Zumbro River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency

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List of acronyms

AUID Assessment Unit Identification Determination

AQL Aquatic Life Use

AQR Aquatic Recreational Use

CCSI Channel Condition and Stability Index

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DOP Dissolved Orthophosphate

E Eutrophic

EPA U.S. Environmental Protection Agency

EPT Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)

EQuIS Environmental Quality Information System

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

FS Full Support

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MNDNR Minnesota Department of Natural Resources

MPCA Minnesota Pollution Control Agency

MSHA Minesota Stream Habitat Assessment

MTS Meets the Standard

N nitrogen

NA Not Assessed

Nitrate-N Nitrate Plus Nitrite nitrogen

NHD National Hydrologic Dataset

NH_3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

POET Plecoptera (mayflies), Odonata (dragon flies), Ephemeroptera (stoneflies) and Trichoptera (caddisflies)

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WPLMN Water Pollutant Load Monitoring Network

ZWP Zumbro Watershed Partnership

Contents

Figures

Tables

Executive summary

The Zumbro River Watershed covers 1,422 mi^2 of the Lower Mississippi Basin in southeastern Minnesota stretching from the far eastern boundaries of Rice and Steele counties through the southern third of Goodhue County and a majority of Dodge, Olmsted and Wabasha counties. The Zumbro River's three warmwater branches comprise the watershed's headwaters, emerging from heavily cultivated agricultural plains in the southern and western reaches of the watershed. Its branches converge in the center of the watershed forming the Zumbro River. The region's rugged bluff county and karst geology give rise to coldwater tributaries in the eastern reaches of the watershed, providing integral habitat for naturally reproducing brown and native brook trout populations. The watershed is also home to the state's third largest city, Rochester; which is expected to grow significantly by 2030. The Zumbro's landscape provides an important agricultural economy for the region vested in crop production and livestock, as well as rich natural resources valuable for both recreation and wildlife.

Native Dakota tribes called it 'Wapka Wazi Oju' *Pines Planted River*, referencing an expansive white pine forest in the watershed's eastern third which was rapidly harvested after European settlement in the 1850s. Early settlers brought intensive agriculture to the region. Vulnerability of the watershed's sandy soils and steep blufflands was poorly understood by new emigrants and as a result the impacts of large storm events were compounded by the effects of poor landuse decisions and brought intense flooding to the new communities. While modern conservation practices have enabled agriculture to continue to sustain in the region, legacy impacts remain. Continued efforts towards conservation benefit both landowners and surface water quality.

Eighty-two stream Assessment Unit Identification Determination (AUID) were assessed for aquatic life use and/or aquatic recreation (Table 61). Of the assessed streams, only 34 were considered to be fully supporting of aquatic life and none were fully supporting of aquatic recreation. Fifty-four AUIDs are non-supporting for aquatic life and/or recreation. Of those, 37 were non-supporting for aquatic life and seventeen were non-supporting for aquatic recreation. Delisting's are being perused for six AUIDs previously listed as impaired for aquatic life use due to excessive turbidity. Four AUIDs are corrections because they meet the new regional standard for Total Suspended Solids (TSS). Two AUIDs were found to now be meeting standards with new data and are proposed for removal from the 303(d) Impaired Waters List in 2016.

Data were assessed for ten trout streams in the Zumbro drainage. Fish Index of Biotic Integrity (FIBI) results met standards where assessed on all but one stream in the Zumbro Watershed, Spring Creek. All cold water streams, where sufficient data was available for assessment, did not meet aquatic recreation standards due to bacteria issues. Macroinvertebrate impairments on cold water streams are isolated to a handful of reaches.

Lake Zumbro and Rice Lake were the only two lakes, of 17 in the watershed, that were assessed for aquatic recreation; both lakes exceeded the eutrophication standards and failed to meet aquatic recreation standards. While levels of mercury and PCBs have dramatically declined, aquatic consumption advisories will remain in place within the Zumbro drainage.

No identifiable secchi trends exist based on data going back to 1976; and the most recent water quality data supports the 2002 listing for nutrients.

Groundwater monitoring conducted in the Zumbro River Watershed in 2013 tested positively for a number of pesticides, including acetochlor, alachlor, atrazine, dimethenamid-nd metoachlor, with some detected up to 100% of the time (MDA, 2014). However, no pesticide detections exceeded any established health risk limit for drinking water. Nitrate was detected in every sample (100%) from the southeast Minnesota region in 2013; 26% of wells tested in the region in 2013 were above the drinking water standard of 10.00 mg/L. In the Zumbro River Watershed, the majority of new wells are within the

water quality standards for arsenic levels, while 10% of wells constructed between 2008 and 2013 have not met standards statewide. Within the Zumbro River Watershed, groundwater withdrawals exhibit a significant rising trend (p=0.001) and surface water withdrawals have increased as well (p=0.05).

Similar to other watersheds in the region, surface water quality standards for drinking water, aquatic life and recreation are compromised by high nitrate, bacteria and turbidity. These stressors are common throughout the watershed and are likely negatively impacting macroinvertebrate communities, which are especially vulnerable to high nitrate levels. Karst features in the region provide easy conduits for pollutants from surface to groundwater and vice versa, enabling contamination to occur more rapidly and with greater severity, further complicating impairments and restoration.

Long term monitoring results on the Zumbro River north of Rochester (1973 – 2008) show trends of decreasing levels of TSS, phosphorous, ammonia and biological oxygen demand (BOD) and increasing levels of nitrogen and chloride. In the short term period of record from 1995 – 2008 decreasing trends were only observed for TSS.

TSS flow weighted mean concentration (FWMC) loading during high flow events in early May in 2012 accounted for 47% of the annual TSS load. Data from 2011 show a similar pattern with a handful of runoff events during the open canopy season accounting for the majority of the annual sediment load.

The 2012 total phosphorus (TP) data was not included due to analytical equipment errors at the Minnesota Department of Health (MDH) Environmental Laboratory. The higher FWMC and load in 2010 are due to the late September storm event when nearly 69% of the annual TP load value passed through the system.

Dissolved Orthophosphate (DOP) FWMC ratios from 2010 and 2011 show 57 and 55% of TP is in the orthophosphate form. 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.

NO_3 + NO_2-N FWMCs for 2010 -2012 were well below the draft acute standard but above the draft chronic Class 2B standard. In 2010, 2011, and 2012, 63, 81 and 46% of sample concentrations exceeded the draft chronic Class 2B standard concentration. As the range in NO_3 + NO_2-N FWMCs is fairly tight for this watershed (5-6.5 mg/L), annual differences in NO_3 + NO_2-N loads can be attributed primarily to annual differences in runoff volume.

Despite known water quality impairments within the Zumbro River, fish communities have shown great resilience and are performing at a high level across much of the watershed. While several Fish Index of Biotic Integrity (FIBI) scores exceeded exceptional use standards across the watershed, macroinvertebrate results did not perform at as equally high; as such no streams were distinguished as exceptional status during assessments. Fish IBI scores above 90 were observed in three tributaries within in the Zumbro including Cold Creek (Cold Creek Subwatershed), the North Fork Zumbro River (North Fork Zumbro River Subwatershed) and Middle Creek (Lower Zumbro Subwatershed). Highest average FIBI scores were observed in the Cold Creek subwatershed (FIBI 91.7), Upper South Fork Zumbro River subwatershed (FIBI 81.4) and Salem Creek subwatershed (FIBI 72.3). Five additional subwatersheds had average FIBI scores above 60 including: South Branch Middle Fork Zumbro River, Upper Middle Zumbro River, North Fork Zumbro River, Upper Zumbro River and Lower Zumbro River.

Macroinvertebrate Index of Biotic Integrity (MIBI) scores indicate that they are not less resilient in this watershed with a higher frequency of impairment. The highest macroinvertebrate IBI scores were observed on the Upper South Fork Zumbro River (MIBI 55.3). Three subwatersheds had average MIBI scores of 45 or greater: Bear Creek, North Branch, Middle Fork Zumbro River and Upper Zumbro River. Biological data collected in 2012 suggest that improvements have been made temporally within the North Fork Zumbro River subwatershed. High levels of nitrates in surface water can have an impact on

macroinvertebrate communities while not affecting fish communities, as seen in Minnesota's other southeastern watersheds.

Lowest FIBI score averages were observed in the Bear Creek Subwatershed (FIBI 44) and Dodge Center Creek (FIBI 49). Connectivity issues caused by dams and impoundments are a concern within the Zumbro, especially within the Bear Creek subwatershed. Limiting stream connectivity inhibits the ability of fish communities to perform natural migration patterns, commonly resulting in extirpation of species above known impoundments due to limited available winter refuge. The worst average MIBI scores were observed in the Dodge Center Creek Subwatershed (MIBI 29) and Mazeppa Creek (MIBI 31).

During MPCA monitoring in the Zumbro River Watershed one species considered endangered within the state of Minnesota was found, the crystal darter and 5 species of special concern were captured, including: black redhorse (21 stations), least darter (1 station), Ozark minnow (19 stations), red fin shiner (3 stations) and red side dace (14 stations). The crystal darter is among the rarest of Minnesota's darter species and is particularly sensitive to siltation, requiring clear fast-flowing rivers (MNDNR, 2016). Population declines have occurred across much of the species' range from activities such as channelization, dredging and impoundments that have altered stream velocities and resulted in sediment loading. Dams have also impacted the species by reducing the amount of suitable habitat and isolating populations (MNDNR, 2016). Salem creek, a Zumbro River tributary, is renowned for its abundant population of rainbow darters (Etheostoma caeruleum), a species extremely sensitive to degradation and excess sediment. Past permits issued by the Minnesota Department of Natural Resources (MNDNR) have allowed rainbow darters of Salem Creek to serve as ambassadors of their species in reintroduction projects to streams where the species had been historically extirpated, including Belle Creek in the Cannon River Watershed.

Despite an abundance of agricultural and urban landuse within the watershed, the Zumbro River's riparian zones remain intact on many stretches of the Zumbro River and its tributaries. While improvements have been made in recent years, additional efforts are necessary to improve water quality and insure compliance with standards. Improvements in water quality should target nonpoint sources of pollution. Implementation of best management practices (BMP) should target sensitive features on the landscape that are known to benefit water quality, to insure a high return on investment for valuable restoration dollars. Reductions in sediment loading could be made by taking efforts to limit erosion and soil loss from agricultural sources. Restoring natural wetlands in the watershed's headwaters would allow for more water retention on the landscape and reduce the impacts of high flows on stream bank erosion and instream sediment loading. Stream restoration efforts should include measures to stabilize stream banks and reduce erosion. Plans to reduce bacteria and nitrate levels should include measures to better control livestock waste, fertilizer management and fix failing septic systems. Measures taken to improve failing macroinvertebrate communities will intern benefit both assemblages. Surface water quality improvements will be dependent on local cooperation as using regulatory authority to reduce nonpoint source pollution is currently limited.

Introduction

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

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

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

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

This watershed wide monitoring approach was implemented in the Zumbro River Watershed beginning in the summer of 2012. This report provides a summary of all water quality assessment results in the Zumbro River Watershed and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds (Figure 1). The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA 2008) (http://www.pca.state.mn.us/sites/default/files/wq-iw1-04i.pdf).

Watershed Pollutant Load Monitoring Network

Funded with appropriations from Minnesota's Clean Water Legacy Fund, the Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers.

Since the program's inception in 2007, the WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and MNDNR flow gaging stations with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations, and MPCA to compute pollutant loads from 201 streams and rivers across Minnesota. monitoring sites span three ranges of scale with annual loads calculated for Basin and Major Watershed sites and seasonal loads for Subwatershed sites:

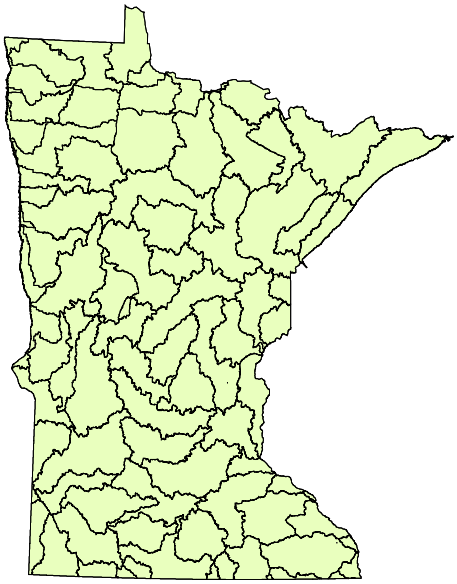

Figure 1. Major watersheds within Minnesota (8-Digit HUC).

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

Major Watershed – tributaries draining to basin rivers with an average drainage area of 1,350 mi^2 (8-digit HUC scale)

Subwatershed – major branches or nodes within major watersheds with average drainage areas of approximately 300-500 mi^2

Data will also be used to assist with: TMDL studies and implementation plans; watershed modeling efforts; watershed research projects and watershed restoration and protection strategies.

More information can be found at the WPLMN website including a map of the sites.

Intensive watershed monitoring

The intensive watershed monitoring strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale (Figure 2). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 80 major watersheds (8-HUC)

within Minnesota. Using this approach many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least one year within the 10-year cycle.

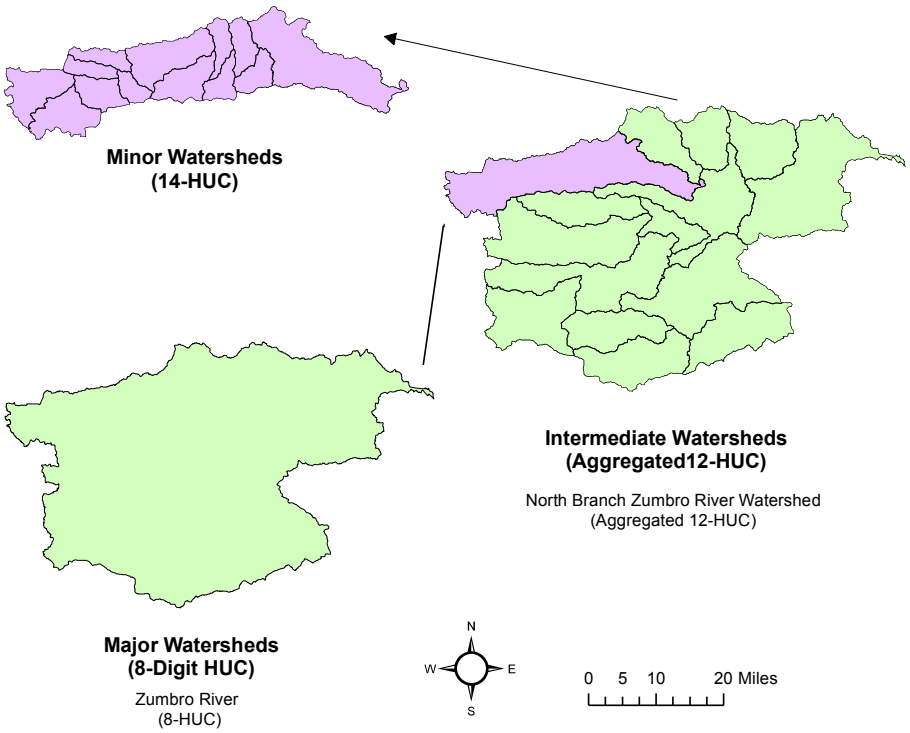

Figure 2. The Intensive Watershed Monitoring Design.

River/stream sites are selected near the outlet of each of three watershed scales, 8-HUC, aggregated 12-HUC and 14-HUC (See Figure 2. The Intensive Watershed Monitoring Design.). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the 8-HUC scale. The outlet of the major 8-HUC watershed (purple dot in Figure 3) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The aggregated 12-HUC is the next smaller subwatershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each aggregated 12-HUC outlet (green dots in Figure 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support. Within each aggregated 12-HUC, smaller watersheds (14-HUCs, typically 10-20 mi^2), are sampled at each outlet that flows into the major aggregated 12-HUC tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 3).

Within the intensive watershed monitoring strategy, lakes are selected to represent the range of conditions and lake type (size and depth) found within the watershed. Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported. Lakes are sampled monthly from May-September for a two-year period. A lake aquatic life assessment method that includes monitoring fish and aquatic plant communities is in development but not yet available for the Zumbro assessment.

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

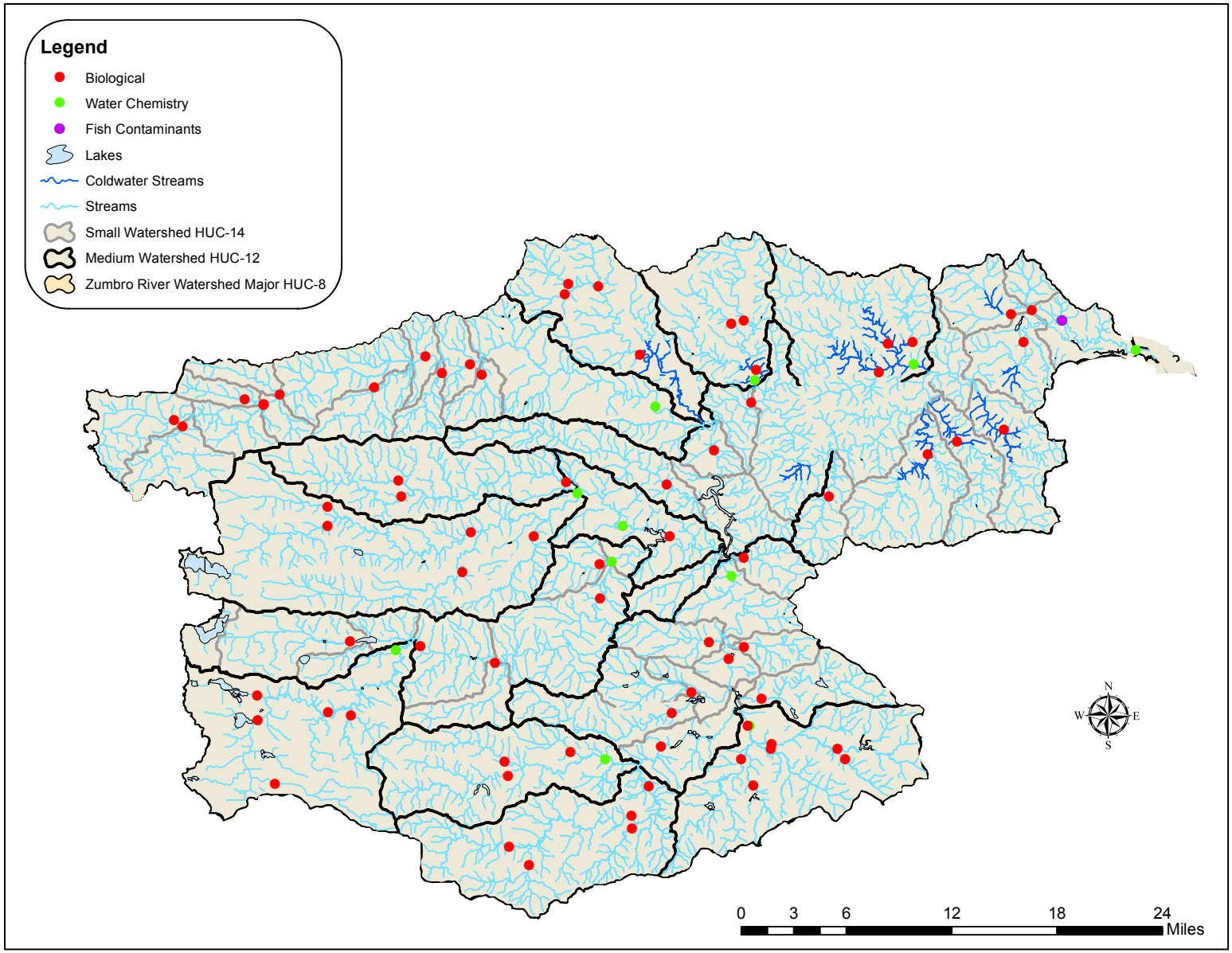

Figure 3. Intensive watershed monitoring sites for streams in the Zumbro River Watershed.

Citizen and local monitoring

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

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

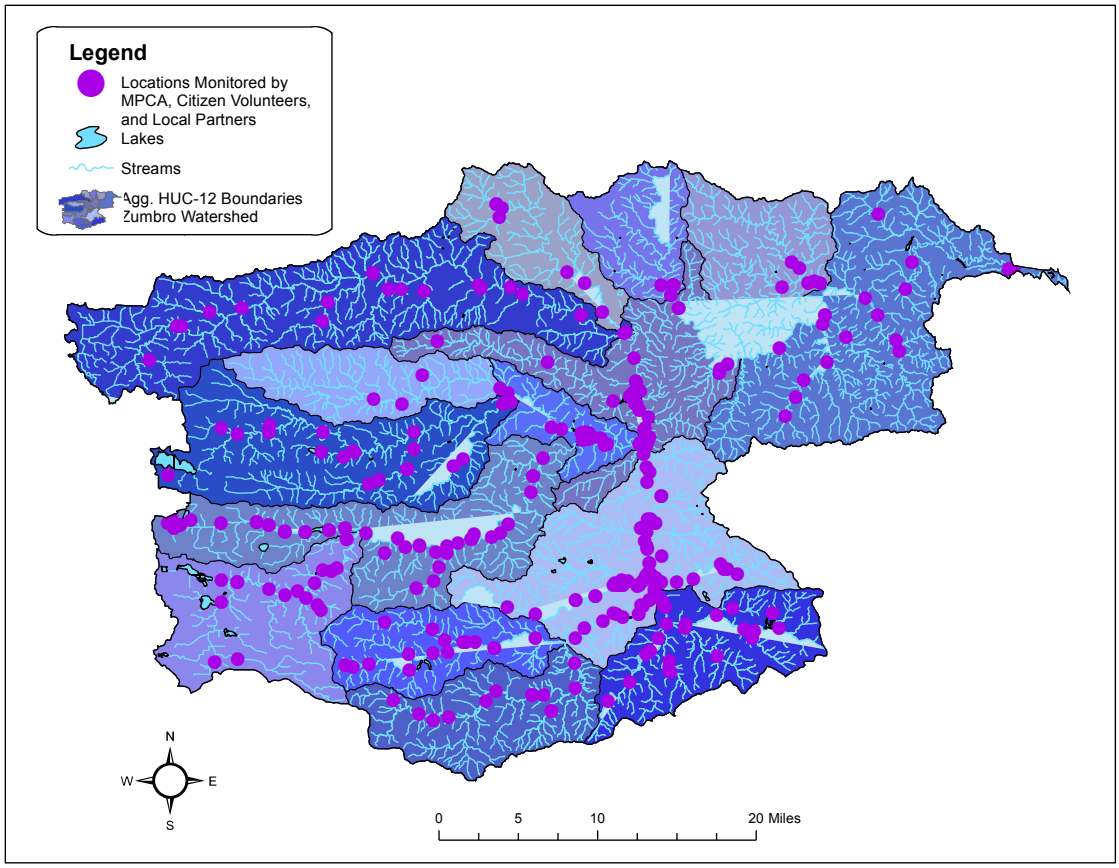

Figure 4. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Zumbro River Watershed.

Assessment methodology

The Clean Water Act requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012): http://www.pca.state.mn.us/index.php/view-document.html?gid=8601.

Water quality standards

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

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates and plants. The sampling of aquatic organisms for assessment is called biological monitoring. Biological monitoring is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. To effectively use biological indicators, the MPCA employs the Index of Biotic Integrity (IBI) for stream assessments. This index is a scientifically validated combination of measurements of the biological community (called metrics). An IBI is comprised of multiple metrics that measure different aspects of aquatic communities (e.g., dominance by pollution tolerant species, loss of habitat specialists). Metric scores are summed together and the resulting index score characterizes the biological integrity or "health" of a site. The MPCA has developed IBI's for (fish and macroinvertebrates) since these communities can respond differently to various types of pollution. Because the rivers and streams in Minnesota are physically, chemically and biologically diverse IBI's are developed separately for different stream classes to account for this natural variation. Further interpretation of biological community data is provided by an assessment threshold or biocriteria against which an IBI score can be compared within a given stream class. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below this threshold is indicative of non-support. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life, including pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride and total suspended sediment. The MPCA adopted regional TSS standards in late 2014 which are replacing the previous statewide turbidity standard to account for regional differences in land use.

Protection for aquatic life uses are divided into three tiers: Exceptional, General and Modified. Exceptional Use waters support fish and macroinvertebrate communities that have minimal changes in structure and function from the natural condition. General Use waters harbor "good" assemblages of fish and macroinvertebrates that are balanced and that have retained their ecosystem functions. Modified Use waters have been extensively altered through legacy (i.e. prior to the CWA)

physical modifications which limit the ability of the biological communities to attain the General Use. Currently the Modified Use is only applied to some rivers and streams with poor biology due to habitat limitations resulting from channelization and ditching practices. These tiered uses are determined before assessment based on the attainment of the applicable biological criteria and/or an assessment of the habitat. For additional information, see: https://www.pca.state.mn.us/water/tiered-aquatic-life-use-talu-framework.

Protection of aquatic recreation means the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of E. coli bacteria in the water. To determine if a lake supports aquatic recreational activities its trophic status is evaluated, using TP, Secchi depth and chlorophyll-a as indicators. Nutrient eutrophication standards for lakes vary depending on which ecoregion the lake is located in, as well as morphological characteristics of the lake (*i.e.* shallow vs. deep lake depth). Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

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

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, dissolved oxygen and toxic pollutants.

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes and wetlands is called the “assessment unit”. A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream “reach” may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R. ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its AUID), comprised of the USGS eight-digit hydrologic unit code (8-HUC) plus a three-character code that is unique within each HUC. Lake and wetland identifiers are assigned by the MNDNR. The Protected Waters Inventory (PWI) provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the AUID and are composed of an eight-digit number indicating county, lake and bay for each basin.

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

Determining use attainment

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

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

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

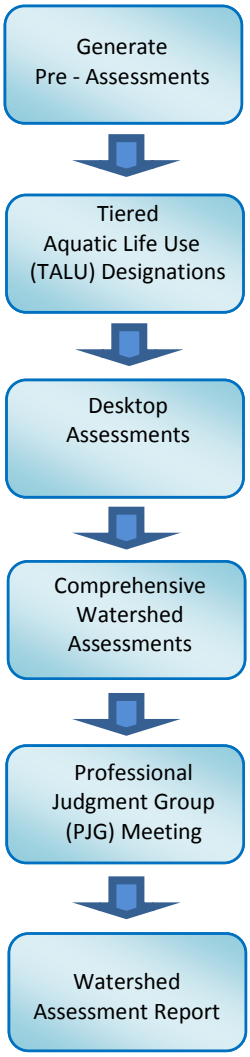

Figure 5. Flowchart of aquatic life use assessment process.

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

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

impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are also included in watershed monitoring and assessment reports.

Data management

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

Period of record

The MPCA uses data collected over the most recent 10-year period for all water quality assessments. This time-frame provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data for the entire period is not required to make an assessment. The goal is to use data that best represents current water quality conditions. Therefore, the most recent subset of data for pollutant categories such as toxics, lake eutrophication and fish contaminants may be given more weight during assessment.

Watershed overview

The Zumbro River Watershed lies in southeastern Minnesota, nestled between the Cannon River, Mississippi River Winona (Whitewater River) and Root River Watersheds. The Zumbro River is comprised of three major branches bearing their watershed's name sake, distinguished by their geographic location within the watershed: South Branch Zumbro River, Middle Fork Zumbro River and North Branch Zumbro River, all originating in the agrarian plains in the western reaches of the watershed and all flowing roughly east and joining to form the mainstem near Mazeppa (Waters 1977). From their confluence the Zumbro River travels nearly 65 miles flowing in a north easterly direction through a deep gorge joining the Mississippi River near Kellogg. The watershed spans 1,422 mi^2, stretching from the far eastern boundaries of Rice and Steele counties and across southern third of Goodhue County and a majority of Dodge, Olmsted and Wabasha counties.

The Zumbro River watershed's streams are primarily classified as warmwater. Gently rolling plains in the western and central regions of the watershed transition moving east into rolling hills and dramatic blufflands characteristic of southeastern Minnesota; this topographical shift, in addition to underlying geology, gives rise to an abundance springs, supplying precious cold water to the watershed's eastern coldwater tributaries including: Mazeppa Creek, Cold Creek, Spring Creek and Trout Brook. Significant portions of these streams are classified as wild or semi-wild trout waters making the region popular among anglers. The Zumbro system is also an important resource for recreation, its swift current and an abundance of snags attribute to its French namesake: "Riviere des Embarras" meaning river of difficulties, offering a challenge to canoeists and kayakers on this designated State Water Trail (MNDNR). Like other watershed's in southeastern Minnesota, the Zumbro Watershed has few natural lakes but several reservoirs; the most prominent in the watershed, Zumbro Lake, was constructed in

1919 and spans 600 acres. The hydroelectric dam provides power to the city of Rochester upstream (Rochester 2013).

Tall prairie grasslands and oak savannas comprised much of the western reaches of the watershed prior to western settlement. The eastern blufflands were surrounded by stands of white pines. The indigenous Dakota tribe inhabited the region until the 1852 Treaty of Traverse de Sioux was signed and forced their removal. European immigrants founded many of the watershed's towns shortly thereafter; choosing locations along the banks of the Zumbro's many rivers for their potential to serve as power sources for timber and flour mills. Pristine forests were cleared and the watershed's rich prairie soils were cultivated. Heavy erosion and catastrophic flooding was brought on by poor land management practices by the new settlers, ravaged many of the small mill towns in the Zumbro valley (MNDNR 2010). Unlike, neighboring Whitewater River, many of the small communities in the Zumbro Valley still exist today but shadow their historic prosperity.

Much of the modern landscape of the Zumbro Watershed has now been modified by agriculture and human development. Remaining natural prairies are limited to the steep slopes of the blufflands; traditional pine forests have transitioned to deciduous hardwood forests and have grown in size due to fire suppression. In 1961, the Richard J. Dorer Memorial Hardwood State Forest, which includes the Zumbro Bottoms State Forest, was created to promote conservation and responsible landuse and restore a landscape tattered by flooding, a result of the land's overuse and misuse. A significant acreage of the forest lies within the watershed's eastern boundaries and serves as a valuable resource for wildlife and recreation in Southeastern Minnesota (MNDNR). The western third of the Zumbro Watershed

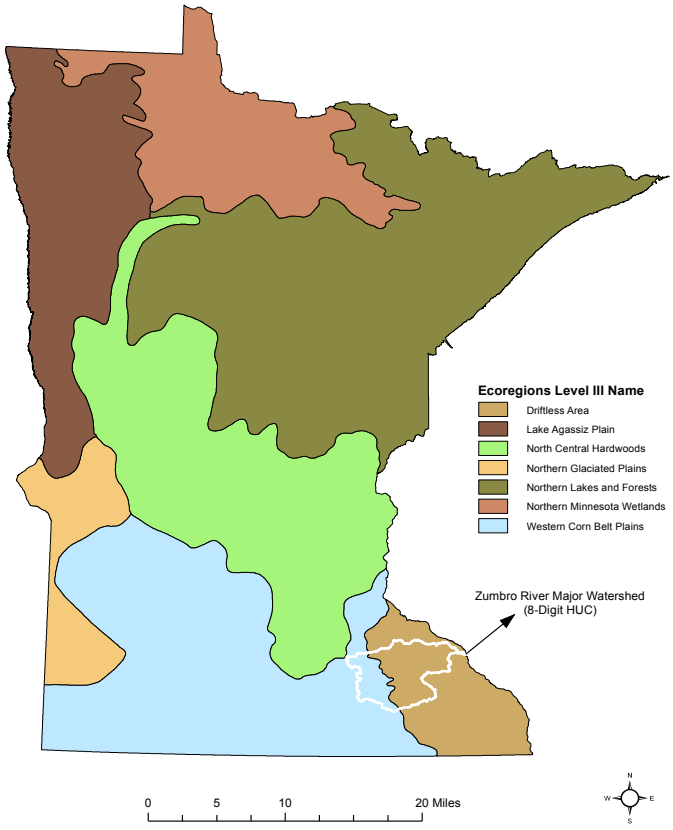

Figure 6. The Zumbro River Watershed within the Western Corn Belt Plains and Driftless Area ecoregion of Southeastern Minnesota.

divides a major transition from the Western Cornbelt Plains ecoregion to the Driftless Area ecoregion. Rich organic glacial prairie soils provide a rich medium for cultivation in the western agricultural hub of the watershed, comprised of Central Iowa and Minnesota Till Prairie. Soils transition moving east into related Eastern Iowa and Minnesota Till Prairie, ultimately shifting towards the karst region and Northern Mississippi Valley Loess Hills. Karst features coincide with increasing slopes and more dramatic topography. As slopes increase, the land's lack of utility as cropland transitions to a growing abundance of pasture lands. Within in the wide valleys of the eastern blufflands there is a more even mixture of grain and rangeland operations and increasing amounts of forested, wetland and natural areas. This rugged terrain falls within the driftless ecoregion. The driftless area, or Paleozoic plateau, is a region of the northern United States, including southeastern Minnesota, southwestern Wisconsin, northeastern Iowa and extreme northwestern Illinois, that was not covered by glaciers during the Wisconsin glaciation. Bedrock forming the plateau dates back to the Paleozic Era containing sedimentary formations from ancient seas of the Ordovician and Devonian periods; it is comprised of limestone, dolomite, sandstone and shale. During the last glaciation the plateau stood above the surrounding plains covered by the Superior and Des Moines glacial lobes. "The driftless area is a geologic relic—affected by surrounding glaciers, but not covered with their remains" (Waters 1977). The lack of glaciation has allowed for slower dissolution soluble limestone bedrock formations by weathering, forming an extensive system of underground caverns, which have led to fragile surface crusts causing sinkholes and disappearing streams.

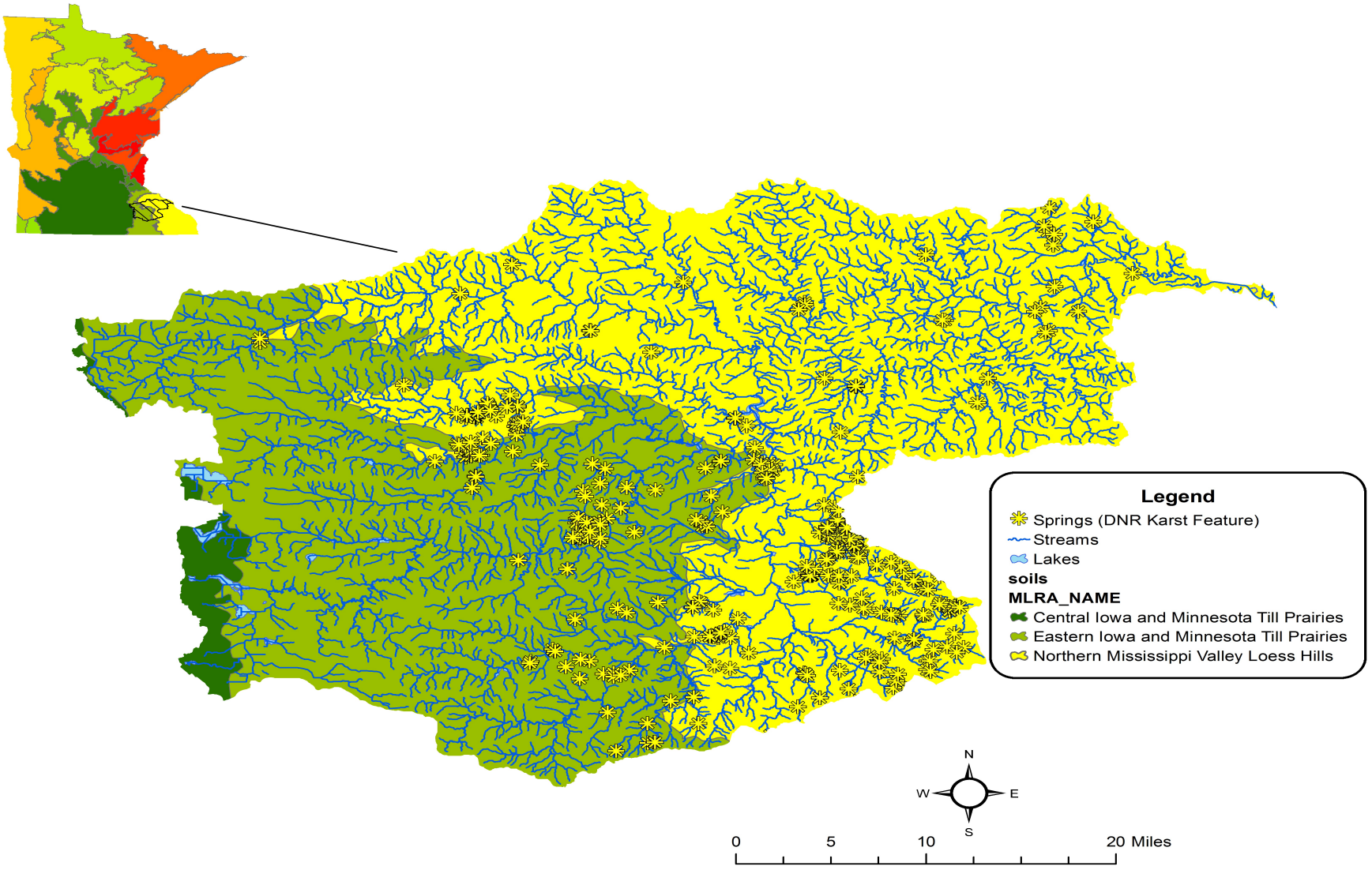

Figure 7. Major Land Resource Areas (MLRA) and springs in the Zumbro River Watershed.

Land use summary

Today, the Zumbro River Watershed's landuse can be characterized as cropland (55.8%), rangeland (23.6%), forest/shrub (9.7%), developed (8.1%), wetland (1.5%), open water (0.4%) and barren land (0.1%) (Figure 8). A majority of the watershed's land is privately owned, roughly 98% (NRCS 2016).

The northern, southern and western regions of the watershed are dominated by row crop agriculture with scattered livestock operations. The Natural Resources Conservation Service (NRCS 2016) estimates that there are 2,730 farms in the watershed; 8% are greater than 1,000 acres, 42% are less than 180 acres, and 50% are of median size (180) – 1000 acres) (NRCS). Cropland is predominately planted in corn, forage for livestock and soybeans (MDA 2009 and MDA 2010). There are currently more than 1,600 permitted Animal Feedlot Operations (AFO) in the watershed (NRCS 2016). Animal livestock units in the watershed are divided as follows: 29% poultry, 17% swine, 4% cattle and 50% other (NRCS 2016). Wabasha County ranks as the state's fourth leading oat producer and fifth leading dairy producer, followed by Goodhue County (MDA 2013). Goodhue County ranks as the state's eighth leading cattle and hay producer and the 14th leading producer in overall agriculture production (MDA 2013). While agriculture is prevalent in the watershed, overall production within the watershed's counties is low when compared to the rest of the state (Dodge (34th), Olmsted (40th) and Wabasha (52nd)) (MDA 2013).

Moving east in the watershed, rangeland and forested uses increase. Rangeland typically surrounds heavily forested blufflands as its steep terrain limits utility for crop production. Forested landuse is greatest on the watershed's eastern boundaries. Frac sand mining is a growing industry in the watershed but this landuse is not reflected in the landuse coverage utilized in this report.

While the watershed is predominately rural, it also encompasses Rochester, Minnesota's third largest city (population: 111,402). As such, Olmsted County has the state's eighth largest population (MDA 2013). Rural population centers in the watershed include smaller towns (Kasson: 6,074, Byron: 5,191, Zumbrota: 3,349, Dodge Center: 2,691, Pine Island: 2,590, Kenyon: 1,817, Mantorville: 1,206 and Wanamingo: 1,084) and rural communities (Mazeppa: 829, West Concord: 799, Viola: 596, Claremont: 540, Kellogg: 439, Zumbro Falls: 244, Millville: 179 and Hammond: 135) (U.S. Census Bureau, 2010). Development in the greater Rochester area is expected to continue to grow, population estimates by the Minnesota Legislature estimate the region's population to increase in the range of 35 to 103% between the years 2000 and 2030 (MPSDC 2002).

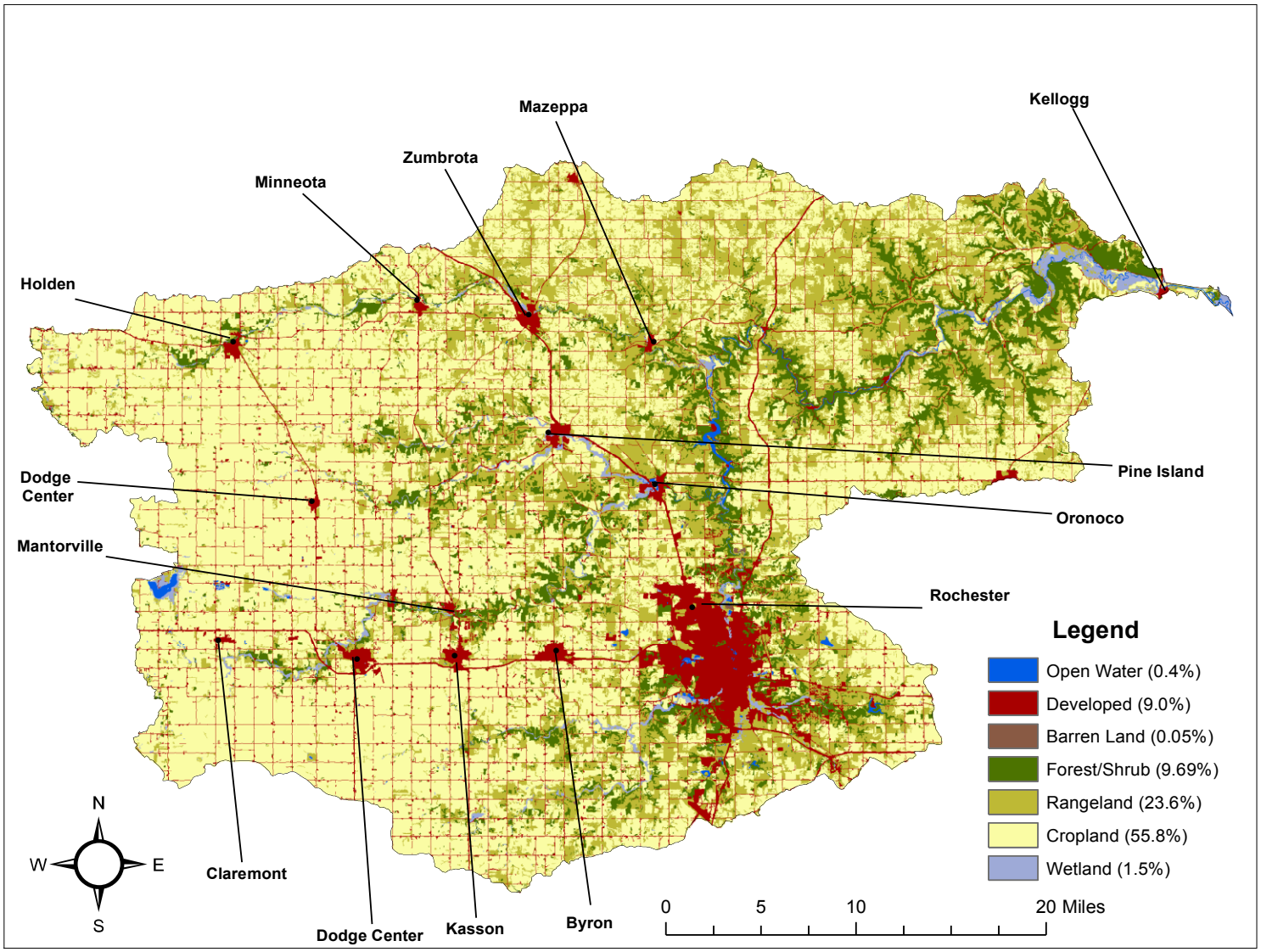

Figure 8. Land use in the Zumbro River Watershed.

Surface water hydrology

The Zumbro River's headwaters lie within its three major branches: South Branch Zumbro River, Middle Fork Zumbro River and North Branch Zumbro River, all traveling roughly 50 miles before joining to form the Zumbro River. The South Branch Zumbro River flows north, serving as the upstream watershed for Rochester's urban center, flowing north and joining Zumbro Lake from the south. The Middle Fork Zumbro River begins at the outlet of Rice Lake and flows east into Zumbro Lake. The North Fork Zumbro River begins a few miles east of Faribault and flows east, converging with Mazeppa Creek before draining to the Zumbro River. The Zumbro River begins at the outlet of Zumbro Lake, an impoundment of the convergence of the South and Middle branches of the Zumbro River, gaining the flow from its North Fork a few miles downstream. From Zumbro Lake, the Zumbro River travels 65 miles in a north easterly direction, passing near the communities of Zumbro Falls, Hammond and Millville, ultimately joining the Mississippi River near Kellogg. The Zumbro River drops approximately 600 feet from its headwaters to its mouth; its mean discharge is 650 ft^3/sec with a maximum exceeding 30,000 ft^3/sec during highest flows (Waters 1977).

Despite an abundance of agricultural and urban landuse within the watershed, the Zumbro River's riparian zones remain intact on many stretches of the Zumbro River and its tributaries. Fifty-six percent of the watershed's streams remain natural while 43% have been altered by channelization, according to the Minnesota Altered Water Source Project (Figure 10). Less than 2% of the watershed's streams are impounded; however, historical records indicate that this number was once far greater.

The powerful flows of the Zumbro's rivers gave rise to the construction of several impoundments. Dams in the watershed were historically built for power generation for flour and timber milling and were constructed not long after the region was settled in the 1850s. In 1919, a hydroelectric dam was built on the Zumbro River, creating present day Zumbro Lake, to supply power to the growing population of Rochester. Overtime many of the watershed's dams were not maintained and dismantled after their utility had run its course, including the once prominent dam that held Shady Lake in the city of Oronoco. Impoundments constructed more recently within and upstream of Rochester's city limits were built to provide flood control to the region. Natural lakes are not a prominent feature of the Zumbro Watershed, only 17 lakes or ponds greater than 10 acres in size exist within the watershed and many are not true lakes but rather man-made reservoirs of riverine systems.

Wetlands

There are approximately 22,000 acres of wetlands in the Zumbro River Watershed, roughly equivalent to 2% of its total area. Primarily concentrated within the riparian corridors of the watershed's rivers and streams, forested and emergent vegetation wetlands are the most predominant wetland types in the watershed (Figure 11). Furthermore, an extensive corridor of floodplain wetlands occurs along the lower reaches of the Zumbro River near the Mississippi River, accounting for a large percentage of the watershed's wetland area. It should be noted that these estimates represent a snapshot of the location, type and extent of wetlands occurring in the early 1980s, when aerial imagery was acquired to develop National Wetlands Inventory (NWI) maps in this part of the state. Updated NWI maps are currently available for the northern region of the watershed (i.e., Rice and Goodhue County).

Soil data can be used to estimate the extent of historic or pre-settlement wetlands and serve as a baseline for comparing current wetland acreage. The NRCS Soil Survey Geographic (SSURGO) database, based on map units classified as "poorly drained" or "very poorly drained", provides an estimate of 168,000 acres of wetlands (~19% of watershed area) had occurred in the Zumbro River Watershed prior to European settlement (Soil Survey Staff, NRCS 2013). Based on the NWI the watershed currently has approximately 22,000 acres of wetlands, representing approximately 2% of the watershed area. A comparison of these two time periods (i.e., pre-settlement vs early 1980s) yields an estimate of 87%

wetland loss for the Zumbro River Watershed. Wetland loss is not uniformly distributed across the watershed with the greatest rates of loss occurring in the headwaters and middle portions of the watershed (Figure 12). The largely intact floodplain along the lower reaches of the Zumbro River resulted in no significant wetland loss in these subwatersheds.

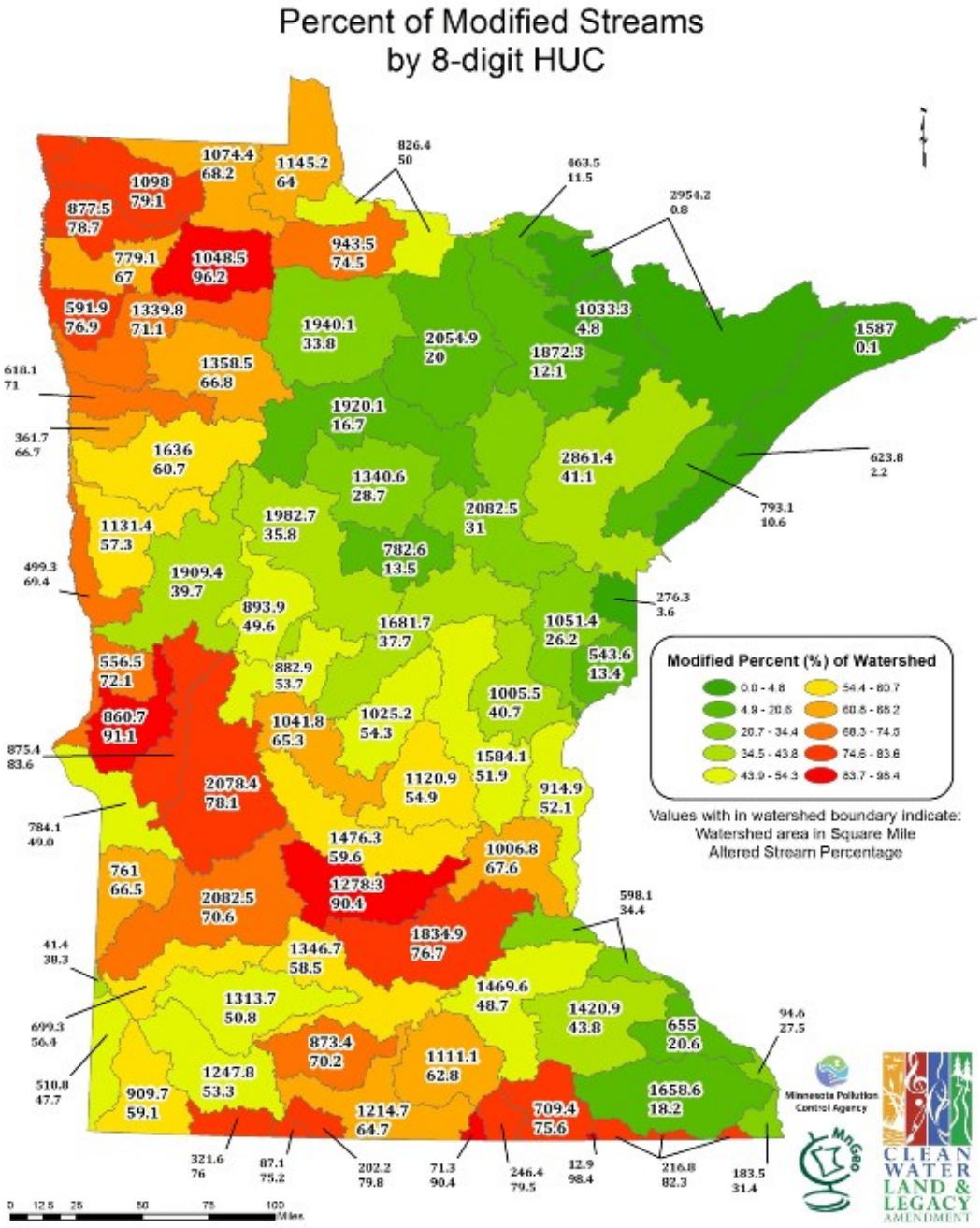

Figure 9. Map of Percent Modified Streams by Major Watershed (8-HUC), the Zumbro Watershed's percentage is low compared to other regions of the state.

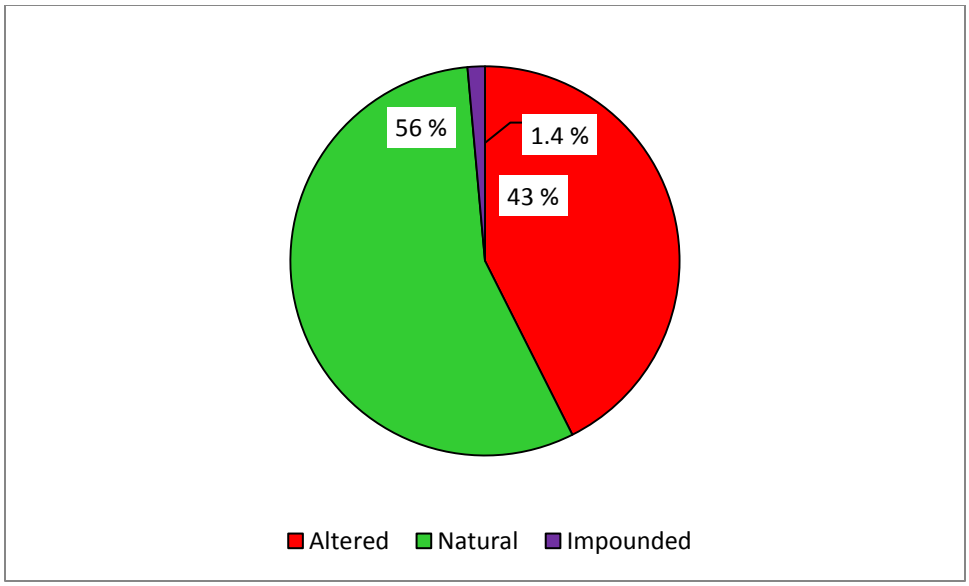

Figure 10. Comparison of natural to altered streams in the Zumbro River Watershed.

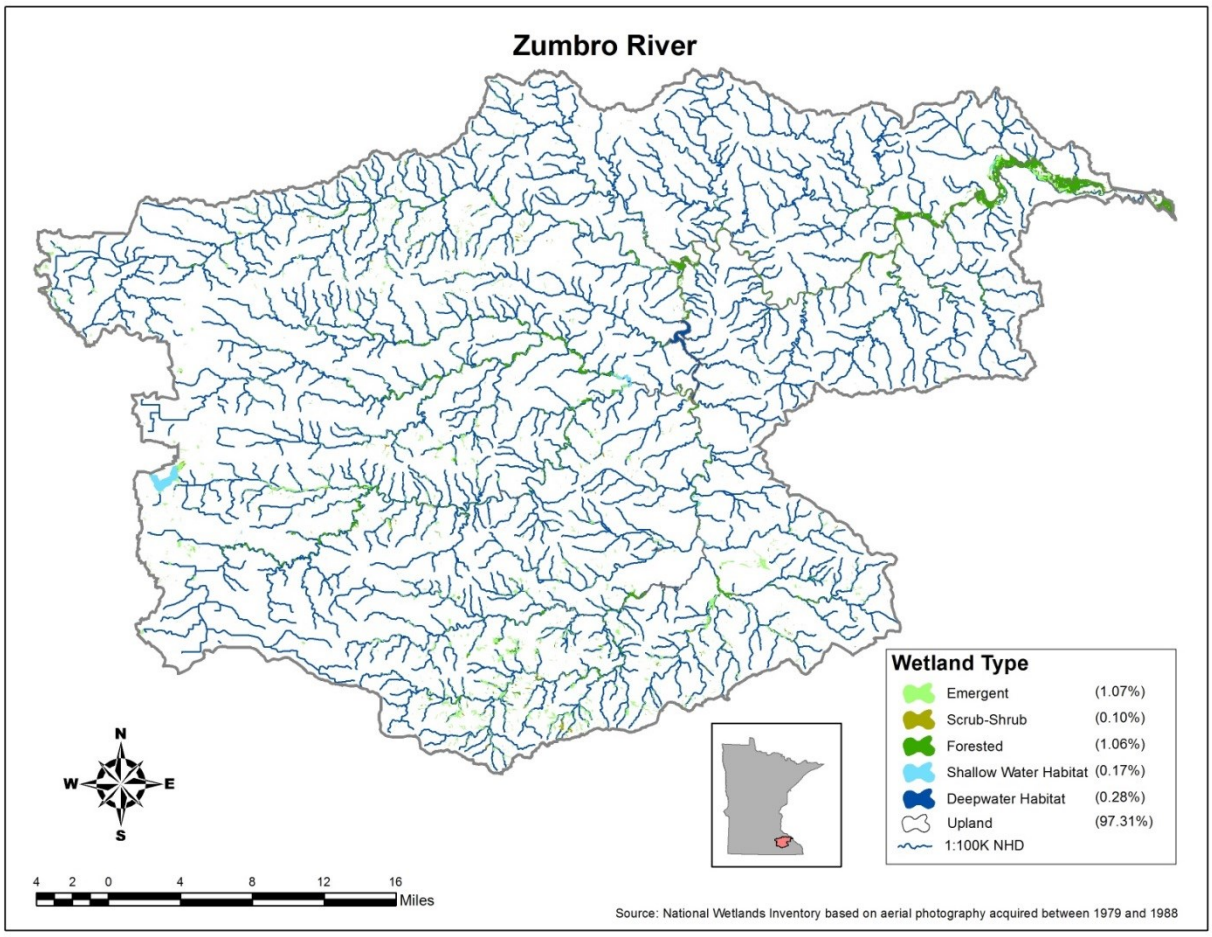

Figure 11. Wetland types and their distribution across the Zumbro River Watershed.

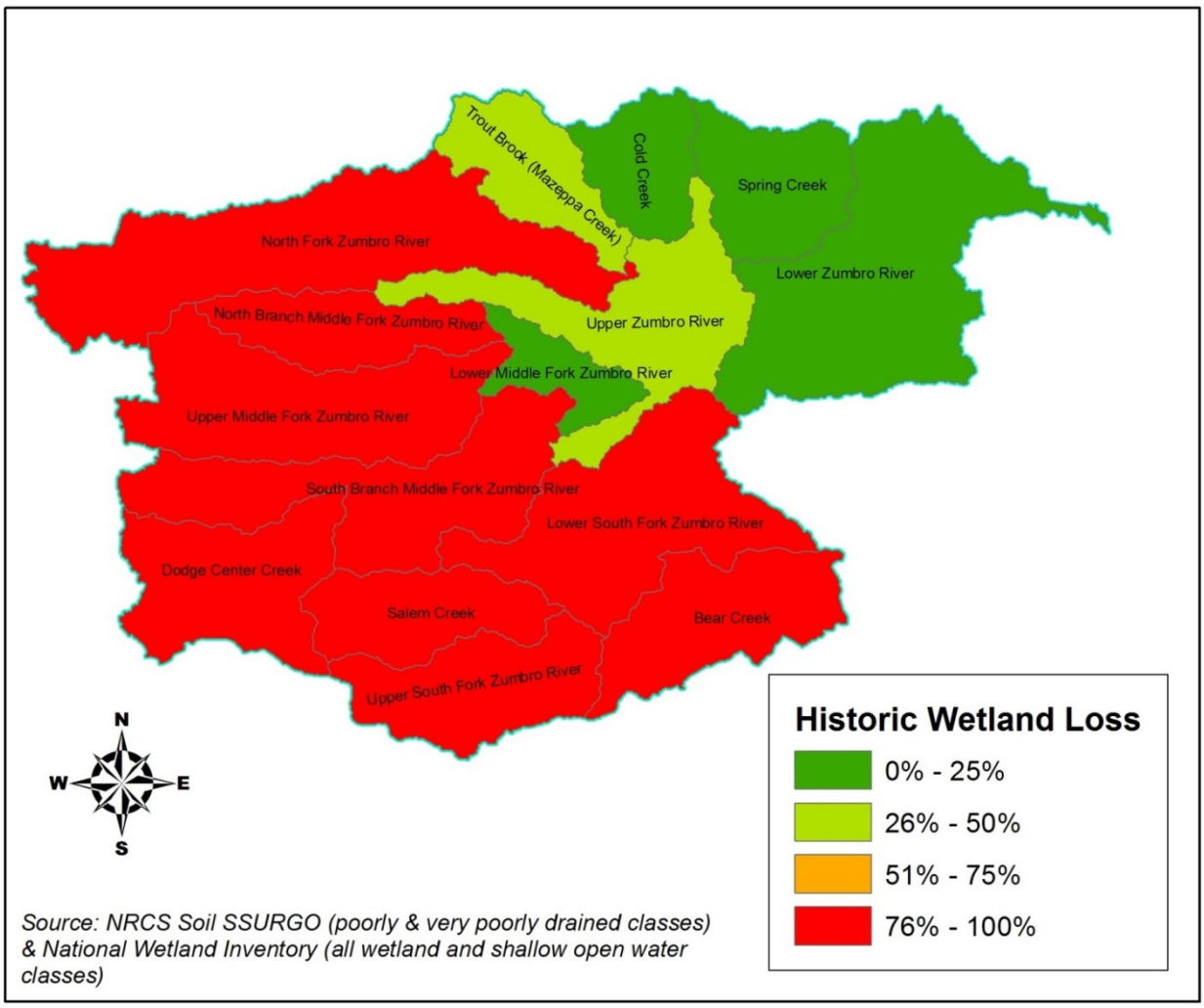

Figure 12. Estimated historic wetland loss in each subwatershed based on a comparison of "poorly drained" and "very poorly drained" soil types (SSURGO database) to wetland extent in the early 1980s (NWI).

Climate and precipitation

The ecoregion has a continental climate, marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.5˚C; the mean summer temperature for the Zumbro River Watershed is 18.88˚C; and the mean winter temperature is -8.3˚ C (Minnesota State Climatologists Office 2003).

Precipitation is the source of almost all water inputs to a watershed. Figure 13 shows two representations of precipitation for calendar year 2012. On the left is total precipitation, showing the typical pattern of increasing precipitation toward the eastern portion of the state. According to this map, the Zumbro River Watershed area received 24-28 inches of precipitation in 2012. The display on the right shows the amount those precipitation levels departed from normal. For the Zumbro River area it shows that precipitation ranged from 4 and 10 inches below normal when monitoring occurred.

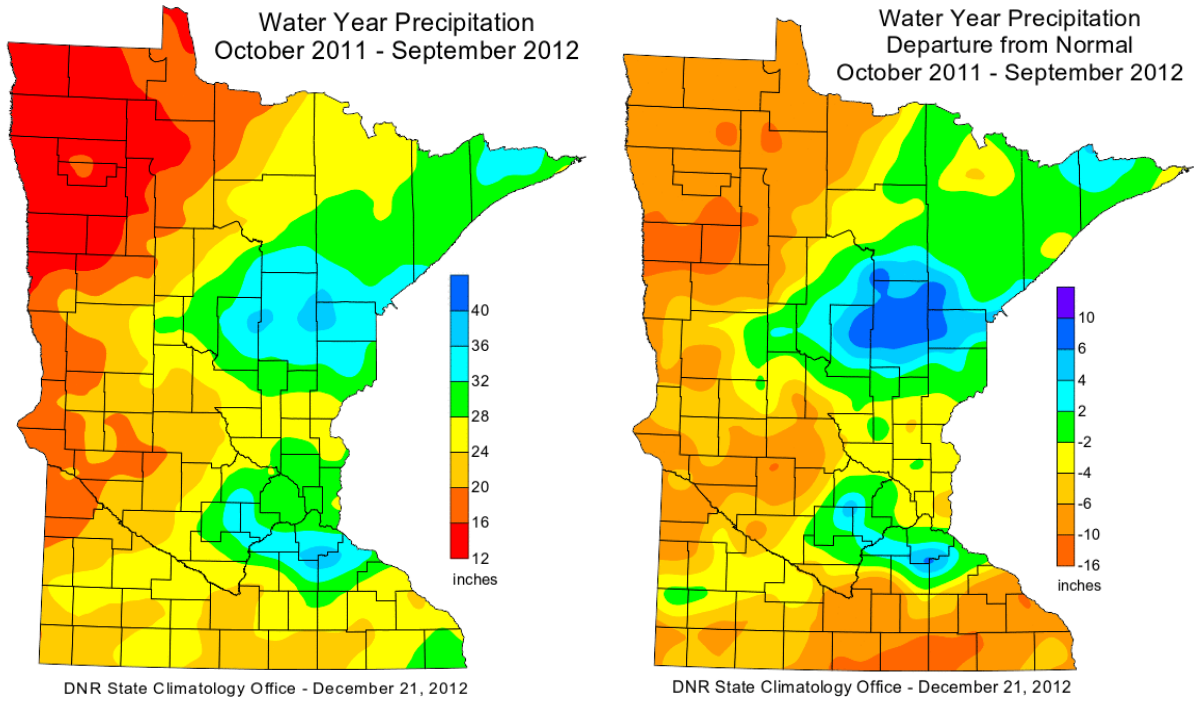

Figure 13. State-wide precipitation levels during the 2012 water year.

The Zumbro River Watershed is located in the southeast precipitation region. Figure 14 and Figure 15 (below) display the areal average representation of precipitation in southeast Minnesota for 20 and 100 years, respectively. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center, available as a link off of the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html. Though rainfall can vary in intensity and time of year, rainfall totals in the southeast region display no significant trend over the last 20 years. However, precipitation in southeast Minnesota exhibits a statistically significant rising trend over the past 100 years (p=0.001). The 100-year trend is a strong and matches similar trends throughout Minnesota.

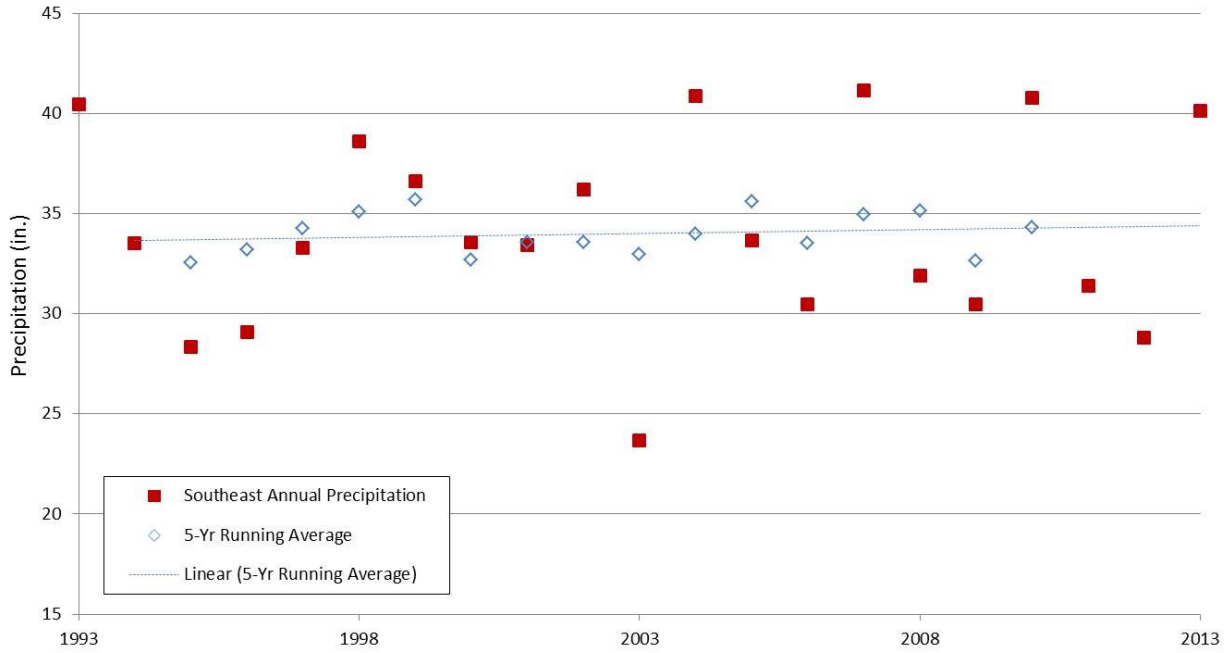

Figure 14. Precipitation trends in Southeastern Minnesota (1993-2013) with five year running average indicating no trends.

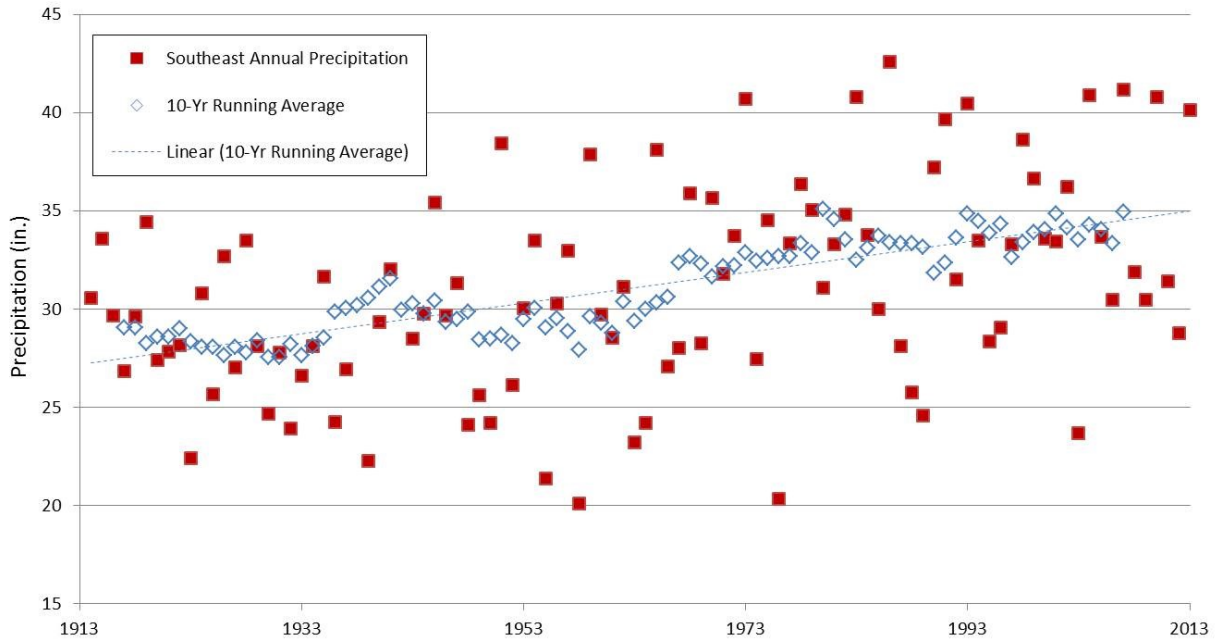

Figure 15. Precipitation trends in Southeastern Minnesota (1913 - 2013) with 10-year running average showing an increasing trend despite year to year variations.

Hydrogeology and groundwater quality

The Zumbro River Watershed is located in southeast Minnesota within the Lower Mississippi River Basin. The watershed is found in the eastern area of the southeast hydrogeological region (Region 5) and is dominated by glacial landforms and till. Due to the Paleozoic bedrock geology of the area, it is primarily limestone, dolomite and sandstone. The main aquifers include the Upper Carbonate Group (Galena and Cedar Valley carbonate aquifers), St. Peter sandstone, Prairie du Chien Group, Jordan sandstone and Franconia-Ironton-Galesville aquifers, and the Mt. Simon aquifer (MPCA 1999).

Geology in southeast Minnesota and the Zumbro River Watershed is characterized by karst features. These geologic features occur where limestone is slowly dissolved by infiltrating rainwater, sometimes forming hidden, rapid pathways from pollution release points to drinking water wells or back to surface water. Surface water and groundwater are so closely connected in karst areas that the distinction between the two is difficult to determine. Groundwater may emerge as a spring, flow a short distance above ground, only to vanish in a disappearing stream, returning to groundwater conduits and perhaps re merge farther downstream again as surface water.

Karst aquifers, like those commonly used in the Zumbro River Watershed, are very difficult to protect from activities at the ground surface because pollutants can be quickly transported to drinking water wells or surface water. Because of this, the best strategy to protect groundwater in this watershed is pollution prevention from common sources like row crop agriculture, septic systems, abandoned wells and animal feedlot operations.

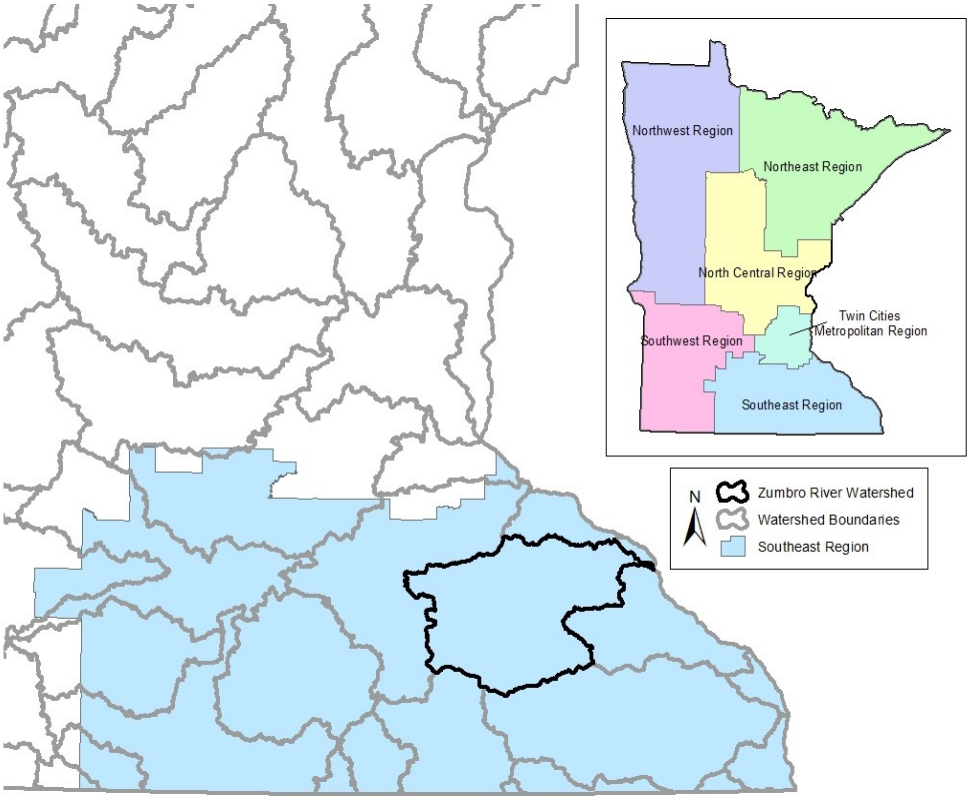

Figure 16. Zumbro River Watershed within the Southeast Hydrogeological Region (Region 5).

The Zumbro River Watershed falls within two of Minnesota's six groundwater provinces: the Southeastern and South-Central Provinces. The majority of the watershed lies within the Southeastern Province, which is characterized by "thin (less than 100 feet) clayey glacial drift overlying Paleozoic sandstone, limestone and dolostone aquifers. Karst characteristics are common in limestone and dolostone bedrock" (MNDNR, 2001). The western region of the watershed is located within the South-Central Province which is characterized by "thick clayey glacial drift with limited extent sand aquifers overlying Paleozoic sandstone, limestone and dolostone aquifers" (MNDNR 2001).

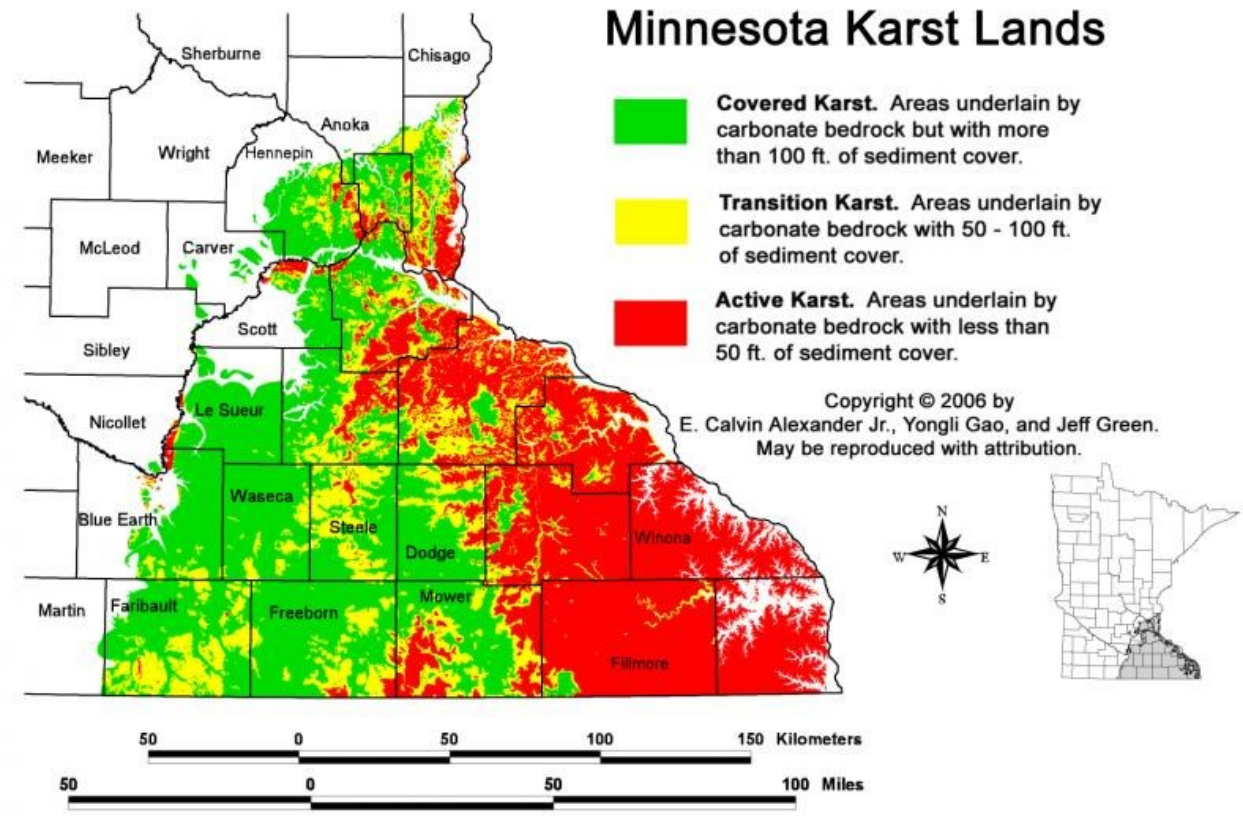

Figure 17. Locations of karst features in southeast Minnesota [Source: Alexander, Gao & Green, 2007].

Recharge of these aquifers is important and limited to areas located at topographic highs, those with surficial sand and gravel deposits, and those along the bedrock/surficial deposit interface. Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS 2007). For the Zumbro River Watershed, the primary average annual recharge rate to surficial materials is six to eight inches per year with some regions ranging from four to six and eight to ten inches per year (Figure 19).

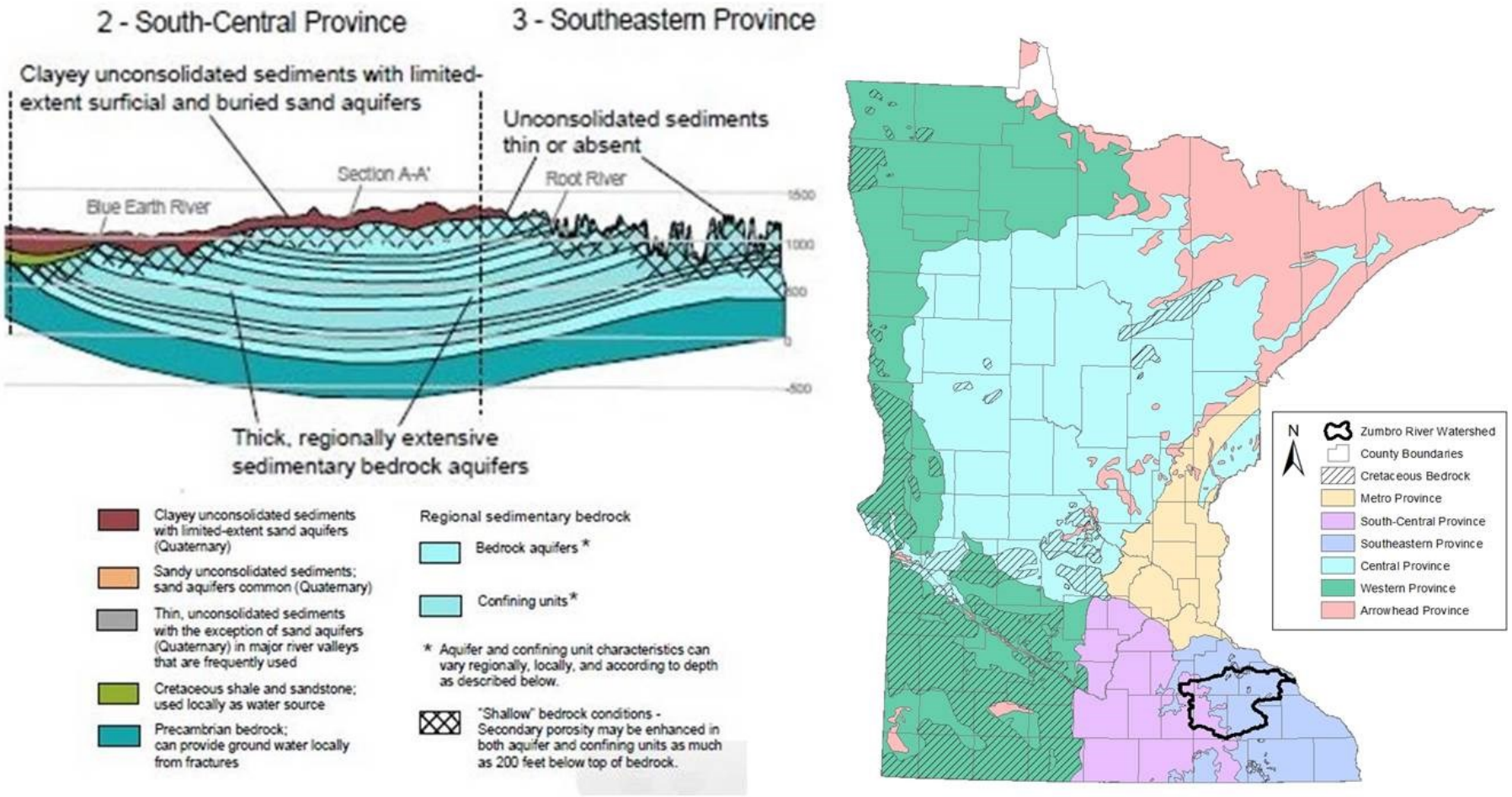

Figure 18. South-Central Province and Southeastern Province Generalized Cross Section (Source: MNDNR, 2001).

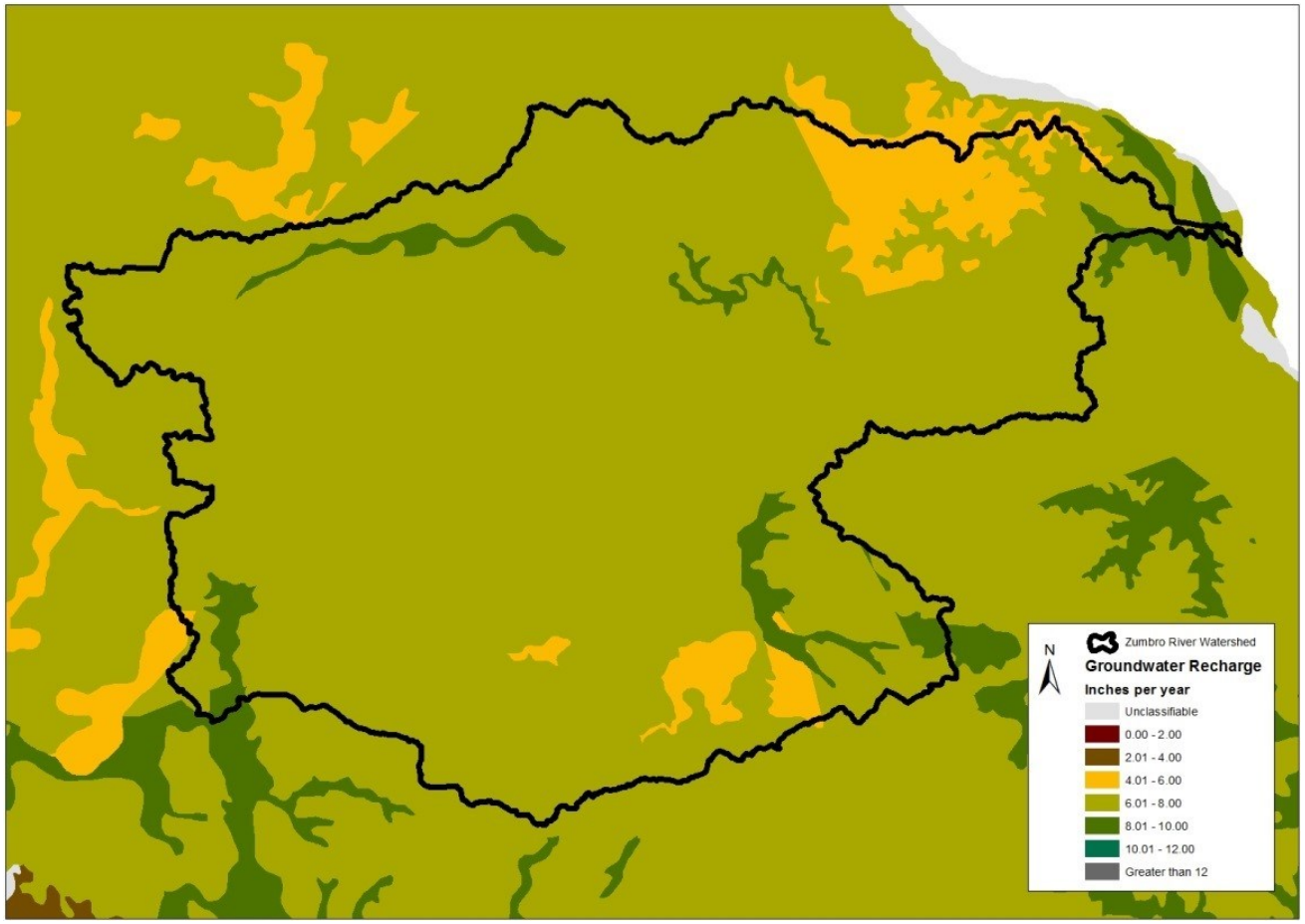

Figure 19. Average Annual Recharge Rate to Surficial Materials in Zumbro River Watershed (1971-2000).

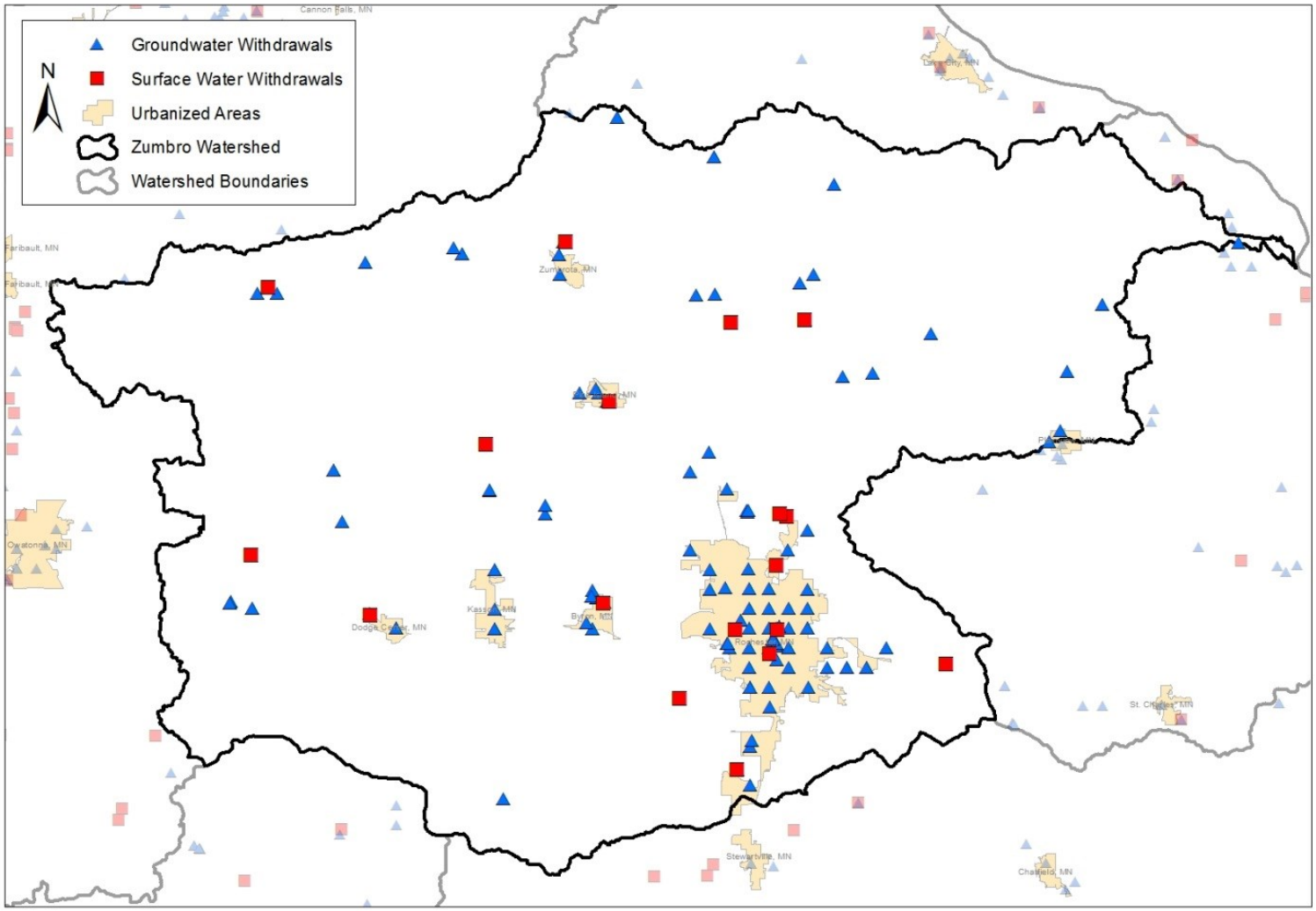

Figure 20. Locations of permitted groundwater withdrawals in the Zumbro River Watershed.

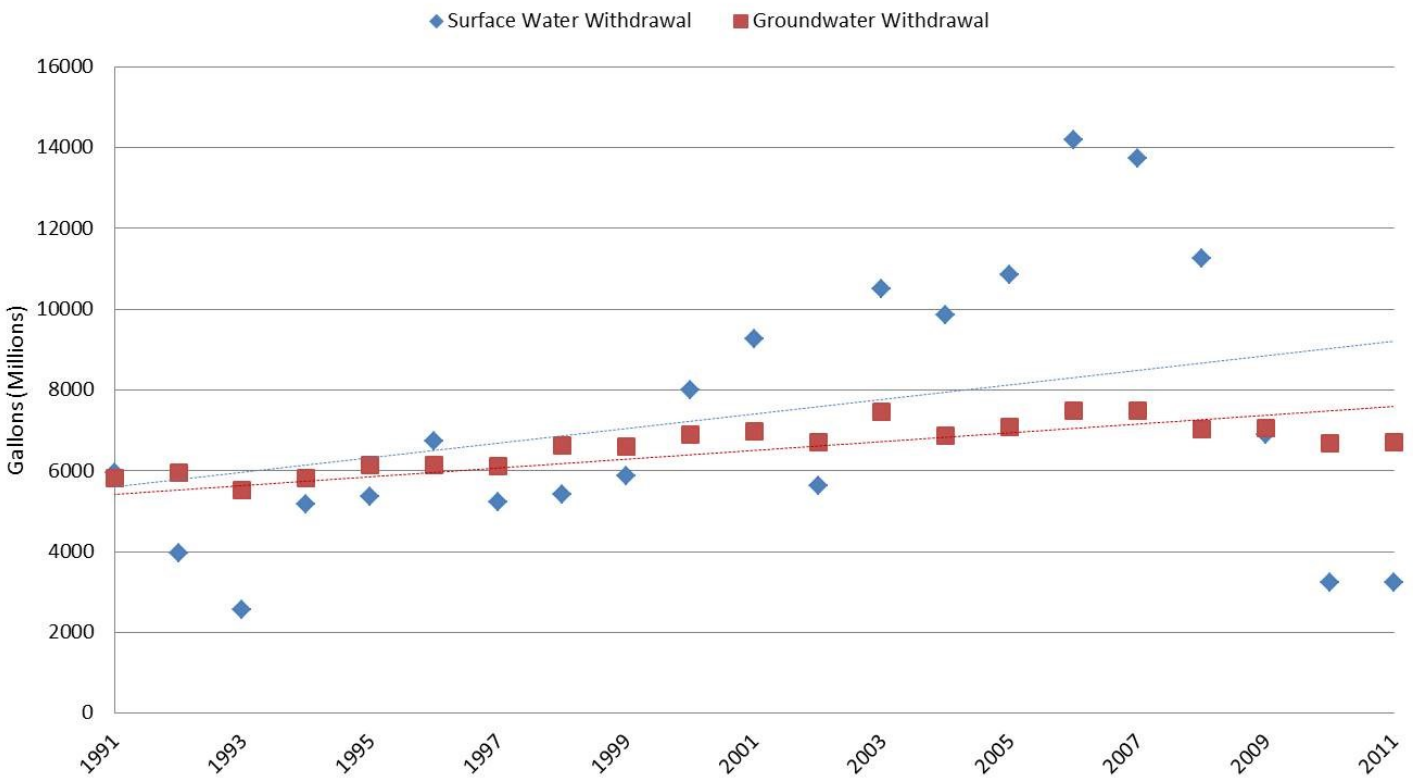

Figure 21. Total annual groundwater and surface water withdrawals in the Zumbro River Watershed (1990-2010).

Watershed-wide data collection methodology

Watershed Pollutant Load Monitoring Network

Intensive water quality sampling occurs throughout the year at all WPLMN sites. Thirty-five samples/year are allocated for basin and major watershed sites and 25 samples/season for subwatershed sites. Between 26 and 43 mid-stream grab samples were collected per year at the MNDNR stream gage on the Zumbro River at Kellogg, US61 (MNDNR/MPCA ID: 41043001; EQuIS ID: S004-484; USGS ID: 05374900). Because correlations between concentration and flow exist for many of the monitored analytes, sampling frequency is typically greatest during periods of moderate to high flow.

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

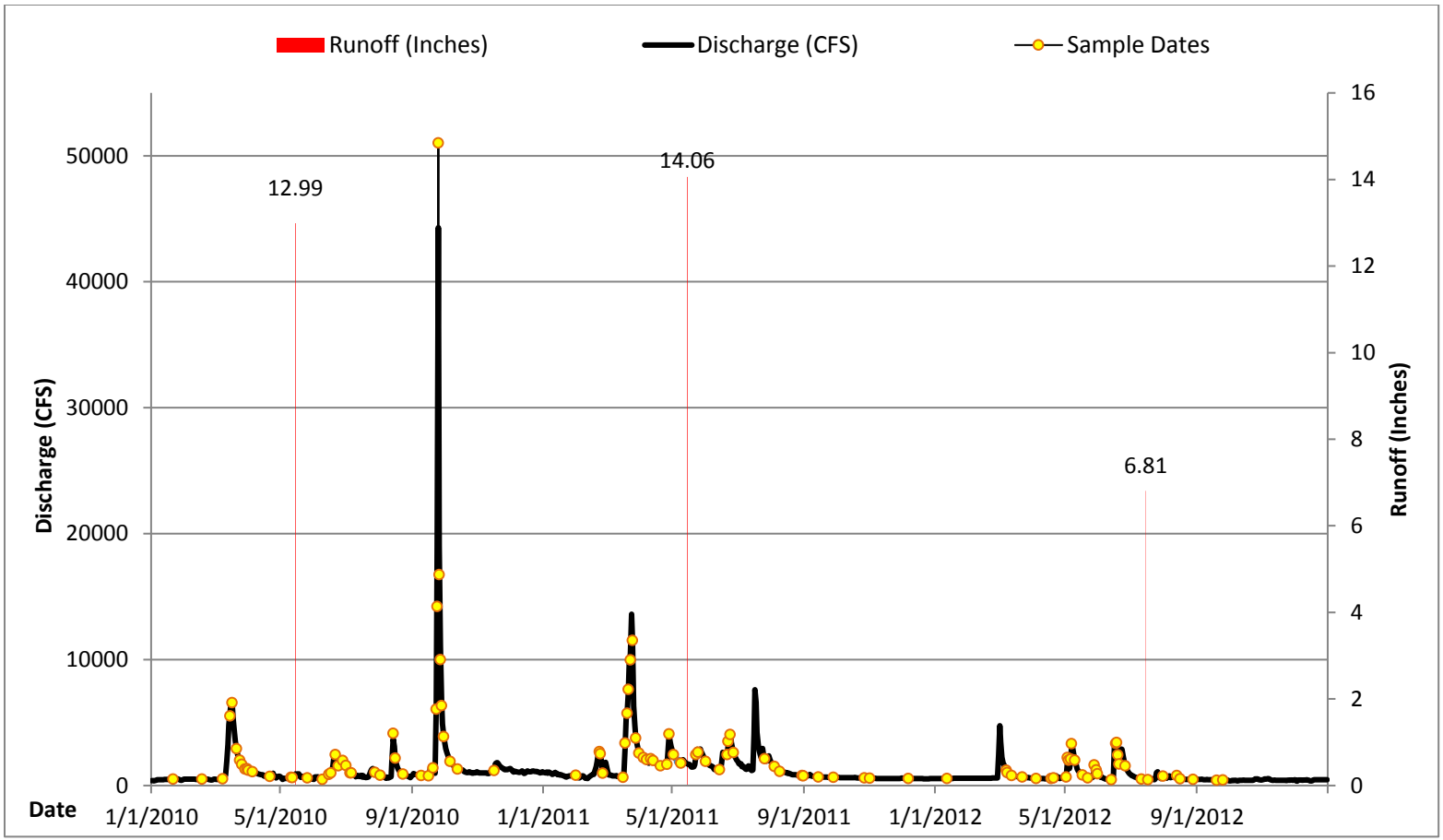

Figure 22. Hydrograph and annual runoff for the Zumbro River near Kellogg, Minnesota (2010-2012).

Stream water sampling

Eighty-two stream reaches in the Zumbro River Watershed were assessed against current water quality standards for water chemistry, biological indicators or both. Based on these assessments, a support status for aquatic life and/or aquatic recreational uses was assigned, which indicate fully supporting, not supporting or insufficient information for the assessed uses. Surface Water Assessment Grants (SWAGs) were awarded to the Zumbro Watershed Partnership (ZWP) and Goodhue SWCD to collect water chemistry samples at 13 subwatershed outlet stations (among others) to supplement MPCA assessment data. Dodge and Olmstead SWCDs assisted in collecting data as well. Those 13 chemistry stations were sampled by grantees and partners from May through September in 2012, and again June through August of 2013 to provide sufficient water chemistry data to assess all components of the aquatic life and recreation use standards. Following the IWM design, water chemistry stations were placed at, or near, the outlet of each major subwatershed that was less than 40 mi^2 in area (purple circles and green circles/triangles in (Figure 3). Additionally, citizen volunteers enrolled in the Citizen Stream Monitoring Program (CSMP) observed physical water characteristics at 33 stream stations and submitted data to MPCA in 2014, which aided in the assessment process. (See Appendix 2 for locations of stream chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study). Sampling methods were consistent among monitoring parties and are described in the document entitled "Standard Operating Procedures (SOP): Intensive Watershed Monitoring – Stream Water Quality Component" found at http://www.pca.state.mn.us/index.php/view-document.html?gid=16141.

Chemistry data submitted by wastewater treatment plants as part of permitted discharges were also reviewed during the assessment process.

Stream flow methodology

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

Stream biological sampling

The biological monitoring component of the IWM in the Zumbro River Watershed was completed during the summer of 2012. A total of 65 sites were newly established across the watershed and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, 5 existing biological monitoring stations within the watershed were revisited in 2012. These monitoring stations were initially established as MNDNR monitoring stations in 2002, as part of a random Lower Mississippi River Basin wide survey in 2004, as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones or as part of a statewide random survey to assess general quality of Minnesota streams in 2010. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2015 assessment was collected in 2012. A total of 65 AUIDs were sampled for biology in the Zumbro River Watershed. Waterbody assessments to determine aquatic life use support were conducted for 70 AUIDs (including five AUIDs that were assessed only using chemical parameters and not biological indicators). Biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles.

To measure the health of aquatic life at each biological monitoring station, indices of biological integrity (IBIs), specifically Fish and Invert IBIs, were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage

area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into 7 distinct warm water classes and 2 cold water classes, with each class having its own unique Fish IBI and Invert IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs) (For IBI classes, thresholds and CIs, see Appendix 4.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold and lower CI indicate that the stream reach does not support aquatic life. When an IBI score falls within the upper and lower confidence limits based on duplicate sampling additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, observations of local land use activities). For IBI results for each individual biological monitoring station, see Appendix 4.

Fish contaminants

Mercury was analyzed in fish tissue samples collected from the Zumbro River and 4 lakes, including Lake Zumbro created by the dam above the main Zumbro River. Polychlorinated biphenyls (PCBs) were measured in fish from the river and10 lakes. MPCA biomonitoring staff collected the fish from the river in 2012. MNDNR fisheries staff collected all other fish.

In addition, fish from Zumbro River and lake were tested for perfluorochemicals (PFCs) between 2007 and 2010. PFCs became a contaminant of emerging concern in 2004, when high concentrations were measured in fish from the Mississippi River. Extensive statewide monitoring of lakes and rivers for PFCs in fish was continued through 2010. After 2010, more focused monitoring for PFCs continued in known contaminated waters, such as the Mississippi River, several lakes in the Twin Cities Metropolitan Area, and some reservoirs in the Duluth area.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled (or skinned), filleted and ground to a homogenized tissue sample. For mercury or PCBs analyses, homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for lab analysis. The Minnesota Department of Agriculture (MDA) Laboratory performed all mercury and PCBs analyses of fish tissue. For PFCs, whole fish were shipped to AXYS Analytical Services Ltd in Sidney, British Columbia, Canada. AXYS did the fish measurements and processing before analyzing the tissue samples for 13 PFCs. The PFC that primarily bioaccumulates in fish and is a known health concern for human consumption is perfluorooctane sulfonate (PFOS).

The Impaired Waters List is submitted every even year to the U. S. Environmental Protection Agency (EPA) for the agencies approval. MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs and PFOS in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs or PFOS, the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 mg/kg for PCBs and 0.200 mg/kg (200 ppb) for PFOS.

Before 2006, mercury in fish tissue was assessed for water quality impairment based on MDH'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 90th percentile) exceed 0.2 mg/kg of mercury, which is one of Minnesota's water quality standards for mercury. At least 5 fish samples per species are required to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006, as well as more recent impairments.

PCBs in fish were intensively monitored in the 1970s and 1980s, showing high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. Therefore, continued widespread frequent monitoring of smaller river systems was not necessary. The current watershed monitoring approach includes screening for PCBs in representative predator and forage fish collected at the pour point stations in each major watershed.

Lake water sampling

The Zumbro River Watershed has 17 lakes at least 10 acres in size. Two lakes (Zumbro and Silver) were monitored for water clarity by citizens enrolled in the Citizen Lake Monitoring Program (CLMP) in partnership with MPCA during 2014. Only 2 lakes (Zumbro and Rice) had sufficient water chemistry data to assess against regional lake eutrophication standards. Monitoring methods were consistent among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality found at: http://www.pca.state.mn.us/publications/wq-s1-16.pdf. The lake water quality assessment standard requires eight observations/samples within a 10-year period for phosphorous, chlorophyll-a and Secchi depth (clarity).

Groundwater monitoring

The MPCA's Ambient Groundwater Monitoring Program has sampled 6 domestic wells and 10 monitoring wells within the Zumbro River Watershed. Figure 49 displays the locations of the MPCA's Ambient Groundwater Monitoring wells in and around the Zumbro River Watershed. The Minnesota Department of Agriculture (MDA) annually monitors pesticides in groundwater through a network of monitoring wells statewide. Southeast Minnesota, including the Zumbro River Watershed, is one of two areas MDA monitors more intensively due to the vulnerable geology.

Wetland monitoring

The MPCA began developing biological monitoring methods for wetlands in the early 1990s, focusing on wetlands with emergent vegetation (i.e., marshes) in a depressional geomorphic setting. This work has resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, and crustaceans) IBIs for the Temperate Prairies (TP), Mixed Wood Plains (MWP) and the Mixed Wood Shield (MWS) level II ecoregions in Minnesota. These IBIs are suitable for evaluating the ecological condition or health of depressional wetland habitats. All of the wetland IBIs are scored on a 0 to 100 scale with higher scores indicating better condition. Wetland sampling protocols can be viewed at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html. Today, these indicators are used in a statewide survey of wetland condition where results can be summarized statewide and for each of Minnesota's three level II ecoregions (Genet 2012).

Individual subwatershed results

HUC-12 subwatersheds

Assessment results for aquatic life and recreation use are presented for each aggregated HUC-12 subwatershed within the Zumbro River Watershed. The primary objective is to portray all the full support and impairment listings within an aggregated 12-HUC subwatershed resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire 8-HUC watershed including aquatic consumption, and drinking water assessments (where applicable) is included in (Appendix 3.1). This scale provides a robust assessment of water quality condition at a practical size for the development, management and implementation of effective TMDLs and protection strategies. The graphics presented for each of the aggregated HUC-12 subwatersheds contain the assessment results from the 2014, Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2012, intensive watershed monitoring effort but also considers available data from the last 10 years.

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

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2012 assessment process (2014 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); determinations made during the desktop phase of the assessmentprocess (see Figure 5). Assessment of aquatic life is derived from the analysis of biological (fish and invert IBIs), dissolved oxygen, total suspended solids, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (*Escherichia coli* or fecal coliform) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Where applicable and sufficient data exist, assessments of other designated uses (e.g., Class 7, drinking water, aquatic consumption) are discussed in the summary section of each aggregated HUC-12 subwatershed as well as in the watershed-wide results and discussion section.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each aggregated HUC-12 subwatershed section. These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of 5 scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of

100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the aggregated HUC-12 subwatershed.

Stream stability results

Stream channel stability information evaluated during each invert sampling visit is provided in each HUC-12 subwatershed section. These tables display the results of the Channel Condition and Stability Index (CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates 3 regions of the stream channel (upper banks, lower banks, and bottom) which may provide an indication of stream channel geomorphic changes and loss of habitat quality which may be related to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2008, and is collected once at each biological station. Consequently, the CCSI ratings are only available for biological visits sampled in 2010, or later. The final row in each table displays the average CCSI scores and a rating for the HUC-12 subwatershed.

Subwatershed outlet water chemistry results

These summary tables display the water chemistry results collected by SWAG grantees for the monitoring station representing the outlet of the HUC-12 subwatershed. These data along with other data collected within the 10-year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to the standards or expectations used for assessing aquatic life and recreation. While not all of the water chemistry parameters of interest have established water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of parameters that provide a basis for evaluating stream water quality data and estimating attainable conditions for an ecoregion. For comparative purposes, water chemistry results for the Zumbro River Watershed are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams within each ecoregion.

Lake assessments

A summary of lake water quality is provided in the aggregated HUC-12 subwatershed sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for Zumbro and Rice Lakes are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 5.2.

Upper South Fork Zumbro River Subwatershed HUC 0704000401-03

The Upper South Fork Zumbro River Subwatershed encompasses the upstream most reaches of the South Branch of the Zumbro River, stretching 77.16 mi^2 over the southeastern corner of Dodge County and the southwestern corner of Olmstead County. The Zumbro River's South Fork begins north of the rural community of Hayfield flowing east following Dodge CSAH 4 past Vernon and continuing near Olmstead CSAH 26 past the rural community of Rock Dell. The river turns north near Olmstead CSAH 104 to the watershed unit's northern boundaries prior to the Zumbro River's confluence with Salem Creek a few miles southwest of Rochester. Land in the watershed primarily managed for agricultural purposes64% is tilled for cropland while 22% is grazed by livestock. Only 6.5% of the watershed remains forested, these forested acres are primarily observed along riverine corridors where topography limits their utility as cropland. Developed areas in the watershed (5.6 %) are limited to the small rural communities of: Hayfield, Vernon, Oslo and Rock Dell. For intensive water chemistry data collection purposes the Upper South Fork Zumbro River Subwatershed was grouped with its lower branch, the Lower South Fork Zumbro River Subwatershed, due to that watershed's nature of being a flow through aggregated HUC 12 watershed. There are no lakes present within the subwatershed.

Table 1. Aquatic life and recreation assessments on stream reaches: Upper South Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-982, ***Zumbro River, South Fork***, *Unnamed cr to Unnamed cr*	12LM074, 10EM155, 12LM071	22.24	WWg	MTS	MTS	NA	NA	MTS	--	NA	--	MTS	--	--	SUP	IF
07040004-969, ***Unnamed creek***, *Unnamed cr to S Fk Zumbro R*	12LM073	2.06	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-968, ***Unnamed creek***, *Unnamed cr to S Fk Zumbro R*	12LM072	3.24	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-983, ***Zumbro River, South Fork***, *Unnamed cr to CR-117/60th Ave SW*	12LM070	2.63	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 2. Minnesota Stream Habitat Assessment (MSHA): Upper South Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM074	Zumbrp River	2.5	12	18	12	26	70.5	Good
1	12LM073	Trib. to Zumbro River, South	0	5	19	10	17	51	Fair
1	10EM155	Zumbro River, South Fork	2.5	10	20.7	10	31	74.2	Good
1	12LM071	Zumbro River, South Fork	0	12	21	13	32	78	Good
2	12LM072	Trib. to Zumbro River, South	5	13.5	10.5	13	26	68.5	Good
1	12LM070	Zumbro River, South Fork	2.5	9.5	16	7	22	57	Fair
Average Habitat Results: *Upper South Fork Zumbro River Subwatershed*			**2.08**	**10.33**	**17.53**	**10.83**	**25.67**	**66.5**	**Good**

Qualitative habitat ratings

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

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

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

Table 3. Channel Condition and Stability Assessment (CCSI): Upper South Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM074	Zumbro River	20	14	10	5	49	Moderately unstable
1	12LM073	Trib. to Zumbro River, South Fork	13	15	11	5	44	Fairly stable
1	10EM155	Zumbro River, South Fork	6	7	9	5	27	Stable
1	12LM071	Zumbro River, South Fork	16	26	30	7	79	Moderately unstable
2	12LM072	Trib. to Zumbro River, South Fork	15	14	7.5	4	40.5	Fairly stable
1	12LM070	Zumbro River, South Fork	30	38	34	11	113	Severely unstable
Average Stream Stability Results: *Upper South Fork Zumbro River Subwatershed*			**16.67**	**19**	**16.92**	**6.17**	**58.75**	**Moderately unstable**

Qualitative channel stability ratings

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

Summary

Biological monitoring results across the subwatershed indicate that water quality in the Upper South Fork Zumbro River Subwatershed is fully supporting its aquatic life use. At large, chemistry data were insufficient to determine support statuses for AQL and AQR; however, water quality parameters observed during single grab samples at biological visits appear generally good across the subwatershed. A full support (FS) status for AQL can be obtained where current chemistry data are insufficient or meet standards, if the biological IBI criteria are met and found to be fully supporting their designated use. Fish IBI scores, at six unique stations, all exceeded upper confident limits for GU thresholds with FIBI scores ranged from 74–86. Invert IBI scores were all within or exceeded upper confidence limits for GU thresholds. MIBI scores ranged from 41.9-70.6. MSHA habitat scores are generally good across the watershed. Lower 'Fair' MSHA scores were observed at the channelized station (12LM073) and 12LM070, concerns include: presence of row crop in the riparian zone and riparian zone size, heavy erosion, moderate embeddedness of coarse substrates, low channel stability (unstable bed and banks) and sparse cover. Lowest FIBI and MIBI scores were observed at the channelized station with the lowest MSHA score (12LM073). FIBI results appear higher at stations with higher MSHA scores and larger riparian buffers-both of which are observed in the more downstream reaches of the watershed in areas with increased gradient which limits the lands utility for agricultural landuse. CCSI results indicate that overall the subwatershed is moderately unstable. It appears that headwaters tributaries are generally more stable and the stream begins to unravel more moving downstream in the watershed with the downstream site scoring worst-severely unstable. Additional intensive water chemistry monitoring at the outlet of the subwatershed could be provide insight as to whether or not the subwatershed is contributing to downstream aquatic life and aquatic recreation impairments on the Lower South Fork Zumbro River Subwatershed.

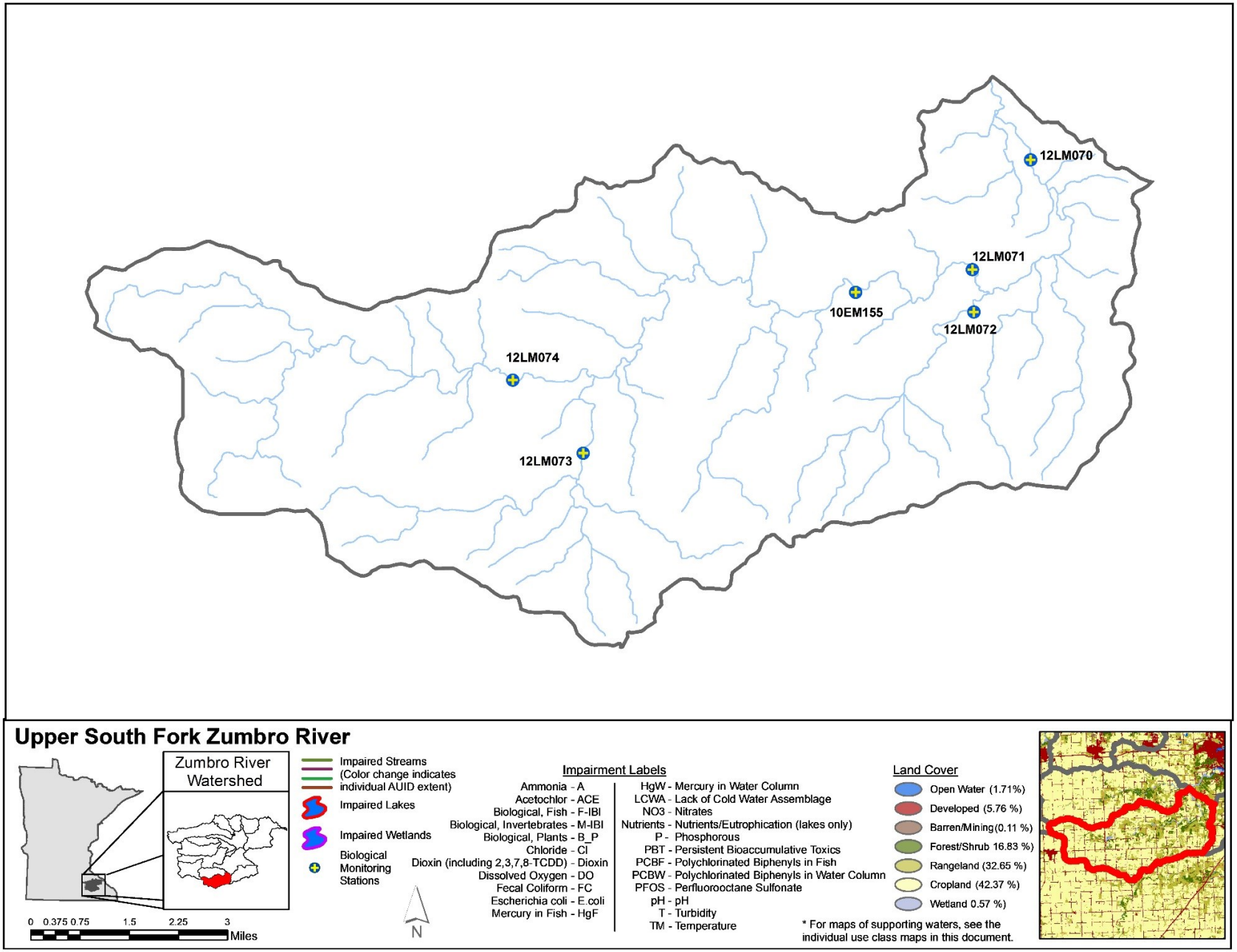

Figure 23. Currently listed impaired waters by parameter and land use characteristics in the Upper South Fork Zumbro River Subwatershed.

Salem Creek Subwatershed HUC 0704000401-04

Salem Creek is diverse in nature including habitat that flows through forested areas with steep gradient and bedrock outcroppings and regions that are have less gradient and are intensely cultivated. Salem Creek begins in southeastern Dodge County south of Vlasaty. The warmwater stream flows in a slight northeasterly direction following Dodge CSAH 6 and CSAH 25 in Olmstead County where it ultimately joins the South Fork of the Zumbro River southwest of Rochester. The watershed encompasses 62.16 mi^2 of the southern regions of the Zumbro River Watershed, comprised primarily cropland (75.51%) and rangeland (12.29%). Forested areas of the watershed are sparse comprising only 5% of the watershed's overall landscape. Development in the watershed is limited to 5.7% of the watersheds area and includes the small communities of Vlasaty, Shanty Town and Salem Corners. Many of the watershed's historic wetlands have been drained for agricultural use (MNDNR Stream Survey Report). The outlet water chemistry station is collocated with biological monitoring station 12LM009. There are no lakes in the subwatershed.

Salem Creek is reknowned for its abundant population of rainbow darters (Etheostoma caeruleum), a species extremely sensitive to degradation and excess sediment. Past permits issued by the MNDNR have allowed rainbow darters of Salem Creek to serve as ambassadors of their species in reintroduction projects to streams where the species had been historically extirpated, including Belle Creek in the Cannon River Watershed.

Figure 24. Salem Creek, biological stations 12LM063 (left), center Rainbow Darter (Lyons) and 12LM009 (right).

Table 4. Aquatic life and recreation assessments on stream reaches: Salem Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-597, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	04LM010	1.85	WWg	EXS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-595, ***Unnamed creek***, *Unnamed cr to Unnamed cr*		0.84	WWg	--	--	--	--	NA	--	--	--	--	--	--	IF	IMP
07040004-594, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	12LM062	1.19	WWg	MTS	MTS	NA	NA	MTS	--	NA	--	--	IF	--	SUP	IF
07040004-503, ***Salem Creek***, *T106 R16W S30, west line to S Fk Zumbro R*	12LM063, 04LM122, 12LM009	19.22	WWg	MTS	EXS	IF	MTS	MTS	MTS	MTS	MTS	--	IF	--	IMP	IMP
07040004-967, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	12LM061	0.69	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 5. Minnesota Stream Habitat Assessment (MSHA): Salem Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM063	Salem Creek	2.5	13	23.25	12	34	84.75	Good
1	04LM010	Trib. to Salem Creek	2	6	16.4	13	30	67.4	Good
1	12LM062	Trib. to Salem Creek	2.5	12.5	19.9	15	22	71.9	Good
2	04LM122	Salem Creek	5	11.75	19.55	11	25	72.3	Good
1	12LM061	Trib. to Salem Creek	0	5.5	17.5	7	19	49	Fair
2	12LM009	Salem Creek	0	4	19.05	13.5	26.5	63.05	Fair
Average Habitat Results: *Salem Creek Subwatershed*			**2**	**8.79**	**19.28**	**11.92**	**26.08**	**68.07**	**Good**

Qualitative habitat ratings

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

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

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

Table 6. Channel Condition and Stability Assessment (CCSI): Salem Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM063	Salem Creek	6	6	4	1	17	Stable
1	12LM062	Trib. to Salem Creek	5	11	4	1	21	Stable
1	12LM061	Trib. to Salem Creek	15	15	17	7	54	Moderately unstable
1	12LM009	Salem Creek	17	30	15	7	69	Moderately unstable
Average Stream Stability Results: *Salem Creek Subwatershed*			**10.75**	**15.5**	**10**	**4**	**40.25**	**Fairly stable**

Qualitative channel stability ratings

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

Table 7. Outlet water chemistry results: Salem Creek Subwatershed.

Station location:	**Salem Creek;** @ CSAH-3 Bridge, 4 MI SE of Byron, MN						
STORET/EQuIS ID:	**S005-422**						
Station #:	**12LM009**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2C) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.7	3.0	2.0	40	0
Chloride	mg/L	12	18.6	24.5	21.2	230	0
Dissolved Oxygen (DO)	mg/L	19	5.81	10.48	8.66	5	0
pH		19	7.9	8.3	8.1	6.5 - 9	0
[1]Secchi Tube	100 cm	63	3	100	71	> 10	1
Total suspended solids	mg/L	12	3	15	7	< 65	0
Escherichia coli (geometric mean)	MPN/100ml	3	143	594	- -	126	3
Escherichia coli	MPN/100ml	15	48	1553	397	1260	1
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	12	0.7	16.6	6.2	- -	
Kjeldahl nitrogen	mg/L	12	0.30	0.46	0.38	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	12	30	410	77	- -	
Specific Conductance	µS/cm	19	423	604	551	- -	
Temperature, water	deg °C	63	9.44	29.40	19.46	- -	
Sulfate	mg/L	12	18.3	24.5	21.7	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Salem Creek Subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Unnamed Creek (07040004-597, 07040004-595 and 07040004-594)

An aquatic life impairment for fish and invertebrates was observed in 2004 on a small tributary of Salem Creek in the watershed's northwestern headwaters (07040004-597). While 12 fish species were captured during 2004 at 04LM010; the sample was dominated by generalists, tolerant species and detritivores causing poor IBI performance. The low invertebrate IBI score was the result of dominance by tolerant taxa and a lack of abundance and diversity of POET taxa typical of higher quality streams in this region. The MSHA habitat was good (67.4) despite present channelization within the reach. A horse pasture was present in riparian zone, but 2004 photographs do not indicate heavy grazing. A one time grab sample for nitrogen collected during the fish visit was high at 26 mg/L (6/22/2004) and may suggest nitrogen as a potential stressor; a high relative abundance of nitrogen tolerant invertebrate taxa supports this as a possibility. Moving further downstream on reach 07040004-595, the tributary was listed as impaired for aquatic recreation (*E.coli* bacteria) in 2008; no additional data was gathered within the assessment window to determine whether or not conditions have since improved. Fish biological conditions appear to improve significantly on downstream AUID (07040004-594) at biological station 12LM062, the FIBI score jumps nearly 40 points compared to upstream impaired reach. MSHA habitat scores also slightly improved moving downstream 67.4 to 71.9. The macroinvertebrate IBI score in this reach was two points below the impairment threshold, but the community composition suggests a community reflective of the excellent habitat conditions present so it was determined to be supporting aquatic life. The high abundance of nitrogen tolerance forms suggests that nitrogen could still be having an impact. Differences are notable in the riparian landuse score (worse upstream) and channel morphology score (worse downstream). This may imply an isolated impairment on the landscape at the upstream station, a change in surrounding landuse between the two stations or a transition from outwash plain to karst topography which occurs between the two stations. Resampling 04LM010 for biology could be useful in understanding if conditions have changed post 2004.

Salem Creek (07040004-503)

A new aquatic life impairment for macroinvertebrates is proposed on Salem Creek. MIBI results show a decreasing trend moving downstream, while the upstream site scored within upper confidence limits of the GU threshold (12LM063), the downstream station (12LM009) scored just below the threshold, resulting in impairment. Site 12LM009 has a high relative abundance of tolerant organisms and lacks diversity of intolerant taxa, particularly, intolerant caddisflies, which is often indicative of low quality, low gradient steams. Fish perform well and exceed upper confidence limits longitudinally across all three stations and temporally in samples taken in 2004 and 2012; communities are robust across all stations and visits. However, FIBI scores, like MIBI scores, also decrease moving downstream. Inverts were only sampled at the upstream and the downstream reaches and are marginal at both stations and hover near the impairment threshold. MSHA scores were on the good to the high side of fair (84.75 – 63) and decrease moving downstream. The upstream most sites of Salem Creek have very intact forested riparian zones (12LM063 and 04LM122), approaching its mouth the stream loses gradient and flows through a more agrarian landscape (12LM009). Decreasing MSHA scores are consistent with what one might expect with the watershed's changing landuse and decreasing biological results moving downstream on Salem Creek. Water quality on Salem Creek is generally good; dissolved oxygen data showed levels approaching the standard at times but not exceeding it. One time grab samples for nitrogen taken during fish visits suggest potential for stress (12LM063: 10 mg/L, 04LM122: 15mg/L (6/30/2004) and 6.5 mg/L (8/4/2004), 12LM009: 5.3 mg/l (7/23/2012) and 9 mg/L (6/12/2012)). A high relative abundance of diversity of nitrogen tolerant invertebrate taxa supports the possibility of nitrogen as a potential stressor. An aquatic recreation impairment *(E. coli* bacteria) on Salem Creek was identified in 1994. While feedlot improvements were made on Salem Creek in the early to mid 2000s, elevated *E.coli* levels observed during intensive water chemistry sampling at a station with an open pasture show

problems persist in Salem Creek and confirms the existing impairment. Monthly geometric mean exceedances imply bacteria levels are chronically elevated and may pose a risk to human health through bodily contact (Table 7). Improvements in instream habitat and reductions in *E.coli* levels could be achieved by limiting cattle access to Salem Creek.

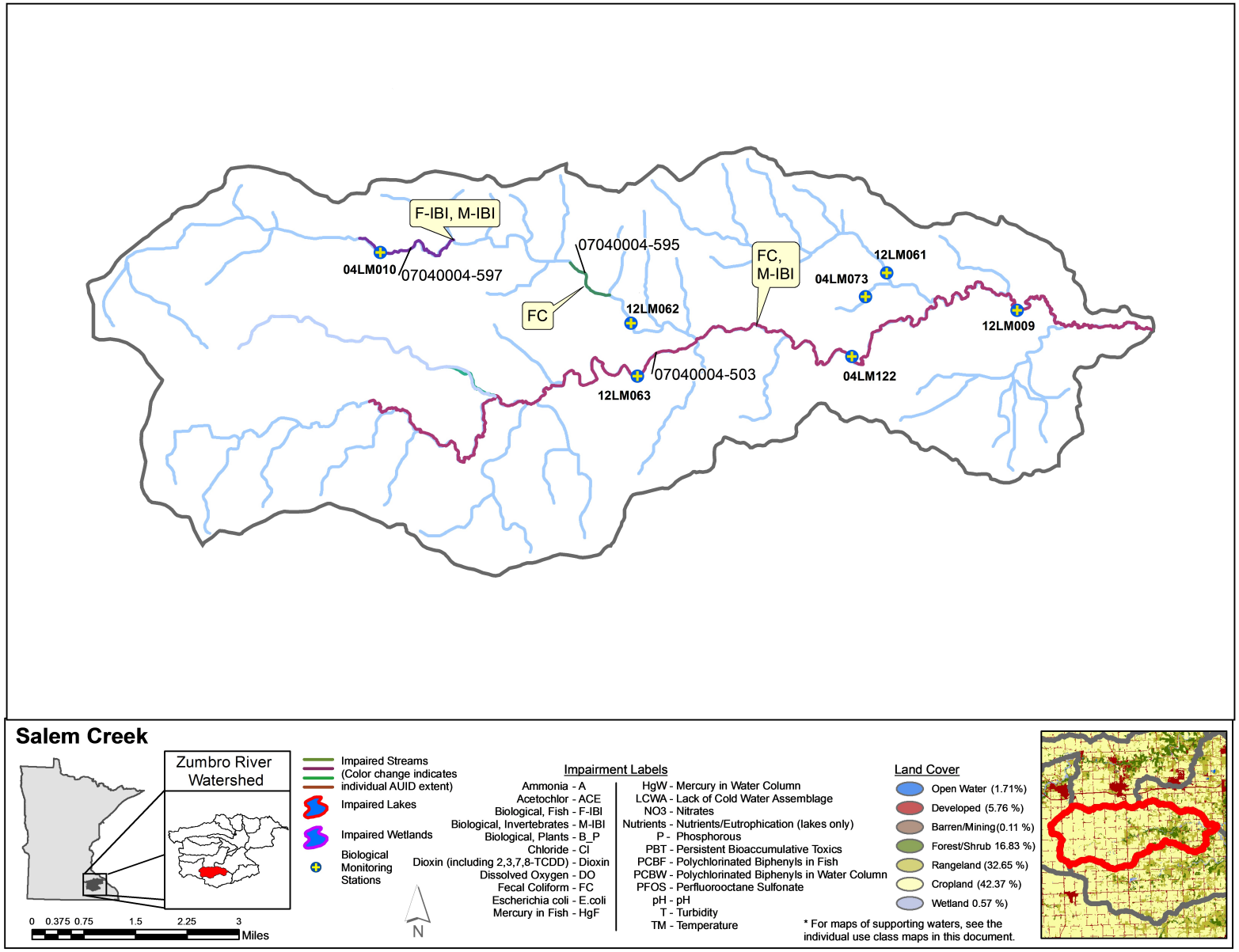

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Salem Creek Subwatershed.

Bear Creek Subwatershed HUC 0704000401-02

The Bear Creek Subwatershed covers 81.35 mi^2 of central Olmsted County. Bear Creek begins in central Olmsted County a few miles northeast of the small rural community of Predmore; it's fed by the subwatershed's sole lake, Chester Lake (Bear Creek Reservoir), a manmade reservoir created in 1994 as part of a flood mitigation project for the city of Rochester. At the outlet of the lake, Bear Creek follows Olmsted CSAH 143 in a northwesterly direction towards Rochester where it joins the South Branch of the Zumbro River. Bear Creek is channelized through a majority of its reach and transitions from a rural stream surrounded by agricultural landuse to an urban stream when it enters the city of Rochester from the southeast. Bear Creek has the highest percentage of developed landuse in the Zumbro River drainage at 19.2%, primarily a result of urban sprawl in the greater Rochester metro area. A majority of its landuse is tied to agricultural production with 32.7% managed for rangeland and 36.2% farmed as cropland. Nearly 10% of the watershed is forested. Intense flooding events impacting the city of Rochester in the 1960s and 1970s led to an intensive flood mitigation project in the greater Rochester area, including the building of a dam in Rochester on Bear Creek in the mid 1990s and the creation of the Bear and Willow Creek reservoirs (Rochester, 2013). As such, Bear Creek is periodically dredged by the city of Rochester/Olmsted County as routine maintenance for the flood control structure. Its intensive water chemistry station is collocated with biological station 12LM008.

Table 8. Aquatic life and recreation assessments on stream reaches: Bear Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-621, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	12LM081	0.71	WWg	EXS	MTS	IF	NA	MTS	--	IF	--	--	IF	--	EXS	IF
07040004-539, ***Bear Creek***, *Headwaters to Willow Cr*	04LM126, 12LM078	16.32	WWg	MTS	MTS	IF	NA	MTS	--	IF	--	--	IF	--	SUP**	IMP
07040004-556, ***Unnamed creek***, *Unnamed cr to Unnamed cr*		1.20	WWg	--	--	--	--	EXS	--	--	--	--	--	--	IMP	--
07040004-619, ***Badger Run***, *Unnamed cr to Unnamed cr*	04LM056	2.60	WWg	MTS	MTS	NA	NA	NA	--	NA	--	--	IF	--	SUP	IF

07040004-620, ***Badger Run***, *Unnamed cr to Bear Cr*	12LM077	1.74	WWg	EXS	MTS	IF	NA	MTS	--	NA	--	--	IF	--	IMP	IF
07040004-800, ***Unnamed creek***, *Unnamed creek to Willow Cr*	12LM080	3.34	WWg	EXS	EXS	NA	NA	MTS	--	NA	--	--	IF	--	IMP	IF
07040004-986, ***Willow Creek***, *Willow R Reservoir 6A to Bear Cr*	04LM024, 12LM079	6.98	WWg	MTS	MTS	NA	NA	MTS	--	NA	--	--	--	--	SUP***	IF
07040004-538, ***Bear Creek***, *Willow Cr to S Fk Zumbro R*	12LM008, 12LM100	2.95	WWg	MTS	MTS	MTS	EXS	MTS	MTS	MTS	MTS	--	IF	--	SUP**	IMP

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

** 07040004-539 and 07040004-538, previously listed for turbidity, old data assessed using new regional TSS and Secchi standards suggests AUID is now meeting standards, AUIDs are proposed for delisting.

***07040004-986, previously listed for turbidity, new data assessed in the 2014 assessment cycle suggests the AUID is now meeting standards and is proposed for delisting.

Table 9. Minnesota Stream Habitat Assessment (MSHA): Bear Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM081	Trib. to Bear Creek	3.75	15	17.9	5	23	64.65	Fair
2	04LM126	Bear Creek	5	13	15.5	10	19.5	63	Fair
1	12LM078	Bear Creek	2	9	14	3	13	41	Poor
1	04LM056	Badger Run	1	12	17.15	9	18	57.15	Fair
1	12LM077	Badger Run	3.5	15	9	10	10	47.5	Fair
1	12LM079	Willow Creek	5	11	14.85	7	10	47.85	Fair
1	04LM024	Willow Creek	1	11	12	8	17	49	Fair
1	12LM080	Trib. to Willow Creek	2.5	11	17.4	6	22	58.9	Fair
1	12LM008	Bear Creek	1	9.5	9	7	14	40.5	Poor
1	12LM100	Bear Creek	1	7	14	12	20	54	Fair
Average Habitat Results: *Bear Creek Subwatershed*			**2.8**	**11.35**	**14.08**	**7.7**	**16.65**	**52.36**	**Fair**

Qualitative habitat ratings

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

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

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

Table 10. Channel Condition and Stability Assessment (CCSI): Bear Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM081	Trib. to Bear Creek	42	40	34	11	127	Extremely unstable
1	04LM126	Bear Creek	16	24	30	5	75	Moderately unstable
1	12LM078	Bear Creek	18	26	30	7	81	Severely unstable
1	12LM077	Badger Run	20	28	30	7	85	Severely unstable
1	12LM079	Willow Creek	27	36	28	7	98	Severely unstable
Average Stream Stability Results: Bear Creek *Subwatershed*			**24.6**	**30.8**	**30.4**	**7.4**	**93.2**	**Severely unstable**

Qualitative channel stability ratings

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

Table 11. Outlet water chemistry results: Bear Creek Subwatershed.

Station location:	**Bear Creek;** Upstream of MN-14 Bridge in Rochester, MN						
STORET/EQuIS ID:	**S001-324**						
Station #:	**12LM008**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.24	2.41	1.59	40	0
Chloride	mg/L	11	32	44	38	230	0
Dissolved Oxygen (DO)	mg/L	19	6.2	10.2	8.5	5	0
pH		19	7.4	8.3	7.9	6.5 - 9	0
[1]Secchi Tube	100 cm	46	4	100	43	> 10	2
Total suspended solids	mg/L	11	7	25	16	< 65	0
Escherichia coli (geometric mean)	MPN/100ml	3	596	906	- -	126	3
Escherichia coli	MPN/100ml	15	345	1414	777	1260	1
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	11	1.6	3.8	2.7	- -	
Kjeldahl nitrogen	mg/L	11	0.30	0.72	0.45	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	11	76	780	171	- -	
Specific Conductance	µS/cm	19	470	660	591	- -	
Temperature, water	deg °C	39	10.00	21.9	16.71	- -	
Sulfate	mg/L	11	19.8	29.1	23.6	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Bear Creek Subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Biological impairments in the Bear Creek Subwatershed appear to be isolated on three small headwaters tributaries: Badger Run (07040004-620) and Unnamed Tributary to Bear Creek 07040004-621 are both impaired for aquatic life for fish and an Unnamed Tributary to Willow Creek (07040004-800) impaired for aquatic life due to both fish and macroinvertebrates.

While biological impairments are isolated within the subwatershed, fish IBI scores at stations that meet FIBI thresholds are marginal across the Bear Creek subwatershed and are only moderately above impairment thresholds. MSHA and CCSI scores indicate that both fair to poor habitat and severely unstable banks are likely stressing the subwatershed's biological communities indicating that additional water storage in the watershed is needed. Substrates in Bear Creek are fairly homogenous, predominately comprised of sand and silt and lack coarse substrates necessary for lithophilic spawners. Two AUIDs previously listed for turbidity, Bear Creek AUIDs 07040004-538 and 07040004-539, now meet the new regional standard for TSS and fully support AQL use and are proposed for delisting. A new aquatic recreation impairment for *E. coli* bacteria is proposed for Bear Creek (7040004-538) based on intensive water chemistry data collected in 2012 and 2013. Multiple months exceed the bacteria geometric standard, indicating chronically elevated levels of bacteria which may pose a risk to human health through bodily contact. Comments made during the best professional judgement meeting by local partners suggest that an abundant Canada goose population could be contributing to conditions observed. Phosphorous levels were severely elevated at times as well; other conventional chemistry parameters meet the use class standard, where they exist (Table 11).

Connectivity issues are a concern within the subwatershed, Bear Creek is impounded by a dam upstream of 12LM100 and at the Bear Creek reservoir in its headwaters and impaired tributaries of Bear Creek have potential fish barrier issues. Limiting stream connectivity inhibits the ability of fish communities to perform natural migration patterns, commonly resulting in extirpation of species above known impoundments due to limited available winter refuge.

Willow Creek (07040004-986)

Willow Creek is a small tributary to Bear Creek on the western side of the subwatershed. Willow Creek was previously listed for turbidity, new data suggests that conditions are improving within Willow Creek, and as such, Willow Creek is a candidate for a delisting. Willow Creek Reservoir is located upstream of the AUID (07040004-986) and was previously listed as impaired for aquatic recreation.

Unnamed Creek (070400004-556)

This AUID is an unnamed creek 1.5 miles east of Rochester and 0.5 miles north of Bear Creek, it was previously listed for turbidity and will remain listed. While conditions appearing to be improving since 2007, the dataset ends in 2009 and insufficient evidence exists to propose delisting. Additional monitoring of this site for TSS or Secchi tube clarity would aid in determining if this AUID should remain listed.

Unnamed Trib. To Willow Creek (07040004-800)

An aquatic life impairment for fish and macroinvertebrates was observed in 2012, on a small tributary to Willow Creek, a tributary of Bear Creek in the watershed's southeastern headwaters (12LM080). Both fish and macroinvertebrate IBIs scored below the threshold and lower confidence intervals. Relative to high gradient streams in this region the macroinvertebrate community had very low overall diversity, high relative abundance of tolerant taxa and intolerant taxa were completely lacking. MSHA habitat score was fair (58.9). Moderate bank erosion was noted as well as sparse fish cover.

Gamehaven Lake dam's influence on stream connectivity and a lack of stability of stream flow may be a significant factor in biological use support. The Gamehaven Lake dam was completed in 1988, to provide water storage in the watershed to help with flooding mitigation downstream in Rochester. Maintaining a more consistent flow pattern at the outflow of Gamehaven Lake would likely improve biological conditions within the reach.

Badger Run (07040004-620)

An aquatic life impairment for fish was observed in 2012, on the lower reach of Badger Run, a central tributary of Bear Creek (12LM077). FIBI results were below lower confidence intervals with a community is dominated by tolerant species (fathead minnow, white sucker and brook stickleback). MIBI was above the upper confidence interval and was supporting for aquatic life. The stream is channelized with an MSHA habitat rating of fair (47.5). The stream is ubiquitous in nature with little variability in stream depth or channel development, sedimentation and substrates are dominated by fines (sand/silt) are a concern within the reach. A geomorphic survey performed by MNDNR suggests the stream may be moving toward bank instability and may impact inverts in the future.

Unnamed Creek (07040004-621)

Biological data suggest an aquatic life impairment for fish at biological station 12LM081. FIBI was well below the threshold and lower confidence interval; the fish community was dominated by tolerant species (brook stickleback). A rockdam upstream of the station suggests potential fish migration concerns. In contrast, MIBI data met general use thresholds. MSHA habitat score is rated on the high side of fair (64.65); while the reach has a wide forested riparian zone, its channel is ubiquitous in nature, predominately wide and shallow with a bed dominated by sand. Sediment is a concern within the reach, coarse substrates are lightly embedded and fish cover was also sparse.

Figure 26. Photographs taken during biological monitoring visits in 2012 at upstream station (left) 04LM126 and downstream station (right) 12LM100.

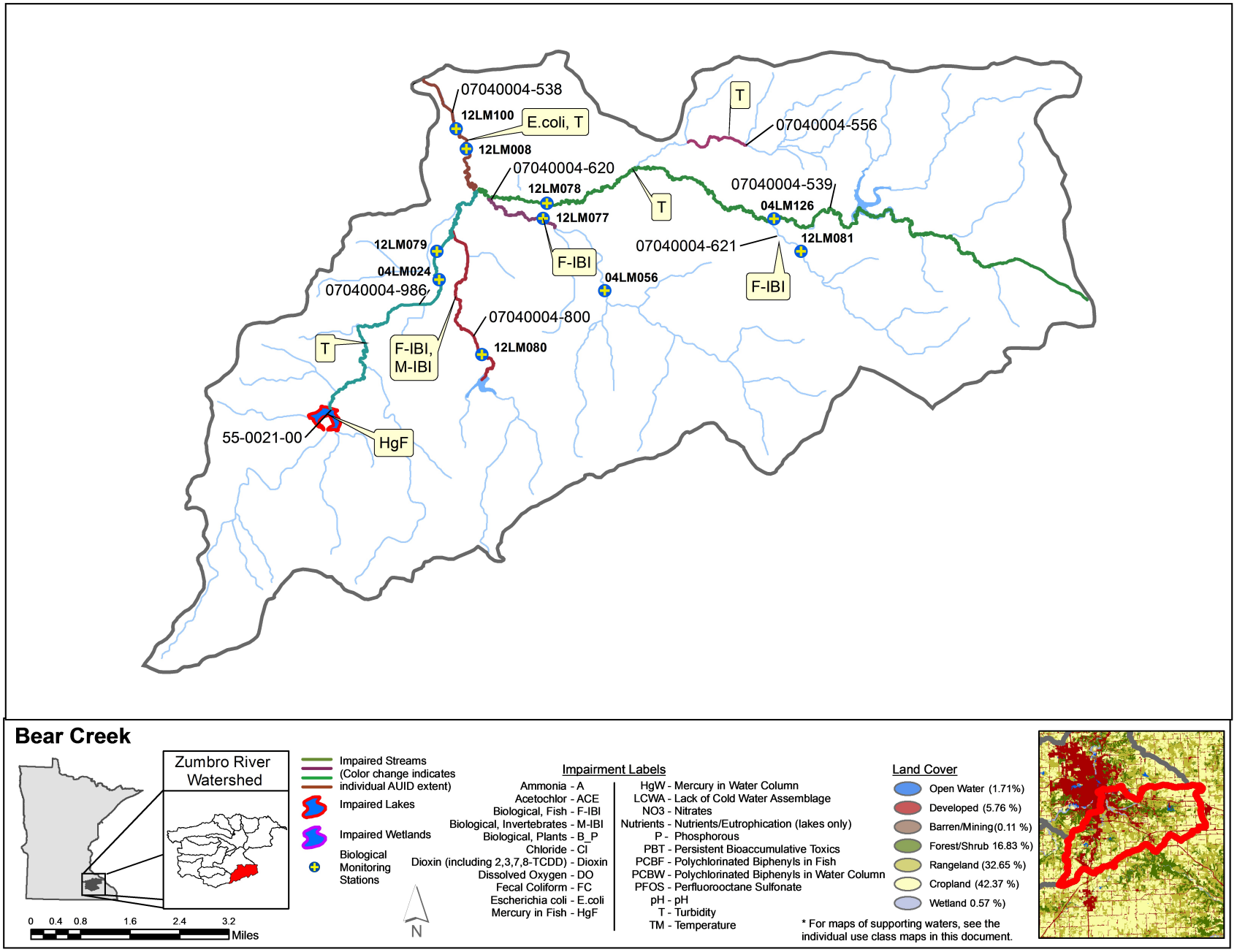

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Bear Creek Subwatershed.

Lower South Fork Zumbro River Subwatershed HUC 0704000401-01

The Lower South Fork Zumbro River Subwatershed is a continuation of the Upper South Fork Zumbro River Subwatershed, the headwaters of the South Branch Zumbro River. Located in central Olmsted County and covering 132.66 mi^2, the subwatershed's landuse is predominately divided between agriculture (23.72% rangeland and 36.73% cropland), residential and urban landuses (26.18% developed), including Rochester, one of the largest growing urban centers in Minnesota outside of the Twin Cities metropolitan area. The subwatershed is 11.4% forested; these forested acres are primarily observed along riverine corridors where topography limits their utility as cropland. The river is joined by Salem Creek to the west before moving northeast through the urban center of Rochester. The South Fork was dammed in the 1930s creating recreation Lake Mayowood, today it is nearly filled with silt. Downstream, the South Fork is joined by Bear Creek before abruptly turning north. The South Fork was dammed again downstream for milling in the 1800s forming present day Silver Lake (Waters, 1977). The river has been dredged and channelized, existing within the confines of a concrete channel within the boundaries of the city as part of a flood mitigation project derived from flooding in the 1960s and 1970s. In addition, multiple reservoirs were constructed along Silver and Cascade Creeks to retain potential floodwaters and on the South Fork Zumbro itself (Rochester, 2013). The outlet of the South Branch River is Zumbro Lake, a 600 acre reservoir created by a hydroelectric dam (constructed in 1919) on the river that joins the Middle Fork and North Branch Middle Fork of the Zumbro River as well as Pine Island Creek (Rochester, 2013). Its intensive water chemistry station is collocated with biological station 12LM007.

Table 12. Aquatic life and recreation assessments on stream reaches: Lower South Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-552, ***Silver Creek***, *Unnamed cr to Unnamed cr*	12LM067	5.84	WWg	MTS	MTS	IF	EXS	MTS	--	IF	--	--	IF	--	IMP	IF
07040004-534, ***Zumbro River, South Fork***, *Old Oakwood Dam to Silver Lk Dam*		0.83	WWg	--	--	--	--	MTS	--	--	--	--	--	--	IF**	--
07040004-535, ***Zumbro River, South Fork***, *Bear Cr to old Oakwood Dam location*		0.54	WWg	--	--	--	--	NA	--	--	--	--	--	--	NA	NA

07040004-553, ***Silver Creek***, *Unnamed cr to Silver Lk (S Fk Zumbro R)*		1.83	WWg	--	--	--	--	MTS	--	--	--	--	--	--	IF	IF
07040004-536, ***Zumbro River, South Fork***, *Salem Cr to Bear Cr*	12LM069	9.54	WWg	MTS	EXS	IF	EXS	MTS	IF	IF	IF	--	IF	--	IMP	IMP
07040004-991, ***Cascade Creek***, *Unnamed cr to Unnamed cr*	04LM123, 12LM102	10.26	WWg	EXS	MTS	IF	MTS	MTS	--	IF	--	--	--	--	IMP	IF
07040004-633, ***Unnamed creek***, *Unnamed cr to Cascade Cr*	12LM068*	1	WWm	MTS	MTS	IF	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-581, ***Cascade Creek***, *Unnamed cr to S Fk Zumbro R*	04LM124	2.84	WWg	MTS	EXS	IF	MTS	MTS	--	IF	--	--	IF	--	IMP	IF
07040004-507, ***Zumbro River, South Fork***, *Cascade Cr to Zumbro Lk*	12LM066, 04LM125, 12LM007	13.65	WWg	MTS	EXS	MTS	EXS	MTS	MTS	MTS	MTS	--	IF	--	IMP	IMP
07040004-602, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	04LM003	0.55	WWm	NA	NA	IF	NA	NA	--	IF	--	--	IF	--	NA	--
07040004-601, ***Unnamed creek***, *Unnamed cr to Unnamed cr*		2.13	WWg	--	--	--	--	MTS	--	--	--	--	--	--	IF**	--

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

** 07040004-534 and 07040004-601, previously listed for turbidity, old data assessed using new regional TSS and Secchi standards suggests AUID is now meeting standards, AUIDs are proposed for delisting. Recent data was lacking to make a new assessment during the 2014 assessment cycle.

Table 13. Minnesota Stream Habitat Assessment (MSHA): Lower South Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM069	Zumbro River, South Fork	3.5	12.5	18.1	14	27	75.1	Good
2	12LM102	Cascade Creek	0.25	9.5	16.925	6.5	19.5	52.675	Fair
2	04LM123	Cascade Creek	0.25	6.5	17	9	17.5	50.25	Fair
1	12LM068	Unnamed Creek	0	8	4.3	6	15	33.3	Poor
1	04LM124	Cascade Creek	0	7	21.45	8	9	65.45	Fair
1	12LM067	Silver Creek	2.5	13.5	15	11	33	75	Good
1	12LM066	Zumbro River, South Fork	3.5	12	20.35	12	22	69.85	Good
1	04LM125	Zumbro River, South Fork	0	8.5	18.6	12	31	71.1	Good
1	04LM003	Trib. to Zumbro River, South	0	9	13.15	1	9	32.15	Poor
2	12LM007	Zumbro River, South Fork	2.5	13.25	16.63	8.5	23	63.88	Fair
Average Habitat Results: Lower *South Fork Zumbro River subwatershed*			**1.36**	**10.2**	**16.7**	**9.18**	**21.18**	**60.54**	**Fair**

Qualitative habitat ratings

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

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

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

Table 14. Channel Condition and Stability Assessment (CCSI): Lower South Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM069	Zumbro River South Fork	17	15	34	7	73	Moderately unstable
1	12LM102	Cascade Creek	36	27	20	7	90	Severely unstable
1	12LM067	Silver Creek	16	24	14	5	59	Moderately unstable
Average Stream Stability Results: *Lower South Fork Zumbro River subwatershed*			**23**	**22**	**22.67**	**6.33**	**74**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 15. Outlet water chemistry results: Lower South Fork Zumbro River Subwatershed.

Station location:	**Zumbro River, South Fork;** @ 90th ST (CR-121) Bridge, 5.5 miles SE of Oronoco, MN						
STORET/EQuIS ID:	**S003-802**						
Station #:	**12LM007**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.3	2.0	1.2	40	0
Chloride	mg/L	11	61	137	91	230	0
Dissolved Oxygen (DO)	mg/L	39	7.0	11.7	9.1	5	0
pH		39	7.4	8.1	7.9	6.5 - 9	0
[1]Secchi Tube	100 cm	48	7	100	58	> 10	4
Total suspended solids	mg/L	41	3	383	53	< 65	11
Escherichia coli (geometric mean)	MPN/100ml	3	105	196	- -	126	2
Escherichia coli	MPN/100ml	15	64	727	205	1260	0
Chlorophyll-a, Corrected	µg/L	17	4	40	16	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	47	0.7	10.6	6.7	- -	
Kjeldahl nitrogen	mg/L	35	0.3	2.4	0.8	- -	
Orthophosphate	µg/L	18	48	150	97	- -	
Pheophytin-a	µg/L	17	1	17	3	- -	
Phosphorus	µg/L	47	87	512	184	- -	
Specific Conductance	µS/cm	37	365	1006	649	- -	
Temperature, water	deg °C	37	7.17	24.55	17.71	- -	
Sulfate	mg/L	11	28.6	43.6	35.8	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Lower South Fork-Zumbro subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

South Fork Zumbro River (07040004-534, 07040004-536, 07040004-507)

The South Fork Zumbro River enters the subwatershed from the south, flowing north, throughout the extent of its reaches within the subwatershed it is historically impaired for both aquatic life (turbidity, 07040004-534 (2010), 07040004-536 (2006), 07040004-507 (2002)) and aquatic recreation (fecal coliform, 07040004-536 (2004), 07040004-507 (1994), 07040004-535 (2004)). A delisting for turbidity is being perused as the data that was used in the original listing meets new regional TSS standards. Data collected at the outlet chemistry station (S003-802) from the 2012 and 2013 monitoring seasons are reflective of the existing impairments found on the South Fork Zumbro. Recent bacteria data confirm the existing impairment on the South Fork of the Zumbro (-507). Monthly geometric mean calculations exceeding the water quality standard of 126 MPN/100mL and are indicative of chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Other conventional chemistry parameters meet the use class standards, where they exist (Table 15).

Both AUIDs 07040004-536 and 07040004-507 are newly proposed for aquatic life impairments for macroinvertebrates. Macroinvertebrate results in Upper South Fork Zumbro River Subwatershed met biological criteria; impairment is first evident in the Lower South Fork at biological station 12LM069. This station had very few sensitive POET taxa, with only a single caddisfly present in the sample; it was dominated by tolerant taxa often found in low gradient streams. This change in the South Fork occurs downstream of the confluence with Salem Creek, suggesting that the same stressors impacting the macroinvertebrate communities of Salem Creek could be impacting biology on the South Fork Zumbro. However, at 12LM069, instream habitat modifications have been made related to city flood mitigation projects (riprapped banks for bank stabilization). Riprap can sometimes provide habitat that would not naturally occur in a steam, in these instances the rocky habitat associated with riprap is not sampled for invertebrates so as to avoid an unnatural signal of improved habitat. Roughly a mile downstream of the site the South Fork of the Zumbro River is impounded creating Mayowood Lake. The impairment continues into AUID 07040004-507 as the river continues through Rochester, just downstream of the Silver Lake impoundment; station 12LM066's macroinvertebrate community had very low diversity for a high gradient stream in this region; it lacked intolerant taxa and was dominated by a few tolerant taxa. Within Rochester, the South Fork of the Zumbro River has been extensively modified, transforming natural stream banks into steep concrete barriers to control potential flooding within city limits. Potential contributions from stormwater, industry and effluent could also be stifling biological improvements. Downstream of Rochester MIBI scores improve slightly, to meet impairment thresholds.

Despite potential negative urban impacts, and connectivity issues, MSHA habitat and FIBI scores are good across all reaches on the AUIDs and are actually lowest at the downstream most station 12LM007, well outside of city limits. However, observed reach level MSHA scores at MPCA biological stations do not likely adequately represent the more degraded habitat conditions on heavily modified channels within city limits. Despite the presence of fish barriers which are likely limiting fish migration, fish communities are performing well. Nitrogen levels appear mildly elevated across all stations at one-time grab chemistry samples (12LM069 7.6 mg/L, 12LM066 7.8 mg/L; 04LM125 4.9 mg/L; 12LM007 10 mg/L and 6 mg/L).

Cascade Creek (07040004-991 and 07040004-581)

Cascade Creek is a small tributary starting in the southwestern region of the watershed; it flows east joining the South Fork Zumbro River in southern Rochester. Cascade Creek was listed for turbidity in 2006 (-991 and -581). Upstream reach (07040004-991) is proposed for an aquatic life impairment for fish based on MPCA results in 2004 and 2012 two samples were collected in each year with results on either side of the threshold, and additional MNDNR data circa 2011 confirm a fish community below impairment thresholds. In contrast, MIBI results are above the impairment threshold at both visits and show temporal improvement in IBI score. However, further downstream the story shifts, 07040004-581 biological information gathered in 2004, from station 04LM124 meets criteria for fish but falls below the threshold for macroinvertebrates. The community has relatively low POET diversity, lacks intolerant taxa and has high relative abundance of tolerant taxa, leading to new macroinvertebrate impairment within this reach. MSHA habitat ratings at both stations were fair across all three stations and show slight improvement moving downstream. All stations offer sparse habitat cover and little channel development. Eroding banks are common at downstream station 12LM102 contributing to sedimentation of coarse substrates. Nitrogen levels appear moderately elevated at upstream stations during June visits (04LM123: 11mg/L and 12LM102: 9.8 mg/L). High abundance of nitrogen tolerant invertebrates at all sites in Cascase Creek supports the elevated nitrogen levels. MNDNR is planning restoration work within the reach to restore habitat integrity and stream stability. Additional monitoring has been proposed to track improvements of restoration efforts. Three barriers within the lower reaches of the watershed built in the mid 1990s for potential future flood mitigation for the city of Rochester may be impacting connectivity for fish migration and resulting in impaired fish communities.

Silver Creek (07040004-552 and 07040004-553)

Silver Creek was listed for turbidity for both reaches (07040004-552 and 07040004-553) in 2006. Data collected on the upper reach (07040004-552) in 2007 and 2008 support the turbidity listing and show TSS easily exceeds the impairment threshold (a single sample collected in 2012 meets the TSS standard). However, this reach fully supports both aquatic life assemblages which directly conflicts with the 2006 turbidity listing. The fish community was well balanced and demonstrated good species richness (16), despite potential connectivity issues related to the Silver Creek impoundment created for potential flood mitigation for the city of Rochester. MSHA habitat scores were also rated good at 75. A TMDL to address turbidity has already been completed which, when fully implemented, will likely bolster the biological assessments and move this reach toward delisting. Recent data collected on the lower reach (07040004-553) in 2009, 2010 and 2012 are limited to Secchi tube measurements which meet the surrogate standard for TSS and suggest overall conditions are improving. No aquatic assemblage data were available on the lower reach (07040004-553) and delisting for turbidity was postponed until the upstream impairment is rectified. Implementation of the turbidity TMDL should also move this reach toward delisting; however, new data will be required to determine support and document a sustained improvement to both reaches.

Unnamed Creek (07040004-601)

Unnamed Creek is a small direct tributary to the South Fork Zumbro River entering on the north side of the city of Rochester from the west. Unnamed Creek (King's Run Creek) was previously listed for turbidity in 2008; data compared to the new Secchi standard warrants a list correction using the original dataset and as such, the creek has been proposed to be removed from the 303(d) Impaired Waters List.

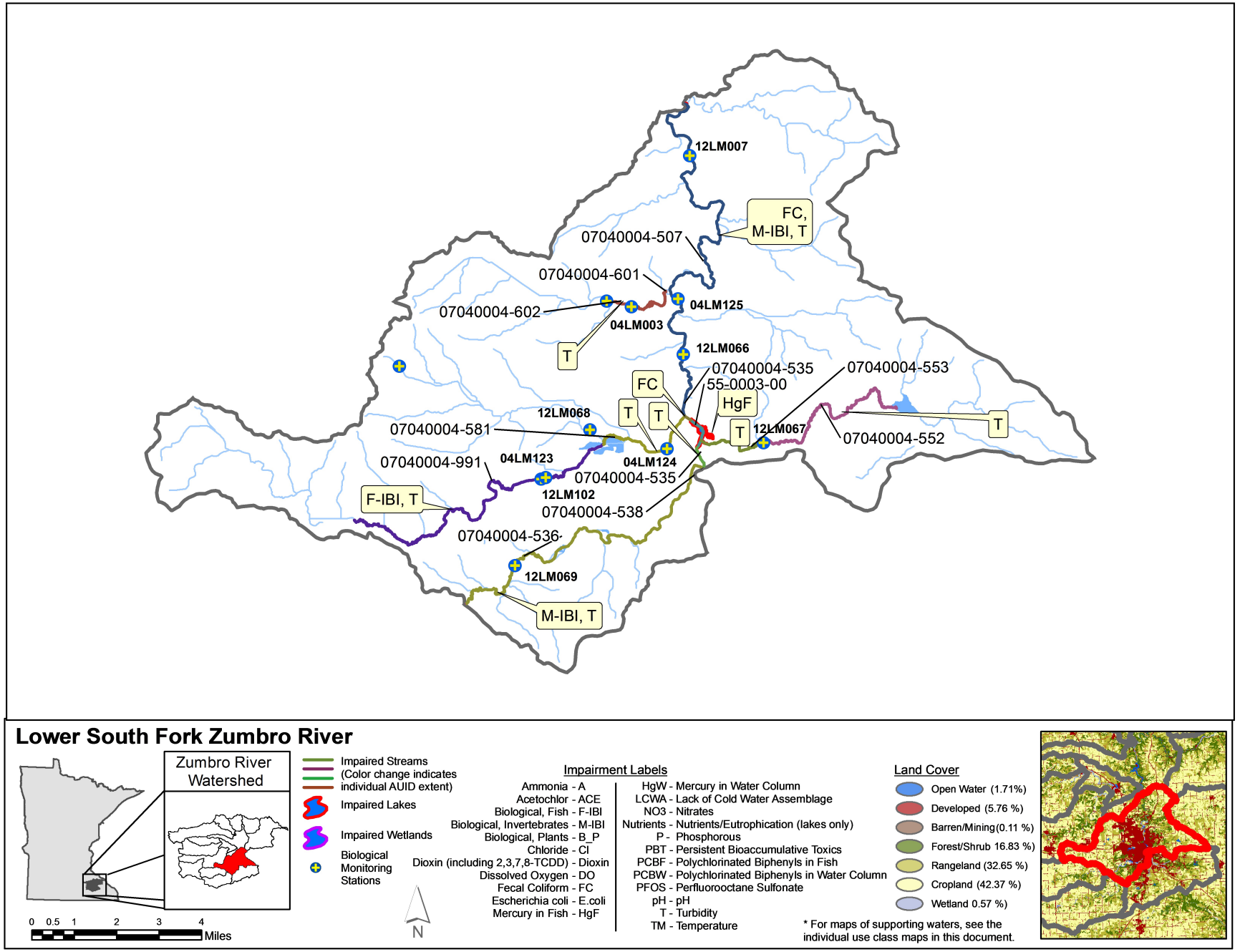

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the Lower South Fork Zumbro River Subwatershed.

Dodge Center Creek Subwatershed HUC 0704000402-02

Dodge Center Creek Subwatershed begins on the eastern edge of central Steele County and flows east into central Dodge County. Dodge Center Creek begins approximately 4.5 miles north of Blooming Prairie and flows northward towards the city of Claremont before turning abruptly east just south of Clarmont where it then flows east towards Dodge Center, passing around its western perimeter before joining the South Branch Middle Fork Zumbro River near Wasioja. Dodge Center Creek's 90.32 mi^2 drainage area is predominately in agricultural production, 80.49% is cultivated as cropland while only 6% is utilized as pasture for livestock. Developed areas in the watershed (8.4%) are limited to the communities of Claremont and Dodge Center. Less than 3% of the watershed remains forested. There are no lakes in the subwatershed. The intensive water chemistry station is collocated with biological station 12LM010.

Table 16. Aquatic life and recreation assessments on stream reaches: Dodge Center Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-545, ***Judicial Ditch 1***, *Headwaters to T106 R18W S27, west line*	12LM059	7.09	LRVW	NA	NA	NA	--	--	--	NA	--	--	--	--	NA	--
07040004-987, ***Judicial Ditch 1 (Dodge Center Creek)***, *T106 R18W S28, east line to Unnamed cr*	12LM060, 04LM140	4.68	WWm	MTS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-988, ***Dodge Center Creek (Judicial Ditch 1)***, *Unnamed cr to -92.99 44.0212*	12LM057	2.33	WWm	EXS	EXS	NA	NA	--	--	NA	--	--	IF	--	IMP	IF
07040004-966, ***Judicial Ditch 7,*** *Headwaters to Dodge Center Creek*	12LM058	4.67	WWm	MTS	MTS	NA	NA	NA	--	NA	--	--	--	--	SUP	IF
07040004-989, ***Dodge Center Creek,*** *-92.99, 44.0212 to S Br M Fk Zumbro R*	12LM056, 12LM054, 12LM053, 12LM010	24.47	WWg	MTS	EXS	MTS	EXS	MTS	MTS	MTS	--	--	--	--	IMP	IMP

07040004-618, ***Henslin Creek,*** *Unnamed cr to Dodge Center Creek*	12LM055	1.22	WWg	MTS	EXS	NA	NA	NA	--	NA	--	--	--	--	IMP	IF

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

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

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM059	Judicial Ditch 1	0	8	8	12	4	32	Poor
1	12LM060	Judicial Ditch 1	0	7	20	10	13	50	Fair
1	04LM140	Judicial Ditch 1	0	6	13.15	6	16	41.15	Poor
1	12LM057	Dodge Center Creek	0	7	15	6	10	38	Poor
1	12LM058	Judicial Ditch 7	0	8	8	10	4	30	Poor
1	12LM056	Dodge Center Creek	2.5	5.5	19.85	12	26	65.85	Fair
1	12LM055	Henslin Creek	2.5	14	17.85	6	23	63.35	Fair
1	12LM054	Dodge Center Creek	4.25	12	16.25	13	21	66.5	Good
1	12LM053	Dodge Center Creek	2.5	13	18.2	13	20	66.7	Good
1	12LM010	Dodge Center Creek	1.25	12	16.3	9	18	56.55	Fair
Average Habitat Results: *Dodge Center Creek Subwatershed*			1.3	9.25	15.26	9.7	15.5	51.01	**Fair**

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

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

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM059	Judicial Ditch 1	8	11	13	7	39	Fairly stable
1	12LM060	Judicial Ditch 1	12	13	19	7	51	Moderately unstable
1	12LM058	Judicial Ditch 7	15	13	22	7	57	Moderately unstable
1	12LM056	Dodge Center Creek	27	17	28	5	77	Moderately unstable
1	12LM055	Henslin Creek	6	20	16	3	45	Fairly stable
1	12LM053	Dodge Center Creek	11	17	24	3	55	Moderately unstable
1	12LM054	Dodge Center Creek	14	11	28	3	56	Moderately unstable
1	12LM010	Dodge Center Creek	13	15	14	3	45	Fairly stable
Average Stream Stability Results: *Dodge Center Creek Subwatershed*			**13.25**	**14.63**	**20.5**	**4.75**	**53.13**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 19. Outlet water chemistry results: Dodge Center Creek Subwatershed.

Station location:	**Dodge Center Creek;** Downstream of 605th St. 3 miles N of Dodge Center						
STORET/EQuIS ID:	**S001-485**						
Station #:	**12LM010**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.8	11.1	4.2	40	0
Chloride	mg/L	11	27.8	54.6	39.5	230	0
Dissolved Oxygen (DO)	mg/L	19	4.27	8.51	6.43	5	2
pH		19	7.4	8.7	8.1	6.5 - 9	0
[1]Secchi Tube	100 cm	34	8	100	54	> 10	2
Total suspended solids	mg/L	11	5	81	29	< 65	2
Escherichia coli (geometric mean)	MPN/100ml	2	356	407	- -	126	2
Escherichia coli	MPN/100ml	14	133	3654	726	1260	2
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	11	0.2	19.3	6.1	- -	
Kjeldahl nitrogen	mg/L	11	0.49	1.28	0.81	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	11	137	352	232	- -	
Specific Conductance	µS/cm	19	511	697	620	- -	
Temperature, water	deg °C	34	5.56	25.14	18.20	- -	
Sulfate	mg/L	11	22.1	33.7	27.1	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Dodge Center Creek Subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Figure 29. Photographs taken during biological monitoring in the subwatershed in 2012, station 12LM060 (left), station 12LM057 (middle) and station 12LM010 (right).

Summary

Dodge Center Creek

Dodge Center Creek begins as Judicial Ditch 1, a limited resource value water (LRVW), receiving the effluent of the city of Hayfield's wastewater treatment facility. Limited habitat availability has played a part in lowering biological expectations in the subsequent reaches of JD1/Dodge Center Creek from traditional general warmwater use to a modified warmwater use class for in its upstream channelized assessable reaches. MSHA habitat scores are generally fair to poor across the subwatershed with best results observed along reaches with wooded riparian corridors near the natural downstream sections of Dodge Center Creek between Claremont and Dodge Center. Downstream of its confluence with JD7, Dodge Center Creek's biological expectations are raised back to general use requirements due the presence of sufficient habitat for sustaining a more robust biological community and a shift towards a more natural stream channel. Poor habitat conditions observed in the channelized reaches of Dodge Center Creek can be attributed to ubiquitous conditions observed at biological stations including: little to no channel development, sedimentation, narrow natural riparian zones, sparse fish cover and domination of fine substrates, all of which are typical of channelized reaches found in watersheds dominated by agricultural landuse. Geomorphological surveys conducted by MNDNR in Dodge Center Creek confirm poor instream habitat conditions observed during MPCA biological visits.

The entire assessable length of JD 1/Dodge Center Creek is impaired for aquatic life due to poor macroinvertebrate communities. In contrast, FIBI scores on the same drainage meet biological criteria at all but one station (12LM057) on Dodge Center Creek/JD 1 (07040004-988) upstream of Dodge Center

Creek's confluence with JD 7. When sampled for invertebrates, this ditched station had very low flows and was dominated by taxa commonly found in wetlands. A fish sample collected on the adjacent upstream AUID, JD 1, is the best scoring site for fish in Dodge Center Creek Subwatershed, while macroinvertebrate results at the station were the poorest observed in the subwatershed. This particular station (12LM060) was ditched and exhibited wetland like characteristics, with very low flows and abundant aquatic vegetation; the macroinverterbrate community reflected these conditions, as it was dominated by invertebrates commonly found in wetland habitats, had very low over-all diversity, very few EPT taxa and lacked any intolerant taxa. An existing turbidity impairment on the lower reach of Dodge Center Creek (07040004-989) (a carry forward impairment from now retired parent AUID) is potentially adding further stress to aquatic life; data gathered as part of intensive watershed monitoring confirms elevated TSS levels on Dodge Center Creek (0704004-989) and supports the listing. Macroinvertebrates tolerant of high levels of TSS were also elevated at all stations on this reach, further confirming the potential for this stressor. Dissolved oxygen data collected at the outlet station (S001-485) also show that concentrations are susceptible to dipping below the 5 mg/L standard; phosphorous and nitrogen levels were occasionally elevated during monitoring, suggesting further degradation that is also likely negatively impacting biological communities. Additional investigation may be beneficial in understanding whether or not the effluent of the Hayfield WWTF and the Dodge Center Creek WWTF may be contributing to the reduced water quality observed in the lower reaches of Dodge Center Creek. Water chemistry grab samples collected during fish visits suggest even higher concentrations of nitrogen in Dodge Center Creek's upper reaches (N above 20 mg/L) and include observations of filamentous algae at biological station 12LM060. However, higher observations may not be sufficient for conclusions regarding longitudinal N loading. While the JD 7 (07040004-966) tributary meets biocriteria aquatic life for both fish and invertebrates, one-time chemistry grab samples indicate that it could potentially be an additional source for both nitrogen and phosphorous to Dodge Center Creek (nitrogen 19mg/L and phosphorous 175 µg/L (6/25/2012).

In addition, a new aquatic recreation impairment for *E. coli* bacteria is proposed for Dodge Center Creek 07040004-989. Monthly geometric mean calculations indicate chronically elevated levels of bacteria, which may pose a risk to human health through bodily contact. Results of intensive water chemistry monitoring can be seen in Table 19.

Better management of the watershed's non-point agricultural sources of pollution is needed to bring water quality into attainment within the subwatershed. Additional review of point sources may be warranted to insure effluent is not contributing to observed impairments.

Henslin Creek (07040004-618)

Henslin Creek is a small tributary that joins Dodge Center Creek upstream of US Hwy 14. Henslin Creek was sampled for both fish and macroinvertebrates in 2012 at 12LM055. Results were marginal for both assemblages; FIBI scored just above the impairment threshold while MIBI scored below the threshold, but within the lower confidence interval, resulting in an aquatic life impairment listing. Despite relatively good stream habitat, the macroinvertebrate community had very low diversity of EPT taxa for a high gradient stream in this region, intolerant taxa were missing and there was a high relative abundance of tolerant taxa MSHA habitat scores are on the high side of fair (63.35), with site concerns including light sedimentation and a low percentage of instream habitat cover. A nitrogen sample taken during fish visit appears moderately elevated (14 mg/L) (6/11/2012). Local partners commented during the PJG meeting that Henslin Creek has natural low flow perennially.

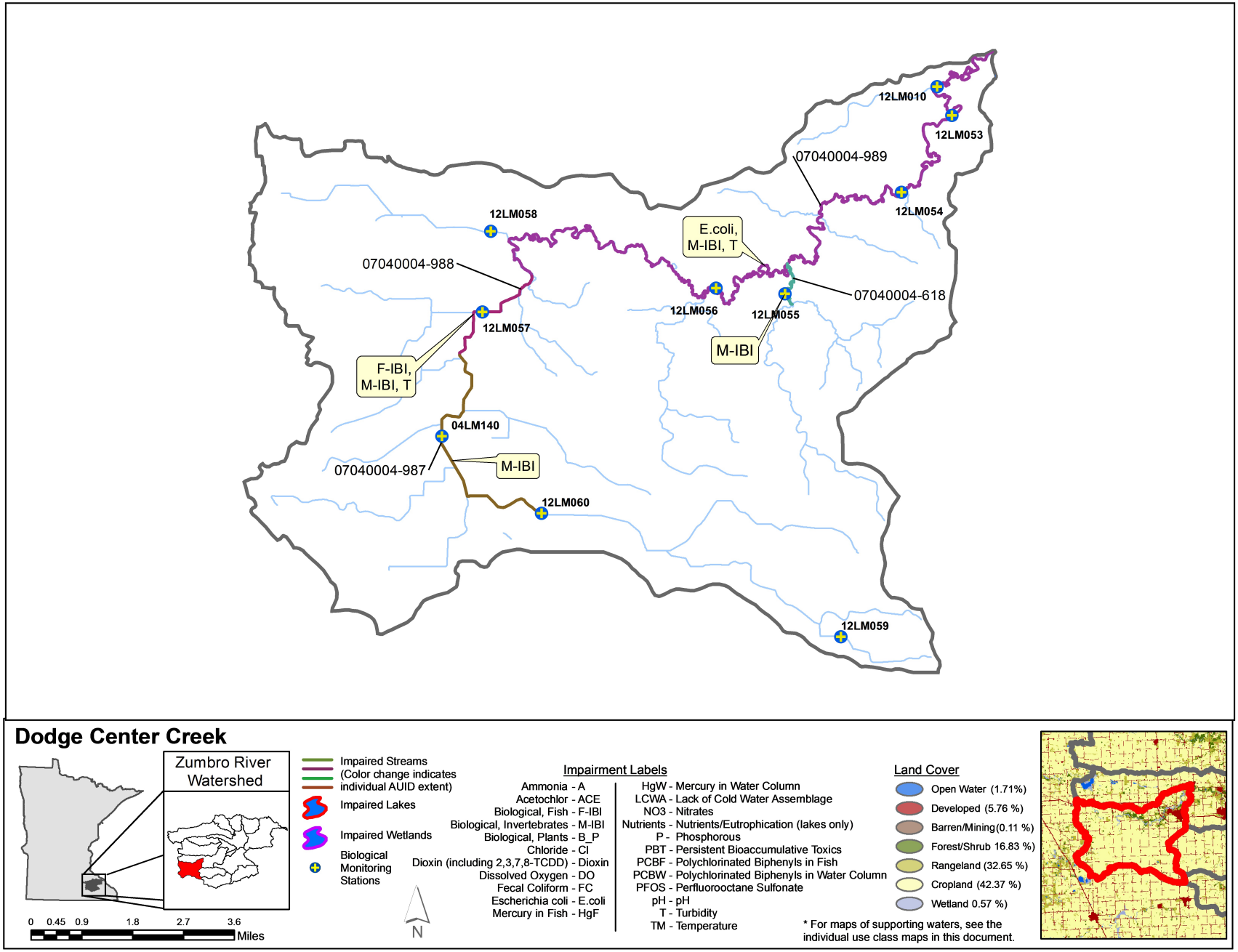

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Dodge Center Creek Subwatershed.

South Branch Middle Fork Zumbro River Subwatershed HUC 0704000402-01

On the border of Steele and Dodge counties, 6 miles east of Owatonna, Rice Lake is the source of the South Branch Middle Fork Zumbro River. The South Branch Middle Fork Zumbro River Subwatershed stretches 125.79 mi^2 across central Dodge County. The South Branch Middle Fork flows east and is joined by Dodge Center Creek to the south in Wasioja. Here the river continues in a southeasterly direction through Mantorville, where it begins flowing northeast. The stream converges with the Middle Fork Zumbro River at the past location of Shady Lake in Oronoco (see Lower Middle Fork Zumbro River Subwatershed for additional information regarding Lake Shady). The stream is dammed just upstream of the town of Mantorville – the Mantorville area was historically reknowned for its high quality limestone quarries, provided limestone across the country – many buildings constructed of this limestone are still in use today. The South Branch Middle Fork Zumbro River Subwatershed's landscape can be characterized by rolling hills and prairie farmland. Seventy-seven percent of the watershed's landscape is employed in agriculture: rangeland (15.3%), cropland (62.3%), remaining landuses are divided between forest (10.2%) and developed (9.23%). The intensive water chemistry monitoring station is collocated with biological station 12LM006.

Table 20. Aquatic life and recreation assessments on stream reaches: South Branch Middle Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication			
													Phosphorous	Response Indicator		
07040004-980, ***Zumbro River, Middle Fork, South Branch***, *Unnamed cr to Dodge Center Cr*	12LM052	9.39	WWg	MTS	EXS	IF	NA	EXS	--	IF	--	--	--	--	IMP	--
07040004-976, ***Zumbro River, Middle Fork, South Branch***, *Dodge Center Cr to Unnamed cr*	12LM051, 12LM084	19.36	WWg	MTS	EXS	MTS	EXS	MTS	--	MTS	MTS	MTS	--	--	IMP	IF
07040004-551, ***Masten Creek***, *Unnamed cr to S Br M Fk Zumbro R*	12LM050	0.33	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-527, ***Unnamed creek***, *T107 R15W S29, south line to S Br M Fk Zumbro R*	04LM121	3.24	LRVW	NA	NA	NA	--	--	--	NA	--	--	--	--	NA	--
07040004-977, ***Zumbro River, Middle Fork, South Branch***, *Unnamed cr to 75th St NW*	12LM049	2.56	WWg	MTS	MTS	IF	NA	MTS	--	IF	--	--	IF	--	SUP	IF
07040004-978, ***Zumbro River, Middle Fork, South Branch,*** *75th St NW to M Fk Zumbro R*	10EM095, 12LM006		WWg	MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS	MTS	--	--	SUP	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 21. Minnesota Stream Habitat Assessment (MSHA): South Branch Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM052	Zumbro River, Middle Fork, South	0	8	12.2	6	17	43.2	Poor
1	12LM051	Zumbro River, Middle Fork, South	2.5	13.	22	12	28	77.5	Good
2	12LM050	Masten Creek	2.75	6,5	20.2	10.5	25.5	65.45	Fair
2	04LM121	Unnamed Stream	0	8.75	18.125	7.5	21.5	84.775	Good
2	12LM084	Zumbro River, Middle Fork, South	2.625	8	18.725	9	26	64.35	Fair
1	12LM049	Zumbro River, Middle Fork, South	2.5	9	18.2	13	27	69.7	Fair
1	10EM095	Zumbro River, Middle Fork, South	2.5	13.5	22.8	14	25	77.8	Good
1	12LM006	Zumbro River, Middle Fork, South	2.5	11	22.05	12	27	74.55	Good
Average Habitat Results: *South Branch Middle Fork Zumbro River Subwatershed*			**1.92**	**10.18**	**19.29**	**10.5**	**24.63**	**69.67**	**Fair**

Qualitative habitat ratings

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

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

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

Table 22. Channel Condition and Stability Assessment (CCSI): South Branch Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM052	Zumbro River, Middle Fork, South Branch	15	11	28	7	61	Moderately unstable
1	12LM051	Zumbro River, Middle Fork, South Branch	13	15	12	5	45	Fairly stable
1	12LM050	Masten Creek	9	6	6	1	22	Stable
1	04LM121	Unnamed Creek	43	29	19	11	102	Severely stable
1	12LM084	Zumbro River, Middle Fork, South Branch	18	7	8	5	38	Fairly stable
1	10EM095	Zumbro River, Middle Fork, South Branch	6	23	5	7	41	Fairly stable
1	12LM006	Zumbro River, Middle Fork, South Branch	11	14	7	3	35	Fairly stable
Average Stream Stability Results: *South Branch Middle Fork Zumbro River Subwatershed*			**16.43**	**15**	**12.14**	**5.57**	**49.14**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 23. Outlet water chemistry results: South Branch Middle Fork Zumbro River Subwatershed.

Station location:	**S. Branch-Middle Fork Zumbro River;** @ CSAH-3, 3.5 MI SW of Oronoco, MN						
STORET/EQuIS ID:	**S001-982**						
Station #:	**12LM006**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	7	0.5	3.0	1.9	40	0
Chloride	mg/L	11	28.8	42.0	35.5	230	0
Dissolved Oxygen (DO)	mg/L	18	6.30	9.70	8.71	5	0
pH		15	7.8	8.3	8.1	6.5 – 9	0
[1]Secchi Tube	100 cm	17	3	100	41	> 10	1
Total suspended solids	mg/L	11	8	72	34	< 65	1
Escherichia coli (geometric mean)	MPN/100ml	3	180	554	- -	126	3
Escherichia coli	MPN/100ml	15	65	6867	733	1260	1
Chlorophyll-a, Corrected	µg/L	17	4	164	39	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	17	0.1	13.2	5.3	- -	
Kjeldahl nitrogen	mg/L	17	0.30	16.80	2.14	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	17	1	7	2	- -	
Phosphorus	µg/L	17	53	856	169	- -	
Specific Conductance	µS/cm	17	387	647	575	- -	
Temperature, water	deg °C	18	10.92	25.95	19.94	- -	
Sulfate	mg/L	11	27.4	35.5	32.4	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Middle Fork of the Zumbro River (South Branch) subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Table 24. Lake assessments: South Branch Middle Fork Zumbro River Subwatershed.

Name	MNDNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Rice	74-0001-00	609	H	100	1.5	1.0*	NT	290.1	92	0.2	NS	IF

* Mean depth estimated by MPCA staff

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

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

Summary

South Branch Middle Fork Zumbro River (07040004 -979, 07040004-980, 07040004-976, 07040004-977, 07040004-978)

Rice Lake is in the headwaters of the subwatershed and has a catchment of nearly 6.8 mi.^{2}, comprised mostly of cultivated agriculture. Aerial photos of the lake show a cattail fringe with isolated pockets of emergent vegetation in open water. Surrounding land use combined with in lake characteristics indicate this water body should be held to the shallow lake eutrophication standards for the Western Corn Belt Plains (WCBP) ecoregion (Appendix 5.1). Rice Lake data show that summer seasonal averages for phosphorous, chlorophyll-a and Secchi depth all exceed the shallow lake eutrophication standards for WCBP (Table 24); as such, the lake does not support AQR and a new impairment for nutrient/eutrophication indicators is proposed. Chloride easily meets the chronic standard of 230 mg/L and is not impacting AQL. For lakes meeting the chloride standard for aquatic life use, a policy decision has been made to assess the lake as insufficient information (IF), as no biological data are available to determine if the lake is supporting its aquatic life use at this time.

The lake outlet's water to the east, where it immediately flows into a channelized ditch (07040004-979), is the start of the South Branch Middle Fork Zumbro. Lake water is likely reducing overall riverine water clarity and impacting aquatic stream communities. There were two AQL macroinvertebrate impairments observed on the South Branch Middle Fork Zumbro River, on AUIDs 07040004-980 and 07040004-976, bookending the confluence of Dodge Center Creek. When these reaches were sampled, all stations were noted to have very turbid water, appearing as "pea soup." The macroinvertebrate communities at both stations that failed to meet the impairment threshold appeared much better than expected given the conditions at the time of sampling. The lowest MIBI score in the subwatershed was observed at the channelized site 12LM052 (MIBI 24.8) (AUID 07040004-980). MIBI scores increase moving downstream, plateauing at 12LM049 (07040004-977) (67.1); MIBI scores then begin drop moving downstream but still meet biocriteria (10EM095 MIBI: 51.5 and 12LM006 MIBI: 46.7 (0704004-978)). While fish meet biological criteria on the South Branch Middle Fork, the worst FIBI scores were also observed up and immediately downstream of the confluence of Dodge Center Creek and also show a slighter decrease in FIBI score after a plateau is reached at station 12LM084. FIBI scores across the South Branch Middle Fork range from 58.5 – 77.8.

Immediately upstream of biological station 12LM084, and a LRWV, carrying the outflow of the Kasson WWTP, joins the South Branch Middle Fork Zumbro River. The fluctuation in FIBI and MIBI scores longitudinally may be a sign of localized or accumulated stress in the downstream reach that could cause future biological degradation. MSHA scores across the watershed generally show an increasing trend in scores moving downstream in the watershed with lowest scores observed in the watershed's channelized headwaters and higher scores observed in natural unmodified reaches. Scores range from poor (33.4) to good (77). CCSI channel stability also gradually improves moving downstream in the watershed.

Nutrient enrichment of the South Branch Middle Fork Zumbro River is evident in the watershed's upstream reaches based on both visual observations in 2012 of abundant algae in the water column and elevated P levels observed during a fish sampling event at 12LM052 (0.105mg/L). One-time grab samples for P collected during fish visits suggest a slight decreasing trend moving downstream in the subwatershed with higher values observed downstream of Rice Lake. N values collected simultaneously suggest lower levels of nitrogen compared to other agrarian subwatersheds in the Zumbro River drainage. Data from the outlet station (S001-982) are the basis for a newly proposed E. coli bacteria impairment for the South Branch of the Middle Fork-Zumbro River (07040004-978); this AUID does not support AQR. Monthly geometric mean calculations are indicative of chronically elevated bacteria levels (Table 24) which may pose a risk to human health through bodily contact. Phosphorous and chlorophyll-a concentrations are elevated. All other conventional chemistry parameters met the use class standards, where they exist. Agricultural landuse is a likely source for nutrient enrichment and is likely impacting impairments observed within the watershed.

Masten Creek (07040004-551)

Masten Creek is a small warmwater tributary draining 12 $mi.^2$ of central South Branch Middle Fork Zumbro Subwatershed. Masten Creek is channelized in its agricultural headwaters and transitions back to a natural stream flowing around the community of Kasson. From here, Masten Creek picks up gradient and riparian widths increase and are predominately forested. The biological station (12LM050) was sampled twice for fish and once for macroinvertebrates in 2012 and met biological criteria during all sampling events. FIBI results exceed exceptional use requirements while MIBI scores fall within confidence limits of general use. MSHA habitat scores were fair at the biological station, partially attributed to a lack of adjacent riparian buffer at the site due to an adjacent golf course. Identified habitat concerns on site include: a narrow riparian zone, light bank erosion, little shade and lightly embedded coarse substrates. One time chemistry grab samples collected during a fish visit show elevated nitrogen levels during June sampling 16 mg/L, which decrease during an observation in July (3 mg/L). Limiting nutrient enrichment on the landscape would benefit aquatic communities within the watershed.

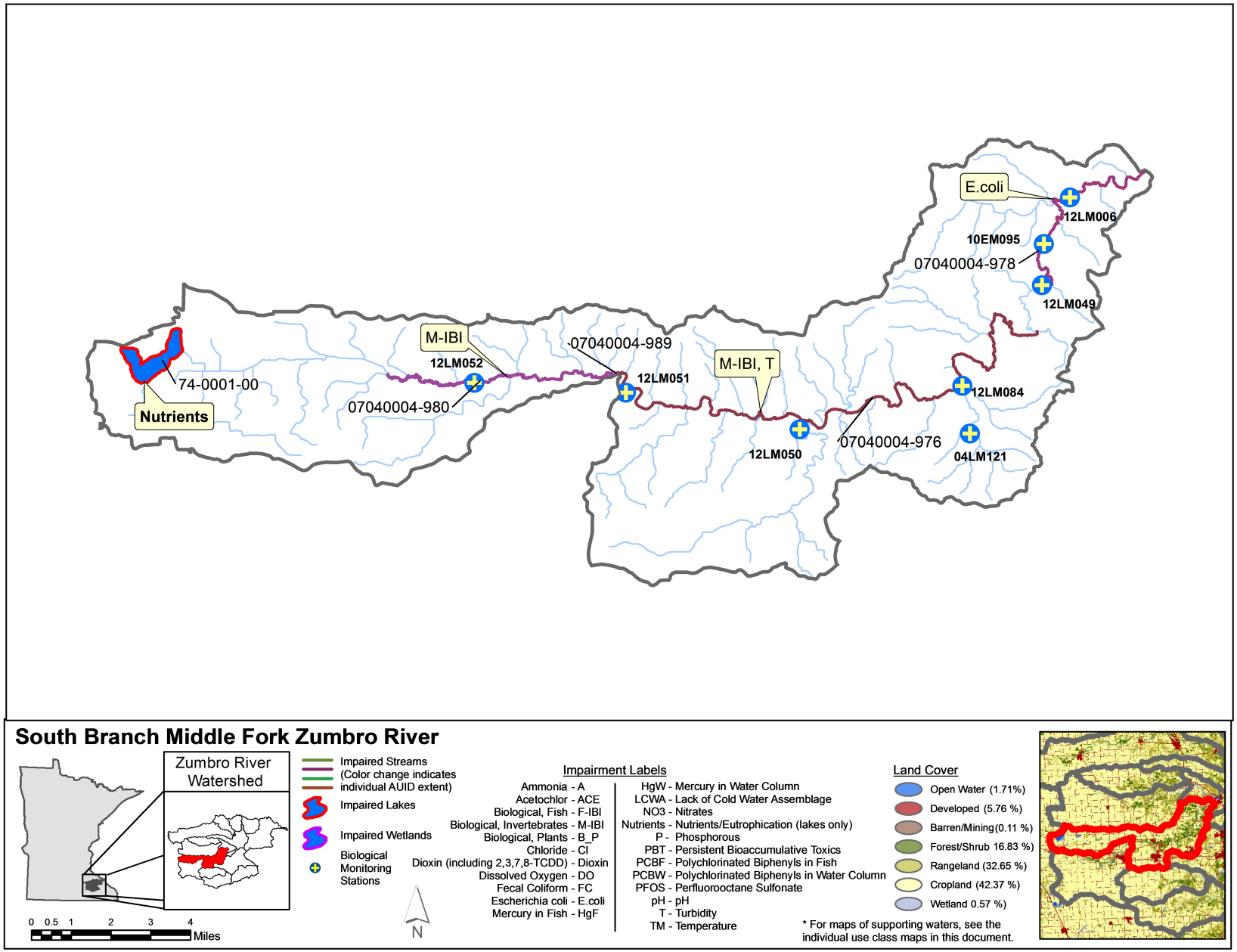

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the South Branch Middle Fork Zumbro River Subwatershed.

Upper Middle Fork Zumbro River Subwatershed HUC 0704000403-02

The Upper Middle Fork Zumbro River's headwaters begin near the borders of Steele, Rice and Goodhue and Dodge counties. The river flows in an easterly direction across northern Dodge County joining the North Branch Middle Fork Zumbro River in Pine Island, where it forms the Middle Fork Zumbro River near the borders of Dodge, Goodhue and Olmsted counties. The 128.96 mi^2 expanse of the subwatershed is extensively worked for agriculture, nearly 76% is cultivated as cropland and 12% is grazed rangeland. Developed areas in the watershed (6.6%) are limited to the small rural communities of: West Concord, Concord, Berne and Pine Island. Only 4.3% of the watershed remains forested. The outlet water chemistry monitoring station was collocated with biological monitoring station 12LM004. There are no lakes in the subwatershed.

Table 25. Aquatic life and recreation assessments on stream reaches: Upper Middle Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-973, ***Zumbro River, Middle Fork***, *T108 R18W S20, west line to N Br M Fk Zumbro R*	07LM022, 04LM142, 12LM045, 12LM046, 12LM004	34.25	WWg	MTS	EXS	MTS	EXS	IF	MTS	MTS	MTS	--	--	--	IMP	IMP
07040004-578, ***Unnamed creek***, *Headwaters to M Fk Zumbro R*	04LM028*	3.70	WWm	MTS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-909, ***Unnamed creek***, *Unnamed cr to M Fk Zumbro R*	12LM044	3.38	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-544, ***Unnamed creek***, *T108 R17W S17, west line to T108 R17W S21, east line*	12LM076	2.54	LRVW	NA	NA	NA	--	--	--	NA	--	--	--	--	NA	--
07040004-524, ***Unnamed creek***, *T108 R17W S22, west line to M Fk Zumbro R*	12LM075	1.67	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-555, ***Milliken Creek***, *Unnamed cr to M Fk Zumbro R*		4.72	WWg	--	--	--	--	EXS	--	--	--	--	--	--	IMP	--
07040004-554, ***Milliken Creek***, *Unnamed cr to Unnamed cr*	04LM141	5.72	WWg	MTS	MTS	IF	MTS	MTS	--	IF	--	--	IF	--	SUP**	IF
07040004-563, ***Harkcom Creek***, *T108 T16W S32, south line to T108 R16W S12, east line*	12LM047	10.20	WWg	MTS	MTS	IF	NA	MTS	--	NA	--	--	IF	--	SUP	IF

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information, **NA** = Not Assessed

Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.
** 07040004-563 was previously listed for turbidity, new data collected suggest the stream is now meeting standards; a proposed delisting has been postponed until after TMDL implementation on upstream AUID 07040004-555 is complete.

Table 26. Minnesota Stream Habitat Assessment (MSHA): Upper Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	07LM022	Zumbro River, Middle Fork	0	10.5	13.2	11	16	50.7	Fair
1	04LM142	Zumbro River, Middle Fork	0	9.5	18.1	13	23	63.6	Fair
1	04LM028	Trib. to Zumbro River, Middle	0	8.5	4.3	11	21	44.8	Poor
1	12LM045	Zumbro River, Middle Fork	0.75	9.5	21.9	9	22	63.15	Fair
1	12LM044	Trib. to Zumbro River, Middle	0	14	16.55	11	25	66.55	Good
2	12LM076	Unnamed Ditch	0	8.75	19.3	8.5	23.5	60.05	Fair
1	12LM075	Unnamed Ditch	0	5	11.25	11	13	40.25	Poor
1	12LM046	Zumbro River, Middle Fork	2.5	11	20.7	12	30	76.2	Good
3	04LM141	Miliken Creek	1.67	8.83	21.6	10.67	23.33	64.77	Fair
1	12LM047	Harkom Creek	2.5	8.5	11.6	11	26	59.6	Fair
1	12LM004	Zumbro River, Middle Fork	2.25	12.5	19.8	7	32	73.55	Good
Average Habitat Results: *Upper Middle Fork Zumbro River Subwatershed*			**0.88**	**9.70**	**16.21**	**10.47**	**23.17**	**60.29**	**Fair**

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

Table 27. Channel Condition and Stability Assessment (CCSI): Upper Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM045	Zumbro River, Middle Fork	20	28	17	5	70	Moderately unstable
1	12LM044	Trib. to Zumbro River, Middle Fork	16	31	19	5	71	Moderately unstable
1	12LM046	Zumbro River, Middle Fork	14	13	7	3	37	Fairly stable
1	04LM141	Miliken Creek	9	9	4	1	23	Stable
1	12LM047	Harkom Creek	15	28	6	5	54	Moderately unstable
1	12LM004	Zumbro River, Middle Fork	28	30	22	5	85	Severely unstable
Average Stream Stability Results: *Upper Middle Fork Zumbro River Subwatershed*			**17**	**23.17**	**12.5**	**4**	**56.67**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 28. Outlet water chemistry results: Upper Middle Fork Zumbro River Subwatershed.

Station location:	**Zumbro River, Upper Middle Fork;** @ New Haven RD 0.5 MI E of Pine Island, MN						
STORET/EQuIS ID:	**S006-065**						
Station #:	**12LM004**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	7	0.9	3.6	2.1	40	0
Chloride	mg/L	11	22.0	32.1	24.6	230	0
Dissolved Oxygen (DO)	mg/L	18	6.57	10.34	8.70	5	0
pH		17	6.5	8.3	8.0	6.5 - 9	0
[1]Secchi Tube	100 cm	27	20	100	77	> 10	0
Total suspended solids	mg/L	11	2	18	9	< 65	0
Escherichia coli (geometric mean)	MPN/100ml	3	350	583	- -	126	3
Escherichia coli	MPN/100ml	15	133	2420	604	1260	2
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	11	3.6	17.9	8.0	- -	
Kjeldahl nitrogen	mg/L	11	0.30	0.82	0.45	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	11	35	161	73	- -	
Specific Conductance	µS/cm	18	558	642	606	- -	
Temperature, water	deg °C	18	11.22	25.39	19.66	- -	
Sulfate	mg/L	11	24.8	29.4	27.3	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Upper Middle Fork of the Zumbro River subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Unnamed Creek (07040004-578)

Unnamed Creek is a small ditch in the watershed's western headwaters that joins the Upper Middle Fork Zumbro River, a couple of miles downstream of biological station 04LM142. The drainage area of biological station 04LM028 is very small at 3.34 $mi.^2$. This station was sampled as part of a random sampling survey in 2004 to assess the general health of streams in the Lower Mississippi River Basin. FIBI results meet modified use thresholds for aquatic life, while macroinvertebrates do not, resulting in a listing for this assemblage. The site is dominated by taxa commonly found in very slow flowing waters or wetlands, many of the taxa being indicative of low DO conditions. It also had very low over-all abundance, low EPT diversity and abundance, and a lack of intolerant taxa. MSHA habitat scores were low, 44.8 and 39 respectively. On site habitat concerns include: a narrow riparian zone surrounded by row crop agriculture, substrates dominated by fine sediments and moderate embeddedness of coarse substrates. One-time water chemistry samples from both reportable and non-reportable visits collected in June and mid July indicate high levels of nitrogen 24-25 mg/L. A very high diversity and abundance of nitrogen tolerant invertebrates agrees with the high nitrogen values. Habitat degradation and poor water chemistry results observed are likely attributed to impacts of channelization and agricultural landuse.

Upper Middle Fork Zumbro River (07040004-973)

Data collected at the outlet chemistry station (S006-065) are the basis for a new aquatic recreation impairment (E. coli bacteria) proposed for the entire length of the Upper Middle Fork of the Zumbro River. Monthly geometric mean calculations indicate chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Aquatic life use impairments on the Upper Middle Fork Zumbro River include an existing turbidity impairment (2008) and a new macroinvertebrate impairment. Outlet water chemistry data agree with previous turbidity impairment listing, while other conventional chemistry parameters met use class standards, where they exist (Table 28).

Macroinvertebrate impairments are isolated to two biological stations on the Upper Middle Fork Zumbro. The lowest scoring biological results are in the upstream portion of the watershed for both fish and macroinvertebrates. A one time grab sample collected in June at biological station 04LM142 show elevated nitrogen levels (23 mg/L). At upstream fish station 07LM022, water chemistry data collected in August 2007 suggest high Phosphorous concentrations (0.378 mg/L). Headwaters biological communities are likely impacted by agricultural landuse including nutrient loading and channelization. Biological conditions improve downstream at biological station 12LM045 (exceptional for fish but only marginally above the impairment threshold for invertebrates). At the next downstream station (12LM046) macroinvertebrate results fail to meet biological criteria while fish IBI scores drop 14+ points, indicating the potential for isolated stressors impacting the reach. The flow conditions and available habitat at this station suggest the potential for high invertebrate IBI scores, but the depressed POET taxa diversity and a near absence of predator taxa are keeping this station from scoring to its potential. At the outlet station, both fish and macroinvertebrates meet biological criteria, MIBI increases by 14+ points while FIBI shows mild improvement. MSHA habitat scores are fair in the headwaters and improve moving downstream, even at station 12LM046 where macroinvertebrates fail to meet biological criteria. Common habitat concerns at biological stations include sparse cover, sedimentation and erosion. One time chemistry grab samples do not indicate potential anamolies at 12LM046. Measures should be taken to better understand what stressors maybe impacting invertebrates at biological station 12LM046.

Additional water chemistry monitoring to fill missing data gaps, including potential differences in stream water quality contributions to the lower Middle Fork Zumbro River, between the North and Upper branch of the Middle Fork, could be useful as the two aggregated 12 subwatersheds are not differentiated by the intensive watershed monitoring station results collected at 12LM005. Data gathered at this station indicate bacteria loading sufficient for an aquatic recreation impairment as well as severely elevated phosphorous and nitrogen concentrations.

Unnamed Creek (0704004-544 and 07040004-524)

Unnamed Creek (07040004-544) is a limited resource value water and receives effluent from West Concord WWTP. Biological data collected on downstream AUID 07040004-524 meet biological criteria for both fish and macroinvertebrates. Despite fair habitat conditions (MSHA 40.25) and channelized condition, this site had a diverse intact macroinvertebrate community with a good richness of EPT. In fact, while there are no biological criteria in place for LRVW to meet at AUID 07040004-544, the biological sample collected within the LRVW fall just below general use threshold and could easily meet modified use thresholds, habitat scores at the biological station were 20 points higher than those observed at the next downstream station within the next AUID (07040004-524).

Miliken Creek (07040004-554 and 07040004-555)

Miliken Creek is a significant tributary of the Upper Middle Fork Zumbro River, stretching over the western two thirds of the subwatershed, joining the Upper Middle Fork in the east. Two consecutive AUIDs on Milliken Creek (07040004-554, and 07040004-555) were previously listed for turbidity in 2006. New TSS and Secchi tube data on AUID (07040004-554) meet the regional standards, suggesting that additional monitoring would be useful in determining current impairment status. The downstream AUID (07040004-555) is lacking new TSS data and the Secchi tube dataset was inconclusive; as such, this AUID will remain listed. Additional monitoring could be conducted on this AUID as well to determine whether or not the existing turbidity impairment is still warranted. However, fish and macroinvertebrate data suggest full support of aquatic life use. Biological visits in 2004 and 2012 at station 04LM141 demonstrate that fish and macroinvertebrates have maintained high quality temporally. All FIBIs exceed the EU threshold while macroinvertebrates only score within upper GU confidence limits. MSHA habitat scores range from fair to good showing improvements from 2004 to 2012. One time water chemistry grab samples show elevated levels of nitrogen observed across sampling events 17-23 mg/L. Measures should be taken to maintain high quality in Miliken Creek and reduce nitrogen loading.

Harcom Creek (07040004-563)

Harcom Creek is a small eastern tributary of Upper Middle Fork Zumbro River joining the river a few miles before it joins the North Branch Middle Fork Zumbro River. Fish and macroinvertebrate data suggest full support of aquatic life use. Secchi tube transparency data support the bio assessment, but insufficient data were available to make an assessment. MSHA habitat score is fair at 59.6, issues observed on site include: moderate embeddedness of coarse substrates, low channel stability as well as heavy bank erosion. One time grab sample for nitrogen collected in June was 5.8 mg/L.

Unnamed Creek (07040004-909)

Unnamed Creek is a small tributary in the subwatershed's western headwaters that joins the Upper Middle Fork Zumbro River downstream of biological station 12LM046. Biological data collected in 2012, suggest that both fish and macroinvertebrate assemblages are exceeding upper confidence limits for GU thresholds, meeting biocriteria for aquatic life. MSHA habitat rated good with excess sedimentation noted as a potential area of concern. One time grab sample for nitrogen collected in July was 14 mg/L. MSHA habitat rated as good.

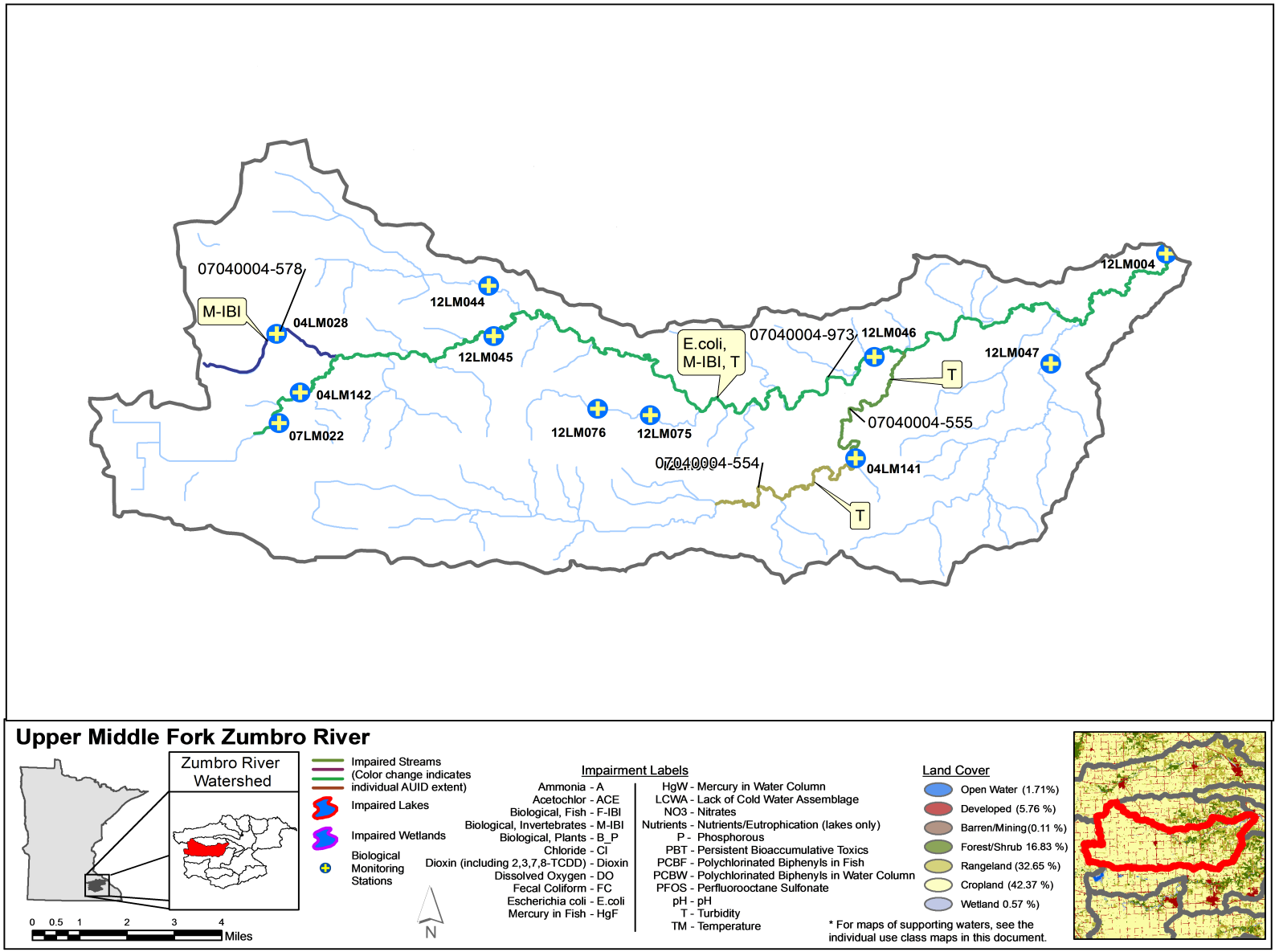

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Upper Middle Fork Zumber River Subwatershed.

North Branch Middle Fork Zumbro River Subwatershed HUC 0704000403-03

The North Branch Middle Fork Zumbro River begins a few miles south of Kenyon near the community of Skyber in the southwestern corner of Goodhue County. The river winds in an easterly direction towards Pine Island where it is joined by the Upper Middle Fork Zumbro River to form the Middle Fork Zumbro River near the borders of Olmsted and Goodhue counties. The subwatershed spans 58.53 mi^2 across a landscape heavily utilized for agriculture (18.43% rangeland and 65.71% cropland), only 8.1% of the watershed remains forested. There are no lakes in the subwatershed. Developed areas in the watershed (6.7%) are limited to the small rural communities of: Skyberg, Roscoe and Pine Island. The intensive water chemistry station is located just outside of the subwatershed in the Middle Fork Subwatershed upstream of the Middle Fork's confluence with the former Shady Lake and the South Branch Middle Fork Zumbro River, the station is collocated with biological monitoring station 12LM005.

Table 29. Aquatic life and recreation assessments on stream reaches: North Branch Middle Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-975, ***Zumbro River, Middle Fork***, ***North Branch***, *T109 R18W S36, north line to M Fk Zumbro R*	04LM054, 12LM041, 12LM042	26.48	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	--	--	SUP***	IF
07040004-965, ***Unnamed creek***, *Unnamed cr to Devlin Cr*	12LM043	2.33	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.
***07040004-975, previously listed for turbidity, new data assessed in the 2014 assessment cycle suggests the AUID is now meeting standards and is proposed for delisting.

Table 30. Minnesota Stream Habitat Assessment (MSHA): North Branch Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM042	Zumbro River, Middle Fork, North	2.5	13	18.1	10	24	67.6	Good
1	12LM043	Trib. to Devlin Creek	2.5	13	13.2	12	22	62.7	Fair
1	04LM054	Zumbro River, Middle Fork, North	2.5	10	19.6	13	27	72.1	Good
1	12LM041	Zumbro River, Middle Fork, North	2.25	2	16	8	14	42.25	Poor
Average Habitat Results: *North Branch Middle Fork Zumbro River Subwatershed*			**2.44**	**9.5**	**16.73**	**10.75**	**21.75**	**61.17**	**Fair**

Qualitative habitat ratings

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

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

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

Table 31. Channel Condition and Stability Assessment (CCSI): North Branch Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM042	Zumbro River, Middle Fork, North Branch	6	10	4	1	21	Stable
1	12LM041	Zumbro River, Middle Fork, North Branch	34	21	18	7	80	Moderately unstable
Average Stream Stability Results: *North Branch Middle Fork Zumbro River Subwatershed*			**20**	**15.5**	**11**	**4**	**50.5**	**Moderately unstable**

Qualitative channel stability ratings

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

Summary

North Branch Middle Fork Zumbro River

The North Branch Middle Fork of the Zumbro River was listed as impaired for aquatic life (turbidity) in 2010. New Secchi tube data meet the standard, but there are insufficient TSS data available for a new assessment. As biological indicators are meeting their designated uses on the North Branch Middle Fork (07040004-975) and more recent data are meeting beneficial use standards, a delisting of turbidity is being persued.

FIBI scores decrease moving downstream in the watershed dropping nearly 10 IBI points per biological site, scores range from 66.7 -83.8. MIBI scores range from 41.3 to 49.8 across sites and do not display any longitudinal patterns. While macroinvertebrates currently meet biological criteria, scores are only marginally above the impairment threshold. Measures should be taken to protect the resource before MIBI quality diminishes. MSHA habitat data across the North Branch Middle Fork Zumbro River is good except for results at the downstream most station (12LM041) which were poor. Issues at this station include moderate levels of suspended sediment, heavy bank erosion, little riparian cover or shade, severe embeddedness of coarse substrates and sparse instream cover. MSHA results are consistent with CCSI findings suggesting moderate instability at 12LM041.

Additional water chemistry monitoring to fill in missing data gaps, including potential differences in stream water quality contributions to the lower Middle Fork Zumbro River, between the North and Upper branch of the Middle Fork, could be useful as the two aggregated 12 subwatersheds are not differentiated by the intensive watershed monitoring station results collected at 12LM005 (S007-126). Data gathered at this station indicate bacteria loading sufficient for an aquatic recreation impairment as well as severely elevated phosphorous and nitrogen concentrations.

Unnamed Trib. To Devlin Creek (07040004-965)

Tributary to Devlin Creek is a small unnamed tributary to Devline Creek, a tributary to the North Branch Middle Fork Zumbro River found in the middle of the subwatershed. Both fish and macroinvertebrate results at station 12LM043 in 2012 indicate that biological criteria are meeting designated use for aquatic life. FIBI scored 11 points above the upper confidence interval. One time grab sample for Nitrogen at the biological visit was moderated at 8.6 mg/L. MSHA habitat rating is fair (62.7), excess sedimentation was noted in pools.

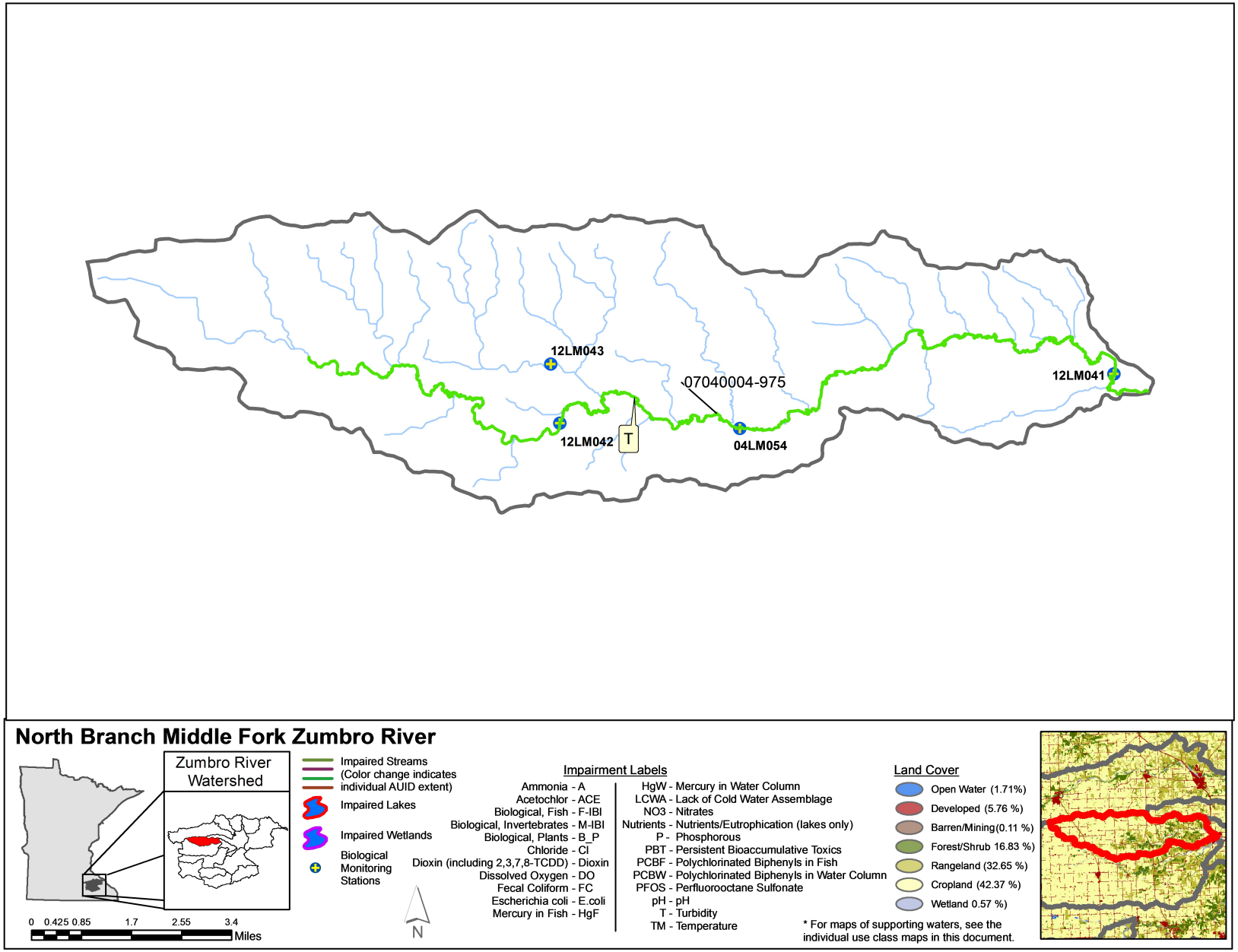

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the North Branch Middle Fork Zumbro River Subwatershed.

Lower Middle Fork Zumbro River Subwatershed HUC 0704000403-01

The Lower Middle Fork Zumbro Subwatershed joins the South Branch Middle Fork Zumbro Subwatershed with the North Branch Middle Fork Zumbro Subwatershed. The two branches converge at the once impounded Shady Lake in the central part of watershed. From here the Middle Fork flows east joining the Upper Zumbro River Subwatershed near Kings Park on Zumbro Lake. The watershed begins near the corner of Goodhue, Dodge and Olmsted counties and flows east to north central Olmsted county draining 30.7 mi^2 of the surrounding landscape. The watershed's landuse is comprised of 39.4% cropland, 36.7% rangeland, 11.1% developed, 7.8% forested and 4% wetland. The convergence of the North Branch Middle Fork and South Branch Middle Fork Zumbro Rivers was first dammed in 1867 to harness the power of the rivers for a sawmill and small grist mill, creating 130 acre Shady Lake. Surging floodwaters continually destroyed wooden dams on the river until a concrete structure was built in the 1930s, expanding the lake's size to 170 acres. Over time the lake was slowly filled in by upstream sediment, in the mid 2000s the lake was barely deep enough to float a canoe, resembling a wetland more than a lake. This dam was compromised beyond repair during a 2010 flood brought upon by an eight-inch rain event, after which the dam was decommissioned and Shady Lake was drained. The dam has been replaced with a 600 foot rapids and the remaining lakebed will be restored as a park and wildlife preserve to restore a more natural balance to the system (Oronoco, 2016). The outlet water chemistry monitoring station co located with biological station 12LM005, within Middle Fork Zumbro River subwatershed, serves as the outlet water chemistry station for the North Branch Middle Fork Zumbro River. This station was placed in the next downstream subwatershed due to lack of better access at the outlet of the North Branch Middle Fork Subwatershed. The Middle Fork Zumbro River Subwatershed does not have a proper intensive water chemistry station near its outlet due to the presence and potential biological and chemical influences of the remnants of Shady Lake, within the City of Oronoco, which would not be representative of the overall condition of the Middle Fork Zumbro River and bias results.

Table 32. Aquatic life and recreation assessments on stream reaches: Lower Middle Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-992, ***Zumbro River, (North Branch,) Middle Fork***, *N Br M Fk Zumbro R to Shady Lk*	12LM005	7.78	WWg	MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS	--	EX	N	IF	IMP
07040004-993, ***Zumbro River, Middle Fork (Shady Lake)***, *S Br M Fk Zumbro R to Zumbro Lk*	02LM027**	6.37	WWg	NA	--	--	EX	EX	--	--	--	--	EX	--	IMP	IF

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

** MNDNR data used as supporting information, not assessed.

Table 33. Minnesota Stream Habitat Assessment (MSHA): Lower Middle Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM005	Zumbro River, Middle Fork	2.5	11.5	16.3	12	29	71.3	Good
Average Habitat Results: ***Lower Middle Fork Zumbro River Subwatershed***			2.5	11.5	16.3	12	29	71.3	**Good**

Qualitative habitat ratings

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

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

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

Table 34. Outlet water chemistry results: Lower Middle Fork Zumbro River Subwatershed.

Station location:	**Zumbro River, Lower Middle Fork;** CSAH-31, 2.5 MI W of Oronoco, MN						
STORET/EQuIS ID:	**S007-126**						
Station #:	**12LM005**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	6	0.8	2.1	1.6	40	0
Chloride	mg/L	15	22.7	34.6	28.8	230	0
Dissolved Oxygen (DO)	mg/L	17	6.74	9.86	8.59	5	0
pH		16	5.8	8.2	7.9	6.5 - 9	1
[1]Secchi Tube	100 cm	21	7	100	75	> 10	1
Total suspended solids	mg/L	11	3	29	15	< 65	0
Escherichia coli (geometric mean)	MPN/100ml	3	164	273	- -	126	3
Escherichia coli	MPN/100ml	15	59	2909	413	1260	1
Chlorophyll-a, Corrected	µg/L	17	1	85	10	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	17	3.8	16.1	8.7	- -	
Kjeldahl nitrogen	mg/L	17	0.30	1.82	0.54	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	17	1	11	2.353	- -	
Phosphorus	µg/L	17	34	424	98	- -	
Specific Conductance	µS/cm	17	456	649	611	- -	
Temperature, water	deg °C	17	10.19	24.10	18.83	- -	
Sulfate	mg/L	11	20.5	25.8	23.5	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]**Secchi Tube** standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Lower Middle Fork Zumbro River subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Upper Middle Fork Zumbro River (retired 07040004-521; now 07040004-992)

The outlet chemistry station for the culmination of the North Branch of the Middle Fork Zumbro River and the Upper Middle Fork Zumbro River is located outside of their respective subwatersheds at (S007-126) due to the lack of road access and a better sampling location. These results are meant to represent the water chemistry of the upstream respective subwatersheds and not the Lower Middle Fork Subwatershed as a whole. Bacteria data collected at this chemistry station are the basis for the newly proposed AQR impairment. Monthly geometric mean calculations indicate chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Phosphorous and inorganic nitrogen concentrations were elevated, sometimes severely, during routine monitoring events. All other conventional chemistry parameters meet use class standards where they exist (Table 34). Both fish and macroinvertebrates, collected at biological station 12LM005 meet biological criteria and are supporting aquatic life criteria. The macroinvertebrate community shows a diverse POET community, with relatively fewer tolerant taxa. MSHA habitat score was good (71.3).

'Cumulative' Lower Middle Fork Zumbro River (retired 07040004-520 and 07040004-519; now combined 07040004-993)

The Middle Fork of the Zumbro River (07040004-519) has an existing turbidity impairment dating back to 2010; however, this AUID (and -520, -521) was retired in 2015 to accommodate changes in hydrology following the removal of the Shady Lake dam. The previous turbidity listing is carried forward to the new AUID (07040004-993) and supported by new TSS data.

Monitoring stations on both branches of the Middle Fork (at US-52 bridge) indicate TSS is problematic based on data collected in 2013-14, but listings have been deferred and will be addressed by the downstream turbidity TMDL.

There are no assessable biological monitoring stations on the cumulative waters of the Lower Middle Fork Zumbro River due to the lack of accessible monitoring locations. However, data from MNDNR, at biological sampling station 02LM027, suggest FIBI would likely meet biocriteria.

A true outlet monitoring station does not exist for the Lower Middle Fork Subwatershed due to the watershed's nature of being a flow through watershed and the lack of easily accessible sampling locations. Future monitoring to capture the collective water chemistry and biology of the Lower Middle Fork of the Zumbro River could help understand the combined quality of Middle Fork's branches before they join the Zumbro River in Zumbro Lake.

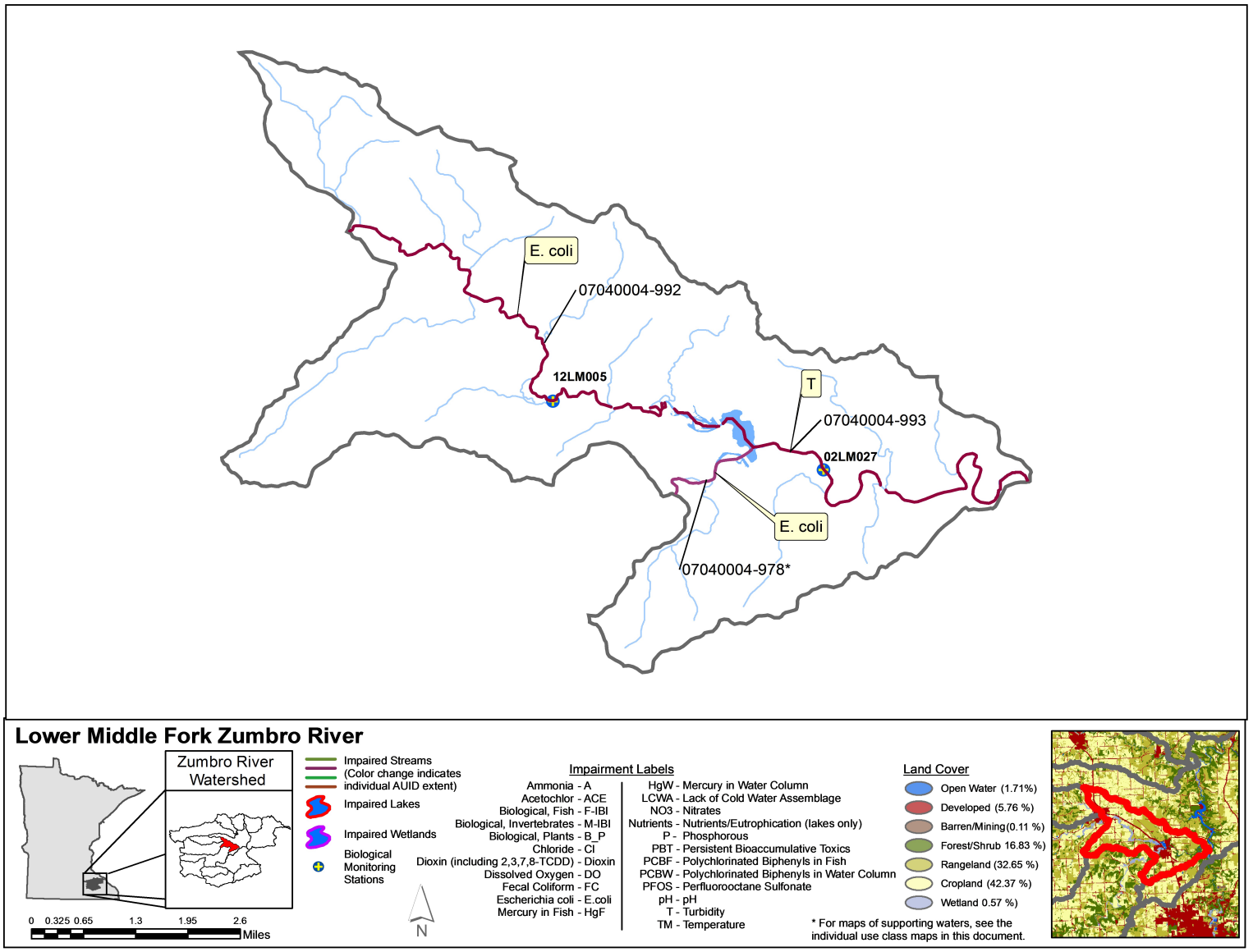

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Lower Middle Fork Zumbro River Subwatershed. * 07040004-978 is associated with the South Branch Middle Fork Zumbro Subwatershed.

Mazeppa Creek Subwatershed HUC 0704000404-02

Mazeppa Creek (Trout Brook) Subwatershed begins in southeastern Goodhue County and flows into southwestern Wabasha County draining 55.72 mile^2 of the surrounding landscape. Its headwaters lie near the village of Goodhue about 7 miles northeast of Zumbrota. Trout Brook flows in a southeasterly direction, dramatically transitioning from flat prairie uplands to steep gradients of rugged hills commonly found in southeastern Minnesota, passing 2 miles north of the town of Mazeppa. It is joined by the North Fork of the Zumbro River just before joining with the Zumbro River in the Upper North Zumbro River Watershed. Mazeppa Creek transitions from a warmwater stream in its headwaters to coldwater when the river runs subterminal due to active karst before it reaches the bluffline. The creek is home to wild brown and brook trout populations (MNDNR, 2014). Agricultural landuse covers nearly 93% of the watershed (59.77% cropland and 32.23% rangeland). Developed areas in the watershed (4.6%) are limited to the small rural community of Oronoco. Only 3.4% of the watershed remains forested, these forested acres are primarily observed along riverine corridors where topography limits their utility as cropland. There are no lakes within the subwatershed. The intensive water chemistry station is collocated with biological monitoring station 12LM011 in the town of Mazeppa.

Table 35. Aquatic life and recreation assessments on stream reaches: Mazeppa Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-515, ***Trout Brook (Mazeppa Creek)***, *T110 R15W S24, west line to N Fk Zumbro R*	12LM011, 04LM134	10.73	CWg	MTS	EXS	MTS	IF	MTS	MTS	MTS	MTS	--	IF	--	IMP	IMP

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 36. Minnesota Stream Habitat Assessment (MSHA): Mazeppa Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM011	Trout Brook	2.5	12	20	13	28	75.5	Good
1	04LM134	Trout Brook	0	9	16.4	9	21	55.4	Fair
Average Habitat Results: *Mazeppa Creek Subwatershed*			**1.25**	**10.5**	**18.2**	**11**	**24.5**	**65.45**	**Fair**

Qualitative habitat ratings

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

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

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

Table 37. Channel Condition and Stability Assessment (CCSI): Mazeppa Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM011	Trout Brook	40	29	15	11	95	Severely unstable
Average Stream Stability Results: *Mazeppa Creek Subwatershed*			40	29	15	11	95	Severely unstable

Qualitative channel stability ratings

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

Table 38. Outlet water chemistry results: Mazeppa Creek Subwatershed.

Station location:	**Trout Brook;** @ CSAH-1, 1.5 MI North of Mazeppa, MN						
STORET/EQuIS ID:	**S005-551**						
Station #:	**12LM011**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2A) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	8	0.2	2.3	0.8	16	0
Chloride	mg/L	9	17.9	24.0	19.3	230	0
Dissolved Oxygen (DO)	mg/L	27	9.68	17.3	12.81	7	0
pH		15	6.3	8.4	7.6	6.5 - 8.5	1
[1]Secchi Tube	100 cm	24	30	100	86	> 55	2
Total suspended solids	mg/L	9	1	12	5	< 10	1
Escherichia coli (geometric mean)	MPN/100ml	3	276	699	- -	126	3
Escherichia coli	MPN/100ml	15	121	2420	648	1260	2
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	9	5.1	8.3	5.7	- -	
Kjeldahl nitrogen	mg/L	9	0.30	0.44	0.32	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	9	26	140	63	- -	
Specific Conductance	µS/cm	24	341	920	489	- -	
Temperature, water	deg °C	24	8.86	14.30	11.49	- -	
Sulfate	mg/L	9	8.5	14.0	11.7	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]**Secchi Tube** standards are surrogate standards derived from the Total Suspended Solids standard of 10 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Trout Brook subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

While biological sampling was attempted within the warmwater headwaters of Mazeppa Creek, these sites were not assessed due to the impacts of Karst topography on the landscape and resulting subterranean flow. This naturally limited stream flow, and the overall potential of these aquatic biological communities. As such, assessments were only made on Mazeppa Creek's coldwater reaches.

Data collected at the outlet chemistry station (S005-551) are the basis for the new *E. coli* bacteria listing proposed for Trout Brook (Mazeppa Creek, 07040004-515). Monthly geometric mean calculations show chronically elevated bacteria levels which may pose a risk to human health through bodily contact. All other conventional chemistry parameters with enough data to assess meet the standards, where they exist. In contrast, macroinvertebrate data suggest a new aquatic life use impairment on Mazeppa Creek. The sample scored below the GU threshold but within the lower confidence interval. The MIBI community lacked POET diversity and abundance and was dominated by few tolerant taxa. Four coldwater indicator taxa were present comprising 5% of all individuals sampled. In contrast, FIBI meet biocriteria during both 2004 and 2012 visits but show a 9.5-point drop in IBI score temporally. Historical accounts of Mazeppa Creek indicate that conditions have declined but still maintain self sustaining populations of both brown and brook trout (MNDNR, 2014). Mazeppa Creek is the only stream in the Lake City Management Area where the natural reproduction of rainbow trout have been documented; however, no rainbow trout were captured during MPCA sampling events in 2012 (MNDNR, 2014).

Upstream intensive agricultural landuse within the watershed is likely contributing to observed impairments observed on Mazeppa Creek. While TSS exceedances for (07040004-515) showed some bias toward precipitation events and were inconclusive to determine a support status for AQL, biological habitat data suggest impacts of TSS are a concern within the watershed including observations of in stream sedimentation, erosion and poor water clarity. This has been corroborated by similar documentation by MNDNR fisheries crews. While MSHA habitat scores are 25 points higher at the 2012 station visit versus the 2004 station visit, this could indicate improved conditions over time or suggest isolated issues observed at the 2004 station. Additional improvements on the landscape are needed to bring Mazeppa Creek into attainment. Protection of the upstream riparian corridor and limiting upstream livestock access to the stream would likely reduce instream *E.coli* levels and erosion and improve instream habitat. MNDNR is planning a habitat improvement project within Mazeppa Creek to provide sufficient conditions for large brown trout.

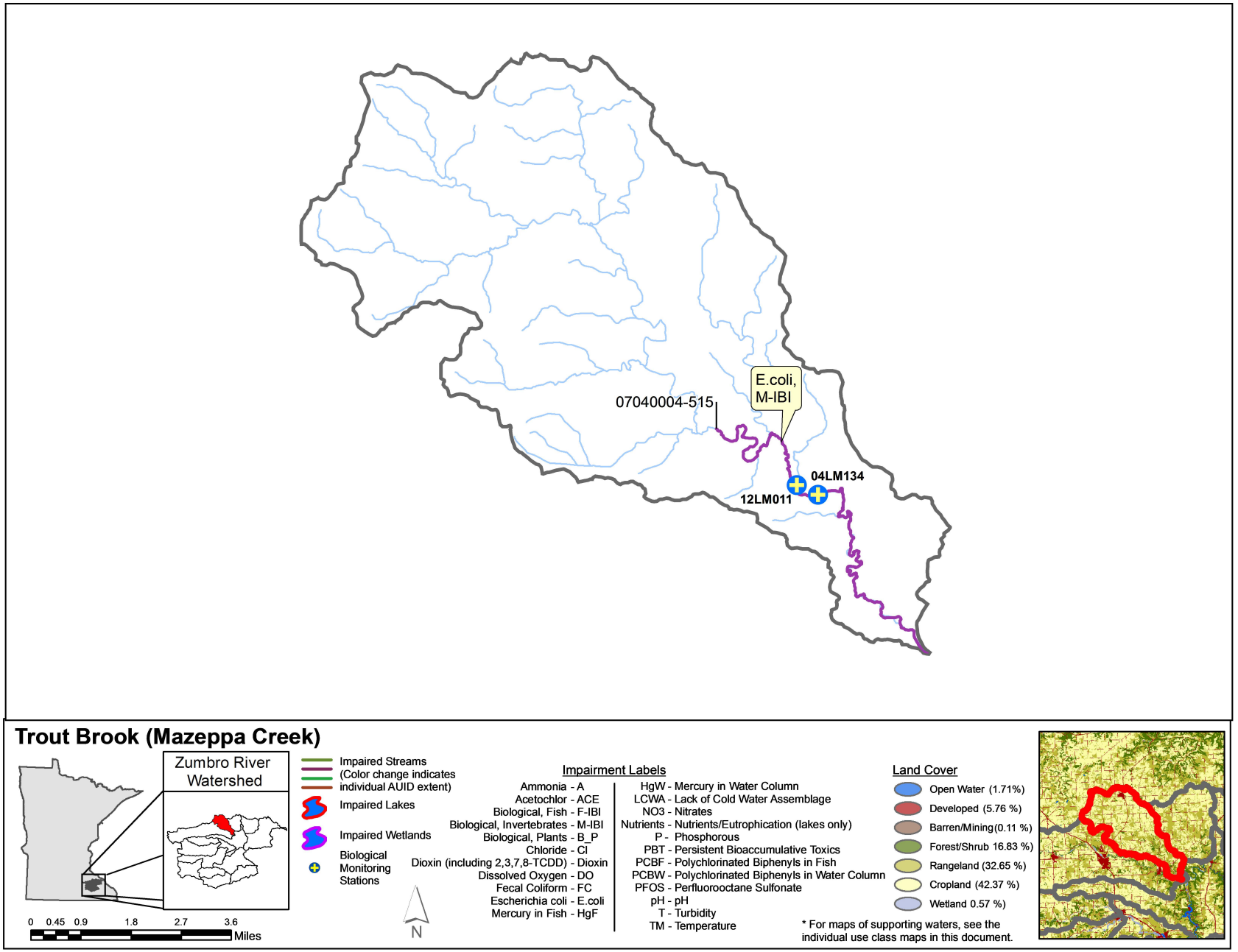

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Mazeppa Creek Subwatershed.

North Fork Zumbro River Subwatershed HUC 0704000404-01

The North Fork of the Zumbro River Subwatershed comprises the northern boundary of the Zumbro Watershed. The subwatershed is mostly rural, stretching 184.18 mile^2 from southeastern Rice County through southern Goodhue County and into southwestern Wabasha County. The northernmost branch of the Zumbro River begins a few miles East of Faribault and flows east following Minnesota Highway 60 through the small community of Kenyon and continues in a slight northeasterly direction past Wanamingo and Zumbrota. Passing through Mazeppa's city center, the stream continues southeast joining the Zumbro River a few miles downstream of the Lake Zumbro dam. A few miles past Mazeppa, the North Branch joins Mazeppa Creek and enters the Upper Zumbro River Subwatershed. Gradient increases on the eastern boundaries of the North Fork, and the stream transitions from warm to coldwater as the abundance of springs increases and water temperature cools. Landuse within the watershed primarily managed for agricultural purposes: 66.9% is tilled for cropland while 18.7% is grazed by livestock. Developed areas in the watershed (5.6%) are limited to the small rural communities of: Walcott, Ruskin, Epsom, Kenyon, Bombay, Wanamingo, Zumbrota and Mazeppa. Only 5.7% of the watershed remains forested, these forested acres are primarily observed along riverine corridors. The intensive water chemistry station is collocated with biological station 12LM003 in downtown Mazeppa. No lakes are present within the watershed.

Table 39. Aquatic life and recreation assessments on stream reaches: North Fork Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:									Eutrophication		Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-611, ***Unnamed creek***, *Unnamed cr to Unnamed cr*	04LM051	2.41	WWg	MTS	--	NA	NA	NA	--	NA	--	--	IF	--	SUP	IF
07040004-970, ***Zumbro River, North Fork***, *Headwaters to T109 R19W S10, east line*	12LM039*	11.06	WWm	MTS	MTS	NA	NA	--	--	NA	--	--	--	--	SUP	NA
07040004-614, ***Unnamed creek***, *Unnamed cr to N Fk Zumbro R*	12LM038	1.26	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-971, ***Zumbro River, North Fork,*** *T109 R19W S11, west line to Trout Bk*	10EM139, 12LM036, 12LM106,	45.22	WWg	MTS	EXS	MTS	IF	MTS	MTS	MTS	MTS	IF	EXS	N	IMP	IMP

	12LM034, 12LM032, 04LM088, 12LM003															
07040004-964, ***Unnamed creek***, *Unnamed cr to N Fk Zumbro R*	12LM037	3.16	WWg	MTS	EXS	IF	IF	--	--	IF	--	--	--	--	IMP	IF
07040004-605, ***Unnamed creek***, *Unnamed cr to N Fk Zumbro R*	04LM071, 12LM101	1.31	WWg	MTS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-606, ***Spring Creek***, *Unnamed cr to Unnamed cr*	04LM087	1.12	WWg	MTS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-608, ***Spring Creek***, *Unnamed cr to Unnamed cr*	12LM035	1.61	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-562, ***Shingle Creek***, *Unnamed cr to N Fk Zumbro R*	12LM033	4.53	WWg	MTS	EXS	NA	NA	--	--	NA	--	--	IF	--	IMP	IF
07040004-579, ***Unnamed creek***, *Headwaters to N Fk Zumbro R*	04LM008	2.81	WWg	MTS	EXS	NA	NA	NA	--	NA	--	--	IF	--	IMP	IF
07040004-963, ***Unnamed creek***, *Unnamed cr to N Fk Zumbro R*	12LM031	2.43	WWg	MTS	MTS	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-511, ***Zumbro River***, *North Fork, Trout Bk to Zumbro R*		1.18	WWg	--	--	MTS	EX	EX	--	MTS	--	--	IF	--	IF	IF

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 40. Minnesota Stream Habitat Assessment (MSHA): North Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	04LM051	Trib. to Zumbro River, North Fork	0	4	12.4	13	19	48.4	Fair
1	12LM039	Zumbro River, North Fork	0	5	10.7	11	7	33.7	Poor
1	12LM038	Trib. to Zumbro River, North Fork	0	0	14.5	6	14	34.5	Poor
1	10EM139	Zumbro River, North Fork	0	5	14	5	13	37	Poor
1	12LM037	Trib. to Zumbro River, North Fork	2.5	10	16.6	11	24	64.1	Fair
2	12LM036	Zumbro River, North Fork	2.5	11	12.25	13.5	18.5	57.75	Fair
1	12LM106	Zumbro River, North Fork	0	10.5	17.7	7	23	58.2	Fair
1	04LM071	Trib. to Zumbro River	2	12	17.7	14	18	66.7	Good
1	12LM101	Trib. to Zumbro River, North Fork	5	13	18.65	12	32	80.65	Good
2	04LM087	Silver Creek	0	8.75	20.4	12	26	67.15	Good
1	12LM035	Spring Creek	0	7.5	16	12	27	62.5	Fair
1	12LM034	Zumbro River, North Fork	0	9	20.3	13	24	66.3	Good
1	12LM033	Shingle Creek	0	6	10.8	7	21	44.8	Poor
1	04LM008	Trib. to Zumbro River, North Fork	2	8.5	14.6	12	28	65.1	Fair
1	12LM032	Zumbro River, North Fork	2.5	5.5	10.9	7	19	44.9	Poor
1	12LM031	Trib. to Zumbro River, North Fork	0	4.5	13.2	12	22	51.7	Fair
1	04LM088	North Fork Zumbro River	0	8.5	18	9	17	52.5	Fair
1	12LM003	Zumbro River, North Fork	1.5	8.	22	16	26	73.5	Good
Average Habitat Results: *North Fork Zumbro River Subwatershed*			**1**	**7.60**	**15.59**	**10.69**	**21.03**	**56.08**	**Fair**

Qualitative habitat ratings

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

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

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

Table 41. Channel Condition and Stability Assessment (CCSI): North Fork Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM038	Trib. to Zumbro River, North Fork	41	25	10	11	87	Severely unstable
1	10EM139	Zumbro River, North Fork	8	7	10	3	28	Fairly stable
1	12LM037	Trib. to Zumbro River, North Fork	31	23	19	5	78	Moderately unstable
1	12LM101	Trib. to Zumbro River, North Fork	10	11	4	1	26	Stable
1	12LM034	Zumbro River, North Fork	34	26	19	7	86	Severely unstable
1	12LM032	Zumbro River, North Fork	28	23	24	7	92	Severely unstable
1	12LM031	Trib. to Zumbro River, North Fork	36	17	17	7	77	Moderately unstable
1	12LM003	Zumbro River, North Fork	21	21	11	5	58	Moderately unstable
1	12LM106	Zumbro River, North Fork	34	38	19	11	102	Severely unstable
Average Stream Stability Results: *North Fork Zumbro River Subwatershed*			**27**	**21.22**	**14.78**	**6.33**	**70.44**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 42. Outlet water chemistry results: North Fork Zumbro River Subwatershed.

Station location:	**Zumbro River, North Fork;** @ Pedestrian Bridge, end of Walnut St. NW in Mazeppa, MN						
STORET/EQuIS ID:	**S005-741**						
Station #:	**12LM003**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.7	13.1	3.8	40	0
Chloride	mg/L	12	25.7	32.4	30.0	230	0
Dissolved Oxygen (DO)	mg/L	27	8.65	16.44	12.04	5	0
pH		19	6.9	9.0	8.1	6.5 - 9	0
[1]Secchi Tube	100 cm	55	5	100	72	> 10	1
Total suspended solids	mg/L	10	4	65	23	< 65	0
Escherichia coli (geometric mean)	MPN/100ml	2	316	1097	- -	126	2
Escherichia coli	MPN/100ml	14	79	24000	2223	1260	2
Chlorophyll-a, Corrected	µg/L	9	1	20	9	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	23	3.1	15.5	6.1	- -	
Kjeldahl nitrogen	mg/L	17	0.03	3.08	0.61	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	9	1	31	5	- -	
Phosphorus	µg/L	27	66	634	134	- -	
Specific Conductance	µS/cm	31	364	10870	934	- -	
Temperature, water	deg °C	57	5.43	23.30	16.74	- -	
Sulfate	mg/L	12	23.8	38.3	32.2	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the North Fork of the Zumbro River subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

North Fork Zumbro River (07040004-970, and 07040004-971)

The North Fork of the Zumbro River was split into two AUIDs during the 2015 assessment process in order to assess its upstream channelized reach (07040004-970), using modified biological criteria, due to limited potential caused by poor habitat conditions. As such, a 2010 aquatic life turbidity listing on the North Fork of the Zumbro River did not carry forward to this new headwaters AUID, as data gathered that contributed to the downstream impairment did not fall within the new headwaters AUID. Biological criteria meet modified thresholds within the AUID, suggesting a supporting aquatic life use designation.

In contrast, aquatic life impairment (macroinvertebrates) within the downstream AUID 07040004-971 is broad, with low scores observed at two upstream stations and the outlet station. While upstream results meet modified use standards, they are held to a lower standard than 07040004-971 and score lower than the next downstream biological station (10EM139). The best MIBI results were observed in the lower half of the AUID station 04LM088, sampled in 2004, had the highest MIBI score (58.8), and the two stations immediately upstream scored above or near the impairment threshold. As with many other streams in southeastern Minnesota, the North Fork of the Zumbro appears to follow a pattern in which highly agriculture headwater streams show impairment but then proceed to transition to conditions more favorable to biological communities, as the instream habitat and riparian conditions improve further down in the valley. The lowermost station (12LM003) still fell below the threshold despite excellent habitat and flow conditions – it's possible that a high flow event several days prior to sampling had an impact on the resulting data. The macroinvertebrate impairment driven by low scores in the upstream portion of the AUID is consistent with the existing turbidity impairment on this AUID. Despite this, fish perform very well; FIBI at all nine stations on the North Fork Zumbro exceed the upper confidence interval except for 04LM088 (2004), this station fell below the threshold but was within lower confidence limits. Data collected in 2012 both up and downstream of this station, suggest that improvements have been made temporally within the North Fork. The highest fish IBI score observed within the subwatershed was at the outlet station, scoring 90.1, one of the highest fish IBI scores observed within the entire Zumbro River Watershed. Overall MSHA habitat ratings across the North Fork Zumbro is fair and show an increasing trend moving downstream in the watershed at all but two stations in the lower reaches of the watershed. While the North Fork of the Zumbro River is classified as a warmwater stream, brown trout have been known to reside within its reaches and were sampled during 2012 MPCA visits. These results may indicate some cold thermal potential. Additional thermal investigation could identify the North Fork's coldwater potential and where thermal transitions might exist. Common habitat problems observed across all stations include a lack of cover and sedimentation issues consistent with the AUID 07040004-971's, turbidity listing. This AUID also has a new listing for aquatic recreation (*E. coli*), determined by data collected at the outlet chemistry monitoring station. Monthly geometric mean calculations show chronically elevated bacteria levels, a number of samples also exceeded the acute standard indicating severely impaired conditions at times; which may be a potential risk to human health through bodily contact. Other conventional chemistry parameters meet the use class standards, where they exist (Table 42).

Unnamed Creek (07040004-964)

Unnamed Creek is a small natural tributary stream in the western headwaters of the North Branch of the Zumbro. Biological data collected in 2012, at 12LM037 resulted in a new listing for macroinvertebrates. A lack of diversity and abundance of intolerant POET taxa, as well as dominance of tolerant invertebrate were the primary reason for the low MIBI score. In contrast fish meet biocriteria. MSHA data are fair with excessive sedimentation and steep non-cohesive soils are noted as potential stressors. A one time water chemistry grab sample for nitrogen collected in July was 9.5 mg/L, suggesting moderately elevated levels of nitrogen during spring months, potentially stressing macroinvertebrate communities. A very high relative abundance of nitrogen tolerant invertebrate taxa corroborates the high nitrogen values.

Unnamed Creek (07040004-605)

Unnamed Creek is a small natural tributary stream in the western headwaters of the North Branch of the Zumbro. Biological data collected in 2004, at 04LM071 and in 2012 at 12LM037 suggest a new impairment for macroinvertebrates, as both samples fell below impairment thresholds. In contrast fish meet biocriteria at both stations with higher scores observed at the upstream 2004, station, potentially indicating some temporal and/or longitudinal degradation. MSHA habitat scores are good at both stations but increase moving downstream. One-time grab samples for nitrogen are higher at June visit in 2012 (12LM101, 19mg/L) at the downstream station but still elevated at the upstream station collected in August of 2004, (04LM071, 8.7 mg/L). High nitrate levels are likely stressing the macroinvertebrate communities and measures should be taken to limit nitrogen loading.

Spring Creek (07040004-606, 07040004-608)

Spring Creek is a small tributary in the central part of the North Fork Zumbro River Subwatershed. 04LM087 (AUID 07040004-606) is located in the watershed's headwaters sampled as part of a random survey in 2004, to better understand overall biological condition of the Lower Mississippi River Basin. These data suggest a new aquatic life impairment for macroinvertebrates. In spite of this, fish results meet biocriteria and MSHA habitat scores within the site are fair to good (60.8 and 73.5). A one-time grab sample in June (23.7 mg/L) suggests elevated spring nitrate levels may be impacting the macroinvertebrate community. Downstream on AUID 07040004-608, biological results collected in 2012 at 12LM035 meet biocriteria but are near impairment thresholds. MSHA habitat scores are also lower at the downstream station; some sedimentation concerns noted including embeddness of course substrates, bank erosion and abundance of fine sediment. This potentially indicates degradation of the overall fish community and of habitat between 2004 and 2012. Nitrate levels measured during a June fish visit indicate elevated levels at 11 mg/L but lower values than those observed upstream in 2004 (23 mg/L). High nitrogen levels collected during grab samples suggest Spring Creek may act as a nitrogen source for the North Fork Zumbro River Subwatershed. Additional monitoring should include resampling biological station 04LM087 to better understand degradation and present condition.

Shingle Creek (07040004-562)

Shingle Creek is a small tributary in the central North Fork Zumbro Subwatershed. Biological data collected in 2012 suggest an aquatic life impairment for macroinvertebrates. The macroinvertbrate community was dominated by tolerant organisms, lacked mayflies and was low in overall POET taxa. In contrast the FIBI score meets biocriteria, exceeding the upper confidence interval (+11). MSHA habitat within the site is poor, problems indicated include an open horse and cattle pasture within the reach, severe erosion, low channel stability and sedimentation concerns. Instream habitat concerns may be contributing to observed impairment. One time chemistry measurements taken during the fish visit in June of 2012 did not point towards potential chemical issues, including high nitrate (0.82 mg/L).

Unnamed Creek (07040004-579)

Unnamed Creek is a small direct tributary in the east central section of the subwatershed. 04LM008 (AUID 07040004-579) was sampled as part of a random survey in 2004, to better understand overall biological condition of the Lower Mississippi River Basin. Biological data are discrepant; macroinvertebrates fail to meet aquatic life standards while the fish sample scored above upper confidence limits, meeting standards. The macroinvertebrate sample has what appears to be a potentially impaired coldwater community and field temperature measurements taken suggest cold temperatures. Fish numbers are high and community is diverse considering small drainage area less than 1 $mi.^2$ MSHA habitat score was on the high end of the fair scale (65.1) despite narrow undisturbed riparian zone adjacent to stream and moderate sedimentation concerns (stream bank erosion and fine substrates). Further follow-up with temperature monitoring to help determine coldwater status is recommended as the site is dominated by coldwater indicator macroinvertebrate taxa. Additional monitoring should include resampling biological station 04LM008 to better understand degradation and present condition.

Unnamed Creek (07040004-614)

Unnamed Creek is a small direct tributary to the North Fork Zumbro River draining approximately 18 $mi.^2$ of the subwatershed. Biological criteria indicate biological assemblages are meeting aquatic life use standards. The fish community appears well balanced scoring 10 points above the upper confidence limits. Biology meet biocriteria despite poor habitat conditions observed and elevated nitrogen observed during July fish visit (13 mg/L). The biological station is surrounded by pasture which is contributing to poor habitat conditions observed including sedimentation, embeddedness of coarse substrates, low channel stability and severe stream bank erosion. Despite these stressors macroinvertebrates still meet standards. Unnamed Creek could be further investigated to see what unique conditions here could provide insight to alleviate other impaired reaches in the watershed.

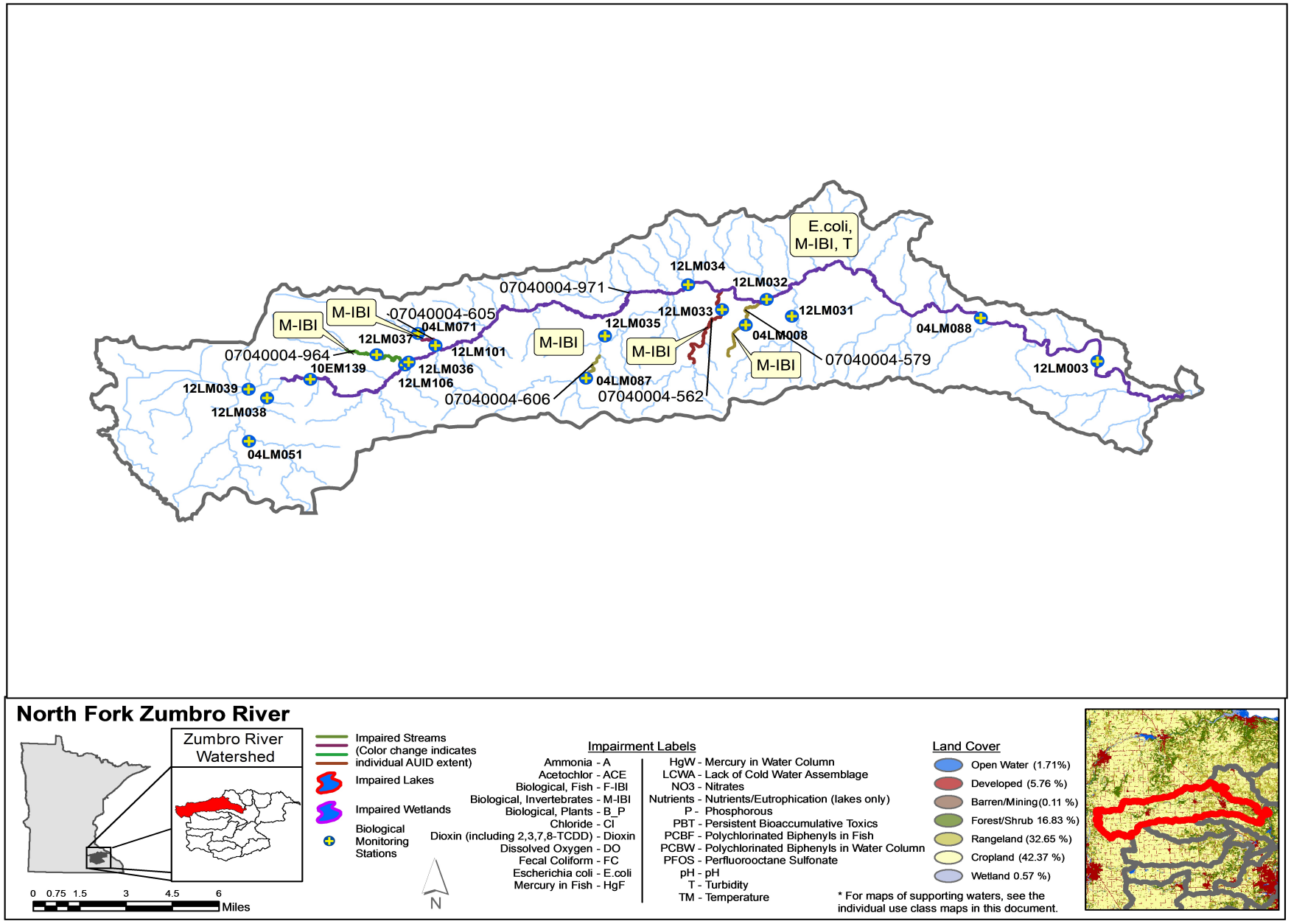

Figure 36. Currently listed impaired waters by parameter and land use characteristics in the North Fork Zumbro River Subwatershed.

Cold Creek Subwatershed HUC 0704000405-04

The Cold Creek subwatershed stretches 45.84 mile^2 across the far northeastern reaches of Goodhue County and northwestern Wabasha County. Ninety-two percent of the watershed's land is managed for agricultural purposes: 40.56% rangeland and 52.36% cropland. Only 3.4% of the watershed remains forested, these forested acres are primarily observed along steep bluff and riverine corridors where topography limits their utility as cropland. Developed areas in the watershed (3.5%) are limited to the small rural communities of: Bear Valley and Oak Center. Cold Creek's headwaters start in the watershed's agricultural uplands; these small tributaries are ephemeral in nature and are classified as warmwater reaches. Moving downstream and south through the subwatershed the presence karst becomes more evident as Cold Creek's flow becomes subterminal. Cold Creek emerges at the surface at the base of the bluff, upstream of CR 68. Here Cold Creek is designated as a coldwater, the result of influences of its time spent underground and nearby springs. Cold Creek is home to naturally reproducing brook and brown trout populations. Cold Creek joins the Zumbro River near Zumbro Falls. The intensive water monitoring station is collocated with biological monitoring station 12LM002. There are no lakes in the subwatershed.

Table 43. Aquatic life and recreation assessments on stream reaches: Cold Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-510, ***Cold Creek***, *T110 R14W S25, north line to Zumbro R*	12LM002	3.26	CWg	MTS	EXS	--	IF	MTS	MTS	EXS	IF	--	IF	--	NS	IF

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

Table 44. Minnesota Stream Habitat Assessment (MSHA): Cold Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM002	Cold Creek	2.5	10	20.4	9	25	66.9	Good
Average Habitat Results: *Cold Creek Subwatershed*			**2.5**	**10**	**20.4**	**9**	**25**	**66.9**	**Good**

Qualitative habitat ratings

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

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

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

Table 45. Channel Condition and Stability Assessment (CCSI): Cold Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM002	Cold Creek	28	31	16	7	82	Severely unstable
Average Stream Stability Results: *Cold Creek Subwatershed*			28	31	16	7	82	Severely unstable

Qualitative channel stability ratings

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

Table 46. Outlet water chemistry results: Cold Creek Subwatershed.

Station location:	**Cold Creek;** just east of CR-68, 0.5 MI NW of Zumbro Falls, MN						
STORET/EQuIS ID:	**S005-362**						
Station #:	**12LM002**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2A) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	9	0.05	2.2	0.7	16	0
Chloride	mg/L	9	13.1	14.2	13.5	230	0
Dissolved Oxygen (DO)	mg/L	27	10.42	23.97	14.62	7	0
pH		19	6.63	8.6	7.7	6.5 - 8.5	1
[1]Secchi Tube	100 cm	27	100	100	100	> 55	0
Total suspended solids	mg/L	9	1	7	4	< 10	0
Escherichia coli (geometric mean)	MPN/100ml	3	40	110	- -	126	0
Escherichia coli	MPN/100ml	15	8	580	113	1260	0
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	9	5.6	6.3	5.9	- -	
Kjeldahl nitrogen	mg/L	9	0.30	6.07	0.94	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	9	41	480	95	- -	
Specific Conductance	µS/cm	24	290	740	431	- -	
Temperature, water	deg °C	24	9.00	12.80	10.56	- -	
Sulfate	mg/L	9	9.8	11.5	10.5	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 10 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Cold Creek subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Similar to other coldwater drainages in the watershed, Cold Creek's headwaters are warmwater and flows subterminally for miles before emerging below the bluffs. As such water quality data was only assessed in its lower coldwater reaches where data was available. Only one AUID was assessed against current water chemistry standards for cold water streams in Cold Creek (07040004-510). No new chemistry related impairments are proposed and no previous impairments exist. Bacteria data collected at the outlet chemistry station (S005-362) were inconclusive. Older bacteria data (from 2009-10) suggest impairment when calculating monthly geometric means; however, the newer set of bacteria data (from 2012-13) suggest bacteria levels are now meeting the monthly geometric mean standard. Additional bacteria monitoring is needed to determine if the change in conditions is sustained from year to year. Other conventional chemistry parameters meet use class standards, where they exist (Table 46).

Contrary to water chemistry results, a new macroinvertebrate impairment is proposed on 07040004-510. Impairment is the result of a single biological invert visit (12LM002) sampled in 2012. The sample scored below the cold water GU threshold and below the lower confidence interval. Despite a very strong coldwater temperature regime, this site was dominated by tolerant taxa and had very vew POET taxa present. Four coldwater taxa were found, comprising only 5% of the total abundance. MNDNR commented that historically macroinvertebrates have performed poorly in Cold Creek. A MNDNR geomorphic survey indicates that the bedload is moving and contributes to poor macroinvertebrate invert habitat. Continuous stream temperature data collected during 2012 surveys show July average temperatures at 12.7 C, not exceeding 15.2 C (Figure 37), suggesting that temperature is not stressing macroinvertebrate communities. In contrast, FIBI results were excellent with FIBI scores of 91.7, demonstrating healthy naturally reproducing brook and brown trout populations. MSHA habitat score was also good (66.9). Nitrate levels appear moderate to low within the reach with maximum levels reaching only 6.3 mg/L during intensive chemistry sampling.

Despite good MSHA scores and past MNDNR habitat improvement projects, the stream still carries a high sand bedload that can fill pool, scour riffle habitats and limit instream cover.

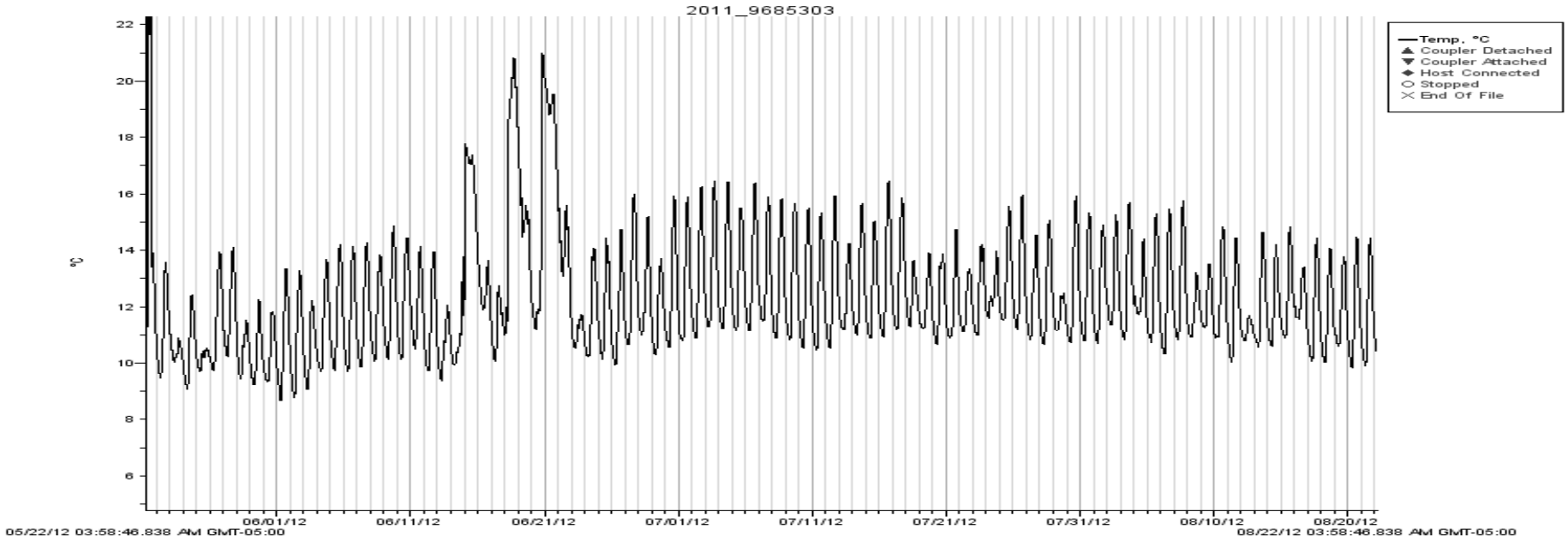

Figure 37. Continuous Temperature Data Collected at biological station 12LM002 in 2012.

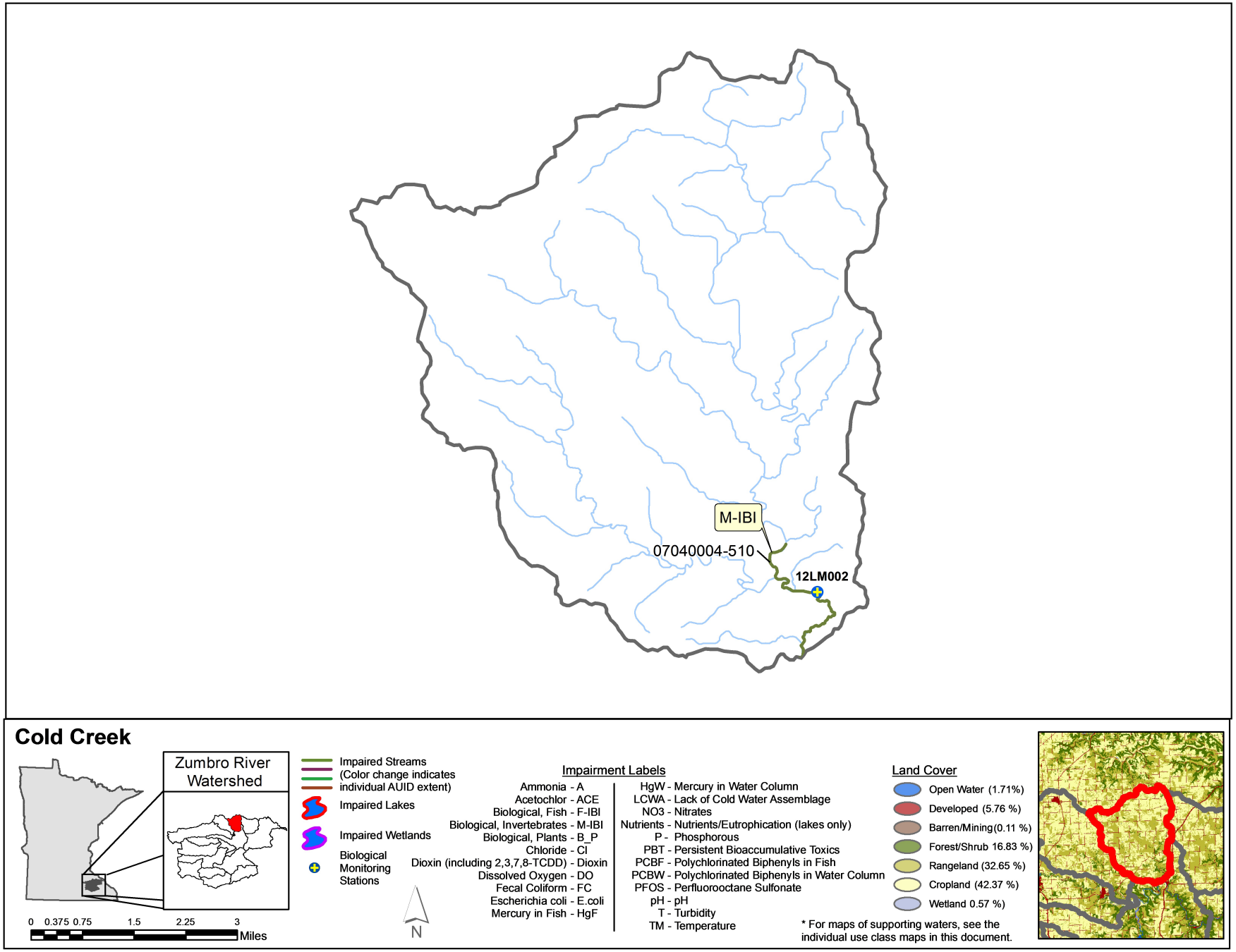

Figure 38. Currently listed impaired waters by parameter and land use characteristics in the Cold Creek Subwatershed.

Upper Zumbro River Subwatershed HUC 0704000405-03

Encompassing 104.14 mile^2 of northeastern Olmsted and southeastern Wabasha counties, the Upper Zumbro River Subwatershed is the culmination of the many branches of the Zumbro River. Starting at Zumbro Lake, the subwatershed receives flow from the South Fork Zumbro River. The Middle Fork Zumbro River enters Zumbro Lake from the west near Kings Park. Further north, Pine Island Creek drains to Zumbro Lake from the west near CR 127. Zumbro Lake is dammed just downstream of CR 90. Operation of the dam started in 1919 to supply electrical needs to the growing city of Rochester while decreasing their dependence on burning coal for electricity (Rochester 2013). About 3 miles downstream from the river's impoundment, the Zumbro River gains the flow of Mazeppa Creek and the North Branch of the Zumbro River from the west. Near Zumbro Falls, Cold Creek discharges to the Zumbro River from the north. The Zumbro River is divided into its upper and lower subwatersheds a couple of miles upstream of the community of Millville. The watershed's landuse is predominately agrarian: 42.4% is cultivated and 32.7% is grazed by livestock. 16.8% of the watershed is forested; forested acres are primarily observed along riverine corridors and steep blufflands. Developed areas in the watershed (5.8%) are limited to the small rural communities of: Kings Park, Cedar Beach, Zumbro Falls and Hammond, Jarrett and Millville. The intensive water chemistry station is located on the Zumbro River in Hammond and is collocated with biological station 02LM005.

Table 47. Aquatic life and recreation assessments on stream reaches: Upper Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia - NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-576, ***Pine Island Creek (Dry Run Creek)***, *Unnamed cr to Zumbro Lk*	04LM066	4.25	WWg	MTS	--	MTS	MTS	MTS	--	MTS	--	--	--	--	MTS	IMP
07040004-506, ***Zumbro River***, *Zumbro Lk to N Fk Zumbro R*	02LM034#, 12LM021, 02LM028#	4.50	WWg	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	MTS	IF
07040004-504, ***Zumbro River,*** *N Fk, Zumbro R to Cold Cr*	12LM020	6.38	WWg	MTS	MTS	IF	IF	IF	--	IF	--	--	IF	--	MTS	--
07040004-502, ***Zumbro River,*** *Cold cr to West Indian cr*	02LM003#, 02LM005#, 10EM107**, 02LM006**,#	24.21	WWg	MTS	MTS	EXS	IF	MTS	MTS	MTS	MTS	MTS	--	--	SUP	IMP
07040004-575, ***Unnamed creek (Hammond Creek)***, *Unnamed cr to Zumbro R*		1.57	CWg	--	--	IF		MTS	--	NA	--	--	--	--	IF	IMP

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information
Abbreviations for Use Support Determinations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **SUP** = Full Support (Meets Criteria); **IMP** = Impaired (Fails Standards)
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use; = insufficient information.
Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water
*Assessments were completed using proposed use classifications changes that have not yet been written into rule.
**Biological station is located in Lower Zumbro River Subwatershed and shares an AUID with biological station 02LM005, for additional information on this station see Lower Zumbro River Subwatershed.
MNDNR data used as supporting information not assessed.

Table 48. Minnesota Stream Habitat Assessment (MSHA): Upper Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	04LM066	Pine Island Creek	5	14	18.2	11	32	80.2	Good
2	12LM021	Zumbro River	3.75	9.75	20.8	11.5	30	75.8	Good
1	12LM020	Zumbro River	3	11.5	20.7	8	28	71.2	Good
1	02LM005	Zumbro River	3.5	11	19.2	9	24	66.7	Good
Average Habitat Results: *Upper Zumbro River Subwatershed*			**3.81**	**11.57**	**19.73**	**9.88**	**28.5**	**73.48**	**Good**

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

Table 49. Channel Condition and Stability Assessment (CCSI): Upper Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM021	Zumbro River	31	11	26	5	73	Moderately unstable
2	02LM005	Zumbro River	20	17	11	5	53	Moderately unstable
Average Stream Stability Results: *Upper Zumbro River Subwatershed*			**25.5**	**14**	**18.5**	**5**	**63**	**Moderately unstable**

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

Table 50. Outlet water chemistry results: Upper Zumbro River Subwatershed.

Station location:	**Zumbro River;** Upstream of CR-11, in Hammond, MN						
STORET/EQuIS ID:	**S003-772**						
Station #:	**02LM005**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	10	0.8	5.7	3.2	40	0
Chloride	mg/L	12	26.9	45.6	35.4	230	0
Dissolved Oxygen (DO)	mg/L	20	3.05	15.11	5.25	5	12
pH		20	6.9	8.5	8.0	6.5 - 9	0
[1]Secchi Tube	100 cm	19	9	100	81	> 10	1
Total suspended solids	mg/L	12	2	134	18	< 65	1
Escherichia coli (geometric mean)	MPN/100ml	2	22	49	- -	126	0
Escherichia coli	MPN/100ml	16	1	2420	220	1260	1
Chlorophyll-a, Corrected	µg/L	18	1	34	6	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	18	3.1	10.2	5.9	- -	
Kjeldahl nitrogen	mg/L	18	0.30	1.31	0.50	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	18	1	5	2	- -	
Phosphorus	µg/L	18	28	319	79	- -	
Specific Conductance	µS/cm	17	466	621	574	- -	
Temperature, water	deg °C	19	11.39	25.64	19.64	- -	
Sulfate	mg/L	12	20.1	29.4	24.3	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Upper Zumbro River subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Table 51. Lake assessments: Upper Zumbro River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Mean Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Mean Secchi (m)	AQR Support Status	AQL Support Status
Zumbro	55-0004-00	697.4	H	37	14.6	3.0*	NT	111.1	35.6	1.5	NS	IF

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

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

Summary

Zumbro Lake Chemistry

Zumbro Lake has a total catchment area of nearly 850 mi.^{2} and is a manmade reservoir located 6 miles north of the city of Rochester and 2.5 miles east of Oronoco. Surrounding land uses and water retention time estimated by MINLEAP modeling indicate this lake should be held to the deep lake eutrophication standards for the WCBP ecoregion (Appendix 5.1). The lake has an existing AQR impairment from an assessment made in 2002. Secchi data are recorded as far back as 1976; the most recent 10 years of secchi data meet the standard despite receiving flow from the South Fork Zumbro and the Middle Fork Zumbro Rivers which delivers waters impaired for both aquatic life (macroinvertebrates and turbidity) and recreation (*E. coli*). While the record for secchi data dates back to 1976, data are insufficient to establish any long-term trend in clarity. Phosphorous and chlorophyll-a both exceed the regional eutrophication standards and confirm the existing AQR impairment (Table 51). Chloride data collected show concentrations never exceeding 59 mg/L, which is well below the chronic standard of 230mg/L. For lakes meeting the chloride standard for AQL, a policy decision has been made to assess the lake as insufficient information (IF), as no biological data are available to determine if the lake is supporting aquatic life use at this time.

Pine Island Creek (Dry Run Creek) (07040004-795, 07040004-576)

Pine Island Creek (Dry Run Creek) is a direct tributary to the Zumbro River, entering Zumbro Lake from the west downstream from the confluence of the Lower Middle Branch but upstream of the confluence of the North Branch Zumbro River. A new aquatic recreation impairment (*E.coli*) is proposed on Pine Island Creek due to chronically elevated levels of bacteria which may pose a risk to human health through bodily contact. All other conventional chemistry parameters with data available on Dry Run Creek met the standards, where they exist. Biological data sampled in 2004 at station 04LM066 (07040004-576) indicate that fish are meeting their designated warmwater use, exceeding upper confidence limits for the southern headwaters warmwater IBI. This station was sampled as part of a random sampling survey in 2004 to assess the general health of streams in the Lower Mississippi River Basin. While macroinvertebrates were also planned for sampling in 2004, water levels were insufficient for sampling in August of 2004. Likewise, Pine Island Creek was planned for sampling in 2012 at the next upstream road crossing at CR 1 AUID (07040004-795) to increase the distance of the biological station from Zumbro Lake to further avoid its potential influence on the sample; however, the site was not sampled for either assemblage due

to the channel having insufficient flow. (AUID 07040004-795 was not assessed in during the 2014, assessment cycle because insufficient data was available for assessment.)

MSHA habitat score at 04LM066 was good (80.2). The one time chemistry grab sample collected during the fish visit in June suggest elevated levels of nitrogen (14 mg/L). Additional measures should be taken in the future to obtain new fish and macroinvertebrate data on Pine Island Creek (07040004-576) to better understand Pine Island Creek's current conditions. MNDNR data suggests Pine Island Creek may have coldwater potential downstream of MPCA station 04LM066. MNDNR stocked brook trout in Pine Island Creek in 2014 and planned to stock again in 2015. Additional temperature monitoring should be conducted to identify the true thermal potential nature of the stream and where the transition from warm to coldwater occurs.

Zumbro River (07040004-506, 07040004-504, 07040004-502)

Few water chemistry data have not been collected on AUID 07040004-506 and 07040004-504 on the Zumbro River. An aquatic recreation impairment observed on downstream AUID 07040004-502 in Hammond suggest upstream impairments for *E. coli* likely follow the Zumbro River downstream from the Zumbro River's three primary branches through AUIDs 07040004-506 and 07040004-504 and onto downstream AUID 07040004-502. The outlet station for this subwatershed is located in the City of Hammond, on the Zumbro River. The AUID (07040004-502) crosses the aggregated HUC-12 boundary to the east and runs to the West Indian Creek confluence in the Lower Zumbro River Subwatershed. The Zumbro River (07040004-502) was previously listed for a fecal coliform bacteria impairment in 2004, which applies to both subwatersheds that this AUID runs through. Data collected at the outlet station (S003-772) were inconclusive to determine if the impairment still exists. Monthly geometric mean calculations are very near the standards of 126 MPN/100mL. Additional monitoring for bacteria is recommended to determine whether the impairment persists or if a delisting should be pursued.

Biological monitoring results across all 3 AUIDs in the Upper Zumbro River Subwatershed demonstrate that both fish and macroinvertebrates are meeting their designated uses for Aquatic Life, despite receiving water from several upstream subwatersheds all impaired for macroinvertebrates, turbidity and *E. coli*. 2012 MPCA FIBI results are very good ranging from 61-86.1 across the subwatershed, with several samples exceeding exceptional use thresholds; communities are diverse and represent healthy aquatic communities. Temporal improvements in fish communities are evident when comparing 2002 MNDNR results to MPCA 2012 results. Macroinveretbrate communities are healthy across the watershed but show a slight drop in score at the middle station 12LM020 on AUID 07040004-504. Habitat scores are good across the subwatershed but show a downward trend moving downstream in the subwatershed. Dissolved oxygen data gathered at the outlet chemistry station on AUID 07040004-502 show concentrations periodically dipping below the 5 mg/L standard, but continuous monitoring data did not show the same magnitude of DO sag. As aquatic communities were in good health; and the chemistry data were determined to be insufficient and the AUID was assessed as fully supporting of AQL use.

Insufficient TSS and Secchi data were available to assess on upstream AUIDs (07040004-506 and 07040004-504) but met standards at downstream AUID 07040004-502. This might suggest sediment contributions from the South Fork and Middle Fork Zumbro Subwatersheds are being deposited within Lake Shady. Additional TSS and Secchi monitoring could be conducted to fill in data gaps. All other conventional chemistry parameters for this AUID met the use class standards, where they exist (Table 50). (Biological data gathered downstream of the subwatershed on 07040004-502 will be discussed in the Lower Zumbro River Subwatershed summary section.)

Unnamed Creek (Hammond Creek) (07040004-575)

An E. coli bacteria impairment is proposed in an unnamed cold water creek in Hammond, Minnesota (Hammond Creek); as such, this AUID does not support AQR and may pose a risk to human health through bodily contact. Chemistry data on Hammond Creek were insufficient to determine a support status for AQL use. MPCA did not collect biological data on Hammond Creek due to relatively close proximity to the Zumbro River and its relatively small drainage area of splitting branches further upstream in the watershed. Measures should be taken to monitor Hammond Creek during the second round of IWM sampling to broaden our understanding of this coldwater system.

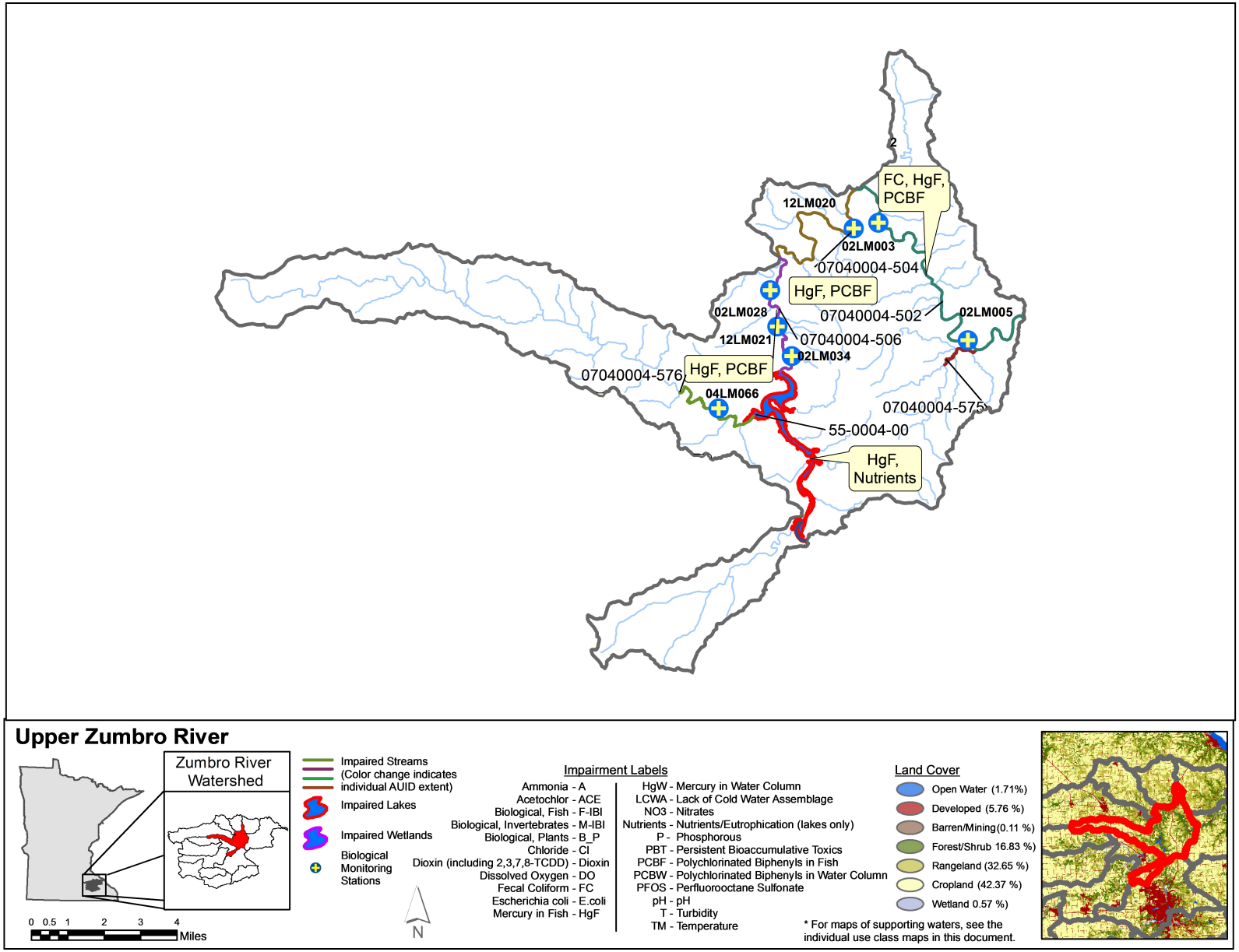

Figure 39. Currently listed impaired waters by parameter and land use characteristics in the Upper Zumbro River Subwatershed.

Spring Creek Subwatershed HUC 0704000405-02

The Spring Creek Subwatershed is located in the northeastern region of the Zumbro Watershed; Spring Creek is a direct tributary to the mainstem Zumbro River in the Lower Zumbro River Subwatershed 3 miles west of the small community of Theilman. The watershed drains nearly 64 mi^2 of north central Wabasha County. Spring Creek is one of the more heavily forested subwatersheds within the Zumbro River drainage at 12%. Similar to the other subwatersheds within the Zumbro, agriculture is commonplace across the watershed; nearly 46% of the land use is pastured for livestock, while 38% is tilled for agriculture. Only 4% of the watershed is developed. The subwatershed's landscape dramatically transitions from flat prairie uplands to steep gradients of rugged hills, a common feature of southeastern Minnesota's karst landscape. These features provide for perfect conditions for the formation of coldwater streams found within the Spring Creek Subwatershed. Both Spring Creek and West Albany Creek are home to brown trout populations. The intensive water chemistry monitoring station is collocated with 12LM001. There are no lakes within the subwatershed.

Table 52. Aquatic life and recreation assessments on stream reaches: Spring Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
													Eutrophication			
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Phosphorous	Response Indicator		
07040004-568, ***Spring Creek***, *Unnamed cr to Unnamed cr*	12LM018	4.19	CWg	MTS	EXS	NA	NA	--	--	NA	--	--	IF	--	IMP	IF
07040004-769, ***Unnamed creek (Spring Creek Tributary)***, *T110 R12W S28, south line to Spring Cr*		0.60	CWg	--	--	IF	--	EX	--	NA	--	--	IF	--	IMP	IMP
07040004-570, ***Spring Creek***, *Unnamed cr to Zumbro R*	12LM001	1.96	CWg	EXP	MTS	IF	EX	EX	MTS	MTS	MTS	--	IF	--	IMP	IMP
07040004-569, ***West Albany Creek***, *T110 T13W S23, north line to Spring Cr*	12LM019	7.78	CWg	MTS	MTS	NA	NA	NA	--	NA	--	--	IF	--	SUP	IF

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

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

Table 53. Minnesota Stream Habitat Assessment (MSHA): Spring Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM018	Spring Creek	2.5	6	19.7	8	22	58.2	Fair
1	12LM019	Trib. to Spring Creek	5	11.5	19.95	7	19	62.45	Fair
1	12LM001	Spring Creek	2.5	5	13.9	8	10	39.4	Poor
Average Habitat Results: *Spring Creek Subwatershed*			**3.33**	**7.5**	**17.85**	**7.67**	**17**	**53.35**	**Fair**

Qualitative habitat ratings

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

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

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

Table 54. Channel Condition and Stability Assessment (CCSI): Spring Creek subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM018	Spring Creek	16	17	28	5	66	Moderately unstable
1	12LM019	Trib. to Spring Creek	14	13	10	3	40	Fairly stable
1	12LM001	Spring Creek	15	15	28	3	61	Moderately unstable
Average Stream Stability Results: *Spring Creek Subwatershed*			**15**	**15**	**22**	**3.67**	**55.67**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 55. Outlet water chemistry results: Spring Creek subwatershed.

Station location:	**Spring Creek;** CSAH-11, 3 MI NW of Theilman, MN						
STORET/EQuIS ID:	**S006-082**						
Station #:	**12LM001**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2A) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	11	0.5	5.3	2.5	16	0
Chloride	mg/L	12	6.8	29.8	9.4	230	0
Dissolved Oxygen (DO)	mg/L	20	4.79	9.40	6.39	7	16
pH		20	7.5	8.4	8.1	6.5 - 8.5	0
[1]Secchi Tube	100 cm	31	7	100	86	> 55	3
Total suspended solids	mg/L	12	3	102	17	< 10	3
Escherichia coli (geometric mean)	MPN/100ml	2	521	675	- -	126	2
Escherichia coli	MPN/100ml	15	269	5143	1140	1260	5
Chlorophyll-a, Corrected	µg/L	0	- -	- -	- -	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	12	2.0	4.3	2.4	- -	
Kjeldahl nitrogen	mg/L	13	0.30	0.81	0.34	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	0	- -	- -	- -	- -	
Phosphorus	µg/L	13	37	390	94	- -	
Specific Conductance	µS/cm	20	438	682	564	- -	
Temperature, water	deg °C	20	7.83	21.80	14.98	- -	
Sulfate	mg/L	12	7.4	25.3	10.1	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]**Secchi Tube** standards are surrogate standards derived from the Total Suspended Solids standard of 10 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Spring Creek subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Spring Creek Tributaries

Unnamed Creek (07040004-769)

This unnamed tributary to Spring Creek lies 1.5 miles west of the Spring Creek confluence with the Zumbro River. A new aquatic recreation impairment (E. coli) was suggested for Unnamed Creek, data collected show consistently elevated bacteria levels which exceeded both the individual and monthly geometric mean standards. A review of Secchi tube data for this Spring Creek tributary also indicate impaired conditions for aquatic life (turbidity). The AUID runs through a dirt bike track which is likely contributing to instream sediment. This will be a priority for addressing sediment/TSS when stressor ID investigates Spring Creek (07040004-570). No biological samples were collected within this AUID. This tributary may be contributing to the poorly performing fish community identified at biological station 12LM001 on Spring Creek (07040004-570).

West Albany Creek (07040004-569)

West Albany Creek is a coldwater tributary of Spring Creek, joining Spring Creek a couple miles upstream of its confluence with the Zumbro River. Biological criteria meet aquatic life standards for both fish and macroinvertebrates. Brown trout were the only coldwater obligates observed during the time of fish sampling. One time grab sample for nitrogen collected in early July are relatively low (2.8 mg/L) compared to other results collected in the Zumbro Watershed. MSHA habitat score is fair (62.45), concerns at the site include excess sedimentation. The presence of beaver activity at the site was noted.

Spring Creek (07040004-568 and 07040004-570)

Spring Creek is a direct coldwater tributary to the Zumbro River. Data collected at the outlet chemistry station (S006-082) are the basis for the new bacteria impairment on Spring Creek (-570). The data show chronically elevated bacteria levels which are likely indicative of problematic conditions existing further up in the watershed. Impairment of aquatic life (macroinvertebrates) is suggested for the upstream AUID of Spring Creek (07040004-568), while an impairment for fish is suggested on Spring Creek's downstream AUID (07040004-570). Upstream station 12LM018 has a relatively weak coldwater macroinvertebrate community and was missing primary taxa typically found in southern coldwater streams, including Gammarus and Brachycentrus. Macroinvertebrate results improve moving downstream on Spring Creek. FIBI scores are similar longitudinally on Spring Creek. The upstream station scores are marginally better than at the downstream impaired reach; both are borderline impairment thresholds. Evidence of natural reproduction of brown trout is present on Spring Creek. MNDNR noted evidence of a naturally reproducing brook trout population upstream of the outlet station on Spring Creek, last observed in 2003. Brown trout, the only coldwater taxa observed during MPCA visits, were last stocked in Spring Creek in the 1980s. The fish communities sampled at both stations show a general dominance of tolerant taxa and communities that suggest warming stream temperatures.

Temperature measurements taken during fish and macroinvertebrate visits indicate that stream temperatures are marginal for coldwater support. Continuous stream temperature loggers were deployed at 12LM018 and 12LM001 in 2012 but were lost post deployment and were unable to be recovered. MNDNR results indicate that temperatures and trout reproduction are potentially limiting factors in Spring Creek. Additional temperature monitoring would be helpful for better understanding of thermal dynamics within Spring Creek and in understanding whether or not temperature is

impacting biological communities. Dissolved oxygen exceedances observed during local partner monitoring conflicted with concurrent continuous data collection and were not used for assessment purposes. Two separate deployments of continuous data collection both indicate that DO is not likely impacting the cold water aquatic communities. At the time of biological monitoring one sample was collected at 12LM001 with a TSS value of 8.4 mg/L. Fourteen additional TSS values from 2012 and 2014 range from 3 mg/L-102 mg/L with an average of 19 mg/L. Of the 13 values, 5 exceed the TSS standard of 10 mg/L for designated coldwater streams. All other conventional water chemistry parameters meet use class standards, where they exist (Table 55).

MSHA habitat scores decrease moving downstream in the watershed. In stream habitat of Spring Creek has been heavily impacted by recent high flow events and upstream agricultural landuse. Outlet station 12LM001 has also likely been impacted by the runoff from upstream motorsports park. These factors have contributed to sedimentation concerns including: heavy bank erosion, dominance of fine substrates, embedded coarse substrates and pools being filled in by upstream sediment load. MNDNR is considering the lower reaches of Spring Creek as a candidate for restoration work. Measures should be taken to control sources of instream sediment to improve overall habitat of Spring Creek.

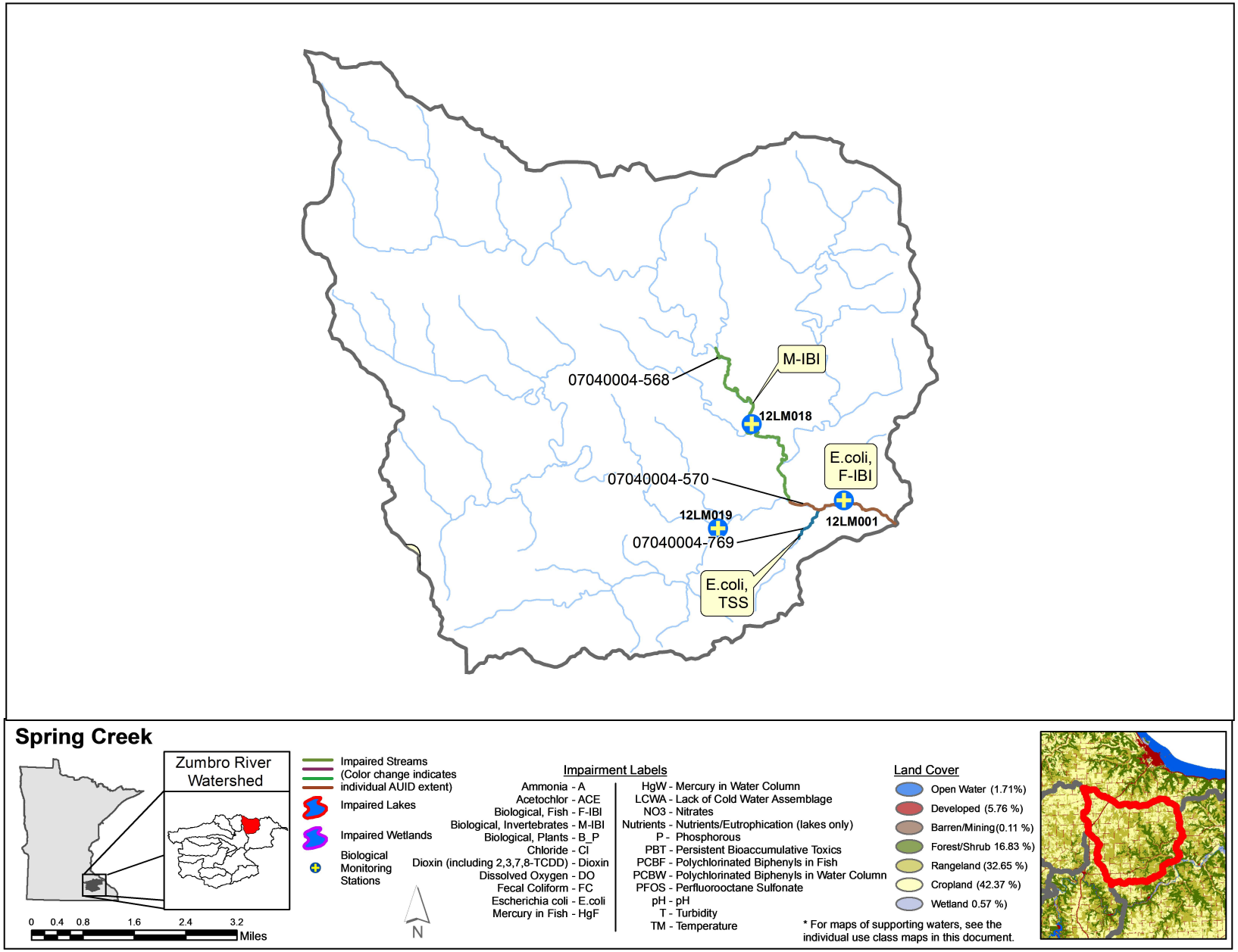

Figure 40. Currently listed impaired waters by parameter and land use characteristics in the Spring Creek Subwatershed.

Lower Zumbro River Subwatershed HUC 0704000405-01

The Lower Zumbro River Subwatershed is the culmination of all of the Zumbro River's many tributaries, comprising 179.5 mi^2 of the Zumbro River HUC 8. The Upper Zumbro River Subwatershed transitions to the Lower Zumbro Watershed downstream of Hammond in south central Wabasha County, the Zumbro River flows northeast through the wide cultivated valleys of steep blufflands in route to its confluence with the Mississippi River near Kellogg. Several miles of channelization and levee construction along the lower reaches of the mainstem below Kellogg have been completed to control flooding of agricultural lands near the mouth of the river (Waters, 1977). Within the watershed the Zumbro River is characterized as a moderately shallow wide sandy river (MNDNR). Many small coldwater tributaries, emerging from a heavy concentration of natural springs (a product of the karst landscape), join the Zumbro River enroute to the Mississippi within the subwatershed including: Long Creek, Middle Creek, West Albany Creek, West Indian Creek and Trout Brook. Both brown and brook trout populations reside within these streams. The Lower Zumbro is the most heavily forested subwatershed in the Zumbro River drainage encompassing 17% of the surrounding landuse. However, similar to other watersheds in the Zumbro, agricultural uses are far more prevalent: 38.3% cropland and 31.5% rangeland. This subwatershed also has the second greatest percentage of wetlands in Zumbro at a meager 3.5%, much of which is found within the Lower Zumbro River's wide floodplain. Zumbro Bottoms State Forest lies within the watershed and is continually managed for timber production by MNDNR. Four percent

of the watershed is developed, with populations concentrated in the small communities of West Albany, Thielman, Dumfries and Kellogg. The intensive water chemistry monitoring station was located on the downstream side of US HWY 61 near Kellogg. Due to the channelized nature of this portion of the Zumbro River not being indicative of the entire AUID, the biological station and fish contaminants station were located further upstream at biological station 02LM009 at a natural section of the Zumbro River. There are no lakes within the subwatershed.

Table 56. Aquatic life and recreation assessments on stream reaches: Lower Zumbro River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Biological Station ID	Reach Length (miles)	Use Class	Aquatic Life Indicators:											Aquatic Life	Aquatic Rec. (Bacteria)
				Fish IBI	Invert IBI	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	Ammonia -NH_3	Pesticides	Eutrophication			
													Phosphorous	Response Indicator		
07040004-502, ***Zumbro River,*** *Cold cr to West Indian cr*	02LM003**#, 02LM005**#, 02LM006#, 10EM107	24.21	WWg	MTS	MTS	IF	IF	MTS	--	MTS	--	MTS	--	--	SUP	IF
07040004-565, ***Long Creek***, *T109 R12W S28, south line to Zumbro R*	12LM016	8.94	CWg	MTS	MTS	NA	NA	IF	--	MTS	--	--	IF	--	SUP	IMP

07040004-567, ***Middle Creek***, *T109 T11W S18, south line to Zumbro R*	12LM015	4.88	CWg	MTS	MTS	IF	NA	IF	--	IF	--	--	IF	--	SUP	IMP
07040004-542, ***West Indian Creek***, *T109 R11W S21, south line to T109 R11W S6, north line*	12LM014	6.52	CWg	MTS	MTS	IF	EXS	EXS	--	MTS	--	--	IF	--	SUP	IMP
07040004-501, ***Zumbro River***, *West Indian Cr to Mississippi R*	02LM007#, 02LM008#, 04LM137, 02LM009, 02LM035#	23.93	WWg	MTS	MTS	MTS	EXS	EXS	MTS	MTS	MTS	--	IF	--	IMP	IF
07040004-571, ***Trout Brook***, *T110 R11W S5, west line to T110 R11W S8, east line*		2.10	CWg	--	--	NA	--	IF	--	NA	--	--	IF	--	IF	IMP
07040004-584, ***Trout Brook***, *T110 R11W S9, west line to Hope Coulee*	12LM013	2.46	WWg	MTS	NA	NA	NA	--	--	NA	--	--	IF	--	SUP	IF
07040004-585, ***Trout Brook***, *Hope Coulee to Zumbro R*	12LM012*	1.35	WWm	EXS	EXS	NA	NA	--	--	NA	--	--	IF	--	IMP	IF

Abbreviations for Indicator Evaluations: **MTS** = Meets Standard; **EXS** = Fails Standard; **IF** = Insufficient Information; **--** = No Data

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

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

Abbreviations for Use Class: **WWg** = warmwater general, **WWm** = Warmwater modified, **WWe** = Warmwater exceptional, **CWg** = Coldwater general, **CWe** = Coldwater exceptional, **LRVW** = limited resource value water

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

**Biological station is located in Upper Zumbro River Subwatershed and shares an AUID with biological station 02LM006 and 10EM107, for additional information on this station see Upper Zumbro River Subwatershed.

MNDNR data used as supporting information, not assessed.

Table 57. Minnesota Stream Habitat Assessment (MSHA): Lower Zumbro River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	12LM016	Long Creek	2.5	12	22	15	34	85.5	Good
1	10EM107	Zumbro River	2.5	9.5	19.65	12	25	68.65	Good
1	12LM015	Middle Creek	5	13	4.3	7	23	52.3	Fair
1	12LM014	West Indian Creek	4.25	6.5	17.4	13	23	64.15	Fair
2	04LM137	Zumbro River	3.75	8	19	7	25.5	63.25	Fair
1	12LM013	Trout Brook	2.5	0	16.1	7	17	42.6	Poor
1	12LM012	Trout Brook	2.5	8	16	1	1	28.5	Poor
2	02LM009	Zumbro River	5	10.5	14.5	7.5	15	52.5	Fair
Average Habitat Results: *Lower Zumbro River Subwatershed*			**3.5**	**8.44**	**16.12**	**8.69**	**20.44**	**57.18**	**Fair**

Qualitative habitat ratings

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

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

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

Table 58. Channel Condition and Stability Assessment (CCSI): Lower Zumbro River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	12LM016	Long Creek	8	15	6	3	32	Fairly stable
1	10EM107	Zumbro River	18	11	22	3	54	Moderately unstable
1	12LM015	Middle Creek	18	19	22	3	62	Moderately unstable
1	12LM014	West Indian Creek	10	11	18	3	42	Fairly unstable
1	04LM137	Zumbro River	16	13	24	7	60	Moderately unstable
1	12LM013	Trout Brook	20	19	28	5	72	Moderately unstable
1	12LM012	Trout Brook	25	19	32	7	83	Severely unstable
1	02LM009	Zumbro River	16	13	28	7	64	Moderately unstable
Average Stream Stability Results: *Lower Zumbro River Subwatershed*			**16.38**	**15**	**22.5**	**4.75**	**58.63**	**Moderately unstable**

Qualitative channel stability ratings

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

Table 59. Outlet water chemistry results: Lower Zumbro River Subwatershed.

Station location:	**Lower Zumbro River;** on CSAH-30 at Kellogg, MN						
STORET/EQuIS ID:	**S000-816**						
Station #:	**02LM035**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**(2B) WQ Standard[1]**	**# of WQ Exceedances****
Ammonia (Unionized)	µg/L	9	0.1	20.796	5.56	40	0
Chloride	mg/L	12	7.4	33.8	27.0	230	0
Dissolved Oxygen (DO)	mg/L	20	3.48	9.84	5.29	5	7
pH		20	7.1	9.4	8.4	6.5 - 9	1
[1]Secchi Tube	100 cm	20	2	100	65	> 10	2
Total suspended solids	mg/L	12	5	824	94	< 65	1
Escherichia coli (geometric mean)	MPN/100ml	2	66	68	- -	126	0
Escherichia coli	MPN/100ml	15	28	2420	274	1260	1
Chlorophyll-a, Corrected	µg/L	17	1	44	11	- -	
Inorganic nitrogen (nitrate + nitrite)	mg/L	18	2.3	8.9	4.9	- -	
Kjeldahl nitrogen	mg/L	17	0.03	3.84	0.61	- -	
Orthophosphate	µg/L	0	- -	- -	- -	- -	
Pheophytin-a	µg/L	17	1	5	2	- -	
Phosphorus	µg/L	17	38	1000	147	- -	
Specific Conductance	µS/cm	20	383	610	557	- -	
Temperature, water	deg °C	20	11.30	26.19	20.77	- -	
Sulfate	mg/L	12	9.7	22.0	19.1	- -	
Hardness	mg/L	0	- -	- -	- -	- -	

[1]Secchi Tube standards are surrogate standards derived from the Total Suspended Solids standard of 65 mg/L.

****Data found in the table above are compiled using the results from data collected at the outlet monitoring station in the Lower Zumbro River subwatershed, a component of the IWM work conducted between May and September from 2012 and 2013. These specific data do not necessarily reflect all data that were used to assess the AUID.**

Summary

Zumbro River (07040004-502 and 07040004-501)

The upstream AUID (07040004-502) on the Zumbro River in the Lower Zumbro River Subwatershed begins in the Upper Zumbro River Subwatershed's boundaries and crosses into the Lower Zumbro River Subwatershed; further discussion on biology and chemistry stations occurring on the portion of the AUID in the Upper Zumbro Subwatershed can be found in the Upper Zumbro River Subwatershed section in this report.

The Lower Zumbro River has previously listed AQR impairments for fecal coliform bacteria on both of its AUIDs (07040004-502 and 07040004-501). Recent bacteria data for both reaches were inconclusive to determine if the impairments are still present; additional monitoring is needed to determine if the listings are still appropriate, or if delisting(s) should be pursued. Downstream AUID 0704004-501 was also previously listed for turbidity; new TSS data confirm the impaired conditions do still exist. Dissolved oxygen (DO) data show concentrations dipping below the 5 mg/L standard; however, the dataset was large enough to outweigh limited exceedances. As such, DO meet the standard and is likely not impacting the aquatic life use. All other conventional chemistry parameters meet the use class standards, where they exist (Table 59).

No new aquatic life impairments are proposed at this time. Fish meet biocriteria on the Zumbro River in this subwatershed. Lowest scores were observed in the upper reaches of the subwatershed at MPCA biological station 10EM107 and MNDNR stations 02LM006 and 02LM007, suggesting isolated stress in the upstream region within the subwatershed. Results improve moving further downstream, exceeding upper confidence limits.

Macroinvertebrate results are below biocriteria at 10EM107 and 04LM137 (during both 2004 and 2012 visits) but improve, meeting bio criteria at downstream station 02LM009. Station 10EM107 was sampled once in 2010; its community assemblage is quite similar to results seen upstream on the AUID in the Upper Zumbro River subwatershed at 02LM005, except for an abundance of a very tolerant taxon at 10EM107 (tricorythodes (mayfly)). This is dragging down the MIBI score, despite the presence of two intolerant taxa. Both sites have Tier 4 communities, suggesting that there has been a noticeable change to the structure and function of the community but not enough to suggest an impaired condition.

MSHA scores decrease moving downstream on the Zumbro River. Decreases in scores are the result of increasing levels of fine sediments that are observed moving downstream on the Zumbro River; presently coarse substrates are severely embedded. An overabundance of sediment in the system has diminished habitat availability in the lower reaches of the Zumbro River.

Crystal darter, a state endangered species in Minnesota, were captured on the lowest station on the Zumbro River during MPCA monitoring in 2012. It is among the rarest of Minnesota's darter species and is particularly sensitive to siltation, requiring clear fast-flowing rivers (MNDNR, 2016). Population declines have occurred across much of the species range from activities such as channelization, dredging and impoundments that have altered stream velocities and resulted in sediment loading. Dams have also impacted the species by reducing the amount of suitable habitat and isolating populations (MNDNR, 2016).

Long Creek (07040004-565)

Long Creek is a direct coldwater tributary of the Zumbro River, draining 28.5 mi.^{2} of the subwatershed. A new aquatic recreation (E. coli bacteria) impairment is proposed on Long Creek. Monthly geometric mean calculations for all AUIDs show chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Secchi tube measurements exceed the regional standard often enough to suggest that suspended solids may be a problem. However, both fish and macroinvertebrates meet their designated uses, as such aquatic life will not be listed for Long Creek at this time. FIBI results were above the EU threshold. Coldwater obligates sampled include both brown and brook trout, young of year individuals were sampled for both species indicating natural reproduction or evidence of recent stocking. The MSHA habitat score was excellent (85.8). One time grab samples for nitrogen collected in July are fairly low for the Zumbro Watershed and do not indicate nitrogen stress. Continuous temperature monitoring data collected in 2012 suggest that the streams coldwater obligate species are not being stressed by warm temperatures, July average temperatures were 15.7 ^{o}C with a maximum July temperature reading of 17.2 ^{o}C. MIBI scores are just above the impairment threshold, measures should be taken to insure macroinvertebrate communities do not degrade further. Implementing a protection strategy to control suspended sediment in Long Creek could help insure that the macroinvertebrate community continues to meet aquatic life standards.

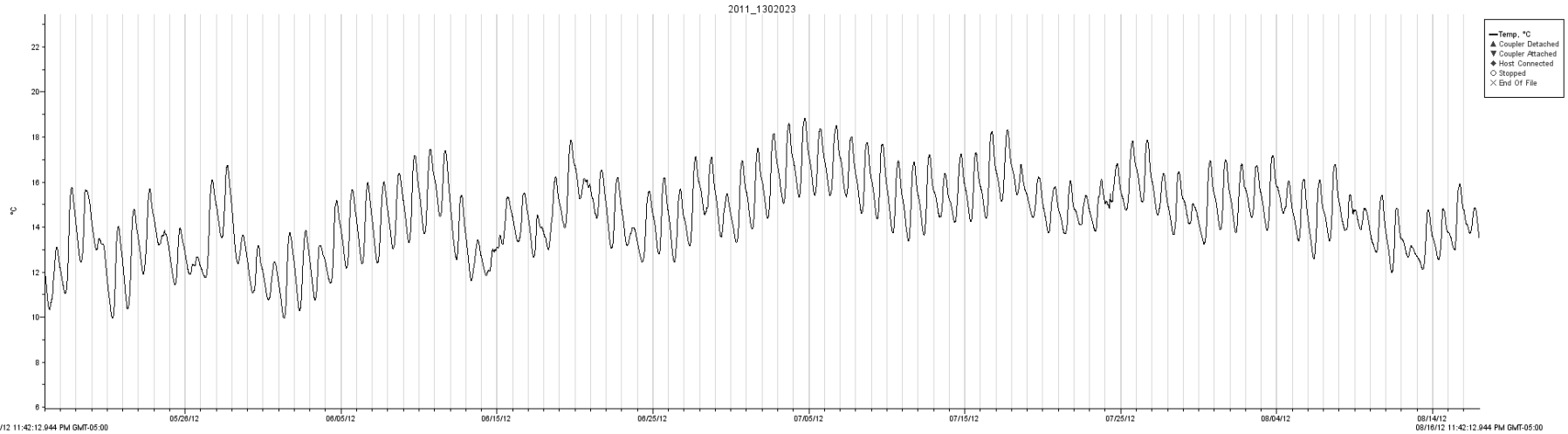

Figure 41. Continuous temperature monitoring data for Long Creek for the summer of 2012 at MPCA biological station.

Middle Creek (07040004-567)

Middle Creek is a small direct coldwater tributary to the Zumbro River, draining roughly 13 mi.^{2} of the subwatershed, joining the Zumbro River just downstream of Long Creek's confluence. A new aquatic recreation impairment is proposed on Middle Creek for *E. coli* bacteria. Monthly geometric mean calculations show chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Biological sampling occurred in 2012, on Middle Creek at station 12LM015. Both fish and invertebrates met biocriteria and full support is recommended for aquatic life. The FIBI score is one of the highest observed within the watershed at 96.5, rising well above an exceptional use threshold. The fish community was dominated by coldwater obligates brook trout and brown trout, young of year individuals were sampled for brook trout indicating natural reproduction or evidence of recent stocking. In contrast, MIBI results are only slightly above impairment thresholds and are teetering towards impairment, although a strong

coldwater community is still present. One time grab samples for nitrogen collected in July are fairly low for the Zumbro Watershed and do not indicate nitrogen stress. Continuous temperature monitoring data collected in 2012 suggest that the streams coldwater obligate species are not being stressed by warm temperatures; July average temperatures were 14.7 °C with a maximum July temperature reading of 16.3 °C. MSHA habitat score was fair;substrates in reach are dominated by silt and coarse substrates are severely embedded where present and sparse fish cover was available within the reach. Measures should be taken to insure that macroinvertebrate communities do not continue to degrade.

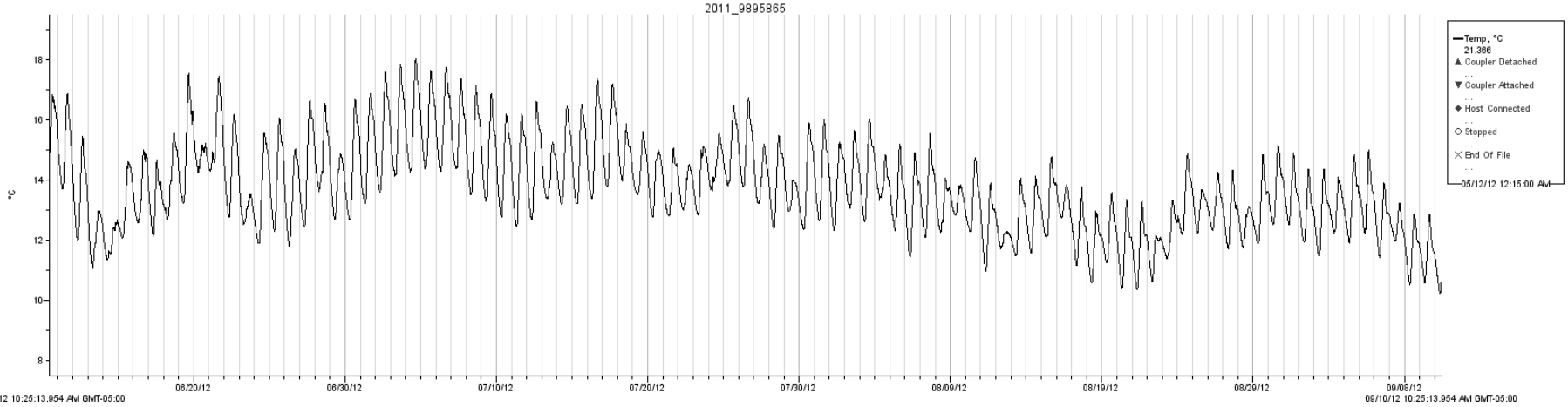

Figure 42. Continuous temperature monitoring data for 2012 on Middle Creek at biological station 12LM015.

West Indian Creek (07040004-542)

West Indian Creek is a small coldwater tributary that flows into the Zumbro River just downstream of Theilman, draining 24 mi.^{2} of the subwatershed. A new aquatic recreation impairment (*E. coli* bacteria) is proposed on West Indian Creek. Monthly geometric mean calculations for all AUIDs show chronically elevated bacteria levels which may pose a risk to human health through bodily contact. Secchi tube and TSS data indicate that West Indian Creek has a new AQL impairment. In contrast, both fish and macroinvertebrates meet bio criteria and are supporting for aquatic life; as such, aquatic life will not be listed at this time. FIBI exceeds upper confidence interval and the exceptional use threshold. While brown trout, brook trout and slimy sculpin were sampled, brown trout dominate the population. The presence of several warm/cool water species suggest some potential warming within the stream or other degradation. MIBI score is above upper confidence limits at 12LM014, with a strong coldwater community present at the time of sampling. MSHA habitat score is rated as fair, in part because of a narrow riparian zone and a lack of shade present in the reach. One time grab samples for nitrogen collected in July are fairly low for the Zumbro Watershed and do not indicate nitrogen stress. Measures should be taken to reduce levels of suspended sediment within West Indian Creek and to maintain the high quality macroinvertebrate community within West Indian Creek.

Trout Brook (07040004-571, 07040004-584, 07040004-585)

Trout Brook is a direct tributary to the Zumbro River joining the river just east of Dumfries. It is designated as coldwater in its upper reaches but transitions to warmwater in its lower reaches before it empties into the Zumbro River. Questions arose during the assessment process questioning whether or not the coldwater transition delineation was accurate due to coldwater obligate macroinvertebrate and fish taxa (brook trout) being sampled at 12LM013, AUID 07040004-584 (currently designated warmwater). Biological data may suggest either some thermal degradation and a shift towards a warmwater community or a coolwater transitional zone in Trout Brook. Unfortunately, continuous temperature monitoring sensors deployed on Trout Brook in 2012, were unable to be recovered during retrieval process. Additional temperature monitoring should be conducted to better understand the true thermal dynamics of the Trout Brook system and update AUIDs with appropriate cold or warmwater use designations. Future monitoring on Trout Brook should include sampling AUID 07040004-571 to determine whether or not biology are meeting aquatic life use parameters within the current coldwater designated reach.

FIBI results decreased moving downstream in the watershed while macroinvertebrate results do the opposite (when comparing the results to a warmwater IBI). A new aquatic life impairment (fish) is proposed on the downstream reach of Trout Brook. Little diversity is present at the site and the fish community is dominated by two tolerant species (bigmouth shiner and white sucker). The macroinvertebrate community meets biocriteria despite this and present taxa suggest a coldwater influence.

MSHA habitat scores are poor at both stations and decrease moving downstream in the watershed. In the lower reach the stream was historically channelized but has not been maintained for many years. Here the reach is ubiquitous in nature, channel type is comprised entirely of run, with little depth variability and is dominated by sand. A lack of potential habitat led the AUID to be assessed as a modified use during the 2014 assessment cycle. Similar to other streams in the Zumbro River, karst topography influences perennial stream flow on Trout Brook. In dry years Trout Brook has a tendency to shift to subterranean flow, reemerging downstream before entering the Zumbro River (MNDNR). It is not well understood whether or not these conditions are a natural phenomenon in Trout Brook or if they could be a result of past channel alteration downstream of Hwy 60 or past flooding events that have loaded the reaches of Trout Brook with vast quantities of sediment (sand).

In addition, a new aquatic recreation (*E. coli* bacteria) impairment is proposed on Trout Brook (07040004-571). Monthly geometric mean calculations show chronically elevated bacteria levels which may pose a risk to human health through bodily contact.

Figure 43. Photographs taken during biological visits on Spring Creek, upstream station 12LM013 (left) and downstream station 12LM012 (right).

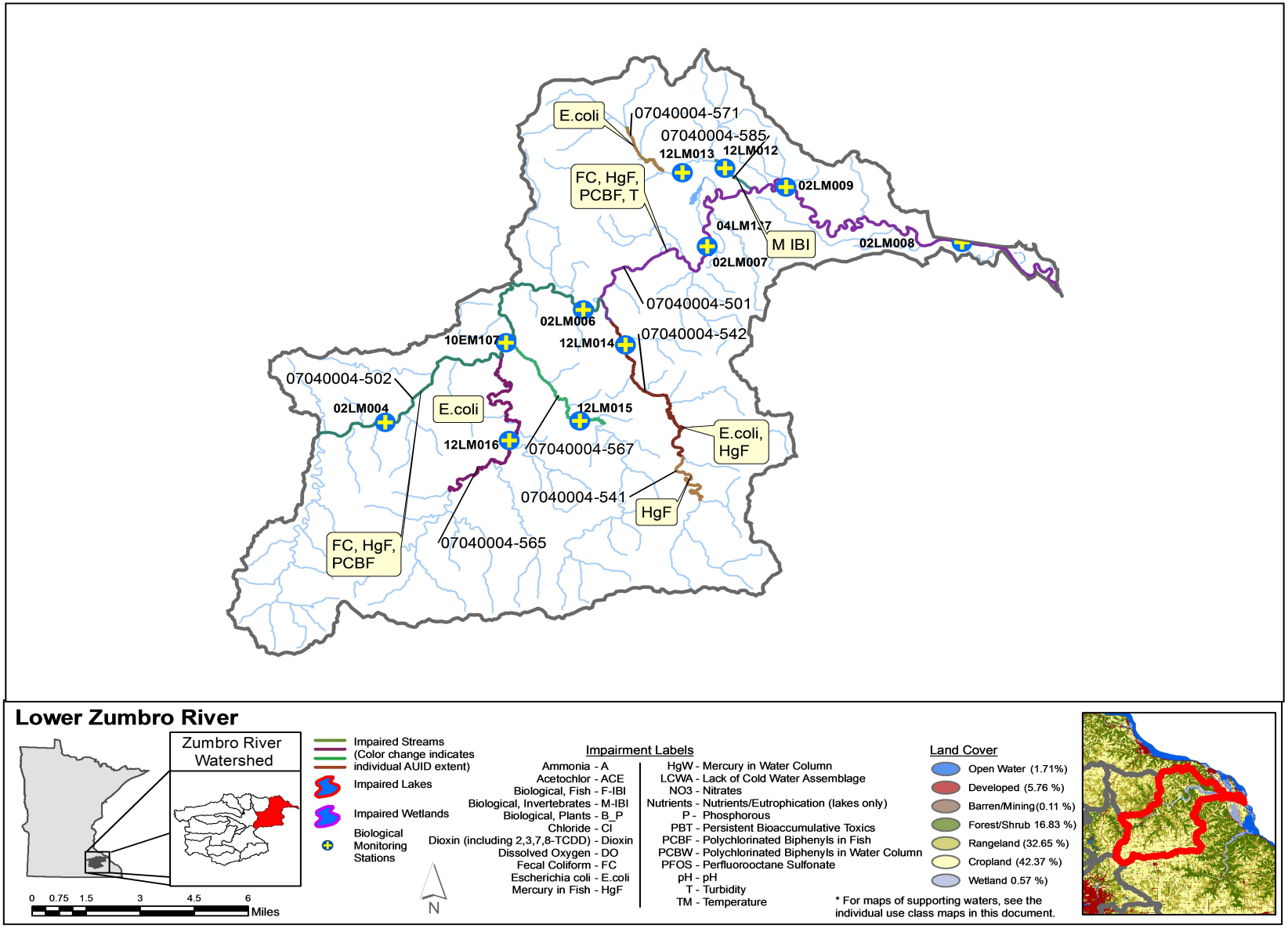

Figure 44. Currently listed impaired waters by parameter and land use characteristics in the Lower Zumbro River Subwatershed. *AUID 07040004-502 crosses from the Upper Zumbro River subwatershed into the Lower Zumbro River subwatershed and is reported on in the Upper Zumbro River subwatershed section.

Watershed-wide results and discussion

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

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

Pollutant load monitoring

The Zumbro River is monitored on State Highway 61 at Kellogg, Minnesota, approximately 5 river miles above the confluence with the Mississippi River. Many years of water quality data from throughout Minnesota combined with the previous analysis of Minnesota's ecoregion patterns, resulted in the development of 3 "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA 2013). Of the state's three RNRs (North, Central, South), the Zumbro River's monitoring station is located within the South RNR for TSS and Central RNR for TP.

Annual flow weighed mean concentrations (FWMCs) were calculated for years 2010-2012, (Figure 45, Figure 46, Figure 47, Figure 48) and compared to the RNR standards (only TP and TSS standards are available for the South and Central RNR). It should be noted that while a FWMC exceeding water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent 10-year period and not based on comparisons with FWMCs (MPCA, 2014). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes and other watershed factors. However, as a general rule, elevated levels of total suspended solids (TSS) and nitrate + nitrite nitrogen (NO_3 + NO_2-N) are regarded as "non-point" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP) can be attributed to both "non-point" as well as "point" or end of pipe sources such as industrial or waste water treatment plants. Major "non-point" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as: vegetative canopy development, soil conditions (frozen/unfrozen saturation level, etc.) and precipitation type, intensity and amount. Surface erosion and instream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development when compared to post-canopy events where soils are more protected and less surface runoff and more infiltration occur. Precipitation type and intensity can influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater or through artificial agricultural and urban drainage networks. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between storm and temporal differences in instream pollutant concentrations. Pollutant loads, the product of concentration and flow, are influenced not only by instream pollutant concentrations but also the volume of runoff delivered to the

stream. During years when high intensity rain events provide the greatest proportion of total annual runoff, FWMCs of TSS tend to be higher and DOP and NO_3+NO_2-N concentrations tend to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS FWMCs tend to be lower while DOP and NO3+NO2-N levels tend to be elevated. Total phosphorus concentrations can be high from both runoff sources although storm generated runoff will typically have a greater proportion of sediment bound phosphorus resulting in lower DOP/TP ratios when compared to snowmelt runoff. Years with larger runoff volumes will typically have larger loads when compared to years with lesser runoff volumes. Figure 45 for example, shows the 2010 TSS load to be approximately 13 times higher than the previous year's load, largely because of differences in runoff volume.

During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS tend to be higher while DOP and NO_3 + NO_2-N concentrations are generally lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while NO_3 + NO_2-N and DOP concentrations are more apt to be elevated. Total phosphorus levels can be high from runoff sources. However, storm generated runoff is typically higher in sediment bound phosphorus resulting in lower DOP/TP ratios when compared to snowmelt runoff.
Water clarity refers to the transparency of water. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

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

Minnesota's water quality standards for river eutrophication and total suspended solids were adopted into State Rule ch 7050 in 2014 and approved by the EPA in January 2015. Within the South RNR, a river is considered impaired when greater than 10% of the individual samples exceed the TSS standard of 65 mg/L (MPCA 2011). From 2010 through 2012, 47, 56 and 45% of the samples from the Zumbro River at Kellogg exceeded the 65 mg/L standard, respectively. The computed FWMCs also exceeded the 65 mg/L standard (Figure 45) during all 3 years. On September 25, 2010 the greatest flood of record occurred for this site with a daily average discharge of over 44,000 cfs recorded. The daily average discharge on the day preceding and following the record flow were each approximately half the peak value, demonstrating the flashy hydrologic nature of this system. This event alone accounted for approximately 61% of the annual TSS load in 2010. Interestingly, snowmelt runoff during March 2010 also accounted for approximately 21% of the annual load and when combined with the September event, approximately 82% of the annual load passed through in a 30 day time frame.

The highest annual TSS FWMC of the three-year period was in 2012. Over the 3 year period, the two highest TSS sample concentrations (3,800 and 3,900 mg/L) were also collected in 2012 following high intensity rain events in early May. These high flow events accounted for approximately 47% of the annual load. Data from 2011 show a similar pattern with a handful of runoff events during the open canopy season accounting for the majority of the annual sediment load.

Table 60 displays total annual loads with the lowest TSS load recorded in 2012, and the highest recorded in 2010. While nonpoint source pollutant loads are often positively correlated with runoff volume (Figure 45), they are also a function of FWMC's, explaining why 2010, has the highest computed load while having the second highest runoff value.

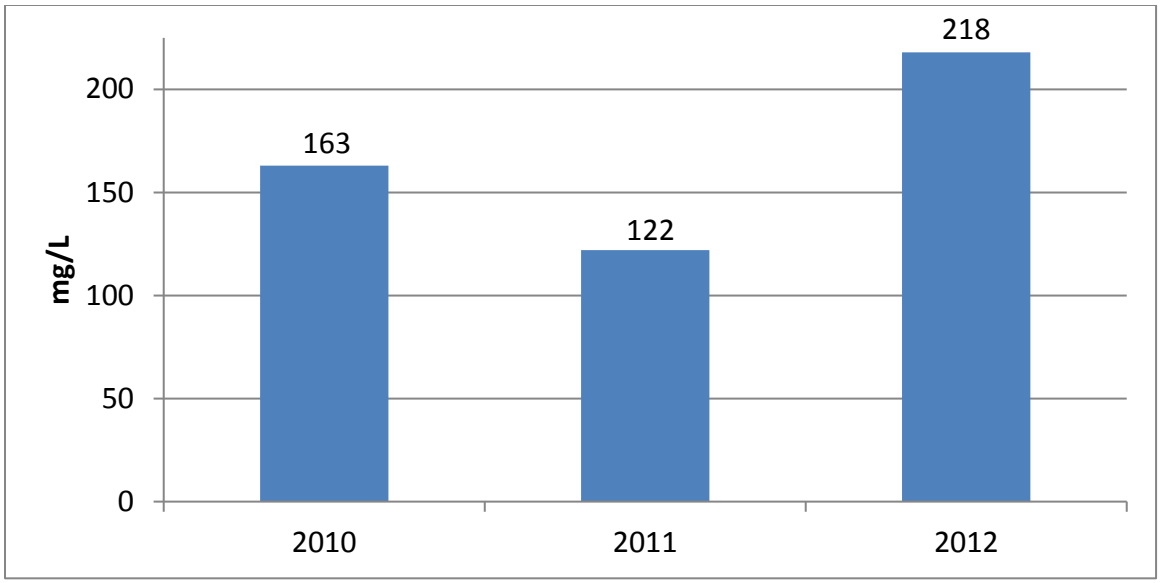

Figure 45. Total Suspended Solids (TSS) flow weighted mean concentrations in the Zumbro River at Kellogg.

Table 60. Annual pollutant loads by parameter calculated for the Zumbro River at Kellogg.

	2010	**2011**	**2012**
Parameter	Mass (kg)	Mass (kg)	Mass (kg)
Total Suspended Solids	197,895,500	159,582,600	138,716,400
Total Phosphorus	421,578	271,839	*
Ortho Phosphorus	239,013	148,915	106,550
Nitrate + Nitrite Nitrogen	6,019,943	8,480,399	3,284,162

*TP was not calculated for 2012 due to laboratory equipment errors.

Total phosphorus

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

Within the Central RNR, the TP standard is 0.10 mg/L as a summer average (June through September). Summer average violations of one or more “response” variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed as impaired. A comparison of the 2010 and 2011 data collected during the summer

averaging period show TP exceedances occurred 81 and 58% of the time, respectively. Both 2010 and 2011 had summer TP means greater than the standard (0.348 mg/L and 0.207 mg/L, respectively). The 2012 total phosphorus data was not included due to analytical equipment errors at the Minnesota Department of Health Environmental Laboratory. Figure 46 illustrates FWMCs greater than the standard, albeit this includes all data throughout the year (not just summer values). Table 60 shows annual loads which exhibit similar traits as the FWMCs. The higher FWMC and load in 2010, are due to the late September storm event when nearly 69% of the annual TP load value passed through the system.

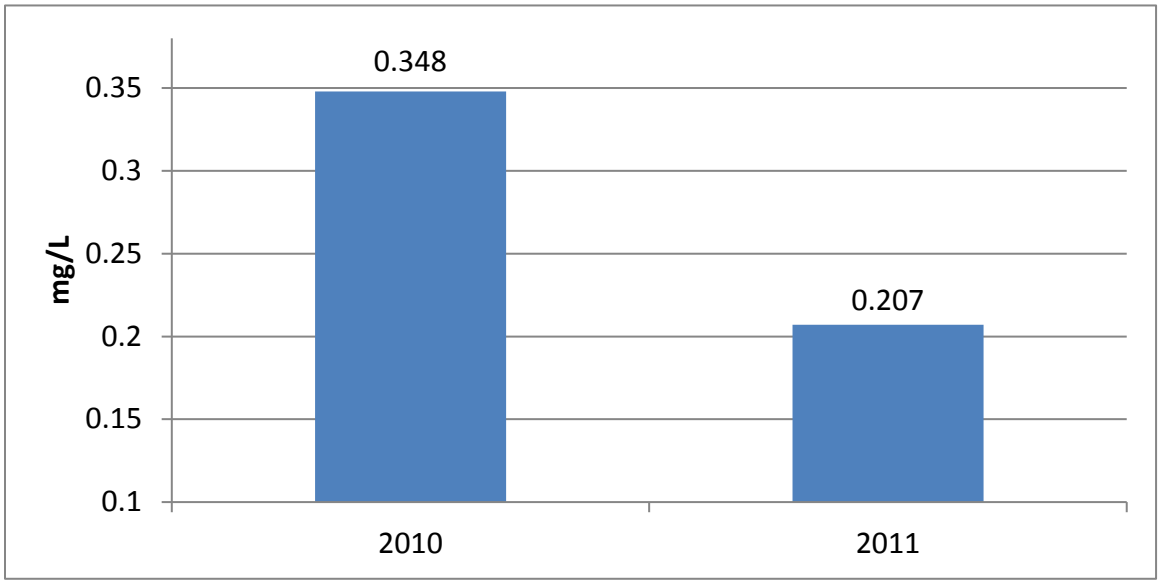

Figure 46. Total Phosphorus (TP) flow weighted mean concentrations for the Zumbro River at Kellogg.

Dissolved orthophosphate

Dissolved orthophosphate (DOP) is a water soluble form of phosphorus that is readily available to algae (bioavailable) (MPCA and MSUM, 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from waste water treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff. Computation of FWMC DOP to TP ratios from 2010 and 2011 show 57 and 55% of TP is in the orthophosphate form, respectively.

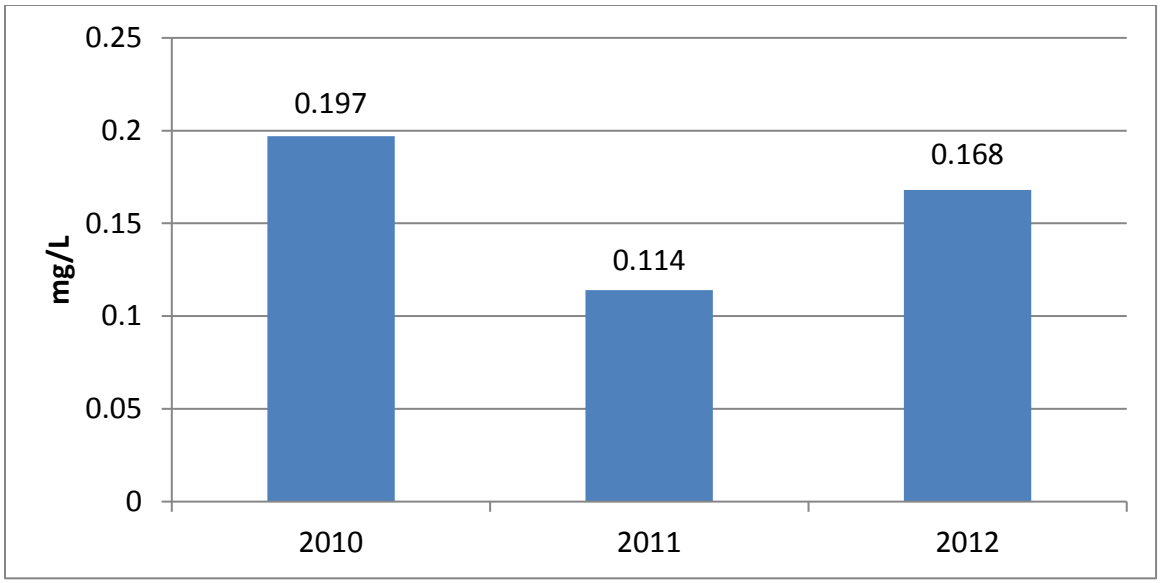

Figure 47. Dissolved Orthophosphate (DOP) flow weighted mean concentrations for the Zumbro River at Kellogg.

Nitrate plus nitrite - nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA, 2013). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-N to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen, with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however, concentrations can vary drastically depending on season, biological activity and anthropogenic inputs. Environmentally, studies have shown that the elevated nitrate-nitrogen levels in the Minnesota River basin contribute to hypoxia (low levels of dissolved oxygen) in the Gulf of Mexico. This occurs by nitrate-nitrogen stimulating the growth of sea algae which, through death and biological decomposition, consume large amounts of dissolved oxygen and thereby threaten aquatic life (MPCA and MSUM, 2009).

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

Figure 48 shows the NO_3 + NO_2-N FWMCs over the 3 year period for the Zumbro River at Kellogg monitoring site. The FWMCs for all 3 years were well below the draft acute standard but above the draft chronic Class 2B standard. In 2010, 2011 and 2012, 63, 81 and 46% of sample concentrations exceeded the draft chronic Class 2B standard, respectively. Table 60 displays annual NO_3 + NO_2-N loads and shows 2011 as having the highest annual load over the 3 year period. As the range in NO_3 + NO_2-N FWMCs is fairly tight for this watershed (5-6.5 mg/L), annual differences in NO_3 + NO_2-N loads can be attributed primarily to annual differences in runoff volume.

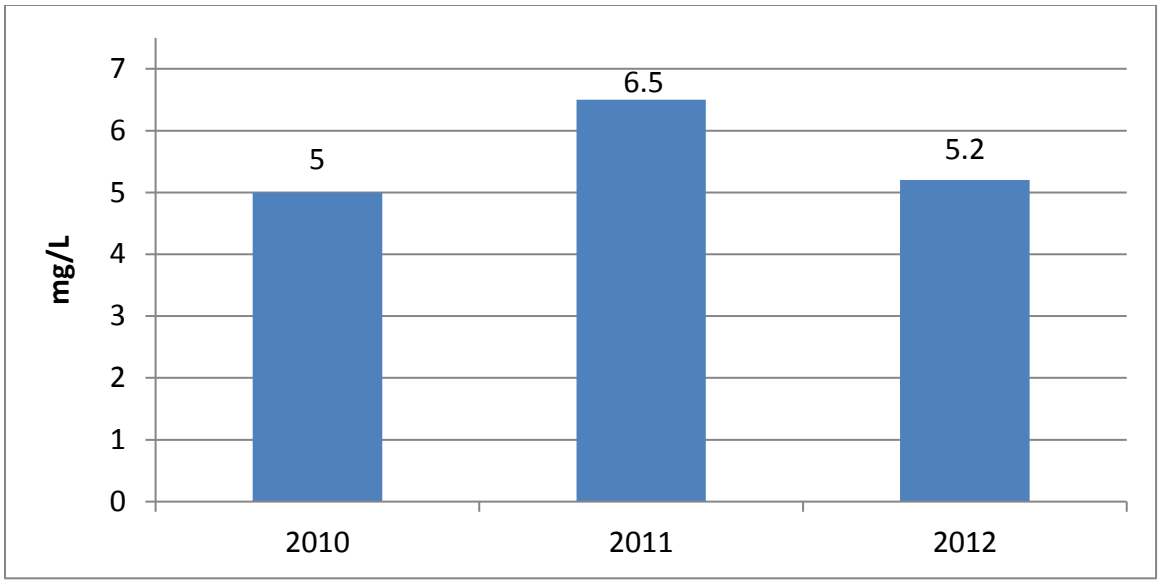

Figure 48. Nitrate + Nitrite Nitrogen (Nitrate-N) flow weighted mean concentrations for the Zumbro River at Kellogg.

Stream water quality

Eighty-two of the 474 stream AUIDs in the Zumbro River Watershed were assessed (Table 61) for aquatic life use, aquatic recreational use or both. Of the assessed streams, only 34 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Two AUIDs were not assessed due to their classification as limited resource waters.

Throughout the watersheds, 54 AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, 37 are non-supporting for aquatic life and 17 are non-supporting for aquatic recreation. Thirteen AUIDs had insufficient information to assess for aquatic life and/or recreational uses.

Six AUIDs previously listed as impaired for aquatic life use due to excessive turbidity are proposed for removal from the 303(d) Impaired Waters List in 2016; 4 AUIDs are list corrections based on new TSS standards while 2 are improvements based on newer data and were found to now be meeting new standards for TSS or Secchi tube.

Table 61. Assessment summary for stream water quality in the Zumbro River Watershed.

				Supporting		Non-supporting			
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	# Delisting's
HUC 8 07040004	**909,440**	**474**	**82**	**34**	**0**	**37**	**17**	**14**	**6**
0704000401-01	84,860	28	9	1	0	5	1	3	2
0704000401-02	52,064	25	8	4	0	3	1	1	3
0704000401-03	49,382	6	4	4	0	0	0	0	0
0704000401-04	39,782	12	4	2	0	2	1	0	0
0704000402-01	80,507	17	7	3	0	2	1	1	0
0704000402-02	57,806	17	6	1	0	4	1	1	0
0704000403-01	19,652	3	3	1	0	2	1	0	0
0704000403-02	82,535	23	7	4	0	3	1	0	0
0704000403-03	37,460	12	2	2	0	0	0	1	1
0704000404-01	117,876	50	12	5	0	7	1	0	0
0704000404-02	35,661	16	1	0	0	1	1	0	0
0704000405-01	114,868	156	7	2	0	4	4	2	0
0704000405-02	40,922	49	5	1	0	3	2	1	0
0704000405-03	66,647	42	6	4	0	0	2	3	0
0704000405-04	29,337	18	1	0	0	1	0	1	0

Lake water quality

There are only 17 lakes/ponds greater than 10 acres in size in the Zumbro River Watershed. Of those 17, only 2 had sufficient data to assess for aquatic recreational standards (Rice Lake 74-0001-00; and Zumbro Reservoir 55-0004-00). Both lakes exceeded the eutrophication standards for the WCBP ecoregion and do not support AQR use.

Table 62. Assessment summary for lake water chemistry in the Zumbro River Watershed.

			Supporting		Non-supporting			
Watershed	Area (acres)	Lakes >10 Acres	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	# Delisting's
HUC 8 0704004	**909,440**	**17**	**0**	**0**	**0**	**2**	**0**	**0**
0704000401-01	84,860	9	0	0	0	0	0	0
0704000401-02	52,064	3	0	0	0	0	0	0
0704000401-03	49,382	1	0	0	0	0	0	0
0704000402-01	80,507	1	0	0	0	1	0	0
0704000405-01	114,868	2	0	0	0	0	0	0
0704000405-03	66,647	1	0	0	0	1	0	0

Fish contaminant results

Twenty fish species from the river and lakes were tested for contaminants. A total of 427 fish were tested between 1977 and 2012. Fish species are identified by codes that are defined by their common and scientific names in Table 63.

Table 64 summarizes contaminant concentrations by waterway, fish species and year. "No. Fish" indicates the total number of fish analyzed and "N" indicates the number of samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish (BGS) and yellow perch (YP). Since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET).

Fish from the Zumbro River were most recently collected in 2012. The mercury concentrations were measured in 5 golden redhorse (GRH) and five smallmouth bass (SMB). The mean concentrations were 0.090 and 0.193 mg/kg, respectively. The highest mercury concentration in an SMB was 0.287 mg/kg, exceeding the 0.2 mg/kg water quality standard for mercury in fish tissue.

All waters that are listed as impaired for mercury or PCBs in fish tissue are identified in Table 64 with a red asterisk (*) for mercury and 2 blue asterisks for PCBs. Willow Reservoir 4 is the only waterway not impaired for mercury. Zumbro River below the Lake Zumbro dam is impaired for PCBs in fish tissue, as well as mercury in fish tissue. Zumbro River went on the Impaired Waters List in 1998 for mercury in fish tissue and the needed reductions addressed in the Statewide Mercury TMDL.

Most of the PCB concentrations in fish tissue from the river were near or below the reporting limit. The highest PCB concentration was 0.100 mg/kg in a walleye from Ten Mile Lake, collected in 1989. A quillback and a carp collected in 2001 had PCB concentrations that exceeded the 0.22 mg/kg threshold for a fish consumption advisory of a meal per month, which led to the river classified as impaired for PCBs in fish tissue on the 2004 Impaired Waters List. Total PCBs concentrations were measured in 2 GRH and 2 SMB from 2001. All 4 fish had PCBs less than the reporting limit (0.025 mg/kg). Lake Zumbro fish have a history of high PCB concentrations. Channel catfish (CHC) were as high as 71 mg/kg in 1977. The last CHC from Lake Zumbro was collected in 2007, and had a PCB concentration of 0.04 mg/kg. Similarly, common carp (C) had a high of 0.96 mg/kg in 1980 and 0.04 mg/kg in 2007.

Perfluorooctane sulfonate (PFOS) concentration is measured in µg/kg (ppb), which is 1000 times' lower units than mercury and PCBs. The impairment threshold is the threshold for a meal per month fish consumption advisory: 200 µg/kg. Rock bass, sauger, and smallmouth bass that were tested in 2010 had measureable levels of PFOS—up to 53.3 µg/kg, indicating they were well below the level for impairment. Fish in Lake Zumbro were tested in 2007 and 2009. All tested fish had levels of PFOS above the reporting limit (~ 5 µg/kg). The highest PFOS concentration, 127 µg/kg, was in a largemouth bass from 2009; still below the impairment threshold.

Overall, the fish contaminant results show PCBs were once very high in Lake Zumbro but have greatly declined. A single carp and single quillback had PCB concentrations from 2001, had PCB concentrations above the impairment thresholds. Those species were not collected in 2012. The smallmouth bass and golden redhorse that were collected in 2012 were below the reporting level. Future fish collections should attempt to collect carp and quillback for retesting of PCBs. Mercury levels in smallmouth bass from 2012 indicate mercury is still a concern for the Zumbro River. Mercury concentrations should be retested in the lakes as well as the river to assess if mercury levels are changing.

Table 63. Fish Species codes, common names and scientific names.

Species	Common Name	Scientific Name
BAS	Bass, unknown species	*Micropterus sp.*
BGS	Bluegill sunfish	*Lepomis macrochirus*
BKS	Black crappie	*Pomoxis nigromaculatis*
C	Common Carp	*Cyprinus carpio*
CHC	Channel catfish	*Ictalurus punctatus*
GRH	Golden redhorse	*Moxostoma erythrurum*
LMB	Largemouth bass	*Micropterus salmoides*
NP	Northern pike	*Esox Lucius*
QUB	Quillback	*Carpiodes cyprinus*
RHS	Redhorse, unknown species	*Moxostoma sp.*
RKB	Rock bass	*Ambloplites rupestris*
RSU	Redhorse sucker	*Moxostoma carinatum*
SAG	Sauger	*Sander canadensis*
SMB	Smallmouth bass	*Micropterus dolomieu*
WE	Walleye	*Sander vitreus*
WHB	White bass	*Morone chrysops*
WHS	White crappie	*Pomoxis annularis*
WSU	White sucker	*Catostomus commersoni*
YEB	Yellow bullhead	*Ictalurus natalis*
YP	Yellow perch	*Perca flavescens*

Table 64. Summary statistics of mercury, PCBs and PFOS, by waterway-species-year.

						Length (in)				Mercury (mg/kg)				PCBs (mg/kg)			PFOS (mg/kg)		
WATERWAY	AUID	SPECIES[1]	YEAR	ANATOMY[2]	NO. FISH	N	Mean	Min	Max	N	Mean	Min	Max	N	Min	Max	N	Min	Max
SILVER*	55000300	C	1986	FILSK	5	1	19.0			1	0.070			1	0.381				
			2002	FILSK	5	1	19.0			1	0.059			1	0.04				
		CHC	1986	FILET	5	2	18.7	15.8	21.5	2	0.555	0.390	0.720	2	0.144	0.743			
		NP	2002	FILSK	4	4	17.5	16.9	18.3	4	0.153	0.108	0.235						
		RHS	2002	FILSK	5	1	12.3			1	0.138								
		WHS	2002	FILSK	10	1	8.2			1	0.121								
		WSU	2002	FILSK	5	1	12.3			1	0.184								
		YP	2002	FILSK	4	1	9.7			1	0.524								
WILLOW RESERVOIR 4	55002000	BGS	2002	FILSK	10	1	6.6			1	0.063								
		BKS	2002	FILSK	10	1	7.9			1	0.083								
		YEB	2002	FILET	9	1	11.1			1	0.142								
WILLOW RESERVOIR 6A*	55002100	BGS	2002	FILSK	10	1	6.3			1	0.138								
		LMB	2002	FILSK	3	3	14.9	13.1	15.9	3	0.519	0.476	0.571						
		WSU	2002	FILSK	4	1	16.0			1	0.262								
ZUMBRO*	55000400	BGS	2009	FILSK	8	1	6.7			1	0.054						1	33.1	
		BKS	1977	FILSK	1	1	10.3							1	0.07				
			1982	FILSK	5	1	9.2			1	0.120			1	0.035				
			1990	FILSK	6	1	7.6			1	0.068			1	0.017				
			2007	FILSK	10	1	8.9			1	0.094			1	<0.01		1	53.2	
			2009	FILSK	8	1	8.3										1	53.8	
		C	1980	FILSK	12	2	18.0	15.7	20.3	2	0.390	0.220	0.560	2	0.31	0.963			
			1986	FILSK	5	1	18.2			1	0.400			1	0.608				
			1990	FILSK	13	7	17.6	15.6	21.6	2	0.195	0.130	0.260	7	0.037	0.38			

WATERWAY	AUID	SPECIES[1]	YEAR	ANATOMY[2]	NO. FISH	Length (in)				Mercury (mg/kg)				PCBs (mg/kg)			PFOS (mg/kg)		
						N	Mean	Min	Max	N	Mean	Min	Max	N	Min	Max	N	Min	Max
			2007	FILSK	4	1	22.4			1	0.162			1	0.04	0.04			
			2009	FILSK	8	8	23.0	20.1	26.0								8	7.27	58.9
		CHC	1977	FILET	7	6	24.5	16.7	28.8					7	2.91	41.4			
			1980	FILET	14	2	18.4	15.9	20.8	2	0.660	0.480	0.840	2	1.9	4.76			
				FILET	5	1	19.7			1	0.490			1	1.92				
			1982	WHORG	5	1	19.7												
			1990	FILET	6	2	20.6	18.4	22.7	2	0.210	0.210	0.210	2	0.11	0.2			
			2007	FILET	6	6	19.3	15.0	24.1	6	0.197	0.089	0.584	1	0.04				
		LMB	1977	FILSK	3	3	13.5	11.6	15.5					3	0.06	0.07			
			1978	WHORG	4	1	9.7			1	0.170			1	0.057				
			1982	FILSK	5	1	14.3			1	0.470			1	0.026				
			1990	FILSK	6	2	15.4	12.4	18.3	2	0.330	0.260	0.400	2	0.034	0.093			
			2009	FILSK	8	8	11.7	9.4	13.4	5	0.244	0.108	0.674				8	38.8	127
		NP	2007	FILSK	6	6	26.8	24.2	28.8	6	0.208	0.151	0.358	1	<0.01				
		RSU		PLUSK	5	1	14.6			1	0.400			1	0.077				
			1978	WHORG	10	2	13.5	12.4	14.6	2	0.200	0.170	0.230	2	0.01	0.298			
		SMB	1978	WHORG	1	1	11.6			1	0.270			1	0.365				
		WHB	1977	FILSK	1	1	9.8							1	0.23				
		WHS	1977	FILSK	1	1	8.7							1	0.25				
			1990	FILSK	5	1	8.8	8.8	8.8	1	0.140			1	<0.01				
ZUMBRO RIVER	above dam (North, Middle, & South Forks) 07040004 - 507, -971, -	BAS	1981	FILSK	2	1	13.6	13.6	13.6	1	0.240			1	0.07				
		BGS	2004	FILSK	4	1	6.6	6.6	6.6	1	0.060			1	<0.01				
		C	2004	FILSK	6	2	24.7	21.3	28.1	2	0.136	0.116	0.155	2	0.04	0.06			
		CHC	1986	FILET	10	2	20.8	20.7	20.8	1	0.320			2	0.81	1.17			
			2004	FILET	1	1	17.5			1	0.181			1	0.03				

WATERWAY	AUID	SPECIES[1]	YEAR	ANATOMY[2]	NO. FISH	Length (in)				Mercury (mg/kg)				PCBs (mg/kg)			PFOS (mg/kg)		
						N	Mean	Min	Max	N	Mean	Min	Max	N	Min	Max	N	Min	Max
	519, -973, -523, -525, -526, -533, -534, -535, -536	RKB	2004	FILSK	1	1	8.3			1	0.580			1	<0.01				
		SMB	2004	FILSK	6	6	14.4	12.3	17.2	6	0.648	0.383	1.237	6	<0.01	0.02			
		WE	2004	FILSK	1	1	19.4			1	0.757			1	0.04				
		WHB	2004	FILSK	7	1	11.2			1	0.193			1	<0.01				
		WSU	1981	FILSK	5	1	14.1			1	0.170			1	0.09				
			1993	FILSK	4	1	13.5			1	0.150			1	0.033	0.033			
	below dam * ** 07040004 -501, -502, -504, -506	BGS	2001	FILSK	10	1	6.9			1	0.062			1	0.02				
		BKS	2001	FILSK	3	1	8.8			1	0.072			1	0.02				
		C	1992	FILSK	11	2	19.9	18.1	21.7	2	0.125	0.100	0.150	2	0.071	0.075			
			2001	FILSK	3	1	22.7			1	0.186			1	0.26				
		CHC	1992	FILET	7	2	19.3	17.7	20.9	2	0.160	0.140	0.180	2	0.039	0.053			
			2001	FILET	2	2	21.9	21.2	22.6	2	0.132	0.109	0.154	2	0.03	0.035			
		GRH	2001	FILSK	3	1	18.2			1	0.178			1	0.02				
			2012	FILSK	5	5	14.5	13.8	16.5	5	0.127	0.090	0.204	2	0.025	0.025			
		NP	2001	FILSK	6	6	24.5	21.9	27.7	6	0.203	0.100	0.393	6	<0.01	0.04			
		QUB	2001	FILSK	3	1	17.5			1	0.173			1	0.59				
		RKB	2010	FILSK	5	5	6.9	5.5	7.7								5	9.38	21.9
		SAG	2010	FILSK	4	4	12.8	12.2	14.4								4	18.6	53.3
		SMB	1981	FILSK	2	1	16.6			1	0.150			1	0.07				
			1992	FILSK	7	1	13.2			1	0.140			1	0.03				
			2001	FILSK	6	6	12.2	9.7	16.9	6	0.181	0.124	0.223	6	0.02	0.035			
			2010	FILSK	5	5	11.2	10.0	12.6								5	<4.88	20.2
			2012	FILSK	5	5	11.9	9.5	13.4	5	0.232	0.193	0.287	2	<0.025	<0.025			
		WE	1981	FILSK	2	1	11.7			1	0.180			1	<0.02				
		WSU	1981	FILSK	5	1	15.4			1	0.300			1	0.18				

WATERWAY	AUID	SPECIES[1]	YEAR	ANATOMY[2]	NO. FISH	Length (in)				Mercury (mg/kg)				PCBs (mg/kg)			PFOS (mg/kg)		
						N	Mean	Min	Max	N	Mean	Min	Max	N	Min	Max	N	Min	Max
			1992	FILSK	14	2	15.0	13.8	16.2	2	0.083	0.045	0.120	1	0.039				
			2001	FILSK	5	1	17.3			1	0.096			1	0.04				

*** Impaired for mercury in fish tissue as of 2012 Draft Impaired Waters List; categorized as EPA Class 4a for waters covered by the Statewide Mercury TMDL.**

****Impaired for PCB in fish tissue and categorized as EPA Class 5 and requires a TMDL.**

1 **Species codes are defined in Table FC1**

2 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism

Groundwater monitoring

Groundwater quality

A baseline study of Minnesota's aquifers determined that groundwater in the southeast region of the state is heavily influenced by the geology. Paleozoic bedrock aquifers generally contain good quality groundwater, while the buried drift and Cretaceous aquifers have poor groundwater; containing high concentrations of dissolved solids and other naturally occurring minerals. Karst areas of the watershed contain more highly oxidized groundwater and are more responsive to recharge as well as impacts from anthropogenic chemicals (MPCA, 1999).

The MPCA's Ambient Groundwater Monitoring Program has sampled 6 domestic wells and 10 monitoring wells within the Zumbro River Watershed. Data from these wells are summarized in the most recent groundwater condition report (Kroening, 2013) and do not differ greatly from the conditions described in the baseline study. Figure 49 displays the locations of the MPCA's Ambient Groundwater Monitoring wells in and around the Zumbro River Watershed.

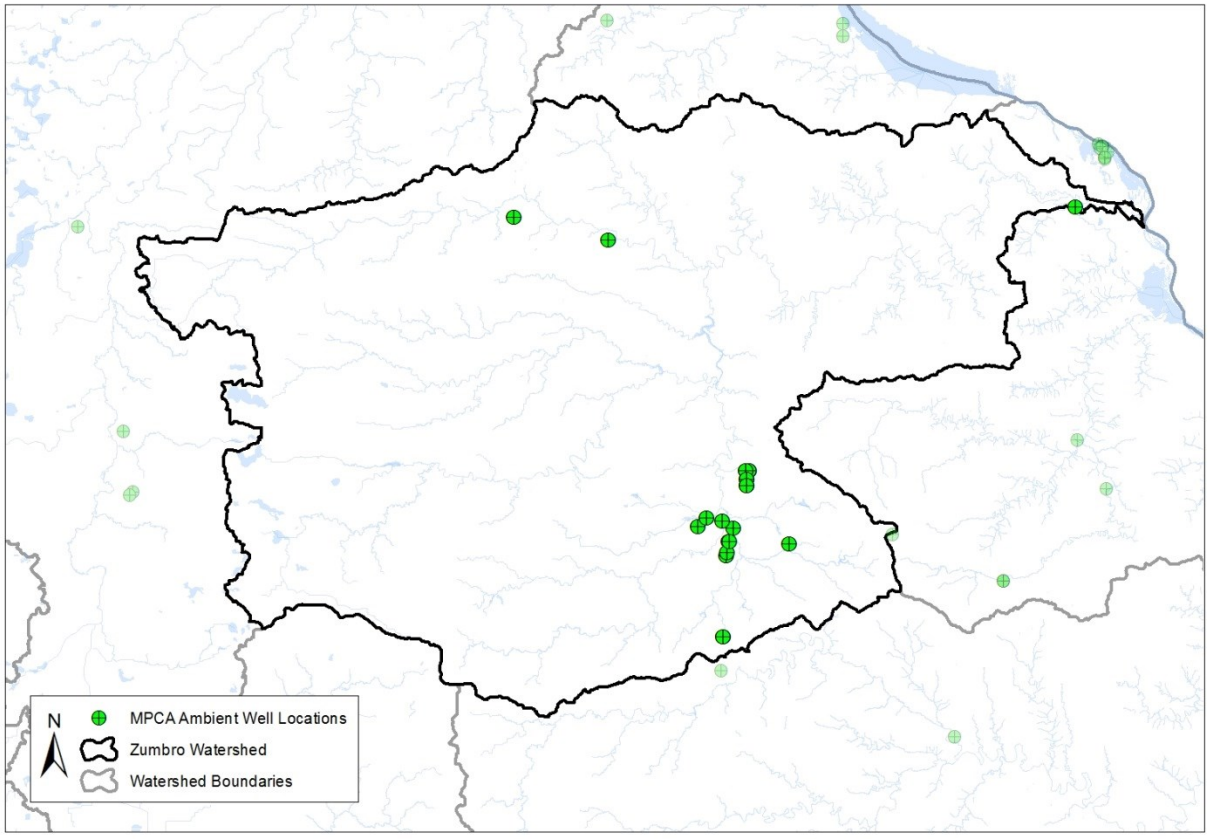

Figure 49. MPCA Ambient Groundwater Monitoring Well Locations within and around the Zumbro River Watershed.

The Minnesota Department of Agriculture (MDA) monitors pesticides and nitrate on an annual basis in groundwater across agricultural areas in the state. The MDA separates the state into regions, which consist of 10 regional water quality monitoring networks that are referred to as Pesticide Monitoring Regions (PMRs) The Zumbro River Watershed lies primarily within the regional water quality monitoring networks for Region 9 (PMR 9), also referred to as the Southeast Region.

MDA annually monitors pesticides in groundwater through a network of monitoring wells statewide. Southeast Minnesota is one of two areas MDA monitors more intensively due to the vulnerable geology. In 2014, this region tested positively for a number of pesticides to include acetochlor, alachlor, atrazine, dimethenamid and metoachlor; however, no pesticide detections exceeded any established health risk limit for drinking water (Figure 50) (MDA 2015).

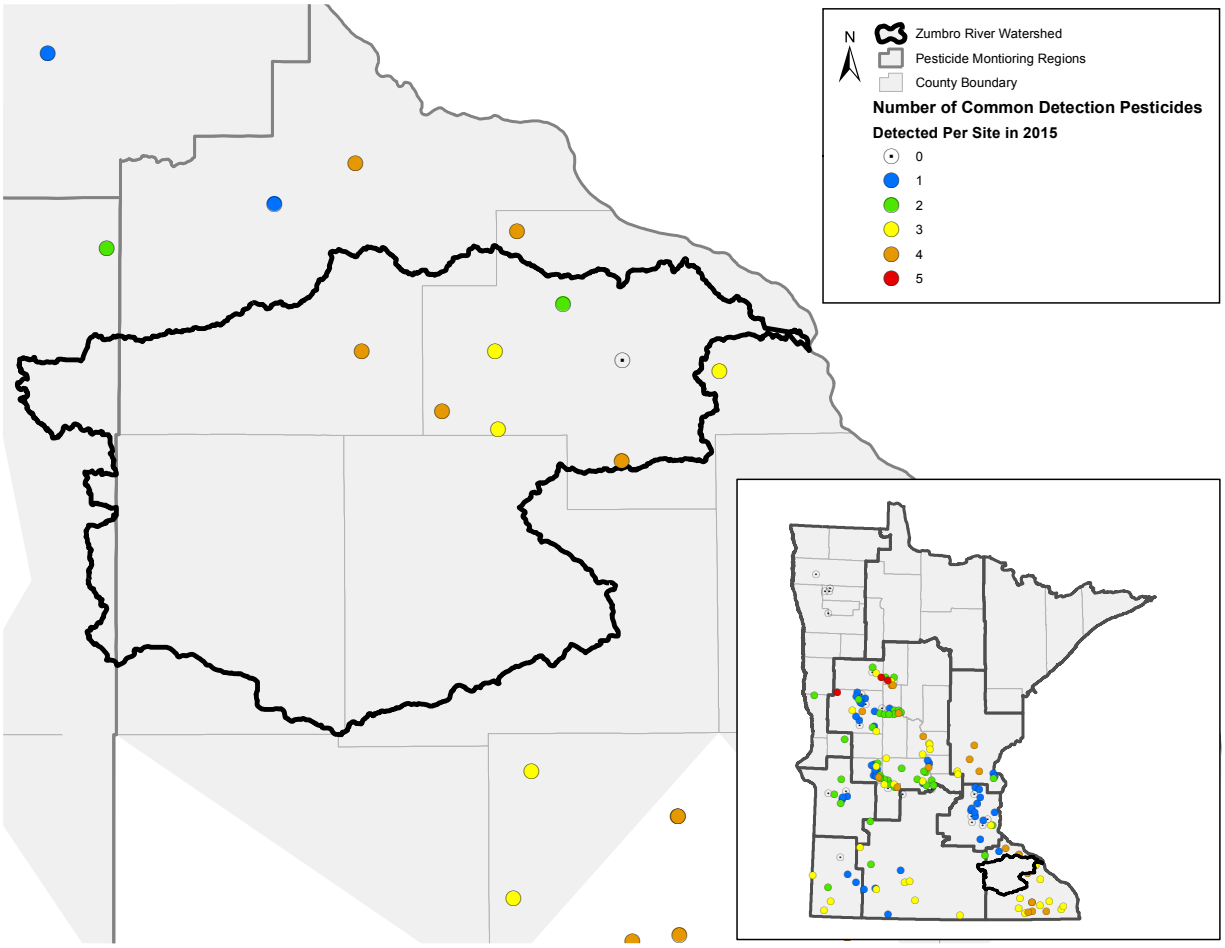

Figure 50. Number of common detection pesticides detected in groundwater samples in 2013 (Source: MDA, 2014).

The MDA also analyzed these well samples for nitrate. The health risk limit for nitrate set by the Minnesota Department of Health is 10.00 (mg/L). Nitrate was detected in every sample from the Southeast Minnesota region in 2013, with a median of 7.63 mg/L (MDA, 2014). Of those samples, 74% ranged in concentration from 3.01 mg/L to 10.00 mg/L. Another 26% were above the drinking water standard of 10.00 mg/L. Sources of nitrate contamination include row crop agriculture, septic systems and animal feedlot operations.

Another source of information on groundwater quality comes from the MDH. Mandatory testing for arsenic of all newly constructed wells has found that 10.4% of all wells installed from 2008 to 2013 have arsenic levels above the MCL for drinking water of 10 micrograms per liter (MDH). In the Zumbro River Watershed, the majority of new wells are within the water quality standards for arsenic levels (Figure 51).

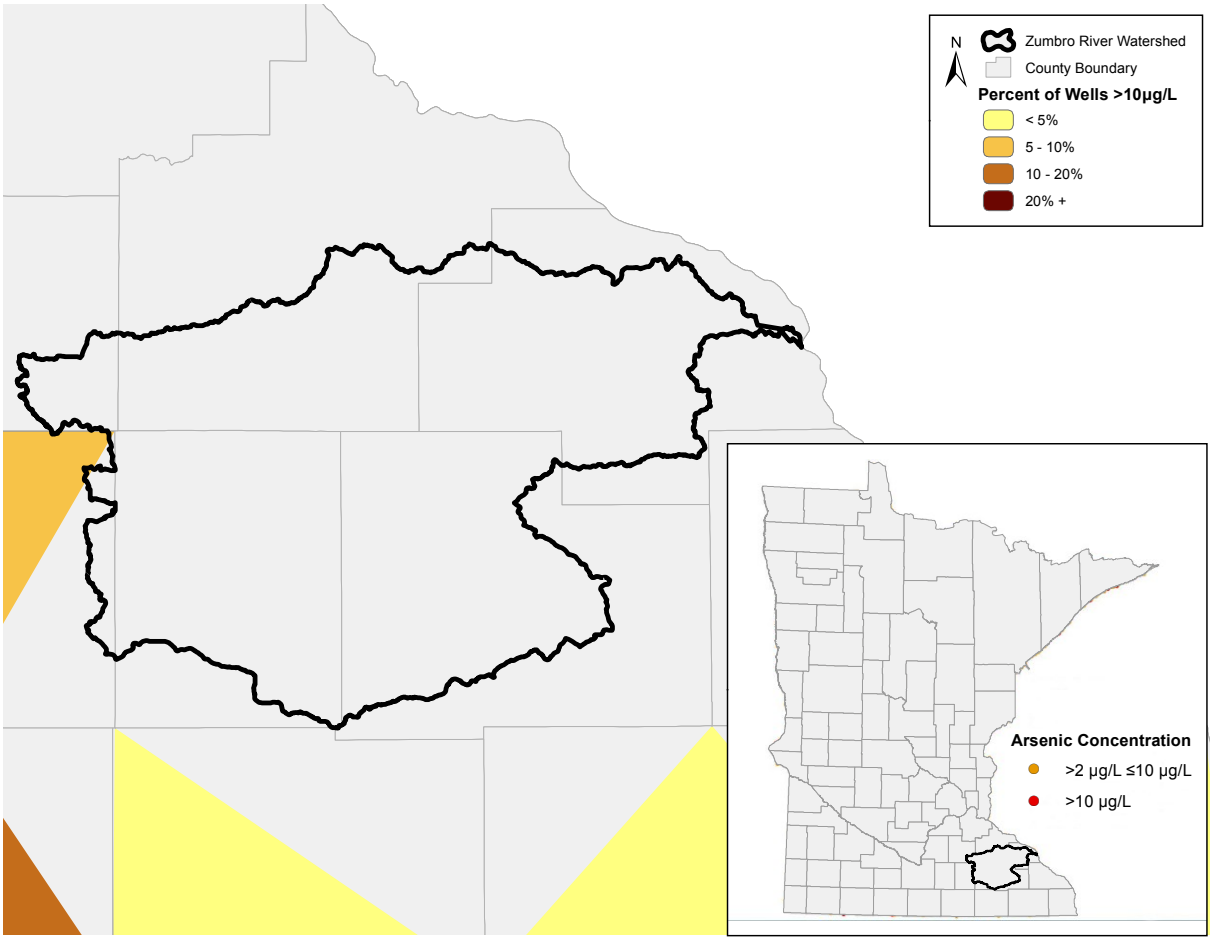

Figure 51. Arsenic occurrence in new wells in Southeast Minnesota (2008-2012) (Source: MDH, 2012).

Groundwater quantity

Monitoring wells from the MNDNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences.

There are currently no functioning MNDNR observation wells in the Zumbro Watershed.

Groundwater/surface water withdrawals

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

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

The 3 largest permitted consumers of water in the state (in order) are municipalities, industry and irrigation. The withdrawals within the Zumbro River Watershed are mostly for municipal (waterworks) and industrial use.

Figure 52 displays total groundwater withdrawals from the watershed from 1991-2011, withdrawals are displayed below as blue diamonds with total surface water withdrawals as red squares. During this time period within the Zumbro River Watershed, groundwater withdrawals exhibit a significant rising trend (p=0.001) and surface water withdrawals have increased as well (p=0.05).

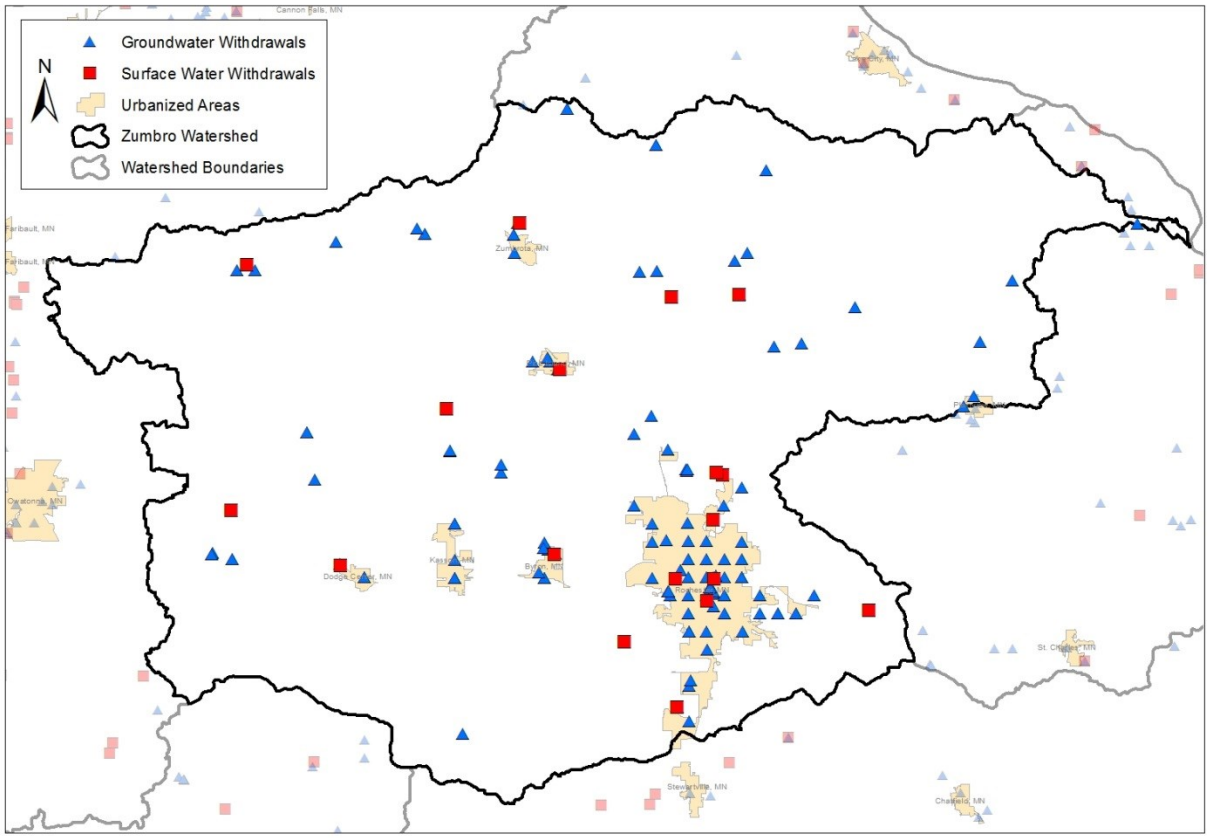

Figure 52. Locations of permitted groundwater withdrawals in the Zumbro River Watershed.

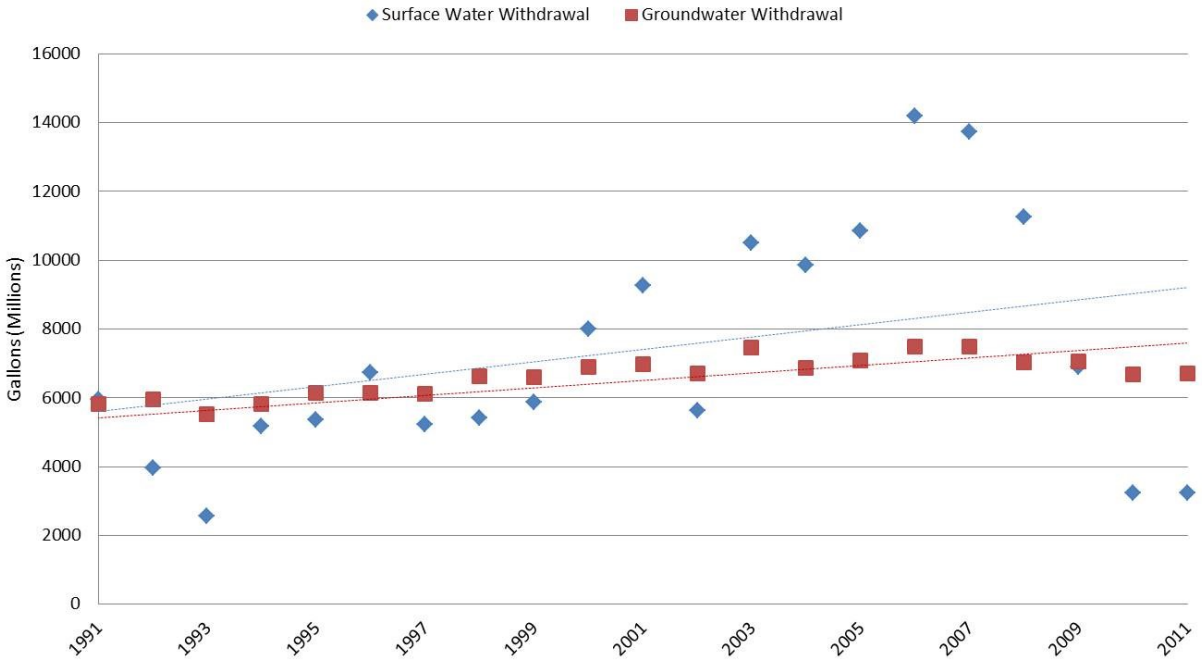

Figure 53. Total annual groundwater and surface water withdrawals in the Zumbro River Watershed (1991-2011).

Stream flow

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

Stream flow for one river in the Zumbro River Watershed was analyzed for annual mean discharge and summer monthly mean discharge (July and August). Figure 54 is a display of the annual mean discharge for the South Fork Zumbro River at Rochester, Minnesota from 1993 to 2013. Figure 55 displays July and August mean flows for the last 20 years for the same water body. The data appears to show a slight increase in average annual streamflow and a slight decrease in average summer monthly streamflow over time, but there is no statistically significant trend. By way of comparison, summer month flows have declined at a statistically significant rate at a majority of streams selected randomly for a study of statewide trends.

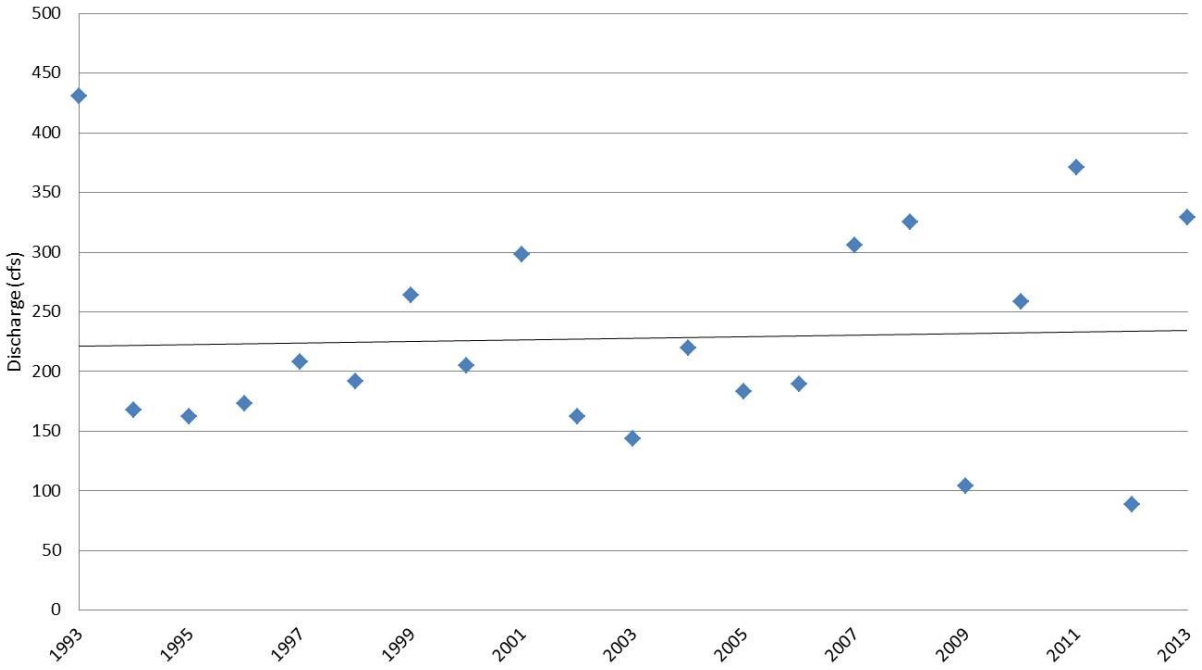

Figure 54. Annual Mean Discharge for the South Fork Zumbro River at Rochester, MN (1993 - 2013).

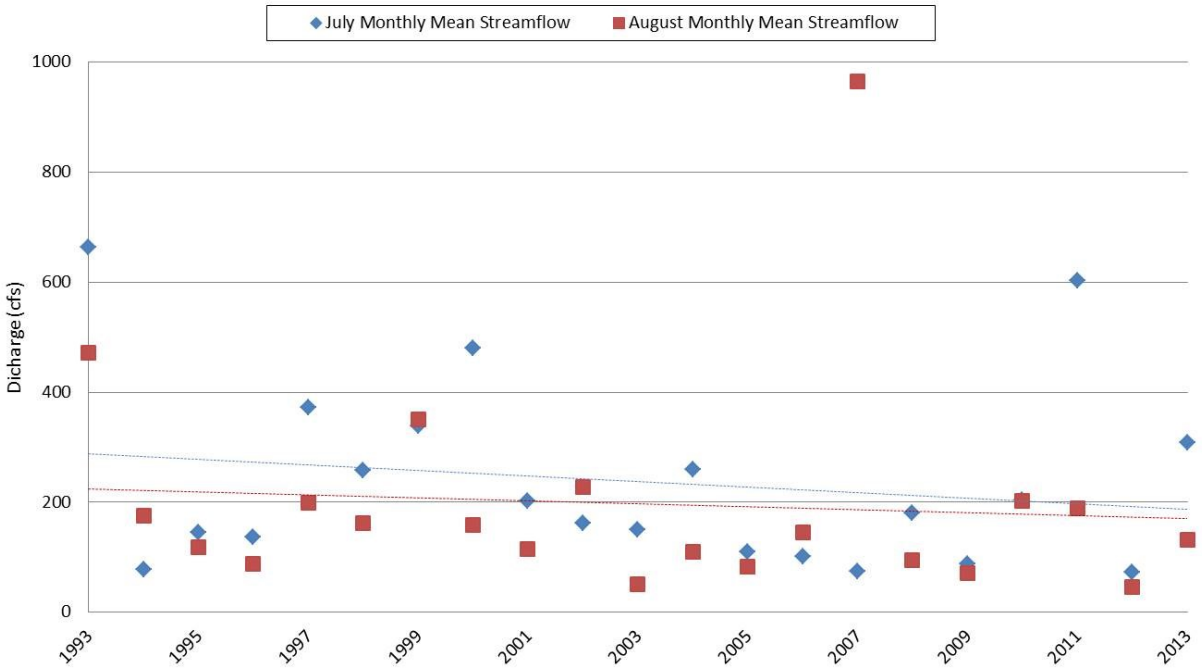

Figure 55. Mean monthly discharge measurements for July and August flows for the South Fork Zumbro River at Rochester, Minnesota (1992-2012).

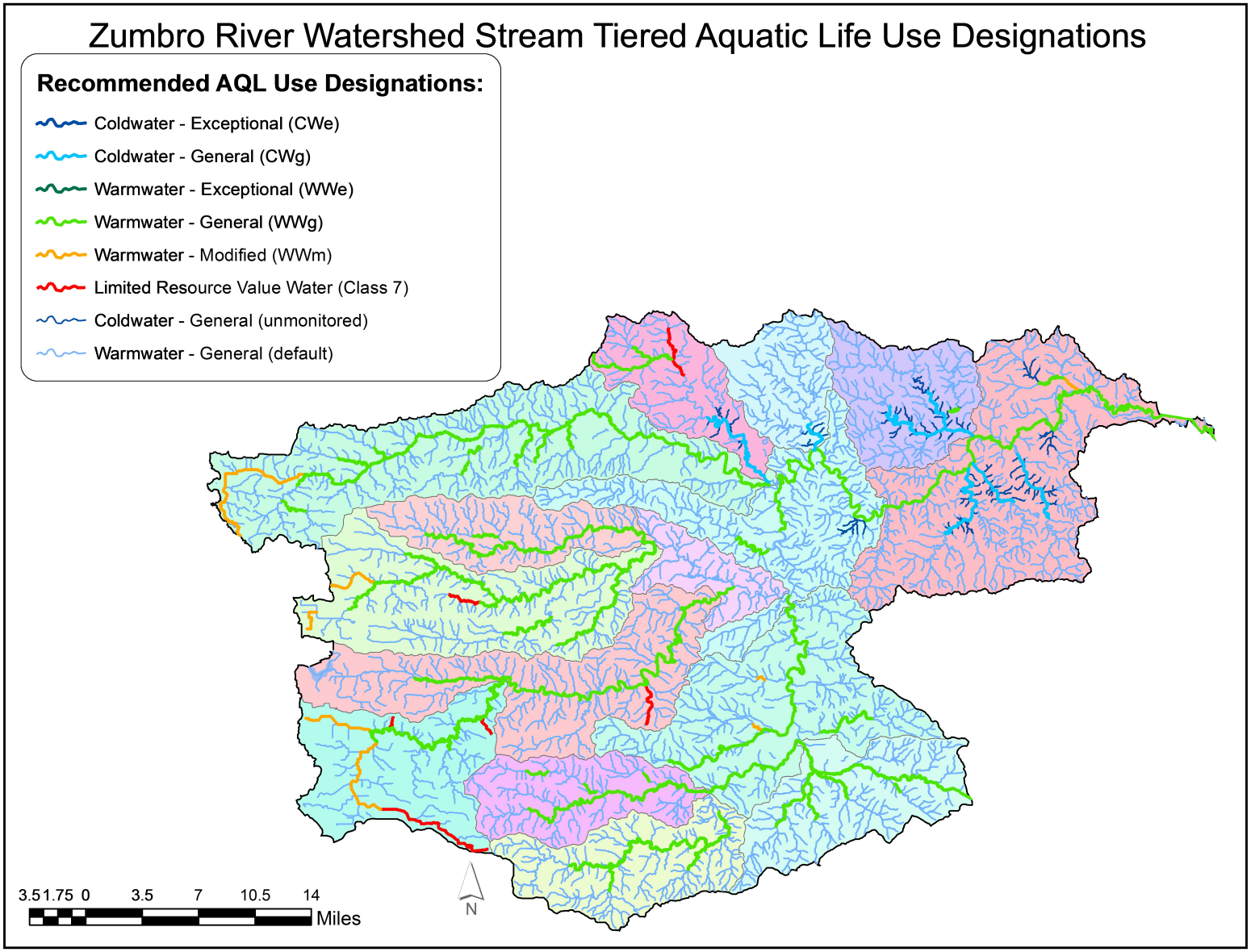

Figure 56. Stream Tiered Aquatic Life Use Designations in the Zumbro River Watershed.

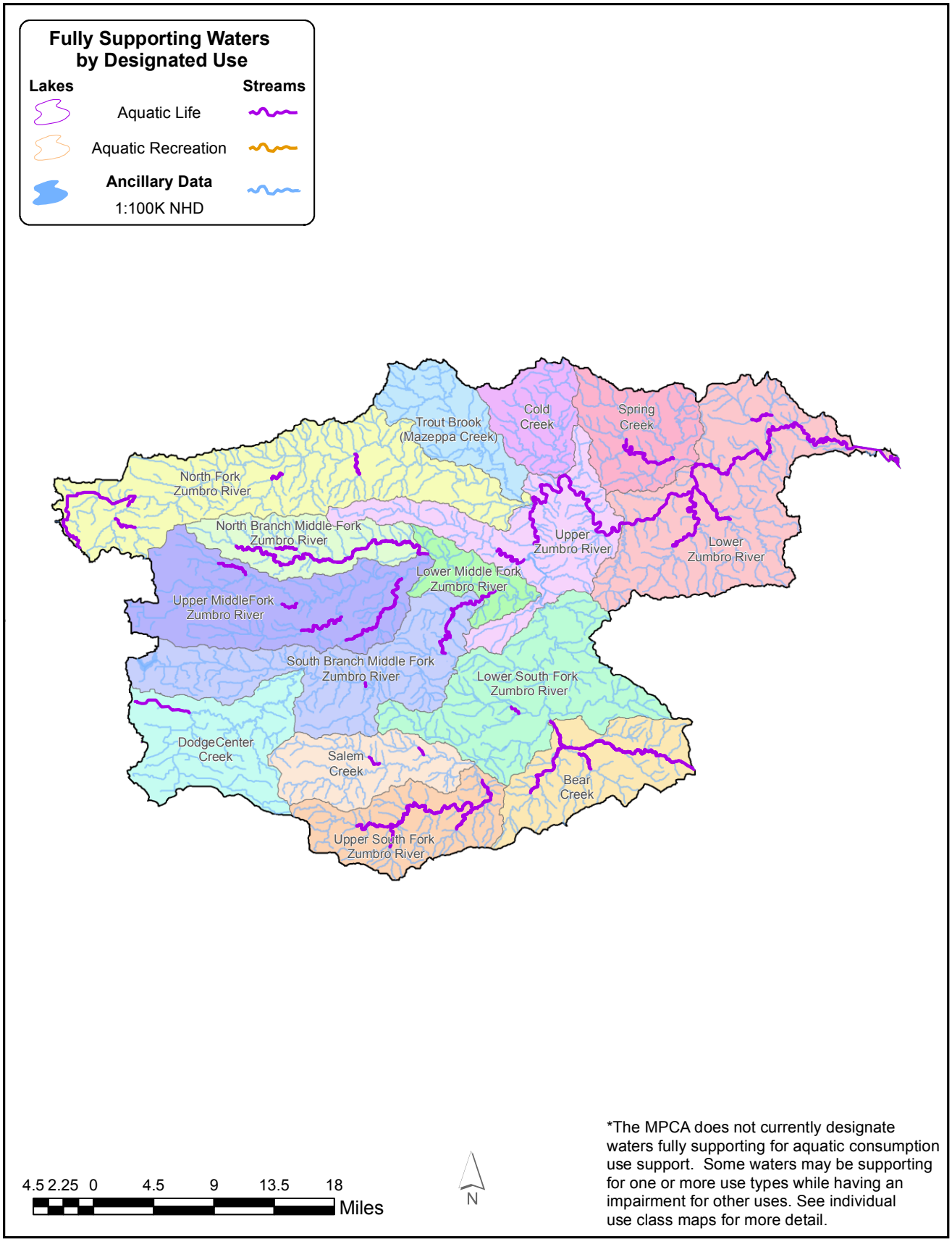

Figure 57. Fully supporting waters by designated use in the Zumbro River Watershed.

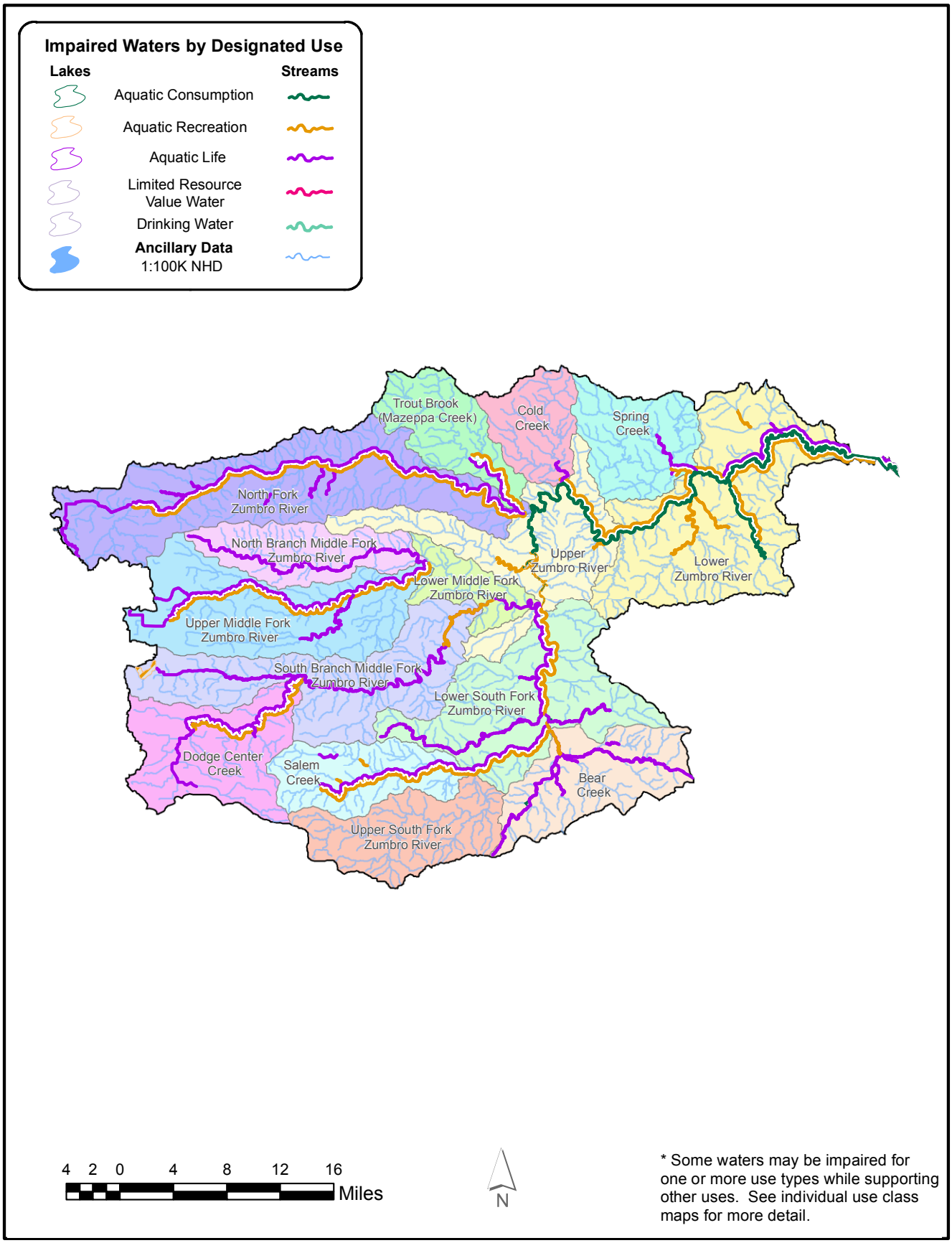

Figure 58. Impaired waters by designated use in the Zumbro River.

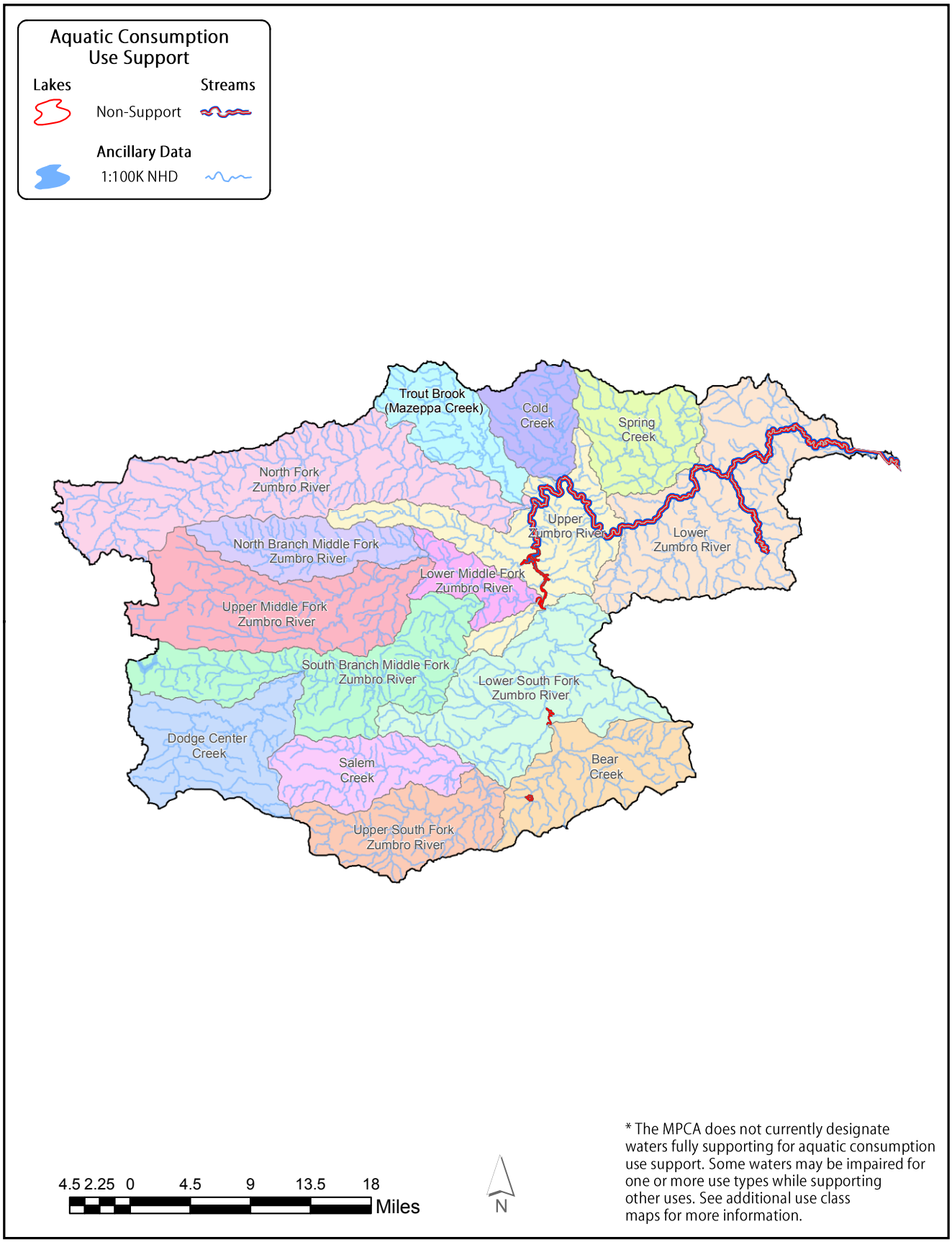

Figure 59. Aquatic consumption use support in the Zumbro River Watershed.

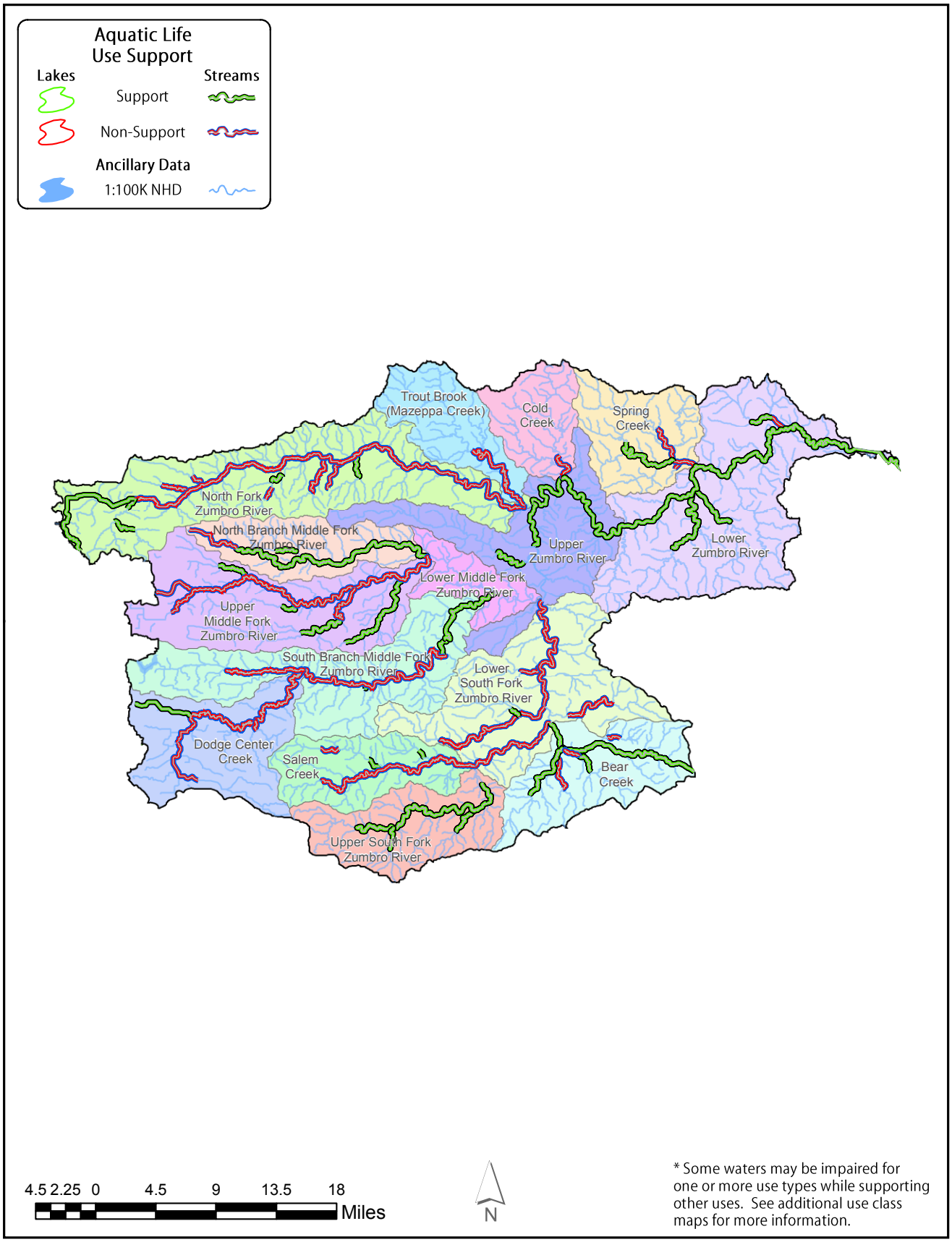

Figure 60. Aquatic life use support in the Zumbro River Watershed.

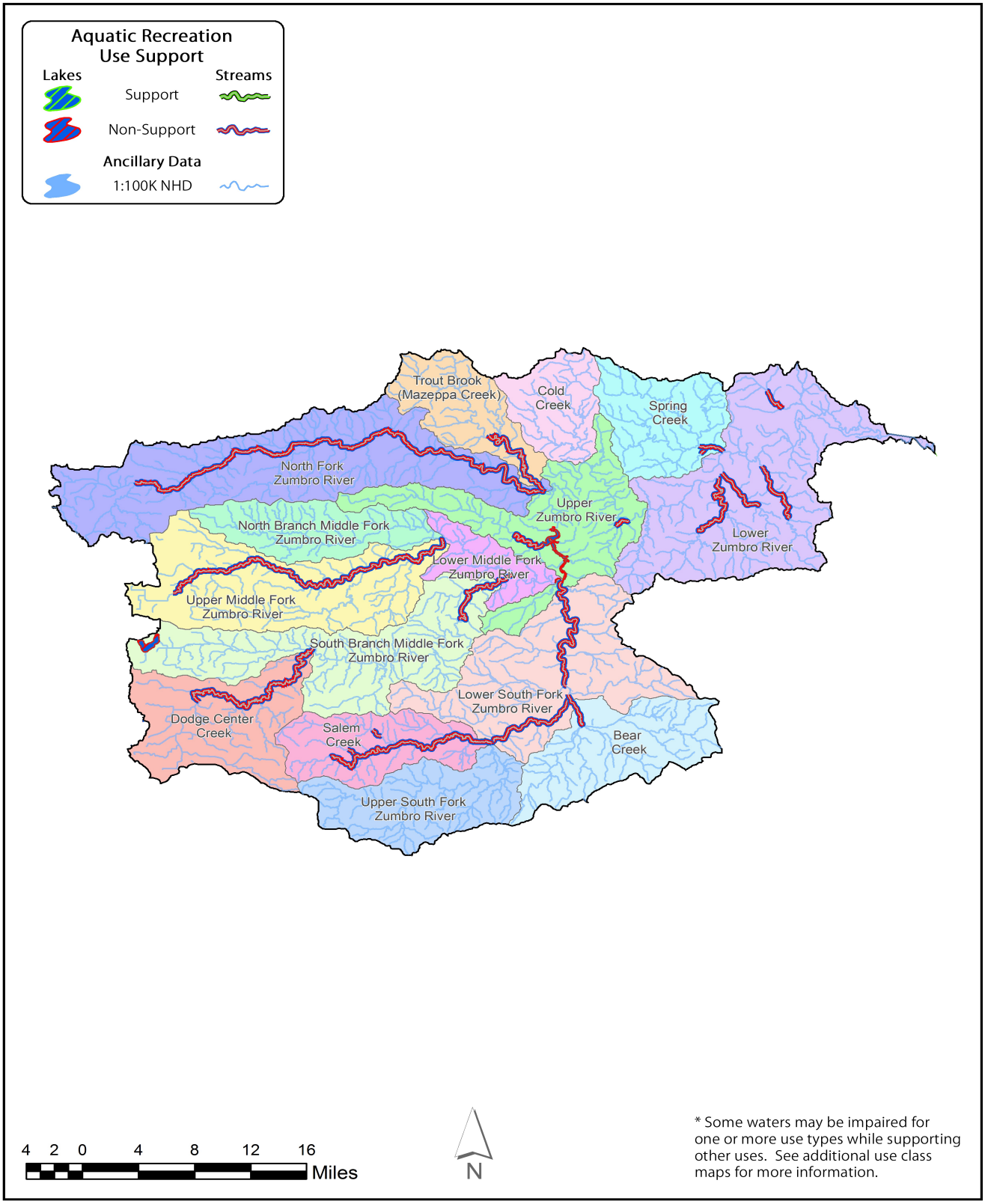

Figure 61. Aquatic recreation use support in the Zumbro River Watershed.

Pollutant trends for the Zumbro River Watershed

Water quality trends at long-term monitoring stations

Water chemistry data were analyzed for trends (Table 65) for the long term period of record (1973-2008) and near term period of record (1995-2008). There were increases in nitrite/nitrates and chloride during the long term period of record. No increasing trends were observed for the short term period of record. Conversely, there were decreases in total suspended solids, total phosphorus, ammonia and biological oxygen demand for the long term period of record. A decreasing trend was also observed in the near term for TSS.

Table 65. Trends in the Zumbro River.

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
Zumbro River at CSAH-14, 3 mi. N of Rochester (ZSF-5.7)						
overall trend (1973–2008)	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**increase**
average annual change	-2.9%	-7.1%	2.3%	-10.0%	-4.6%	3.0%
total change	**-64%**	**-92%**	**120%**	**-97%**	**-81%**	186%
recent trend (1995 – 2008)	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**	little data
average annual change	-6.7%					
total change	-42%					
median concentrations first 10 years	45	0.9	3	0.50	5	36
median concentrations most recent 10 years	16	0.2	7	<.05	2	54

Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90% confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data. Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.

Water clarity trends at citizen monitoring sites

Citizen volunteer monitoring occurs at only 33 streams in the watershed. Water clarity has shown no trend.

Table 66. Water Clarity Trends at Citizen Stream Monitoring Sites.

Zumbro River Watershed HUC 07040004	Citizen Stream Monitoring Program	Citizen Lake Monitoring Program
number of sites w/ increasing trend	0	0
number of sites w/ decreasing trend	0	0
number of sites w/ no trend	33	4

Summaries and recommendations

While improvements have been made within the Zumbro River Watershed, non- point sources of pollution from a landscape dominated by agricultural landuses continue to impact the watershed's surface water quality. While overall conditions may appear less dire than other regions of the state, measures must be taken to insure water quality does not degrade further. Eighty-two of the 474 stream AUIDs were assessed (Table 61) for aquatic life use and/or aquatic recreational use. Of the assessed streams, only 34 streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Fifty-four AUIDs are non-supporting for aquatic life and/or recreation. Of those, 37 were non-supporting for aquatic life and 17 were non-supporting for aquatic recreation.

Aquatic recreation impairments are prevalent within the Zumbro, impacting all Zumbro River AUIDs where sufficient data was available to make an assessment and both assessed lakes. The abundance of permitted feedlots in the watershed (1600+), along with data gaps, indicates that impairment is likely more widespread within the Zumbro and its tributaries than the impairments shown in Figure 61. Future monitoring should be focused on filling in potential impairment gaps across the watershed including attaining sufficient assessment level data for the rest of the watersheds lakes.

Aquatic life use impairments in the watershed are abundant but are rarely in agreement between fish and macroinvertebrate communities' assemblages; despite known water quality problems one might expect to impact both assemblages. Fish communities have shown great resilience and are performing at a high level across much of the watershed. Seventy-four species of fish have been identified within the Zumbro drainage during MPCA and MNDNR surveys. Failing macroinvertebrate communities are a preliminary sign of ecological and water chemical stress; measures taken to improve their condition will in turn benefit both assemblages and help limit further degradation which could impact fish populations in the future. Some biotic impairments are likely the result of nonpoint source pollution and localized stress due to degraded habitat conditions. High nitrogen levels are likely impacting macroinvertebrate communities as seen in other watersheds across southeastern Minnesota. Data shows increased levels of nitrogen were most evident in the upper and middle portions of the watershed during spring months and decrease moving east towards the mainstem Zumbro River where groundwater springs are more prevalent. Nitrate is a contaminant of concern in the Zumbro River Watershed. Rapid transfer to groundwater of surficial contaminants like nitrate is a growing problem in karst areas of Southeastern Minnesota. Pollution prevention from identified sources is the most effective method for groundwater protection in these areas.

High levels of turbidity in the watershed can attributed to a combination of altered hydrology, agricultural runoff and legacy impacts of past disturbance. Increases instream flow are not only a result of more intense storm events but also of increasing implementation of tile drainage on the landscape and urban stormwater runoff. This results in increasing water levels within riverine systems resulting in greater levels of stream bank erosion and instream sedimentation, impacting water clarity and diminishing the quality of aquatic habitat. Six AUIDs previously listed as impaired for aquatic life use due to excessive turbidity are being considered for removal from the 303(d) Impaired Waters List in 2016, 4 are due to corrections to the list based on a transition from a turbidity standard to a TSS standard that better represents the data and 2 are due to new information suggesting improved conditions.

Aquatic consumption assessments indicate general improvement in overall watershed condition. Fish consumption advisories were put in place after the Zumbro River was listed for mercury in 1998 and PCBs in 2004. PCBs, once very high in Lake Zumbro, have greatly declined in recent years; recent measurements suggest concentrations may now be meeting standards. Future fish collections should attempt to collect carp and quillback for retesting of PCBs to identify whether efforts should be made towards potential delisting. Mercury levels in smallmouth bass from 2012 indicate mercury is still a

concern for the Zumbro River. Mercury concentrations should be retested in the lakes as well as the river to assess if mercury levels are changing.

The direct correlation of increasing groundwater withdrawals and decreasing surficial water quantity has been documented in other areas of Minnesota such as Little Rock Creek and White Bear Lake. To provide a detailed cause and effect between withdrawals and water quantity is beyond the scope of this report. However, statistically significant increases in withdrawals would justify heightened attention given the unique groundwater and surface water interactions in this predominantly karst watershed.

Retrospectively, the Zumbro River Watershed has many water quality impairments but is not beyond repair. The watershed provides a valuable resource to people of Minnesota that is in need of restoration and protection to insure conditions do not continue to degrade. Reductions in nonpoint source pollution are essential for bringing water quality standards into attainment. Placement of BMPs on the landscape would benefit a targeted approach, identifying the most sensitive karst areas that are more prone to act as pathways of contamination and would likely result in making more significant impacts on water quality. Cooperation between landowners and local stakeholders is essential for the success of a sustainable urban and agricultural economy that does not neglect water quality.

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Appendix 1 - Water chemistry definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix 2.1 - Intensive watershed monitoring water chemistry stations in the Zumbro River Watershed

Biological Station ID	STORET/ EQuIS ID	Water body Name	Location	12-digit HUC
02LM005	S003-772	Zumbro River	Upstream of CR 11, in Hammond	0704000405-03
02LM035	S000-816	Zumbro River	Downstream of CSAH 30, in Kellogg	0704000405-01
12LM001	S006-082	Spring Creek	At CSAH 11, 3 mi. NW of Theilman	0704000405-02
12LM002	S005-362	Cold Creek	Just E of CR68, 0.5 mi NW of Zumbro Falls	0704000405-04
12LM003	S005-741	Zumbro River, North Fork	Downstream of Hwy 60, in Mazeppa	0704000404-01
12LM004	S006-065	Zumbro River, Middle Fork	At SE 8th St, .5 mi. E of Pine Island	0704000403-02
12LM005	S007-126	Zumbro River, Middle Fork	At CSAH 31, 2.5 mi. W of Oronoco	0704000403-01
12LM006	S001-982	Zumbro River, Middle Fork, South Branch	At CSAH 3, 3.5 mi. SW of Oronoco	0704000402-01
12LM007	S003-802	Zumbro River, South Fork	At CR 121, 5.5 mi. SE of Oronoco	0704000401-01
12LM008	S001-324	Bear Creek	Bear Ck, Upstream of MN-14 Br. in Rochester	0704000401-02
12LM009	S005-422	Salem Creek	At CSAH 3, 4 mi. SE of Byron	0704000401-04
12LM010	S001-485	Dodge Center Creek	Downstream of 605th St, 3 mi. N of Dodge Center	0704000402-02
12LM011	S005-551	Trout Brook	At CSAH 1, 1.5 mi. N of Mazeppa	0704000404-02

Appendix 2.2 - Biological monitoring stations in the Zumbro River Watershed

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07040004-982	12LM074	Zumbro River, South Fork	Downstream of 260th Ave, 6 mi. E of Hayfield	Dodge	Upper South Fork Zumbro River
07040004-969	12LM073	Unnamed creek	Upstream of Hwy 30, 7 mi. E of Hayfield	Dodge	Upper South Fork Zumbro River
07040004-982	10EM155	Zumbro River, South Fork	1 mi. Upstream of 80th Ave SW, 7.5 mi. SW of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-982	12LM071	Zumbro River, South Fork	Downstream of CSAH 15, 5.5 mi. SW of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-968	12LM072	Unnamed creek	Downstream of CSAH 15, 6 mi. SW of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-983	12LM070	Zumbro River, South Fork	Upstream of CR 104, 5 mi. SW of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-503	12LM063	Salem Creek	Upstream of 260th Ave, 4 mi. SE of Kasson	Dodge	Salem Creek
07040004-597	04LM010	Unnamed creek	Downstream of CSAH 9, 2 mi. SW of Kasson	Dodge	Salem Creek
07040004-594	12LM062	Unnamed creek	Downstream of CSAH 8, 3.5 mi. SE of Kasson	Dodge	Salem Creek
07040004-503	04LM122	Salem Creek	~9 mi. SW Rochester	Olmsted	Salem Creek
07040004-967	12LM061	Unnamed creek	Upstream of CSAH 25, 3 mi. S of Byron	Olmsted	Salem Creek
07040004-503	12LM009	Salem Creek	Upstream of CSAH 3, 4 mi. SE of Byron	Olmsted	Salem Creek
07040004-621	12LM081	Unnamed creek	Downstream of CSAH 23, 4.5 mi. W of Eyota	Olmsted	Bear Creek
07040004-539	04LM126	Bear Creek	Upstream of CSAH 19, 5 mi W of Eyota	Olmsted	Bear Creek
07040004-539	12LM078	Bear Creek	Upstream of CSAH 36, 2 mi. SE of Rochester	Olmsted	Bear Creek
07040004-619	04LM056	Badger Run	Just downstream of Hwy 52, 3.3 mi SE of Rochester	Olmsted	Bear Creek
07040004-620	12LM077	Badger Run	Upstream of 30th Ave SE, 1.5 mi. SE of Rochester	Olmsted	Bear Creek
07040004-986	12LM079	Willow Creek	Downstream of 30th St SE, 0.5 mi. S of Rochester	Olmsted	Bear Creek
07040004-986	04LM024	Willow Creek	Upstream of TH 52 in southern Rochester	Olmsted	Bear Creek
07040004-800	12LM080	Unnamed creek	Upstream of CR 101, 2.5 mi. S of Rochester	Olmsted	Bear Creek
07040004-538	12LM008	Bear Creek	Upstream of Hwy 14, in Rochester	Olmsted	Bear Creek
07040004-538	12LM100	Bear Creek	Upstream of Hwy 14, in Rochester	Olmsted	Bear Creek
07040004-536	12LM069	Zumbro River, South Fork	Off of Old Valley Rd SW, 3 mi. W of Rochester	Olmsted	Upper South Fork Zumbro River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07040004-991	12LM102	Cascade Creek	Downstream of 45th Ave SW, 2 mi. W of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-991	04LM123	Cascade Creek	Downstream of CR104, 1 mi W of Rochester.	Olmsted	Upper South Fork Zumbro River
07040004-633	12LM068	Unnamed creek	Upstream of 7th St NW, in Rochester	Olmsted	Upper South Fork Zumbro River
07040004-581	04LM124	Cascade Creek	In city of Rochester, downstream of Hwy 52 crossing	Olmsted	Upper South Fork Zumbro River
07040004-552	12LM067	Silver Creek	Upstream of Silver Creek Rd NE, 1 mi. E of Rochester	Olmsted	Lower South Fork Zumbro River
07040004-507	12LM066	Zumbro River, South Fork	Upstream of CSAH 22, .5 mi. N of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-507	04LM125	Zumbro River, South Fork	@ USGS Gaging station, adjacent to Sewage Disposal Plant, north side of Rochester.	Olmsted	Upper South Fork Zumbro River
07040004-602	04LM003	Unnamed creek	Downstream of TH 52, in the NW corner of Rochester	Olmsted	Upper South Fork Zumbro River
07040004-507	12LM007	Zumbro River, South Fork	Upstream of CR 121, 5.5 mi. SE of Oronoco	Olmsted	Upper South Fork Zumbro River
07040004-545	12LM059	Judicial Ditch 1	Downstream of 180th Ave., 3 mi. NW of Hayfield	Dodge	Dodge Center Creek
07040004-987	12LM060	Judicial Ditch 1	Downstream of CSAH 3, 6 mi. S of Claremont	Dodge	Dodge Center Creek
07040004-987	04LM140	Judicial Ditch 1	1 mi. upstream of CR O; 4 mi S of Claremont	Dodge	Dodge Center Creek
07040004-988	12LM057	Dodge Center Creek	Upstream of 120th Ave, 2.5 mi. S of Claremont	Dodge	Dodge Center Creek
07040004-966	12LM058	Judicial Ditch 7	Downstream of CSAH 1, 1 mi. S of Claremont	Dodge	Dodge Center Creek
07040004-989	12LM056	Dodge Center Creek	Downstream of CSAH 5, 3 mi. W of Dodge Center	Dodge	Dodge Center Creek
07040004-619	12LM055	Henslin Creek	Downstream of 645th St, 2.5 mi. SW of Dodge Center	Dodge	Dodge Center Creek
07040004-989	12LM054	Dodge Center Creek	Upstream of CSAH 7, 1 mi. N of Dodge Center	Dodge	Dodge Center Creek
07040004-989	12LM053	Dodge Center Creek	Upstream of 200th Ave., 2.5 mi. N of Dodge Center	Dodge	Dodge Center Creek
07040004-989	12LM010	Dodge Center Creek	Downstream of 605th St, 3 mi. N of Dodge Center	Dodge	Dodge Center Creek
07040004-979	07LM021	Zumbro River, South Branch Middle Fork	Downstream of CSAH 1, 2.5 mi. N of Claremont	Dodge	South Branch Middle Fork Zumbro River
07040004-980	12LM052	Zumbro River, Middle Fork, South Branch	Downstream of Hwy 56, 4 mi. W of Wasioja	Dodge	South Branch Middle Fork Zumbro River
07040004-976	12LM051	Zumbro River, Middle Fork, South Branch	Upstream of CSAH 9, in Wasioja	Dodge	South Branch Middle Fork Zumbro River
07040004-551	12LM050	Masten Creek	Downstream of 615th St, 0.5 mi. SE of Mantorville	Dodge	South Branch Middle Fork Zumbro River
07040004-527	04LM121	Unnamed Stream	Upstream of CSAH 5, 1 mi N of Byron.	Olmsted	South Branch Middle Fork Zumbro River
07040004-976	12LM084	Zumbro River, Middle Fork South Branch	Adjacent to CR 105, in Oxbow Bend Park, 2.5 mi. N of Byron	Olmsted	South Branch Middle Fork Zumbro River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07040004-977	12LM049	Zumbro River, Middle Fork, South Branch	Upstream of CSAH 14, 6 mi. NE of Byron	Olmsted	South Branch Middle Fork Zumbro River
07040004-978	10EM095	Zumbro River, Middle Fork, South Branch	Adjacent to end of 90th St NW, 6 mi. NW of Rochester	Olmsted	South Branch Middle Fork Zumbro River
07040004-978	12LM006	Zumbro River, Middle Fork, South Branch	Downstream of CSAH 12, 3.5 mi. SW of Oronoco	Olmsted	South Branch Middle Fork Zumbro River
07040004-577	04LM053	Trib. to Zumbro River, Middle Fork	Upstream of CSAH 37, ~7.5 miles NE of Owatonna	Steele	Upper Middle Fork Zumbro River
07040004-973	07LM022	Zumbro River, Middle Fork	Upstream of 555th St, 6 mi. E of Merton	Dodge	Upper Middle Fork Zumbro River
07040004-973	04LM142	Zumbro River, Middle Fork	upstream of CSAH 1, 7.5 mi SW of Kenyon	Dodge	Upper Middle Fork Zumbro River
07040004-578	04LM028	Trib. to Zumbro River, Middle Fork	Upstream of CR C, 5 mi. W of West Concord	Dodge	Upper Middle Fork Zumbro River
07040004-973	12LM045	Zumbro River, Middle Fork	Downstream of 160th Ave, 2 mi. NW of West Concord	Dodge	Upper Middle Fork Zumbro River
07040004-909	12LM044	Trib. to Zumbro River, Middle Fork	Upstream of 160th Ave, 3 mi. NW of West Concord	Dodge	Upper Middle Fork Zumbro River
07040004-524	12LM076	Unnamed Ditch	Upstream of 180th Ave., 1 mi. E of West Concord	Dodge	Upper Middle Fork Zumbro River
07040004-524	12LM075	Unnamed Ditch	Downstream of CSAH 7, 2.5 mi. E of West Concord	Dodge	Upper Middle Fork Zumbro River
07040004-973	12LM046	Zumbro River, Middle Fork	Upstream of 237th Ave, 6 mi. SW of Pine Island	Dodge	Upper Middle Fork Zumbro River
07040004-554	04LM141	Miliken Creek	Upstream of CSAH 22, 7 mi SW of Pine Island	Dodge	Upper Middle Fork Zumbro River
07040004-563	12LM047	Harkom Creek	Downstream of 275th Ave, 3 mi. SW of Pine Island	Dodge	Upper Middle Fork Zumbro River
07040004-973	12LM004	Zumbro River, Middle Fork	Downstream of SE 8th St, 0.5 mi. E of Pine Island	Goodhue	Upper Middle Fork Zumbro River
07040004-975	12LM042	Zumbro River, Middle Fork, North Branch	Upstream of CR A (520th St), 4 mi. NE of West Concord	Dodge	North Branch Middle Fork Zumbro River
07040004-965	12LM043	Trib. to Devlin Creek	Upstream of 94th Ave, 5 mi. NE of West Concord	Goodhue	North Branch Middle Fork Zumbro River
07040004-975	04LM054	Zumbro River, Middle Fork, North Branch	Just upstream of Hwy 57, ~2.4 mi. W of Pine Island	Dodge	North Branch Middle Fork Zumbro River
07040004-975	12LM041	Zumbro River, Middle Fork, North Branch	Downstream of 511th Ave, in Pine Island	Goodhue	North Branch Middle Fork Zumbro River
07040004-992	12LM005	Zumbro River, Middle Fork	Upstream of CSAH 31, 2.5 mi. W of Oronoco	Olmsted	Lower Middle Fork Zumbro River
07040004-993	02LM027*	Zumbro River, Middle Fork	1 mi. downstream from Oronoco dam	Olmsted	Lower Middle Fork Zumbro River
07040004-515	04LM134	Trout Brook	Downstream of CSAH 1, 2 mi. Mazeppa	Wabasha	Mazeppa Creek

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07040004-611	04LM051	Trib. to Zumbro River, North Fork	Downstream of CR 80 (Jacobs Ave.), 6 miles SW of Kenyon	Rice	North Fork Zumbro River
07040004-970	12LM039	Zumbro River, North Fork	Upstream of CR 80, 5 mi. W of Kenyon	Rice	North Fork Zumbro River
07040004-614	12LM038	Trib. to Zumbro River, North Fork	Downstream of 230th Street, 4.5 mi. W of Kenyon	Rice	North Fork Zumbro River
07040004-971	10EM139	Zumbro River, North Fork	0.25 mi. upstream of Larson Ave, 3.5 mi. W of Kenyon	Rice	North Fork Zumbro River
07040004-964	12LM037	Trib. to Zumbro River, North Fork	Downstream of 10th Ave, 1.5 mi. W of Kenyon	Goodhue	North Fork Zumbro River
07040004-971	12LM036	Zumbro River, North Fork	Upstream of Hwy 60, .5 mi. W of Kenyon	Goodhue	North Fork Zumbro River
07040004-971	12LM106	Zumbro River, North Fork	Downstream of Hwy 60, .5 mi. W of Kenyon	Goodhue	North Fork Zumbro River
07040004-605	04LM071	Trib. to Zumbro River	1 mi. upstream of Hwy 56, 1 mi. N of Kenyon	Goodhue	North Fork Zumbro River
07040004-605	12LM101	Trib. to Zumbro River, North Fork	Upstream of Hwy 56, 1 mi. N of Kenyon	Goodhue	North Fork Zumbro River
07040004-606	04LM087	Silver Creek	Upstream of CSAH 12, 6 miles SW of Wanamingo	Goodhue	North Fork Zumbro River
07040004-608	12LM035	Spring Creek	Downstream of CSAH 1, 4 mi. SW of Wanamingo	Goodhue	North Fork Zumbro River
07040004-971	12LM034	Zumbro River, North Fork	Upstream of CSAH 30, 1.5 mi. NW of Wanamingo	Goodhue	North Fork Zumbro River
07040004-562	12LM033	Shingle Creek	Downstream of Hwy 60, .5 mi. S of Wanamingo	Goodhue	North Fork Zumbro River
07040004-579	04LM008	Trib. to Zumbro River, North Fork	Upstream of Hwy 60, 1 mi. S of Wanamingo	Goodhue	North Fork Zumbro River
07040004-971	12LM032	Zumbro River, North Fork	Upstream of 135th Ave, 1.5 mi. E of Wanamingo	Goodhue	North Fork Zumbro River
07040004-963	12LM031	Trib. to Zumbro River, North Fork	Upstream of Hwy 60, 2 mi. E of Wanamingo	Goodhue	North Fork Zumbro River
07040004-971	04LM088	North Fork Zumbro River	Just upstream of CSAH 10, 2 miles E of Zumbrota	Goodhue	North Fork Zumbro River
07040004-971	12LM003	Zumbro River, North Fork	Upstream of Hwy 60, in Mazeppa	Wabasha	North Fork Zumbro River
07040004-510	12LM002	Cold Creek	Downstream of CR 68, 5.5 mi. NE of Mazeppa	Wabasha	Cold Creek
07040004-576	04LM066	Pine Island Creek	upstream of CR 127, ~5.8 miles E of Pine Island	Wabasha	Upper Zumbro River
07040004-506	02LM034	Zumbro River	5 mi. E of Hammond	Wabasha	Upper Zumbro River
07040004-506	12LM021	Zumbro River	Upstream of CSAH 7, 4 mi. SE of Mazeppa	Wabasha	Upper Zumbro River
07040004-506	02LM028*	Zumbro River	Downstream CSAH 7, 3.5 mi. SE of Mazeppa	Wabasha	Upper Zumbro River
07040004-504	12LM020	Zumbro River	Adjacent to Bluff Valley Campground, 4 mi. E of Mazeppa	Wabasha	Upper Zumbro River
07040004-502	02LM003*	Zumbro River	0.8 mi. S of Zumbro Falls	Wabasha	Upper Zumbro River

AUID	Biological Station ID	Waterbody Name	Biological Station Location	County	Aggregated 12-digit HUC
07040004-502	02LM005	Zumbro River	bridge access at Hammond	Wabasha	Upper Zumbro River
07040004-502	02LM006*	Zumbro River	Theilman canoe access	Wabasha	Upper Zumbro River
07040004-568	12LM018	Spring Creek	Upstream of Twp Rd 80, 8 mi. S of Lake City	Wabasha	Spring Creek
07040004-764	12LM017	Trib. to Spring Creek	Downstream of Hwy 60, 4.5 mi. NW of Theilman	Wabasha	Spring Creek
07040004-570	12LM001	Spring Creek	Adjacent to CSAH 11, 3 mi. NW of Theilman	Wabasha	Spring Creek
07040004-569	12LM019	Trib. to Spring Creek	Downstream of Hwy 60, 4.5 mi. W of Theilman	Wabasha	Spring Creek
07040004-565	12LM016	Long Creek	Downstream of CSAH 8, 3.5 mi. SE of Millville	Wabasha	Lower Zumbro River
07040004-502	10EM107	Zumbro River	Adjacent to CSAH 11, 3 mi. NE of Millville	Wabasha	Lower Zumbro River
07040004-567	12LM015	Middle Creek	Adjacent to FR, W of CR 86, 3.5 mi. S of Theilman	Wabasha	Lower Zumbro River
07040004-542	12LM014	West Indian Creek	Upstream of CSAH 4, 4 mi. SE of Theilman	Wabasha	Lower Zumbro River
07040004-501	02LM007*	Zumbro River	Funk Ford canoe access	Wabasha	Lower Zumbro River
07040004-501	04LM137	Zumbro River	Downstream of CR 86, 6 mi. SW of Wabasha	Wabasha	Lower Zumbro River
07040004-584	12LM013	Trout Brook	Adajacent to Hwy 60, 6 mi. SW of Wabasha	Wabasha	Lower Zumbro River
07040004-585	12LM012	Trout Brook	Downstream of Hwy 60, 4.5 mi. SW of Wabasha	Wabasha	Lower Zumbro River
07040004-501	02LM009	Zumbro River	Kruger canoe access 2 mi. E of Dumfries	Wabasha	Lower Zumbro River
07040004-501	02LM008*	Zumbro River	canoe access near Kellogg	Wabasha	Lower Zumbro River
07040004-501	02LM035*	Zumbro River	canoe access near Kellogg	Wabasha	Lower Zumbro River

*MNDNR Biological monitoring station data used as ancillary information for assessment process.

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

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
***Aggregated HUC 12:* 0704000401-03 (*Upper South Fork Zumbro River*)**																							
07040004-981 Zumbro River, South Fork Headwaters to Unnamed cr	7.47	2Bg, 3C	IF	NA	NA	NA							IF										
07040004-982 Zumbro River, South Fork Unnamed cr to Unnamed cr	22.24	2Bg, 3C	FS	IF	NA	NA			MTS	MTS	NA	NA	MTS		NA							MTS	NA
07040004-969 Unnamed creek Unnamed cr to S Fk Zumbro R	2.06	2Bg, 3C	FS	IF	NA	NA			MTS	MTS	NA	NA			NA		IF						
07040004-968 Unnamed creek Unnamed cr to S Fk Zumbro R	3.24	2Bg, 3C	FS	IF	NA	NA			MTS	MTS	NA	NA			NA		IF						
07040004-983 Zumbro River, South Fork Unnamed cr to CR-117/60th Ave SW	2.63	2Bg, 3C	FS	IF	NA	NA			MTS	MTS	NA	NA			NA		IF						
07040004-984 Zumbro River, South Fork CR-117/60th St SW to Salem Cr	2.11	2Bg, 3C	NA	NA	NA	NA																	
Aggregated HUC 12:* 0704000401-04 *(Salem Creek)																							
07040004-597, Unnamed creek, Unnamed cr to Unnamed cr	1.85	2Bg, 3C	NS				MIBI, FIBI		EXS	EXS	NA	NA	NA		NA								
07040004-595, Unnamed creek, Unnamed cr to Unnamed cr	0.84	2Bg, 3C	NA										NA										
07040004-594, Unnamed creek, Unnamed cr to Unnamed cr	1.19	2Bg, 3C	FS						MTS	MTS	NA	NA	MTS		NA								

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12:* 0704000401-04 *(Salem Creek)																							
07040004-508, Salem Creek, Headwaters to T106 R17W S25, east line	4.73	2Bg, 3C	NA										MTS										
07040004-503, Salem Creek, T106 R16W S30, west line to S Fk Zumbro R	19.2	2Bg, 3C	NS	NS			MIBI		MTS	EXS	IF	MTS	MTS	MTS	MTS	MTS							EX
07040004-967, Unnamed creek, Unnamed cr to Unnamed cr	0.69	2Bg, 3C	FS						MTS	MTS	NA	NA			NA								
Aggregated HUC 12: 0704000401-02 (Bear Creek)																							
07040004-621, Unnamed creek, Unnamed cr to Unnamed cr	0.71	2Bg, 3C	NS				FIBI		EXS	MTS	IF	NA	MTS		IF								
07040004-539, Bear Creek, Headwaters to Willow Cr	16.3	2Bg, 3C	FS*	NA					MTS	MTS	IF	NA	MTS		IF								NA
07040004-556, Unnamed creek, Unnamed cr to Unnamed cr	1.20	2Bg, 3C	NS										EX										
07040004-619, Badger Run, Unnamed cr to Unnamed cr	2.60	2Bg, 3C	FS						MTS	MTS	NA	NA	NA		NA								
07040004-620, Badger Run, Unnamed cr to Bear Cr	1.74	2Bg, 3C	NS	NA			FIBI		EXS	NA	IF	NA	MTS		NA								
07040004-800, Unnamed creek, Unnamed cr to Willow Cr	3.34	2Bg, 3C	NS				MIBI		EXS	EXS	NA	NA	MTS		NA								

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS), *Existing Impairment.
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID), Stream Reach Name, Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12: 0704000401-02 (Bear Creek) (continued)																							
07040004-985, Willow Creek, Headwaters thru Willow R Reservoir 6A (55-0021-00)	7.46	2Bg, 3C	NA	NA									NA										IF
07040004-986, Willow Creek, Willow R Reservoir 6A to Bear Cr	6.98	2Bg, 3C	FS*	NA			Turbidity		MTS	MTS	NA	NA	MTS		NA								NA
07040004-538, Bear Creek, Willow Cr to S Fk Zumbro R	2.95	2Bg, 3C	FS*	NS			E. coli		MTS	MTS	MTS	EX	MTS	MTS	MTS	MTS							EX
07040004-623, Unnamed creek, Headwaters to Unnamed cr	1.75	2Bg, 3C	NA										MTS										
07040004-935, Badger Run, Home Cr to Unnamed cr	0.98	2Bg, 3C																					IF
Aggregated HUC 12: 0704000401-01 (Lower South Fork Zumbro River)																							
07040004-552, Silver Creek, Unnamed cr to Unnamed cr	5.84	2Bg, 3C	NS	NA					MTS	MTS		EX	MTS		IF		IF						NA
07040004-534, Zumbro River, South Fork, Old Oakwood Dam to Silver Lk Dam	0.83	2Bg, 3C	IF*										MTS										
07040004-535, Zumbro River, South Fork, Bear Cr to old Oakwood Dam location	0.54	2Bg, 3C		NA *									NA										
07040004-553, Silver Creek, Unnamed cr to Silver Lk (S Fk Zumbro R)	1.83	2Bg, 3C	IF*	NA									MTS										NA

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:															Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12: 0704000401-01 (Lower South Fork Zumbro River) (continued)																							
07040004-536, Zumbro River, South Fork, Salem Cr to Bear Cr	9.54	2Bg, 3C	NS	NS			MIBI		MTS	EXS		EX	MTS	IF	IF	IF	IF						NA
07040004-991, Cascade Creek, Unnamed cr to Unnamed cr	10.3	2Bg, 3C	NS	NA			FIBI, Turbidity		EXS	MTS		MTS	MTS		IF		IF						NA
07040004-633, Unnamed creek, Unnamed cr to Cascade Cr	1	2Bm, 3C	FS						MTS	MTS		NA			NA								
07040004-990, Cascade Creek, Headwaters to Unnamed cr	7.46	2Bg, 3C	NA										MTS										
07040004-581, Cascade Creek, Unnamed cr to S Fk Zumbro R	3	2Bg, 3C	NS	NA			MIBI		MTS	EXS		MTS	MTS		IF		IF						IF
07040004-604, Unnamed creek, Unnamed cr to S Fk Zumbro R	1.14	2Bg, 3C	NA										MTS										
07040004-507, Zumbro River, South Fork, Cascade Cr to Zumbro Lk	13.65	2Bg, 3C	NS	NS			MIBI Nutrients		MTS	EXS		EX	MTS	MTS	MTS	MTS	IF	IF		IF	IF		EX
07040004-602, Unnamed creek, Unnamed cr to Unnamed cr	0.55	2Bm, 3C	NA						NA	NA		NA	NA		IF								
07040004-601, Unnamed creek, Unnamed cr to Unnamed cr	2.13	2Bg, 3C	NA										MTS										

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

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12: 0704000402-02 (Dodge Center Creek)																							
07040004-545, Judicial Ditch 1, Headwaters to T106 R18W S27, west line	7.09	7									NA				NA								
07040004-987, Judicial Ditch 1 (Dodge Center Creek), T106 R18W S28, east line to Unnamed cr	4.68	2Bm, 3C	NS				MIBI		MTS	EXS	NA	NA	NA		NA								
07040004-988, Dodge Center Creek (Judicial Ditch 1), Unnamed cr to -92.99 44.0212	2.33	2Bm, 3C	NS				MIBI, FIBI		EXP	EXS	NA	NA			NA								
07040004-966, Judicial Ditch 7, Headwaters to Dodge Center Cr	4.67	2Bm, 3C	FS						MTS	MTS	NA	NA			NA								
07040004-989, Dodge Center Creek, -92.99, 44.0212 to S Br M Fk Zumbro R	24.47	2Bg, 3C	NS	NS			MIBI, E. coli, Turbidity		MTS	EXS	MTS	EX	MTS	MTS	MTS	MTS							EX
07040004-618, Henslin Creek, Unnamed cr to Dodge Center Cr	1.22	2Bg, 3C	NS				MIBI		MTS	EXS	NA	NA			NA								
07040004-617, Henslin Creek, Unnamed cr to Unnamed cr	1.23	2Bg, 3C	NA										IF										
07040004-546, Unnamed ditch (Ripley Ditch 6), Headwaters to JD 1	2.58	2Bg, 3C	IF										IF										
07040004-615, Henslin Creek, Unnamed cr to Unnamed cr	0.84	2Bg, 3C	NA										MTS										

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

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12: 0704000402-01 (South Branch Middle Fork Zumbro River)																							
07040004-980, Zumbro River, Middle Fork, South Branch, Unnamed cr to Dodge Center Cr	9.39	2Bg, 3C	NS				MIBI, Turbidity		MTS	EXS	IF	NA	EX		IF								
07040004-979, Zumbro River, Middle Fork, South Branch, Headwaters to Unnamed cr	6.07	2Bg, 3C									IF	NA	EX		NA								
07040004-976, Zumbro River, Middle Fork, South Branch, Dodge Center Cr to Unnamed cr	19.36	2Bg, 3C	NS				MIBI, TSS		MTS	EXS	MTS	EX	MTS		MTS	MTS						MTS	NA
07040004-549, Unnamed creek (Stuccy Creek), Headwaters to S Br M Fk Zumbro R	2.51	2Bg, 3C											MTS										
07040004-551, Masten Creek, Unnamed cr to S Br M Fk Zumbro R	0.33	2Bg, 3C	FS						MTS	MTS	NA	NA			NA								
07040004-550, Masten Creek, Headwaters to Unnamed cr	4.56	2Bg, 3C											MTS										
07040004-799, Unnamed creek, Headwaters to Masten Cr	5.46	2Bg, 3C		NA									MTS										
07040004-527, Unnamed creek, T107 R15W S29, south line to S Br M Fk Zumbro R	3.24	7									NA				NA								
07040004-977, Zumbro River, Middle Fork, South Branch, Unnamed cr to 75th St NW	2.56	2Bg, 3C	FS	IF					MTS	MTS	IF	NA	MTS		IF								

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

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12: 0704000402-01 (South Branch Middle Fork Zumbro River) (continued)																							
07040004-978, Zumbro River, Middle Fork, South Branch, 75th St NW to M Fk Zumbro R	8.56	2Bg, 3C	FS	NS			E. coli		MTS	MTS	IF	MTS	MTS	MTS	MTS	MTS						MTS	EX
Aggregated HUC 12:0704000403-02 - (Upper Middle Fork Zumbro River)																							
07040004-973, Zumbro River, Middle Fork, T108 R18W S20, west line to N Br M Fk Zumbro R	34.5	2Bg, 3C	NS	NS			MIBI, E. coli, Turbidity		MTS	EXS	MTS	EXS	IF	MTS	MTS	MTS							EX
07040004-578, Unnamed creek, Headwaters to M Fk Zumbro R	3.70	2Bm, 3C	NS	IF			MIBI		MTS	EXS	NA	NA	NA		NA								
07040004-909, Unnamed creek, Unnamed cr to M Fk Zumbro R	3.38	2Bg, 3C	FS						MTS	MTS	NA	NA			NA								
07040004-544, Unnamed creek, T108 R17W S17, west line to T108 R17W S21, east line	2.54	7	NA								MTS				NA								
07040004-524, Unnamed creek, T108 R17W S22, west line to M Fk Zumbro R	1.67	2Bg, 3C	FS	IF					MTS	MTS	NA	NA			NA								
07040004-555, Milliken Creek, Unnamed cr to M Fk Zumbro R	4.72	2Bg, 3C	NS										EX										
07040004-554, Milliken Creek, Unnamed cr to Unnamed cr	5.72	2Bg, 3C	FS*						MTS	MTS	IF	MTS	MTS		IF								
07040004-563, Harkcom Creek, T108 T16W S32, south line to T108 R16W S12, east line	10.2	2Bg, 3C	FS	IF					MTS	MTS	IF	NA	MTS		NA								

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:														Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12:0704000403-02 (Upper Middle Fork Zumbro River) (continued)																							
07040004-577, Unnamed creek, Headwaters to M Fk Zumbro R	1.95	2Bm, 3C	NA						MTS	NA		IF	IF		IF								
07040004-972, Zumbro River, Middle Fork, Headwaters to T108 R18W S19, east line	4.47	2Bg, 3C	FS																				
Aggregated HUC 12:0704000403-03 (North Branch Middle Fork Zumbro River)																							
07040004-975, Zumbro River, Middle Fork, North Branch, T109 R18W S36, north line to M Fk Zumbro R	26.48	2Bg, 3C	FS*	IF					MTS	MTS	MTS	MTS	MTS	MTS	MTS	MTS							IF
07040004-965, Unnamed creek, Unnamed cr to Devlin Cr	2.33	2Bg, 3C	FS						MTS	MTS	NA	NA			NA								
07040004-974, Zumbro River, Middle Fork, North Branch, Headwaters to T109 R18W S25, south line	4.64	2Bg, 3C																					
Aggregated HUC 12:0704000403-01 (Lower Middle Fork Zumbro River)																							
07040004-992, Zumbro River, Middle Fork, N Br M Fk Zumbro R to S Br M Fk Zumbro R	9.01	2Bg, 3C	IF	NS			E. coli		MTS	MTS	MTS			MTS	MTS	MTS	EX	MTS					EX

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

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:															Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12:0704000405-02 (Spring Creek) (continued)																								
07040004-769, Unnamed creek (Spring Creek Tributary), T110 R12W S28, south line to Spring Cr	0.60	1B, 2Ag, 3B	NS	NS			E. coli, TSS				IF		EX		NA								EX
07040004-570, Spring Creek, Unnamed cr to Zumbro R	1.96	1B, 2Ag, 3B	NS	NS			E. coli, FIBI		EXP	MTS	IF	EX	EX	MTS	MTS	MTS							EX
07040004-569, West Albany Creek, T110 T13W S23, north line to Spring Cr	7.78	1B, 2Ag, 3B	FS	IF					MTS	MTS	NA	NA	NA		NA								
07040004-764, Unnamed creek (Spring Creek Tributary), Unnamed cr to Unnamed cr	1.10	2Bg, 3C	IF						MTS	EXS	NA				NA								
Aggregated HUC 12:0704000405-01 (Lower Zumbro River)																							
07040004-502, Zumbro River, Cold Cr to West Indian Cr	24.21	2Bg, 3C	FS	IF					MTS	MTS	EX	IF	MTS	MTS	MTS	MTS						MTS	IF
07040004-561, Silver Spring Creek, Headwaters to Zumbro R	10.75	2Bg, 3C									NA	NA	NA		NA								
07040004-565, Long Creek, T109 R12W S28, south line to Zumbro R	8.94	1B, 2Ag, 3B	FS	NS			E. coli		MTS	MTS	NA	NA	IF		MTS								EX
07040004-567, Middle Creek, T109 T11W S18, south line to Zumbro R	4.88	1B, 2Ag, 3B	FS	NS			E. coli		MTS	MTS	IF	NA	IF		IF								EX
07040004-542, West Indian Creek, T109 R11W S21, south line to T109 R11W S6, north line	6.52	1B, 2Ag, 3B	FS	NS			E. coli		MTS	MTS	IF	EX	EX		MTS								EX

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

AUID DESCRIPTIONS		USES							Aquatic Life Indicators:															Aquatic Recreation Indicators:
Assessment Unit ID (AUID) Stream Reach Name Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	TSS	Secchi Tube	Chloride	pH	AmmoniaNH3	Phosphorous	Chlorophyl A	Chlorophyl A Uncorrected	BOD	DO Flux	Pesticides	Bacteria
Aggregated HUC 12:0704000405-01 (Lower Zumbro River) (continued)																							
07040004-501, Zumbro River, West Indian Cr to Mississippi R	23.93	2Bg, 3C	NS	IF					MTS	MTS	MTS	EX	EX	MTS	MTS	MTS							IF
07040004-571, Trout Brook, T110 R11W S5, west line to T110 R11W S8, east line	2.10	1B, 2Ag, 3B	IF	NS			E. coli				NA		IF		NA								Ex
07040004-584, Trout Brook, T110 R11W S9, west line to Hope Coulee	2.46	2Bg, 3C	FS	IF					MTS	NA	NA	NA			NA								
07040004-585, Trout Brook, Hope Coulee to Zumbro R	1.35	2Bm, 3C	NS	IF			FIBI		EXS	EXS	NA	NA			NA								

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedence (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2014 reporting cycle; = new impairment; = full support of designated use.

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

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	Max Depth (m)	Watershed Area (acres)	% Littoral	Mean depth (m)	AQR Support Status	AQL Support Status
55-0004-00	Zumbro	Olmsted	0704000405-03	WCBP	697.4	14.6	540,667	37%	3.0*	NS	IF
74-0001-00	Rice	Steele	0704000402-01	WCBP	609.2	1.5	4,316	100%	1.0*	NS	IF

Abbreviations:

FS – Full Support

NS – Non-Support

IF – Insufficient Information

N/A – Not Assessed

WCBP – Western Corn Belt Plains

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

*These depths were created by MPCA Staff.

Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

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

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

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Use Class	Threshold	FIBI	Visit Date
Aggregated HUC 12: 0704000401-03 (Upper South Fork Zumbro River)								
07040004-982	12LM074	Zumbro River, South Fork	17.37	3	WWg	55	85	7/12/2012
07040004-969	12LM073	Unnamed creek	11.67	3	WWg	55	80	6/11/2012
07040004-982	10EM155	Zumbro River, South Fork	52.1	2	WWg	50	86	6/9/2010
07040004-982	12LM071	Zumbro River, South Fork	55.74	2	WWg	50	74	6/25/2012
07040004-968	12LM072	Unnamed creek	7.06	3	WWg	55	80	7/16/2012
07040004-968	12LM072	Unnamed creek	7.06	3	WWg	55	88	6/27/2012
07040004-983	12LM070	Zumbro River, South Fork	73.42	2	WWg	50	77	6/13/2012
Aggregated HUC 12: 0704000401-04 (Salem Creek)								
07040004-503	12LM063	Salem Creek	22.95	3	WWg	55	85	6/13/2012
07040004-597	04LM010	Unnamed creek	6.98	3	WWg	55	43	6/22/2004
07040004-594	12LM062	Unnamed creek	13.64	3	WWg	55	81	7/17/2012
07040004-503	04LM122	Salem Creek	45.2	2	WWg	50	67	8/4/2004
07040004-503	04LM122	Salem Creek	45.2	2	WWg	50	69	6/30/2004
07040004-967	12LM061	Unnamed creek	5.89	3	WWg	55	80	6/26/2012
07040004-503	12LM009	Salem Creek	55.51	2	WWg	50	75	6/12/2012
07040004-503	12LM009	Salem Creek	55.51	2	WWg	50	78	7/23/2012
Aggregated HUC 12: 0704000401-02 (Bear Creek)								
07040004-621	12LM081	Unnamed creek	5.44	3	WWg	55	19	6/12/2012
07040004-539	04LM126	Bear Creek	13.94	3	WWg	55	41	6/30/2004
07040004-539	04LM126	Bear Creek	13.94	3	WWg	55	54	6/12/2012
07040004-539	12LM078	Bear Creek	30.37	2	WWg	50	53	6/13/2012
07040004-619	04LM056	Badger Run	12.71	3	WWg	55	57	6/30/2004

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi²	Fish Class	Use Class	Threshold	FIBI	Visit Date
Aggregated HUC 12: 0704000401-02 (Bear Creek) (continued)								
07040004-620	12LM077	Badger Run	15.63	3	WWg	55	36	6/12/2012
07040004-986	12LM079	Willow Creek	19.43	3	WWg	55	65	7/18/2012
07040004-986	04LM024	Willow Creek	19.28	3	WWg	55	70	7/1/2004
07040004-800	12LM080	Unnamed creek	4.98	3	WWg	55	0	6/12/2012
07040004-538	12LM008	Bear Creek	78.08	2	WWg	50	43	7/18/2012
07040004-538	12LM100	Bear Creek	78.52	2	WWg	50	54	6/27/2012
Aggregated HUC 12: 0704000401-01 (Lower South Fork Zumbro River Watershed)								
07040004-536	12LM069	Zumbro River, South Fork	145.14	2	WWg	50	66	6/12/2012
07040004-991	12LM102	Cascade Creek	17.93	3	WWg	55	49	6/27/2012
07040004-991	12LM102	Cascade Creek	17.93	3	WWg	55	55	7/31/2012
07040004-991	04LM123	Cascade Creek	17.89	3	WWg	55	54	6/30/2004
07040004-991	04LM123	Cascade Creek	17.89	3	WWg	55	65	8/23/2004
07040004-633	12LM068	Unnamed creek	11.57	3	WWm	33	51	6/12/2012
07040004-581	04LM124	Cascade Creek	38.01	2	WWg	50	59	8/10/2004
07040004-552	12LM067	Silver Creek	17.72	3	WWg	55	70	6/12/2012
07040004-507	12LM066	Zumbro River, South Fork	300.97	1	WWg	49	57	6/28/2012
07040004-507	04LM125	Zumbro River, South Fork	312.39	1	WWg	49	60	9/1/2004
07040004-602	04LM003	Unnamed creek	8.83	3	WWm	33	27	6/30/2004
07040004-507	12LM007	Zumbro River, South Fork	341.4	1	WWg	49	48	6/27/2012
07040004-507	12LM007	Zumbro River, South Fork	341.4	1	WWg	49	58	7/31/2012
Aggregated HUC 12: 0704000402-02 (Dodge Center Creek)								
07040004-545	12LM059	Judicial Ditch 1	1.09	3	LRVW	No expectation	67.2	6/26/2012
07040004-987	12LM060	Judicial Ditch 1	11.82	3	WWm	33	54.4	6/25/2012

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Use Class	Threshold	FIBI	Visit Date
Aggregated HUC 12: 0704000402-02 (Dodge Center Creek) (continued)								
07040004-987	04LM140	Judicial Ditch 1	22.27	3	WWm	33	37.4	6/21/2004
07040004-988	12LM057	Dodge Center Creek	38.42	2	WWm	35	32.4	6/25/2012
07040004-966	12LM058	Judicial Ditch 7	8.90	7	WWm	15	25.6	6/25/2012
07040004-989	12LM056	Dodge Center Creek	65.25	2	WWg	50	51.1	7/2/2012
07040004-619	12LM055	Henslin Creek	10.23	3	WWg	55	59.2	6/11/2012
07040004-989	12LM054	Dodge Center Creek	83.77	2	WWg	50	49.9	7/3/2012
07040004-989	12LM053	Dodge Center Creek	86.76	2	WWg	50	57.6	7/3/2012
07040004-989	12LM010	Dodge Center Creek	89.71	2	WWg	50	55.6	7/2/2012
Aggregated HUC 12: 0704000402-01 (South Branch Middle Fork Zumbro River)								
07040004-979	07LM021	Zumbro River, South Branch Middle Fork	15.56	3	WWg	55	67.9	8/16/2007
07040004-980	12LM052	Zumbro River, Middle Fork, South Branch	29.73	3	WWg	55	62.2	7/11/2012
07040004-976	12LM051	Zumbro River, Middle Fork, South Branch	134.41	2	WWg	50	58.5	7/2/2012
07040004-551	12LM050	Masten Creek	12.08	3	WWg	55	83.1	7/31/2012
07040004-527	04LM121	Unnamed Stream	3.80	3	WWg	55	37.4	7/1/2004
07040004-976	12LM084	Zumbro River, Middle Fork, South Branch	187.2	2	WWg	50	74.5	6/14/2012
07040004-976	12LM084	Zumbro River, Middle Fork, South Branch	187.2	2	WWg	50	77.8	7/30/2012
07040004-977	12LM049	Zumbro River, Middle Fork, South Branch	198.65	2	WWg	50	77.4	7/11/2012
07040004-978	10EM095	Zumbro River, Middle Fork, South Branch	201.10	2	WWg	50	74.6	6/10/2012
07040004-978	12LM006	Zumbro River, Middle Fork, South Branch	212.76	2	WWg	50	69.3	7/16/2012
Aggregated HUC 12: 0704000403-02 (Upper Middle Fork Zumbro River)								
07040004-577	04LM053	Trib. to Zumbro River, Middle Fork	1.26	3	WWm	33	34.4	6/12/2004
07040004-973	07LM022	Zumbro River, Middle Fork	9.95	3	WWg	55	53.8	8/15/2007
07040004-973	04LM142	Zumbro River, Middle Fork	10.86	3	WWg	55	56.9	6/22/2004
07040004-578	04LM028	Trib. to Zumbro River, Middle Fork	3.34	3	WWm	33	50.1	6/22/2004

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Use Class	Threshold	FIBI	Visit Date
Aggregated HUC 12: 0704000403-02 (Upper Middle Fork Zumbro River) (continued)								
07040004-973	12LM045	Zumbro River, Middle Fork	28.64	3	WWg	55	84.4	7/18/2012
07040004-909	12LM044	Trib. to Zumbro River, Middle Fork	14.99	3	WWg	55	81.4	6/14/2012
07040004-544	12LM076	Unnamed Ditch	3.26	3	LRWV	No expectation	51.7	6/28/2012
07040004-524	12LM076	Unnamed Ditch	3.26	3	LRWV	No expectation	50.4	7/31/2012
0704004-524	12LM075	Unnamed Ditch	4.57	3	WWg	55	55	7/18/2012
07040004-973	12LM046	Zumbro River, Middle Fork	68.26	2	WWg	50	70.9	7/12/2012
07040004-554	04LM141	Miliken Creek	27.72	3	WWg	55	81.6	6/23/2004
07040004-563	12LM047	Harkom Creek	13.09	3	WWg	55	62.9	6/12/2012
07040004-973	12LM004	Zumbro River, Middle Fork	128.51	2	WWg	50	71.7	7/17/2012
Aggregated HUC 12: 0704000403-03 (North Branch Middle Fork Zumbro River)								
07040004-975	12LM042	Zumbro River, Middle Fork, North Branch	19.20	3	WWg	55	83.8	7/10/2012
07040004-965	12LM043	Trib. to Devlin Creek	4.43	3	WWg	55	72.5	6/14/2012
07040004-975	04LM054	Zumbro River, Middle Fork, North Branch	39.58	2	WWg	50	74.1	7/21/2004
07040004-975	12LM041	Zumbro River, Middle Fork, North Branch	55.82	2	WWg	50	66.7	7/10/2012
Aggregated HUC 12: 0704000403-01 (Lower Middle Fork Zumbro River)								
07040004-992	12LM005	Zumbro River, Middle Fork	202.30	2	WWg	50	56.4	7/10/2012
07040004-519	02LM027	Zumbro River	427.54	1	WWg	49	75.9	8/13/2012
Aggregated HUC 12: 0704000404-02 (Mazeppa Creek)								
07040004-515	12LM011	Trout Brook	48.98	10	Cwg	50	60.1	6/26/2012
07040004-515	04LM134	Trout Brook	49.13	10	CWg	50	69.6	7/7/2004
Aggregated HUC 12: 0704000404-01 (North Fork Zumbro River)								
07040004-611	04LM051	Trib. to Zumbro River, North Fork	6.98	3	WWg	55	68	8/3/2004
Aggregated HUC 12: 0704000404-01 (North Fork Zumbro River) (Continued)								
07040004-970	12LM039	Zumbro River, North Fork	16.81	3	WWm	33	73.5	7/10/2012
07040004-614	12LM038	Trib. to Zumbro River, North Fork	16.99	3	WWg	55	71.6	7/10/2012
07040004-971	10EM139	Zumbro River, North Fork	37.06	2	WWg	50	60.2	6/8/2010

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Use Class	Threshold	FIBI	Visit Date
07040004-964	12LM037	Trib. to Zumbro River, North Fork	5.18	3	WWg	55	62	7/10/2012
07040004-971	12LM036	Zumbro River, North Fork	52.66	2	WWg	50	72.6	7/2/2012
07040004-971	12LM036	Zumbro River, North Fork	52.66	2	WWg	50	67.4	7/23/2012
07040004-971	12LM106	Zumbro River, North Fork	54.16	2	WWg	50	62.3	9/5/2012
07040004-605	04LM071	Trib. to Zumbro River	16.26	3	WWg	55	77.9	8/18/2004
07040004-605	12LM101	Trib. to Zumbro River, North Fork	62.35	10	WWg	50	48.4	7/18/2012
07040004-606	04LM087	Silver Creek	5.45	3	WWg	55	67.8	8/23/2004
07040004-606	04LM087	Silver Creek	5.45	3	WWg	55	71.8	6/24/2004
07040004-608	12LM035	Spring Creek	10.04	3	WWg	55	59.4	6/13/2012
07040004-971	12LM034	Zumbro River, North Fork	105.99	2	WWg	50	64.8	6/11/2012
07040004-562	12LM033	Shingle Creek	7.30	3	WWg	55	73.3	6/13/2012
07040004-579	04LM008	Trib. to Zumbro River, North Fork	0.87	3	WWg	55	63	6/23/2004
07040004-971	12LM032	Zumbro River, North Fork	119.84	2	WWg	50	61.8	7/9/2012
07040004-963	12LM031	Trib. to Zumbro River, North Fork	8.04	3	WWg	55	84.3	6/13/2012
07040004-963	12LM031	Trib. to Zumbro River, North Fork	8.04	2	WWg	50	83.7	7/24/2012
07040004-971	04LM088	North Fork Zumbro River	160.54	2	WWg	50	43.9	7/22/2004
07040004-971	12LM003	Zumbro River, North Fork	173.99	2	WWg	50	90.1	7/17/2012
Aggregated HUC 12: 0704000405-04 (Cold Creek)								
07040004-510	12LM002	Cold Creek	44.37	10	CWg	50	91.7	6/26/2012
Aggregated HUC 12: 0704000405-03 (Upper Zumbro River)								
07040004-576	04LM066	Pine Island Creek	27.64	3	WWg	55	62.7	6/21/2004
07040004-506	02LM034	Zumbro River	845.86	1	WWg	49	73.4	9/11/2002
07040004-506	12LM021	Zumbro River	848.65	1	WWg	49	61	8/29/2012
07040004-506	12LM021	Zumbro River	848.65	1	WWg	49	75.3	7/23/2012
07040004-506	02LM028	Zumbro River	850.99	1	WWg	49	66.8	8/14/2002
07040004-504	12LM020	Zumbro River	1101.52	1	WWg	49	86.1	7/19/2012
07040004-502	02LM003	Zumbro River	1155.84	1	WWg	49	62.2	6/10/2002

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Use Class	Threshold	FIBI	Visit Date
07040004-502	02LM005	Zumbro River	1165.07	1	WWg	49	69.6	6/17/2002
07040004-502	02LM005	Zumbro River	1165.07	1	WWg	49	80.8	7/19/2012
07040004-502	02LM006	Zumbro River	1336.80	1	WWg	49	48.8	6/18/2002
Aggregated HUC 12: 0704000405-02 (Spring Creek)								
07040004-568	12LM018	Spring Creek	18.33	10	WWg	50	49.3	7/17/2012
07040004-764	12LM017	Trib. to Spring Creek	10.49	3	CWg	55	65	7/11/2012
07040004-570	12LM001	Spring Creek	62.35	10	CWg	50	48.4	7/18/2012
07040004-569	12LM019	Trib. to Spring Creek	25.04	10	CWg	50	59.8	7/11/2012
Aggregated HUC 12: 0704000405-01 (Lower Zumbro River)								
07040004-565	12LM016	Long Creek	28.51	10	CWg	50	76.4	7/11/2012
07040004-502	10EM107	Zumbro River	1243.11	1	WWg	49	63.7	8/23/2010
07040004-567	12LM015	Middle Creek	13.30	10	CWg	50	96.5	7/9/2012
07040004-542	12LM014	West Indian Creek	23.98	10	CWg	50	74.4	7/12/2012
07040004-501	02LM007	Zumbro River	1377.33	1	WWg	49	44.3	6/18/2002
07040004-501	04LM137	Zumbro River	1378	1	WWg	49	82.5	8/31/2004
Aggregated HUC 12: 0704000405-01 (Lower Zumbro River) (continued)								
07040004-501	04LM137	Zumbro River	1378	1	WWg	49	70.5	7/30/2012
07040004-584	12LM013	Trout Brook	14.66	3	WWg	55	60.4	7/11/2012
07040004-585	12LM012	Trout Brook	21.58	3	WWg	55	23.3	7/9/2012
07040004-501	02LM009	Zumbro River	1407.91	1	WWg	49	65.2	8/20/2012
07040004-501	02LM008	Zumbro River	1420.52	1	WWg	49	60.9	6/19/2002
07040004-501	02LM035	Zumbro River	1420.52	1	WWg	49	67.8	9/24/2002

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

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Use Class	Threshold	MIBI	Visit Date
Aggregated HUC 12: 0704000401-03 (Upper South Fork Zumbro River)								
07040004-982	12LM074	Zumbro River, South Fork	17.37	6	WWg	43	59	7/3/2012
07040004-969	12LM073	Unnamed creek	11.67	5	WWg	37	41.9	7/31/2012
07040004-982	10EM155	Zumbro River, South Fork	52.1	5	WWg	37	46.1	8/24/2010
07040004-982	12LM071	Zumbro River, South Fork	55.74	6	WWg	43	53.8	8/1/2012
07040004-968	12LM072	Unnamed creek	7.06	5	WWg	37	61.5	8/1/2012
07040004-968	12LM072	Unnamed creek	7.06	5	WWg	37	54.1	8/14/2014
07040004-983	12LM070	Zumbro River, South Fork	73.42	5	WWg	37	70.6	8/1/2012
Aggregated HUC 12: 0704000401-04 (Salem Creek)								
07040004-503	12LM063	Salem Creek	22.95	5	WWg	37	39.7	8/7/2012
07040004-503	12LM063	Salem Creek	22.95	5	WWg	37	45.4	8/7/2012
07040004-597	04LM010	Unnamed creek	6.98	6	WWg	43	36.2	8/23/2004
07040004-594	12LM062	Unnamed creek	13.64	5	WWg	37	34.9	8/7/2012
07040004-967	12LM061	Unnamed creek	5.89	6	WWg	43	47.6	
07040004-503	12LM009	Salem Creek	55.51	6	WWg	43	40	8/2/2012
07040004-503	12LM009	Salem Creek	55.51	6	WWg	43	40.7	8/2/2012
Aggregated HUC 12: 0704000401-02 (Bear Creek)								
07040004-621	12LM081	Unnamed creek	5.44	6	WWg	43	63.4	7/31/2012
07040004-539	04LM126	Bear Creek	13.94	6	WWg	43	31.9	8/17/2004
07040004-539	04LM126	Bear Creek	13.94	6	WWg	43	55.8	7/31/2012
07040004-539	12LM078	Bear Creek	30.37	6	WWg	43	68.6	7/31/2012
07040004-619	04LM056	Badger Run	12.71	5	WWg	37	38.2	8/31/2014
07040004-619	04LM056	Badger Run	12.71	5	WWg	37	38.2	8/31/2004
07040004-620	12LM077	Badger Run	15.63	6	WWg	43	60.4	7/31/2012

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Use Class	Threshold	MIBI	Visit Date
Aggregated HUC 12: 0704000401-02 (Bear Creek) (continued)								
07040004-986	12LM079	Willow Creek	19.43	5	WWg	37	42.7	7/31/2012
07040004-986	04LM024	Willow Creek	19.28	6	WWg	43	54.4	8/17/2004
07040004-800	12LM080	Unnamed creek	4.98	5	WWg	37	21.8	7/31/2012
07040004-538	12LM100	Bear Creek	78.52	5	WWg	37	47.1	8/2/2012
Aggregated HUC 12: 0704000401-01 (Lower South Fork Zumbro River Watershed)								
07040004-536	12LM069	Zumbro River, South Fork	145.14	6	WWg	43	38.5	8/1/2012
07040004-991	12LM102	Cascade Creek	17.93	5	WWg	37	54.5	8/2/2012
07040004-991	04LM123	Cascade Creek	17.89	5	WWg	37	43.8	8/16/2014
07040004-633	12LM068	Unnamed creek	11.57	5	WWm	24	28.3	7/31/2012
07040004-581	04LM124	Cascade Creek	38.01	5	WWg	37	34.4	8/16/2004
07040004-552	12LM067	Silver Creek	17.72	5	WWg	37	45.3	7/31/2012
07040004-507	12LM066	Zumbro River, South Fork	300.97	5	WWg	37	21.5	8/2/2012
07040004-507	04LM125	Zumbro River, South Fork	312.39	6	WWg	43	52.4	8/19/2004
07040004-602	04LM003	Unnamed creek	8.83	6	WWm	30	21	8/17/2004
07040004-507	12LM007	Zumbro River, South Fork	341.4	6	WWg	43	54.4	8/1/2012
Aggregated HUC 12: 0704000402-02 (Dodge Center Creek)								
07040004-	12LM059	Judicial Ditch 1	1.09	6	LRVW	43	15.5	7/31/2012
07040004-987	12LM060	Judicial Ditch 1	11.82	6	WWm	30	18.5	7/31/2012
07040004-987	04LM140	Judicial Ditch 1	22.27	6	WWm	30	33.2	8/25/2004
07040004-988	12LM057	Dodge Center Creek	38.42	6	WWm	30	24.6	8/7/2012
07040004-966	12LM058	Judicial Ditch 7	8.90	6	WWm	30	32.8	7/3/2012
07040004-989	12LM056	Dodge Center Creek	65.25	5	WWg	37	38.9	8/2/2012
07040004-619	12LM055	Henslin Creek	10.23	5	WWg	37	30.4	8/2/2012

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Use Class	Threshold	MIBI	Visit Date
Aggregated HUC 12: 0704000402-02 (Dodge Center Creek) (continued)								
07040004-989	12LM054	Dodge Center Creek	83.77	6	WWg	43	30.2	8/2/2012
07040004-989	12LM053	Dodge Center Creek	86.76	5	WWg	37	41.1	8/2/2015
07040004-989	12LM010	Dodge Center Creek	89.71	5	WWg	37	Sample lost	
Aggregated HUC 12: 0704000402-01 (South Branch Middle Fork Zumbro River)								
07040004-980	12LM052	Zumbro River, Middle Fork, South Branch	29.73	5	WWg	37	24.8	8/2/2012
07040004-976	12LM051	Zumbro River, Middle Fork, South Branch	134.41	5	WWg	37	34.4	8/7/2012
07040004-976	12LM084	Zumbro River, Middle Fork, South Branch	187.2	5	WWg	37	56.9	7/30/2012
07040004-551	12LM050	Masten Creek	12.08	5	WWg	37	41.7	8/17/2004
07040004-551	12LM050	Masten Creek	12.08	5	WWg	37	38.4	8/17/2012
07040004-527	04LM121	Unnamed Stream	3.80	5	WWg	37	27.6	8/7/2012
07040004-977	12LM049	Zumbro River, Middle Fork, South Branch	198.65	5	WWg	37	67.1	8/1/2012
07040004-978	10EM095	Zumbro River, Middle Fork, South Branch	201.10	5	WWg	37	51.5	8/10/2010
07040004-978	12LM006	Zumbro River, Middle Fork, South Branch	212.76	5	WWg	37	46.7	8/1/2012
Aggregated HUC 12: 0704000403-02 (Upper Middle Fork Zumbro River)								
07040004-577	04LM053	Trib. to Zumbro River, Middle Fork	1.26	6	WWg	43	25.3	8/25/2004
07040004-973	04LM142	Zumbro River, Middle Fork	10.86	5	WWg	37	29	8/25/2004
07040004-578	04LM028	Trib. to Zumbro River, Middle Fork	3.34	6	WWm	43	23	8/25/2004
07040004-973	12LM045	Zumbro River, Middle Fork	28.64	5	WWg	37	41.8	8/7/2012
07040004-909	12LM044	Trib. to Zumbro River, Middle Fork	14.99	5	WWg	37	50.4	8/7/2012
07040004-973	12LM046	Zumbro River, Middle Fork	68.26	5	WWg	37	33.7	8/8/2012
07040004-554	04LM141	Miliken Creek	27.72	5	WWg	37	42.4	8/17/2004
07040004-554	04LM141	Miliken Creek	27.72	5	WWg	37	40.1	8/8/2012

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Use Class	Threshold	MIBI	Visit Date
Aggregated HUC 12: 0704000403-02 (Upper Middle Fork Zumbro River) (continued)								
07040004-563	12LM047	Harkom Creek	13.09	5	WWg	37	46.3	8/8/2012
07040004-973	12LM004	Zumbro River, Middle Fork	128.51	5	WWg	37	48.8	8/1/2012
Aggregated HUC 12: 0704000403-03 (North Branch Middle Fork Zumbro River)								
07040004-975	12LM042	Zumbro River, Middle Fork, North Branch	19.20	5	WWg	37	49.8	8/8/2012
07040004-965	12LM043	Trib. to Devlin Creek	4.43	5	WWg	37	45	8/8/2012
07040004-975	04LM054	Zumbro River, Middle Fork, North Branch	39.58	5	WWg	37	41.3	8/17/2004
07040004-975	12LM041	Zumbro River, Middle Fork, North Branch	55.82	5	WWg	37	56	8/1/2012
Aggregated HUC 12: 0704000403-01 (Lower Middle Fork Zumbro River)								
07040004-992	12LM005	Zumbro River, Middle Fork	202.30	6	WWg	43	62.8	8/1/2012
Aggregated HUC 12: 0704000404-02 (Mazeppa Creek)								
07040004-515	12LM011	Trout Brook	48.98	9	CWg	43	33.1	8/9/2012
Aggregated HUC 12: 0704000404-01 (North Fork Zumbro River)								
07040004-970	12LM039	Zumbro River, North Fork	16.81	6	WWm	30	27.5	8/9/2012
07040004-970	12LM039	Zumbro River, North Fork	16.81	6	WWm	30	33.1	8/9/2012
07040004-614	12LM038	Trib. to Zumbro River, North Fork	16.99	5	WWg	37	39.4	8/9/2012
07040004-971	10EM139	Zumbro River, North Fork	37.06	6	WWg	43	34.8	8/10/2010
07040004-964	12LM037	Trib. to Zumbro River, North Fork	5.18	5	WWg	37	26.5	8/13/2012
07040004-605	12LM101	Trib. to Zumbro River, North Fork	62.35	5	WWg	37	23.6	8/9/2012
07040004-606	04LM087	Silver Creek	5.45	6	WWg	43	34.8	8/17/2004
07040004-608	12LM035	Spring Creek	10.04	5	WWg	37	37.1	8/9/2012
07040004-971	12LM034	Zumbro River, North Fork	105.99	5	WWg	37	27.4	8/9/2012
Aggregated HUC 12: 0704000404-01 (North Fork Zumbro River) (continued)								
07040004-562	12LM033	Shingle Creek	7.30	5	WWg	37	26	8/2/2012
07040004-579	04LM008	Trib. to Zumbro River, North Fork	0.87	5	WWg	37	42.8	8/17/2004
07040004-971	12LM032	Zumbro River, North Fork	119.84	6	WWg	43	65.7	8/9/2012
07040004-963	12LM031	Trib. to Zumbro River, North Fork	8.04	6	WWg	43	66.5	8/9/2012

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Use Class	Threshold	MIBI	Visit Date
07040004-963	12LM031	Trib. to Zumbro River, North Fork	8.04	6	WWg	43	58.8	8/21/2014
07040004-971	04LM088	North Fork Zumbro River	160.54	6	WWg	43	18.7	8/30/2004
Aggregated HUC 12: 0704000405-04 (Cold Creek)								
07040004-510	12LM002	Cold Creek	44.37	9	CWg	31	44.9	7/30/2012
Aggregated HUC 12: 0704000405-03 (Upper Zumbro River)								
07040004-506	12LM021	Zumbro River	848.65	2	WWg	31	44.9	8/9/2012
07040004-504	12LM020	Zumbro River	1101.52	2	WWg	31	36.4	7/30/2012
07040004-502	02LM005	Zumbro River	1165.07	2	WWg	31	56.3	8/9/2012
Aggregated HUC 12: 0704000405-02 (Spring Creek)								
07040004-568	12LM018	Spring Creek	18.33	9	WWg	43	28	8/1/2012
07040004-764	12LM017	Trib. to Spring Creek	10.49	5	CWg	37	26.6	8/1/2012
07040004-570	12LM001	Spring Creek	62.35	9	CWg	43	51.2	8/1/2012
07040004-569	12LM019	Trib. to Spring Creek	25.04	9	CWg	43	46.9	8/1/2012
Aggregated HUC 12: 0704000405-01 (Lower Zumbro River)								
07040004-565	12LM016	Long Creek	28.51	9	CWg	43	45.2	8/1/2012
07040004-502	10EM107	Zumbro River	1243.11	2	WWg	31	23.8	8/19/2010
07040004-567	12LM015	Middle Creek	13.3	9	CWg	43	43.8	8/1/2012
07040004-542	12LM014	West Indian Creek	23.98	9	CWg	43	66.3	8/1/2012
07040004-501	04LM137	Zumbro River	1378	2	WWg	31	43.8	8/24/2004
Aggregated HUC 12: 0704000405-01 (Lower Zumbro River) (continued)								
07040004-501	04LM137	Zumbro River	1378	2	WWg	31	28.6	8/1/2012
07040004-584	12LM013	Trout Brook	14.66	5	WWg	37	25.1	8/1/2012
07040004-585	12LM012	Trout Brook	21.58	6	WWg	43	43.8	8/1/2012
07040004-501	02LM009	Zumbro River	1407.91	2	WWg	31	35.3	8/1/2012

Appendix 5.1 - Minnesota's ecoregion-based lake eutrophication standards

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

Appendix 5.2 - MINLEAP model estimates of phosphorus loads for lakes in the Zumbro River Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
55-0004	Zumbro	111.1	396	35.6	409	1.5	0.2	570	162,216	32	31%	284.61	0.03	100.84	H
74-0001	Rice	290.1	142	149.2	92	0.2	0.5	566	1,368	36	75%	2.42	1.02	0.98	H

Abbreviations: **H** – Hypereutrophic **M** – Mesotrophic --- No data

E – Eutrophic **O** – Oligotrophic

Appendix 6 – Fish species found during biological monitoring surveys

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
American brook lamprey	20	29
banded darter	21	263
bigmouth shiner	72	1766
black bullhead	8	79
black crappie	6	17
black redhorse	21	628
blacknose dace	82	3530
blackside darter	26	147
Bluegill	24	126
bluntnose minnow	71	3118
brassy minnow	10	44
brook silverside	3	5
brook stickleback	48	633
brook trout	7	361
brown trout	15	1236
carmine shiner	16	222
central mudminnow	8	86
central stoneroller	83	10305
channel catfish	3	9
channel shiner	1	2
common carp	17	138
common shiner	70	7749
creek chub	103	5845
crystal darter	1	1
emerald shiner	5	391
fantail darter	65	2123
fathead minnow	57	1093
flathead catfish	1	1
freshwater drum	4	21
Gen: Catostomus	1	1
Gen: redhorses	5	63
gizzard shad	3	110
golden redhorse	36	761
green sunfish	56	1260

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
hornyhead chub	7	131
hybrid minnow	5	6
hybrid sunfish	3	3
johnny darter	92	3780
lamprey ammocoete	3	13
largemouth bass	19	196
largescale stoneroller	13	829
least darter	1	5
Logperch	19	117
longnose dace	56	1215
longnose gar	1	1
mimic shiner	3	42
Mooneye	1	2
northern hogsucker	43	1263
northern pike	5	8
Ozark minnow	19	1176
pearl dace	1	3
Pumpkinseed	1	15
Quillback	10	108
rainbow darter	30	1118
redfin shiner	3	19
redside dace	14	366
rock bass	29	382
sand shiner	29	1710
Sauger	4	11
shoal chub	1	1
shorthead redhorse	22	457
silver redhorse	13	75
slenderhead darter	9	32
slimy sculpin	2	149
smallmouth bass	28	327
southern redbelly dace	49	2082
spotfin shiner	15	721
spottail shiner	2	4
Stonecat	27	91
tadpole madtom	6	13

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Walleye	5	8
western sand darter	3	6
white bass	3	6
white crappie	1	1
white sucker	101	12328
yellow bullhead	1	1
yellow perch	3	8

Appendix 7 – Macroinvertebrate species found during biological monitoring surveys

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Ablabesmyia	40	97
Acari	72	359
Acentrella	33	140
Acerpenna	1	3
Acilius	1	1
Acroneuria	9	16
Aeshna	18	69
Aeshnidae	5	7
Agabus	1	1
Amphipoda	6	18
Anacaena	5	5
Anafroptilum	11	27
Anax	2	9
Ancylidae	4	4
Ancyronyx	14	35
Anopheles	17	66
Antocha	9	12
Argia	9	24
Atherix	36	93
Atrichopogon	9	17
Baetidae	26	143
Baetis	83	2583
Baetisca	4	10
Belostoma	9	10
Berosus	3	6
Bezzia	1	1
Bezzia/Palpomyia	5	8
Boyeria	19	37
Brachycentrus	28	418
Branchiobdellida	12	98
Brillia	50	163
Caecidotea	14	133
Caenis	38	277
Callibaetis	13	49

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Calopterygidae	48	301
Calopteryx	27	100
Cambaridae	2	2
Cambarus	8	17
Cardiocladius	4	6
Ceraclea	2	2
Ceratopogonidae	6	11
Ceratopogoninae	18	29
Ceratopsyche	70	835
Chaetocladius	1	2
Cheumatopsyche	77	2397
Chimarra	1	1
Chironominae	1	5
Chironomini	32	126
Chironomus	20	65
Cladopelma	2	2
Cladotanytarsus	29	75
Clinocera	1	1
Coenagrionidae	37	545
Conchapelopia	13	16
Coptotomus	2	2
Corduliidae	1	1
Corixidae	22	163
Corydalidae	2	2
Corynoneura	46	141
Crangonyx	1	2
Crenitis	1	1
Cricotopus	78	811
Cryptochironomus	27	40
Cryptotendipes	9	22
Culex	1	1
Culicidae	10	17
Culicoides	1	1
Dasyhelea	2	4
Decapoda	2	2
Diamesa	1	1

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Dicranota	13	22
Dicrotendipes	62	513
Diphetor	1	1
Diplocladius	1	1
Dixella	10	35
Dixidae	3	4
Dolichopodidae	2	2
Dreissena	5	37
Dubiraphia	60	506
Dytiscidae	12	28
Elmidae	26	119
Empididae	20	34
Enallagma	8	40
Enchytraeus	3	15
Endochironomus	9	20
Ephemera	1	8
Ephemerella	1	3
Ephemerellidae	2	4
Ephydridae	39	92
Eukiefferiella	26	117
Fallceon	1	2
Ferrissia	42	263
Forcipomyia	4	5
Fossaria	16	28
Frenesia	1	1
Gammarus	31	607
Gerridae	6	8
Glossosoma	3	7
Glossosomatidae	1	1
Glyptotendipes	6	6
Gomphidae	4	5
Gomphus	1	1
Gonomyia	1	1
Gyraulus	11	87
Gyrinus	6	7
Haliplus	4	11

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Helichus	18	41
Helicopsyche	18	454
Helisoma	2	9
Helobdella	1	1
Helopelopia	3	3
Hemerodromia	38	117
Hemiptera	1	1
Heptagenia	16	177
Heptageniidae	24	123
Hesperophylax	2	5
Hetaerina	11	21
Heterotrissocladius	1	1
Hexagenia	5	13
Hexatoma	2	2
Hirudinea	23	54
Hyalella	28	225
Hydridae	1	2
Hydrobaenus	1	1
Hydrobiidae	1	4
Hydrochus	2	2
Hydrophilidae	8	13
Hydropsyche	54	341
Hydropsychidae	69	839
Hydroptila	78	525
Hydroptilidae	25	57
Hydrozoa	4	7
Ilybius	2	2
Isonychia	28	83
Isoperla	1	2
Iswaeon	6	18
Labiobaetis	20	99
Labrundinia	56	299
Lampyridae	1	1
Larsia	3	5
Leptoceridae	10	13
Leptophlebiidae	2	5

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Lethocerus	1	1
Leucorrhinia	1	4
Leucrocuta	9	14
Libellulidae	1	3
Limnephilidae	9	10
Limnephilus	1	2
Limnophyes	17	70
Limonia	3	3
Limoniinae	1	1
Liodessus	3	3
Lymnaeidae	9	13
Lype	1	1
Maccaffertium	46	309
Macronychus	42	466
Mesovelia	3	5
Metrobates	1	1
Micrasema	1	1
Micropsectra	27	267
Microtendipes	50	223
Microvelia	10	18
Muscidae	5	13
Naididae	1	1
Nais	3	16
Nanocladius	41	75
Nectopsyche	32	78
Nemata	9	11
Nematoda	6	12
Nematomorpha	1	1
Neoplasta	3	8
Neoplea	9	16
Neoporus	3	5
Neureclipsis	3	3
Neuroptera	1	1
Nigronia	4	6
Nilotanypus	17	39
Notonecta	1	1

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Nyctiophylax	1	1
Ochrotrichia	1	6
Odontomesa	3	6
Odontomyia/Hedriodiscus	2	3
Oligochaeta	87	1415
Ophiogomphus	6	11
Optioservus	48	356
Orconectes	62	85
Orthocladiinae	34	172
Orthocladius	40	164
Orthocladius (Symposiocladius)	3	9
Ostracoda	2	2
Oxyethira	2	3
Pagastia	4	16
Palmacorixa	2	6
Parachironomus	4	4
Paracladopelma	2	3
Paracloeodes	2	3
Paracymus	3	3
Paragnetina	10	33
Parakiefferiella	21	57
Paralauterborniella	4	7
Paraleptophlebia	1	6
Paramerina	16	91
Parametriocnemus	32	194
Paraphaenocladius	3	3
Parapoynx	1	2
Paratanytarsus	84	1167
Paratendipes	24	59
Peltodytes	4	6
Pericoma	1	1
Pericoma / Telmatoscopus	2	2
Perlesta	1	1
Perlidae	8	15
Perlodidae	3	7

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Petrophila	1	1
Phaenopsectra	55	205
Phryganeidae	1	2
Physa	89	1991
Physella	9	352
Physidae	1	8
Pisidiidae	39	138
Planorbella	5	23
Planorbidae	9	61
Plauditus	17	219
Pleurocera	2	4
Polycentropodidae	2	2
Polycentropus	7	9
Polypedilum	99	4072
Procladius	23	48
Procloeon	15	44
Prodiamesa	1	1
Prostoma	1	1
Protoptila	3	32
Pseudochironomus	1	1
Pseudocloeon	15	219
Pseudosuccinea	4	8
Psychodidae	2	3
Psychomyia	3	7
Pteronarcys	14	36
Pycnopsyche	6	6
Radotanypus	1	1
Ranatra	1	1
Rhagovelia	3	17
Rheocricotopus	29	179
Rheotanytarsus	77	1713
Robackia	1	2
Saetheria	9	19
Saldidae	1	1
Sciomyzidae	7	8
Scirtidae	5	6

Taxonomic Name	Quantity of Stations Where Present	Quantity of Individuals Collected
Sialis	2	2
Sigara	8	23
Simuliidae	2	2
Simulium	70	1067
Sphaeriidae	2	7
Stagnicola	5	14
Stempellina	1	1
Stempellinella	19	27
Stenacron	20	53
Stenelmis	68	793
Stenochironomus	27	87
Stenonema	11	95
Stictochironomus	4	6
Stratiomyidae	4	4
Stratiomys	1	1
Sublettea	10	52
Tabanidae	7	8
Tanypodinae	38	109
Tanypus	1	1
Tanytarsini	53	437
Tanytarsus	85	1223
Teloganopsis	1	17
Thienemanniella	69	196
Thienemannimyia	5	34
Thienemannimyia Gr.	78	472
Tipula	15	25
Tipulidae	4	7
Trepaxonemata	2	12
Tribelos	2	2
Trichocorixa	2	5
Trichoptera	2	2
Tricorythodes	37	536
Tropisternus	3	3
Tubificinae	4	11
Turbellaria	20	81
Tvetenia	63	451
Veliidae	14	35
Xenochironomus	2	2
Zavrelimyia	7	18