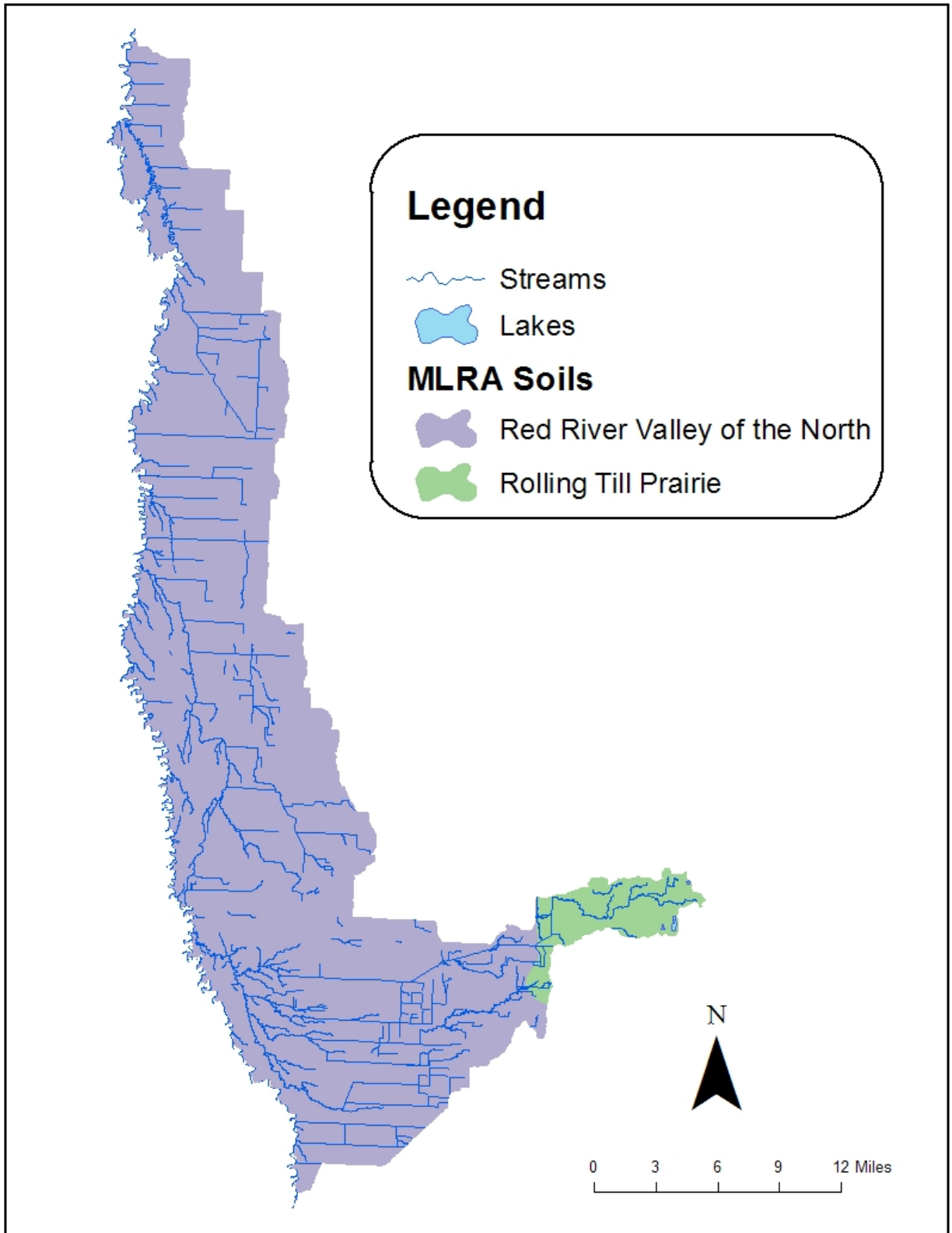


Figure 7: Soils of the Upper Red River of the North Watershed

## Land use summary

Historical land cover in the Upper Red River of the North watershed was mainly tall grass prairie and wet prairie prior to western settlement in Minnesota (Marschner, 1975). The tall grass prairie included species such as Indian grass, big bluestem, asters, and goldenrod. The wet prairie was a mixture of grasses, forbs, and shrubs. The grasses of the wet prairie included big bluestem and prairie cord grass. Forbs in this type of prairie were primarily represented by species such as goldenrods, sunflowers, and asters. The willow dominated the shrub species in the wet prairie and had patchy or limited extent (Emmons and Oliver Resources, 2009). Larger streams and rivers had narrow forested floodplains, followed by broader zones of woodland or brushland (MDNR, 2011). Frequent prairie fires provided the forested areas with protection, except in areas along streams where fire shadows existed, which were the broad zones of woodland or brushland consisting of elm, ash, cottonwood, and box elder trees (Red River Flood Damage Reduction Working Group, 2001).

The late 1800s brought western settlement and a major land use change in the Red River Valley. The main avenues of transportation during this time were riverboats and railways, which opened much of this area to the settlers (Waters, 1977). The land was beginning to transform from river valley into productive farms of substantial acreage. Farming the river valley proved to be a challenge due to the poorly drained soils. Due to the railroad having success with drainage ditches, the farmers soon started to use this method to drain the wet soil on their farms. Minnesota recognized the need for drainage work and then passed a comprehensive bill to deal with the issue in 1883. Then in 1887 the law was expanded and North Dakota enacted a similar law in 1893 (Krenz and Leitch, 1993). The extensive drainage ditch networks reduced the amount of water on the land to facilitate farming.

Today, in just the Minnesota portion of the this watershed, land cover is distributed as follows: 84.97% cropland, 8.0% developed, 3.42% wetlands, 2.06% rangeland, 0.84% forest/shrub, 0.75% open water, and 0.01% barren/mining (Figure 8).

Approximately 99% of the land within this watershed is owned by private landowners. Agriculture is the most extensive land use practice within the area and very little of the natural vegetation remains. The vast majority of streams have been channelized and an extensive ditch network has been constructed to facilitate drainage for agriculture. About 71% of the farmers are full time producers and only 29% are part time producers. There are an estimated 377 farms that range from the small family farm to large operations of 1,000 acres or more. The average farm size is 113 acres, with 69% of the farms being less than 500 acres in size. There are only 39 permitted feedlots within the watershed, with 4% cattle (beef and dairy), 6% swine, 38% turkey, and 51% being other animals (NRCS, 2011). The main row crops are spring wheat, soybeans, potatoes, sugar beets, corn, oil-producing crops, and edible beans (USDA, 2006).

The population of this watershed is estimated at 138,908, equating to roughly about 230 people per square mile. This number is heavily influenced by the population residing in Fargo, North Dakota, which is not within the scope of this report. As of 2010 the population of Fargo, North Dakota was 105,549, which is roughly 75% of the total population within the watershed. The largest population centers are located on the US Highway 75, I-94, and US Highway 10 corridors, including the major cities of Breckenridge/Wahpeton, Dilworth, and metropolitan area Fargo/Moorhead. There are many small cities along these corridors, which include Comstock, Kent, Rothsay, Sabin, and Wolverton.

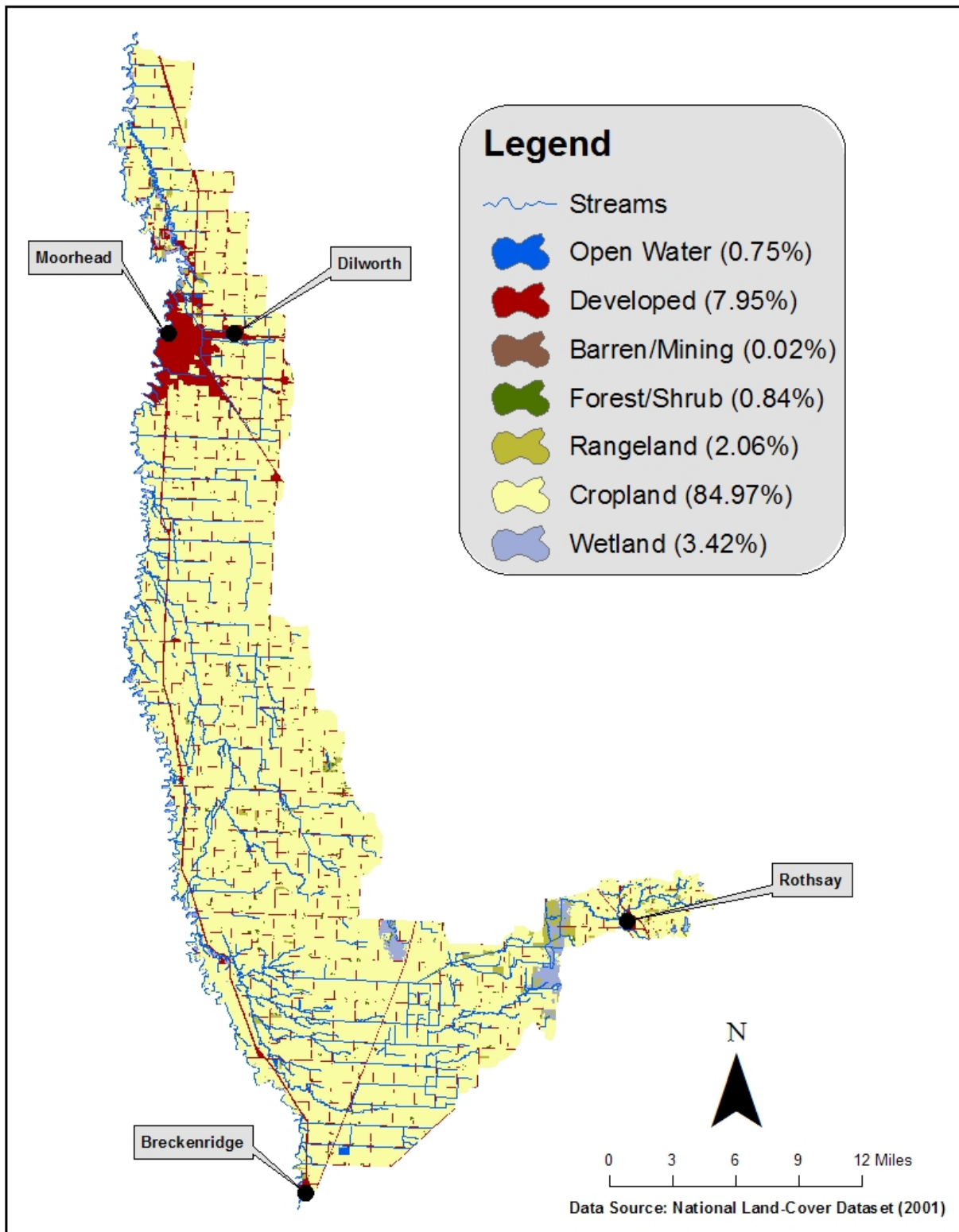


Figure 8: Land use in the Upper Red River of the North Watershed

## Surface water hydrology

The Upper Red River of the North originates from the confluence of the Bois De Sioux River and the Otter Tail River, which meet in the far west central part of Wilkin County, Minnesota. From here, the river then continues to flow north into Clay County and it eventually meets the outlet of the Buffalo River. The mainstem Red River of the North flows all the way into Manitoba and eventually empties into Lake Winnipeg. The mainstem of the Red River of the North spans a course of 400 miles, dropping 210 feet in elevation, and averages a gradient of about a half a foot per river mile (Waters, 1977).

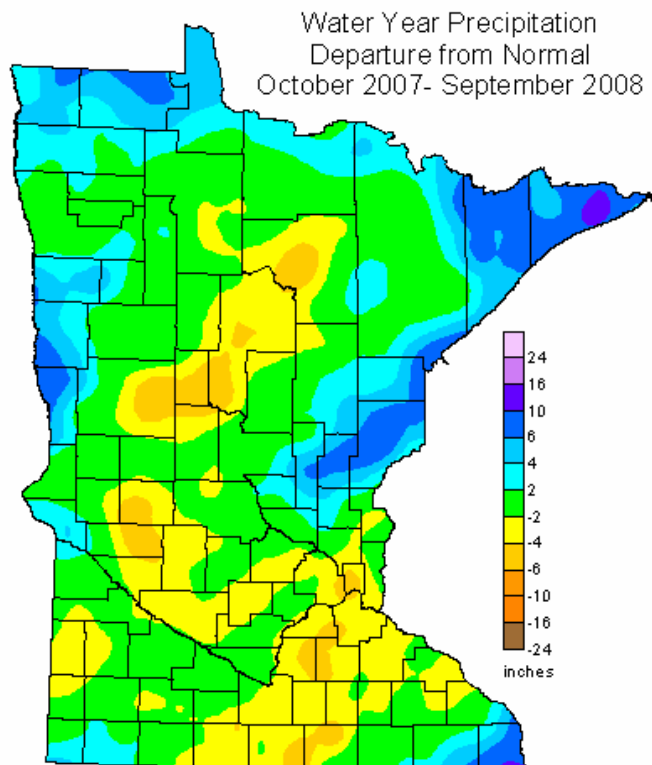
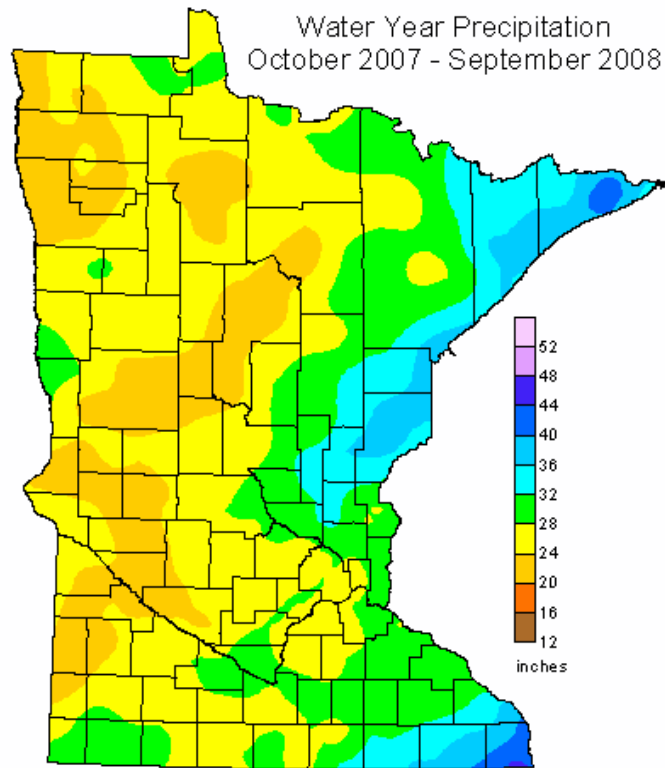
The Upper Red River of the North watershed in Minnesota contains four intermediate watersheds and 38 minor watersheds. This watershed has seven small lakes with a combined surface area of 193 acres. There are 1557 acres of wetlands in this watershed. Within the watershed, there are two dams and these are located on the mainstem of the Red River (MNDNR, 2007). There is a flood diversion project at the confluence of the Otter Tail River, Bois de Sioux, and the Red River of the North, in the city of Breckenridge. A large flood diversion project that will divert flow from the Red River around Fargo, ND is in the planning stages.

Whiskey Creek and Wolverton Creek are the two main tributaries in Minnesota. Together these tributaries account for the majority of water draining into the mainstem of the Red River. Both tributaries have been extensively channelized and also have a significant amount of drainage ditches contributing to them. They are both very low gradient streams with fine textured stream beds of silt and clay. Consequently, the stability of these streams can be influenced by the backwater flooding of the mainstem Red River (EOR, 2009). The increased periods of saturation combined with increased stream flows due to channelization, result in an increased rate of bank erosion in these streams. The bank instability and erosion is extremely evident at the mouth of Wolverton Creek (Simon et Al., 2008 and EOR, 2009). This instability of the streams seems to suggest that the stream channels are changing. In fact historical land survey notes from the 1870's suggest that parts of Whiskey Creek are about 50% narrower now than in pre-settlement times (EOR, 2009). This narrowing suggests that the stream is incising to accommodate increased flows or it was channelized for drainage purposes.

## Climate and precipitation

Annual precipitation levels in the watershed range from 27.41 to 35.16 inches (Minnesota State Climatologists Office, 2011). During the October 2007-September 2008 water year, which encompasses the time span in which the majority of the data was collected in the watershed, the precipitation levels were slightly to moderately higher than normal (Figure 9).





**Figure 9: Precipitation in the Upper Red River of the North Watershed**

## V. Watershed wide data collection methodology

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### Pollutant load monitoring

The Upper Red River of the North watershed has no load monitoring stations. Information on water pollutant loads for the mainstem Red River of the North will be included in a future report.

### Stream water sampling

A total of two water chemistry stations (Figure 10) were sampled in the summer of 2008 and 2009 to provide data for water quality assessments. The monitoring took place cooperatively between staff from the MPCA and the Red River Watershed Management Board (RRWMB). These water chemistry sites were located near the outlets of intermediate (HUC-11) watersheds, following the MPCA's watershed monitoring approach.

The HUC-11 outlet water chemistry data are summarized in Tables 4 and 8, and include those parameters most closely related to the standards or expectations used in the waterbody assessments (i.e. supporting aquatic life and aquatic recreational use). Not all water chemistry parameters of interest have developed water quality standards. McCollor and Heiskary (1993) developed ecoregion expectations for a number of water quality parameters in streams. These guidelines provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. The ecoregion expectations were based on the 75<sup>th</sup> percentile from a long term dataset of least impacted streams.

### Stream biological sampling

A total of 13 biological stations were established throughout the watershed and sampled during the summer months of 2008 (Figure 10). Most of these stations were located near the outlets of the 11-digit HUC watersheds and minor HUC-14 watersheds. Originally, there were 29 stations selected for biological sampling but 16 were deemed non-sampleable due to the stations being dry, insufficient flows (<50% of the reach has water), impoundments, or no channel or water body present. While data from the last ten years was used for this assessment, the majority of data used was collected in 2008. A total of 11 AUIDs were sampled for biology in the Upper Red River of the North watershed (i.e. two AUIDs had two stations each) with three AUIDs being assessed for aquatic life use support. Of these, one AUID had sufficient information to make a judgment on aquatic life use support and the other two sites were not assessed due to insufficient information (i.e. other sites located on the same AUID that were >50% channelized) but were still assessed for aquatic recreation. Certain AUIDs were not assessed due to the fact that biological criteria for channelized, coldwater streams, and large rivers were not developed at the time of the assessments. A total of seven AUIDs in the Upper Red River of the North watershed were not assessed due to channelized conditions of the stream channel within the sampling reach and one AUID was not assessed because of its status as a limited resource value water (i.e. class 7, also was channelized).

To measure the health of the biological communities at each assessable biological monitoring station, Indices of Biological Integrity (IBI) were used, specifically the Fish Index of Biological Integrity (F-IBI) and the Macroinvertebrate Index of Biological Integrity (M-IBI). The F-IBI and M-IBI partition streams into seven distinct warm water classes and two coldwater classes to account for natural, physical, and biological differences associated with different regions of the state, drainage area, gradient, and water temperature (Appendix 4.1). Fish and macroinvertebrate communities within each class are more similar to each other than those occurring in other classes. By partitioning, or accounting for the natural

variation in streams, any changes in IBI scores within a class should reflect real change due to human-induced impacts. Each class specific IBI has a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals. IBI scores higher than the upper confidence limit reflect good biological condition, while scores below the lower confidence limit reflect poor biological condition. 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, refer to Appendix 4.2-4.3.

## Fish contaminants

Mercury and polychlorinated biphenyls (PCBs) have been analyzed in fish tissue samples from the Upper Red River from 1979 to 2010 by the MDNR fisheries. Over that time, 10 fish species have been analyzed. In 2010, only channel catfish were collected.

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

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These studies identified that high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. This implied that it was not necessary to continue widespread frequent monitoring of smaller river systems as is done with mercury. However, limited PCB monitoring was included in the watershed sampling design to ensure that this conclusion is still accurate. Impairment assessment for PCBs in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health. If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs, the MPCA considers the lake or river impaired. The threshold concentration for impairment is 0.22 mg/kg PCBs and more restrictive advice is recommended for consumption (one meal per month).

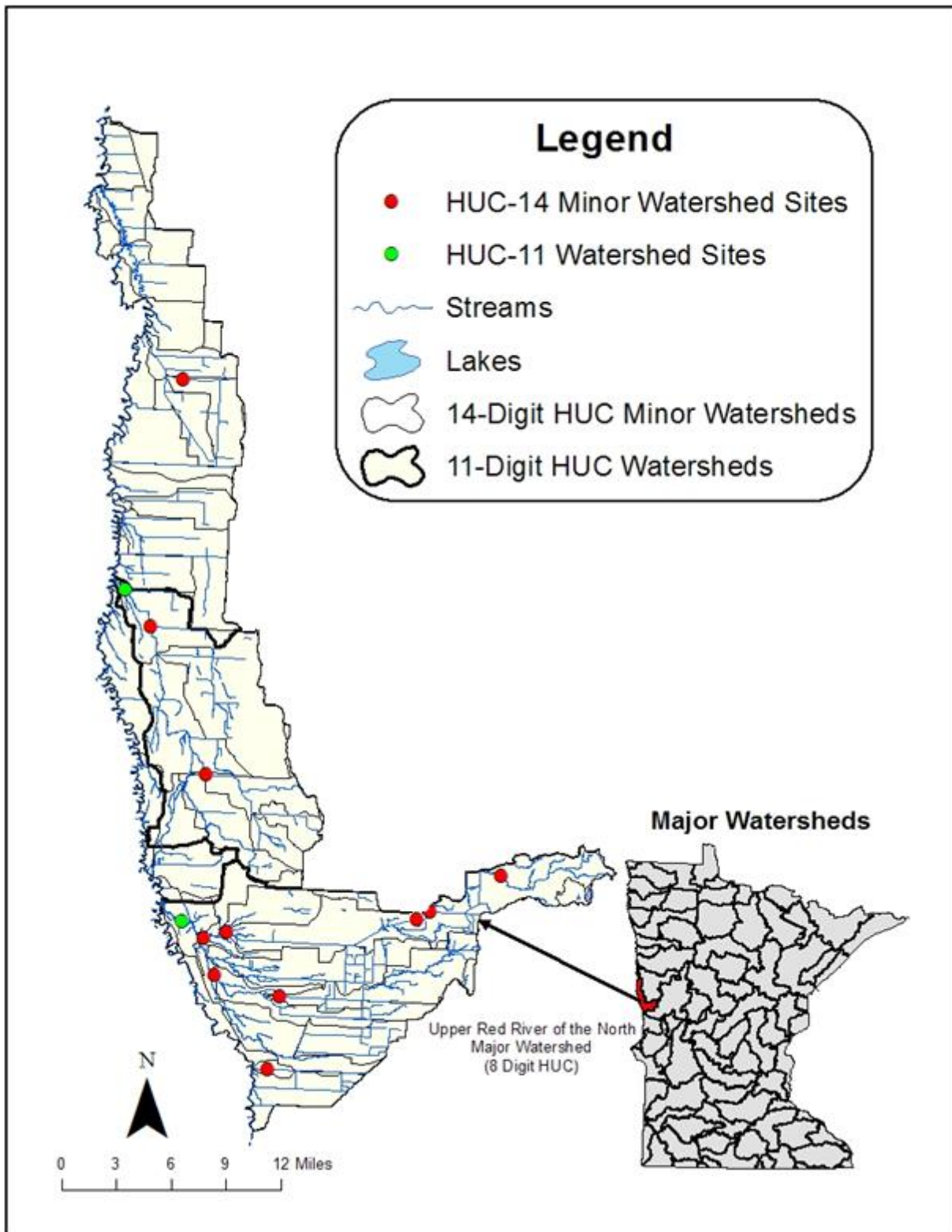


Figure 10: Intensive watershed monitoring stations in the Upper Red River of the North Watershed

## Lake water sampling

Due to the limited natural ability for water retention and drainage, there are no assessable lakes within the Upper Red River Watershed. Only one lake within the Upper Red River watershed is classified as protected by the MDNR. Nelson Lake (56-1015-00) lies in the eastern tip of the Whiskey Creek subwatershed. Neither assessment level data nor CLMP trend data is available for this lake. All other waterbodies within the Upper Red River watershed have a wetland classification or are listed as a non-protected pit. No lake water chemistry sampling was conducted and there will be no further discussion regarding lakes in this report. However, consideration should still be given to these water bodies when determining the dynamics of how water travels and is influenced throughout the watershed.

## VI. Individual HUC-11 watershed results

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Assessment results are presented for each HUC-11 watershed unit within the Upper Red River of the North Watershed, enabling the assessment of all surface waters at one time and the ability to develop comprehensive TMDL studies on a watershed wide basis rather than the reach by reach and parameter by parameter approach that has been typically employed historically. 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 TMDL's and protection strategies. The primary objective of this monitoring strategy 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 most recent 2011 assessment cycle as well as any impairment listings carried forward from previous assessment cycles. Discussion of assessment results will focus primarily on the 2008 intensive watershed monitoring effort, but will also consider all available data from the last ten years. The Red River of the North 11-digit HUC 09020104020 is a mainstem section of stream with no sampleable tributaries. Monitoring results for this section of the Red River mainstem will be included in a future report describing the results of the longitudinal survey for the Red River of the North.

Given all of the potential sources of data and differing assessment methodologies for assessing indicators and designated uses, it is not feasible to provide results or summary tables for every monitoring station by parameter. However, in the proceeding pages an individual account of each 11-digit HUC sub-watershed is provided. Within each account, readers are given a brief description of the watershed along with a series of tables including a 1) stream assessment table, where an overall assessment result is provided for each AUID by each assessable parameter and designated use (i.e. aquatic life and aquatic recreation), 2) non-assessable AUID table where a general indication of condition is provided for channelized streams (where applicable), 3) a stream habitat results table, 4) a watershed outlet water chemistry results table, 5) a table describing lake water chemistry (where applicable) and finally, 6) a narrative that summarizes the unique components of the assessment and highlights noteworthy findings in the results.

### Stream assessment

This table provides a summary of all assessable AUIDs by parameter within the watershed (where sufficient information was available to make an assessment). The tables denote the use support status of each individual water chemistry and biological parameter, as well as an overall use support assessment for aquatic life and aquatic recreation for each assessable AUID. The assessment for aquatic life is derived from analyzing biological data, DO, turbidity, chloride, pH, and NH<sub>3</sub> to determine use status, while the assessment for aquatic recreation in streams is solely based on E. coli concentrations. Immediately following the AUID-specific use support results, the location of any assessed biological

monitoring sites are listed. Water chemistry station locations are not provided because information collected as specific locations within each AUID are combined for the purposes of conducting water body assessments. Some AUIDs within the sub-watershed do not have sufficient information for assessment and are not included in this table. Following the stream assessment table is a table describing a narrative biological condition of stations that could not be assessed due to their occurrence on channelized AUIDs, and is not an assessment for aquatic life for these systems. For more information regarding water chemistry parameters monitored in these studies refer to Appendix 1. A complete listing of all AUIDs within the watershed may be found in Appendix 3.

## Channelized stream assessment

Ratings of **Good** for channelized streams are based on Minnesota's general use threshold for aquatic life. 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**. For more information regarding channelized stream parameters refer to Appendices 5.1 – 5.3.

## Stream habitat results

These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) surveys that are conducted during each fish sampling visit. The MSHA provides information on available fish habitat, land use and buffers along the immediate site reach, providing clues for impacts such as siltation or eutrophication which may lead to unhealthy fish and macroinvertebrate communities. The MSHA score is comprised of numerous scoring categories including land use, riparian zone, instream zone (substrate, embeddedness, cover types and amounts) and channel morphology (depth variability, sinuosity, stability, channel development, velocity) which are summed for a total possible score of 100 points. Total scores for each category and a summation of the total MSHA score are included. Where multiple visits occur at the same station, the relative scores from each visit have been averaged. The final row in each table displays average MSHA scores for each scoring category for that particular sub-watershed. A qualitative habitat rating was then assigned to each station: Good  $\geq 66$ , Fair 45-65, or Poor  $\leq 44$ .

## Watershed outlet water chemistry results

These summary tables display the water chemistry results for the intensive watershed station representing the outlet of the HUC-11 watershed. This data can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. While not all of the water chemistry parameters of interest have developed water quality standards, McCollor and Heiskary (1993) have developed ecoregion expectations for a number of water quality parameters in streams. These ecoregion expectations provide a good basis for evaluating water quality data and estimating attainable water quality for an ecoregion. The ecoregion expectations were based on the 75<sup>th</sup> percentile from a long term dataset of least impacted streams.

## HUC-11 and HUC-8 figures

The figures presented for each of the following HUC-11 watershed units contain the assessment results from the most recent assessment cycle as well as any impairment listings carried forward from previous assessment cycles. Following the results by HUC-11 watershed are a series of figures that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Upper Red River of the North watershed (HUC-8).



# Whiskey Creek Watershed Unit

HUC 09020104010

The Whiskey Creek Watershed is the largest subwatershed in the Upper Red River of the North drainage, encompassing 165.63 square miles in Otter Tail and Wilkin Counties. This watershed contains the headwaters of the Red River of the North, which begins in far west central Wilkin County, an area of mixed residential and agricultural land use. The cities of Breckenridge, Minnesota and Wahpeton, North Dakota, as well as the small town of Kent are within the watershed. Land use is primarily cropland (86.6%) with much smaller percentages of developed land (5.3%), wetlands (4.1%), rangeland (2.3%), forest/shrub (0.9%), and open water (0.6%). As such, there are several point (e.g., wastewater treatment facilities) and numerous non-point (e.g., row crops, housing developments) pollution sources. Biological monitoring station 08RD052 represents the outlet of this subwatershed.

## Stream assessment

Table 1: Aquatic life and recreation assessment on the stream reaches in the Whiskey Creek Watershed. Reaches are organized upstream to downstream in the table

AUID <i>Reach Name, Reach Description</i>	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Aquatic Life	Aquatic Rec.	
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH <sub>3</sub>	Pesticides			Bacteria
09020104-516 <i>Unnamed creek, CD 6A to Whiskey Cr</i>	3.6	2B	08RD060	Upstream of Twp 48, 1.5 mi. SE of Kent	MTS	EXS	--	--	--	--	--	--	--	IF*	NA
09020104-520 <i>Whiskey Creek, T133 R47W S13, east line to Red R</i>	20	2C	08RD052	Downstream of Mainstreet, In Kent	MTS	EXS	IF	EXS	--	MTS	MT	--	EX	NS	NS

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

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

Key for Cell Shading:   = previous impairment or deferred impairment prior to 2012 reporting cycle;   = new impairment;   = full support of designated use.

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

†Reach was assessed based on use class included in table and existing use class as defined in Minn. Rule 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

Table 2: Non-assessed biological stations on channelized AUIDs in the Whiskey Creek 11-Digit HUC

AUID <i>Reach Name, Reach Description</i>	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
09020104-537 <i>Unnamed ditch, Unnamed ditch to Red R</i>	5	2B	08RD067	Adjacent to 310th St, 4 mi. N of Breckenridge	Poor (2)	Poor
09020104-531 <i>County Ditch 1A, Unnamed cr to CD 1B</i>	5.5	2B	08RD056	At Twp 184, 3.5 mi. NE of Brushvale	Poor	Poor
09020104-533 <i>Unnamed creek, Unnamed cr to Whisky Cr</i>	1	2B	08RD057	Upstream of Twp 54, 2 mi. N of Brushvale	Fair	Poor
09020104-518 <i>Unnamed creek, T135 R45W S25, north line to Unnamed ditch</i>	5	7	08RD079	Downstream of CR 19, 2 mi. E of Rothsay	Good	Poor
09020104-523 <i>Unnamed ditch (County Ditch 6A) Unnamed cr to Unnamed cr</i>	0.5	2B	08RD076	Upstream of CR 15, 7 mi. SW of Rothsay	Good	Fair (2)
09020104-524 <i>County Ditch 6A, Unnamed cr to Unnamed cr</i>	1.8	2B	05RD033	Downstream of CR 15, ~6 miles SW of Rothsay	Good	Fair
09020104-516 <i>Unnamed creek, CD 6A to Whiskey Cr</i>	3.6	2B	08RD054	Downstream of CR 3, 2 mi. E of Kent	Good (2)	Poor

Table 3: Minnesota Stream Habitat Assessment (MSHA) results for the Whiskey Creek 11-Digit 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	08RD056	County Ditch 23	0	6.5	7	10	10	33.5	Poor
1	08RD079	Unnamed creek	0	10.5	6.5	13	13	43	Poor
1	08RD076	County Ditch 6A	0	6	10.8	8	14	38.8	Poor
1	05RD033	County Ditch 6A	0	8	16	14	21	59	Fair
1	08RD057	County Ditch 1	0	7.5	13.6	10	12	43.1	Poor
2	08RD067	Trib. to Red River	0	7	15.2	7.5	17.5	47.2	Fair
1	08RD052	Whiskey Creek	0	7.5	8.45	12	17	44.95	Poor
2	08RD054	Trib. to Whiskey Creek	0.6	6.8	15.0	9.5	10.5	42.3	Poor
1	08RD060	Trib. to Whiskey Creek	0	7	8	9	13	37	Poor
<b>Average Habitat Results: <i>Whiskey Creek 11 HUC</i></b>			0.06	7.4	11.17	10.3	14.2	43.13	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 4: Outlet water chemistry results for the Whiskey Creek 11-Digit HUC**

Station location:	Whiskey Creek at Main Street in Kent											
Storet ID:	S004-881											
Station #:	08RD052											
Parameter	D.O.	E. Coli	NH <sub>3</sub>	NO <sub>2</sub> + NO <sub>3</sub>	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	C	cm
# Samples	21	19	10	10	10	21	9	10		21	21	21
Minimum	4.77	18.5	0.04	0.02	0.88	7.6	0.13	17		446	12.14	7.5
Maximum	9.64	816.4	0.08	1.28	1.51	8.27	0.42	79		1311	24.6	34.5
Mean	7.40	243.99	0.05	0.30	1.17	8.10	0.24	41.10		943.38	18.61	19.52
Median	7.17	146.7	0.05	0.11	1.24	8.18	0.21	36.5		1000	19.4	20
WQ standard <sup>1</sup>	5.0	126/1260	0.04			6.5 - 9.0		100			30	20
# WQ exceedances <sup>2</sup>	1/21	0/19	7/10	4/10	0/10	0/21	2/9	0/10		17/21	0/21	10/21
RRV 75th Percentile <sup>3</sup>			0.2	0.1		8.4	0.33	74		630	25	

<sup>1</sup>Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25

<sup>2</sup>Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

<sup>3</sup>Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCullor and Heiskary 1993).

\*\*Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Whiskey Creek 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.

## Summary

Only one AUID (09020104-520) within this watershed is assessable. Impairment for aquatic life was indicated by both biological (macroinvertebrate) and chemical (turbidity) measures taken near the outlet of Whiskey Creek. All other AUIDs within this watershed were predominantly channelized and therefore not assessed. However, the biological results from the upstream channelized streams suggest that the problems noted at the outlet can be traced back to poor biological and physical conditions in the upstream watershed where most stations have poor ratings for either fish or macroinvertebrates and the habitat is generally poor. One area of the watershed that performed better biologically was the far north eastern corner of the basin where F-IBI scores were good and two out of three macroinvertebrate stations were fair.

Not surprisingly in a watershed so dominated by channelization, the poor biological condition of streams in the watershed was associated with generally poor habitat conditions. Habitat scores ranged from poor to fair with most habitat sub-categories including land use, the amount of fish cover, and channel morphology all scoring poorly. The lack of good, quality habitat anywhere within the watershed may be an important factor affecting the health of streams and the aquatic communities found therein.

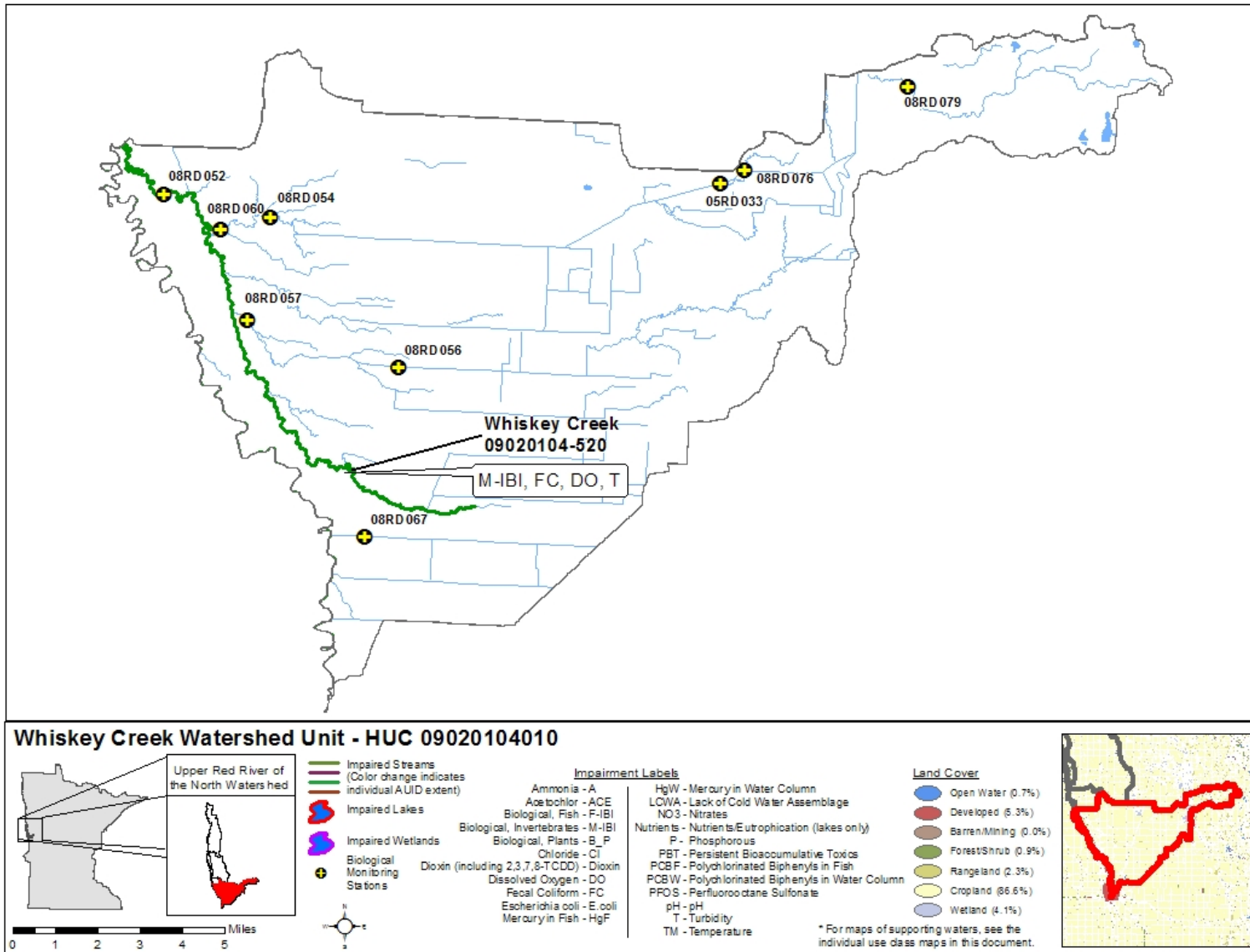


Figure 11: Currently listed impaired waters by parameters and land use characteristics in the Whiskey Creek Watershed Unit

## Red River of the North Watershed Unit

HUC 09020104020

The Red River of the North Watershed is the smallest watershed in the Upper Red River of the North drainage, encompassing 30.8 square miles in Clay and Wilkin Counties. This watershed contains numerous small tributaries and drainage ditches, which empty directly into the mainstem Red River. The mainstem of the Red River is located on the northern edge of the town of Kent and stretches north past the towns of Wolverton and then Comstock. Land use in this portion of the watershed is a mixture of cropland (82.3%), developed (7.3%), wetlands (6.7%), open water (2.6%), forest/shrub (0.9%), rangeland (0.05%), and barren/mining (0.01%). As such, there is several point (e.g., wastewater treatment facilities) and numerous non-point (e.g., row crops, housing developments) pollution sources throughout the watershed. The only biological monitoring station located in this subwatershed is station 05RD010, a mainstem Red River of the North site, which is not within the scope of this study. The agency has not yet started monitoring the main stem rivers in a comprehensive manner to collect the necessary biological and chemical data to fully determine aquatic life use support. Mainstem AUIDs will be reviewed in the future to determine aquatic life use support once the monitoring strategy for these rivers has been implemented.



## Red River of the North Watershed Unit - HUC 09020104020

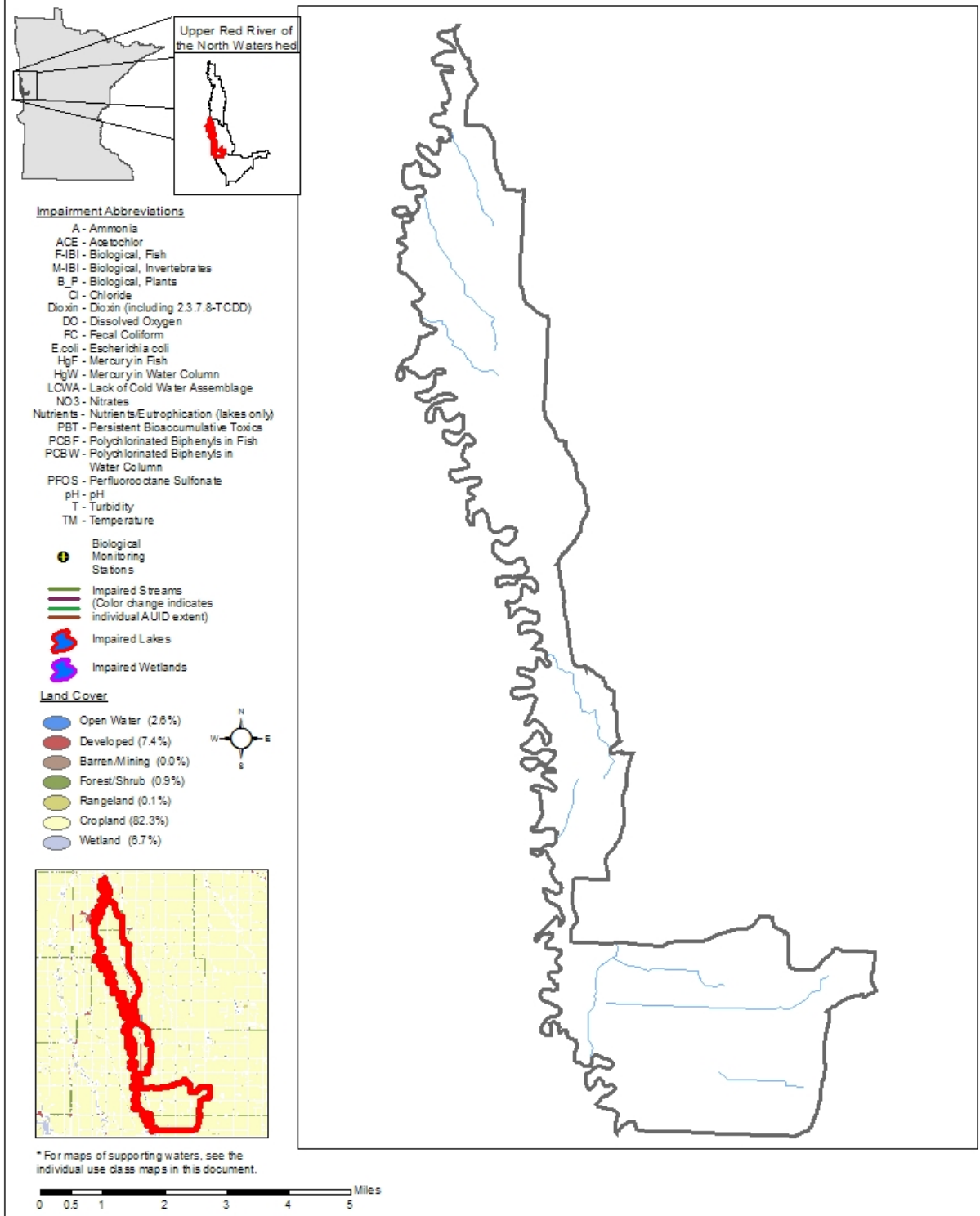


Figure 12: Currently listed impaired waters by parameters and land use characteristics in the Red River of the North Watershed Unit

## Comstock Coulee Watershed Unit

HUC 09020104030

The Comstock Coulee Watershed is the third largest subwatershed in the Upper Red River of the North drainage, encompassing 105.47 square miles in Clay and Wilkin Counties. This watershed contains the entire Wolverton Creek drainage, which begins in eastern Wilkin County, an area rich with agricultural land. The watershed includes the city of Barnesville and the small town of Comstock near its outlet to the mainstem Red River. Land use in this portion of the watershed is primarily cropland (92.87%) with smaller amounts of developed land (4.6%), forest/shrub (1.2%), rangeland (0.58%), wetlands (0.42%), open water (0.3%), and barren/mining (0.03%). There is several point (e.g., wastewater treatment facilities) and numerous non-point (e.g., row crops, housing developments) pollution sources throughout this subwatershed. Biological monitoring station 08RD051 represents the outlet of this subwatershed.

### Stream assessment

Table 5: Aquatic life and recreation assessment on the stream reaches in the Comstock Coulee Watershed. Reaches are organized upstream to downstream in the table

AUID <i>Reach Name, Reach Description</i>	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Aquatic Life	Aquatic Rec.	
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH <sub>3</sub>	Pesticides			Bacteria
09020104-512 <i>Wolverton Creek, Unnamed cr to Red R</i>	12.7	2C	08RD051	Downstream of 130th Ave S, 7 mi. NW of Comstock	EXS	EXS	EXS	EXP	MT	MTS	MT	--	EX	IF*	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:   = previous impairment or deferred impairment prior to 2012 reporting cycle;   = new impairment;   = full support of designated use.

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

†Reach was assessed based on use class included in table and existing use class as defined in Minn. R. 7050 is different. MPCA is currently in the process of changing the existing use class for this AUID in rule based on an analysis of the biological community and temperature data.

**Table 6: Non-assessed biological stations on channelized AUIDs in the Comstock Coulee 11-Digit HUC**

AUID <i>Reach Name, Reach Description</i>	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
09020104-538 <i>County Ditch 22, Unnamed Cr to Wolverton Cr</i>	2.4	2B	08RD065	At CR 30, 3 mi. E of Wolverton	Poor (2)	Poor
09020104-512 <i>Wolverton Creek, Unnamed Cr to Red R</i>	12.7	2C	08RD063	Downstream of CR 58, 1.5 mi. NE of Comstock	Good	Poor

**Table 7: Minnesota Stream Habitat (MSHA) results for the Comstock Coulee 11-Digit HUC**

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
2	08RD065	Trib. to Wolverton Creek	0	7	9	4	8.5	28.5	Poor
1	08RD063	Wolverton Creek	0	7.5	9.25	8	14	38.75	Poor
1	08RD051	Wolverton Creek	0	3.5	9.15	6	18	36.65	Poor
<b>Average Habitat Results: <i>Comstock Coulee 11 HUC</i></b>			0	6.0	9.1	6.0	13.5	34.6	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 8: Outlet water chemistry results for the Comstock Coulee 11-Digit HUC**

Station location:	Wolverton Ck at 130th Ave S, 3 mi NW Comstock											
Equis ID:	S005-322											
Station #:	08RD051											
Parameter	D.O.	E. Coli	NH <sub>3</sub>	NO <sub>2</sub> + NO <sub>3</sub>	TKN	pH	TP	TSS	TSVS	Spec. cond.	Temp.	T-tube
Units	mg/l		mg/l	mg/l	mg/L		mg/l	mg/l	mg/L	uS/cm	C	cm
# Samples	18	17	8	8	8	18	8	8		18	18	18
Minimum	2.62	21.3	0.04	0.02	0.83	7.26	0.31	10		258	13.07	4
Maximum	10.84	613.1	0.081	2.03	1.66	8.55	1.01	76		1252	26.94	66
Mean <sup>1</sup>	7.43	250.96	0.05	0.56	1.25	8.10	0.59	35.13		880.56	20.69	22.83
Median	7.70	172.2	0.04	0.04	1.27	8.22	0.54	31		993.5	20.63	20.75
WQ standard <sup>2</sup>	5.0	126/1260	0.04			6.5 - 9.0		100			30	20
# WQ exceedances <sup>3</sup>	2/18	0/17	3/8	3/8	0/8	1/18	7/8	0/8		14/18	0/18	9/18
RRV 75th Percentile <sup>4</sup>			0.2	0.1		8.4	0.33	74		630	25	

<sup>1</sup>Total suspended solids and Transparency tube standards are surrogate standards derived from the turbidity standard of 25

<sup>2</sup>Represents exceedances of individual maximum standard for *E. coli* (1260/100ml) or fecal coliform.

<sup>3</sup>Based on 1970-1992 summer data; see *Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions* (McCullor and Heiskary 1993).

\*\*Data found in the table above was compiled using the results from data collected at the pour point monitoring station in the Whiskey Creek 11 HUC, a component of the IWM work conducted in 2008 and 2009. This specific data does not necessarily reflect all data that was used to assess the AUID.

## Summary

Lower Wolverton Creek within the Comstock Coulee HUC-11 watershed unit (09020104-512) had enough data for assessment but the aquatic life assessment was deferred because the AUID was over 81% channelized (Table 5). The segment was assessed for aquatic recreation and found to be impaired due to high levels of *E. coli* bacteria.

Like Lower Wolverton Creek, most other segments within this watershed were predominantly channelized and therefore were not assessed. However, the data collected on the two channelized stations (08RD063 and 08RD065) suggest that the problems noted at the outlet can be traced back to poor biological and physical conditions throughout the watershed where most stations were rated poor for either fish or macroinvertebrates and the habitat was uniformly poor. The only bright spot in the watershed was at station 08RD063 where the fish IBI was rated good. However, even at this station the invert IBI was poor. Because macroinvertebrates are less mobile than fish they may be responding more to the poor habitat within the reach. Habitat scores in general were poor at all three stations with riparian, substrate, fish cover, and channel morphology all averaging poorly. Not surprisingly land use near the three stations all scored zeroes due to the extensive percentage of land being utilized as row crop. Overall this watershed is best characterized as having highly modified upland land uses and waterways that are highly modified to promote drainage. These practices appear to have had a direct negative impact on stream habitat and biota.

# Comstock Coulee Watershed Unit - HUC 09020104030

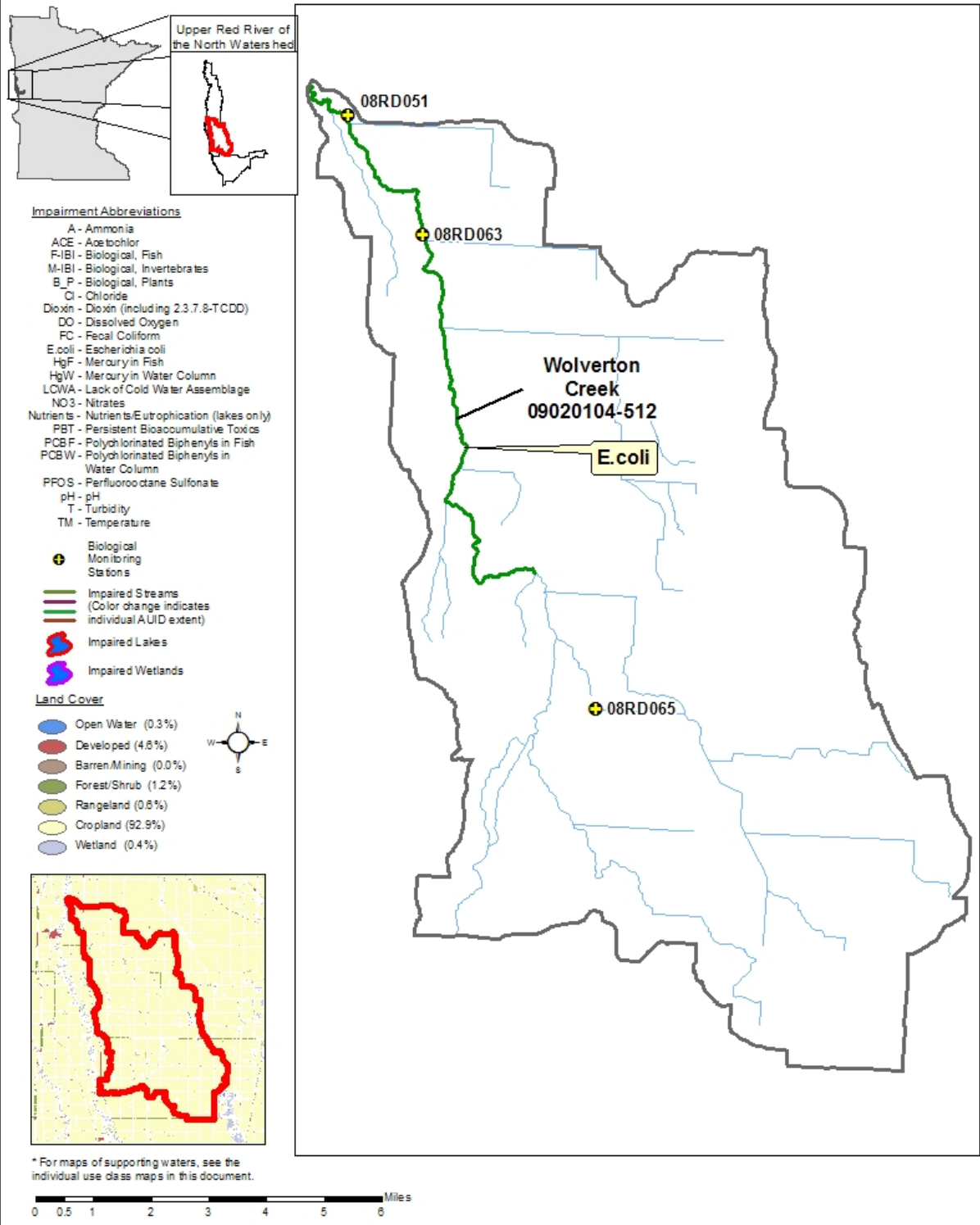


Figure 13: Currently listed impaired waters by parameters and land use characteristics in the Comstock Coulee Watershed Unit

## Red River of the North Watershed Unit

HUC 09020104060

The other Red River of the North Watershed is the second largest watershed in the Upper Red River of the North drainage, encompassing 138.47 square miles in Clay County. This watershed unit contains small tributaries and drainage ditches, along with the mainstem Red River up to the outlet of the Buffalo River. The watershed's southern and northern boundaries are roughly four miles northwest of Comstock to the town of Georgetown, respectively. This watershed also contains the densely populated areas of Moorhead and Dilworth. Also located in the far south eastern portion of the watershed unit, is the small town of Sabin. Land use in this watershed is a predominantly cropland (80.06%) with smaller percentages of developed land (15.03%), wetlands (2.74%), open water (0.98%), rangeland (0.68%), forest/shrub (0.49%), and barren/mining (0.02%). As such, there is several point (e.g., wastewater treatment facilities) and numerous non-point (e.g., row crops, housing developments) pollution sources throughout this subwatershed. This watershed unit contains one biological station on drainage ditch #41 (08RD072). There are no assessable stations in this watershed that are not on the mainstem of the Red River of the North. These mainstem stations will be assessed in a forthcoming report that will focus exclusively on the mainstem.

### Stream assessment

Table 9: Non-assessed biological stations on channelized AUIDs in the Red River of the North 11-Digit HUC

AUID <i>Reach Name, Reach Description</i>	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
09020104-539 <i>County Ditch 41, Unnamed ditch to CD 47</i>	3.0	2B	08RD072	At 4th Ave SW, in Dilworth	Poor	Poor

Table 10: Minnesota Stream Habitat Assessment (MSHA) results for the Red River of the North 11-Digit 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	08RD072	County Ditch 41	0	8	3	9	7	27	Poor
<b>Average Habitat Results: Red River of the North 11 HUC</b>			0	8	3	9	7	27	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)

## Summary

The lone sampleable station in this watershed (08RD072) on County Ditch #41 performed poorly for both fish and macroinvertebrates. The station also had the poorest habitat score (MSHA=27) of any station in the entire 8-digit HUC watershed. Although this station was not assessable, the data shows that habitat is having a direct effect on both the fish and macroinvertebrate communities. The agency has not yet started monitoring the main stem rivers in a comprehensive manner to collect the necessary biological and chemical data to fully determine aquatic life use support. The mainstem Red River of the North will be reviewed in the future to determine aquatic life use support once the monitoring strategy for these rivers has been implemented.



# Red River of the North Watershed Unit - HUC 09020104060

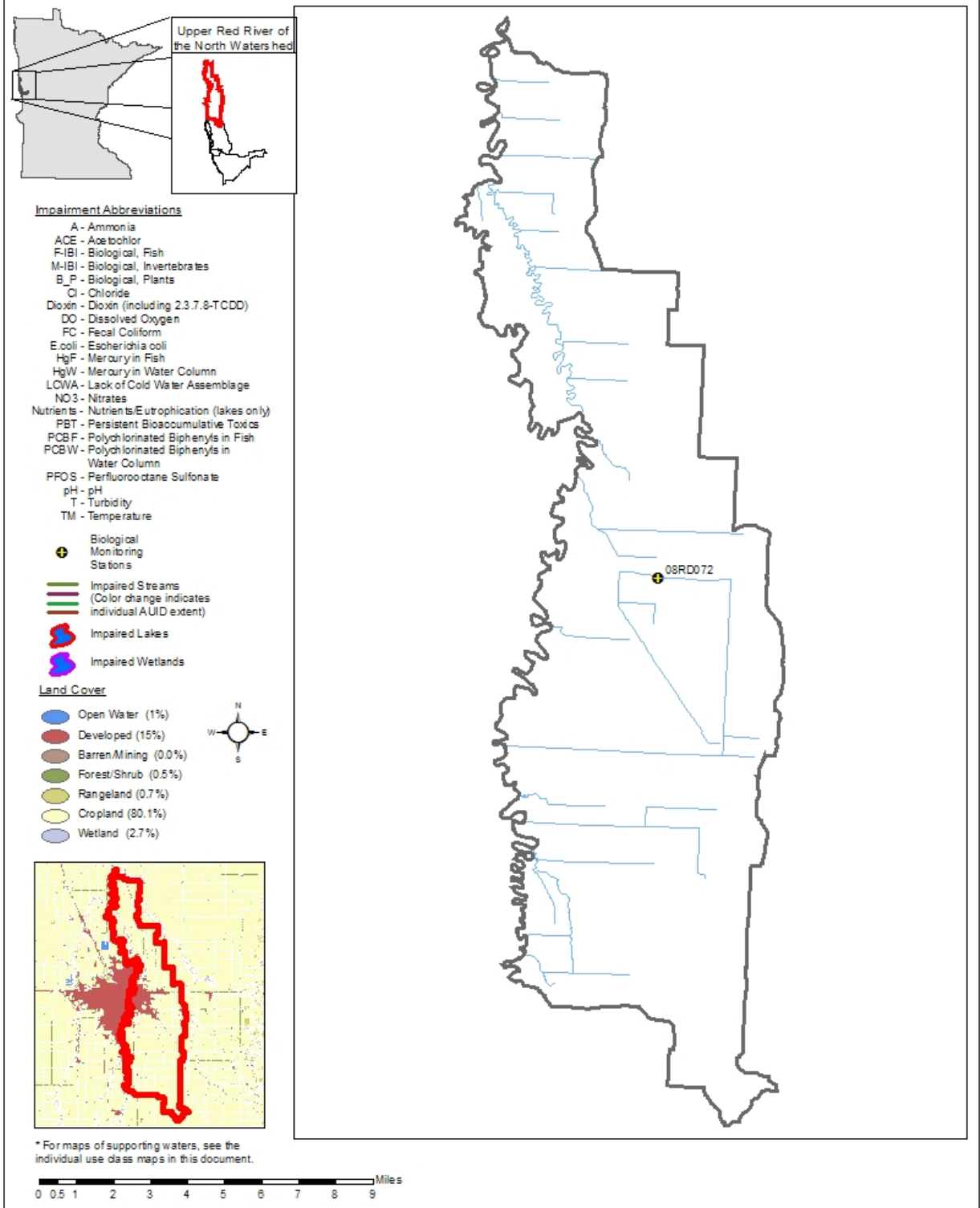


Figure 14: Currently listed impaired waters by parameters and land use characteristics in the Red River of the North Watershed Unit

## VII. Watershed-wide results and discussion

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Assessment results and data summaries for aquatic life and aquatic recreation are included in this section for the entire 8-digit HUC watershed unit of the Upper Red River of the North, grouped by sampling type. There is no summary of aquatic consumption, load monitoring and lake water quality results due to the small drainage area of streams and limited number of lakes in this watershed. A series of graphics that provide an overall summary of assessment results by designated use, impaired waters, and waters that fully support beneficial uses within the entire Upper Red River of the North watershed follows the results.

### Stream water quality

Overall, the lack of riparian cover found on many of the streams in the watershed, combined with the intensive agricultural land use and altered hydrology, result in poor water quality conditions throughout the watershed. Due to naturally occurring fine silts and clays, overland runoff, and stream bank scouring many tributaries in the watershed have elevated TSS and turbidity. High levels of bacteria were found in all subwatersheds that were assessed for bacteria (09020104-512 & 09020104-520). Dissolved oxygen was assessed only on lower Wolverton Creek (09020104-512), where it did not meet the standard and has been listed as a potential severe impairment.

### Biological monitoring

#### Fish

Historically, it has been shown that 86 different species of fish can be sampled in the Red River of the North basin. Although the Upper Red River of the North watershed is located near the head waters of the Red River of the North basin, 46 of these species were found during the sampling for this report. This watershed does not have any endangered fish species but it does have three species of special concern in Minnesota: *Acipenser fulvescens* (Lake Sturgeon), *Etheostoma microperca* (Least Darter), and *Notropis nubilus* (Pugnose Shiner). No known invasive fish or aquatic plant species are known to exist in this watershed, with the exception of the exotic *Cyprinus carpio* (Common Carp).

Some fish species occurred in high densities while other species had a more limited distribution and low numbers of individuals. The most ubiquitous and abundant fish species within the watershed was the *Cyprinella spiloptera* (Spotfin Shiner), which was sampled at 13 of the 18 stations totaling 1,153 individuals (this number includes five of the Red River of the North mainstem stations). Other fish species commonly found throughout the watershed included *Catostomus commersonii* (White Sucker), *Pimephales promelas* (Fathead Minnow), and *Cyprinus carpio* (Common Carp). *Moxostoma valenciennesi* (Greater Redhorse), *Percina caprodes* (Logperch), *Etheostoma caeruleum* (Rainbow Darter), and *Ictiobus bubalus* (Smallmouth Buffalo) were sampled at only one station and totaled less than three individuals. A complete list of the species sampled, how many stations each species was sampled at, and the total number of individuals can be found in appendix 6.1.

#### Macroinvertebrates

The invertebrates sampled ranged from some with very low tolerance levels to high tolerance levels of pollutants or impairments. The most common habitat sampled for invertebrates were aquatic macrophytes and stream banks. Other habitats that were sampled included wood, riffles/rocks, and/or leaf packs. Much like the fish sampling, the number and types of macroinvertebrates found was very site

specific perhaps due to localized impairments or flow related problems. Overall, 130 different families of macroinvertebrates were found throughout the watershed with the number of individuals in a family ranging from 19 to 5.8 million. The most commonly sampled invertebrates were from the Chironomidae family, commonly known as Chironomids or non-biting midges. In contrast, many macroinvertebrate families were represented by relatively few individuals (<500) such as the Tanyderidae (Primitive Crane Flies), Saldidae (Shore Bugs), and Tetrastemmatidae (Ribbon Worms). There are larger numbers of tolerant versus intolerant species. This may be related at least in part to the poor and rather unstable condition of most stream habitat, found throughout the entire watershed. A complete summary of families sampled and the total number counted within that family can be found in appendix 6.2.

## **Watershed-wide**

Fish and invertebrate communities throughout the Upper Red River of the North watershed are in generally poor condition. Problems with habitat condition, water chemistry, and flow may all play a role in limiting the biology. Macroinvertebrate communities in particular tend to perform poorly, perhaps due to their sensitivity to unstable habitat as a consequence of their relative lack of mobility.

## **Stressor ID**

The Upper Red River of the North watershed is a system heavily influenced by soils, land use, and drainage intensity. With such intensive land management within the watershed, a narrower spectrum of fish and other aquatic life is to be expected. Several stressors in the Upper Red River of the North play an important role in limiting the health of these biological communities.

A loss of habitat due to channelization is one of the primary biological stressors within the Upper Red River of the North watershed. A review of the Minnesota Stream Habitat Assessment finds that 10 of the 13 biological stations assessed had overall poor ratings. Typically, healthier fish communities reside in streams that have not been "maintained" or excavated at all or for a relatively long time. If a channelized reach is given time and a watershed that is not contributing heavy sediment loads, they can recover biologically and sometimes contain good fish communities resulting in high IBI scores. Channelized streams are typically cleaned out on a more regular basis due to receiving heavy sediment loads from in-stream and/or external sources and often are not able to recover biologically between clean outs due to the frequent re-adjustment.

Hydrologic modification within the Upper Red River of the North watershed is also a primary stressor. With extensive channelization and an increase in the rate of tiling to promote drainage throughout the watershed, a flashy stream hydrograph is created resulting in unstable stream channels. The channel instability is further enhanced by the removal of riparian cover which allows for further bank erosion and increasing sedimentation. In these highly managed systems, extreme flow events tend to erode the stream bank and bed during periods of heavy precipitation or runoff. Streams managed for drainage tend to contribute significant sediment loads downstream. Less than ideal conditions for most species are created with the loss of banks and bed habitat through sloughing, erosion, and deposition. Contrarily, drought conditions in channelized streams are exacerbated because water moves through the system more quickly resulting in an increased risk of low flow conditions, or in some cases completely dry channels. Sensitive members of an aquatic community can be significantly impacted by the loss of base flow that results from intensive drainage during dry years when stream temperatures and flow rates can vary dramatically.

Overland runoff from agricultural fields can play an important role in degradation of biological communities within a watershed. Hundreds of tons of sediment are washed off fields and into watercourses during spring runoff and summer storms every year. Erosion can be minimal when sufficient vegetation is in place in the form of grassed waterways, riparian buffers and/or other conservation practices. In contrast, where the vegetative buffers are poor or not present, significant erosion can occur and can form blowouts, gullies, and head cuts.

First order streams in particular can be a significant source of nutrients and sediment to an entire watershed. Most of the first order streams in this watershed are farmed through or cultivated and planted each season into row crops. During spring melt and summer storm events (of sufficient intensity), these streams collect flow and discharge downstream carrying sediment and nutrients into the receiving ditch and stream system. These farmed-through first order streams can be a significant source of pollutants to the stream system. By restoring these streams with native vegetation buffers, these systems can stabilize and retain the pollutants that would otherwise be transported downstream each year. The cumulative effect of restoring first order streams could be significant in terms of nutrient and sediment reduction.

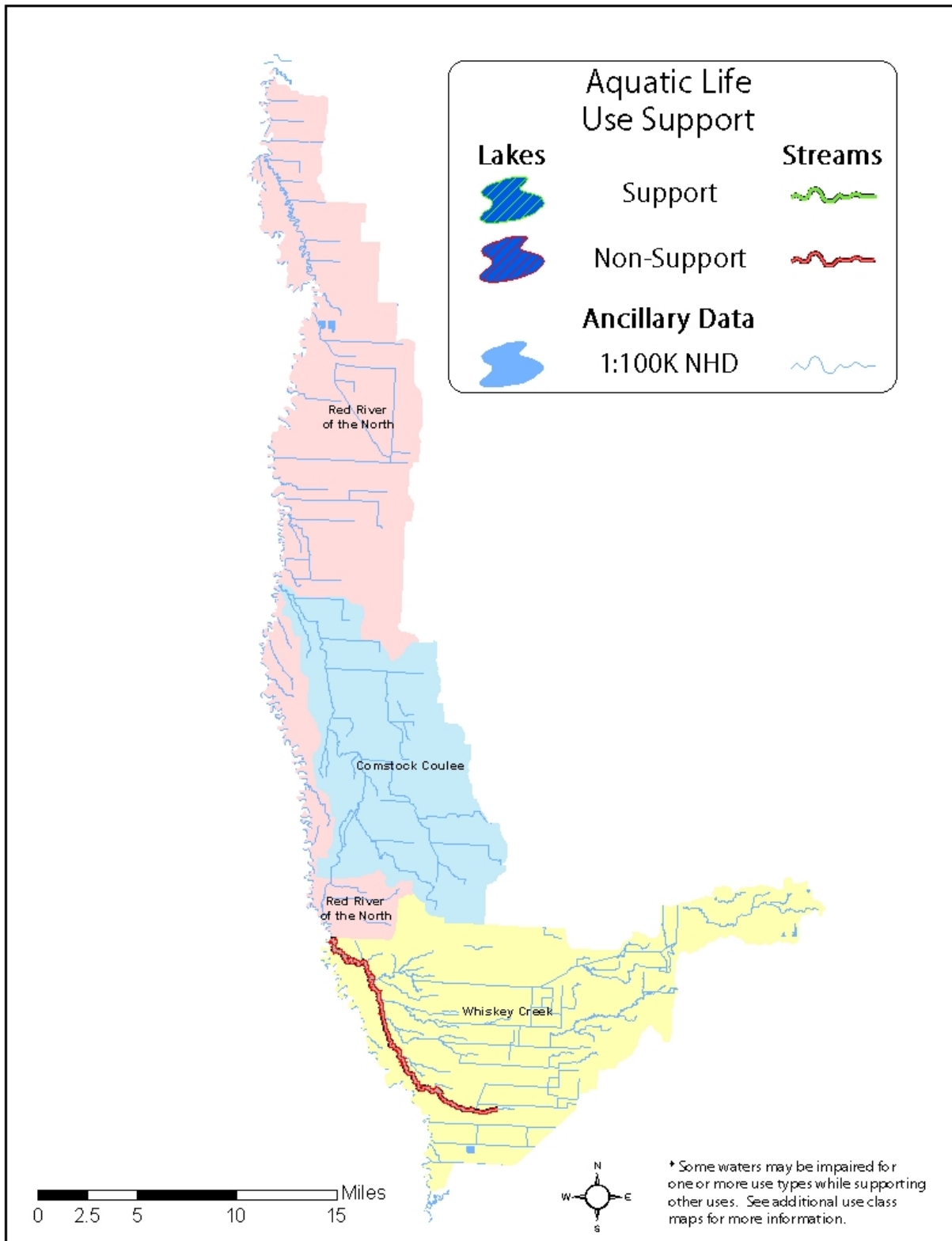


Figure 15: Aquatic life use support in the Upper Red River of the North Watershed

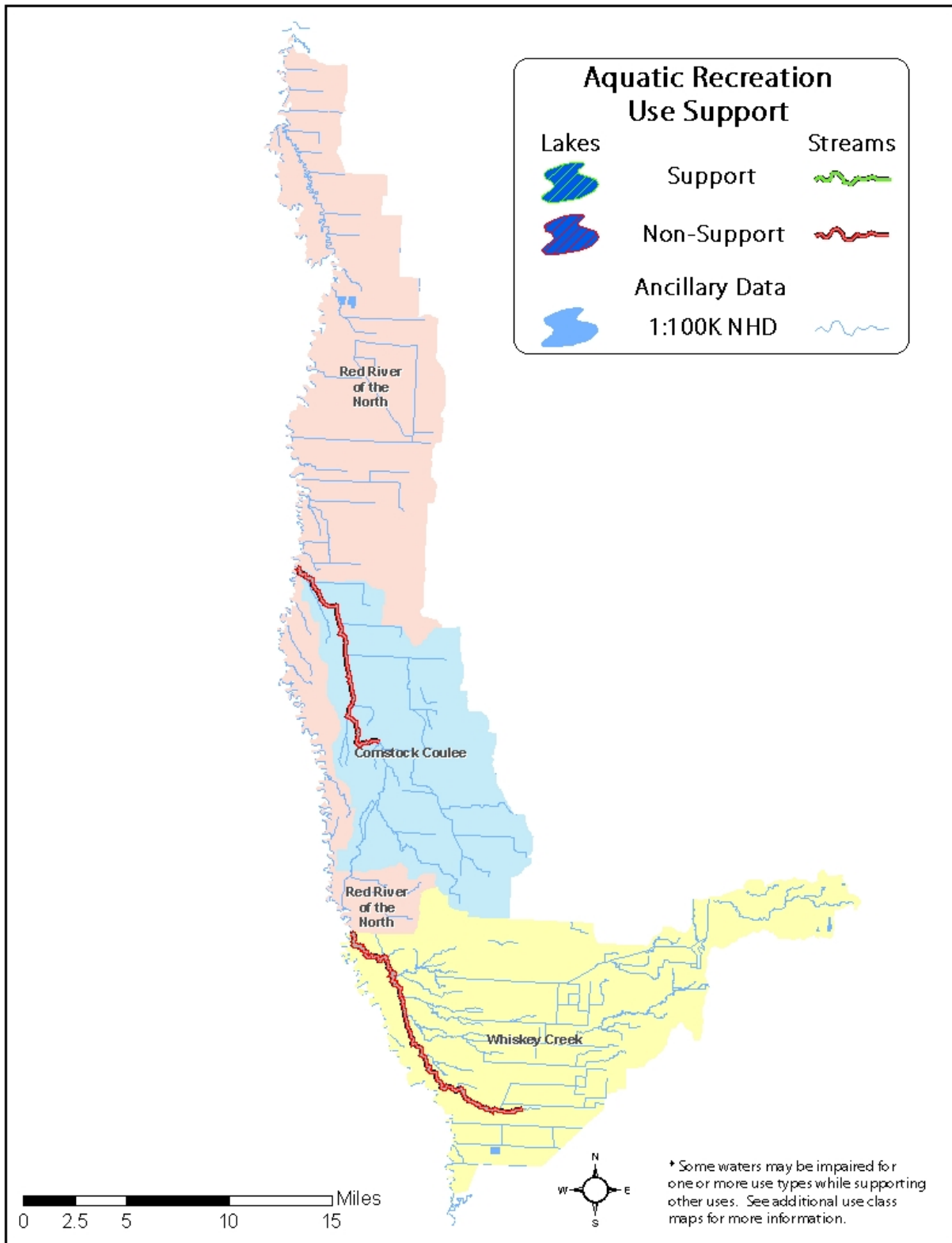


Figure 16: Aquatic recreation use support in the Upper Red River of the North Watershed

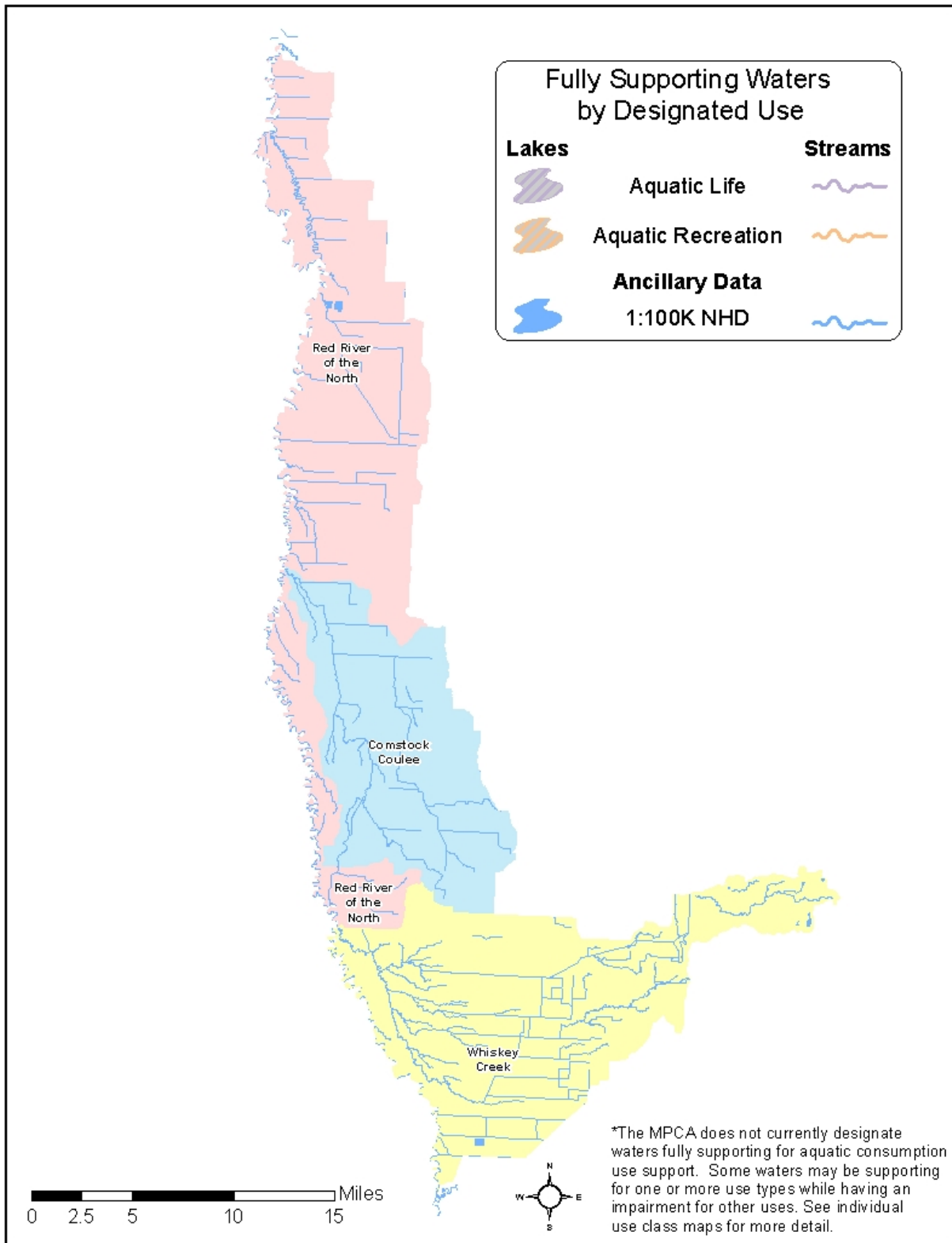


Figure 17: Fully supporting water by designated use in the Upper Red River of the North Watershed



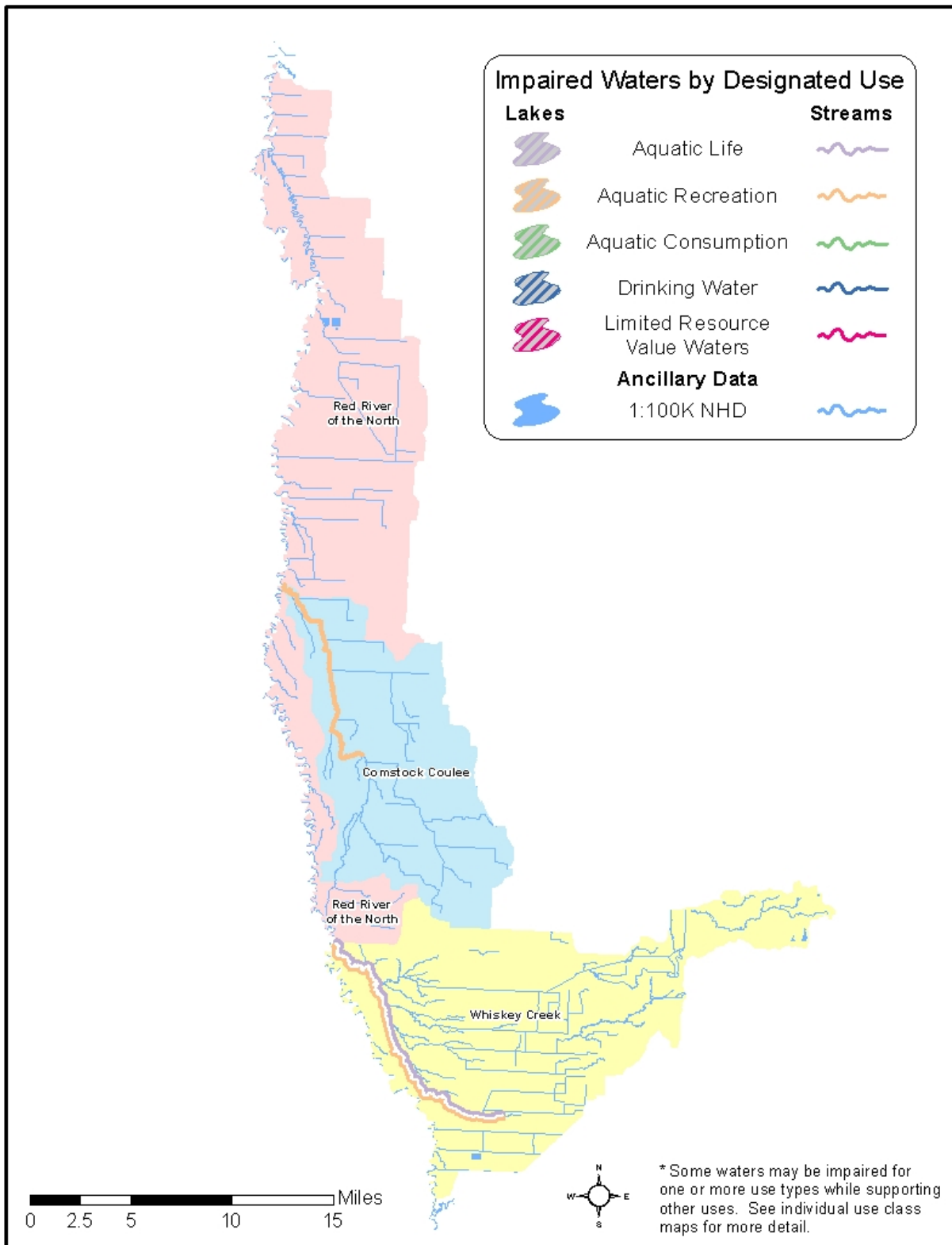


Figure 18: Impaired waters by designated use in the Upper Red River of the North Watershed

## VIII. Summaries and recommendations

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The Upper Red River of the North, once known for its vast tallgrass prairie and wetlands, has seen a widespread conversion into farmland and urban/suburban development throughout the last century. The prevailing land use is agriculture, with 99% of the land within the watershed being in private ownership (NRCS 2011). Many of the streams in the watershed have become destabilized do to the high degree of channelization and agricultural drainage in the watershed, combined with inadequate riparian buffers. As a result, dramatic fluctuations of water levels result in more water discharge, typified by higher peak flows and lower base flows. This causes some of the streams to have insufficient flows during the majority of the year, placing significant stress on aquatic communities.

Consequentially, only 13 stations (11 AUIDs) were sampled for biology. Of those 11 AUIDs, only three were assessed. Two AUIDs were found to be impaired for aquatic recreation and one was impaired for aquatic life. The majority of the other streams were channelized and the assessments deferred pending the adoption of tiered aquatic life uses (TALU). There are currently no stream segments in the watershed that fully support aquatic life or aquatic recreation. Aquatic biological impairments were found on the mainstem of Whiskey Creek.

Both Whiskey and Wolverton Creek (09020104-520 & 09020104-512) were found to be impaired for turbidity and also exceed the state standard for bacteria (*E. coli*) values. Dissolved oxygen (DO) was also a concern, with one of the sites exceeding criteria with a potentially severe impairment. Dissolved oxygen impairments often indicate nutrient enrichment, most likely the result of runoff from agricultural fertilizer. The nutrient enriched sites cause algae to produce excessive levels of oxygen during the day and increase oxygen demand at night. Once the algae and plants die they are decomposed by bacteria and fungi that also consume oxygen. With such extreme changes in DO, aquatic communities and sensitive aquatic species may become stressed, exist in low densities, and/or may be nonexistent within a system. Other indicators such as chloride, pH, and NH<sub>3</sub> all met their respective thresholds at the two sites that were assessed.

Habitat throughout the watershed was observed to be generally in poor condition and the MSHA scores supported those findings. Even though quality habitat may exist in a few isolated areas throughout the watershed, it is likely that the generally poor habitat combined with flow instability throughout the majority of the watershed may negate the positive influences those areas may have. It is also possible that higher IBI scores sometimes found in larger streams may be influenced by the year round flows that may provide a degree of stability and may offset the negative influence of poor habitat.

While improvements have been made to the water quality of the Upper Red River of the North watershed over the last thirty years with regards to point source discharges, many of its waterbodies struggle to attain water quality standards. With the high volume of suspended sediment and nutrients throughout the watershed, it is not only important to note the possible negative influence it may have on the river's aesthetic and recreational value, but also to its adjoining downstream waters and the biological communities that reside there. In order to see measureable improvements in water quality, measures must be taken to address primarily non-point source pollution across the watershed.

Additional monitoring should include investigating the extent of existing and new impairments and the effects of BMP implementation. Studies to identify the potential of dam retrofitting or removal to improve stream connectivity, and to examine the effects of groundwater withdrawal in areas of the watershed where there is a strong interaction between surface and groundwater would be beneficial. More targeted stream chemistry monitoring is needed in areas where sufficient data for assessment is lacking and to determine the extent and stressors of known impairments. Because stream habitat has such a profound effect on aquatic life, steps should be taken to minimizing habitat loss, possibly by

reducing and/or limiting the amount of channelization, drainage, and tiling occurring within the watershed. An effort to reduce the amount of agricultural, livestock, and urban runoff would also be beneficial to water quality.

Due to the extent of private land within this watershed, maintaining water quality standards will require landowner participation to mitigate any problem areas. A strong effort to involve landowners, citizens, and natural resource managers is needed to find solutions for the widespread problems that exist within this watershed. Perhaps by working with landowners to target BMPs and improve conditions in agricultural fields along riparian corridors, significant water quality improvements can be attained. Protection strategies should be developed to protect remaining forested areas and natural landscapes throughout the watershed. Protection efforts are also needed for the few areas where aquatic biological diversity appears to be marginally better. Continued efforts to monitor, evaluate, and document declining or improving conditions are needed to focus efforts and improve water quality where it is needed most.

Development of a watershed-wide TMDL and Water Restoration and Protection Strategy (WRAPS) are anticipated to begin in 2014. The TMDL will focus primarily on the ongoing turbidity and bacteria impairments within the watershed. With a large proportion (82%) of the watershed in agricultural production, the TMDL study will focus on the reduction of runoff to waterways.

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## X. Appendix 1 - Water chemistry definitions

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**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 does air temperature.

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

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

**Total Suspended Solids (TSS)** – TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or “cloudiness” of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms.

The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. Higher turbidity results in less light penetration which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

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

**Unionized Ammonia (NH<sub>3</sub>)** – Ammonia is present in aquatic systems mainly as the dissociated ion NH<sub>4</sub><sup>+</sup>, which is rapidly taken up by phytoplankton and other aquatic plants for growth. Ammonia is an excretory product of aquatic animals. As it comes in contact with water, ammonia dissociates into NH<sub>4</sub><sup>+</sup> ions and –OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

## XI. Appendix 2 - Intensive watershed monitoring stations

Biological Station ID	STORET ID	Waterbody Name	Location	11-digit HUC
08RD052	S004-881	Whiskey Creek	At Main Street in Kent	09020104010
NONE				09020104020
08RD051	S005-322	Wolverton Creek	At 130 <sup>th</sup> Ave S, 3 mi NW Comstock	09020104030
NONE				09020104060

## XII. Appendix 3 - AUID table of results (by parameter and beneficial use)

National Hydrography Dataset (NHD) Assessment Segment AUID	Stream Segment Name	Segment Description	NHD Length (Miles)	USES				BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS										ECOREGION EXPECTATIONS						
				Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Fish	Macroinvertebrates	Acetochlor	Alachlor	Atrazine	Chloride	Bacteria (Aquatic Recreation)	Metolachlor	Dissolved Oxygen	pH	Turbidity	Un-ionized ammonia	Oxygen Demand (BOD)	Nitrite/Nitrate	Total Phosphorous	Suspended Solids			
<b>HUC 11: 09020104010 (Whiskey Creek)</b>																										
09020104-503	Red River of the North	Breckenridge Dam to Whiskey Cr	24.97	2Bd	NS	FS	NA	+	+					+	+		IF	+	-	+			+			
09020104-506	Red River of the North	Otter Tail R to Breckenridge Dam	2.35	2Bd	NA	NA	NA																			
09020104-515	County Ditch 6A	CD 23 to Unnamed cr	5.97	2B	NA	NA	NA																			
09020104-516	Unnamed creek	CD 6A to Whiskey Cr	3.64	2B	IF	NA	NA	+	-																	
09020104-517	Unnamed ditch (County Ditch 6A- 2)	Unnamed ditch to Unnamed ditch	2.78	7	NA	NA	NA																			
09020104-518	Unnamed creek	T135 R45W S25, north line to Unnamed ditch	4.95	7	NA	NA	NA																			
09020104-520	Whiskey Creek	T133 R47W S13, east line to Red R	19.93	2C	NS	NS	NA	+	-					-			IF	+	-	+						
09020104-521	Whiskey Creek	T133 R47W S13, east line to Red R	19.93	2C	NA	NA	NA																			
09020104-522	Whiskey Creek	Headwaters to T133 R46W S18, west line	0.86	2C	NA	NA	NA																			
09020104-523	Unnamed ditch (County Ditch 6A)	Unnamed cr to Unnamed cr	0.56	2B	NA	NA	NA																			







### XIII. Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
<b>Fish</b>						
1	Southern Rivers	2B	46	±11	57	35
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
10	Southern Coldwater	2A	45	±13	58	32
11	Northern Coldwater	2A	37	±10	47	27
<b>Invertebrates</b>						
1	Northern Forest Rivers	2B	43	±10.8	53.8	32.2
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
8	Northern Coldwater Streams	2A	26	±12.4	38.4	13.6
9	Southern Coldwater Streams	2A	46.1	±13.8	59.9	32.3

## XIV. Appendix 4.2 - Biological monitoring results-fish IBI

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi <sup>2</sup>	Fish Class	Threshold	FIBI	Visit Date
HUC 11: 09020104010 (Whiskey Creek Watershed)							
09020104-503	06RD001	Red River of the North	3882.88	1	46	76	06-Sep-06
09020104-503	06RD002	Red River of the North	3993.55	1	46	77	06-Sep-06
09020104-516	08RD060	Unnamed creek	65.95	2	45	52	19-Jun-08
09020104-518	08RD079	Unnamed creek	10.51	3	51	57	22-Jul-08
09020104-520	08RD052	Whiskey Creek	144.92	2	45	53	23-Jul-08
HUC 11: 09020104020 (Red River of the North Watershed)							
09020104-505	05RD010	Red River of the North	4187.44	1	45	71	20-Sep-06
HUC 11: 09020104030 (Comstock Coulee Watershed)							
09020104-512	08RD051	Wolverton Creek	100.46	2	45	43	10-Sep-08
HUC 11: 09020104060 (Red River of the North Watershed)							
09020104-508	06RD003	Red River of the North	6596.35	1	46	71	06-Sep-06
09020104-511	05RD030	Red River of the North	13968.49	1	46	31	19-Sep-06

## XV. Appendix 4.3 - Biological monitoring results-macroinvertebrate IBI

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi <sup>2</sup>	Invert Class	Threshold	MIBI	Visit Date
HUC 11: 09020104010 (Whiskey Creek Watershed)							
09020104-503	06RD001	Red River of the North	3993.55	2	30.7	31.87	14-Aug-06
09020104-503	06RD002	Red River of the North	3882.88	2	30.7	30.42	14-Aug-06
09020104-516	08RD060	Unnamed creek	65.95	7	40	5.71	16-Sep-08
09020104-518	08RD079	Unnamed creek	10.51	7	40	18.21	16-Sep-08
09020104-520	08RD052	Whiskey Creek	144.92	7	40	9.39	16-Sep-08
HUC 11: 09020104020 (Red River of the North Watershed)							
09020104-505	05RD010	Red River of the North	4187.44	2	30.7	20.20	14-Aug-06
HUC 11: 09020104030 (Comstock Coulee Watershed)							
09020104-512	08RD051	Wolverton Creek	100.46	7	40	30.83	16-Sep-08
HUC 11: 09020104060 (Red River of the North Watershed)							
09020104-508	06RD003	Red River of the North	6596.35	2	30.7	21.65	14-Aug-06
09020104-511	05RD030	Red River of the North	13968.49	2	30.7	20.25	15-Aug-06

## XVI. 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
<b>Fish</b>				
1	Southern Rivers	>45	45-31	<31
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
10	Southern Coldwater Streams	>44	44-30	<30
11	Northern Coldwater Streams	>36	36-21	<21
<b>Invertebrates</b>				
1	Northern Forest Rivers	>42	42-27	<27
2	Prairie Forest Rivers	>30.6	30.6-14.7	<14.7
3	Northern Forest Streams RR	>50.2	50.2-34.3	<34.3
4	Northern Forest Streams GP	>52.3	52.3-36.4	<36.4
5	Southern Streams RR	>35.8	35.8-20.9	<20.9
6	Southern Forest Streams GP	>46.7	46.7-30.8	<30.8
7	Prairie Streams GP	>38.2	38.2-22.3	<22.3
8	Northern Coldwater Streams	>25	25-14	<14
9	Southern Coldwater Streams	>46	46-30.1	<30.1

## XVII. Appendix 5.2 - Channelized stream AUID fish IBI scores

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi <sup>2</sup>	Fish Class	Good	Fair	Poor	FIBI	Visit Date
HUC 11: 09020104010 (Whiskey Creek Watershed)									
09020104-516	08RD054	Trib. To Whiskey Creek	48.41	2	100 – 45	44-30	29 – 0	40	18-Jun-08
09020104-516	08RD054	Trib. To Whiskey Creek	48.41	2	100 – 45	44-30	29 – 0	49	23-Jul-08
09020104-523	08RD076	County Ditch 6A	26.34	3	100 – 51	50-36	35 – 0	71	22-Jul-08
09020104-524	05RD033	County Ditch 6-A	26.76	3	100 – 51	50-36	35 – 0	57	19-Jul-05
09020104-531	08RD056	County Ditch 23	18.07	3	100 – 51	50-36	35 – 0	0	19-Jun-08
09020104-533	08RD057	County Ditch 1	31.31	2	100 – 45	44-30	29 – 0	42	19-Jun-08
09020104-537	08RD067	Trib. To Red River	71.47	2	100 – 45	44-30	29 – 0	12	19-Jun-08
09020104-537	08RD067	Trib. To Red River	71.47	2	100 – 45	44-30	29 – 0	6	23-Jul-08
HUC 11: 09020104020 (Red River of the North Watershed)									
HUC 11: 09020104030 ( Comstock Coulee Watershed)									
09020104-512	08RD063	Wolverton Creek	94.06	2	100 – 45	44-30	29 – 0	54	22-Jul-08
09020104-538	08RD065	County Ditch 22	19.22	7	100 – 40	39 – 25	24 – 0	0	18-Jun-08
09020104-538	08RD065	County Ditch 22	19.22	7	100 – 40	39 – 25	24 – 0	18	22-Jul-08
HUC 11: 09020104020 (Red River of the North Watershed)									
09020104-539	08RD072	County Ditch 41	9.57	7	100 – 40	39 – 25	24 – 0	0	18-Jun-08

## XVIII. Appendix 5.3 - Channelized stream AUID macroinvertebrate IBI scores

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi <sup>2</sup>	Invert Class	Good	Fair	Poor	MIBI	Visit Date
HUC 11: 09020104010 (Whiskey Creek Watershed)									
09020104-516	08RD054	Trib. To Whiskey Creek	48.41	7	100 – 38.2	38.2-22.3	22.2 – 0	12.88	16-Sep-08
09020104-523	08RD076	County Ditch 6A	26.34	7	100 – 38.2	38.2-22.3	22.2 – 0	50.83	16-Sep-08
09020104-523	08RD076	County Ditch 6A	26.34	7	100 – 38.2	38.2-22.3	22.2 – 0	24.13	16-Sep-08
09020104-524	05RD033	County Ditch 6-A	26.76	7	100 – 38.2	38.2-22.3	22.2 – 0	24.16	20-Sep-05
09020104-531	08RD056	County Ditch 23	18.07	7	100 – 38.2	38.2-22.3	22.2 – 0	4.08	16-Sep-08
09020104-533	08RD057	County Ditch 1	31.31	7	100 – 38.2	38.2-22.3	22.2 – 0	6.13	16-Sep-08
HUC 11: 09020104020 (Red River of the North Watershed)									
HUC 11: 09020104030 ( Comstock Coulee Watershed)									
09020104-512	08RD063	Wolverton Creek	94.06	7	100 – 38.2	38.2-22.3	22.2 – 0	16.56	16-Sep-08
09020104-538	08RD065	Trib. To Wolverton Creek	19.22	7	100 – 38.2	38.2-22.3	22.2 – 0	21.35	16-Sep-08
HUC 11: 09020104020 (Red River of the North Watershed)									
09020104-539	08RD072	County Ditch 41	9.57	7	100 – 38.2	38.2-22.3	22.2 – 0	12.90	16-Sep-08

## XIX. Appendix 6.1 - Biological monitoring results-fish species, stations collected at, and total number of individuals collected

Fish species	Stations collected at	Number of individuals
Spotfin Shiner	13	1153
White Sucker	12	126
Fathead Minnow	11	220
Common Carp	10	230
Creek Chub	8	195
Channel Catfish	8	108
Sand Shiner	8	105
Blackside Darter	8	76
Shorthead Redhorse	7	127
Common Shiner	6	110
Emerald Shiner	6	69
Freshwater Drum	6	34
Northern Pike	6	14
Black Bullhead	5	140
Central Stoneroller	5	83
Silver Redhorse	5	45
Goldeye	5	25
Johnny Darter	5	21
Rock Bass	5	16
Quillback	5	15
Green Sunfish	5	13
Sauger	5	7
Brook Stickleback	4	54
White Bass	4	38
Walleye	4	24
Orange spotted Sunfish	4	22

Fish species	Stations collected at	Number of individuals
Bluegill	4	18
Black Crappie	4	9
Bigmouth Buffalo	4	6
Central Mudminnow	3	80
Blacknose Dace	3	20
Bigmouth Shiner	3	13
Mooneye	3	3
Goldern Redhorse	2	55
Smallmouth Bass	2	16
Pearl Dace	2	11
Silver Chub	2	6
Bluntnose Minnow	2	4
Tadpole Madtom	2	4
Stonecat	2	2
Trout-Perch	2	2
Northern Redbelly Dace	1	13
Greater Redhorse	1	3
Logperch	1	2
Rainbow Darter	1	1
Smallmouth Buffalo	1	1



## XX. Appendix 6.2 - Biological monitoring results – macroinvertebrate families and total number of individuals collected

Family Name	Number of Individuals	Family Name	Number of Individuals	Family Name	Number of Individuals
Chironomidae	5818332	Dytiscidae	78071	Taeniopterygidae	17214
Baetidae	1663963	Limnephilidae	75050	Ephemeraidae	16948
Hyaellidae	1417818	Ephemerellidae	73967	Gomphidae	14934
Hydropsychidae	1297510	Philopotamidae	73036	Psychomyiidae	12236
Physidae	987563	Ceratopogonidae	65778	Perlodidae	10583
Elmidae	845785	Ephydriidae	64600	Capniidae	10583
Simuliidae	697794	Empididae	64277	Potamanthidae	10412
Caenidae	645848	Haliplidae	58767	Gyrinidae	10317
Heptageniidae	551228	Tipulidae	52117	Psychodidae	9462
Tricorythidae	363337	Pleidae	48773	Dryopidae	9291
Coenagrionidae	338884	Lepidostomatidae	39767	Pyrilidae	8759
Gammaridae	335616	Polycentropodidae	37145	Gerridae	8607
Leptophlebiidae	323247	Perlidae	34827	Sialidae	8360
Pisidiidae	246316	Rhyacophilidae	33668	Scirtidae	8284
Planorbidae	190969	Glossosomatidae	33421	Pteronarcidae	8208
Ancylidae	187910	Culicidae	31008	Tabanidae	7790
Corixidae	178866	Valvatidae	30476	Corduliidae	7638
Brachycentridae	172539	Aeshnidae	29108	Sciomyzidae	7600
Leptoceridae	162450	Athericidae	29070	Leuctridae	6897
Lymnaeidae	129143	Hydrophilidae	26961	Hydridae	6726
Bithyniidae	107863	Dixidae	26106	Viviperidae	6289
Hydrobiidae	106780	Cambaridae	22591	Stratiomyidae	5472
Asellidae	96653	Belostomatidae	22097	Corydalidae	5358
Calopterygidae	92454	Phryganeidae	22059	Veliidae	4845
Helicopsychidae	81757	Hydraenidae	17537	Libellulidae	4617

Family Name	Number of Individuals	Family Name	Number of Individuals	Family Name	Number of Individuals
Dreissenidae	4161	Cordulegastridae	836	Curculionidae	190
Notonectidae	3458	Ptychopteridae	817	Siphonuridae	190
Sphaeruisidae	3401	Chaoboridae	779	Hydrometridae	152
Nepidae	3211	Goeridae	760	Syrphidae	152
Crambidae	3154	Macromiidae	608	Saldidae	133
Crangonyctidae	2964	Sericostomatidae	589	Macroveliidae	114
Uenoidae	2603	Isonychiidae	570	Noctuidae	114
Mesoveliidae	2166	Metreopodidae	532	Phoridae	95
Nemouridae	1938	Hebridae	513	Chrysomelidae	76
Polymitarcyidae	1900	Pleuroceridae	418	Staphylinidae	57
Glossiphoniidae	1729	Sisyridae	380	Truncatellidae	57
Corbiculidae	1197	Branchiobdellidae	304	Isotomidae	19
Dolichopodidae	1197	Chloroperlidae	247	Nepticulidae	19
Leptohyphidae	1026	Lampyridae	247	Tanyderidae	19
Erpobdellidae	988	Aphididae	228	Tetrastemmatidae	19
Psephenidae	988	Entomobryidae	209	Arctiidae	19
Unionidae	950	Hirudinidae	209		
Molannidae	855	Lestidae	209		