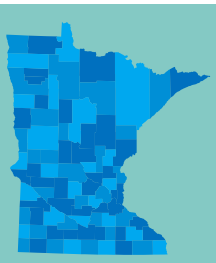
Stressor Identification

December 2018

Lower Minnesota River Watershed Streams Stressor Identification Report

A study of local stressors limiting the biotic communities in the streams of the Lower Minnesota Watershed.

MINNESOTA POLLUTION CONTROL AGENCY



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Key Terms & Abbreviations

AUID	Assessment Unit ID
BOD	biological oxygen demand
CADDIS	Causal Analysis/Diagnosis Decision Information System
DO	Dissolved Oxygen
EPA	Environmental Protection Agency of the United States
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FIBI	Fish Index of Biological Integrity
GP	Glide/Pool
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
IWM	Intensive Watershed Monitoring
MDNR	Minnesota Department of Natural Resources
MIBI	Macroinvertebrate Index of Biological integrity
mg/L	milligrams per Liter
MPCA	Minnesota Pollution Control Agency
MSHA	MPCA Stream Habitat Assessment
NBS	near bank stress
RR	Riffle/Run
SID	Stressor Identification
SOE	Strength of Evidence
TIV	Tolerance Indicator Value
TMDL	Total Maximum Daily Load
WRAPS	Watershed Restoration and Protection Strategy

Executive summary

The Minnesota Pollution Control Agency (MPCA) uses biological monitoring and assessment as a means to determine and report the condition of the state's rivers and streams. This basic approach is to examine fish and aquatic macroinvertebrate communities and related habitat conditions at multiple sites throughout a major watershed. From these data, an Index of Biological Integrity (IBI) score can be developed, which provides a measure of overall community health. Stream and river reaches are assigned an Assessment Unit Identification (AUID) number and will be referred to as the AUID in this report. AUIDs with low IBI scores are determined to have a biological impairment. If biological impairments are found, stressors to the aquatic community must be identified.

Stressor identification is a formal and rigorous process that identifies stressors causing biological impairment of aquatic ecosystems and provides a structure for organizing the scientific evidence supporting the conclusions (Cormier et al. 2000). It looks at causal factors – negative ones harming fish and insects, and positive ones leading to healthy biology. Stressors may be physical, chemical, or biological. In simpler terms, it is the process of identifying the major factors causing harm to aquatic life. Stressor identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act.

This report summarizes stressor identification work in the Lower Minnesota River watershed. There were 74 reaches identified with biological impairment in the watershed. The impairments in this report are organized by 10-digit Hydrologic Unit Code (HUC). There are eleven HUCs discussed in this report.

After examining many candidate causes for the biological impairments, the following stressors were identified as probable causes of stress to aquatic life:

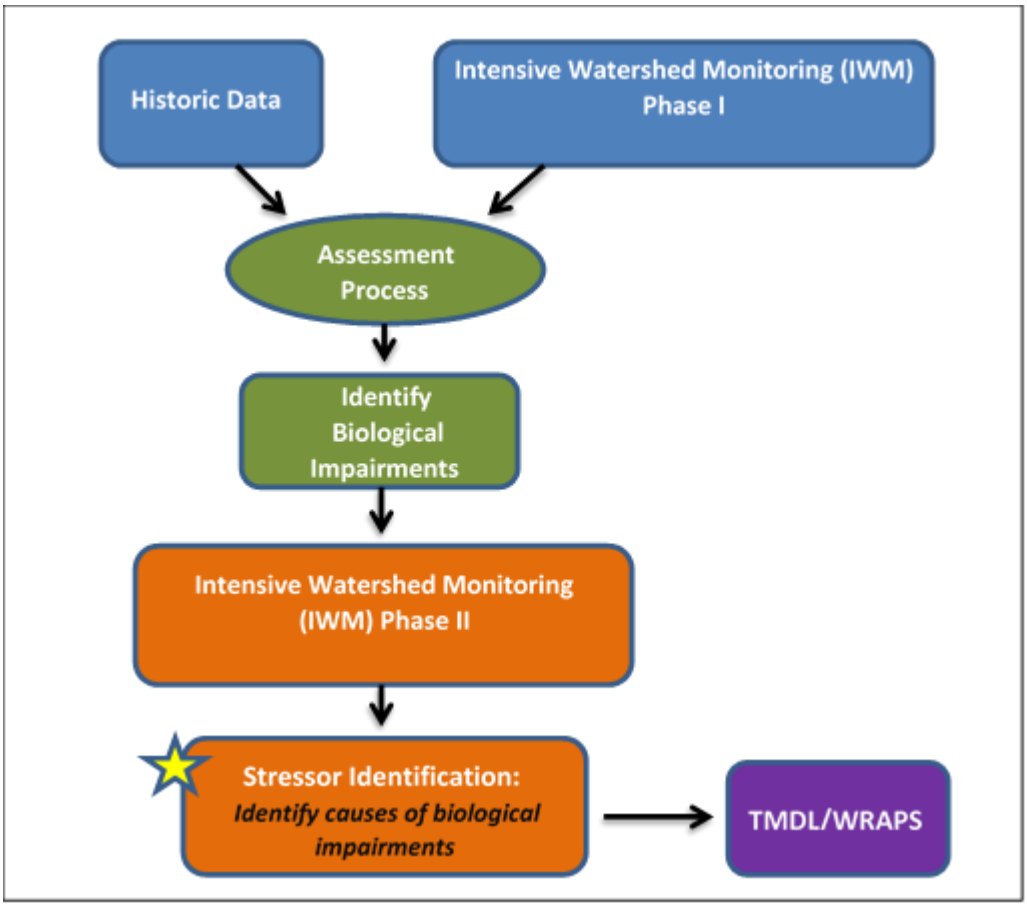
1. Introduction

1.1 Monitoring and Assessment

Water quality and biological monitoring in the Lower Minnesota River watershed have been ongoing. As part of the MPCA's Intensive Watershed Monitoring (IWM) approach, monitoring activities increased in rigor and intensity during the years of 2014-2015 and focused more on biological monitoring (fish and macroinvertebrates) as a means of assessing stream health. The data collected during this period, as well as historic data dated back until 2004, were used to identify stream impairments (Figure1).

Once a biological impairment is discovered, the next step is to identify the source(s) of stress on the biological community. A Stressor Identification (SID) analysis is a step-by-step approach for identifying probable causes of impairment in a particular system. Completion of the SID process does not result in a finished Total Maximum Daily Load (TMDL) study. The product of the SID process is the identification of the stressor(s) for which the TMDL may be developed. In other words, the SID process may help investigators nail down excess fine sediment as the cause of biological impairment, but a separate effort is then required to determine the TMDL and implementation goals needed to restore the impaired condition.

Figure 1. Process map of Intensive Watershed Monitoring, Assessment, Stressor Identification and TMDL processes.

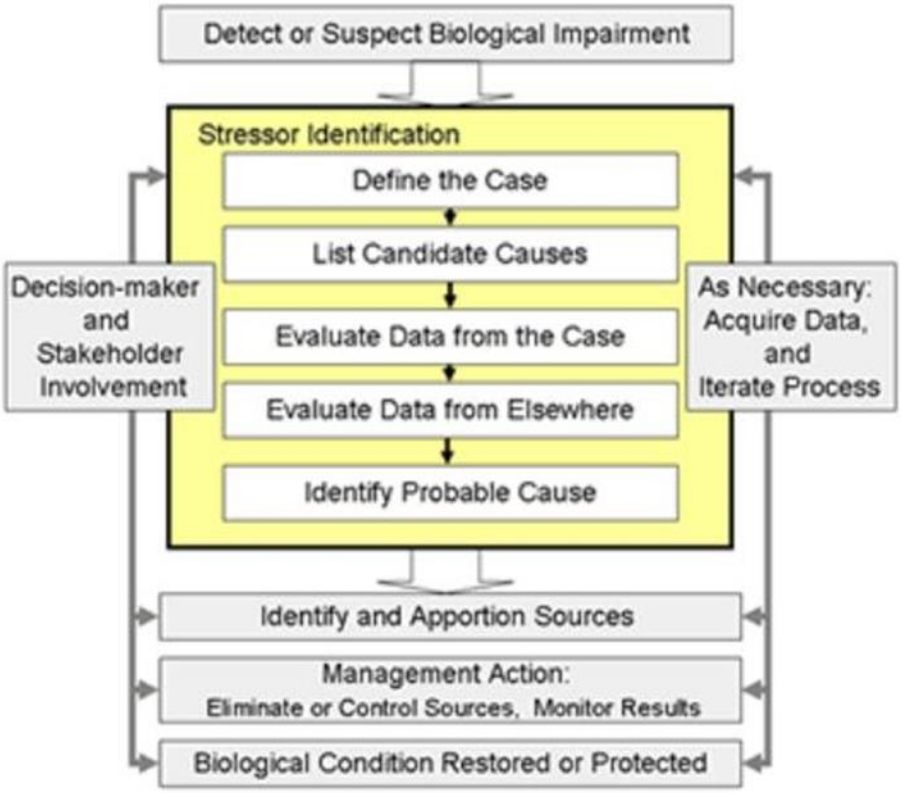


1.2 Stressor Identification Process

The MPCA follows the U.S. Environmental Protection Agency's (EPA) process of identifying stressors that cause biological impairment, which has been used to develop the MPCA's guidance to stressor identification (Cormier et al. 2000; MPCA 2008). The EPA has also developed an updated, interactive web-based tool, the Causal Analysis/Diagnosis Decision Information System (CADDIS; EPA 2010). This system provides an enormous amount of information designed to guide and assist investigators through the process of Stressor Identification. Additional information on the Stressor Identification process using CADDIS can be found here: http://www.epa.gov/caddis/.

Stressor Identification is a key component of the major watershed restoration and protection projects being carried out under Minnesota's Clean Water Legacy Act. SID draws upon a broad variety of disciplines and applications, such as aquatic ecology, geology, geomorphology, chemistry, land-use analysis, and toxicology. A conceptual model showing the steps in the SID process is shown inFigue 2. Through a review of available data, stressor scenarios are developed that aim to characterize the biological impairment, the cause, and the sources/pathways of the various stressors.

Figure 2. Conceptual model of Stressor Identification process (Cormier et al. 2000).



Strength of evidence (SOE) analysis is used to evaluate the data for candidate causes of stress to biological communities. The relationship between stressor and biological response are evaluated by considering the degree to which the available evidence supports or weakens the case for a candidate cause. Typically, much of the information used in the SOE analysis is from the study watershed (i.e., data from the case). However, evidence from other case studies and the scientific literature is also used in the SID process (i.e., data from elsewhere).

Developed by the EPA, a standard scoring system is used to tabulate the results of the SOE analysis for the available evidence. A narrative description of how the scores were obtained from the evidence should be discussed as well. The SOE table allows for organization of all of the evidence, provides a checklist to ensure each type has been carefully evaluated and offers transparency to the determination process.

The existence of multiple lines of evidence that support or weaken the case for a candidate cause generally increases confidence in the decision for a candidate cause. Additionally, confidence in the results depends on the quantity and quality of data available to the SID process. In some cases, additional data collection may be necessary to accurately identify the stressor(s) causing impairment. Additional detail on the various types of evidence and interpretation of findings can be found here: http://www.epa.gov/caddis/si_step_scores.html.

1.3 Common Stream Stressors

The five major elements of a healthy stream system are stream connections, hydrology, stream channel assessment, water chemistry and stream biology. If one or more of the components are unbalanced, the stream ecosystem may fail to function properly and is listed as an impaired water body. Table 1 lists the common stream stressors to biology relative to each of the major stream health categories.

Table 1. Common streams stressors to biology (i.e., fish and macroinvertebrates).

Stream Health	Stressor(s)	Link to Biology
Stream Connections	**Loss of Connectivity** • Dams and culverts • Lack of Wooded riparian cover • Lack of naturally connected habitats/ causing fragmented habitats	Fish and macroinvertebrates cannot freely move throughout system. Stream temperatures also become elevated due to lack of shade.
Hydrology	**Altered Hydrology** **Loss of habitat due to channelization** **Elevated Levels of TSS** • Channelization • Peak discharge (flashy) • Transport of chemicals	Unstable flow regime within the stream can cause a lack of habitat, unstable stream banks, filling of pools and riffle habitat, and affect the fate and transport of chemicals.
Stream Channel Assessment	**Loss of Habitat due to excess sediment** **Elevated levels of TSS** • Loss of dimension/pattern/profile • Bank erosion from instability • Loss of riffles due to accumulation of fine sediment • Increased turbidity and or TSS	Habitat is degraded due to excess sediment moving through system. There is a loss of clean rock substrate from embeddedness of fine material and a loss of intolerant species.
Water Chemistry	**Low Dissolved Oxygen Concentrations** **Elevated levels of TSS** **Chloride** **Elevated levels of Nutrients** • Increased nutrients from human influence (Nitrates, Phosphorus) • Widely variable DO levels during the daily cycle • Increased algal and or periphyton growth in stream • Increased nonpoint pollution from urban and agricultural practices • Increased point source pollution from urban treatment facilities	There is a loss of intolerant species and a loss of diversity of species, which tends to favor species that can breathe air or survive under low DO conditions. Biology tends to be dominated by a few tolerant species.
Stream Biology	Fish and macroinvertebrate communities are affected by all of the above listed stressors	If one or more of the above stressors are affecting the fish and macroinvertebrate community, the IBI scores will not meet expectations and the stream will be listed as impaired.

1.4 Report Format

This report is grouped by the eleven 10-digit HUCs in the Lower Minnesota River watershed that contain biologically impaired streams. AUIDs are discussed individually. All 74 biological impairments are evaluated and discussed in further detail.

2. Overview of the Lower Minnesota Watershed

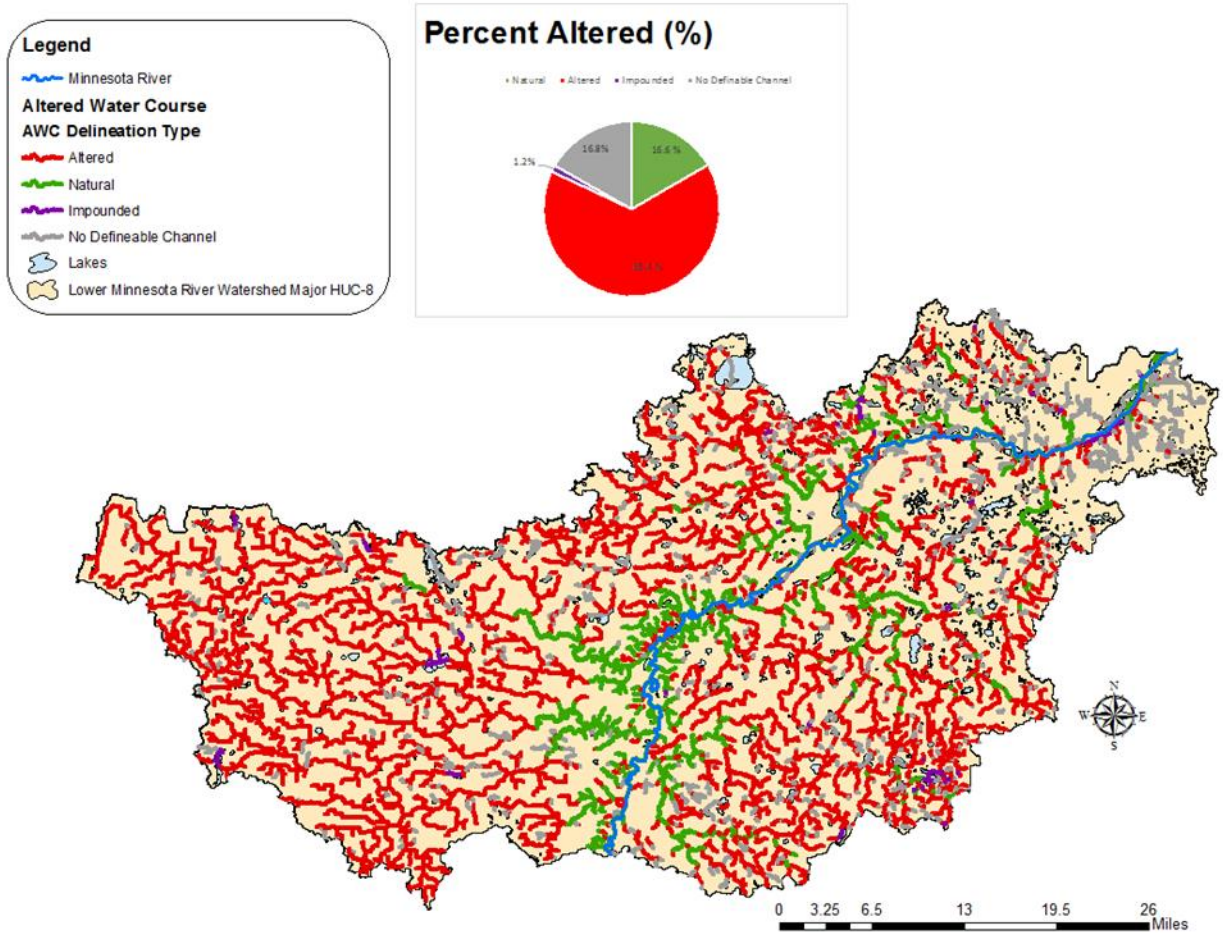
2.1 Background

The Lower Minnesota River watershed includes the lowest reach of the Minnesota River and flows into the Mississippi at Fort Snelling. The second largest watershed in the Minnesota River Basin, it covers 1,760 square miles, divided by the Minnesota River itself. Major tributaries in the rural part of the watershed include the Rush River and High Island Creek. Tributaries in the urban area include Bevens Creek, Carver Creek, Sand Creek, Ninemile Creek, and the Credit River, among others. A relatively flat section of river, the 50-mile stretch of the Minnesota contained within this watershed drops approximately 90 feet in elevation from the small town of Ottawa in Le Sueur County, to its confluence with the Mississippi River in St. Paul. (MPCA website)

Ninety percent of historic wetlands in the watershed have been removed from the landscape to improve agricultural productivity. Of what remains, 80% of wetlands in the watershed are in poor to fair condition (MPCA, 2017).

Even among agricultural watersheds, the TSS and TP FWMCs measured on High Island Creek in Henderson are among the highest measured within the WPLMN. FWMCs for TSS and TP on High Island dramatically increase between Arlington and Henderson, while NO3+NO2-N FWMCs between sites are similar (MPCA, 2017).The DNR found of the " Twenty-two reaches of stream were surveyed in the Lower Minnesota River watershed. Of these, zero would be considered "stable.""(DNR, 2017a).

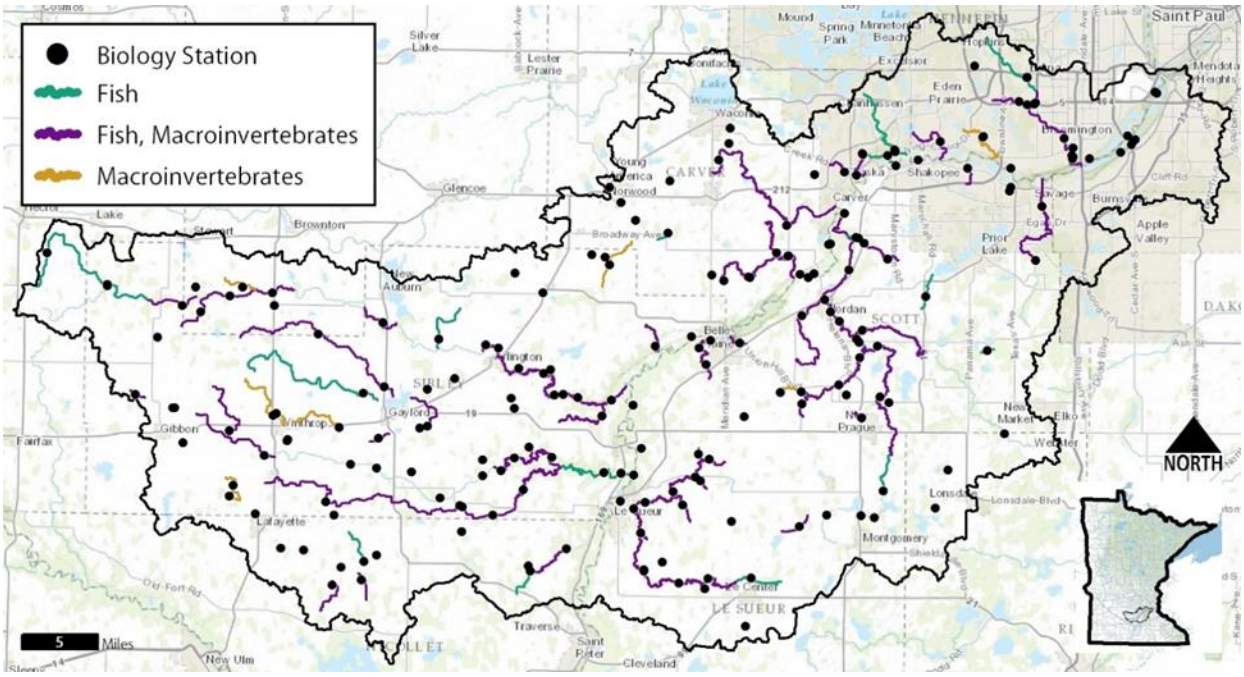
Figure 3. Altered waterbodies in the Lower Minnesota River Watershed.



2.2 Monitoring Overview

In 2014-2015, IWM was performed in the Lower Minnesota River Watershed. Biological monitoring and water chemistry data from systematically selected sites throughout the watershed as well as data from other water monitoring stations taken within 10 years of the biological monitoring were used to assess the conditions of the watershed. The biological monitoring stations that led to aquatic life listings and included in this report are mapped in Figure 3. Additional information can be found in subsequent sections of this report, in addition to the comprehensive Lower Minnesota River Watershed Monitoring and Assessment Report.

Figure 4. Map of monitoring stations in the Lower MN River Watershed.



2.3 Summary of Biological Impairments

The approach used to identify biological impairments includes assessment of fish and aquatic macroinvertebrates communities and related habitat conditions at sites throughout a watershed. The resulting information is used to develop an index of IBI. The IBI scores can then be compared to range of thresholds.

The fish and macroinvertebrates within each Assessment Unit Identification (AUID) were compared to a regionally developed threshold and confidence interval and utilized a weight of evidence approach. The water quality standards call for the maintenance of a healthy community of aquatic life. IBI scores provide a measurement tool to assess the health of the aquatic communities. IBI scores higher than the impairment threshold indicate that the stream reach supports aquatic life. Conversely, scores below the impairment threshold indicate that the stream reach does not support aquatic life. Confidence limits around the impairment threshold help to ascertain where additional information may be considered to help inform the impairment decision. When IBI scores fall within the confidence interval, interpretation and assessment of the waterbody condition involves consideration of potential stressors and draws upon additional information regarding water chemistry, physical habitat, and land use, etc.

In the Lower Minnesota River Watershed, 74 AUIDs are currently impaired for poor biological assemblage; 48 reaches that were impaired for both fish and macroinvertebrates, 18 reaches for fish only impairments, and 8 reaches for macroinvertebrate only impairments. Of the 74 impairments, they were evenly divided between General Use and Modified Use criteria (37 in each category).

Table 2. Impairments in the Lower Minnesota River Watershed.

		Impairments	
Stream Name	**AUID #**	**Biological**	**Water Quality**
Riley Creek	07020012-511	Fish, Macroinvertebrates	Turbidity, E. Coli
Sand Creek	07020012-513	Fish, Macroinvertebrates	E. Coli, Nutrient/Eutrophication
Bevens Creek	07020012-514	Fish, Macroinvertebrates	Turbidity, E. Coli
Rush River	07020012-521	Fish	Turbidity, E. Coli
Sand Creek	07020012-538	Fish	Turbidity
Rush River	07020012-548	Fish, Macroinvertebrates	Turbidity
County Ditch 42	07020012-551	Macroinvertebrates	-
Rush River, North Branch (Judicial Ditch 18)	07020012-555	Fish, Macroinvertebrates	E. Coli
Rush River, North Branch (County Ditch 55)	07020012-556	Fish, Macroinvertebrates	-
Robert Creek	07020012-575	Fish, Macroinvertebrates	TSS, E. Coli
Unnamed creek	07020012-579	Fish, Macroinvertebrates	-
Unnamed creek	07020012-580	Fish	-
Unnamed creek (East Cr.)	07020012-581	Fish, Macroinvertebrates	Turbidity, E. Coli
Unnamed creek (Assumption Creek)	07020012-582	Fish	-
Rush River, Middle Branch (County Ditch 23 and 24)	07020012-586	Fish, Macroinvertebrates	-
Judicial Ditch 11	07020012-590	Fish	-
Judicial Ditch 11	07020012-593	Fish, Macroinvertebrates	-
Barney Fry Creek	07020012-602	Fish, Macroinvertebrates	E. Coli
Unnamed creek (County Ditch 13)	07020012-604	Fish	-
County Ditch 10	07020012-628	Macroinvertebrates	E. Coli
County Ditch 13	07020012-636	Macroinvertebrates	-
High Island Creek	07020012-653	Fish, Macroinvertebrates	Turbidity, E. Coli
County Ditch 49	07020012-677	Fish, Macroinvertebrates	-
Judicial Ditch 15	07020012-682	Fish, Macroinvertebrates	-
County Ditch 39	07020012-683	Macroinvertebrates	-
Bluff Creek	07020012-710	Fish	Turbidity

		Impairments	
Stream Name	**AUID #**	**Biological**	**Water Quality**
Raven Stream	07020012-716	Fish, Macroinvertebrates	Chloride, E. Coli
Ninemile Creek, South Fk	07020012-723	Fish, Macroinvertebrates	-
Forest Prairie Creek	07020012-725	Fish, Macroinvertebrates	E. Coli
Unnamed creek (Prior Lake Outlet Channel)	07020012-728	Fish, Macroinvertebrates	-
Unnamed creek	07020012-732	Fish, Macroinvertebrates	-
Unnamed ditch	07020012-763	Fish, Macroinvertebrates	-
County Ditch 34	07020012-764	Fish, Macroinvertebrates	-
Judicial Ditch 4	07020012-767	Fish	-
Unnamed creek	07020012-768	Fish, Macroinvertebrates	-
County Ditch 42	07020012-772	Fish, Macroinvertebrates	-
County Ditch 32A	07020012-783	Fish, Macroinvertebrates	-
County Ditch 9	07020012-784	Fish	-
Judicial Ditch 1	07020012-785	Macroinvertebrates	-
County Ditch 44	07020012-786	Fish, Macroinvertebrates	-
Unnamed ditch	07020012-788	Macroinvertebrates	-
County Ditch 56	07020012-790	Macroinvertebrates	-
County Ditch 18	07020012-791	Fish	-
County Ditch 47A	07020012-792	Fish	-
County Ditch 75	07020012-793	Fish	-
Judicial Ditch 12	07020012-794	Fish	-
County Ditch 50	07020012-796	Fish, Macroinvertebrates	-
Unnamed creek	07020012-798	Fish, Macroinvertebrates	-
County Ditch 30A	07020012-801	Fish, Macroinvertebrates	-
Chaska Creek	07020012-803	Fish, Macroinvertebrates	-
Carver Creek	07020012-806	Fish, Macroinvertebrates	Nutrient/eutrophication, Turbidity
Ninemile Creek	07020012-807	Fish	-
Ninemile Creek	07020012-808	Fish, Macroinvertebrates	-
Ninemile Creek	07020012-809	Fish, Macroinvertebrates	Chloride, E. coli
Credit River	07020012-811	Fish, Macroinvertebrates	Chloride, E. coli, Turbidity

		Impairments	
Stream Name	**AUID #**	**Biological**	**Water Quality**
Silver Creek	07020012-813	Fish, Macroinvertebrates	Acetochlor, E. coli, Turbidity
Porter Creek	07020012-817	Fish, Macroinvertebrates	E. coli, Turbidity, Nutrient/eutrophication
Unnamed creek	07020012-822	Fish, Macroinvertebrates	-
Le Sueur Creek	07020012-823	Fish	-
Le Sueur Creek	07020012-824	Fish, Macroinvertebrates	E. coli
Rush River, South Branch	07020012-825	Fish, Macroinvertebrates	E. coli
Rush River, South Branch	07020012-826	Fish, Macroinvertebrates	E. coli
Purgatory Creek	07020012-828	Macroinvertebrates	E. coli
Unnamed creek (Brewery Cr.)	07020012-830	Fish, Macroinvertebrates	E. coli
Buffalo Creek	07020012-832	Fish, Macroinvertebrates	E. coli, Turbidity
High Island Creek	07020012-834	Fish, Macroinvertebrates	E. coli, Turbidity
High Island Creek	07020012-838	Fish, Macroinvertebrates	E. coli
Sand Creek	07020012-839	Fish	Chloride, Turbidity, Nutrient/eutrophication
Sand Creek	07020012-840	Fish, Macroinvertebrates	Chloride, Turbidity, Nutrient/eutrophication
Raven Stream, West Branch	07020012-842	Fish, Macroinvertebrates	E.coli
Bevens Creek	07020012-843	Macroinvertebrates	E. coli, Nutrient/eutrophication
Bevens Creek	07020012-845	Fish	-
Bevens Creek	07020012-848	Fish, Macroinvertebrates	E. coli, Turbidity, Nutrient/eutrophication,
Unnamed creek	07020012-849	Fish	-

2.4 Hydrological Simulation Program-FORTRAN (HSPF) Model

The Hydrological Simulation Program - Fortran (HSPF) is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants. HSPF was developed from the watershed-scale Agricultural Runoff Management (ARM) and Non-Point Source (NPS) models into a basin-scale analysis framework that includes fate and transport in one dimensional stream channels. It is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with in-stream hydraulic and sediment-chemical interactions. The result of this simulation is a time history of the runoff flow rate, sediment load, and nutrient and pesticide concentrations, along with a time history of water quantity and quality at the outlet of any subwatershed. HSPF simulates three sediment types (sand, silt, and clay) in addition to a single organic chemical and transformation product of that chemical.

The HSPF watershed model contains components to address runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/transformation of chemical constituents in stream reaches. Primary external forcing is provided by the specification of meteorological time series. The model operates on a lumped basis within subwatersheds. Upland responses within a subwatershed are simulated on a per-acre basis and converted to net loads on linkage to stream reaches within each subwatershed and the upland areas are separated into multiple land use categories.

An HSPF watershed model was run for the Lower Minnesota River Watershed to predict water quality condition throughout the watershed on an hourly basis from 1995-2009. Data from 1995, exclusively may not always be valid however, as the model may take up to one simulated year for parameters to reach calibration targets. Streams with biological impairments used the model output to supplement water quality analyses.

3. Possible Stressors to Biological Communities

There is a comprehensive list of potential stressors to aquatic biological communities compiled by the EPA (https://www.epa.gov/caddis-vol1/aquatic-stressors-can-potentially-cause-biological-impairment). This comprehensive list serves two purposes. First, it can serve as a checklist for investigators to consider all possible options for impairment in the watershed of interest. Second, it can be used to identify potential stressors that can be eliminated from further evaluation. In some cases, the data may be inconclusive and limit the ability to confidently determine if a stressor is causing impairment to aquatic life. It is imperative to document if a candidate cause was suspected, but there was not enough information to make a scientific determination. In this case, management decisions can include modification of sampling plans and future evaluation of the inconclusive case. Alternatively, there may be enough information to conclude that a candidate cause is not causing biological impairment and therefore can be eliminated. The inconclusive or eliminated causes will be discussed in more detail in the following section.

A candidate cause is defined as a "hypothesized cause of an environmental impairment that is sufficiently credible to be analyzed" (EPA, 2012). Identification of a set of candidate causes is an important early step in the SID process and provides the framework for gathering key data for causal analysis. A more detailed description of possible candidate causes or stressors is provided in the document *Stressors to Biological Communities in Minnesota's Rivers and Streams* (MPCA, 2017). This information provides an overview of the pathway and effects of each candidate stressor considered in the biological stressor identification process with relevant data and water quality standards specific to Minnesota. The U.S. Environmental Protection Agency (EPA) has additional information, conceptual diagrams of sources and causal pathways, and publication references for numerous stressors on its CADDIS website. Background information specific to candidate causes/stressors in Minnesota can be found here. This information provides an overview of the pathway and effects of each candidate stressor considered in the biological stressor identification process with relevant data and water quality standards specific to Minnesota.

3.1 Inconclusive Causes

- Ammonia
- Toxics
- Predation and interspecies competition
- Physical trampling
- Parasitism

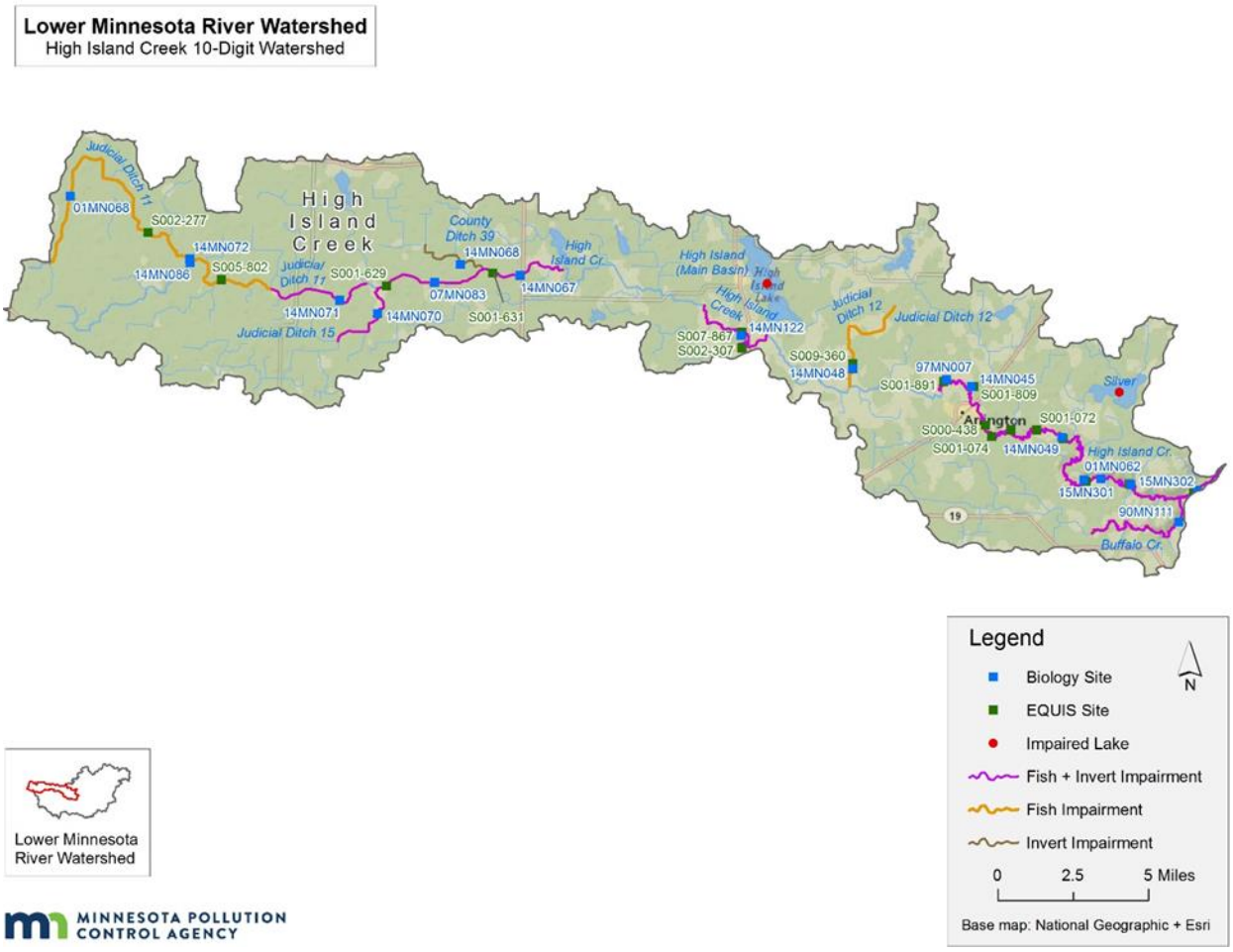
4. Evaluation of Candidate Causes

The list of candidate causes was narrowed down after initial data evaluation resulting in seven candidate causes for final analysis in this report. The seven remaining candidate causes are:

- Dissolved oxygen (DO)
- Eutrophication
- Nitrate
- Total suspended solids (TSS)
- Habitat
- Flow Alteration and Connectivity
- Chloride/Ionic Strength

5. High Island Creek HUC 10 (0702001206)

Figure 5. Map of the High Island Creek HUC 10.



5.1 High Island Creek (-653)

High Island Creek (-653) is a 7.10 mile long stream reach located in southern McLeod county. This stream reach extends from Judicial Ditch 15 down to the confluence with Bakers Lake. This reach is

impaired for biology due to both the fish and macroinvertebrate assemblages at the two biological monitoring stations located along this stream section, 07MN083 and 14MN067. The reach is also impaired for Turbidity.

Biology

Fish

High Island Creek (-653) was sampled for fish multiple times at its biological monitoring stations 07MN083 and 14MN067. The average FIBI scores for these sites are 10.5 (07MN083) and 20.0 (14MN067). Both of these average FIBI scores are well below the Fish Class 2 Southern Streams Modified Use Threshold of 35. Both sites lacked benthic insectivore and sensitive taxa, while also having a high percentage of tolerant fish species resulting in very poor metric scores (Figure 6).

Figure 6. Fish metrics of sites on High Island Creek.

Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach; however, the samples were taken throughout the reach. Concentrations ranged from 2.96 mg/L to 18.05 mg/L. The three values below 5 mg/L were collected at the beginning and mid reach sections of the reach at stations S001-629, S001-631, and S012-754. Some elevated temperatures (28 and 31.6˚C) were also collected, which effects DO. The large difference in DO values is indicative of possible high daily DO fluctuations.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.2 mg/L with 16% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Three visits at station 07MN083 and 12UM058 had a percentage of zero fish

Table 3. DO related metrics.

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
07MN083 (2007)	0	37.21	8	NA	NA	NA	NA
07MN083 (2015)	0	99.72	3	NA	NA	NA	NA
07MN083 (2016)	0	58.26	12	NA	NA	NA	NA
14MN067 (2014)	19.64	36.61	11	67.88	7.59	0	6.14
14MN067 (2015)	0	93.5	10	NA	NA	NA	NA
14MN067 (2016)	0.59	32.35	12	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	15.09	25.34	14.52				6.19
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	86.63
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

that take three years or longer to mature, indicating that fish are quick to reproduce due to short life spans from the influence of human disturbance. Station 14MN067 had percentages of fish that mature at greater than three years ranging from 0 to 19.64%, decreasing from 19.64% in 2014 to 0.59% in 2016. Low DO values also correspond with increased serial spawning fish percentage. Stations ranged from 32.35 to 99.72%. All values were higher than the class average of serial spawners. Fathead minnow and other species very tolerant to low DO conditions comprised 16%-80% of the fish community at station 07MN083. Very tolerant species (fathead minnow, central mudminnow, brook stickleback) comprised 41-90% of the fish community at station 14MN067 with over 2000 fathead minnows collected during the 2015 visit.

Macroinvertebrate data is only available from one visit at station 14MN067. Species that are specifically intolerant to DO were not found in the sample and the DO tolerant percentage was 67.88% of individuals. Very low values of DO have been found on this reach and the biological response is indicative of DO stress to the fish community. Low DO is a stressor on this reach of High Island Creek.

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.036 to 0.2 mg/L. There were 18 values in 2001 and 2002 above the southern standard of 0.150 mg/L with the highest value 1.25 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 1.0-1.3 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Recent BOD and chlorophyll-a data is not available, but a BOD value of 8 mg/L was taken in 2001. There is no DO flux data available. While DO flux is not available, there are a range of DO values ranging from 2.96 mg/L to 18.05 mg/L which is indicative of DO fluctuations. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.6 to 10.07. Station 07MN083 had thick macrophyte growth (Figure 7).

Figure 7. Algal growth at 07MN083 (August 20, 2015).

All visits at both stations were lacking any sensitive or darter species. Tolerant percentages were all greater than 75%, with five of the six visits having a community comprised of greater than 99% tolerant fish. A positive relationship exists between eutrophication and omnivorous fish. There was a range of omnivorous fish percentages at both stations (24.11-86.38%), and they both had an elevated value (61% at station 07MN083 and 86.38% at station 14MN067).

There was only one macroinvertebrate sample collected on this reach, and it was dominated by two species (91.77% of the sample was comprised of just two species). The number of taxa (17) and the EPT percentage were also very low (2.13%). The biological communities are showing the effects of the elevated phosphorus and pH values. Eutrophication is a stressor on the headwaters section of High Island Creek.

Table 4. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
07MN083 (2007)	0	0	100	61.43	NA	NA	NA
07MN083 (2015)	0	0	100	15.43	NA	NA	NA
07MN083 (2016)	0	0	99.22	42.13	NA	NA	NA
14MN067 (2014)	0	0	75.89	24.11	17	2.13	91.77
14MN067 (2015)	0	0	100	86.38	NA	NA	NA
14MN067 (2016)	0	0	99.41	30	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	8.24	13.32	45.53	25.08			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.58	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2000-2016, a total of 44 nitrate samples were taken From High Island Creek (-653). These sample values ranged from 0.05-28.8 mg/L, with an average value of 14.15 mg/L. This average value is a very high nitrate concentration. A quantile regression analysis showed that macroinvertebrate class 7 streams with a nitrate concentration of 11.5 mg/L or higher, have a 90% probability of being impaired. High Island Creek (-653) exceeded this level 28 times (63.64%) since 2000.

Additionally, site 14MN067 had a drain tile present (Figure 8). Drain tiles typically contain higher concentrations of nitrates as they drain into the stream from the agricultural fields.

Figure 8. Drain title at site 14MN067 (August 3, 2016)

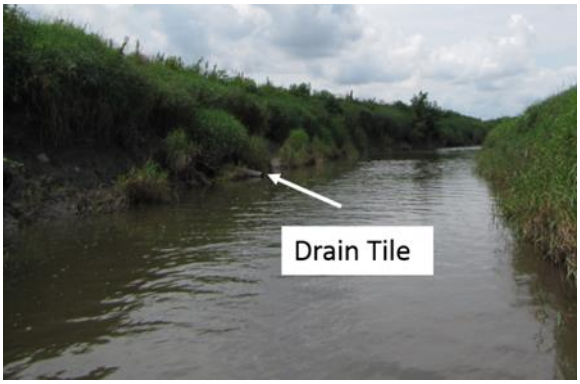


Table 5. Nitrate related metrics.

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN067	**5.88**	**32.42**	**0.00**	**4.09**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in High Island Creek scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI modified Use Threshold (Table 5). The site, 14MN067, did have lower amounts of nitrate tolerant taxa and an above average amount of Trichoptera taxa; however, the site lacked nitrate intolerant species and had a poor Nitrogen TIV score.

Given the high nitrate concentrations from the chemical data set, the quantile regression analysis, the presence of a nitrate source, as well as the low Nitrogen TIV score and lack of nitrate intolerant species, Nitrates are a stressor to the impaired biological communities in High Island Creek (-653).

Candidate Cause Sediment

High Island Creek (-653) had 45 TSS samples taken from 2000-2016. These samples ranged in value from 2-956 mg/L with an average TSS concentration of 96.74 mg/L. Of these samples, eight were above the 65 mg/L standard for TSS. Additionally, 527 secchi tube measurements were taken from this reach from 2004-2016. These samples ranged from 4-100 cm, with an average reading of 45.74 cm. Of these measurements, 18 were at or below the 10 cm standard for transparency. This reach is currently listed as impaired for turbidity from a 2006 assessment.

Table 6. Sediment related fish metrics.

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07MN083	**9.00**	**0.04**	**4.43**	**0.04**	**9.00**	**0.00**	**8.96**	**0.00**	**0.04**	**20.57**
14MN067	**3.16**	**1.49**	**1.18**	**8.23**	**3.16**	**0.00**	**9.60**	**0.00**	**10.57**	**22.28**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in High Island Creek (-653) scored below average in nine (07MN083) and ten (14MN067) of the suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 6). Site 07MN083 had a slightly above average amount of herbivorous individuals but scored poorly in the remaining metrics.

Table 7. Sediment related macroinvertebrate metrics.

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN067	**17.59**	**0**	**8**	**28.79**	**2.13**	**0**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in High Island Creek (-653) at site 14MN067 scored below average in four of the six sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 7). This site did have lower amounts of TSS tolerant taxa and individuals, but also lacked many species that are more intolerant of higher suspended sediment levels. The overall TSS Index score was also below average.

Based on the high rate of exceedances from the TSS data, as well as the majority of both the fish and macroinvertebrate metrics related to suspended sediment scoring below average, in addition to the current turbidity listing along this reach, suspended sediment is a stressor to aquatic life in High Island Creek (-653).

Candidate Cause Habitat

Figure 9. Poor sinuosity at site 07MN083 (August 20, 2018).

High Island Creek (-653) had qualitative habitat assessments take place at its biological monitoring sites, 07MN083 and 14MN067, during the fish and macroinvertebrate sampling events in 2007, 2014, 2015, and 2016. The average MSHA score from these visits was 32.4 (Poor) at 07MN083 and 30.93 (Poor) at 14MN067. Limiting the habitat at these sites was the row crop agriculture dominating the local land use, very narrow riparian buffer, moderate to heavy bank erosion, light stream shading, sand and silt substrates, moderate to severe embeddedness, sparse to nearly absent fish cover, little depth variability, poor sinuosity (Figure 9), poor channel development, and moderate channel stability. A breakdown of the MSHA category scores for these sites can be seen in Figure 10.

Figure 10. MSHA metric scores on High Island Creek.

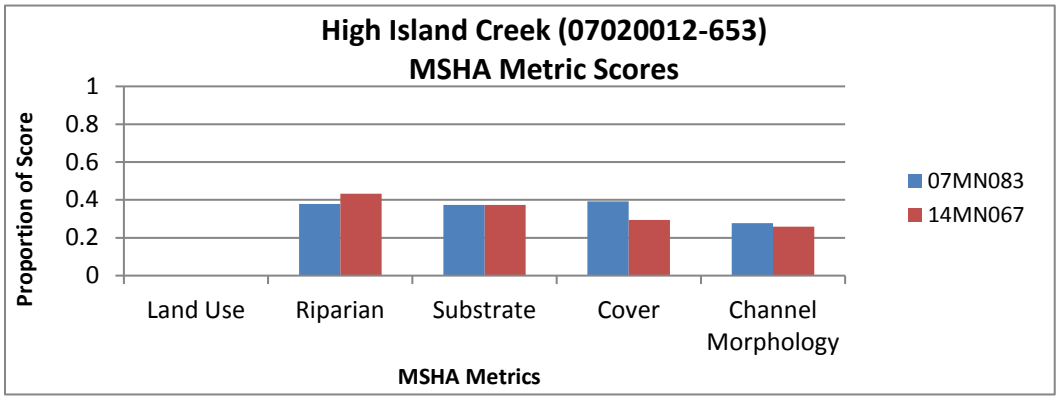


Table 8.Habitat related fish metrics.

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
07MN083	0.00	8.96	0.00	9.00	0.04	16.96	99.74	49.59
14MN067	0.00	9.60	0.00	3.16	7.93	18.08	91.77	57.10
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in High Island Creek (-653) at sites 07MN083and 14MN067 scored below average in every habitat related metric when compared to other Class 2 Southern Streams stations meeting the FIBI Modified Use Threshold (Table 8). This reach was dominated by tolerant and pioneering individuals, while also lacking species requiring specialized habitat conditions to live and reproduce. These results indicate a fish community stressed by the current habitat conditions.

Table 9. Habitat related macroinvertebrate metrics.

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN067	**2.13**	**28.66**	**0.91**	**2.13**	**31.40**	**67.07**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN067 (No sample at 07MN083) scored below average in 2 of the 6 habitat related metrics when compared to other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 9). This site had decreased numbers of EPT and Clinger individuals, but scored much better in the remaining metrics.

The MSHA scored poor at both biological sites along this reach. The fish community reflected the MSHA by scoring below average in all of the habitat related metrics. The photographic evidence also showed degraded habitat conditions present. While the macroinvertebrate community does not currently signal a strong sign of stress at 14MN067, it may do so in the future if conditions remain degraded. Further monitoring of this site and a sample at 14MN083 may indicate stress. The lack of habitat is a stressor to the fish community in High Island Creek (-653) at this time.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 672 to 1127 µS/cm. The ecoregion norm for the Western Cornbelt Plains (based on the 75th percentile of annual specific conductance values) is 810 (McCollor et. al, 1993).

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased.

Station 14MN067, in 2014, was the only station sampled for macroinvertebrates. The EPT percentage was 2.13% and the mayfly (Ephemeroptera) percentage was even lower at 1.83% with two species present. The taxa count was below the class average with reductions in mayfly taxa and EPT richness.

Table 10. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
07MN083 (2007)	NA	NA	NA	NA	0
07MN083 (2015)	NA	NA	NA	NA	0
07MN083 (2016)	NA	NA	NA	NA	0.13
14MN067 (2014)	17	2	1.83	2.13	4.46
14MN067 (2015)	NA	NA	NA	NA	0
14MN067 (2016)	NA	NA	NA	NA	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					***6.17***
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	***33.59***	***3.45***	***16.53***	***20.58***	
Expected response to stress	↓	↓	↓	↓	↑

The macroinvertebrate community was comprised of 31.21% of conductivity tolerant individuals and didn't have any intolerant individuals. Elevated chloride can also lead to increases in sunfish based assemblages. All visits had a Centrarchidae (sunfish) percentage below the class average. Species that are tolerant to conditions with high ionic strength comprised a range of 15-86% of the fish community. The tolerant percentages were higher at the downstream station 14MN067 than at 07MN083. Specific conductance values were limited on this reach but there were a few values above 1000 uS/cm.

The biological communities are indicative of stress but more data would be helpful to confirm that ionic strength is causing or the decline in biology and not other stressors. While the periodic elevated values might be contributing as a stressor, it is not a clear stressor at this time.

Candidate Cause: Altered Hydrology/Connectivity

This reach of High Island Creek, its upstream watershed and contributing tributaries are 100% altered according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this

section of High Island Creek experiencing low flow at less than 1 cfs 8% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The average percentage for generalist fish in class 2 waters was 43.87%. The two sites had a population of general fish ranging from 15.43 to 87.74%. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species ranged from 15.43-85.31%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates was less than 1%.

Channelization is connected to and contributing to the lack of habitat. The effects of altered hydrology seem to be contributing to the increase of generalized fish percentages, which are more adaptable to changing conditions and food sources. Altered hydrology is a contributing stressor too through channelization and drainage changes. Altered hydrology is also likely contributing to both eutrophication and lack of habitat. Increased flow events can cause increased bank erosion and bedload transport, eventually leading to excess sedimentation once flows subside, affecting fish and macroinvertebrate species that rely on clean substrate for habitat and/or reproduction. Based on extended low flow periods shown in the models, sediment deposition and increased generalized and decreased long-lived individuals, altered hydrology is a stressor that is also affecting habitat.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in High Island Creek (-653) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 11). It was inconclusive at this time if Chloride is a stressor as well. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 11. Stressors on High Island Creek (07020012-653).

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride/Ionic strength	Flow Alteration/Connectivity
High Island Creek	07020012-653	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.2 High Island Creek (-834)

High Island Creek (-834) is a 22.48 mile long stream reach located in eastern Sibley county. This reach begins approximately two miles downstream of 425th Ave and extends down to the confluence with the Minnesota River. This reach is impaired for biology due to both the fish and macroinvertebrate

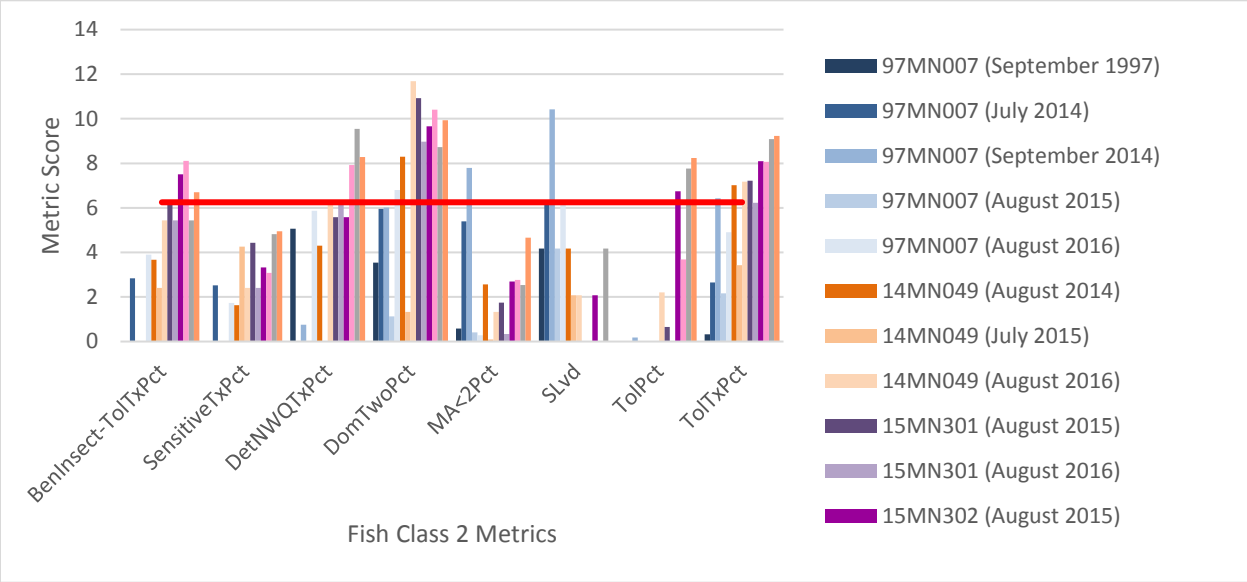
assemblages. There are six biological monitoring stations located along this reach: 01MN062, 14MN049, 14MN116, 15MN301, 15MN302, and 97MN007. This reach is also impaired for Turbidity.

Biology

Fish

High Island Creek (-834) was sampled many times for fish across six biological monitoring stations from 2001-2016. The average FIBI scores from these sites are: 23.7 (97MN007), 52.1 (01MN062), 27.9 (14MN049), 52.0 (14MN116), 33.25 (15MN301), 44.9 (15MN302). Sites 01MN062 and 14MN116 had average FIBI scores above the Fish Class 2 Southern Streams General Use Threshold of 50, while the other four sites along this reach fell below. In general, the sites along this reach were comprised of many tolerant, short-lived, and early-maturing individuals resulting in lower FIBI metric scores. See Figure 11 for a breakdown of the average metric scores at the sites along this reach.

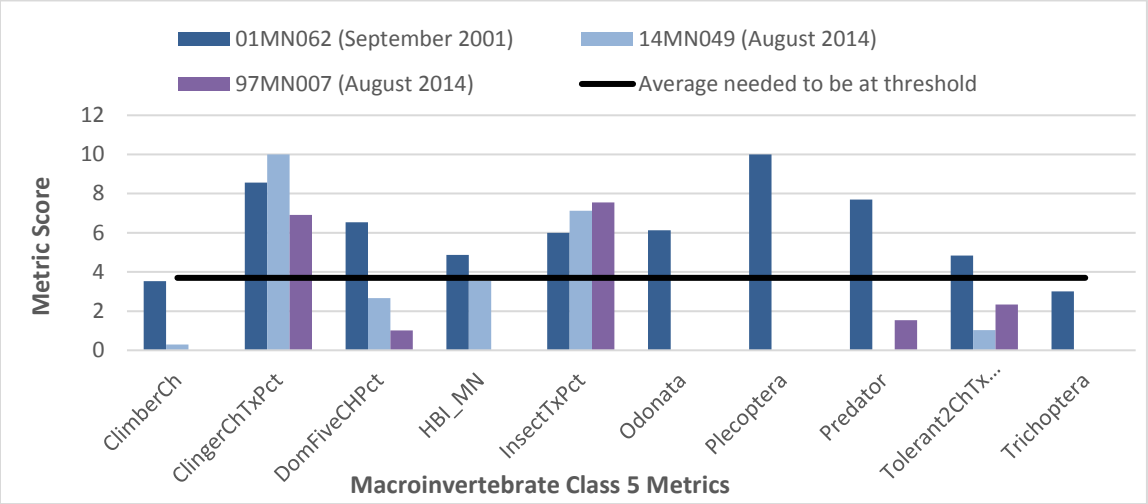
Figure 11. Fish biological metrics.



Macroinvertebrates

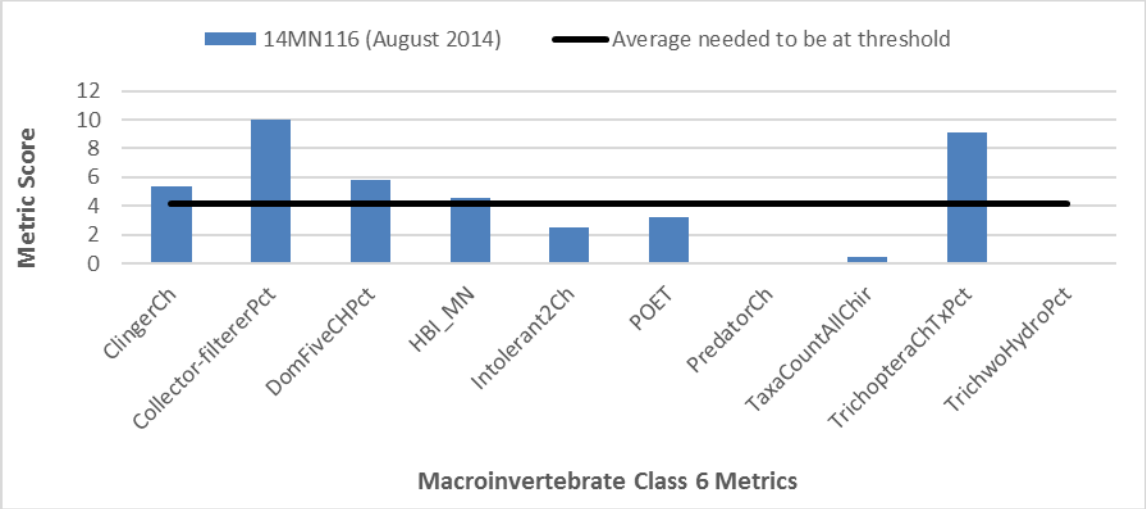
The macroinvertebrate community was sampled at four of the sites along this reach from 2001-2014. The MIBI scores from these sites are 61.2 (01MN062), 24.7 (14MN049), and 19.4 (97MN007). Like the fish community, site 01MN062 had a MIBI score above the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. The other two sites fell below this level. Site 01MN062 had metric scores reaching the average needed to meet the threshold in eight of the ten metrics comprising the MIBI for this class, while the other two sites each had two metrics reach this level (Figure 12).

Figure 12. Macroinvertebrate biological metrics in Class 5.



Site 14MN116 was sampled for macroinvertebrates in August of 2014. The MIBI score from this visit was 44.9, which is above the Macroinvertebrate Class 6 Southern Forest Streams GP General Use Threshold of 43. Five of the ten metrics comprising the MIBI for this site scored above the average needed to reach the threshold. This site also had two metrics score zero (PredatorCh, TrichwoHydroPc) limiting the MIBI score for this site. (Figure 13)

Figure 13. Macroinvertebrate biological metrics in Class 6



Candidate Cause Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years (2009-2016). Samples were collected throughout the length of the reach. Concentrations ranged from 2.85 mg/L to 16.31 mg/L with 17 days below 5 mg/L (8%). Values below 5 mg/L were taken at stations S001-891 and S001-873 which are both in the upper reach of High Island Creek.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-14.6 mg/L with 11% of values below the water quality standard of 5 mg/L with the majority of low values near the town of Arlington.

Table 12. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebr	DO Tolerant Index Score
97MN007 (7/30/14)	17.33	12.38	11	8.62	8.39	4	7.37
97MN007 (9/3/14)	17.11	8.55	9	NA	NA	NA	NA
97MN007 (2015)	0.71	7.07	12	NA	NA	NA	NA
97MN007 (2016)	1.29	21.85	16	NA	NA	NA	NA
14MN049 (2014)	6.44	43.73	17	0.32	7.14	4	7.86
14MN049 (2015)	0.85	18.08	13	NA	NA	NA	NA
14MN049 (2016)	7.14	50.48	23	NA	NA	NA	NA
15MN301 (2015)	3.66	43.24	25	NA	NA	NA	NA
15MN301 (2016)	1.94	62.50	23	NA	NA	NA	NA
15MN302 (2015)	8.78	55.73	25	NA	NA	NA	NA
15MN302 (2016)	13.85	53.41	27	NA	NA	NA	NA
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				8.62	7.04	8.97	7.10
14MN116	6.55	69.65	28	1.32	7.53	6	7.54
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				16.56	7.12	5.38	6.81
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	12.36	28.72	20.38	8.67	7.32	6.79	74.35
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There was a range of values at individual stations; 17.33% at station 97MN007 in 2014 to 0.71% in 2015 and 0.85 at station 14MN049 in 2015 to 7.14% in 2016. Stations 97MN007 and 15MN302 both had percentages above class average, but they also had percentages well below. Values at stations 14MN049 and 15MN301 were all below the class average. Low DO values also correspond with increased serial spawning fish percentages. Stations ranged from 7.07 to 62.50%. Station 97MN007 had the lowest percentages, all under the class averages of serial spawners. Serial spawner percentages increased from upstream to downstream along this reach. The fish communities were comprised of low DO tolerant fish that ranged from 44%-84% at station 97MN007, 19%-55% at station 14MN049, 24%-27% at station 15MN301, and 14%-18% at station 15MN302.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at each station. Intolerant macroinvertebrate taxa was 4 at both stations that had information, and DO tolerant percentage ranged from 0.32 to 8.62. Low DO was not a stressor to the macroinvertebrate community. There are low DO values in the upper part of this reach, but there is not a consistent biological fish response. Low DO is inconclusive as a stressor.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.018 to 2.88 mg/L with 65% over 0.150 mg/L. The highest value was collected in September upstream of the Minnesota River (station S000-676). Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 7% in April to 100% in June and an average of 46%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.4 mg/L with a mean of 0.2 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Recent BOD and chlorophyll-a data are not available, but 46% of BOD values taken between 1998-2002 were above the southern standard of 3 mg/L. The highest value (9 mg/L) was taken just downstream of Arlington. Chlorophyll-a values range from 2.1 to 45.2 ug/L, with only one value above the southern standard of 40 ug/L.

Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Typical daily pH fluctuations in streams are 0.2-0.3 (Heiskary et al., 2013). pH values ranged from 6.17 to 9.13, with 10% over a value of 8.5. Continuous pH data at station 97MN007 showed daily fluxes ranging from 0.03 to 0.3 at station 97MN007 with values ranging from 7.45 to 8.16. Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox and Nagels 2001). Continuous DO data produced daily flux values that were elevated to 4.93 mg/L. The water quality standard for DO flux in the south region of the state is 4.5 mg/L. Daily DO fluctuations are a measure of stress on the aquatic community. Station 97MN007 had thick algal growth (Figure 14). Algal respiration and photosynthesis are considered primary drivers of daily flux in DO, and high daily fluctuations of DO are connected to nutrient concentrations.

Figure 14. Algal growth at station 97MN007 (August 21, 2015))

Sensitive and darter percentages increased from up to downstream (zero at station 97MN007 to 16.22% at station 15MN302). The tolerant percentages decreased from up to downstream stations (99.15% at station 97MN007 to 49.62% at station 15MN302). A positive relationship exists between eutrophication and omnivorous fish. There was a range of omnivorous fish percentages (57.43% at station 97MN007 to 5.49% at station 15MN302).

Table 13. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
97MN007 (7/30/14)	0.50	0.50	79.70	57.43	29	80.92	59.38
97MN007 (9/3/14)	0	0	74.34	55.26			
97MN007 (2015)	0	0	99.15	40.17	NA	NA	NA
97MN007 (2016)	0.26	0.77	91.77	15.42	NA	NA	NA
14MN049 (2014)	0.68	1.02	81.36	19.66	18	73.57	42.36
14MN049 (2015)	1.13	0	97.18	8.47	NA	NA	NA
14MN049 (2016)	4.29	1.9	66.67	11.43	NA	NA	NA
15MN301 (2015)	10.56	6.34	72.54	10	NA	NA	NA
15MN301 (2016)	1.94	0.83	75.83	10.56	NA	NA	NA
15MN302 (2015)	16.22	9.92	49.62	9.92	NA	NA	NA
15MN302 (2016)	4.40	0.88	61.10	5.49	NA	NA	NA
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
14MN116	21.03	4.03	43.95	6.55	22	78.05	33.65
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.93**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

There were three macroinvertebrate samples collected on this reach, and the EPT percentage were all high (73.57-80.92%). However, the second most dominant species (17% of the population) at station 97MN007 was a caddisfly species that is tolerant to eutrophication conditions (Cheumatopsyche). Cheumatopsyche were also the most tolerant species at station 14MN116. The most dominant species at station 14MN049 were Ceratopsyche which are fairly tolerant. While EPT percentages were high, the species were tolerant to eutrophic conditions.

Station 97MN007 was dominated by two taxa, but the composition of the macroinvertebrate communities became more diverse further downstream. The taxa richness at each station were lower than class averages. However, the fish community is showing the effects of the elevated phosphorus, DO flux and pH values in the headwaters of the reach. Eutrophication is a localized fish stressor on the upper section of High Island Creek.

Candidate Cause Nitrate

From 2000-2016, a total of 759 nitrate samples were taken from this portion of High Island Creek. These samples ranged from 0.05-31.1 mg/L with an average value of 9.02 mg/L. A quantile regression analysis of macroinvertebrate Class 5 streams showed that nitrate concentrations at 18.1 mg/L or higher had a 75% probability of being impaired. High Island Creek (-834) had 79 (10.41%) samples at or exceeding 18.1 mg/L.

Table 14. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
01MN062	11.11	36.83	1.13	2.57
97MN007	6.90	75.69	0.00	4.65
14MN049	11.11	43.53	0.32	3.23
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
14MN116	15.15	41.77	0.16	3.26
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblages scored below average at one (01MN062), four (97MN007), three (14MN049), and two (14MN116) of the nitrate related metrics when compared to the respective macroinvertebrate classes of those sites (Table 14). At the majority of the sites, few nitrate tolerant and Trichoptera taxa were present, and the Nitrogen TIV score was also below average. The impacts of nitrates seemed to be most profound in the upstream portion of this stream reach as site 97MN007 scored the worst. Conditions improved somewhat moving downstream.

Based on the high observed nitrate concentrations, the quantile regression analysis, as well as the majority of the nitrate related biological metrics, especially in the upstream portion of this stream reach, nitrates are indeed a stressor to the biological communities in High Island Creek (-834) at this time.

Candidate Cause Sediment

From 2004-2016, High Island Creek (-834) had 677 TSS samples taken from it. These TSS concentrations ranged from 1.2-3,940 mg/L with an average value of 163 mg/L. Of these samples, 266 (39.29%) were at or above the 65 mg/L standard for TSS. Additionally, from 2004-2016, a total of 736 secchi tube measurements were taken from this reach. These measurements ranged from 0-100 cm, with an average value of 25.9 cm. Of these readings, 182 were either at or below the 10 cm standard for secchi

tube. Also, this reach was assessed in 2006 and determined to be impaired for Turbidity. This impairment was confirmed again during the 2016 assessment of this reach. Of all of the major tributaries to the Minnesota River, data from 2000-2008 shows High Island Creek to have the third largest TSS yield after the Le Sueur River and Sand Creek (MRBDC 2009).

Table 15. Fish metrics related to sediment

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
97MN007	10.24	0.00	9.72	7.50	10.18	0.15	17.37	0.00	26.92	26.23
14MN049	4.79	0.11	19.68	5.14	6.42	2.03	9.42	0.00	8.83	25.32
15MN301	7.02	0.14	10.05	4.77	11.31	6.25	6.10	0.07	4.46	28.13
01MN062	12.93	0.32	6.31	12.62	17.98	11.04	16.40	0.00	5.36	26.96
15MN302	10.86	0.21	5.14	12.30	17.17	10.31	25.68	0.00	10.13	29.78
14MN116	5.29	0.76	12.34	10.20	0.88	21.03	7.93	19.90	10.45	28.97
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in High Island Creek (-834) scored below average in seven (14MN116), eight (97MN007), nine (14MN049, 15MN301), and all ten (01MN062, 15MN302) of the ten suspended sediment related metrics when compared to the Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 15). All of these sites had low amounts of benthic feeder, Centrarchid, perciformid (perch-like), riffle dwelling, and simple lithophilic individuals, while also having very poor TSS index scores across the board.

Table 16. Macroinvertebrate metrics related to sediment.

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
01MN062	15.28	1	13	35.98	25.43	1.14
97MN007	26.26	0	12	73.23	27.38	0.00
14MN049	17.12	0	8	32.18	63.69	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
14MN116	18.54	0.5	11	61.52	74.51	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in three (14MN049), four (01MN062), five (14MN116), and six (97MN007) of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations and Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 16). All of the sites had low numbers or completely lacked TSS Intolerant taxa. Site 01MN062 was the only site of the group that had low amounts of collector-filter individuals.

The very extensive data set for this reach shows a high standard exceedance rate for both the TSS samples and secchi tube measurements. The majority of the fish and macroinvertebrate metrics related to suspended sediment scored below average as well. This reach is also currently listed as impaired for turbidity. Based on all of this information, suspended sediment is a stressor to aquatic life in High Island Creek (-834).

Candidate Cause Habitat

High Island Creek (-834) had qualitative habitat assessments take place at its biological monitoring sites (upstream to downstream), 97MN007, 14MN049, 15MN301, 01MN062, 15MN302, and 14MN116, during the fish and macroinvertebrate sampling events in 2001, 2014, 2015, and 2016. The average MSHA score was 44.72 (Poor) at 97MN007, 56.46 (Fair) at 14MN049, 67.85 (Good) at 15MN301, 65 (Fair) at 01MN062, 70.5 (Good) at 15MN302, and 38.85 (Poor) at 14MN116. The middle sites along this reach scored better in the substrate and channel morphology categories. These sites tended to have more course substrates and more channel stability that the sites furthest upstream and downstream lacked. A breakdown of the MSHA category scores for these sites can be seen in Figure 15. “Historic incision and a fairly unstable pattern (e.g. sinuosity of 1.18 is low for a C channel) set the channel up poorly to withstand floods” (DNR, 2017a). The 2014 flood caused wider channels and caused some riffles to flow sideways as well as eroding banks by up to 38 feet (Figure 16) (DNR, 2017a). At study locations throughout the reach, the presence of point bars indicate that the stream does not have the stream power to move sand at low flow conditions (DNR, 2017a).

Figure 15. MSHA Metric Scores.

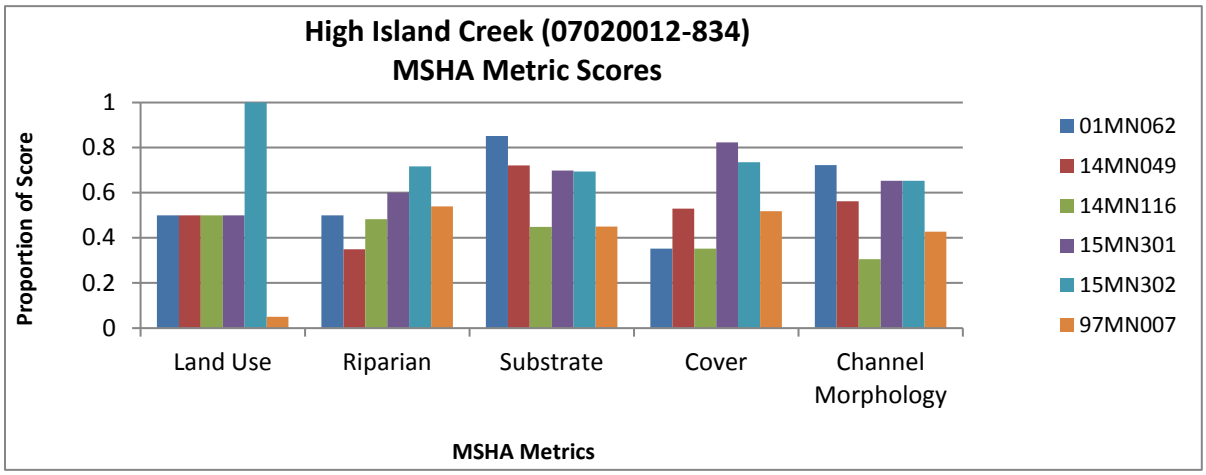


Figure 16. Sideways riffle on High island Creek. DNR photo credit

Table 17. Habitat related fish metrics.

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
97MN007	0.3	17.37	0.25	10.18	7.24	33.27	88.98	41.33
14MN049	1.57	9.42	1.29	6.42	4.32	32.02	81.73	34.60
15MN301	5.41	6.10	3.86	11.31	1.19	28.70	74.18	36.58
01MN062	14.2	16.4	9.46	17.98	2.21	36.59	45.74	29.34
15MN302	10.04	25.68	6.91	17.17	6.79	36.86	55.36	16.13
14MN116	4.28	7.93	4.16	0.88	6.80	8.44	43.95	7.68
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

High Island Creek (-834) is a longer stream reach with an abundance of monitoring sites. The fish sampling at the six monitoring stations consistently measured below average in the majority of habitat related metrics when compared to other Class 2 Southern Stream stations that did meet the FIBI General Use Threshold. (Table 17) Overall, this stream reach had many tolerant and pioneer species, while also lacked many species requiring specialized habitat conditions to live and reproduce. These results are indicative of a stream being stressed by habitat conditions.

Table 18. Habitat related macroinvertbrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN062	22.29	2.57	51.71	36.86	43.43	19.14
97MN007	3.38	4.62	79.38	80.92	9.85	7.69
14MN049	0.32	6.05	80.25	73.57	9.55	0.64
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
14MN116	1.10	7.02	84.51	75.69	15.46	3.75
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrates were sampled at four stations along this reach. Site 01MN062, which had a good scoring MSHA, coincidentally scored below average in four of the six habitat related metrics. The remaining sites scored below average in two of the six evaluated metrics when compared to sites meeting the threholds in their respective classes (Table 18).

Given the length and number of biological monitoring stations along this reach, it is not surprising to see a wide variety of results. While a couple of the middle sites in this reach had good MSHA scores, the fact that the most upstream and downstream sites scored poorly, and all of the fish sites had the majority of their habitat related metrics score below average, habitat is a stressor along this reach.

Candidate Cause Chloride/Ionic Strength

A small dataset of chloride values were available on this reach, ranging from 13.8 to 32.1 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 147 to 6600 µS/cm. The highest values were collected at station S001-891 in Arlington and station S000-676 in the downstream section. Continuous data collected in 2016 had a range of specific conductance values from 429 to 1155 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Less than 1% of the values were greater than 1,000 uS/cm.

Table 19. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
97MN007 (7/30/14)	29	9	59.69	80.92	0
97MN007 (9/3/14)	NA	NA	NA	NA	0
97MN007 (2015)	NA	NA	NA	NA	0
97MN007 (2016)	NA	NA	NA	NA	0
14MN049 (2014)	18	7	28.66	73.57	0.34
14MN049 (2015)	NA	NA	NA	NA	0
14MN049 (2016)	NA	NA	NA	NA	0
15MN301 (2015)	NA	NA	NA	NA	0
15MN301 (2016)	NA	NA	NA	NA	0.28
15MN302 (2015)	NA	NA	NA	NA	0.19
15MN302 (2016)	NA	NA	NA	NA	0.22
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
14MN116	20	5	19.37	73.33	0.76
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0	39.46	5	18.26	30.93	
Expected response to stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentages were all higher than 73% and the mayfly (Ephemeroptera) percentages ranged from 19.37-59.69%. The taxa counts were all below the class average. The macroinvertebrate community was comprised of a range of 26.50-71.08% conductivity tolerant individuals and intolerant individuals ranged from 0 to 1.

Elevated chloride can also lead to increases in sunfish based assemblages. All visits had a Centrarchidae (sunfish) percentage below 1%. Species that are tolerant to conditions with high ionic strength comprised a range of 15-46% of the fish community. There are instances of elevated specific conductance concentrations that might be influencing the biological community with low taxa count. While the periodic specific conductance elevated values might be contributing as a stressor, chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. It is inconclusive at this time.

Candidate Cause: Altered Hydrology/Connectivity

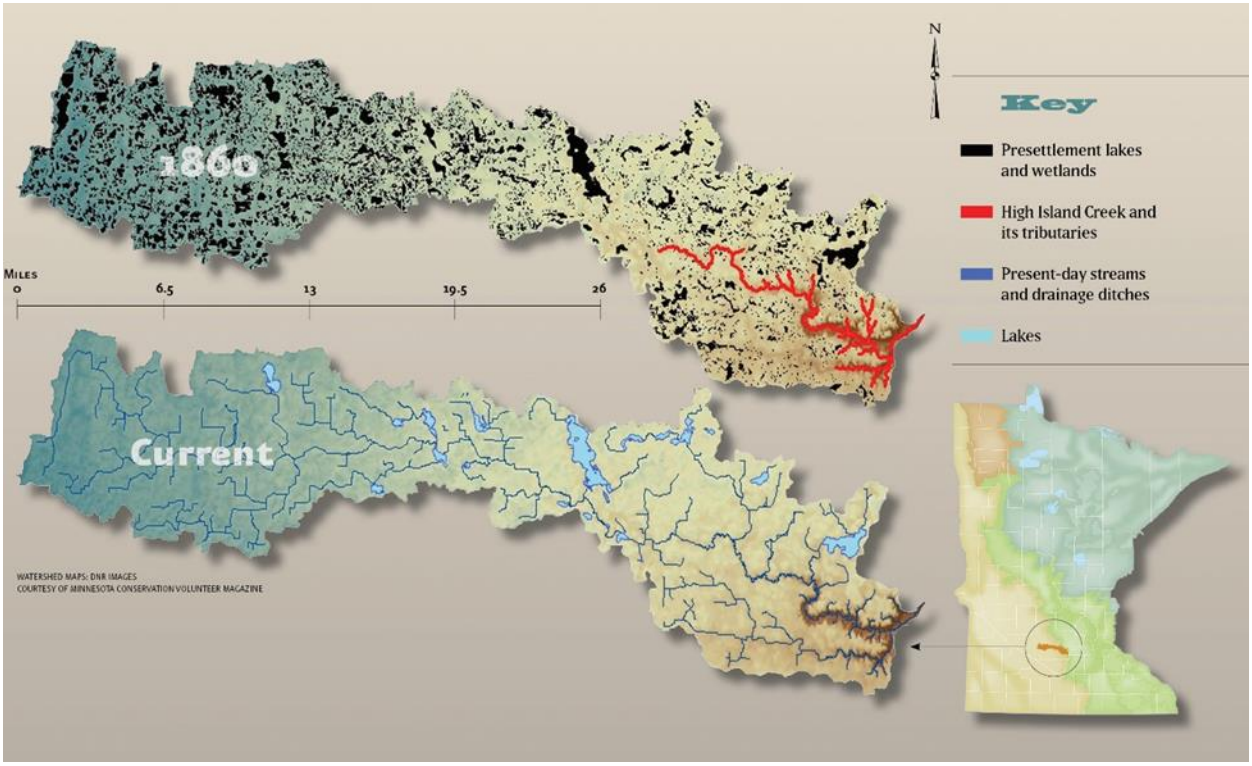
While this reach of High Island Creek is a natural stream, the MPCA altered watercourse layer measured 73.22% of the High Island Creek sub-watershed as channelized. Increases in the drainage network have decreased the water storage of the watershed by 77.69% (DNR, 2017a). Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section of High Island Creek experiencing low flow at less than 1 cfs 4% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The sites had a population of generalist fish ranging from 11.84 to 92.79%. The highest percentages were at station 97MN007. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species ranged from 2.71-47.10%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates ranged from 0 to 2.78%.

The upstream watershed altered hydrology is likely contributing to both eutrophication and lack of habitat, but is not a clear stressor. Altered hydrology is inconclusive as a stressor. Increased flow events can cause increased bank erosion and bedload transport, eventually leading to excess sedimentation once flows subside, affecting fish and macroinvertebrate species that rely on clean sub strate for habitat and/or reproduction.

Figure 17. Dramatically altered watershed. Courtesy from "Diet for Troubled Waters", 2016, January-February, Minnesota Conservation Volunteer/DNR



Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. "Longitudinal connectivity is especially important for fish species as they make seasonal migrations to spawning, nursery, feeding, or overwintering habitats" (DNR, 2017a). Since the High Island Creek dam was compromised in June 2014, 18 new fish species have been found upstream from the former dam (DNR, 2017a). The MPCA and DNR are studying the rate of fish migration since the dam was removed. The dam was a clear barrier to migratory fish prior to its removal (Table 20). Sampling in 2015 and 2016 after the dam was removed show that migratory fish previously lacking have now moved to upstream stations (Table 21). Connectivity has been restored and is no longer a stressor.

Table 20. Migratory fish prior to dam removal

CommonName	97MN007	14MN049		01MN062	14MN116
blackside darter		X		X	
central stoneroller				X	X
golden redhorse					
greater redhorse					
Iowa darter					X
shorthead redhorse					X
silver lamprey			Dam		
slenderhead darter	X	X		X	X
silver redhorse					
spottail shiner					
quillback					
walleye	X	X		X	X
white bass					
white sucker	X	X		X	X

Table 21. Migratory fish after dam removal

CommonName	97MN007	14MN049	15MN301		15MN302
blackside darter		X	X		X
central stoneroller		X	X		X
golden redhorse					X
greater redhorse					
Iowa darter					
shorthead redhorse		X	X		X
silver lamprey				Former Dam Location	
silver redhorse		X			
slenderhead darter		X	X		X
silver redhorse					
spottail shiner					
quillback					
walleye	X	X	X		X
white bass					
white sucker	X	X	X		X

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in High Island Creek (-834) are being stressed by Eutrophication, Nitrates, Suspended Sediment, and Habitat. (Table 22) It was inconclusive at this time if Dissolved Oxygen and Chloride are stressors as well. Flow Alteration/Connectivity was determined not to be stressing the biological communities. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 22. Stressors on High Island Creek (-834)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
High Island Creek (-834)	07020012-834	o	●	●	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.3 High Island Creek (-838)

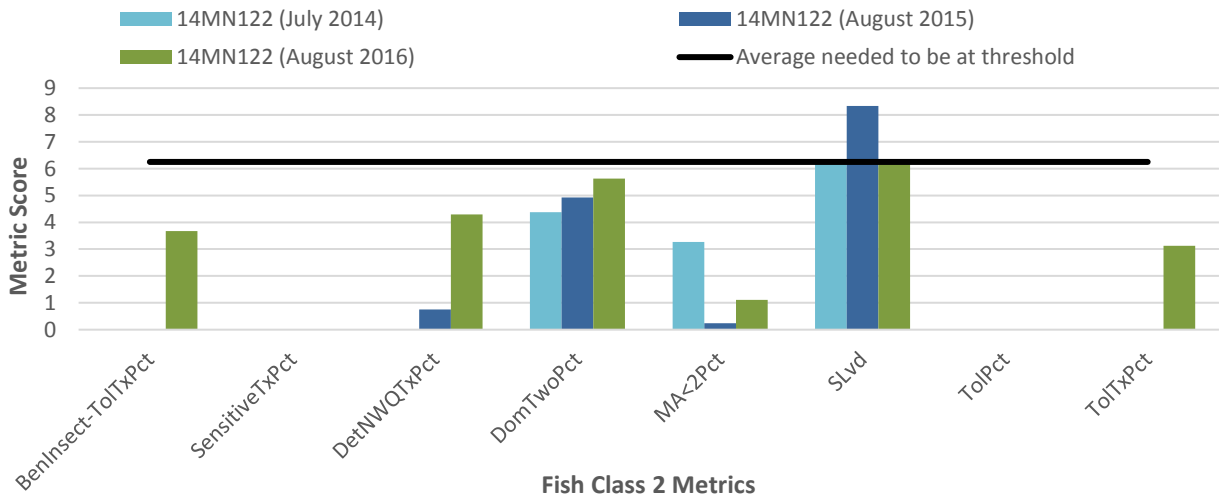
High Island Creek (-838) is a 4.54 mile long stream reach located in northern Sibley county. This reach extends from the downstream side of Mcleod/Sibley county border to the confluence with High Island Creek (-833). This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN122, located along this stream section.

Biology

Fish

High Island Creek (-838) was sampled for fish at its biological monitoring station, 14MN122, three times from 2014-2016. The FIBI scores from these visits were 13.9 (2014), 14.3 (2015), and 24.1 (2016). All three of these scores are far below the Fish Class 2 Southern Streams General Use Threshold of 50. All three visits did have a lower number of short-lived species resulting in the only metric score that reached the level needed to attain the threshold. These visits also lacked any sensitive taxa and had high amounts of tolerant individuals resulting in metric scores of zero. (Figure 18).

Figure 18. Fish biological metrics

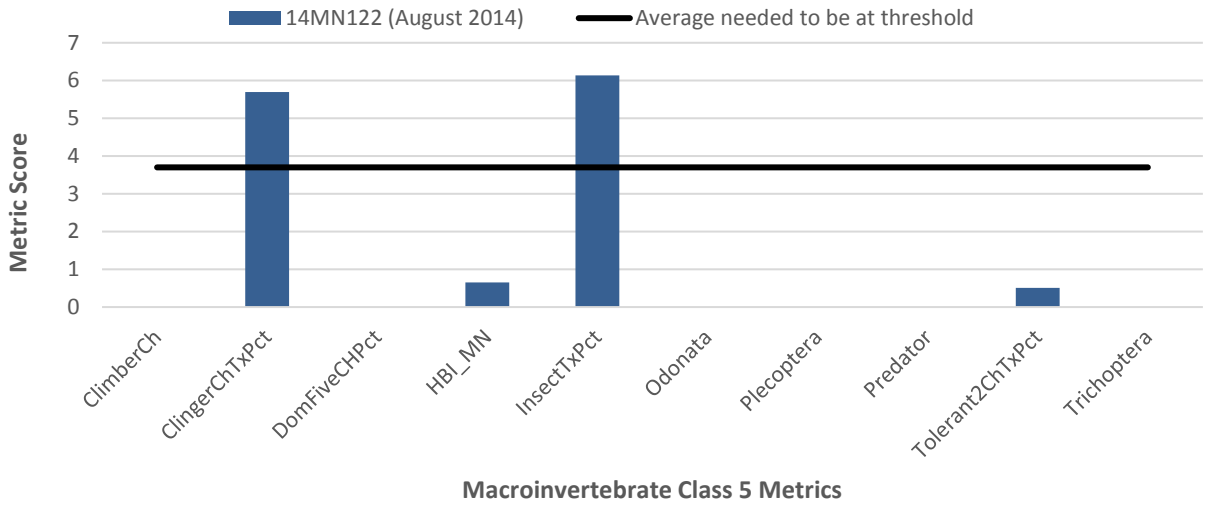


Macroinvertebrates

The macroinvertebrate community was also sampled at site 14MN122 along this reach in August of 2014. The MIBI score for this visit was 13.0, which is well below the Macroinvertebrate Class 5 Southern

Streams RR General Use Threshold of 37. Only two of the ten metrics scored above the average needed to meet the threshold (ClingerChTxPct, InsectTxPct), while six metrics had a score of zero (Figure 19).

Figure 19. Macroinvertebrate biological metrics



Candidate Cause Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 4.02 mg/L to 11.4 mg/L with 3 days below 5 mg/L (12%). The values were taken in the downstream portion of the reach near Highway 22. Values below 5 mg/L were taken at station S007-867, which is located upstream of the wetland complex.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.2-14.8 mg/L with 26% of values below the water quality standard of 5 mg/L.

Table 23. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
14MN122 (2014)	4.14	41.42	9	5.59	8.12	5	7.38
14MN122 (2015)	0.29	31.45	9	NA	NA	NA	NA
14MN122 (2016)	0.79	15.59	17	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	12.36	28.72					
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)			17.02	8.62	7.04	8.97	7.10
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All samples were below 4.2%, all well below the class average. Low DO values also correspond with increased serial spawning fish percentage. The 2014 visit had the highest percentage (41.42%) while the two subsequent visits were right at and below the class average. Species that are very tolerant to low DO conditions (fathead minnow, central mudminnow, black bullhead) comprised 35-85% of the fish community at station 14MN122.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; 5 intolerant macroinvertebrate taxa and 5.59% DO tolerant percentage. There are low DO values in this reach, but there is not a consistent biological response. Low DO is inconclusive as a stressor on this section of High Island Creek.

Candidate Cause Eutrophication

Phosphorus values ranged from 0.06 to 0.419 mg/L in recent years with 70% of values over the southern standard of 0.150 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Phosphorus concentrations were not dominated by orthophosphorus concentrations, with a range of 7% to 99% and an average of 22%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.20 mg/L .

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, there is no data on these parameters. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.4 to 8.59.

All visits at both stations lacked any had sensitive or darter species. Tolerant percentages were all greater than 94%. A positive relationship exists between eutrophication and omnivorous fish. There was a range of omnivorous fish percentage (13.07-44.64%), with one value below and two above the class average.

There was only one macroinvertebrate sample collected on this reach, and it was dominated by two species (60.56% of the sample was comprised of just two species). The EPT percentage was high (75.78%), but was dominated by eutrophic tolerant Cheumatopsyche, and the taxa richness was low. The fish biological community is showing the effects of the elevated phosphorus and pH values. Eutrophication is a stressor to both the fish and macroinvertebrate communities on this section of High Island Creek.

Table 24. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN122 (2014)	0	0	95.86	23.96	23	75.78	60.56
14MN122 (2015)	0	0	99.71	44.64	NA	NA	NA
14MN122 (2016)	0	1.26	94.96	13.07	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	18.65	11.68	44.85	16.53			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					41.92	43.90	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2016, a total of 13 nitrate samples were taken from High Island Creek (-838). The nitrate sample values ranged from 0.05-22.4 mg/L with an average value of 11.14 mg/L. A quantile regression analysis showed that when a macroinvertebrate Class 5 stream exceeded 18.1 mg/L nitrate, there was a 75% probability that the stream would be impaired. High Island Creek (-838) had two instances in which the nitrate concentration was above 18.1 mg/L.

Table 25. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN122	**8.70**	**73.29**	**0.00**	**4.24**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in High Island Creek (838) at site 14MN122 scored below average in all four of the nitrate related metrics evaluated when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 25). The site lacked nitrate intolerant species, while having few Trichoptera taxa. The numbers of nitrate tolerant taxa were high and the Nitrogen TIV score was below average.

Based on the elevated nitrate concentrations observed, as well as the poor scoring nitrate related biological metrics in the macroinvertebrate assemblage, nitrates are a stressor to aquatic life in High Island Creek (-838).

Candidate Cause Sediment

From 2001-2016, a total of 25 TSS samples were taken from High Island Creek (-838). These samples ranged in value from 7.2-512.5 mg/L with an average TSS concentration of 66.81 mg/L. Of these samples, three were above the 65 mg/L standard for TSS. Also, in this same time period, 35 secchi tube readings were taken. These values ranged from 5.6-100 cm with an average reading of 33.93 cm. Of these measurements, only one was below the 10 cm minimum standard for transparency. This reach was determined to be impaired for turbidity during the 2016 assessment.

Table 26. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN122	**7.39**	**0.00**	**23.13**	**2.16**	**7.18**	**0.00**	**9.08**	**0.00**	**6.75**	**23.50**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in High Island Creek (-838) scored below average in nine of the 10 suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 26). The site, 14MN122, did have an above average amount of herbivorous individuals, but scored poorly in the remaining metrics especially TSS index score.

Table 27. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN122	**22.82**	**0**	**10**	**69.25**	**51.55**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 27). This reach did have a high amount of collector-filterer species and a lower

amount of TSS tolerant taxa. However, the reach also had a poor TSS index score, a high amount of TSS tolerant individuals, and was completely without TSS intolerant and Plecoptera taxa.

Based on the high exceedance rate of the TSS samples, the majority of the suspended sediment related metrics for both the fish and macroinvertebrate communities, as well as the current turbidity impairment, suspended sediment is a stressor to aquatic life in High Island Creek (-838).

Candidate Cause Habitat

High Island Creek (-838) had a qualitative habitat assessment take place at its biological monitoring site, 14MN122, during the fish and macroinvertebrate sampling events in 2014, 2015, and 2016. The average MSHA score from these visits was 52.15 (Fair). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, heavy bank erosion (Figure 20), sand substrates, moderate embeddedness, moderate channel stability, and fair channel sinuosity. A breakdown of the MSHA category scores for this site can be seen in Figure 21.

Figure 20. Eroding banks at site 14MN122 (August 18, 2014)

Figure 21. Habitat metrics at site 14MN122

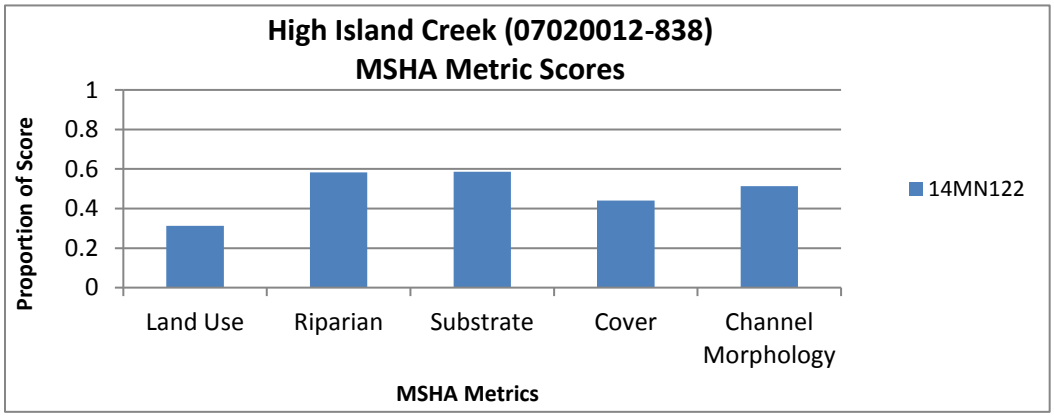


Table 28. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN122	0.42	9.08	0.42	7.18	1.74	16.61	96.84	39.56
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in High Island Creek (-838) scored below average in all habitat related metrics when compared to all other Class 2 Southern Stream stations that meet the FIBI General Use Threshold (Table 28). The fish community at site 14MN122 was sampled three times from 2014-2016. These samples all had significant numbers of fairly tolerant fish species including: green sunfish, bigmouth shiners, fathead minnows, and brassy minnows.

Table 29. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN122	**1.55**	**4.04**	**85.40**	**75.78**	**7.76**	**5.90**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage fared better than the fish community as only two of the six habitat related metrics were below average compared to other Class 5 Southern Stream stations meeting the MIBI General Use Threshold (Table 29). High amounts of both EPT and clinger individuals, while having fewer amounts of both burrowers and legless macroinvertebrates does not typically signal habitat stress.

Given how poorly the fish responded to the habitat related metrics, the photographic evidence of degraded conditions, as well as the fair MSHA score. Habitat is a stressor to the fish community at this time. The macroinvertebrate assemblage, while scoring well in habitat related metrics, may degrade if the habitat conditions do not improve.

Candidate Cause Chloride/Ionic Strength

A small dataset of chloride values were available on this reach, ranging from 12.9 to 27.7 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 297 to 1001 µS/cm. All values were collected at station S007-891 in Arlington and station S000-867. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Only one value was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The one macroinvertebrate EPT percentage was higher than 75% and the mayfly (Ephemeroptera) percentage was 36.64%. The taxa count was 23, below the class average. The macroinvertebrate community was comprised of 68.63% conductivity tolerant individuals and with 0 intolerant individuals.

Table 30. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN122 (2014)	23	9	36.34	75.78	0
14MN122 (2015)				NA	0
14MN122 (2016)				NA	0
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					*4.89*
Expected response to stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. None of the visits had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised a range of 0-42% of the fish community.

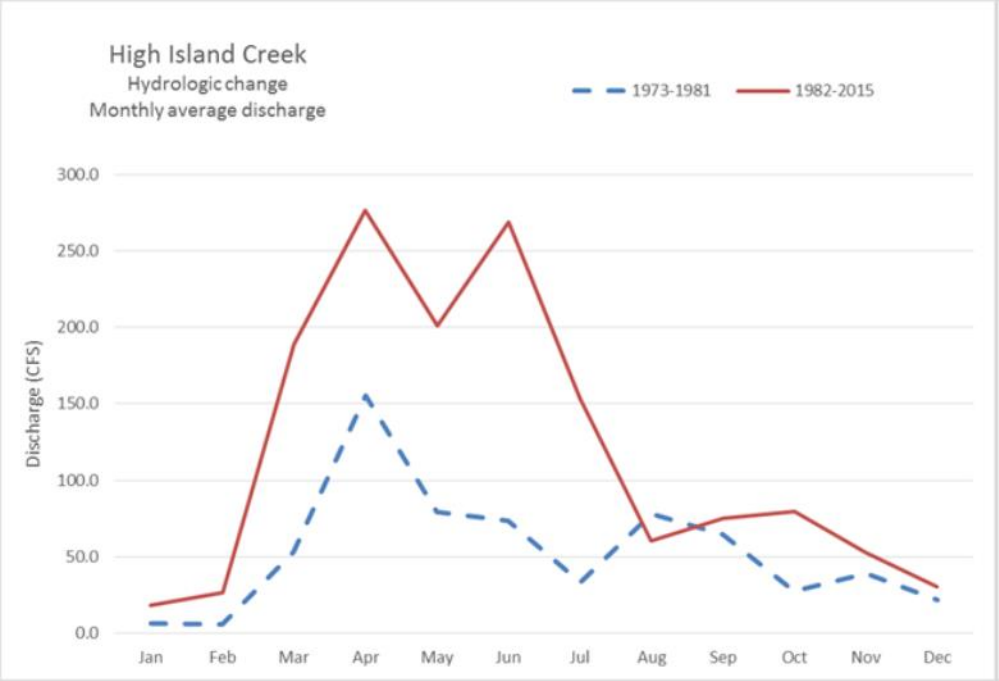
There are instances of elevated specific conductance concentrations that might be influencing the biological community with low taxa count; however, the mayfly and EPT percentages were higher. While one specific conductance value was above 1000 µg/L, the preponderance of evidence indicates ionic strength is not a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured 73.22% of the High Island Creek sub-watershed as channelized. While this reach of High Island Creek is a natural channel, the entire upstream watershed and all contributing tributaries are 100% altered according to the MPCA altered watercourse layer. There were no known connectivity issues.

Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities. As observed at the gage on High Island Creek near Henderson, discharge has increased over time (Figure 22).

Figure 22. High Island Creek Hydrological change over time (DNR, 2017a).



Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section of High Island Creek is experiencing low flow at less than 1 cfs 13% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The sites had a population of generalist fish ranging from 31.95 to 69.42%. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species ranged from 4.73-47.40%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present. The upstream watershed altered hydrology is likely contributing to both eutrophication and lack of habitat and is a contributing stressor based on the biological communities.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in High Island Creek (-838) are being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 31). Dissolved Oxygen was determined to be inconclusive as a stressor while Chloride was determined not to be stressing the biological communities. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 31. Stressors on High Island Creek (-838)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
High Island Creek	07020012-838	o	●	●	●	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.4 Judicial Ditch 11 (-590)

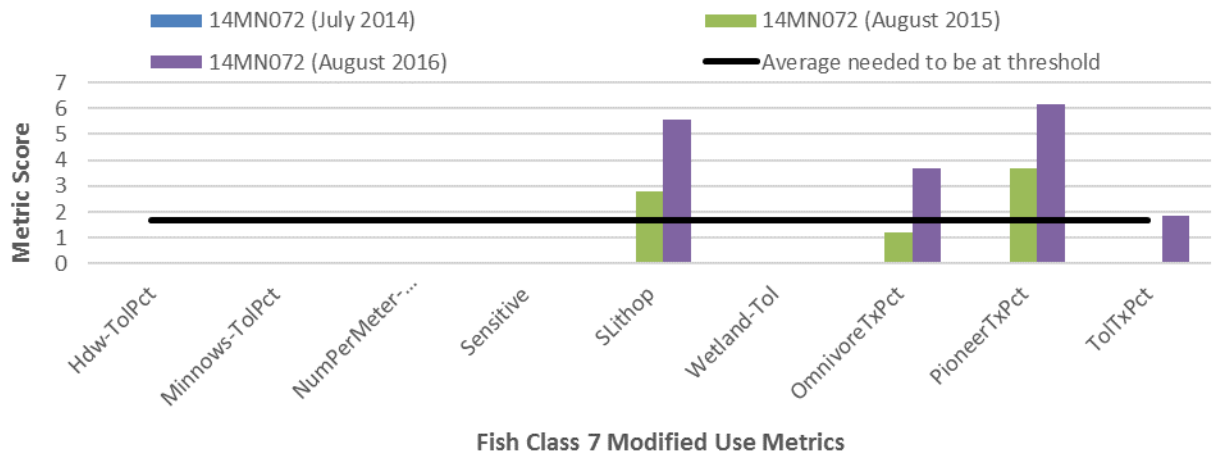
Judicial Ditch 11 (-590) is a 13.82 mile long stream reach located in eastern Renville and northwestern Sibley County. This reach extends from County Ditch 103 to the confluence with County Ditch 10 and has one biological monitoring station, 14MN072. This reach is impaired for biology due to its fish assemblage.

Biology

Fish

Judicial Ditch 11 (-590) was sampled for fish at its biological monitoring station, 14MN072, three times from 2014-2016. The FIBI scores from these visits were 0 (2014), 7.7 (2015), and 17.4 (2016). The 2016 scored above the modified use threshold while the visits from 2014 and 2015 both scored below the Fish Class 7 Low Gradient Modified Use Threshold of 15. The 2016 visit did score above the average needed to reach the threshold in four of the nine metrics. The 2015 visit scored above this average in just two of the metrics. For a further breakdown of the metric scores, see Figure 23.

Figure 23. Biological fish metrics



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2009-2016). Concentrations ranged from 1.59 mg/L to 17.45 mg/L with 2 values below 5 mg/L and one value of 5.84 mg/L. Values were taken in the mid and downstream sections of the reach. Values below 5 mg/L were taken at mid-reach stations S005-802 and 14MN072.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-12.9 mg/L with 41% of values below the water quality standard of 5 mg/L.

Table 32. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
14MN072 (2014)	0	63.70	1	NA	NA	NA	NA
14MN072 (2015)	0	70.49	9	NA	NA	NA	NA
14MN072 (2016)	1.48	100	9	NA	NA	NA	NA
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	4.38	28.58	11.74				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All samples were below 1.5% of mature females, with two values of zero. Low DO values also correspond with increased serial spawning fish percentage. All three visits had percentages well above the class average for those sites that meet the modified IBI standard for serial spawners. Species that are very tolerant to low DO conditions (fathead minnow, green sunfish, black bullhead) comprised 88-100% of the fish community at station 14MN072 (although the fish survey in 2014 was comprised of only one fathead minnow). Macroinvertebrates were not sampled on this reach. There are low DO values in this reach, which is reflected in the fish biological response. Low DO is a stressor.

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.036 to 0.28 mg/L. The highest value was collected in July at station 14MN072. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 21% in May to 88% in July and an average of 67%. Station 14MN072 had thick macrophyte growth (Figure 24). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.9 mg/L with a mean of 0.3 mg/L.

Figure 24. Macrophyte and algal growth at station 14MN072 (August 2, 2016)

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus.

A small group of BOD values ranged from 2 to 9.1, with 3 of the eight values from 2000-2001 above the southern regional standard of 3.5 mg/L. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.43 to 9.73. Values of pH over 8.5 are tied to eutrophication. DO flux and chlorophyll-a data were not available.

All visits had zero sensitive or darter species, which have a negative relationship with eutrophication. Tolerant percentages were all greater than 98%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. All values of omnivorous fish percentages were higher than 64% all well above the class average for sites meeting the IBI standard.

Table 33. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN072 (2014)	0	0	100	100	NA	NA	NA
14MN072 (2015)	0	0	100	76.04	NA	NA	NA
14MN072 (2016)	0	0	98.52	64.44	NA	NA	NA
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Threshold (15.0)	**16.71**	**6.74**	**55.88**	**16.77**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Macroinvertebrate were not collected on this reach. The fish biological community is showing the effects of the elevated phosphorus, BOD, and pH values. Eutrophication is a stressor to the fish community on this section of Judicial Ditch 11.

Candidate Cause Nitrate

From 2000-2016, a total of 16 nitrate samples were taken from Judicial Ditch 11 (-590). These nitrate concentrations ranged from 0.65-21 mg/L with an average value of 9.64 mg/L. A quantile regression analysis showed that a similar macroinvertebrate Class 7 stream would have a 90% probability of being impaired with a nitrate concentration at 11.5 mg/L or higher. Site 14MN072 had six instances in which the nitrate concentration exceeded this level.

Furthermore, drain tiles were spotted in this reach. Drain tiles are often a source for high nitrates as nitrates applied to the landscape infiltrate the soil and into the drain tiles before entering the stream.

Given the high nitrate concentrations, the quantile regression analysis, as well as the presence of drain tiles, nitrates are a stressor to aquatic life in Judicial Ditch 11 (-590). A macroinvertebrate sample during base flow conditions is recommended to further determine the impact nitrates are having on that community.

Candidate Cause Sediment

From 2000-2016, a total of 14 TSS samples were taken from Judicial Ditch 11 (-590). These samples ranged in value from 3.2-300 mg/L, with an average value of 72.17 mg/L. Of these samples, six were above the 65 mg/L standard for TSS. Additionally, from 2000-2016, a total of 19 secchi tube measurements were taken along this reach. These measurements ranged from 4-82 cm with an average reading of 44.84 cm. Of these readings, four were below the 10 cm minimum standard for transparency.

Table 34. Sediment related metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN072	**1.29**	**0.00**	**1.33**	**0.49**	**1.29**	**0.00**	**1.78**	**0.00**	**1.42**	**23.79**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 11 (-590) at site 14MN072 scored below average in all 10 of the suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 34). The TSS index score along this reach scored especially poor.

No macroinvertebrate sample was taken along this reach.

Based on the very poor scoring fish metrics related to suspended sediment, combined with the high rate of standard exceedances with the TSS samples and secchi tube measurements, suspended sediment is a stressor to aquatic life in Judicial Ditch 11 (-590).

Candidate Cause Habitat

Judicial Ditch 11 (-590) had a qualitative habitat assessment take place at its biological monitoring site, 14MN072 during the fish and macroinvertebrate sampling events in 2014, 2015, and 2016. The average MSHA score from these visits was 21.75 (Poor). Limiting the habitat at this site was the row crop as the dominant land use (Figure 25), narrow stream riparian buffer, no stream shading, no course substrates, large amounts of silt, sparse fish cover, limited depth variability, no riffles, poor channel sinuosity, and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 26. The channel is now deeply incised and cannot reach its floodplain after cleanout in 2015 (DNR, 2017a) (Figure 26).

Figure 25. Habitat metric scores

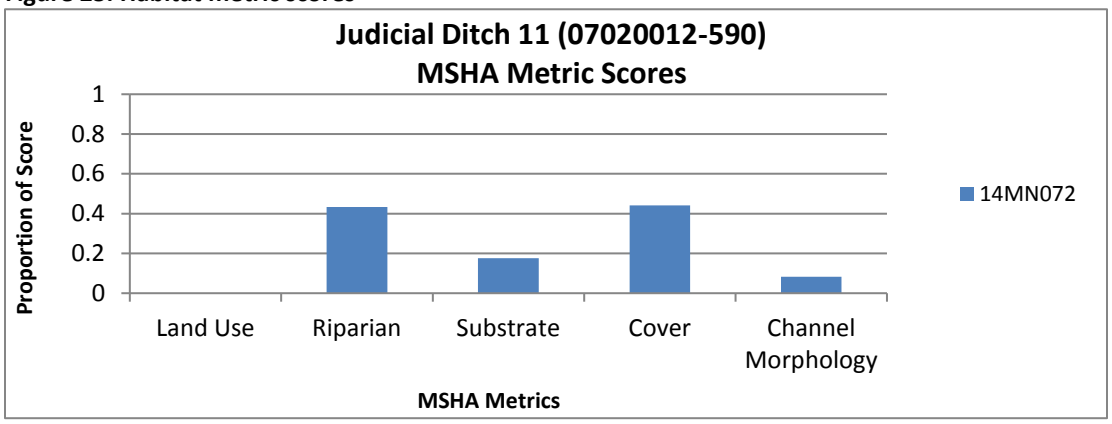


Figure 26. The channel at site 14MN072 before and after cleanout (DNR, 2017a). Photo credit DNR.

Table 35. Habitat related biological fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN072	**0.00**	**1.78**	**0.00**	**1.29**	**0.49**	**4.69**	**99.51**	**86.70**
Statewide average for Class 7 Low Gradient stations that are meeting the Modified Use FIBI Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Judicial Ditch 11 (-590) was relatively poor as it scored below average in all habitat related metrics when compared to similar Class 7 Low Gradient stations that did meet the Modified Use Threshold (Table 35). The fish community in this reach was dominated by fathead minnows (67.7%). Fathead minnows are very tolerant to poor habitat conditions.

Given the poor scoring MSHA, as well as the below average scoring fish habitat metrics, and the dominance of very tolerant fish species, like fathead minnows, lack of habitat is a stressor to the fish community in this reach.

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 732 to 1191 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Three values were greater than 1,000 µS/cm on this reach.

Table 36. Biological metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN072 (2014)	NA	NA	NA	NA	0
14MN072 (2015)	NA	NA	NA	NA	0
14MN072 (2016)	NA	NA	NA	NA	0
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)					*4.38*
Expected response to stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Macroinvertebrates were not sampled on this reach. Elevated chloride can lead to increases in sunfish based assemblages. None of the visits had any Centrarchidae (sunfish) collected. Fish species that are tolerant to conditions with high ionic strength comprised a range of 66-100% of the fish community.

There are instances of elevated specific conductance concentrations that might be influencing the biological community with the high percentage of fish tolerant to conductivity. While the periodically elevated specific conductance values might be contributing as a stressor, chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. It is inconclusive at this time.

Candidate Cause Altered Hydrology/Connectivity

The reach is 100% altered according to the MPCA altered watercourse layer. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). There were no known connectivity issues. Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 35% of the time in the headwaters of the reach and 16% of the time in the downstream reach during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The sites had a population of generalist fish ranging from 83.70 to 100%. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species ranged from 74.07-100%. The channelized reach is likely contributing to both eutrophication and lack of habitat and is a contributing stressor based on the fish community.

Conclusions and recommendations

The biological communities in Judicial Ditch 11 (-590) have multiple stressors that are clearly negatively impacting quality of life (Table 37). These stressors include: Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. Chloride was inconclusive as a stressor at this point. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 37. Stressors on Judicial Ditch 11 (-590)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 11	07020012-590	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.5 Judicial Ditch 11 (-593)

Judicial Ditch 11 is located in northwestern Sibley county before flowing into southwestern McLeod county. This 3.86 mile long reach extends from County Ditch 10 to the confluence with Judicial Ditch 24. This reach is immediately downstream of Judicial Ditch 11 (-590). This reach contains one biological sampling station, 14MN071, and is impaired for biology due to both the fish and macroinvertebrate assemblages. The ditch was cleaned out in 2014.

Biology

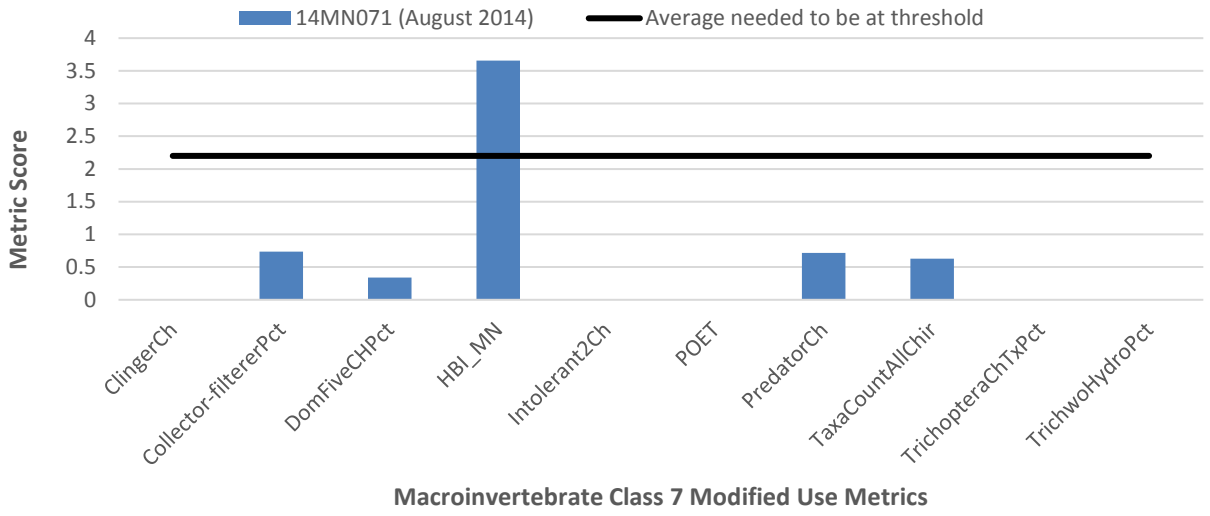
Fish

Judicial Ditch 11 (-593) was sampled for fish in July of 2014 at its biological monitoring station, 14MN071. The FIBI score for this visit was zero. The community was dominated by tolerant fish taxa, and all of the metrics had a score of zero.

Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 14MN071. The MIBI score for this visit was 6.1, which is far below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Only one of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold (HBI_MN). Five of the nine metrics scoring below this level scored zero, greatly limiting the MIBI score for this site (Figure 27).

Figure 27. Macroinvertebrate biological metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 8.37 mg/L to 11.46 mg/L without any recorded values below 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-12.9 mg/L with 54% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The one sample (14.29%) had a value right at the class average of sites that met the standard for mature females. Low DO values also correspond with increased serial spawning fish percentage. The one visit had a percentages well above the class average for serial spawners. Species that are very tolerant to low DO conditions were not collected, but only seven fish total were collected. The collected fish were all moderately tolerant to low DO conditions.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; no intolerant macroinvertebrate taxa were collected and DO tolerant individuals comprised 71.52% of the population. There were no low DO values on this reach, but the dataset was very small and the biological response is indicative of possible DO stress. Based on the high rate of exceedance of the HSPF results, the number of DO tolerant fish and macroinvertebrates, serial spawners, and the downstream reach of High Island Creek where DO is a stressor, DO is a stressor in this reach.

Table 38. Biological metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN071	14.29	71.43	3	71.52	7.76	0	5.79
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	15.09	25.34	14.52				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.024 to 0.319 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.0 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have impacts that are more direct on biology than phosphorus; however, none of these data was available on this reach. As a result of eutrophication, pH values also increase. pH values ranged from 7.55 to 8.31.

The one fish visit lacked any zero sensitive or darter species, which have a negative relationship with eutrophication. Tolerant percentage was 85.71%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages was 14.29, lower than the class average of those meeting the modified standard. There was only one macroinvertebrate sample collected on this reach, and it was dominated by two species (72.76% of the sample was comprised of just two species). No EPT species were present and the taxa richness was low. EPT require healthy oxygen levels. The biological communities are showing the effects of the elevated phosphorus. Eutrophication is a stress or to both the fish and macroinvertebrate communities on this section of Judicial Ditch 11 (-593).

Table 39. Biological metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN071	0	0	85.71	14.29	21	0	72.76
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2016, two nitrate samples were taken from Judicial Ditch 11 (-593). These samples were 22 mg/L on 7/16/2014 and 13 mg/L on March 3, 2016, with an average concentration of 17.5 mg/L. A quantile regression analysis showed that a similar macroinvertebrate Class 7 stream would have a 90% probability of being impaired with a nitrate concentration at 11.5 mg/L or higher. Both nitrate samples at 14MN071 were above this level.

Additionally, site 14MN071 had the presence of drain tiles. Drain tiles are a common way for high nitrate concentrations to enter a stream in agricultural regions. (Figure 28). A sample measuring the nitrate concentration from the drain tile was taken on March 3, 2016 and the value was 39 mg/L.

Figure 28. Drain tile located at site 14MN071 (March 6, 2016)

Table 40. Nitrate related biological metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN071	**0.00**	**34.98**	**0.00**	**3.58**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN071 scored below average in three of the four nitrate related metrics evaluated when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 40). There was a complete lack of nitrate intolerant taxa as well as Trichoptera species. The Nitrogen TIV score was also below average.

Based on the high nitrate levels measured, the quantile regression analysis, the presence of drain tiles, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in Judicial Ditch 11 (-593).

Candidate Cause Sediment

From 2014-2016, a total of two TSS samples were taken from Judicial Ditch 11 (-593). The results of these samples were 48 mg/L on July 16, 2014 and 2.8 mg/L onMarch 3, 2016, with both samples below the TSS standard. Additionally, two secchi tube measurements were taken. These measurements were 18 cm on July 16, 2014 and 52 cm onAugust 19, 2014.

The HSPF model also calculated daily TSS values for this reach from 1996-2012. These values ranged from 3.8-1,086 mg/L with an average TSS concentration of 55.7 mg/L. Of these calculations, 1,550 (24.96%) were above the 65 mg/L standard for TSS. This exceedance rate is very high.

Table 41. Habitat related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN071	**14.29**	**0.00**	**0.00**	**14.29**	**14.29**	**0.00**	**28.57**	**0.00**	**14.29**	**19.86**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Judicial Ditch 11 (-593) at site 14MN071 scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 41). This reach did have a slightly above average amount of simple lithophilic individuals, but scored poorly in the remaining metrics.

Table 42. Habitat related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN071	**16.45**	**0**	**7**	**22.91**	**3.10**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Judicial Ditch 11 (-593) scored below average in four of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 42). The community at site 14MN071 had lower amounts of both TSS tolerant taxa and individuals, which is a good sign. However, the site lacked many collector-filterer, Plecoptera, and TSS intolerant species, while also having a TSS index score that indicates potential stress from sediment.

While none of the observed data indicated potential issues with suspended sediment, the data set was very small. The HSPF model calculated a high rate of exceedance. The model was backed up by the majority of the suspended sediment related metrics for both the fish and macroinvertebrate communities scoring below average. Therefore, suspended sediment is a stressor to aquatic life in Judicial Ditch 11 (-593) at this time.

Candidate Cause Habitat

Judicial Ditch 11 (-593) had a qualitative habitat assessment take place at its biological monitoring site, 14MN071, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 39.6 (Poor). Limiting the habitat at this site was the row crop as the dominant land use, narrow stream riparian buffer, moderate to heavy bank erosion (Figure 29), light shading, sand substrates, sparse fish cover, limited depth variability, moderate channel stability, poor channel sinuosity, and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 30.

Figure 29. Eroded stream bank at site 14MN071. (July 16, 2014)

Figure 30. Habitat metrics

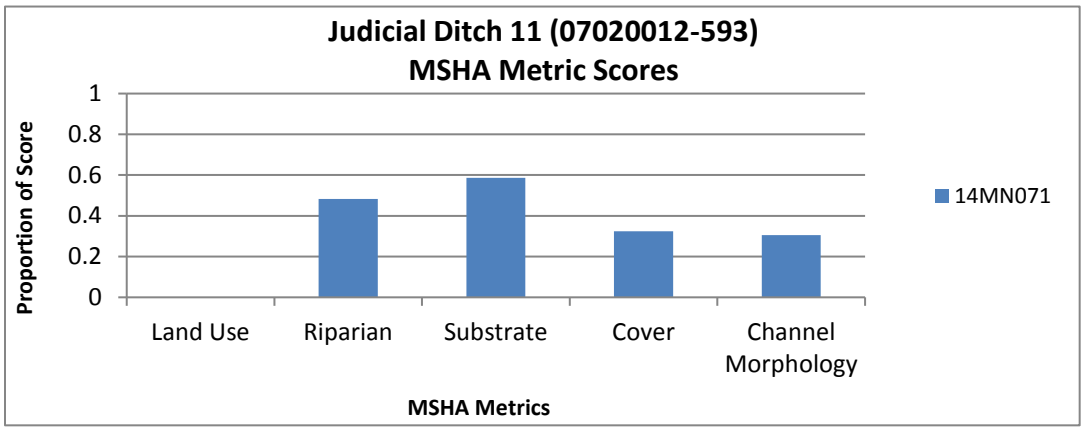


Table 43. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN071	**0.00**	**28.57**	**0.00**	**14.29**	**14.29**	**28.57**	**85.71**	**0.00**
Statewide average for Class 2 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 11 (-593) scored below average in five of the eight habitat related metrics when compared to other Class 2 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 43). The fish sample at 14MN071 had relatively few fish sampled (7) and it was also noted that the stream was recently negatively impacted by a flood event.

Table 44. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN071	**7.43**	**33.13**	**0.31**	**0.00**	**42.11**	**56.35**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at 14MN071 did score above average in four of the six habitat related metrics when compared to other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 44). The macroinvertebrate community consisted of mainly Hyalella species (54.8%), which tend to become abundant in degraded conditions.

Given the poor MSHA score, many poor scoring fish habitat metrics, as well as some poor scoring macroinvertebrate habitat metrics, and photographic evidence of degraded habitat conditions, the lack of habitat is a stressor to the biological communities in Judicial Ditch 11 (-593).

Candidate Cause Chloride/Ionic strength

Only one chloride value was available on this reach, a value of 18.8 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 885 to 1,037 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Only one value was greater than 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. Neither EPT or mayfly (Ephemeroptera) species were present. The taxa count was 21, below the class average. The macroinvertebrate community was comprised of 37.46% conductivity tolerant individuals and no intolerant individuals. Elevated chloride can also lead to increases in sunfish based assemblages. None of the visits had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength were not present in the fish community.

There was one instance of an elevated specific conductance concentration that might be influencing the biological community with low taxa count; however, other stressors can also affect taxa count and the fish and macroinvertebrate numbers collected were both limited possibly inflating the metric values. While one specific conductance value was above 1,000 uS/cm, the preponderance of evidence indicates ionic strength is not a stressor.

Table 45. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN071	21	0	0	0	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					6.17
Statewide average for Class 7 Low Gradient stations that are meeting the MIBI Modified Use Threshold (15.0)	33.59	3.45	16.52	20.58	
Expected response to stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% altered according to the MPCA altered watercourse layer. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). There were no known connectivity issues. Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 16% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish of 14.29%. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species were not present. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates was less than 1%. The channelized reach is likely contributing to both eutrophication and lack of habitat and is a contributing stressor based on the fish community.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Judicial Ditch 11 (-593) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 46). Chloride was ruled out as a stressor at this point. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 46. Stressors on Judicial Ditch (-593)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 11	07020012-593	●	●	●	●	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.6 Judicial Ditch 15 (-682)

Judicial Ditch 15 (-682) is a 3.07 mile long stream reach located predominantly in southwestern McLeod county. This stream section extends from County Ditch 31 to the confluence with High Island Creek. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN070, along this stream reach.

Biology

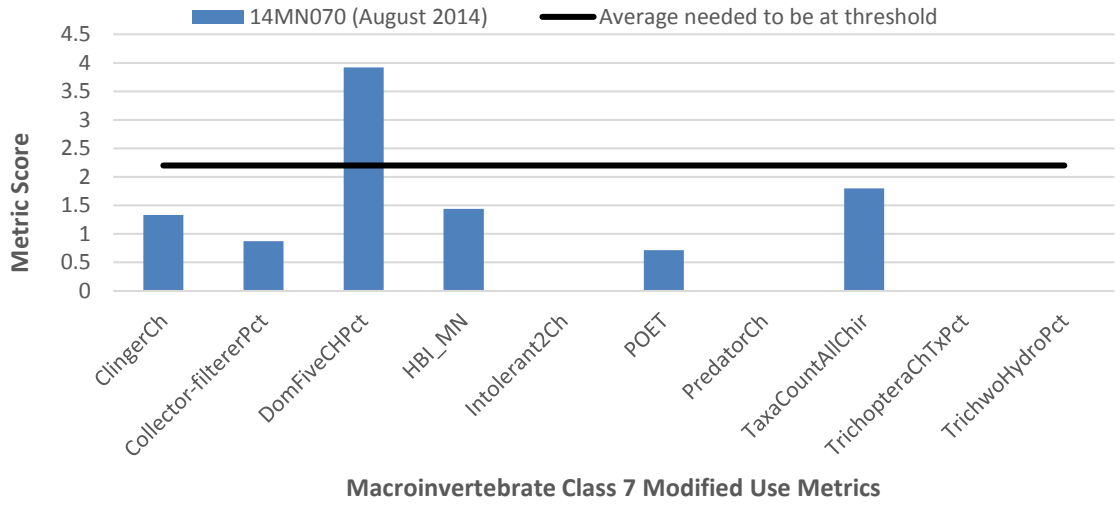
Fish

Judicial Ditch 15 (-682) was sampled for fish at its biological monitoring station, 14MN070, in July of 2014. The FIBI score for this visit was 0. The community was dominated by tolerant fish taxa, and all of the metrics had a score of 0 except for the number of fish collected per meter (minus the tolerant fish) which had a score of 0.04.

Macroinvertebrates

The macroinvertebrate assemblage was sampled in August of 2014 at site 14MN070. This visit had an MIBI score of 10.1, which is well below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Only one of the ten metrics comprising this class MIBI scored above the average needed to reach the threshold (DomFiveCHPct). Four of the nine metrics scoring less than the average needed to reach the threshold actually scored zero which severely limits the MIBI score (Figure 31).

Figure 31. Macroinvertebrate biological metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 6.9 to 7.07 mg/L without any recorded values below 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.3 mg/L with 29% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The one sample had a value of half of the community (50%) comprised of individuals that reproduce at a mature age; however, only two fish individuals were collected at this site which is inflating the percentage. This is also inflating the serial spawning percentage, since one of the two fish collected is a species that serial spawns (fathead minnows). Low DO values also correspond

with increased serial spawning fish percentage. Of the two fish individuals collected, one is very tolerant to low DO conditions.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; no intolerant macroinvertebrate taxa were collected, and DO tolerant individuals comprised 41.31% of the population. There was very limited DO and fish data available on this reach, and while the macroinvertebrate data indicates some possible DO stress, low DO is inconclusive as a stressor.

Table 47. Metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
14MN070	50	50	2	41.31	8.43	0	5.04
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	4.38	28.58	11.74				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause: Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.067 to 0.202 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 1.0-1.1 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus; however, none of these data are available. As a result of eutrophication, pH values also increase. pH values ranged from 7.42 to 7.96. Algal growth was observed during monitoring (Figure 32).

Figure 32. Algal growth at site 14MN070 (August 9, 2016)

The one fish visit had no sensitive or darter species, which have a negative relationship with eutrophication. The percentage of tolerant fish individuals was 50%, just below the class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages was 50%, well above the class average of those meeting the modified standard. The only macroinvertebrate sample collected on this reach had a little less than half of the community dominated by two species (45.57%). A small number of EPT species were present (4.26%). EPT require healthy oxygen levels. The biological communities are showing the effects of the elevated phosphorus. Eutrophication is a stressor to both the fish and macroinvertebrate communities on this section of Judicial Ditch 15 (-682).

Table 48. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN070	0	0	50	50	25	4.26	45.57
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	16.71	6.74	55.88	16.77			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.58	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2014-2016, two nitrate samples were taken from Judicial Ditch 15 (-682). These nitrate samples were 24 mg/L on July 16, 2014 and 25 mg/L on September 9, 2016, with an average value of 24.5 mg/L. A quantile regression analysis showed that a similar macroinvertebrate Class 7 stream would have a 90% probability of being impaired with a nitrate concentration at 11.5 mg/L or higher. Both nitrate samples at 14MN070 were over twice this concentration.

Judicial Ditch 15 (-682) also had drain tiles present in the reach. Drain tiles are a common pathway for nitrates to reach the stream from field applications. Water entering the stream via drain tile often have elevated nitrate concentrations.

Table 49. Metrics related to nitrate

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN070	**0.00**	**72.79**	**0.00**	**4.83**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN070 scored below average in all four of the evaluated nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold. This site completely lacked any Trichoptera and nitrate intolerant taxa, while also having many nitrate tolerant individuals. The Nitrogen TIV score was also below average.

Based on the high nitrate concentrations, the quantile regression analysis, the presence of drain tiles, and the poor scoring nitrate related metrics in the macroinvertebrate community, nitrates are a stressor to aquatic life in Judicial Ditch 15 (-682).

Candidate Cause: Sediment

From 2014-2016, two TSS samples were taken from Judicial Ditch 15 (-682). These values were 80 mg/L on July 16, 2014 and 4.4 mg/L on September 9, 2016. The 2014 sample exceeded the 65 mg/L TSS standard. Additionally, two secchi tube measurements were taken in 2014. These readings were 13 and 27 cm.

The HSPF model also calculated TSS concentrations for this reach from 1996-2012. These values ranged from 1.8-852.7 mg/L with an average TSS concentration of 20.2 mg/L. Of these calculations, 568 (9.15%) were above the 65 mg/L standard for TSS.

Table 50. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN070	**0.00**	**0.00**	**0.00**	**50.00**	**0.00**	**0.00**	**50.00**	**0.00**	**50.00**	**29.11**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 15 (-682) scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 50). The site, 14MN070, did have higher numbers of Perciformid (perch-like), simple lithophilic, and long lived individuals. However, the remaining metrics scored very poor especially the TSS index score.

Table 51. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN070	**16.91**	**0**	**10**	**40.33**	**3.61**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN070 scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 51). The site had a slightly below average number of TSS tolerant taxa; however, there were both high percentages of TSS tolerant individuals and species and individuals that are sensitive to higher TSS levels. The TSS index score was also higher than average, which can signal potential TSS stress.

The very limited dataset does show that one of the two samples exceeded the TSS standard. The HSPF model also had a higher percentage of calculations that exceeded the TSS standard as well. Both of the fish and macroinvertebrate metrics related to suspended sediment scored very poorly. Therefore, suspended sediment is a stressor to aquatic life in Judicial Ditch 15 (-682) at this time.

Candidate Cause: Habitat

Judicial Ditch 15 (-682) had a qualitative habitat assessment take place at its biological monitoring site, 14MN070, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 27.5 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use (Figure 33), the narrow stream riparian buffer, the lack of stream shading, the high abundance of silt that has covered many course substrates, poor channel sinuosity and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 34.

Figure 33. Site 14MN070

Figure 34. Habitat metrics

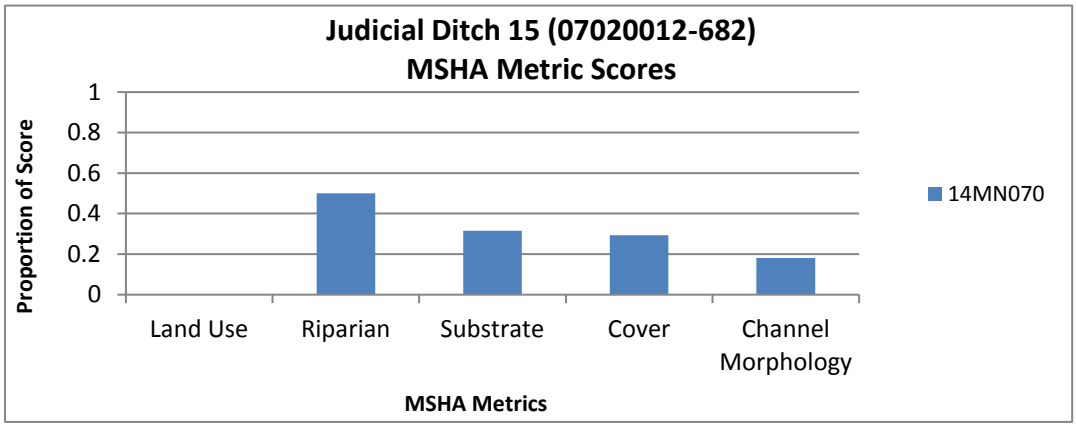


Table 52. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN070	**0**	**50.00**	**0**	**0**	**50.00**	**50.00**	**50.00**	**50.00**
Statewide average for channelized Low Gradient stations that are meeting the FIBI Threshold (15.0)	*7.25*	*21.04*	*6.99*	*7.55*	*3.77*	*26.36*	*55.88*	*19.65*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in this reach scored below average in four of the eight habitat related metrics when compared to all other channelized low gradient streams. The fish community was very limited as only one fathead minnow and one walleye were sampled, which can skew the metric results listed in Table 52.

Table 53. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN070	**17.70**	**63.61**	**1.64**	**4.26**	**85.25**	**15.08**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88.*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN070 scored poorly in the habitat related metrics as five of the six related metrics were below average compared to Class 7 Prairie Streams GP stations that did meet the MIBI Modified Use Threshold (Table 53). The high amounts of burrower and legless species are strong indications that the habitat conditions are degraded in this stream reach.

Considering the poor MSHA score as well as the many low scoring macroinvertebrate habitat related metrics, the lack of habitat is a stressor to the biological communities in Judicial Ditch 15 (-682).

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 992 to 1,246 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Two values in the small dataset were greater than 1,000 µS/cm.

Table 54. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN070	25	2	4.26	4.26	0
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)					*4.38*
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both less than 5%. The taxa count was 25, below the class average. The macroinvertebrate community was comprised of 74.75% conductivity tolerant individuals and with 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. None of the visits had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 50% of the fish community. There are instances of elevated specific conductance concentrations that might be influencing the biological community with low taxa count, mayfly and EPT percentages. While the periodic specific conductance elevated values might be contributing as a stressor, chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. It is inconclusive at this time.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% altered according to the MPCA altered watercourse layer. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 30% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow (Figure 35). The stream went dry in September 2013 which affects connectivity.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish of 50%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population of 50%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a percentage of 8.19%. The channelized reach is likely contributing to both eutrophication and lack of habitat and is a contributing stressor based on the fish community.

Figure 35. Site 14MN070 went dry during fall 2013 (9/26/13)

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Judicial Ditch 15 (-682) are being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 55). Dissolved Oxygen and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 55. Stressors on Judicial Ditch 15 (-682)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 15	07020012-682	o	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.7 County Ditch 39 (-683)

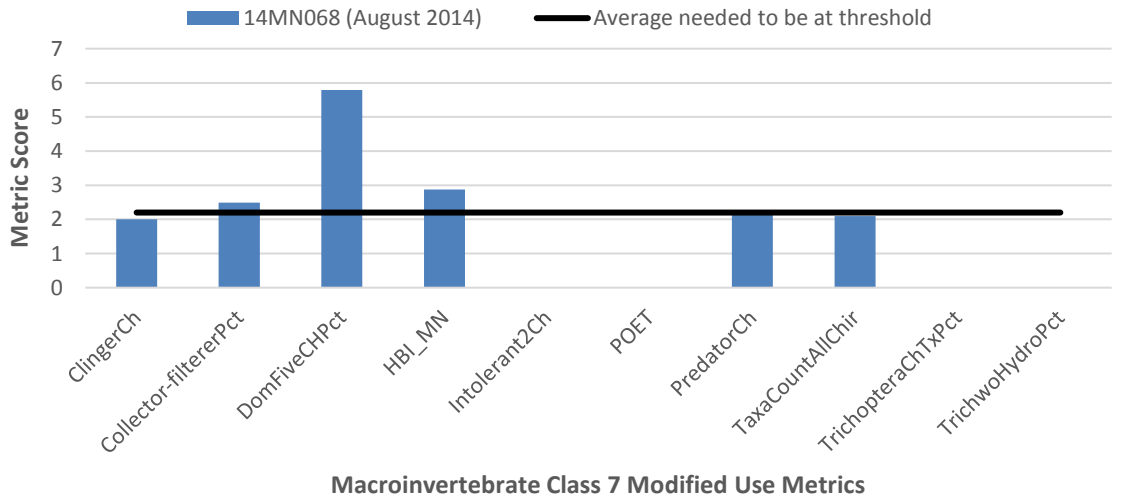
County Ditch 39 (-683) is a 2.87 mile long tributary to High Island Creek located in western McLeod county. This reach is impaired for biology due to its macroinvertebrate community. There is one biological monitoring station, 14MN068, along this stream reach.

Biology

Macroinvertebrates

County Ditch 39 (-683) was sampled for macroinvertebrates at its biological monitoring station, 14MN068, in August of 2014. The MIBI score for this visit was 17.4, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Four of the metrics comprising the MIBI for this class scored at or above the average needed to reach the threshold. However, four metrics also scored a zero limiting the MIBI score for this visit (Figure 36).

Figure 36. Habitat metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). The two concentrations ranged from 9.48 to 11.6 mg/L without any recorded values below 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.0-13.0 mg/L with 43% of values below the water quality standard of 5 mg/L.

Table 56. Metrics related to DO

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN068	0	0	100	16.67	26	8.06	47.74
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	10.56	76.69	19.80			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.58	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were collected that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawning individuals comprised 1/3 of the fish community, just above the class average of sites that met the modified threshold. Fish that are very tolerant to low DO conditions comprised 83%.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; No intolerant macroinvertebrate taxa were collected and DO tolerant individuals comprised 32.79% of the population. There were no low DO values on this reach, but the dataset was very small and the biological response is indicative of possible DO stress. Low DO is inconclusive as a stressor on reach.

Candidate Cause Eutrophication

Only one phosphorus value was available on this stream, a value of 0.127 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.8 mg/L with a mean of 0.5 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus; however, none of these data are available. As a result of eutrophication, pH values also increase. pH values ranged from 8.28 to 8.39, and were not elevated.

The one fish visit had no sensitive or darter species, which have a negative relationship with eutrophication. The percentage of tolerant fish individuals was 100%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages was 16.67%, just below the class average. The only macroinvertebrate sample collected on this reach had a little less than half of the community dominated by two species (47.74%). A small number of EPT species were present (8.06%). EPT require healthy oxygen levels. While there were some indications of stress to the fish and macroinvertebrate communities, based on the lack of chemical data, and the omnivorous percentage eutrophication is inconclusive as a stressor.

Table 57. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN068	**0**	**0**	**100**	**16.67**	**26**	**8.06**	**47.74**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**6.02**	**10.56**	**76.69**	**19.80**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

One nitrate sample was taken from County Ditch 39 (-683). This sample was taken on 07/16/2014 and the nitrate concentration was 16 mg/L. A quantile regression of macroinvertebrate Class 7 streams showed that when nitrate concentrations exceeded 11.5 mg/L there was a 90% probability of impairment. The one collected sample from this reach was well above this level.

Additionally, the HSPF model calculated daily nitrate values for this reach from 1996-2012. These values ranged from 2.0-27.0 mg/L with an average nitrate concentration of 8.3 mg/L. This value is relatively high compared to other subwatersheds within the Lower Minnesota River watershed. The model also calculated 19.19% of the nitrate concentrations to be in excess of 11.5 mg/L.

Drain tiles were also present in this stream reach and provide an easy pathway for nitrates to enter a streams system.

Table 58. Nitrate related metrics

Station	TrichopteraCh TxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN068	**0.00**	**62.06**	**0.00**	**4.62**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 39 (-683) scored below average in three of the four evaluated nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 58). This site lacked Trichoptera and nitrate intolerant taxa, while also having a very poor Nitrogen TIV score.

Based on the high observed nitrate value, the quantile regression analysis, the presence of drain tiles, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in County Ditch 39 (-683).

Candidate Cause: Sediment

There was one TSS sample collected from County Ditch 39 (-683). This sample result was 18 mg/L and was taken during the fish sampling visit on July 16,2014. Additionally, two secchi tube readings were taken. These results were 51 cm on July 16, 2014 and 33 cm on August 19, 2014.

The HSPF model calculated daily TSS values for this reach from 1996-2012. These values ranged from 0.8-527.0 mg/L with an average TSS concentration of 21.3 mg/L. The model also calculated that the TSS levels would exceed the 65 mg/L standard 9.19% of the time.

Table 59. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN068	**0.00**	**0.00**	**2.78**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**16.32**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 39 (-683) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 59). This reach had many metric scores of zero, which is a very strong signal for sediment stress.

Table 60. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN068	**15.81**	**0**	**11**	**40.51**	**9.68**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 39 (-683) scored below average in five of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 60). At site 14MN068, the macroinvertebrates did have an above average TSS index score; however, this reach also had a high number of TSS tolerant individuals, TSS tolerant taxa, while also having zero TSS intolerant taxa and Plecoptera taxa, as well as a lower amount of collector-filterer individuals.

The chemical data set in this reach is very limited. The HSPF model did calculate a higher level of exceedances of the TSS standard and the biological communities scored rather poorly in the vast majority of the suspended sediment related metrics. With the limited data, suspended sediment is inconclusive as a stressor at this time. Further chemical monitoring is needed along this reach to better gage the impact that suspended sediment is having on the biological communities in County Ditch 39 (-683).

Candidate Cause: Habitat

County Ditch 39 (-683) had a qualitative habitat assessment take place at its biological monitoring site, 14MN068, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 46.5 (Fair). Limiting the habitat at this site was the row crop agriculture as the dominant land use (Figure 37), a narrow riparian buffer, a lack of depth variability, fair stream sinuosity and channel development. Further MSHA analysis can be seen in Figure 38.

Figure 37. Site 14MN068 (July 16, 2014)

Figure 38. Habitat metrics

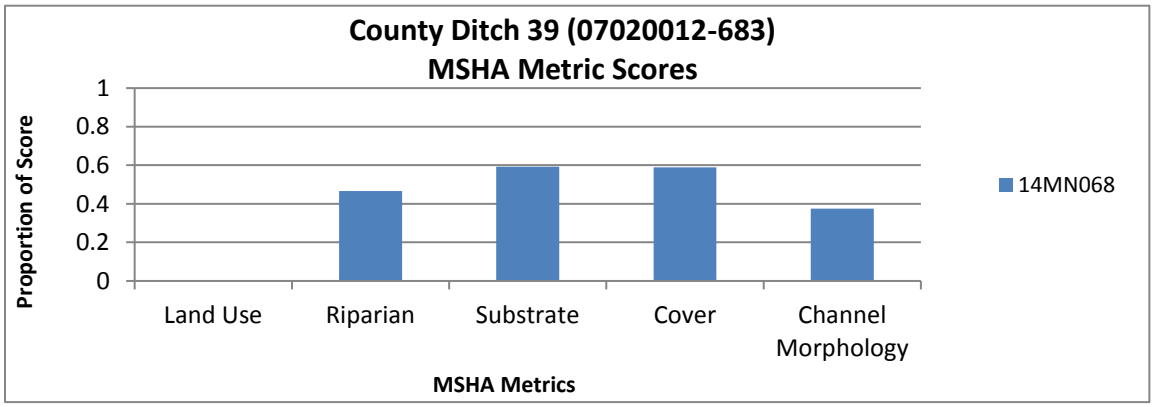


Table 61.Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN068	0.00	0.00	0.00	0.00	0.00	0.00	100.00	16.37
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 39 (-683) consisted of just five different species: brook stickleback, central mudminnow, bigmouth shiner, fathead minnow, and brassy minnow. All five of these species are tolerant (100%). Additionally, this site scored below average in seven of the eight habitat related categories when compared to other Class 3 Southern Headwaters stations that met the FIBI Modified Use Threshold. (Table 61)

Table 62. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN068	19.35	45.81	3.55	8.06	75.48	24.19
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN068 scored below average in four of the six habitat related metrics when compared to Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold. (Table 62). The high numbers of both burrower and legless individuals is a strong signal of degraded habitat conditions and high levels of sedimentation.

Based on the MSHA score, in addition to the below average scoring habitat metrics for both of the fish and macroinvertebrate assemblages, the lack of habitat is a stressor in this stream reach.

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 636 to 828 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely

meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 63. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN068	26	1	8.06	8.06	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both 8.06%. The taxa count was 26, below the class average. The macroinvertebrate community was comprised of 60.77% conductivity tolerant individuals and with 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. The visit did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 58% of the fish community. The small dataset had no elevated specific conductance concentrations. The biological communities are indicative of possible stress, but other stressors could be contributing to the low values. Chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Ionic strength is not a stressor at this time.

Candidate Cause: Altered Hydrology/Connectivity

County Ditch 39 (-683) and entire upstream watershed is 100% altered according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 36% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish of 16.67%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population of 58.33%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were collected. The channelized reach is likely contributing to lack of habitat and is a contributing stressor to the biological communities.

Conclusions and recommendations

The impaired macroinvertebrate community in County Ditch 39 (-683) are being stressed by Nitrates, Habitat, and Flow Alteration/Connectivity (Table 64). Dissolved Oxygen, Eutrophication, and Suspended Sediment were inconclusive as stressors at this point. Chloride was determined to not be a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 64. Stressors on County Ditch 39 (-683)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 39	07020012-683	o	o	●	o	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.8 Judicial Ditch 12 (-794)

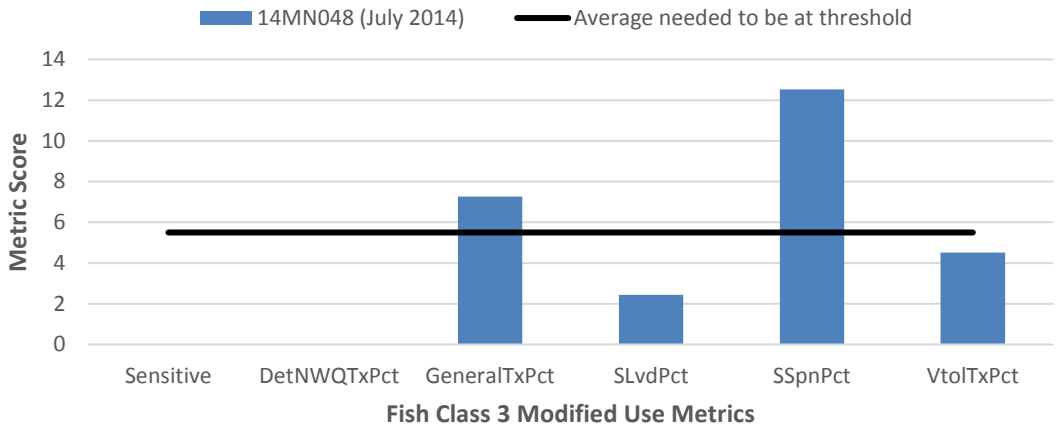
Judicial Ditch 12 (-794) is a 4.31 mile long reach that extends upstream of County Road 13 down to the confluence with High Island Creek in northern Sibley County. This reach is impaired for biology due to its fish assemblage. There is one biological monitoring station, 14MN048, located along this reach. During biological monitoring that site was recorded as being putrid and had recently been blown out from a flood.

Biology

Fish

Judicial Ditch 12 (-794) was sampled for fish in July of 2014 at its biological monitoring station, 14MN048. The FIBI score for this visit was 26.7, which is below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This site had lower numbers of serial spawning individuals and generalist feeding taxa resulting in metric scores that were above the average needed to reach the threshold. However, the remaining four metrics scored below average (SLvdPct, VtolTxPct) or zero (Sensitive, DetNWQTxPct). (Figure 39)

Figure 39. . Habitat metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach with only two values taken in 2014 and 2016. Concentrations were both low, at 5.34 and 6.17 mg/L. Interestingly, the low value of 5.34 was taken in the afternoon at 14:30 on September 9, 2016. The lowest values of DO are usually found prior to 9 AM.

Table 65. Metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
14MN048	0.16	19.19	7	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	1.43	10.56	10.03				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-12.6 mg/L with 38% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Less than 1% of individuals were collected that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawning individuals comprised 19.19% of the fish community, above the class average of sites that met the modified threshold. Fish that are very tolerant to low DO conditions comprised 91% of the community dominated by brassy minnows and fathead minnows. Macroinvertebrates were not collected at this site.

There were two low DO values on this reach, but the dataset was very small. While the fish biological response is indicative of possible DO stress, low DO is currently inconclusive as a stressor.

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.150 to 0.497 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data are available. As a result of eutrophication, pH values also increase. pH values ranged from 7.66 to 7.72.

There were no sensitive or darter fish species, which have a negative relationship with eutrophication. The percentage of tolerant individuals present was 99.84%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was just above the class average (26.29%). Macroinvertebrate were not collected on this reach. The fish biological community is showing the effects of the elevated phosphorus values. Eutrophication is a stressor to the fish community on this section of Judicial Ditch 12.

Table 66. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN048	0	0	99.84	26.29	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	10.56	76.69	19.80			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

One nitrate sample was taken from Judicial Ditch 12 (-794). This sample had a nitrate concentration of 5 mg/L and was taken on July 17, 2014. Additionally, the HSPF model calculated daily nitrate concentrations for Judicial Ditch 12 (-794) from 1996-2012. These values ranged from 1.3-25.4 mg/L with an average nitrate concentration of 6.9 mg/L.

With the limited chemical and macroinvertebrate data, it is difficult to determine if nitrates are a stressor to aquatic life in Judicial Ditch 12 (-794) at this time. More monitoring is suggested to assess the impact of nitrates, therefore, nitrates are inconclusive as a stressor in this reach.

Candidate Cause Sediment

Judicial Ditch 12 (-794) had one TSS sample during the fish sampling event. This value was 110 mg/L on July 17, 2014. This value was above the TSS standard for TSS. Additionally, the secchi tube reading was 10 cm on the same day.

The HSPF model calculated daily TSS concentrations for this reach from 1996-2012. These values ranged from 1.9-523.4 mg/L with an average TSS concentration of 21.2 mg/L. Of these calculations, 641 (10.32%) were above the 65 mg/L standard for TSS.

Table 67. Sediment related metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN048	**3.55**	**0.00**	**65.16**	**0.16**	**3.55**	**0.00**	**3.71**	**0.00**	**7.42**	**26.30**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 12 (-794) at site 14MN048 scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold. (Table 67). This reach did have an above average number of herbivorous and long lived individuals, however the remaining metrics, especially TSS index score, were far below average.

The very limited data set for this reach had only one TSS sample above the 65 mg/L TSS standard. The HSPF model also calculated a high exceedance rate and the majority of the suspended sediment related fish metrics scored below average. Therefore, suspended sediment is a stressor to aquatic life in this reach.

Candidate Cause Habitat

Judicial Ditch 12 (-794) had a qualitative habitat assessment take place at its biological monitoring site, 14MN048, during the fish sampling in 2014. The average MSHA score from these visits was 40.35 (Poor). Limiting the habitat at this site was the row crop agriculture as the primary land use, a very narrow riparian buffer, moderate bank erosion, light stream shading, sand substrates, moderate embeddedness, sparse fish cover, poor sinuosity (Figure 40), fair channel development, and moderate channel stability. Further MSHA analysis can be seen in Figure 41.

Figure 40. Site 14MN048

Figure 41. Habitat related metrics

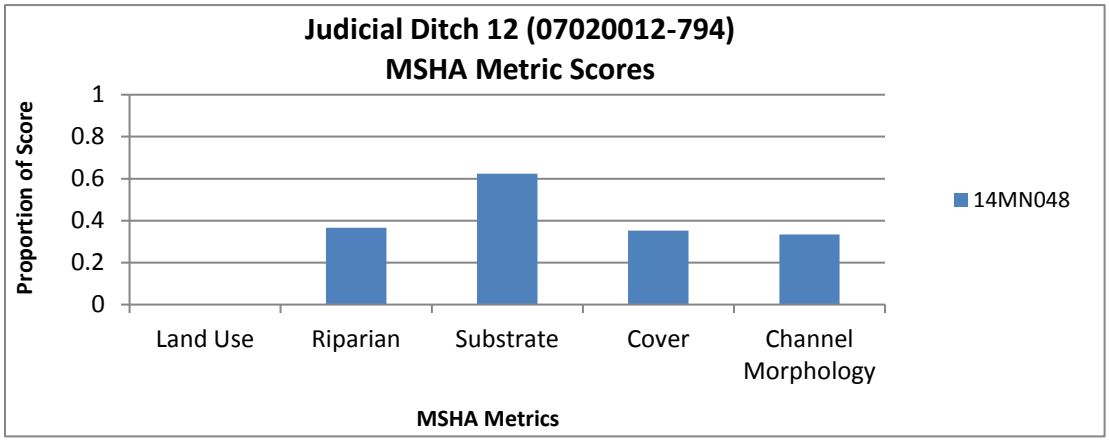


Table 68. Habitat related metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSuc Pct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN048	**0.00**	**3.71**	**0.00**	**3.55**	**0.16**	**8.39**	**99.84**	**23.71**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN048 scored below average at seven of the eight habitat related metrics when compared to Class 3 Southern Headwaters stations that met the FIBI Modified Use Threshold. (Table 68). The majority of the fish sampled were Brassy Minnows or Fathead Minnows (84.19%). These two species tend to be tolerant and can be present in high numbers in degraded streams.

No macroinvertebrate sample was taken along this reach.

Based on the poor MSHA score, and nearly all of the habitat related fish metrics scoring below average when compared to other sites in similar classes that meet the FIBI threshold, the lack of habitat is a stressor to the impaired fish community in Judicial Ditch 12 (-794).

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 539 to 895 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 69. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN048	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Expected response to stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Macroinvertebrates were not collected on this reach. Elevated chloride can lead to increases in sunfish based assemblages. The visit did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 26% of the fish community. The small dataset had no elevated specific conductance concentrations. The biological communities are indicative of possible stress, but other stressors could be contributing to the low values. Chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Ionic strength is inconclusive as a stressor at this time based on limited data.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% altered according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 40% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow. Macroinvertebrates were not sampled due to lack of flow in August of 2014.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish of 34.52%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population of 19.03%. The channelized reach is likely contributing to eutrophication and lack of habitat and is a contributing stressor to the biological communities.

Conclusions and recommendations

The impaired fish community in Judicial Ditch 12 (-794) are being stressed by Eutrophication, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 70). Dissolved Oxygen, Nitrates and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 70. Stressors on Judicial Ditch 12 (-794)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 12	07020012-794	o	●	o	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

5.9 Buffalo Creek (-832)

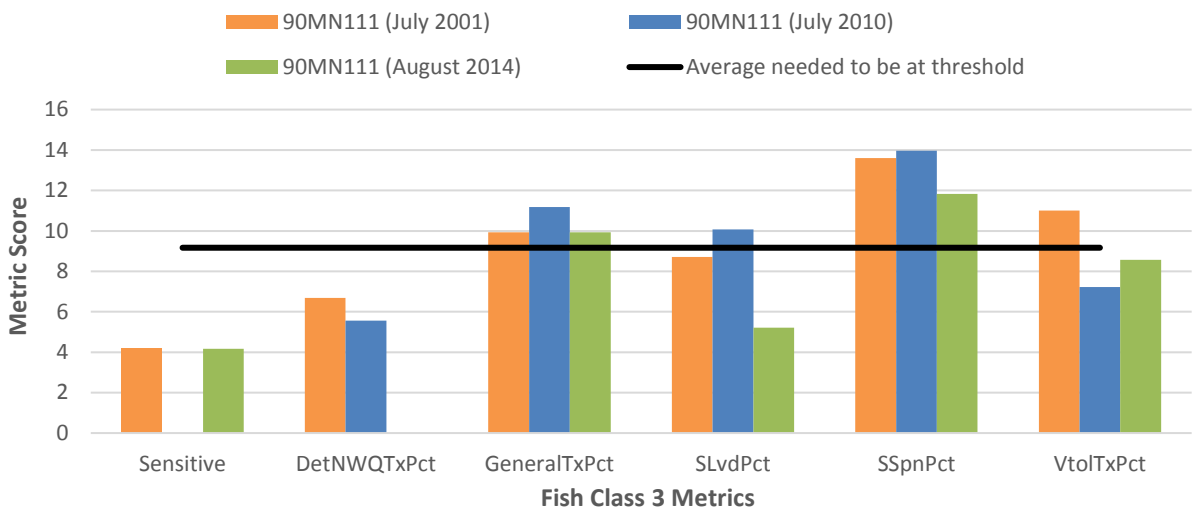
Buffalo Creek (-832) is a 6.21 mile long stream reach located in Sibley county. The stream is a tributary to High Island Creek and has one biological monitoring station, 90MN111. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. The reach is also impaired for Turbidity.

Biology

Fish

Buffalo Creek (-832) was sampled for fish three times from 2001-2014 at biological monitoring station 90MN111. The FIBI scores from these visits were 54.1 (2001), 48.0 (2010), and 39.7 (2014). All three of these FIBI scores were below the Fish Class 3 Southern Headwaters General Use Threshold of 55. In general, these visits showed very few sensitive fish individuals, while also showing higher numbers of detritivore feeding fish resulting in poor FIBI metric scores (Figure 42).

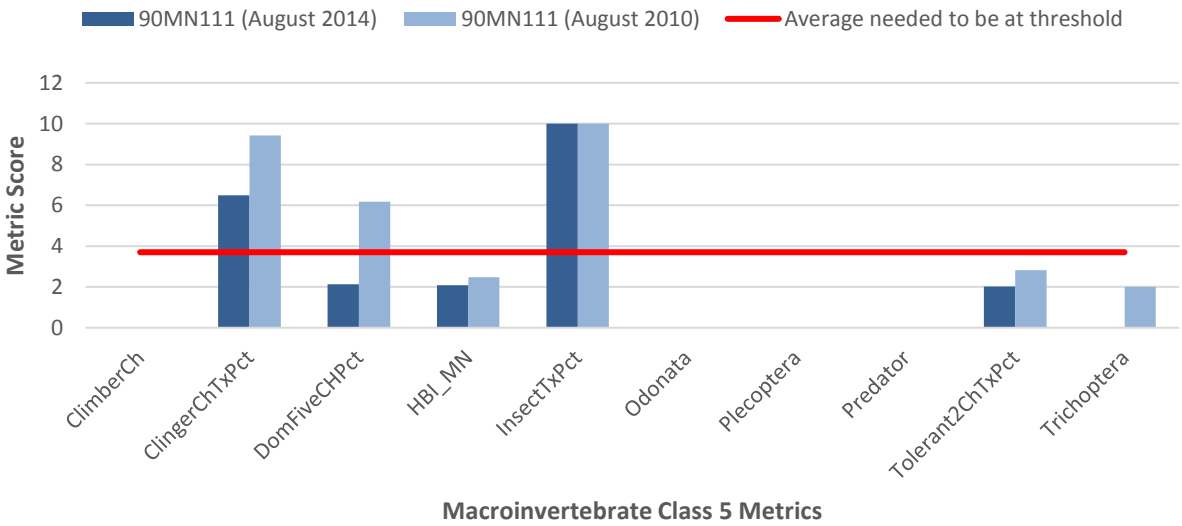
Figure 42. Biological fish metrics



Macroinvertebrates

The macroinvertebrate community was sampled at site 90MN111. The MIBI scores from these visits were 32.9 (August 2010), and 22.7 (August 2014). Both of these MIBI scores fell below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Both sites were limited as four of the ten metrics comprising the MIBI for this class scored zero (ClimberCh, Odonata, Plecoptera, Predator) (Figure 43).

Figure 43. Biological macroinvertebrate metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2010-2016). Concentrations ranged from 6.89 to 10.16 mg/L without any recorded values below 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-14.0 mg/L with 16% of values below the water quality standard of 5 mg/L.

Table 71. Metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
90MN111 (2010)	0	12.58	15	8.49	7.50	8	7.27
90MN111 (2014)	0	22.42	14	1.55	7.64	6	7.60
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**15.09**	**25.34**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were collected during either visit that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawning individuals increased from 12.58% in 2010 to 22.42% in 2014. Fish that are very tolerant to low DO conditions comprised 11% of the community in 2010 and 19% in 2014.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Eight intolerant macroinvertebrate taxa were collected in 2010 and six intolerant taxa were collected in 2014. DO tolerant individuals comprised 8.49% of the population in 2010 and 1.55% in 2014. There were no low DO values on this reach, but the dataset was very small. While there was a lack of individuals that mature at a mature age, the preponderance of evidence indicates DO is not a stressor.

Candidate Cause: Eutrophication

A large phosphorus dataset is available on this reach, ranging from to 0.01 mg/L to 2.64 mg/L with 23% of values over the water quality standard of 5 mg/L. All of the values were collected in the middle of the reach. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 21% to 100% and an average of 68%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.-3.2 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however no recent data are available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.66 to 8.51.

Table 72. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
90MN111 (2010)	0	7.55	83.33	9.75	36	40.88	65.09
90MN111 (2014)	0.22	5.05	86.37	7.25	19	34.06	72.14
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The fish visits both had less than 1% sensitive species, and while the darter percentages were higher they were still lower than the class average and the only darters collected were johnny darters which are more tolerant. Both sensitive and darter species have a negative relationship with eutrophication. The percentage of tolerant fish individuals was over 80% during both visits. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages were both below 10%, below the class average. Both macroinvertebrate samples collected on this reach had more than half of the community dominated by two species. The EPT species were present at levels above class average, however a large amount of the EPT species present are tolerant to eutrophic conditions. Based the increased phosphorus levels, and the preponderance of evidence eutrophication is a stressor.

Candidate Cause: Nitrate

Buffalo Creek (-832) had 246 nitrate samples taken from 2004-2016. These sample values ranged from 0.2-36.3 mg/L, with an average value of 14.22 mg/L. A quantile regression analysis of macroinvertebrate Class 5 sites showed that when the nitrate concentrations exceeded 18.1 mg/L, there was a 75% probability of being impaired. A total of 88 of the observed values exceeded this level.

Table 73. Metrics related to nitrate

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
90MN111	10.72	72.99	0.53	3.51
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Buffalo Creek scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 73). The site, 90MN111, had low numbers of Trichoptera and nitrate intolerant species, a high amount of nitrate tolerant taxa, and a poor Nitrogen TIV Score.

Based on the high observed nitrate values, the quantile regression analysis, as well as the poor scoring macroinvertebrate metrics related to nitrates, nitrates are a stressor to aquatic life in Buffalo Creek (-832).

Candidate Cause: Sediment

From 2004-2016, a total of 250 TSS samples were taken along Buffalo Creek (-832). These values ranged from 2-4,370 mg/L with an average value of 163.03 mg/L. Of these samples, 85 (34%) were above the 65 mg/L standard for TSS. Additionally, 277 secchi tube measurements were taken during this same time period. These values ranged from 1-100 cm, with an average reading of 40.42 cm.

This reach was assessed and determined to be impaired for turbidity in 2008.

Table 74. Sediment related fish metric

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
90MN111	**34.47**	**0.30**	**35.64**	**5.58**	**29.30**	**0.07**	**32.57**	**0.00**	**1.57**	**17.08**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Buffalo Creek (-832) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 74). This reach did have above average amount of herbivorous and riffle dwelling individuals, which can indicate a reach not being negatively impacted by suspended sediment, however, site 90MN111 scored below average in the remaining eight metrics.

Table 75. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
90MN111	16.14	0.33	7.67	30.57	22.73	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Buffalo Creek (-832) at site 90MN111 scored below average in four of the six TSS related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold. (Table 75). This reach did have lower amounts of TSS tolerant taxa and individuals, but did score below average in the remaining metrics.

Based on the high exceedance rate of the observed TSS samples, the majority of the suspended sediment related metrics of both the fish and macroinvertebrate communities scoring below average, as well as the current turbidity impairment along this reach, suspended sediment is a stressor to aquatic life in Buffalo Creek (-832).

Candidate Cause: Habitat

Buffalo Creek (-832) had a qualitative habitat assessment take place at its biological monitoring site, 90MN111, during the fish and macroinvertebrate sampling events in 2001, 2010, and 2014. The average score from the four visits during this time period was 63.81 (Fair). Limiting the habitat conditions at this site were the presence of some row crop agriculture in the land use, bank erosion, the presence of fine substrates (Figure 44), moderate embeddedness, and low to moderate channel stability. Further MSHA analysis can be seen in Figure 45.

Figure 44. Sand at site 90MN111 (August 4, 2014)

A DNR study found the stream channel to be deeply incised without access to its floodplain with poor stability. “Prior to the 2010 and 2014 flood events, the Buffalo Creek site had fairly good habitat and vegetative protection on the banks, but the degree of incision, unstable pattern, and flood flow confinement from the bridge were exploited by the floods” (DNR, 2017a).

Figure 45. Habitat metrics

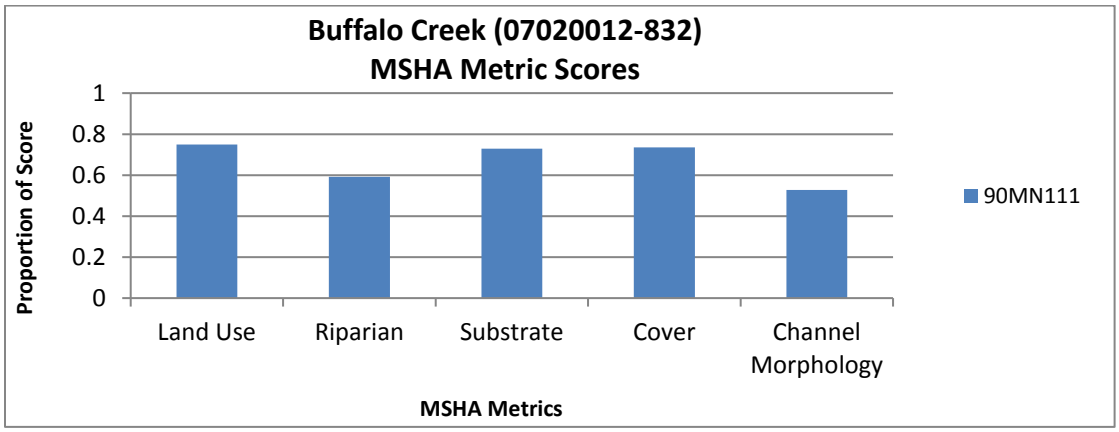


Table 76. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
90MN111	**5.28**	**32.57**	**5.28**	**29.30**	**0.08**	**69.04**	**87.42**	**20.68**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Buffalo Creek (-832) scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold. While the site did have an above average amount of riffle dwelling individuals, the site did lack many habitat specialist species and instead had many tolerant species including creek chubs, blacknose dace, central stonerollers, brassy minnows, and spotfin shiners.

Table 77. Habitat related macroinvertebrate metrics

Station	BurrowerPct +	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
90MN111	**4.42**	**15.14**	**45.22**	**47.34**	**47.52**	**17.30**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 90MN111 scored below average in two of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 77). This site did have a larger number of legless individual that can signal sedimentation, and a higher presence of Caenis genera. These are a genus of mayfly that can be present in degraded habitat conditions.

While the macroinvertebrate community scored fairly well when evaluating the habitat related metrics, the fish assemblage did not. The lack of many habitat specialist species, the fair MSHA score, as well as the amount of bank erosion and fine sediment present conclude that the habitat conditions in Buffalo Creek are a stressor to the impaired biological communities.

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 618 to 895 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both 26.10% in 2010 and 22.60% in 2014. The taxa count was 19 in 2014 down from 36 in 2010, below the class average in both years. The macroinvertebrate community was comprised of 46.86% conductivity tolerant individuals in 2010 and 53.87% with 0 intolerant individuals.

Table 78. Metrics related to DO

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
90MN111 (2010)	36	6	26.10	26.10	0.63
90MN111 (2014)	19	2	22.60	22.60	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Expected response to stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Both visits had less than 1% of Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 38% of the fish community in 2010 and 24% in 2014. The small dataset had no elevated specific conductance concentrations. The biological communities are not indicative of possible stress, but the decrease in values from 2010 to 2014 is concerning. Chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Ionic strength is inconclusive.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% natural according to the MPCA altered watercourse layer, however the entire upstream watershed is altered. Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. Flow conditions seem to be affecting the biology due to extended periods of low flow. A large flow dataset from 2004-2013 ranging from 0 to 745.96 cfs with 12% of values 1 cfs or less.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A perched culvert was located by the DNR on Buffalo Creek (Figure 46). The perched culvert is creating a fish barrier to the upstream watershed (Table 79).

Figure 46. Perched culvert. Photo credit DNR

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 53.19-57.55%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 10.33-17.92%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The range of long-lived macroinvertebrates ranged from 0.62-2.83%. The upstream channelized reach is likely contributing to the low flow conditions and to lack of habitat and is a contributing stressor to the biological communities. The perched culvert is also acting as a fish barrier with altered hydrology acting as a stressor.

Table 79. Migratory fish upstream and downstream of perched culvert

CommonName	14MN109		90MN111
blackside darter			
central stoneroller			X
Iowa darter			
shorthead redhorse			
slenderhead darter		Perched culvert	
silver redhorse			
spottail shiner			
quillback			
walleye			
white bass			
white sucker	X		X

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Buffalo Creek (-832) are being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 80). Chloride was inconclusive as a stressor at this point while Dissolved Oxygen was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the High Island Creek HUC 10 watershed, please see page 92.

Table 80. Stressors on Buffalo Creek (-832)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Buffalo Creek	07020012-832	---	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

High Island Creek HUC 10 Conclusions and Recommendations

The nine biologically impaired stream reaches in the High Island Creek subwatershed had numerous stressors throughout. Stressors determined in at least eight of the nine impaired reaches include Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. More Dissolved Oxygen and Chloride data are needed to determine the extent of those stressors.

The predominant land use in this subwatershed, row crop agriculture, is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

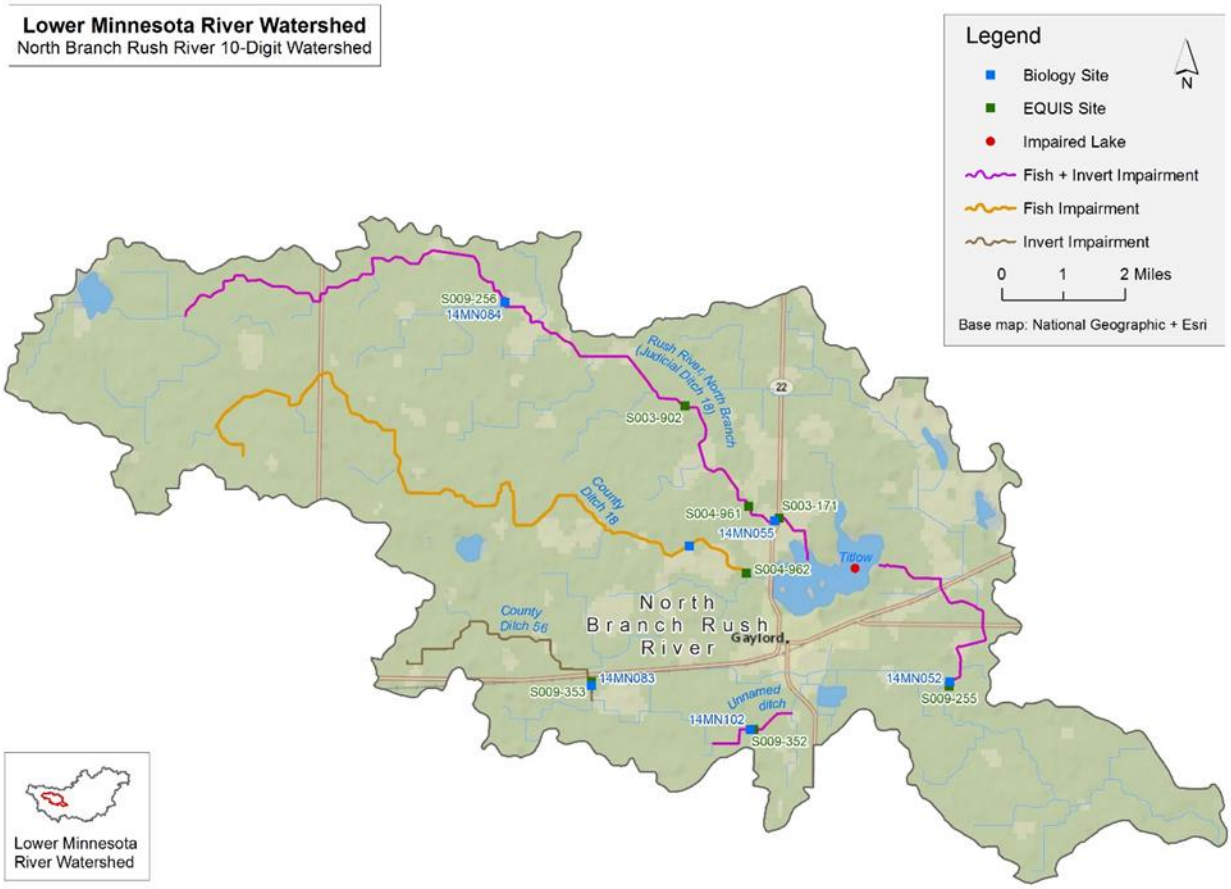
A large effort is needed in the High Island Creek watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, and reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing Best Management Practices (BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting dissolved oxygen issues as well.

Table 81. Stressor in the High Island Creek HUC 101

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
High Island Creek	07020012-653	●	●	●	●	●	●	o
High Island Creek	07020012-834	o	●	●	●	●	o	o
High Island Creek	07020012-838	---	●	●	●	●	●	---
Judicial Ditch 11	07020012-590	●	●	●	●	●	●	o
Judicial Ditch 11	07020012-593	●	●	●	●	●	●	---
Judicial Ditch 15	07020012-682	o	●	●	●	●	●	o
County Ditch 39	07020012-683	o	o	●	o	●	●	---
Judicial Ditch 12	07020012-794	o	●	o	●	●	●	o
Buffalo Creek	07020012-832	---	●	●	●	●	●	o

6. North Branch Rush River Huc 10 (0702001202)

Figure 47. Sites in the North Branch Rush River HUC 10



6.1 North Branch Rush River (Judicial Ditch 18-555)

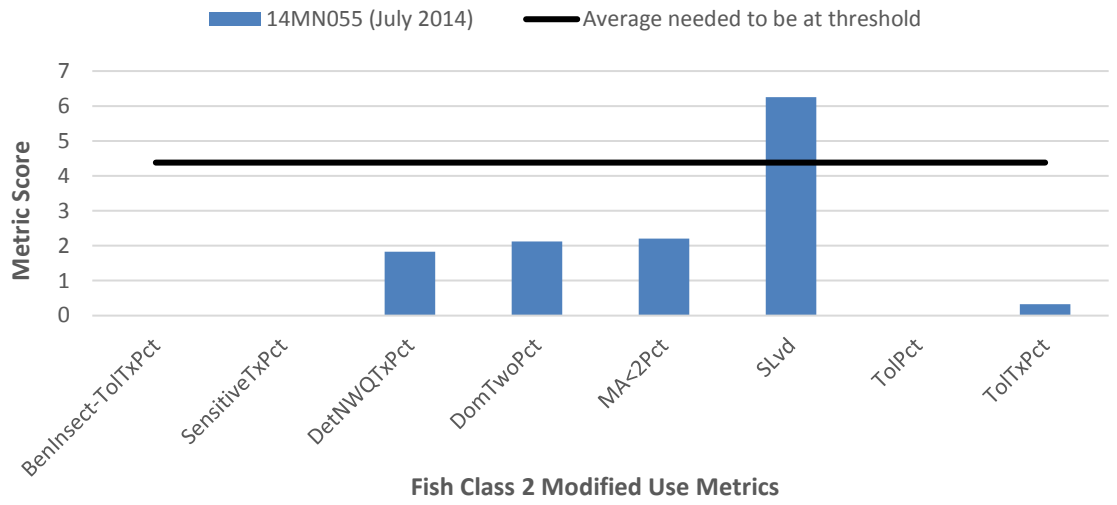
North Branch Rush River/Judicial Ditch 18 (-555) is a 14.81 mile long reach that begins in north central Sibley county before flowing into south central McLeod county before returning to Sibley county and flowing into Titlow Lake. This reach is impaired for biology due to the fish and macroinvertebrate assemblages. There are two biological monitoring stations, 14MN055 and 14MN084, located along this stream reach.

Biology

Fish

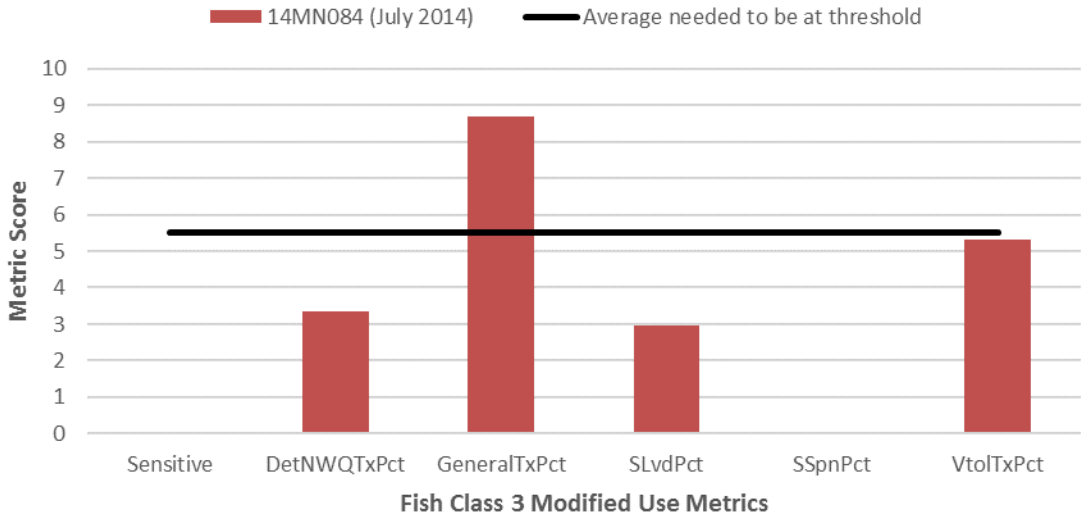
North Branch Rush River/Judicial Ditch 18 (-555) was sampled for fish at two biological monitoring stations, 14MN055 and 14MN084, in July of 2014. Site 14MN055 had a FIBI score of 7.7, which is far below the Fish Class 2 Southern Streams Modified Use Threshold of 35. This site did have a lower amount of short-lived individuals which resulted in the only metric score to score above the average needed to reach the threshold. The remaining metrics scored below average or zero (Figure 48).

Figure 48. Fish Class 2 metrics



Site 14MN084 had a FIBI score of 20.3, which is also well below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. This site did have a lower amount of generalist feeding fish resulting in the only metric score to be above the average needed to reach the threshold. This site also lacked sensitive fish taxa and had abundant numbers of serial spawning individuals resulting in a lower metric score (Figure 49).

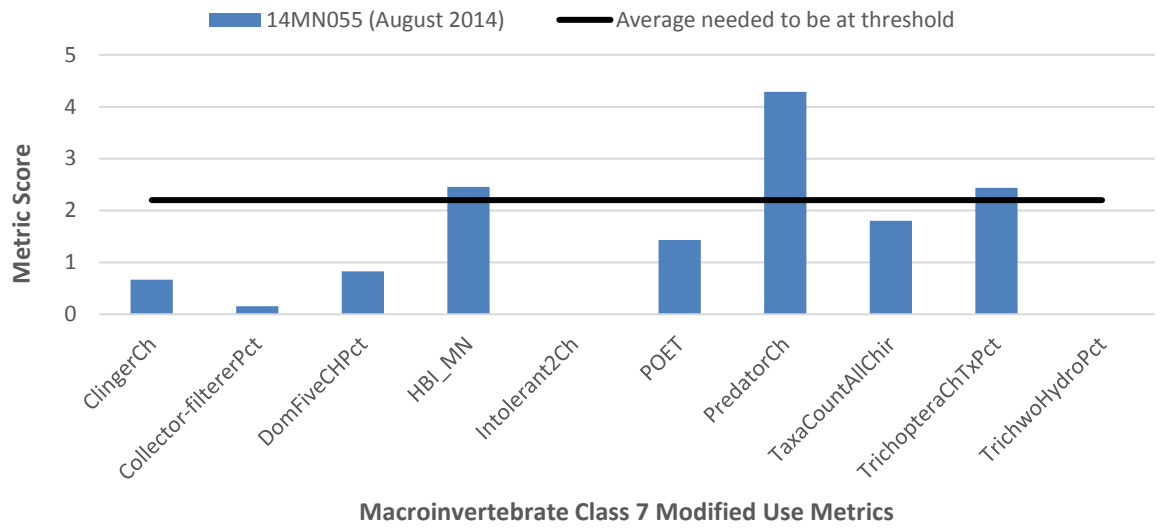
Figure 49. Fish Class 3 metrics



Macroinvertebrates

Site 14MN055 along this stream reach was also sampled for macroinvertebrates in August of 2014. The MIBI score at this site was 14.1, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Just three of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold (HBI_MN, PredatorCh, TrichopteraChTxPct). Two metrics (Intolerant2Ch, TrichwoHydroPct) scored zero limiting the MIBI score for this site (Figure 50).

Figure 50. Macroinvertebrate metrics



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2008-2016). Concentrations were taken both in the upper and lower sections of the river and ranged from 3.57 mg/L to 17.72 mg/L with two days below 5 mg/L (12%). Values below 5 mg/L were taken at station S004-961. Continuous DO data produced daily values below 5.5 mg/L at station 14MN055 with a low value of 4.23 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.9-13.6 mg/L with 15% of values below the water quality standard of 5 mg/L.

Table 82. Metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN055	0	61.20	12	46.50	8.13	0	5.39
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**15.09**	**25.34**	**14.52**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
14MN084	0	81.13	15	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both visits had zero fish that take three years or longer to mature, indicating that fish are quick to reproduce due to short life spans from the influence of human disturbance. Low DO values also correspond with increased serial spawning fish percentage. Stations ranged from 61.20 to 81.13%, both well above the class averages of serial spawners in modified sites that met the standard. Fathead minnow and other species very tolerant to low DO conditions comprised 73%-74% of the fish communities.

Macroinvertebrate data is only available from one visit at station 14MN055. Species that are specifically intolerant to DO were not found in the sample and the DO tolerant percentage was 46.50% of individuals. Very low values of DO have been found on this reach and the biological response is indicative of DO stress to the fish community. Low DO is a stressor on this reach of North Branch Rush River/Judicial Ditch 18 (-555).

Candidate Cause Eutrophication

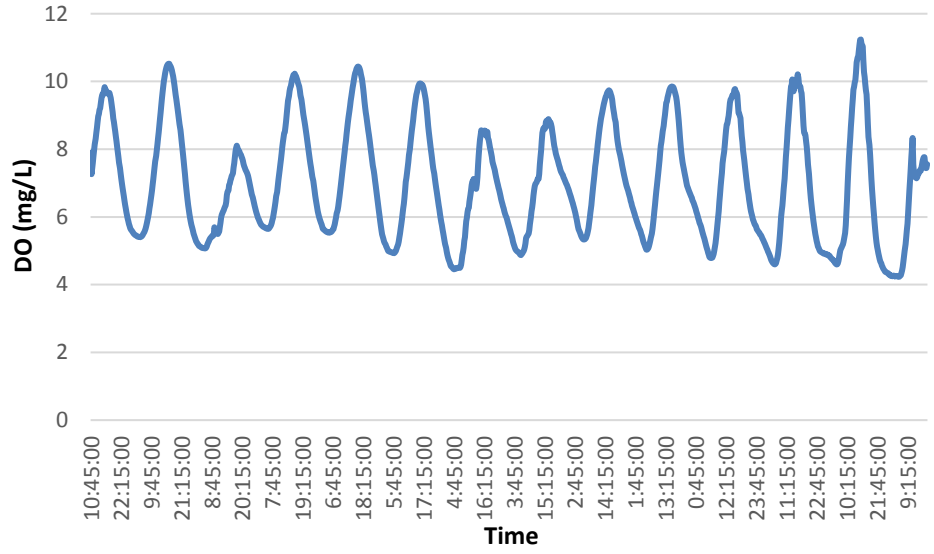
Phosphorus values ranged from 0.02 to 1.7 mg/L with 80% over the southern streams standard of 0.150 mg/L. The highest value was collected in June near Gaylord (station S004-961). Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 30% in April to 99% in July and an average of 77%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.0 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Elevated DO flux is caused by increased algae (Figure 51) and macrophyte production, which in turn increases photosynthesis, respiration, and decomposition. As a result of eutrophication, pH values also increase. Station 14MN084 had thick macrophyte growth (Figure 51).

Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.48 to 8.92. BOD and chlorophyll-a data were not available. Continuous pH data showed daily fluxes ranging from 0.38 to 0.39 at station 14MN055 with values ranging from 7.66 to 8.18. Typical daily pH fluctuations are 0.2-0.3 (Heiskary et al., 2013). Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox and Nagels 2001). Continuous DO data produced daily flux values were elevated to 5.36 mg/L at station 14MN055 (Figure 52). The water quality standard for DO flux in the south region of the state is 5 mg/L.

Figure 51. Macrophyte growth at site 14MN055 (August 3, 2016)

Figure 52. Continuous DO data collected in 2016



Sensitive individuals were not found at either station, and both had less than 2% darter species which is well below both class averages. The percentage of tolerant fish individuals was above 96% at both stations. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages were both above 73%, well above the class averages of those meeting the modified standard. The only macroinvertebrate sample collected on this reach had a little more than half of the community dominated by two species (54.13%). A very small number of EPT species were present (1.22%). EPT require healthy oxygen levels. The biological communities are showing the effects of the elevated phosphorus, pH, and DO flux. Eutrophication is a stressor to both the fish and macroinvertebrate communities on this headwater section of the North Branch Rush River/Judicial Ditch 18 (-555).

Table 83. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN055	0	0	98.96	81.54	25	1.22	54.13
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
14MN084	0	1.89	96.23	73.58	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2003-2016, a total of 42 nitrate samples were taken from North Branch Rush River/Judicial Ditch 18 (-555). These nitrate concentrations ranged from 0.2-27 mg/L with an average value of 13.09 mg/L. A quantile regression analysis showed that a similar macroinvertebrate Class 7 stream would have a 90% probability of being impaired with a nitrate concentration at 11.5 mg/L or higher. Nitrate samples at 14MN055 exceeded this level 26 times.

Furthermore, North Branch Rush River (-555) has drain tiles located in it. Drain tiles provide an easy pathway for high levels of nitrates to enter the stream. The nitrate concentration of a drain tile along this reach was sampled on July 21, 2016 and was 29 mg/L. For comparison, the stream had a nitrate concentration of 27 mg/L at the same time of sample.

Table 84. Metrics related to nitrate

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN055	**4.00**	**39.21**	**0.00**	**3.73**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN055 scored below average in three of the four nitrate related metrics evaluated when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold. (Table 84). The site had low amounts of Trichoptera taxa and lacked nitrate intolerant species as well. The Nitrogen TIV score was also below average.

Based on the high measured nitrate concentrations, the quantile regression analysis, the presence of drain tiles, as well as the results of the nitrate related biological metrics, nitrates are a stressor to aquatic life in North Branch Rush River/Judicial Ditch 18 (-555).

Candidate Cause: Sediment

From 2003-2016 a total of 39 TSS samples were taken from North Branch Rush River/Judicial Ditch 18 (-555). These values ranged from 2-588 mg/L, with a median value of 9 mg/L. Of these TSS samples, 7 (17.95%) were above the 65 mg/L TSS standard. Additionally, from 2003-2016 a total of 68 secchi/transparency tube readings were taken. These values ranged from 13-86 cm with an average value of 44.48 cm.

The HSPF model calculated daily TSS values for this reach from 1996-2012. These values ranged from 1.71-878.36 mg/L with an average TSS concentration of 22.87 mg/L. Of these calculations, 625 (10.06%) were above the 65 mg/L standard for TSS.

Table 85. Fish metrics related to sediment

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN084	**4.72**	**0.00**	**1.89**	**1.89**	**3.77**	**0.00**	**4.72**	**0.00**	**0.94**	**22.88**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
14MN055	**13.90**	**0.00**	**0.83**	**0.00**	**13.90**	**0.00**	**13.49**	**0.00**	**18.26**	**24.22**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in North Branch Rush River/Judicial Ditch 18 (-555) scored below average in all 10 of the suspended sediment related metrics at both sites, 14MN084 and 14MN055, when compared to all Class 3 Southern Headwaters and Class 2 Southern streams stations that meet the FIBI Modified Use Threshold (Table 85). The TSS index scores were especially poor at these two sites. These results are common in streams likely being negatively impacted by suspended sediment.

Table 86. Macroinvertebrate metrics related to sediment

Station	**TSS Index Score**	**TSS Intolerant Taxa**	**TSS Tolerant Taxa**	**TSS Tolerant Pct**	**Collector Filterer Pct**	**Plectoptera Pct**
14MN055	22.77	0	12	68.39	0.92	0.00
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in North Branch Rush River/Judicial Ditch 18 (-555) scored below average in all of the TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI modified use Threshold (Table 86). The reach had an especially poor TSS index score and a very high amount of TSS tolerant individuals.

Based on the high rate of exceedances from the observed data, as well as the modeled data, in addition to the very poor scoring fish and macroinvertebrate metrics related to suspended sediment, suspended sediment is a stressor to aquatic life in North Branch Rush River/Judicial Ditch 18 (-555).

Candidate Cause Habitat

North Branch Rush River/Judicial Ditch 18 (-555) had qualitative habitat assessments take place at its biological monitoring sites, 14MN055 and 14MN084, during the fish and macroinvertebrate sampling events in 2014. The average MSHA scores from these visits was 32.35 (Poor) at 14MN055 and 47.35 (Fair) at 14MN084. Limiting the habitat at these sites was the predominance of row crop agriculture as the nearby land use, light to moderate bank erosion, narrow riparian buffers, light stream shading, sand and silt substrates, light embeddedness, sparse fish cover, moderate channel stability, poor sinuosity (Figure 53), and poor to fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 54.

Figure 53. Poor sinuosity at site 14MN084 (July 16, 2014)

Figure 54. Habitat metrics

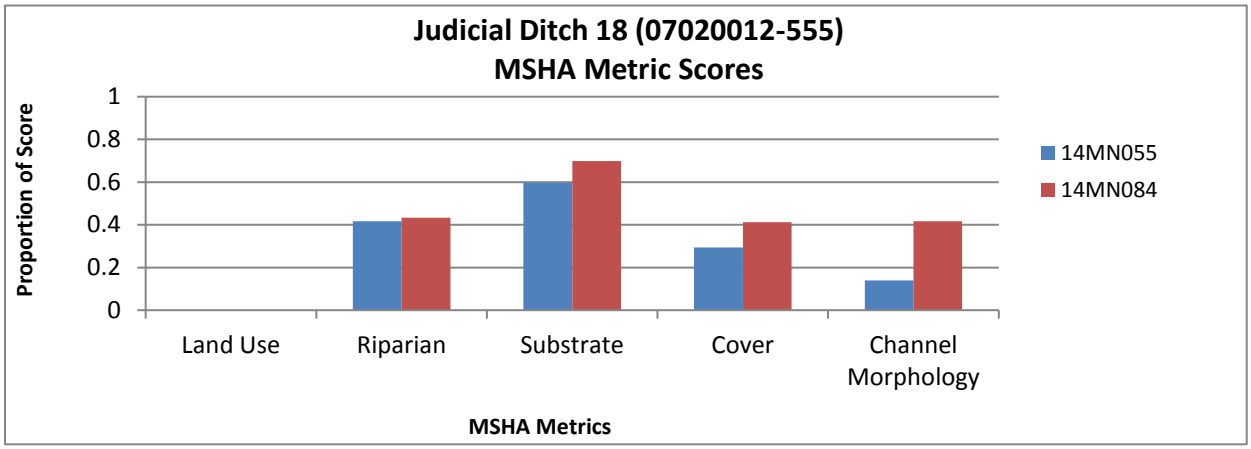


Table 87. Fish metrics related to habitat

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN084	1.89	4.72	1.89	3.77	0.00	13.21	96.23	77.36
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
14MN055	0.00	13.49	0.00	13.90	0.00	15.15	98.96	51.66
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in North Branch Rush River/Judicial Ditch 18 (-555) scored below average in all of the evaluated habitat metrics at both sites, 14MN084 and 14MN055, when compared to sites in their respective stream classes that did meet the FIBI threshold. The extremely high amount of tolerant individuals and the relatively few species that require specialized habitat is a strong signal of degraded habitat conditions.

Table 88. Macroinvertebrate metrics related to habitat

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN055	**59.02**	**31.80**	**1.53**	**1.22**	**92.35**	**4.28**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community was not sampled at site 14MN084 along this reach. At site 14MN055, the assemblage scored below average in five of the six habitat related metrics when compared to other Class 7 Prairie Streams GP stations that did meet the MIBI Modified Use Threshold. The high amount of both burrower and legless individuals can often signal an abundance of fine substrates like sand and silt.

Based on the poor to fair MSHA scores, and the majority of the habitat related metrics of both the fish and macroinvertebrate communities scoring below average relative to their class, the lack of habit is a stressor to both assemblages in North Branch Rush River/Judicial Ditch 18 (-555).

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 478 to 1,027 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the dataset was greater than 1,000 uS/cm.

Table 89. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN055	25	1	0.31	1.22	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					6.17
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
14MN084	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					1
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. Only station 14MN055 had a macroinvertebrate visit. The EPT and mayfly (Ephemeroptera) percentages were both below 1.5%. The taxa count was 25, below the class average. The macroinvertebrate community was comprised of 73.56% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Neither visit had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 74-80% of the fish community. The dataset had one elevated specific conductance concentration but both the fish and macroinvertebrate communities had high percentages of conductivity tolerant species. The biological communities are indicative of possible stress, but chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% natural according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 16% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 83.02-83.40%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 54.77-70.75%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates was 0.31% at station 14MN055. The channelization is likely contributing to the low flow conditions and to lack of habitat and is a contributing stressor to the biological communities.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in North Branch Rush River/Judicial Ditch 18 (-555) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 90). Chloride was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the North Branch Rush River HUC 10 watershed, please see page 139.

Table 90.Stressors on the North Branch Rush River (-555)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
North Branch Rush River (Judicial Ditch 18)	07020012-555	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

6.2 County Ditch 55 (-556)

County Ditch 55 (-556) is a 3.81 mile long channelized stream reach located in central Sibley county. This stream section extends from Titlow Lake to the intersection with County Road 67. This stream is

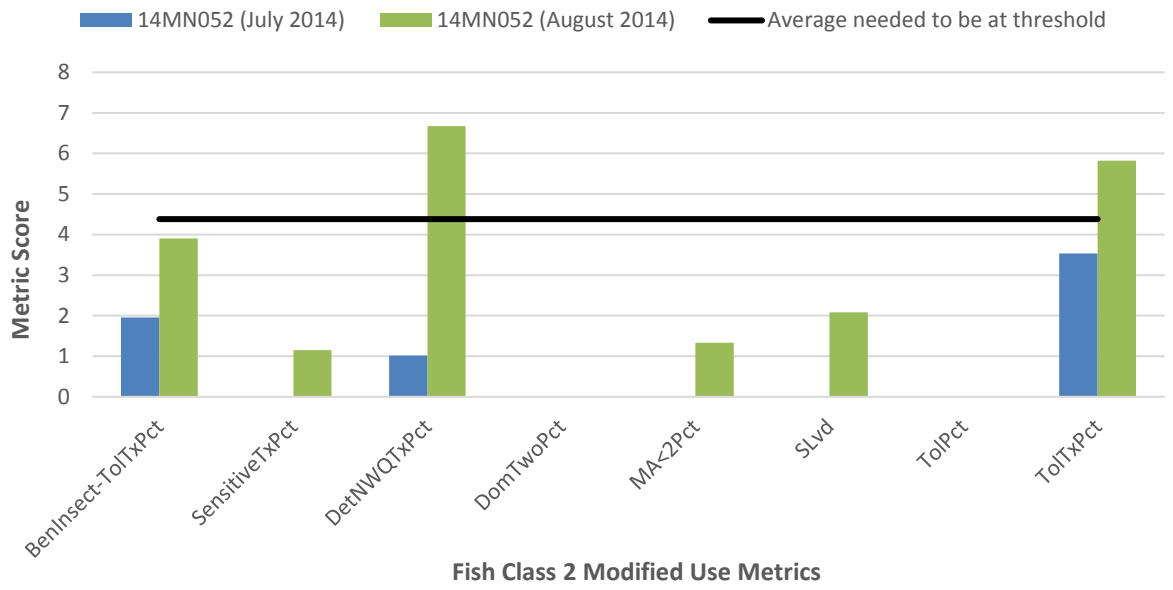
impaired for biology due to both the fish and macroinvertebrate assemblages found at 14MN052, the only biological monitoring station along this stream reach.

Biology

Fish

County Ditch 55 (-556) was sampled for fish at biological monitoring site, 14MN052, in both July and August of 2014. The July 2015 visit had a FIBI score of 6.5, which is well below the Fish Class 2 Southern Streams modified use threshold of 35. This reach scored below average or very poorly in all of the metrics comprising the FIBI. The August 2014 visit fared slightly better with an FIBI score of 21.0, however, this score was still below the threshold. This visit did have fewer amounts of detritivorous and tolerant taxa resulting in higher metric scores. The remaining metrics scored below average or poorly.

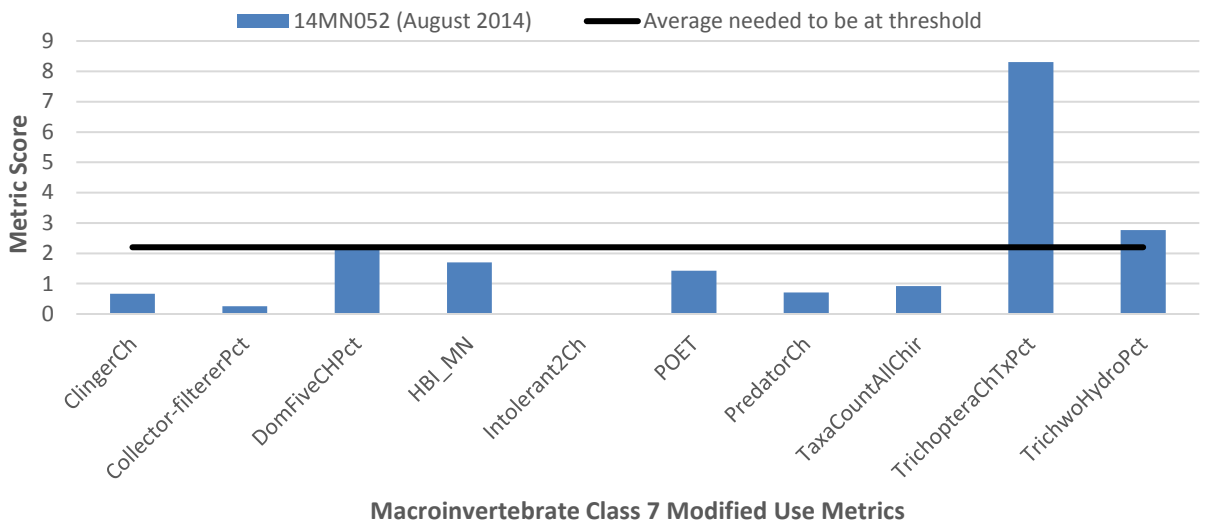
Figure 55. Fish metrics



Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 14MN052. The MIBI score for this visit was 19.0 which is below the macroinvertebrate Class 7 Prairie Streams GP modified use threshold of 22. Three of the 10 MIBI metrics were above the average needed to meet the Class 7 threshold, while the remaining seven metrics scored below average or poorly. At this site, snails were the most dominant macroinvertebrate collected. Dicrotendipes, a type of midge were also collected in high numbers, which consistently correlate with poor stream conditions (MPCA, 2017).

Figure 56. Macroinvertebrate metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016) with 5 values. Concentrations were all sampled at the end of the reach and ranged from 6.21 mg/L to 11.32 mg/L without any recorded values below 5 mg/L. All values were taken from 2014-2016.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.8-14.6 mg/L with 19.5% of values below the water quality standard of 5 mg/L. Lower values were concentrated in the upper section of the reach.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The two samples had values well below the class average of sites that met the modified standard for mature females. Low DO values also correspond with increased serial spawning fish percentage. Both visits had percentages well above the class average at 69% or higher for serial spawners. Species that are very tolerant to low DO conditions comprised 77.33-84.65% of the fish communities.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; no intolerant macroinvertebrate taxa were collected and DO tolerant individuals comprised 62.75% of the population. There were no low DO values in the very small dataset for this reach, but the biological response is indicative of possible DO stress. Low DO is inconclusive as a stressor on this section of County Ditch 55 (-556).

Table 91. Metrics related to DO

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN052 (7/15/2014)	0.11	88.14	16	62.75	8.35	0	5.73
14MN052 (8/28/2014)	1.39	69.02	24	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	15.09	25.34	14.52				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.166 to 0.272 mg/L. The highest value was collected in July at station 14MN052. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-0.6 mg/L with a mean of 0.1 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Elevated DO flux is caused by increased algae (Figure 57) and macrophyte production, which in turn increases photosynthesis, respiration, and decomposition. There is no available DO flux, BOD, or chlorophyll-a data. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.61 to 9.05.

Figure 57. Algae at site 14MN052 (September 30, 2013)

Sensitive individual's percentages at both visits were below 0.10%, and both had less than 2.5% darter species which is well below class average for modified sites that met the standard. The percentage of tolerant fish individuals was above 95% at both stations. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentages were both above 83%, well above the class average of sites meeting the modified standard. The only macroinvertebrate sample collected on this reach had a little less than half of the community dominated by two species (44.44%). EPT individuals were present at 19.28%, however the mayfly species present

can tolerate degraded conditions. The biological communities are showing the effects of the elevated phosphorus and pH. Eutrophication is a stressor to both the fish and macroinvertebrate communities.

Table 92. Eutrophication related metrics

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN052 (7/15/2014)	0	1.66	96.06	82.59	22	19.28	44.44
14MN052 (8/28/2014)	0.07	2.49	95.08	83.65			
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

A total of three nitrate samples were taken from 2014-2016 in County Ditch 55 (-556). These sample values ranged from 0.01-3.4 mg/L, with an average value of 2.18 mg/L. Additionally, from 1996-2012 daily nitrate concentrations were calculated for County Ditch 55 (-556) by the HSPF model. These values ranged from 0.3-18.2 mg/L with an average nitrate concentration of 4.8 mg/L. Site 14MN052 also had drain tile present, which is a common pathway for nitrates to enter the stream system (Figure 58).

Figure 58. Drain tile at site 14MN052 (September 30, 2013)

Table 93. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN052	13.64	66.67	0.00	4.42
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 93). The site, 14MN052, did have a good number of Trichoptera individuals, however, the site had many nitrate tolerant taxa, no nitrate intolerant taxa, and a high Nitrogen TIV score which can indicate potential stress from nitrate levels.

The macroinvertebrate nitrate related metrics scored fairly poorly in this reach, however, the observed and modeled nitrate values in County Ditch 55 (-556) were relatively low. It is likely that other factors are causing the biological metrics to score poorly. Nitrates are not a stressor to aquatic life at this time in County Ditch 55 (-556).

Candidate Cause Sediment

County Ditch 55 (-556) had three TSS samples taken from 2014-2016. These values ranged from 22-72 mg/L, with an average value of 50 mg/L. One of these values was above the 65 mg/L standard for TSS. Additionally, six secchi tube measurements were taken from 2014-2016. These values ranged from 12-35 cm, with an average reading of 20.58 cm.

The HSPF model also calculated daily TSS concentrations for this reach. These values ranged from 1.4-520.3 mg/L with an average TSS concentration of 18.0 mg/L. Of these calculations, 167 (2.69%) were above the 65 mg/L standard for TSS.

Table 94. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN052	**5.78**	**0.00**	**1.79**	**2.36**	**3.70**	**0.03**	**4.57**	**0.00**	**11.94**	**24.58**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 55 (-556) scored below average in all 10 of the suspended sediment related metrics at site 14MN052 when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 94). The TSS index score scored especially poor.

Table 95. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN052	**17.85**	**0**	**8**	**34.97**	**1.31**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 95). This reach did have a lower amount of TSS tolerant taxa and individuals, but scored below average in the remaining metrics.

One of the observed measurements in the small data set available was above the TSS standard, however the HSPF calculated standard exceedances at a fairly low rate. However, the fish and macroinvertebrate metrics related to suspended sediment generally point to potential stress as the index scores for both communities were rather poor with a lack of species that are intolerant of high sediment conditions. Therefore, TSS is a stressor to aquatic life in County Ditch 55 (-556).

Candidate Cause Habitat

County Ditch 55 (-556) had a qualitative habitat assessment take place at its biological monitoring site, 14MN052, during the fish and macroinvertebrate sampling events in 2014. The MSHA score from this visit was 33.23 (Poor). Limiting the MSHA was the predominant row crop land use, a narrow riparian buffer, severe bank erosion (Figure 59), light stream shading, sand and silt substrates, severe embeddedness, sparse fish cover, poor sinuosity, fair channel development, and moderate bank stability. A breakdown of the MSHA category scores for this site can be seen in Figure 60.

Figure 59. Bank erosion at site 14MN052 (July 15, 2014)

Figure 60. Habitat metric scores

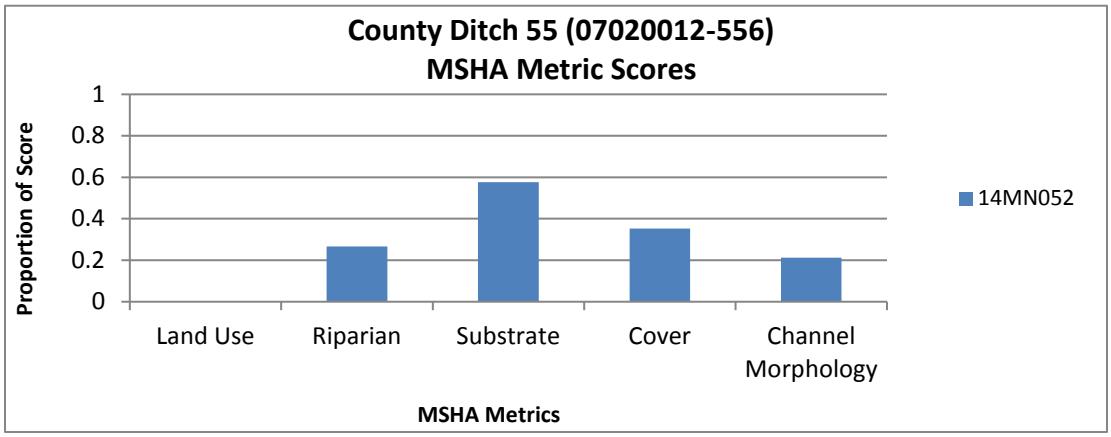


Table 96. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN052	**2.11**	**4.57**	**2.11**	**3.70**	**0.89**	**5.23**	**95.57**	**73.44**
Statewide average for Class 2 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN052 scored below average in all of the habitat related metrics when compared to all other Class 2 Southern Headwaters stations that did meet the FIBI modified use threshold. The community was dominated by fathead minnows (78%). Fathead minnows are very tolerant of degraded habitat conditions.

Table 97. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN052	**37.58**	**26.47**	**1.31**	**19.28**	**74.18**	**26.80**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN052 scored below average in three of the six habitat related metrics when compared to other Class 7 Prairie Streams GP that met the MIBI modified use threshold. The elevated numbers of both burrower and legless individuals can often signal the presence of fine substrates that reflects a degraded stream.

Based on the poor MSHA score, the fish community scoring below average in all of the habitat related metrics, and the macroinvertebrate community scoring low in half of their respective metrics, the habitat conditions in County Ditch 55 (-556) are stressing the biological communities in this reach.

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 431 to 612 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset were greater than 1,000 µS/cm.

Table 98. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN052 (7/15/2014)	22	1	17.97	19.28	0
14MN052 (8/28/2014)	NA	NA	NA	NA	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					**6.17**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both close to or above the class average. The taxa count was 22, below the class average. The macroinvertebrate community was comprised of 65.69% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Neither visit had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 84%-85% of the fish community. The small dataset had no elevated specific conductance concentrations and the biological communities are not indicative of possible stress. Ionic strength is not a stressor.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 27% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 84.42-89.19%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 66.81-81.49%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates was 0.33%. Based on extended low flow periods shown in the models, and increased generalized and nest guarder species and decreased long lived individuals, altered hydrology is a stressor that is also affecting habitat.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 55 (-556) are being stressed by Eutrophication, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 99). Dissolved Oxygen was inconclusive as a stressor at this time. Nitrates and Chloride were both ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the North Branch Rush River HUC 10 watershed, please see page 139.

Table 99. Stressor on County Ditch 55 (-556)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 55	07020012-556	o	●	---	●	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

6.3 Unnamed ditch (-788)

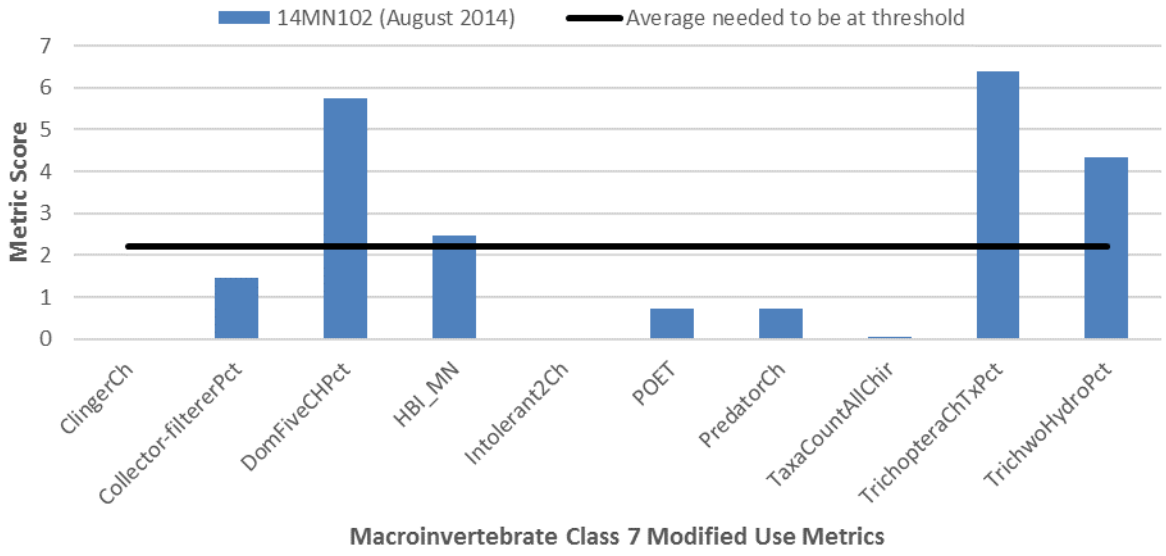
County Ditch 18 (-788) is a 1.59 mile reach that flows into Mud Lake located in the city of Gaylord. The reach is impaired for macroinvertebrates. There is one biological station, 14MN102, located on this reach.

Biology

Macroinvertebrates

Unnamed Ditch (-788) was sampled for macroinvertebrates in August of 2014. The MIBI score for this visit was 21.9, which is just slightly below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. During this visit, four of the ten metrics scored above the average needed to reach the MIBI threshold for this class. The MIBI was also limited by two metrics scoring zero (ClingerCh, Intolerant2Ch). (Figure 61). In general, the macroinvertebrate sample showed low diversity and dominance of tolerant taxa.

Figure 61. Macroinvertebrate metrics



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations were all sampled at the end of the reach and ranged from 6.54 mg/L to 7.58 mg/L without any recorded values below 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.0-13.4 mg/L with 12% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were collected that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Station 14MN102 had 24.37% of serial spawners, twice the class average for modified sites meeting the threshold. Species that are very tolerant to low DO conditions comprised 59.7% of the fish community dominated by fathead minnows and brook sticklebacks.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; no intolerant macroinvertebrate taxa were collected and DO tolerant individuals comprised 44.23% of the population.

There were no low DO values in the very small dataset this reach, but the biological response is indicative of possible DO stress. Low DO is inconclusive as a stressor on this section of Unnamed ditch (-788).

Table 100. DO related metrics

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN102	0	10.92	88.24	49.58	19	17.31	51.92
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**6.02**	**10.56**	**76.69**	**19.80**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Eutrophication

Two phosphorus values were available on this stream, 0.131 and 0.21mg/L. The value of 0.21 mg/L was collected in July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.2 mg/L with a mean of 0.4 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data were available. As a result of eutrophication, pH values also increase. pH values ranged from 8.01 to 8.03.

Table 101. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN102	0	10.92	88.24	49.58	19	17.31	51.92
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	10.56	76.69	19.80			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.58	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

There were no sensitive individuals present, while the darter individuals were just above class average. The percentage of tolerant fish individuals was 88.24%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was 49.58%, well above the class average of those stations that met the modified standard.

The macroinvertebrate EPT individuals were present at 17.31%, just below the class average. EPT require healthy oxygen levels. The macroinvertebrate sample had slightly more than half of the community dominated by two species. The biological communities are showing some mixed results. Eutrophication is inconclusive as a stressor to both the fish and macroinvertebrate communities on this section of Unnamed ditch (-788).

Candidate Cause: Nitrate

One nitrate sample was taken from Unnamed ditch (-788). This sample was taken on July 31, 2014 and had a nitrate concentration of 17 mg/L. A quantile regression analysis of macroinvertebrate Class 7 sites showed that when nitrate concentrations exceeded 11.5 mg/L, there was a 90% probability of impairment. Additionally, the HSPF model calculated daily nitrate values for this minor watershed from 1996-2012. These values ranged from 0.1-25.6 mg/L with an average nitrate concentration of 4.8 mg/L.

Furthermore, drain tiles were present at site 14MN102. Drain tiles are a common pathway for nitrates to enter a stream system (Figure 62).

Figure 62. Drain tile at site 14MN102 (July 31, 2014)

Table 102. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN102	**10.53**	**71.15**	**0.00**	**3.01**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 102). The site, 14MN102, had a good nitrogen TIV score and an above average amount of Trichoptera taxa, however, no nitrate intolerant taxa were present and the site had a high amount of nitrate tolerant species.

Based on the high observed value, the quantile regression analysis, the presence of drain tiles as a likely pathway for nitrates, as well as half of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in Unnamed ditch (-788).

Candidate Cause: Sediment

One TSS sample was collected from Unnamed ditch (-788). This sample was 53 mg/L and was taken on July 30, 2014. Also, two secchi tube measurements were taken along this reach. These readings were 18 cm on July 31, 2014 and 19 cm on August 19, 2014.

Additionally, the HSPF model calculated daily TSS values in this subwatershed from 1996-2012. These values ranged from 3.3-831.3 mg/L with an average TSS concentration of 23.8 mg/L. Of these calculations, 559 (9%) were above the 65 mg/L standard for TSS.

Table 103. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN102	**18.49**	**0.00**	**2.52**	**10.92**	**15.13**	**0.00**	**20.17**	**0.00**	**14.29**	**20.12**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed ditch (-788) scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 103). The site, 14MN102, did have an above average amount of long lived fish individuals, however, the rest of the metrics scored rather poorly.

Table 104. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN102	**15.12**	**0**	**6**	**32.69**	**5.77**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Ditch (-788) at site 14MN102 scored below average in three of the six TSS related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 104). The community had lower amounts of both tolerant taxa and individuals, as well as a better than average TSS index score. The site did lack TSS intolerant and Plecoptera species and had low amounts of collector-filterer individuals, which can be a signal for sediment stress.

The very limited data set does not indicate high suspended sediment levels. The model does predict a fairly high standard exceedance rate. The suspended sediment metrics in the fish community indicates likely stress from suspended sediment, however, the macroinvertebrates do not as the TSS index score was good and there was a low presence of TSS tolerant taxa and TSS tolerant individuals. Based on the mixed chemical and biological results, suspended sediment is inconclusive as a stressor in Unnamed ditch (-788) at this time.

Candidate Cause: Habitat

Unnamed Ditch (-788) had a qualitative habitat assessment take place at its biological monitoring site, 14MN102, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 32.5 (Poor). Limiting the MSHA was the predominant row crop land use, a narrow riparian buffer, moderate bank erosion, no stream shading, sand and silt substrates, light embeddedness, sparse to nearly absent fish cover, little depth variability, poor sinuosity (Figure 63), poor channel development, and moderate bank stability. A breakdown of the MSHA category scores for this site can be seen in Figure 64.

Figure 63. Site 14MN102 (August 19, 2014)

Figure 64. Habitat metrics

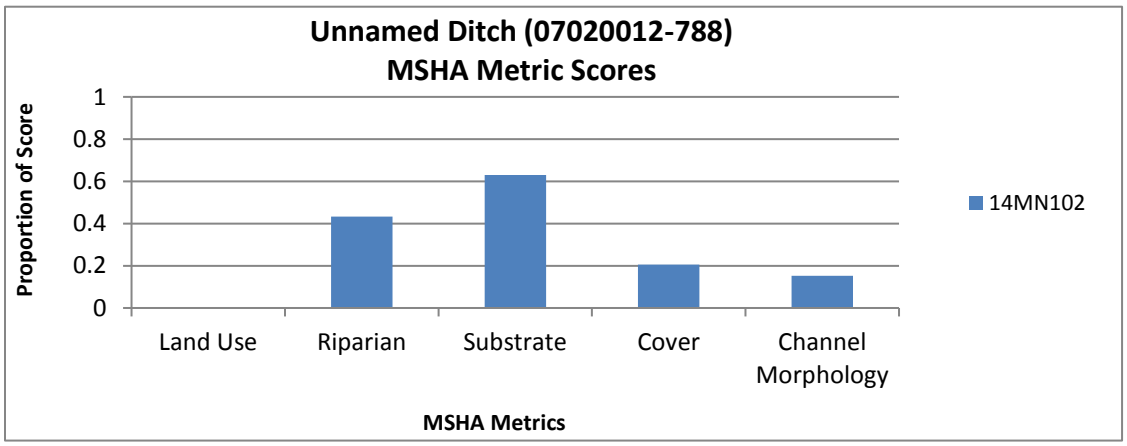


Table 105. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN102	**10.92**	**20.17**	**10.92**	**15.13**	**0.84**	**36.13**	**88.24**	**40.34**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage at site 14MN102 along Unnamed Ditch (-788) scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 105). The fish community consisted of many species that are very tolerant and commonly found in degraded habitat conditions including fathead minnows, brook sticklebacks, common carp, creek chubs, and white suckers.

Table 106. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN102	**26.92**	**32.69**	**3.85**	**17.31**	**71.15**	**26.92**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN102 scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 106). The high amount of both burrower and legless individuals present correlates to the predominant sand and silt substrates found throughout the reach. This is often the case in sites stressed by poor habitat conditions.

Based on the poor MSHA score, as well as the poor scoring fish and macroinvertebrate habitat related metrics, the poor habitat conditions in Unnamed Ditch (-788) are stressing the impaired biological communities at this time.

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 594 to 847 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 107. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN102	19	1	13.46	17.31	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both close to but below the class average. The taxa count was 19, below the class average. The macroinvertebrate community was comprised of 59.62% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Station 14MN102 did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 58.82% of the fish community. The small dataset had no elevated specific conductance concentrations and the biological communities are not indicative of possible stress. Ionic strength is not a stressor.

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 15% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 63.03% of the population. The number of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 46.22% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present. Based on extended low flow periods shown in the models, and increased generalized and nest guarder species and lack of long lived individuals, altered hydrology is a stressor that is also affecting habitat on this section of Unnamed Ditch (-788).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed ditch (-788) are being stressed by Nitrates, Habitat, and Flow Alteration/Connectivity (Table 108). Dissolved Oxygen, Eutrophication, and Suspended Sediment were inconclusive as stressors at this time. Chloride was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the North Branch Rush River HUC 10 watershed, please see page 139.

Table 108. Stressors on Unnamed ditch (-788)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Ditch	07020012-788	o	o	●	o	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

6.4 County Ditch 56(-790)

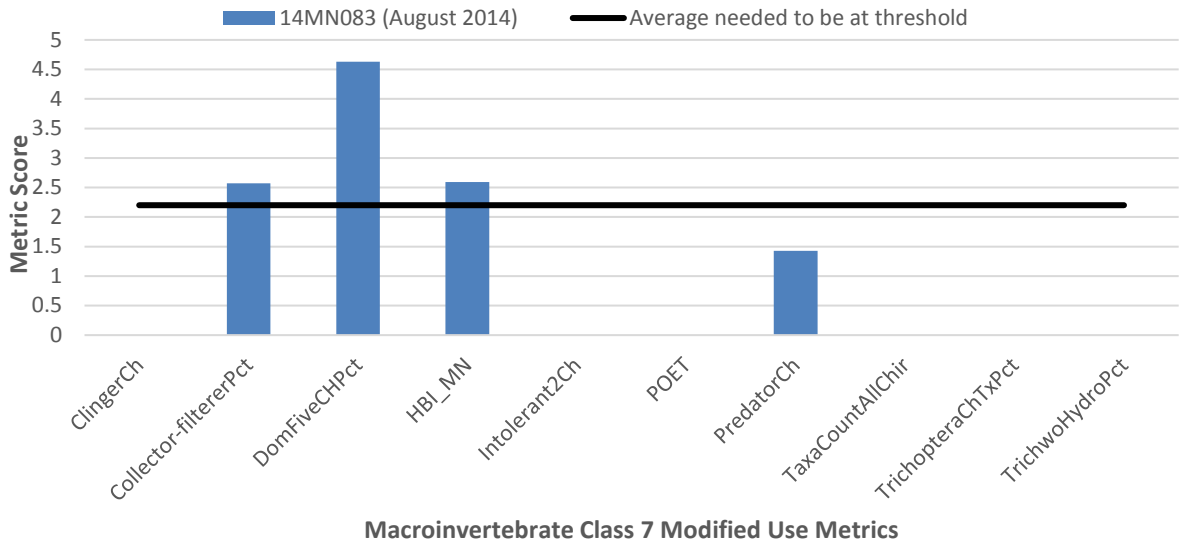
County Ditch 56 (-790) is a 4.66 mile long channelized reach that is located just east of Winthrop. This reach constitutes the headwaters of County Ditch 56 and extends from T-120 down to an Unnamed Creek at T-8. This reach is impaired for biology due to its macroinvertebrate assemblage. There is one biological monitoring station, 14MN083, located at the downstream section of the reach.

Biology

Macroinvertebrates

County Ditch 56 (-790) was sampled for macroinvertebrates at its biological monitoring station, 14MN083, in August of 2014. The MIBI score during this visit was 11.2, which is below the macroinvertebrate Class 7 Prairie Streams GP Modified Use threshold of 22. This site had three of the ten metrics comprising the class 7 MIBI score above the average needed to reach the threshold (collector-filtererPct, DomFiveCHPct, HBI_MN) while the remaining metrics scored below average or a zero altogether (Figure 66).

Figure 65. Biological metrics



Candidate Cause: Dissolved Oxygen

There is a very small DO dataset on this reach in recent years with three values (2014-2016). One of the three values collected on this reach was below 5 mg/L; 4.88, 5.68 and 5.95. All values were collected at the biological station 14MN083 and were collected from 2014-2016.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.0-13.4 mg/L with 12% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No fish were collected that have a higher mature age. Low DO values also correspond with increased serial spawning fish percentage. The percentage of serial spawner individuals at this site was just above the class average for modified sites meeting the standard. Species that are very tolerant to low DO conditions comprised 35% of the fish community.

Table 109. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN083	**0**	**14.49**	**11**	**26.25**	**8.08**	**0**	**3.56**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	1.43	10.56	10.03				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No intolerant macroinvertebrate taxa were collected and DO tolerant individuals comprised 26.25% of the population, and they were all very tolerant to low DO conditions. The DO tolerant score, looking at the macroinvertebrate community as a whole, was one of the lowest in the entire watershed. All DO values in the very small dataset were below 5 mg/L, and the biological response is indicative of DO stress. Low DO is a stressor on this section of County Ditch 56 (-790).

Candidate Cause: Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.150 to 0.497 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.2 mg/L with a mean of 0.4 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data are available. As a result of eutrophication, pH values also increase. pH values ranged from 7.66 to 7.72.

Table 110. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa
14MN083	0	0	99.84	26.29	16	0	37.5
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**6.02**	**10.56**	**76.69**	**19.80**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

There were no sensitive or darter fish individuals or macroinvertebrate EPT individuals present. EPT require healthy oxygen levels. Fish and macroinvertebrate species in these categories all decrease with eutrophication effects. The percentage of tolerant fish individuals was 99.84%. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was 26.29%, just above the class average of those stations that met the modified standard. The macroinvertebrate sample had less than 40% of the community dominated by two species. The biological communities are showing the effects of elevated phosphorus. Eutrophication is a stressor to both the fish and macroinvertebrate communities.

Candidate Cause: Nitrate

One nitrate sample was taken from County Ditch 56 (-790). This sample was 13 mg/L and was taken on 07/13/2014. A quantile regression analysis of macroinvertebrate Class 7 stream sites showed that when nitrate concentrations exceed 11.5 mg/L, there is a 90% probability for impairment. The recorded nitrate sample was 13 mg/L and well above this level.

Additionally, the HSPF model calculated daily nitrate values for this reach from 1996-2012. These nitrate concentrations ranged from 0.1-25.6 mg/L with an average value of 4.8 mg/L.

Drain tiles were also found at the monitoring site. Drain tiles are a common pathways for nitrates to enter a stream system (Figure 66).

Figure 66. Drain tile at site 14MN083 (September 30, 2013)

Table 111. Nitrate related metrics

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN083	**0.00**	**50.00**	**1.25**	**3.50**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 56 (-790) scored below average in two of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 111).

Based on the lack of Trichoptera, a poor Nitrogen TIV score, the high observed and modelled values, the presence of drain tiles, as well as the quantile regression analysis, nitrates are a stressor to aquatic life in County Ditch 56 (-790).

Candidate Cause: Sediment

One TSS sample was taken from County Ditch 56 (-790). This value was 87 mg/L and was taken onJuly 30, 2014. Two transparency values were also taken from this reach. These measurements were 10 cm on July 30, 2014 and 19 cm onAugust 19, 2014.

Additionally, the HSPF model calculated daily TSS values for this subwatershed from 1996-2012. These values ranged from 3.3-831.3 mg/L with an average concentration of 23.8 mg/L. Of these calculations, 9% were above the TSS standard of 65 mg/L.

Table 112. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN083	**22.46**	**0.00**	**7.97**	**16.67**	**5.80**	**0.00**	**2.90**	**0.00**	**13.04**	**19.09**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 56 (-790) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 112). This reach did have higher numbers of long lived and Perciformid individuals, but scored poorly in the remaining metrics.

Table 113. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN083	**11.82**	**0**	**6**	**36.25**	**10.00**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in three of the six suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 113). The site, 14MN083, lacked Plectoptera and TSS intolerant taxa, while having a higher number of TSS tolerant individuals. However, this reach did have an above average number of collector-filterer individuals, an above average TSS index score, and lower amounts of TSS tolerant taxa.

The chemical data set in this reach is very limited and the biological metric results related to suspended sediment are fairly mixed when comparing the fish and macroinvertebrate communities. Based on this information, suspended sediment is inconclusive as a stressor in County Ditch 56 (-790) at this time. More chemistry sampling is recommended to better gage the impacts that suspended sediment could be having on the biotic communities.

Candidate Cause: Habitat

County Ditch 56 (-790) had a qualitative habitat assessment take place a biological monitoring site, 14MN083, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 39.35 (Poor). Limiting the habitat conditions at this site was the land use, which was dominated by row crop agriculture, a moderate riparian buffer, presence of silt and sand substrates, heavy siltation, poor sinuosity (Figure 67), moderate channel stability, and fair channel development. See Figure 68 for a further breakdown of the MSHA category scores.

Figure 67. Erosion and sediment at site 14MN083 (July 30, 2014)

Figure 68. Habitat metrics

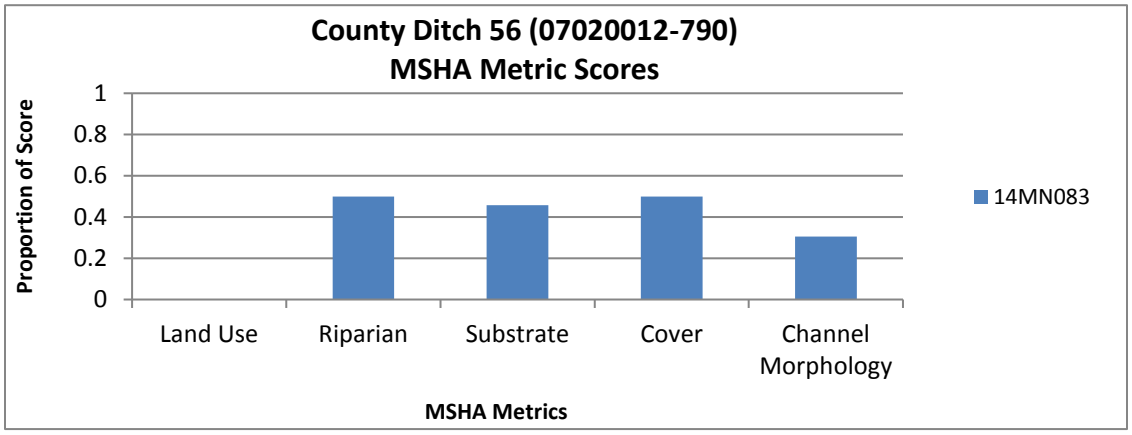


Table 114. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN083	**16.67**	**2.90**	**16.67**	**5.80**	**0.00**	**41.30**	**83.33**	**56.52**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN083 along County Ditch 56 (-790) scored below average in the majority of the habitat related metrics when compared to Class 3 Headwaters stations that met the FIBI Modified Use Threshold. (Table 114) The fish sample was dominated by fairly tolerant fish species like creek chubs, common carp, brook sticklebacks, and fathead minnows. The abundance of these species generally signals that the habitat is degraded.

Table 115. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN083	**28.75**	**46.25**	**2.50**	**0.00**	**88.75**	**5.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 646 to 898 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both 0. The taxa count was 16, below the class average. The macroinvertebrate community was comprised of 48.75% conductivity tolerant individuals and 0 intolerant individuals.

The macroinvertebrate assemblage at site 14MN083 also scored below average in the majority of the habitat related metrics when compared to Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold (Table 115). The elevated numbers of both burrower and legless individuals as well as the lack of EPT species often signals increased sedimentation and habitat stress.

The MSHA score at site 14MN083 was poor and the majority of the habitat related biological metrics for both the fish and macroinvertebrate assemblages reflect this. Therefore, habitat is a stressor in County Ditch 56 (-790).

Candidate Cause Chloride/Ionic strength

Elevated chloride can also lead to increases in sunfish based assemblages. Station 14MN083 did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 38.68% of the fish community. The biological communities are indicative of possible

stress, but chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Ionic strength is inconclusive as a stressor in County Ditch 56 (-790).

Table 116. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN083	16	0	0	0	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 15% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 55.80% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 34.78% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present. Based on extended low flow periods shown in the models, and increased generalized and nest guarder species and lack of long lived individuals, altered hydrology is a stressor that is also affecting habitat in County Ditch 56 (-790).

Conclusions and recommendations

The impaired macroinvertebrate community in County Ditch 56 (-790) are being stressed by DO, eutrophication, nitrates, suspended sediment, habitat, and flow alteration/connectivity (Table 117). Chloride was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the North Branch Rush River HUC 10 watershed, please see page 139.

Table 117. Stressors on County Ditch 56 (-790)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 56	07020012-790	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

6.5 County Ditch 18 (-791)

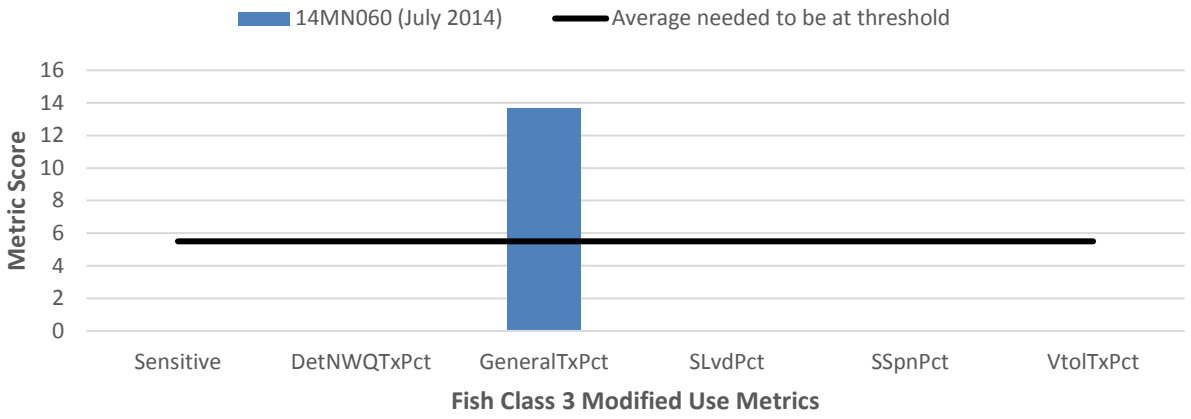
County Ditch 18 (-791) is a 13.48 mile reach located in Sibley County. The stream flows into the impaired Titlow Lake located in the city of Gaylord. The reach is impaired for fish. There is one biological station, 14MN060, located on this reach.

Biology

Fish

County Ditch 18 (-791) was sampled for fish at its biological monitoring station, 14MN060, in July of 2014. The FIBI score during this visit was 13.7 which is well below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. The site had a lower number of generalist taxa resulting in a higher metric score, while the remaining metrics scored a zero. (Figure 70) The fish community present consisted of mainly tolerant species including bigmouth shiners, sand shiners, fathead minnows, brook sticklebacks, and bluntnose minnows.

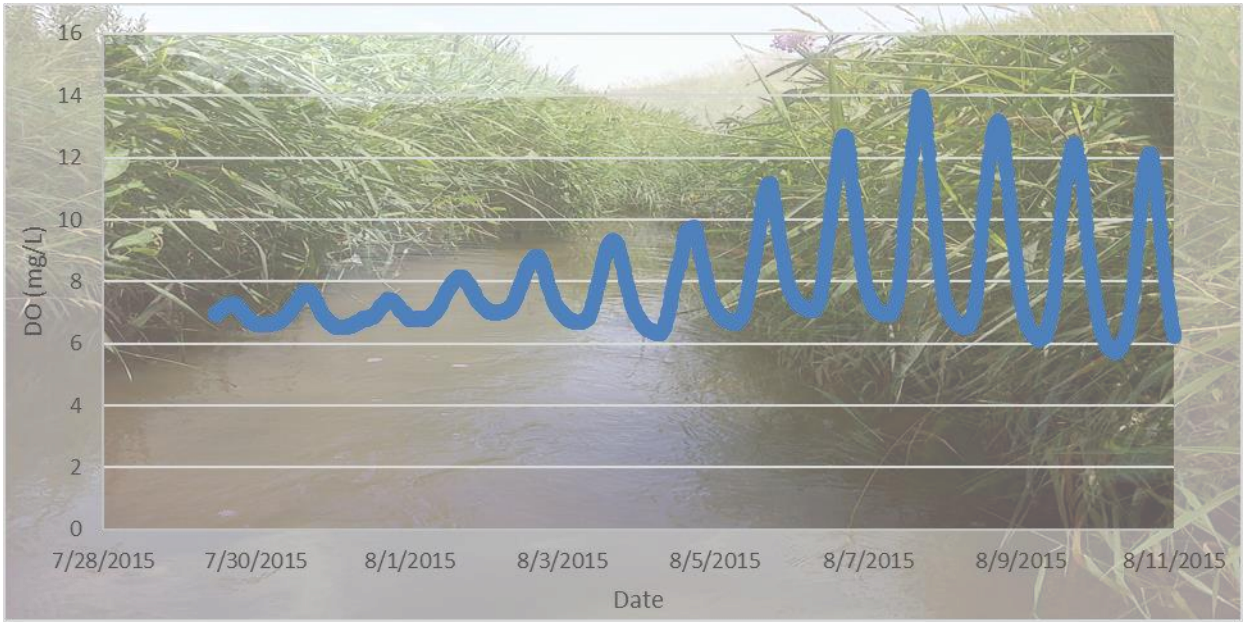
Figure 69. Biological metrics



Candidate Cause Dissolved Oxygen

The two individual samples collected on this reach were 7.1 and 17.09 mg/L at biological station 14MN060. Continuous data collected was collected over 14 days in 2016 at station 14MN060. All values were above 5 mg/L, with a low value of 5.2 mg/L (Figure 70).

Figure 70. Continuous DO data at site 14MN060



Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.0-13.4 mg/L with 18% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No fish were collected that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The percentage of serial spawner individuals at this site was 91.59%, indicating domination of fish species that continually reproduce in defense of altered stream conditions. Species that are very tolerant to low DO conditions comprised 20% of the fish community. The rest of the fish community was tolerant to low DO conditions.

Macroinvertebrates were not sampled on this reach. All DO values in the small dataset were above 5 mg/L with a low value of 5.2 mg/L. The fish biological response is indicative of DO stress, however low

DO values were not recorded during continuous monitoring. Low DO is inconclusive as a stressor on this section of County Ditch 18.

Table 118. DO related merics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN060	0	91.59	5	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	1.43	10.56	10.03				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.069 to 0.159 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.0 mg/L with a mean of 0.2 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD and chlorophyll-a data were not available. Continuous DO data produced daily flux values that were elevated to 7.32 mg/L. The water quality standard for DO flux in the south region of the state is 5 mg/L. As a result of eutrophication, pH values also increase. pH values ranged from 7.87 to 8.35. All continuous pH data collected in 2016 over 14 days were under a value of 8.5. pH daily fluctuation values were all below 0.25 mg/, which is within the normal range of pH fluctuations.

Table 119. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert
14MN060	0	0	100	11.68	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	10.56	76.69	19.80			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Darter and sensitive species were not present at station 14MN060. Tolerant fish individuals made 100% of the population. Along with tolerant species, a positive relationship exists between eutrophication and

omnivorous fish. However, the omnivorous fish percentage was below the class average of sites meeting the modified standard. Macroinvertebrates were not sampled on this reach. The fish community is showing the effects of the elevated phosphorus and DO flux. Eutrophication is a stressor to the fish community.

Candidate Cause: Nitrate

From 2014-2016, a total of three nitrate samples were taken from County Ditch 18 (-791). These nitrate concentrations ranged from 8.3-26.0 mg/L with an average value of 15.4 mg/L. A quantile regression analysis for macroinvertebrate Class 7 sites showed that when nitrate concentrations exceed 11.5 mg/L, there was a 90% probability for impairment. While site 14MN060 was not sampled for macroinvertebrates due to low flow conditions, it is likely that the community would be impaired based on the quantile regression analysis.

Additionally, the HSPF model calculated daily nitrate values for County Ditch 18 (-791) from 1996-2012. These values ranged from 0.1-26.1 mg/L with an average value of 5.8 mg/L.

Furthermore, drain tiles were present at this site. Drain tiles are a common pathway for water high in nitrates to enter the stream system. (Figure 71).

Figure 71. Drain tiles at site 14MN060 (July 30, 2014)

Despite no macroinvertebrate data, the high nitrate observed and calculated data, the quantile regression analysis, in addition to the presence of drain tiles, nitrates are a stressor to aquatic life in County Ditch 18 (-791). Macroinvertebrate sampling during base flow conditions would provide additional information on the extent of the stress that nitrates are having on this reach.

Candidate Cause: Sediment

From 2014-2016, three TSS samples were taken from County Ditch 18 (-791). These sample values ranged from 58-75 mg/L, with an average value of 67.33 mg/L. Additionally, two secchi tube readings were taken in 2014. These values were 23 cm on July 30, 2014 and 77 cm onAugust 18, 2014.

The HSPF model also calculated daily TSS values for this reach from 1996-2012. These values ranged from 3.6-900.64mg/L with an average reading of 29.4 mg/L. The model calculated that the TSS standard would be exceeded 12.66% of the time.

Table 120. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN060	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**21.29**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 18 (-791) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 120). Very little diversity was present at site 14MN060, with only five species present that are generally considered to be tolerant.

There was not a macroinvertebrate sample taken along this reach.

The high exceedance rate calculated by the model, two of the three observed values above the TSS standard, as well as the presence of a tolerant fish community that scored poorly in all suspended sediment related metrics is evidence that suspended sediment is a stressor to aquatic life in County Ditch 18 (-791).

Candidate Cause: Habitat

County Ditch 18 (-791) had a qualitative habitat assessment take place at biological monitoring site 14MN060, during the fish and macroinvertebrate sampling events in 2014. The MSHA score from this visit was 31.25 (Poor). Limiting the habitat conditions at this site was the land use, which was dominated by row crop agriculture, a narrow to moderate riparian buffer, some heavy bank erosion (Figure 72), light stream shading, heavy siltation, sparse fish cover, poor sinuosity, low channel stability, and poor channel development. See Figure 73 for a further breakdown of the MSHA category scores.

Figure 72. Erosion at site 14MN060 (July 30, 2014)

Figure 73. Habitat metrics

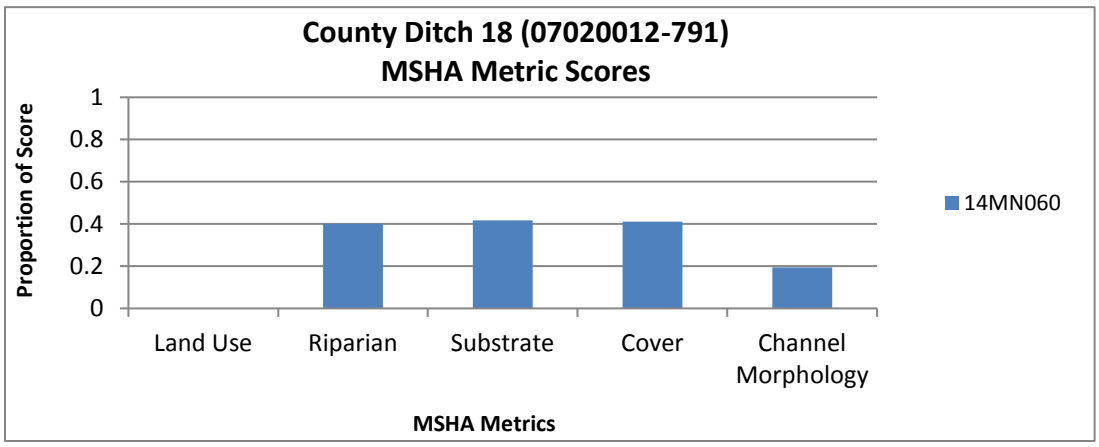


Table 121. Habitat related metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN060	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**100.00**	**14.49**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 18 scored below average in seven of the eight habitat related metrics when compared to all another Class 3 Southern Headwaters Stations that meet the FIBI Modified Use Threshold (Table 121). The assemblage was comprised of all species that are tolerant of degraded habitat conditions including, bigmouth shiners, sand shiners, fathead minnows, brook sticklebacks, and bluntnose minnows.

Based on the poor MSHA score as well as majority of the habitat related metrics of the fish community scoring below average, in addition to the photographic evidence of a degraded stream, habitat is indeed a stressor to the impaired fish community in County Ditch 18 (-791).

Candidate Cause Chloride/Ionic strength

One chloride value was available on this reach; a value of 27.6 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 596 to 957 µS/cm. Continuous data collected in August of 2016 ranged from 853 to 975 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 122. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN060	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors.

Elevated chloride can lead to increases in sunfish based assemblages. Station 14MN060 did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 42.06% of the fish community. Without a macroinvertebrate sample, there is not enough information to determine biological stress. The biological communities are indicative of possible stress. Chloride values taken throughout the year would help our knowledge of the ditch. Ionic strength is inconclusive as a stressor in County Ditch 18 (-791).

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 26% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow (Figure 74). The stream went dry in September 2013, which affects connectivity.

Figure 74. Low flow at site 14MN060 (September 24, 2013)

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 14.49% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 22.90% of the fish community. Based on extended low flow periods shown in the models altered hydrology is a stressor that is also affecting habitat in County Ditch 18 (-791).

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. The culvert at the road crossing has an drop off (Figure 75) which can prevent fish migration particularly during the extended low flow periods.

Figure 75. Perched culvert at site 14MN060 (July 30, 2014)

Conclusions and recommendations

The impaired fish community in County Ditch 18 (-791) is being stressed by DO, eutrophication, nitrates, suspended sediment, habitat, and flow alteration/connectivity (Table 123). Chloride was inconclusive as

a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the North Branch Rush River HUC 10 watershed, please see below.

Table 123. Stressors on County Ditch 18 (-791)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 18	07020012-791	o	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

North Branch Rush River HUC 10 Conclusions and Recommendations

The five biologically impaired stream reaches in the North Branch Rush River subwatershed were being negatively impacted by multiple stressors throughout the watershed. Stressors determined in at least four out of the five impaired reaches include Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. More Dissolved Oxygen and Chloride data are needed to determine the extent of those stressors.

The predominant land use in this subwatershed, row crop agriculture, is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the DO conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

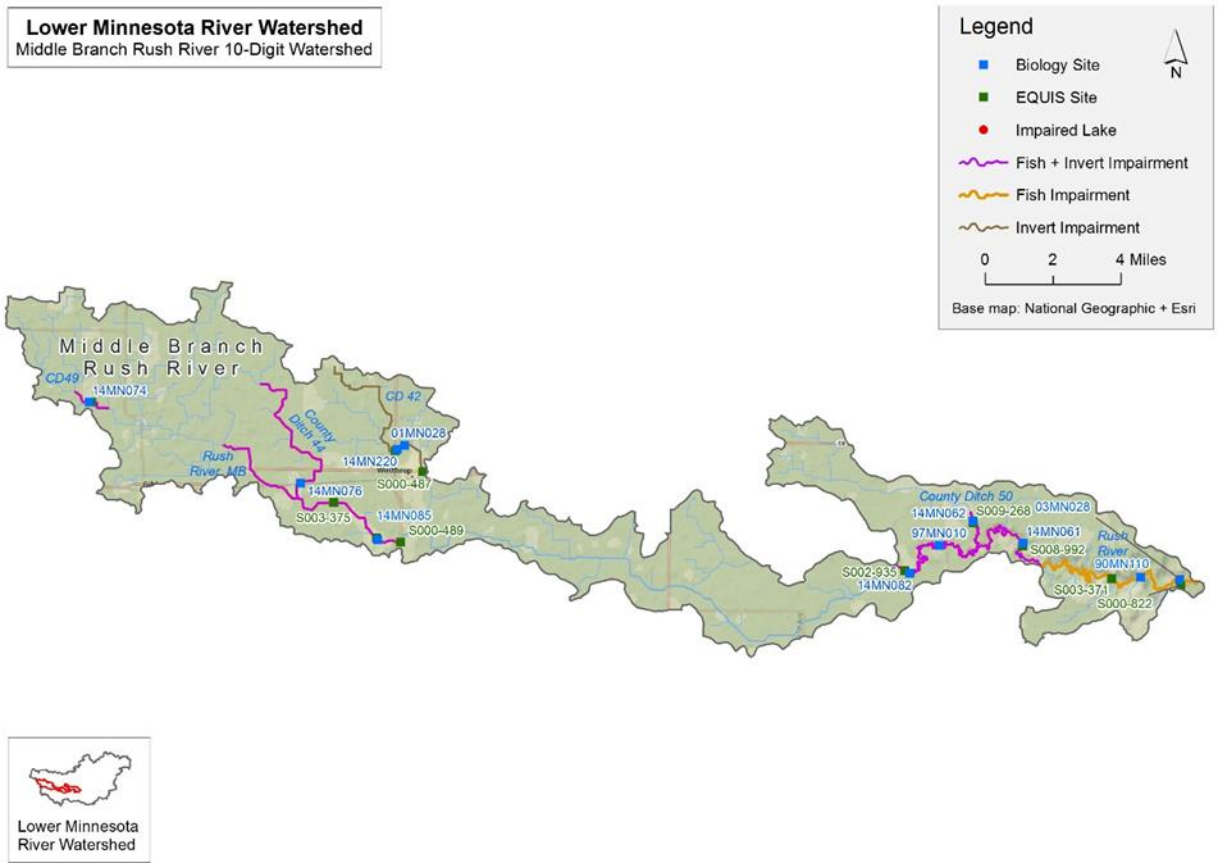
A large effort is needed in the North Branch Rush River watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing Best Management Practices (BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting dissolved oxygen issues as well.

Table 124. Stressors on streams in the North Branch Rush River HUC

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
North Branch Rush River (Judicial Ditch 18)	07020012-555	●	●	●	●	●	●	o
County Ditch 55	07020012-556	o	●	---	●	●	●	---
Unnamed Ditch	07020012-788	o	o	●	o	●	●	---
County Ditch 56	07020012-790	●	●	●	●	●	●	o
County Ditch 18	07020012-791	o	●	●	●	●	●	o

7. Middle Branch Rush River HUC 10 (0702001204)

Figure 76. Sampling sites and streams in the Middle Branch Rush River HUC



7.1 Rush River (-521)

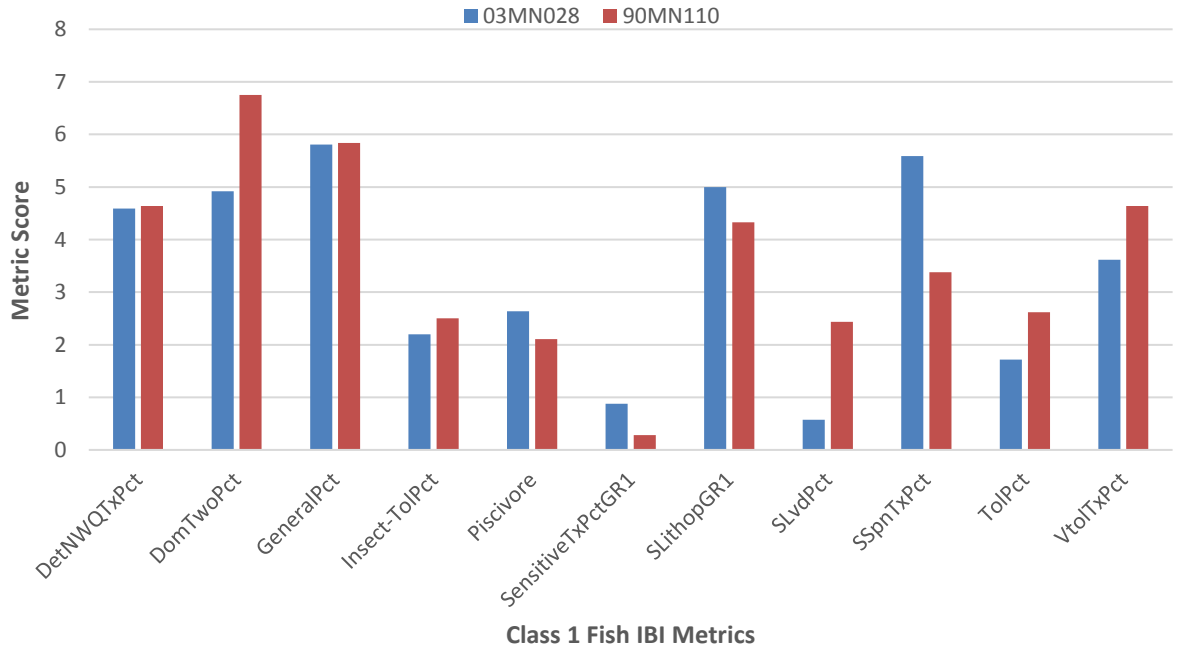
Rush River (-521) is an 8.22 mile long stream reach that is located between the confluence of South Branch Rush River and extending to the Minnesota River. This reach is impaired for biology due to its fish assemblage. There are two biological monitoring locations along this reach, 03MN028 and 90MN110. The reach is also impaired for Turbidity.

Biology

Fish

Rush River (-521) was sampled for fish three times between its two biological monitoring stations. Station 03MN028 was sampled in June and July of 2003. The average FIBI score from these visits was 37.55 while site 90MN110 had an FIBI score of 40.9 (2014). All of these FIBI scores are below the Fish Class 1 Southern Rivers General Use Threshold of 49. See Figure 77 for a more comprehensive look at different metric scores comprising this IBI for these visits along Rush River (-521).

Figure 77. Biological metrics



Candidate Cause Dissolved Oxygen

There is a large DO dataset on this reach in recent years (2016-2016). Concentrations ranged from 3.22 mg/L to 13.54 mg/L. Only one recorded value was below the water quality standard of 5 mg/L; the value was taken in June. All DO data were collected in the lower part of the reach.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.7-14.2 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 125. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
90MN110	10.67	68.69	26	0	7.13	6	7.42
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	**37.47**	**35.61**	**22.44**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. 10.67% of the fish population collected reproduce at a mature age, less than half the class average. Low DO values also correspond with increased serial spawning fish percentage. The percentage of serial spawner individuals at this site was 68.69%, twice the class average. Species that are very tolerant to low DO conditions comprised 2.4% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Six macroinvertebrate intolerant taxa were collected and there were zero DO tolerant individuals. While the serial spawners were elevated, the preponderance of evidence indicates DO is not a stressor.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.022 to 2.07 mg/L with 52% over 0.150 mg/L. The highest value was collected during September near Le Sueur just upstream of the Minnesota River (station S000-822). Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 3% in May to 100% in July and an average of 42%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.3 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Only four BOD values were available and were from 1998; ranging from 1.3 to 5 mg/L. More recent chlorophyll-a values are available, ranging from 1 to 94 mg/L with 12.5% of 16 values over the southern standard of 40 mg/L. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.77 to 8.65. There is no DO flux data available.

Table 126. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish	Invert Taxa	EPT Pct	Dominant 2 Invert
90MN110	2.93	0.31	64.89	3.28	18	36.13	69.68
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	**13.75**	**4.46**	**22.36**	**15.72**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Both sensitive and darter species were present at station 90MN110, but in numbers, less than class averages. Darter species decreased from 5.14% in 1990 to 1.48% in 2010 to 0.31% in 2014. Sensitive individuals have been absent throughout the years. The percentage of tolerant fish individuals was also above class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was very low at 3.28%, well below the class averages of those meeting the general standard. The macroinvertebrate sample collected on this reach had almost 70% of the community dominated by two species. Individuals of EPT species were present at 36.13%, but the most prevalent family was Cheumatopsyche which can tolerate eutrophic conditions. Along with elevated phosphorus and chlorophyll-a values, sensitive and darter species were low and darter individuals have decreased over time. Tolerant individuals were also high. Eutrophication is a stressor to the fish community. Macroinvertebrate taxa was low and the community was dominated by two species, but other stressors can also effect these factors. It is of note that the second most common species was a caddisfly that can be found in eutrophic conditions, but currently eutrophic conditions are inconclusive as a stressor to the macroinvertebrate community in this section of Rush River (-521).

Candidate Cause Nitrate

From 2003-2016, a total of 293 nitrate samples were taken from Rush River (-521). These values ranged from 0.09-30.4 mg/L with an average nitrate concentration of 13.02 mg/L. A quantile regression of macroinvertebrate Class 5 streams showed that when nitrate concentrations exceeded 18.1 mg/L or higher, there was a 75% probability that the stream would be impaired. Rush River (-521) had 80 (27.3%) nitrate concentrations in excess of 18.1 mg/L. Of all of the major tributaries to the Minnesota River, data from 2000-2008 shows Rush Creek to have the second largest nitrate yield after only the Le Sueur River (MRBDC 2009).

Table 127. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN028	**11.47**	**40.95**	**1.40**	**3.24**
90MN110	**22.22**	**44.52**	**0.32**	**3.31**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Rush River (-521) scored below average in two of the four nitrate related metrics at both sites, 03MN028 and 90MN110, when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (TABLE). Both sites had lower amounts of nitrate tolerant taxa. Site 90MN110 did have a higher amount of Trichoptera taxa, but also had few nitrate intolerant species. Site 03MN028 had few Trichoptera taxa, while having a higher amount of nitrate intolerant taxa. Both sites did have a below average Nitrogen TIV score.

Based on the very high nitrate concentrations observed from the extensive data set, as well as the below average Nitrogen TIV scores and other below average scoring nitrate related metrics, nitrates are a stressor to aquatic life in Rush River (-521).

Candidate Cause: Sediment

Rush River (-521) was assessed and listed as impaired for turbidity in 2008. From 2003-2016, 292 TSS samples were taken from this reach. These values ranged from 2-3,750 mg/L, with an average TSS concentration of 292 mg/L. During this time, 154 (52.74%) of the samples, were at or above the 65 mg/L TSS standard.

Table 128. Sediment related fish metrics.

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN028	**5.20**	**0.00**	**3.22**	**0.56**	**4.53**	**0.78**	**4.05**	**0.00**	**7.57**	**29.12**
90MN110	**12.77**	**0.00**	**10.01**	**1.66**	**12.16**	**2.93**	**9.27**	**0.00**	**12.86**	**30.20**
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	*21.36*	*4.12*	*1.04*	*17.97*	*13.92*	*13.53*	*24.97*	*4.63*	*43.61*	*25.99*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Rush River (-521) at sites 03MN028 and 90MN110 scored below average in nine of the suspended sediment related metrics when compared to all other Class 3 Southern Rivers stations that meet the FIBI General Use Threshold (Table 128). Both sites did have an above average amount of herbivorous species individuals, but scored poorly in the other metrics. These results signal a community that is being negatively impacted by the suspended sediment conditions present.

Table 129. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
03MN028	**20.25**	**1.5**	**19.5**	**60.24**	**29.78**	**1.72**
90MN110	**16.67**	**1**	**6**	**41.61**	**76.77**	**0.32**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Rush River (-521) scored below average in four of the six suspended sediment related metrics at both sites, 03MN028 and 90MN110, when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 129). Both sites had below average TSS index scores, few TSS intolerant taxa, and a high amount of TSS tolerant individuals.

Based on the large chemical data set with a very high amount of samples above the standard, the poor scoring fish and macroinvertebrate metrics related to suspended sediment, as well as the current turbidity impairment for this reach, all suggest that suspended sediment is a stressor to aquatic life in Rush River (-521).

Candidate Cause Habitat

Rush River (-521) had qualitative habitat assessments take place at its biological monitoring sites, 03MN028 and 90MN110, during the fish and macroinvertebrate sampling events in 2003 and 2014. The average MSHA scores from these visits was 48.7 (Fair) at 03MN028 and 53.63 (Fair) at 90MN110. Limiting the habitat at these sites was moderate bank erosion, severe embeddedness, low channel stability, fair sinuosity, light stream shading, sparse to moderate fish cover, and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 78. A DNR study found “the stream bed was dominated with sands, point bars were covered with large gravels and small cobbles which means the stream has the competence to move larger particles at high flows, but does not have the capacity to transport sands at lower flows” (DNR, 2017a). The lack of transport at low flows creates fine sediments filling in pools, reducing their depths and sediment embeddedness in riffles (DNR, 2017a). A bank study measured 190 feet of erosion since 2011 (DNR, 2017a).

Figure 78. Habitat metrics

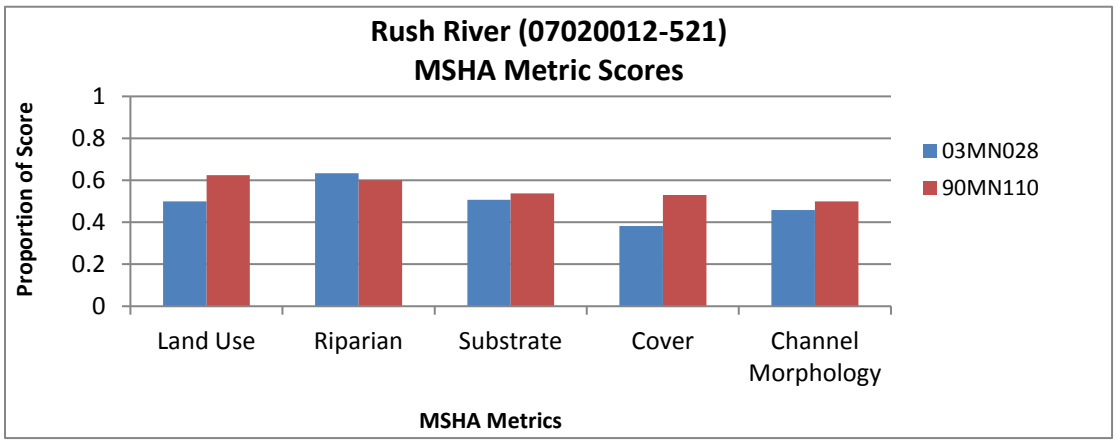


Table 130. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN028	**2.36**	**4.05**	**2.08**	**4.53**	**2.22**	**9.66**	**67.74**	**21.29**
90MN110	**2.67**	**9.27**	**2.67**	**12.16**	**7.91**	**19.33**	**64.89**	**2.14**
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)	*20.61*	*24.97*	*18.51*	*13.92*	*15.18*	*29.21*	*22.05*	*5.21*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Rush River (-521) scored below average in almost all of the habitat related metrics between the two sites when compared to all other Class 1 Southern Rivers stations that did meet the FIBI General Use Threshold (Table 130). The high amounts of tolerant individuals as well as the lower amount of habitat specialists are indicators of degraded habitat conditions.

Table 131. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN028	**5.43**	**5.29**	**56.68**	**65.40**	**25.86**	**11.81**
90MN110	**0.32**	**12.58**	**81.94**	**36.13**	**59.35**	**2.58**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored better than the fish community as just two habitat related metrics at site 03MN028, and three at site 90MN110 scored below average when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 131).

Based on the poor scoring metrics in the impaired fish community as well as the fair MSHA scores, the fish assemblage is indeed being stressed by the current habitat conditions along Rush River (-521).

Candidate Cause Chloride/Ionic strength

A small chloride dataset is available with values ranging from 22.5-90.6 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 641 to 750 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was close to the class average at 36.13%, but the mayfly (Ephemeroptera) percentage was much lower at 6.77%. The taxa count was 18, well below the class average. The macroinvertebrate community was comprised of 40.32% conductivity tolerant individuals and 1 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Station 90MN110 did not have any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 36.90% of the fish community. The biological metrics are mixed and the lack of elevated chloride and conductivity values indicate that ionic strength is not a stressor in this section of Rush River (-521).

Table 132. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
90MN110	18	4	6.77	36.13	0
Statewide average for Class 1 Southern Rivers stations that are meeting the FIBI General Use Threshold (49.0)					**4.12**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach of the Rush River is natural, but analysis of the MPCA altered watercourse layer measured 82.54% of the Rush River sub-watershed as channelized. There were no known connectivity issues. Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 10.58% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 8.40% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates was 0.32% at station 90MN110. The channelization is likely contributing to lack of habitat but altered hydrology is not currently a stressor to this section of the Rush River (-521).

Conclusions and recommendations

The impaired fish community in Rush River (-521) are being stressed by nitrates, suspended sediment, and habitat. (Table 133) Eutrophication was inconclusive as a stressor at this time. Dissolved Oxygen, Chloride, and Flow Alteration/Connectivity were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 133. Stressors on Rush River (-521)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Rush River	07020012-521	---	o	●	●	●	---	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.2 Rush River (-548)

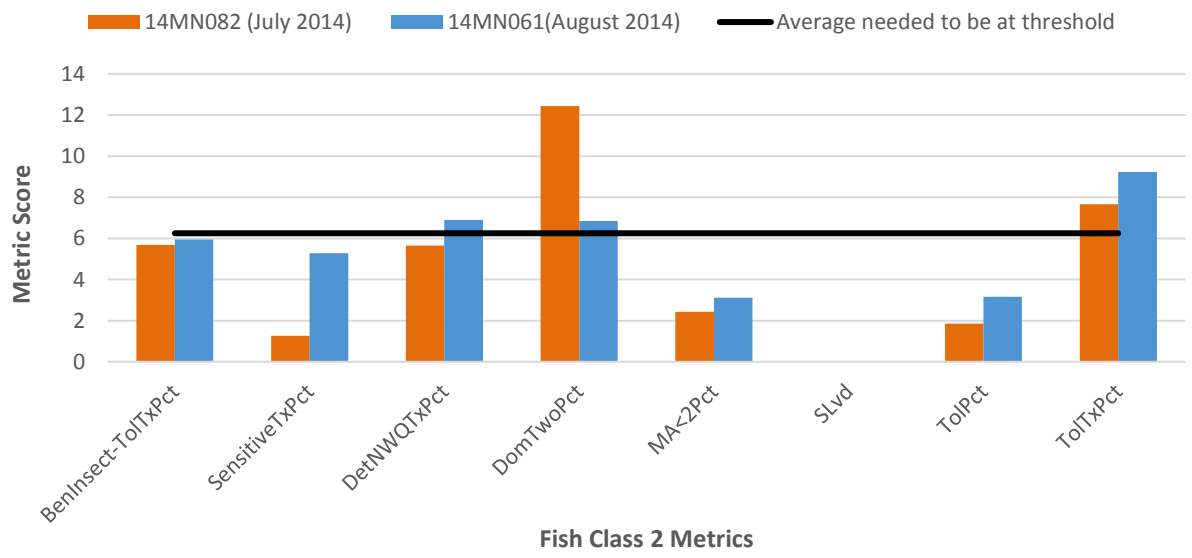
Located in southeastern Sibley county is Rush River (-548). This reach is 11.54 miles long and extends from Middle Branch Rush River to the confluence with South Branch Rush River. This stream is impaired for biology due to both fish and macroinvertebrate assemblages. There are three biological monitoring stations, 14MN061, 14MN082, and 97MN010, located along this reach. This reach is also impaired for Turbidity.

Biology

Fish

Rush River (-548) was sampled for fish at both biological monitoring stations, 14MN082 and 14MN061, in 2014. The FIBI scores for these sites were 37.0 (14MN082) and 40.5 (14MN061). Both of these scores are below the Fish Class 2 Southern Streams General Use Threshold of 50. Both sites had a high presence of short-lived, tolerant, and early maturing individuals resulting in lower FIBI metric scores (Figure 79).

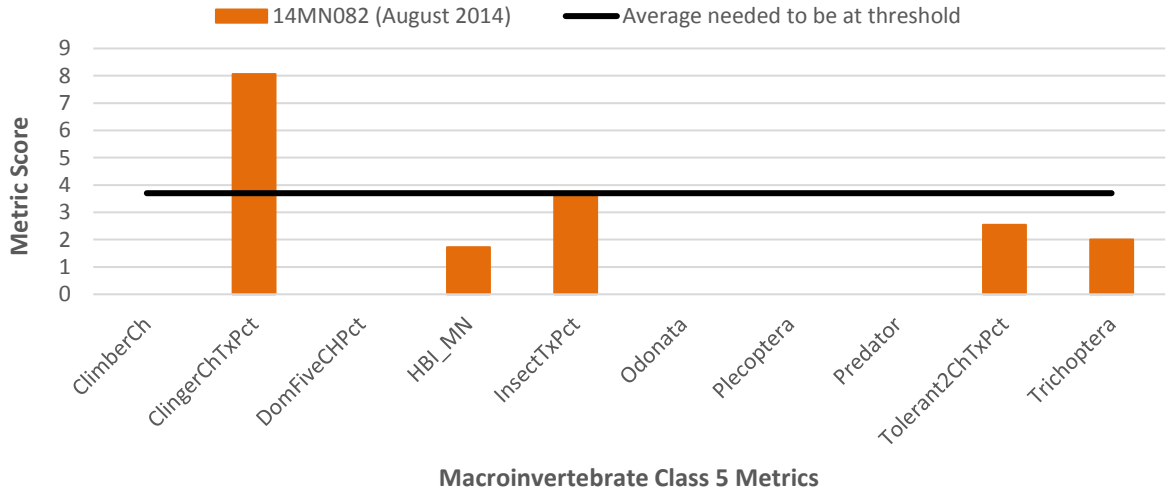
Figure 79. Biological fish metric scores



Macroinvertebrates

Sites 14MN082 and 14MN061 were also sampled for macroinvertebrates in August of 2014. The MIBI scores for these sites were 18.1 (14MN082) and 27.1 (14MN061). Both of these MIBI scores are below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Site 14MN082 reached the average needed to meet the threshold in just two of the ten metrics, while site 14MN061 fared slightly better as it achieved this level in three of the metrics. The MIBI was very limited with four metrics comprising the MIBI scoring zero.

Figure 80. Biological macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 7.08 mg/L to 13.85 mg/L without any recorded values below 5 mg/L. The small dataset included samples taken throughout the reach.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.7-14.1 mg/L with 5.5% of values below the water quality standard of 5 mg/L.

Table 134. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN061	1.38	68.58	21	1.32	7.39	6	7.49
14MN082	1.51	60.16	22	5.33	7.76	4	7.48
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Low numbers of individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Both stations had elevated serial spawner individuals, more than three times higher than the class average for sites meeting the general standard. Species that are very tolerant to low DO conditions comprised 18% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Four or more macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 5.33% of the population or less. All DO values in the small dataset were above 5 mg/L with a low value of 7.08 mg/L. The fish biological response is indicative of DO stress but the macroinvertebrate community is not. Based on the fish community, DO is a stressor to the Rush River (-548).

Candidate Cause Eutrophication

A small phosphorus dataset is available on this reach, ranging from 0.03 to 0.165 mg/L. The highest value was collected during July just downstream of where the north and middle branches join (station 14MN082). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.5 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 8.12 to 8.62. There are no DO flux, BOD, or chlorophyll-a data available.

Sensitive individuals were present at both biological stations, but in numbers much less than the class average for sites that meet the general standard. Darter individuals were present in greater numbers and were above average at station 14MN082 however all but one of the darters was a johnny darter, which are more tolerant. The percentage of tolerant fish individuals were above class average at both stations. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was very low at station 14MN061 and right at the

class average for station 14MN082. Individuals of EPT species were present at high levels, but were dominated by Cheumatopsyche which can be found in eutrophic conditions. In the small dataset, there were a few elevated phosphorus and pH values, and while tolerant individuals were higher than average, omnivorous individuals were less than average. Macroinvertebrate taxa was low and while the EPT individuals were high the most common species can be found in eutrophic conditions. Currently eutrophic conditions are inconclusive as a stressor to the macroinvertebrate and fish communities. Further phosphorus data along with continuous DO and chlorophyll-a on Rush River (-548) would be helpful.

Table 135. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN061	2.29	5.5	63.07	2.98	30	50.83	36.54
14MN082	0.41	13.32	67.99	16.21	22	73.27	55.97
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	19	11.47	45.1	17			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					41.92	43.90	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2016 a total of four nitrate samples were taken from Rush River (-548). These values ranged from 8.9-26.0 mg/L, with an average nitrate concentration of 16.98 mg/L. A quantile regression of macroinvertebrate Class 5 streams showed that when nitrate concentrations exceeded 18.1 mg/L or higher, there was a 75% probability that the stream would be impaired. Rush River (-548) exceeded this value twice with nitrate values of 19 and 26 mg/L. Of all of the major tributaries to the Minnesota River, data from 2000-2008 shows Rush Creek to have the second largest nitrate yield after only the Le Sueur River (MRBDC 2009).

Table 136. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN061	**20.00**	**53.31**	**0.00**	**3.41**
14MN082	**18.18**	**68.34**	**0.00**	**3.76**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Rush River (-548) scored below average in three of the four nitrate related metrics at both sites, 14MN061 and 14MN082, when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 136). Both sites did have an above average number of Trichoptera taxa, however, they also had a high amount of nitrate tolerant taxa, no nitrate intolerant taxa, and a poor Nitrogen TIV score.

Based on the elevated nitrate concentrations observed, the quantile regression analysis, in addition to the majority of the poor scoring macroinvertebrate metrics related to nitrates, nitrates are a stressor to aquatic life in Rush River (-548).

Candidate Cause Sediment

From 2014-2016, three TSS samples were taken from Rush River (-548). These samples ranged from 4.4-140 mg/L with an average TSS concentration of 51.2 mg/L. One of the three samples was above the 65 mg/L TSS standard. Additionally, from 2003-2014 58 secchi tube measurements were taken. These values ranged from 0-75 cm, with an average reading of 23.12cm. Of these readings, seven were at or below the 10 cm standard.

The HSPF model also calculated daily TSS values for this reach from 1996-2012. These values ranged from 3.4-857.7 mg/L with an average TSS concentration of 37.7 mg/L. The model predicted that TSS concentrations would be above the 65 mg/L standard 794 (12.79%) times during this time period.

Table 137. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN061	**35.03**	**0.00**	**12.36**	**13.74**	**14.56**	**0.41**	**8.65**	**0.00**	**4.53**	**27.42**
14MN082	**22.94**	**0.00**	**17.20**	**6.42**	**19.27**	**2.29**	**6.42**	**0.46**	**3.67**	**24.15**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Rush River (-548) scored below average in nine of the ten suspended sediment related metrics at both sites, 14MN061 and 14MN082, when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 137). Both sites did have an above average amount of herbivorous fish individuals, however, the sites scored poorly in the other metrics that could indicate stress from suspended sediment.

Table 138. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN061	**17.25**	**0**	**10**	**50.66**	**62.13**	**0.00**
14MN082	**19.09**	**0**	**8**	**65.52**	**69.18**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Rush River (-548) scored below average in four of the six suspended sediment related metrics at both sites when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 138). Both sites, had low amounts of TSS tolerant taxa, while also having a good amount of collector-filterer individuals. The site did have a poor TSS index score, a high amount of TSS tolerant individuals, and a complete lack of TSS intolerant and Plecoptera taxa.

Based on the majority of the fish and macroinvertebrate metrics related to suspended sediment scoring below average, the higher rate of exceedance observed with the secchi tube and the HSPF model, as well as the very high TSS values recorded in the next reach downstream, Rush River (-521), suspended sediment is a stressor to aquatic life in Rush River (-548).

Candidate Cause Habitat

Rush River (-548) had qualitative habitat assessment take place at biological monitoring sites, 14MN061 and 14MN082, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 49 (Fair) at 14MN061 and 51.68 (Fair) at 14MN082. Limiting the habitat at these sites was the row crop and open pasture dominating the local land use, no riparian buffer, moderate to severe bank erosion (Figure 81), no stream shading, sand and clay substrates, and moderate channel stability. These sites did seem to have an ample amount of fish cover while in the stream. A breakdown of the MSHA category scores for this site can be seen in Figure 82. Due to a channel cutoff and resulting loss of 830 feet of streambed between the 1991 and 2003 aerial photos, the stream slope increased stream power and bank failure likelihood (DNR, 2017a).

Figure 81. (Left) Eroded bank at site 14MN061, (Right) Eroded bank at site 14MN082.

Figure 82. Habitat metrics

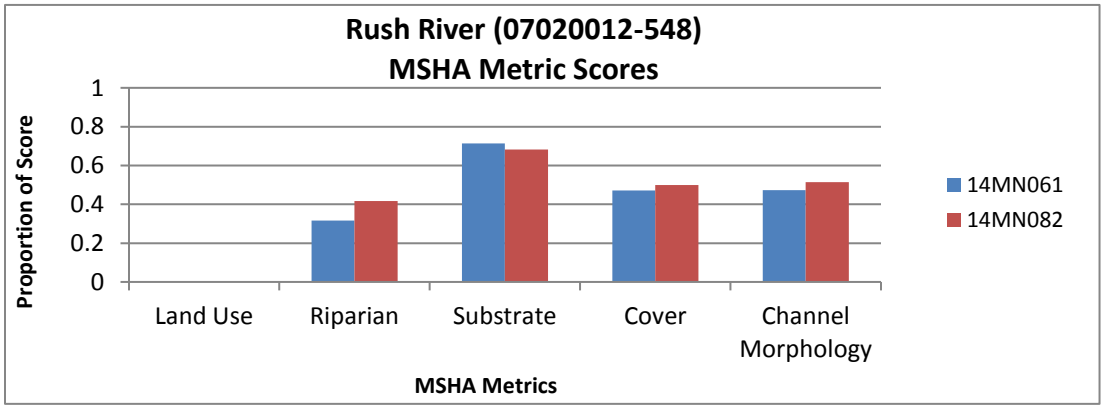


Table 139. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSuc Pct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN061	**14.91**	**6.42**	**5.50**	**19.27**	**1.15**	**25.00**	**63.07**	**9.63**
14MN082	**25.41**	**8.65**	**13.87**	**14.56**	**0.96**	**19.92**	**67.99**	**28.30**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Rush River (-548) had below average scores in seven of the eight habitat metrics analyzed when compared to Class 2 Southern Streams that meet the General Use Threshold. The high number of poor scoring metrics tends to indicate habitat stress.

Table 140. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN061	**1.99**	**15.95**	**67.77**	**50.83**	**38.87**	**6.64**
14MN082	**0.94**	**14.47**	**74.53**	**73.27**	**20.44**	**6.60**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community fared better than fish when comparing habitat metrics. This assemblage scored below average for sites meeting the Class 5 General Use Threshold in 2 of 6 metrics at site 14MN061 and in just 1 of 6 at site 14MN082. Site 14MN061 did have a higher amount of legless individuals, which are mostly tolerant and can signal potential degradation.

Given the habitat scores, the poor scoring fish metrics, as well as the photographic evidence of degradation, the habitat conditions are a stressor to the fish community in Rush River (-548). The macroinvertebrate community seems to be less affected at this time, however, if conditions do not improve it may become a habitat stressor as well in Rush River (-548).

Candidate Cause Chloride/Ionic strength

No chloride values are available on this reach of the Rush River. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 758 to 992 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 141. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN061	30	9	14.29	50.83	0
14MN082	22	5	8.18	73.27	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentages were both above the class average, but the mayfly (Ephemeroptera) percentages were lower than the class average. The taxa counts were both below the class average. The macroinvertebrate community was not comprised of any intolerant individuals at either site and 43% and 65% conductivity tolerant individuals at stations 14MN061 and 14MN082 respectively.

Elevated chloride can also lead to increases in sunfish based assemblages. Neither station had any Centrarchidae (sunfish) collected. Species that are tolerant to conditions with high ionic strength comprised 50% and 57% of the fish community at stations 14MN061 and 14MN082. The biological metrics are mixed. Chloride values taken throughout the year would help our knowledge of this reach of the river. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach of the Rush River is predominantly natural, but analysis of the MPCA altered watercourse layer measured 82.54% of the Rush River sub-watershed as channelized. There were no known connectivity issues. Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 1% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The generalist fish species comprised 13.53% and 32.42% of the population at stations 14MN061 and 14MN082 respectively. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 10.09 and 35.71% of the fish community stations 14MN061 and 14MN082 respectively. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present at either station. The upstream channelization is likely contributing to lack of habitat but altered hydrology is not currently a stressor to this section of the Rush River (-548).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Rush River (-548) are being stressed by DO, Nitrates, Suspended Sediment, and Habitat (Table 142). Dissolved Oxygen was inconclusive as a stressor at this time. Flow Alteration/Connectivity was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 142. Stressor on Rush River (-548)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Rush River	07020012-548	●	o	●	●	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.3 Rush River, Middle Branch (County Ditch 23 and 24) (-586)

Middle Branch Rush River (-586) is a 7.18 mile long channelized stream section that is located in western Sibley county. This stream reach extends from just upstream of County Road 3 down to the intersection with County Road 15 south of Winthrop. This reach is impaired for biology due to the fish and macroinvertebrate assemblages at its biological monitoring station 14MN085.

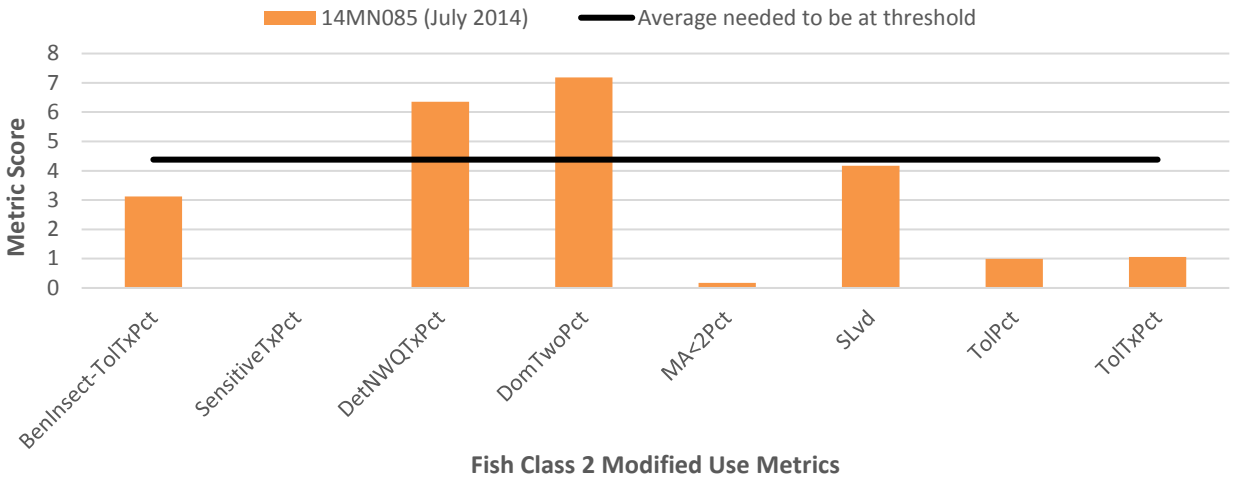
Biology

Fish

Middle Branch Rush River (County Ditch 23 and 24) (-586) had a fish sampling event take place in July of 2014 biological monitoring station 14MN085. The FIBI score for this site was 23.1, which is well below the Fish Class 2 Southern Streams Modified Use threshold of 35. Of the eight metrics comprising the

FIBI, only two of the metrics scored above the average needed to reach the FIBI threshold for this class (DetNWQTxPct, DomTwoPct) (Figure 83). The remaining metrics scored below average or very poorly.

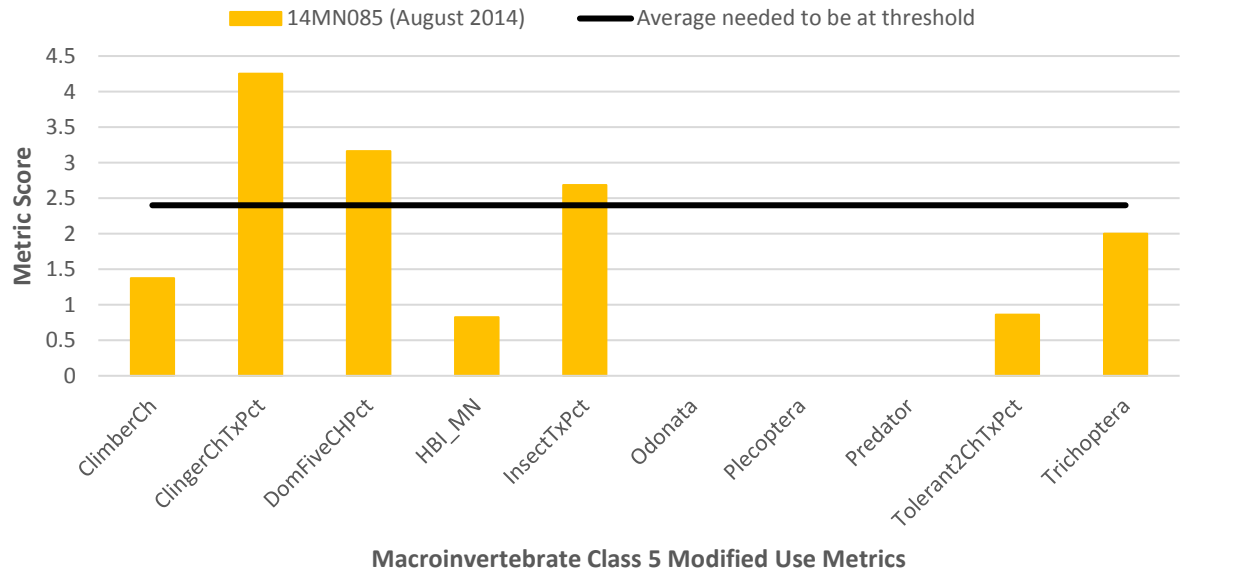
Figure 83. Biological fish metric scores



Macroinvertebrates

A macroinvertebrate sample was also taken at site 14MN085. This sample was collected in August 2014 and had an MIBI score of 15.2. This score is also below the macroinvertebrate Class 5 Southern Streams RR Modified Use threshold of 24. This stream reach scored above the average needed to reach the MIBI threshold for this class in three of the 10 metrics comprising the Class 5 MIBI (Figure 84). The complete lack of Odonata, Plectoptera, and predator species significantly impacted the ability of this stream to reach the MIBI threshold.

Figure 84. Biological macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach. Concentrations ranged from 10 mg/L to 19.6 mg/L without any recorded values below 5 mg/L. Additionally, the HSPF model calculated daily minimum DO

values in May-September from 1996-2012. These values ranged from 0-13.6 mg/L with 22% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was right at the class average for sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised 31% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Two macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 20.86% of the population (just above the class average). All DO values in the small dataset were above 5 mg/L with a low value of 10 mg/L. While there was a lack of individuals that reproduce at a mature age, the number of serial spawning fish, and low DO tolerant fish and macroinvertebrates indicate low DO is not a stressor at this time. More DO samples would be helpful to better characterize the DO regime on this stream.

Table 143. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN085	0	23.89	10	20.86	8.07	2	6.79
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	15.09	25.34	14.52				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)				18.23	7.57	4.51	6.75
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of recent (2014-2016) phosphorus values are available on this stream, ranging from 0.059 to 0.073 mg/L. Additional samples taken in 2003 were 0.269 and 0.381 mg/L. The HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-2.2 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. As a result of eutrophication, pH values also increase. pH values ranged from 7.9 to 8.36. BOD, chlorophyll-a, and DO flux data were not available, however a DO value of 19.6 mg/L indicates possible DO fluctuations due to eutrophication. Thick algal growth was observed at station 14MN085 (Figure 85).

Figure 85. Algal growth at site 14MN085 (September 24, 2013)

Table 144. Metrics related to eutrophication

Phosphorus Relevant Metrics	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN085	0	28.34	71.26	9.31	29	31.38	35.69
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)					**33.60**	**36.82**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals were not present at station 14MN085 while darter species were present at numbers great then class average meeting the modified standard, the darter individuals were all johnny darters which are more tolerant. The percentage of tolerant fish individuals were above class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was low at 9.31%, below the class averages of those meeting the standard. The macroinvertebrate sample collected on this reach comprised 35.69% of the community dominated by two species. Individuals of EPT species were present at 31.38%, just below the class average but the most prevalent family was Cheumatopsyche, which can tolerate eutrophic conditions. In the small dataset from the last few years, there were no elevated phosphorus or pH values. There was a lack of sensitive fish individuals, a high number of tolerant fish individuals, and lowered omnivorous individuals. Invert taxa were close to the class average and the EPT individuals were high, but most common species was a caddisfly that can be found in eutrophic conditions. Based on a mixed response, eutrophic conditions are inconclusive as a stressor to the biological communities. Further sample collection, including more recent phosphorus data and daily DO fluctuations would be helpful.

Candidate Cause Nitrate

From 2003-2016 a total of nine nitrate samples were taken from Middle Branch Rush River (-586). These sample values ranged from 0.8-23.6 mg/L with an average nitrate concentration of 12.73 mg/L. Quantile regression analysis for a macroinvertebrate Class 5 site showed that if a nitrate concentration exceeded 18.1 mg/L there was a 75% probability for impairment. This reach had three nitrate samples exceeding 18.1 mg/L.

Drain tiles were also present in this stream and are an easy pathway for nitrates to enter a stream system.

Table 145. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN085	**13.79**	**70.25**	**0.00**	**4.36**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*10.99*	*57.02*	*0.30*	*3.22*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Middle Branch Rush River (-586) scored below average in three of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 145). The site, 14MN085, had a high percentage of nitrate tolerant taxa, while having zero nitrate intolerant species. The Nitrogen TIV score was very poor as well.

Based on the quantile regression analysis, the high observed nitrate values, the presence of drain tiles, as well as the majority of the macroinvertebrate nitrate related metric scores being below average, nitrates are a stressor to aquatic life in this reach.

Candidate Cause Sediment

From 2003-2016, a total of eight TSS samples were taken from Middle Branch Rush River (-586). These values ranged from 3.6-80 mg/L with an average TSS concentration of 23.08 mg/L. Only one of the TSS samples was above the 65 mg/L standard for TSS.

Also, from 2003-2015 a total of 262 secchi tube measurements were taken from this reach. These values ranged from 5-100 cm, with an average reading of 49 cm. Seven (2.67%) of these measurements were at or below the 10 cm secchi tube standard.

Additionally, during the 2016 assessment of this reach, the TSS and secchi tube data for this reach was determined to be in full support of aquatic life.

Table 146. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN085	**31.58**	**0.00**	**0.81**	**28.34**	**3.24**	**0.00**	**9.31**	**0.00**	**0.00**	**16.08**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Middle Branch Rush River (-586) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 146). This reach did have a good TSS index score as well as an above average number of benthic feeder individuals. The remaining metrics scored poorly.

Table 147. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN085	**18.84**	**0**	**9**	**65.95**	**29.23**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*16.10*	*1.16*	*10.53*	*36.67*	*22.05*	*0.10*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN085 in this reach scored below average in four of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 147). This reach had a lower amount of TSS tolerant taxa and an above average amount of collector-filterer species, however the reach lacked TSS intolerant taxa, Plectoptera species, while also having a poor TSS index score and a high amount of TSS tolerant individuals.

While the majority of the suspended sediment biological metrics score below average for both the fish and macroinvertebrate communities, the strong data set and resulting assessment indicate that sedimentation is not an issue in this reach. It is likely that other stressors are causing below average metric scores. Therefore, suspended sediment is not a stressor in Middle Branch Rush River (-586) at this time.

Candidate Cause Habitat

Middle Branch Rush River (-586) had a qualitative habitat assessment take place at biological monitoring site, 14MN085, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 37.7 (Poor). Limiting the habitat at this site was the row crop as the dominant land use (Figure 86), moderate stream riparian buffer, heavy bank erosion, light stream shading, sand substrates, sparse fish cover, poor channel sinuosity (Figure 88), moderate channel stability, and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure87. A DNR study found the stream channel to be deeply incised, over-widened with poor stability (DNR, 2017a).

Figure 86. Land use at site 14MN085 (July 29, 2014)

Figure 87. Habitat metrics

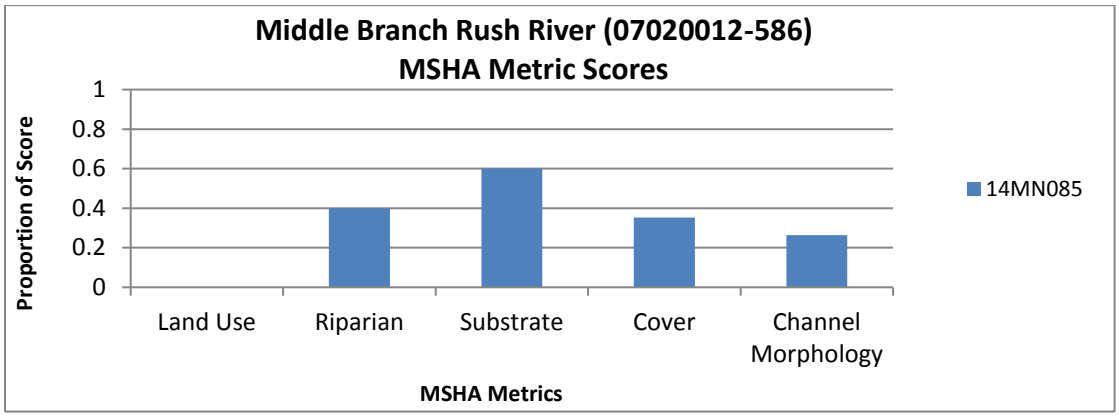


Table 148. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN085	**28.34**	**9.31**	**28.34**	**3.24**	**0.00**	**24.70**	**71.26**	**49.80**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Middle Branch Rush River (-586) scored below average in six of the eight habitat related biological metrics when compared to other Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (Table 148). The high amount of tolerant and pioneer individuals are good indicators of potentially degraded habitat conditions.

Table 149. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN085	**13.54**	**41.23**	**31.38**	**31.38**	**61.85**	**11.08**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*6.43*	*19.88*	*38.44*	*27.84*	*44.43*	*18.90*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that met the MIBI Modified Use threshold (Table 149). The elevated numbers of both burrower and legless individuals likely indicates that many fine substrates are present, which is common in streams with degraded habitat conditions.

Based on the poor MSHA rating, as well as the many below average habitat related metrics in both the fish and macroinvertebrate communities, the biology in this channelized section of the Middle Branch Rush River (-586) is being stressed by the current habitat conditions.

Candidate Cause Chloride/Ionic strength

No chloride values are available on this reach of the Rush River. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 763 to 813 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset were greater than 1,000 µS/cm.

Table 150. Metrics related to ionic strength

Station	**TaxaCountAllChir**	**EphemeropteraCh**	**EphemeropteraPct**	**EPTPct**	**Cent-TolPct**
MN085	29	4	3.69	31.38	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					**6.17**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	36.82	*4.43*	*17.02*	*33.60*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was just below the class average, while the mayfly (Ephemeroptera) percentage was much lower than the class average. The taxa count was slightly below the class average. The macroinvertebrate community was comprised of 67.79% conductivity tolerant individuals and no intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 38% of the fish community. Ephemoptera is the only lowered metric and while chloride values taken throughout the year would help our knowledge of this reach of the river, ionic strength is currently not a stressor Middle Branch Rush River (-586).

Candidate Cause: Altered Hydrology/Connectivity

This reach of the Rush River and the upstream watershed are 100% modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 25% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 30.77% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 58.30% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present. The channelization, extended low flow periods shown in the models, and biological communities show altered hydrology is a stressor that is also affecting habitat in Middle Branch Rush River (-586).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Middle Branch Rush River (County Ditch 23 and 24) (-586) are being stressed by Nitrates, Habitat, and Flow Alteration/Connectivity (Table 151). Eutrophication was inconclusive as a stressor at this time. Dissolved Oxygen and Suspended Sediment were ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 151. Stressors on Rush River, Middle Branch (-586)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Rush River, Middle Branch (County Ditch 23 and 24)	07020012-586	---	o	●	---	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.4 County Ditch 42 (-551)

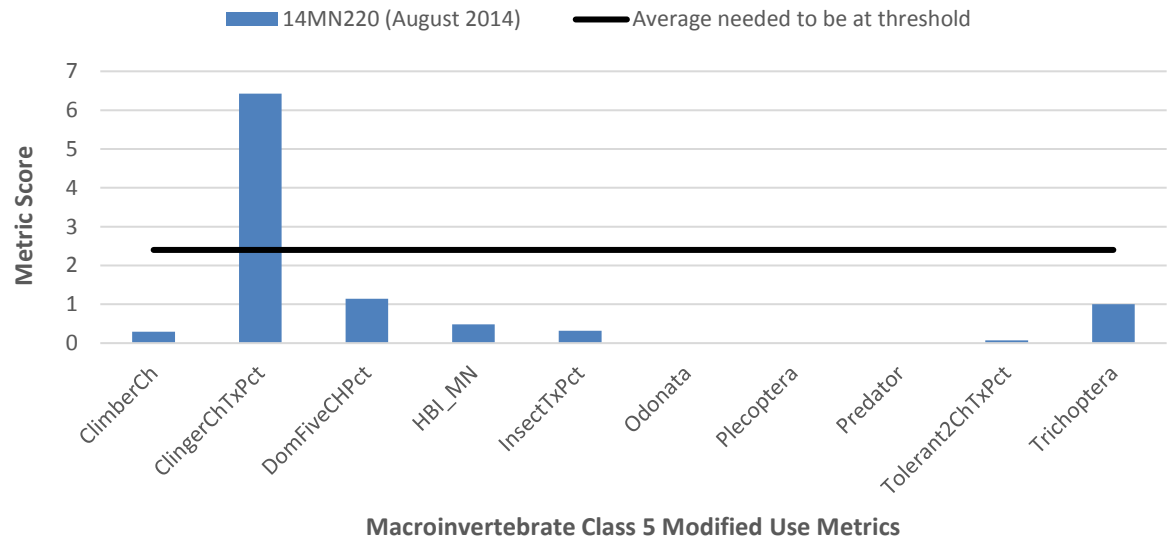
County Ditch 42 (-551) is a 6.02 mile long reach located in Sibley County. This reach constitutes the headwaters of County Ditch 42 and extends from County Road 10 down to T113 R29W S31, south line. The biological impairment along this reach is due to the macroinvertebrate assemblage. There are two biological monitoring stations, 01MN028 and 14MN220, located along this reach.

Biology

Macroinvertebrates

County Ditch 42 (-551) was sampled for macroinvertebrates at biological monitoring station, 14MN220, in August of 2014. The MIBI score during this visit was 9.7, which is well below the Macroinvertebrate Class 5 Southern Streams RR General Use threshold of 24. This site did have a large number of clinger taxa, which was the only MIBI metric that scored above the average needed to reach the MIBI threshold. The remaining nine metrics scored very poorly.

Figure 88. Biological metrics

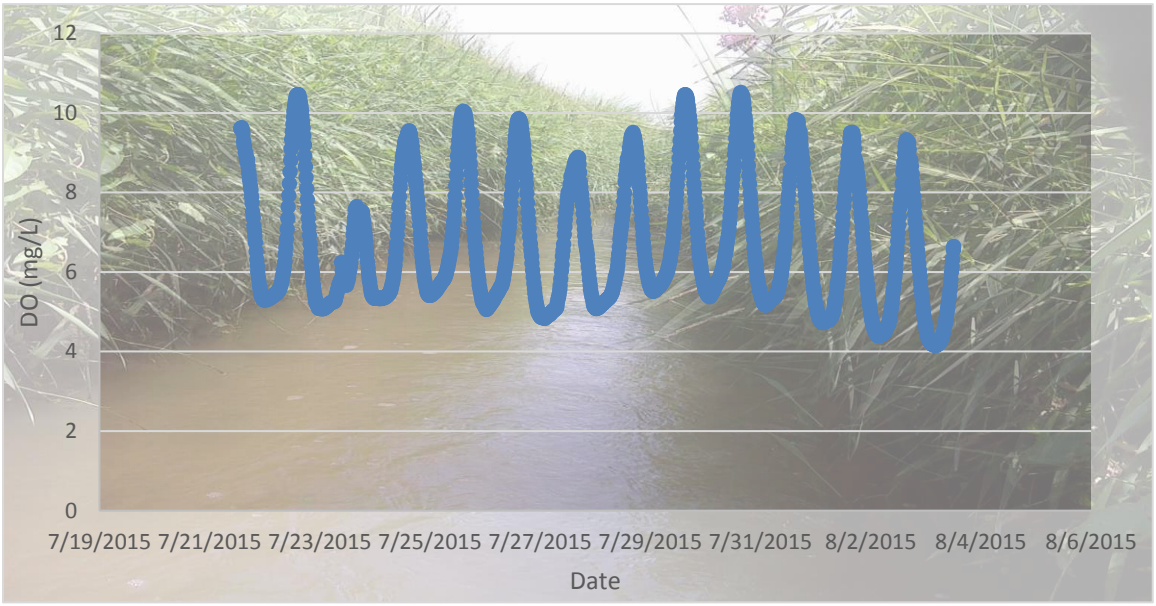


Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 6.79 mg/L to 12.2 mg/L without any recorded values below 5 mg/L. The lowest value was collected in August. Continuous DO data produced daily values below 5.5 mg/L at station 14MN055 with a low value of 4.17 mg/L (Figure 89).

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.6 mg/L with 22% of values below the water quality standard of 5 mg/L.

Figure 89. Continuous DO data



The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was five times the class average for sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised 80% of the fish community, dominated by fathead minnows.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Three macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 31.82% of the population (twice the class average). The last three days of continuous DO data collection were below 5 mg/L. There was a lack of individuals that reproduce at a mature age, a lack of serial spawning fish, and elevated low DO tolerant fish and macroinvertebrates indicating low DO is a stressor in County Ditch 42 (-551).

Table 152. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN220	0	58.54	5	31.82	8.18	3	6.69
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)				**18.23**	**7.57**	**4.51**	**6.75**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.098 to 0.243 mg/L. The highest value was collected during July at station 14MN220. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-4.4 mg/L with a mean of 0.6 mg/L.

Figure 90. Algal growth at station 14MN220 (July 21, 2016)

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Elevated DO flux is caused by increased algae (Figure 90) and macrophyte production, which in turn increases photosynthesis, respiration, and decomposition. BOD and chlorophyll-a data were not available. Continuous DO data produced daily flux values that were elevated to 4.98 mg/L at station 14MN220. The water quality standard for DO flux in the south region of the state is 5 mg/L. As a result of eutrophication, pH values also increase. pH values ranged from 7.75 to 8.43. Continuous pH data showed daily fluxes ranging from 0.14 to 0.51 at station 14MN220 with values ranging from 8.25 to 9.1 Typical daily pH fluctuations are 0.2-0.3 (Heiskary et al., 2013). Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox and Nagels 2001).

Sensitive individuals were not present at station 14MN220 while darter species were present at numbers greater than the class average of sites meeting the modified standard, the darter individuals were all johnny darters, which are more tolerant. The percentage of tolerant fish individuals was just above class average. Along with tolerant species, a positive relationship exists between eutrophication

and omnivorous fish. The omnivorous fish percentage was more than three times the class average for station. Individuals of EPT species were present at high levels, but were dominated by a caddisfly (Cheumatopsyche) which can be found in eutrophic conditions and Caenis can tolerate degraded conditions. The biological communities are showing the effects of the elevated phosphorus values, DO flux, pH values and flux, and algal growth. Eutrophic conditions are a stressor to the macroinvertebrate and fish communities in County Ditch 42 (-551).

Table 153. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN220	0	19.51	80.49	58.54	30	51.82	45.45
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	5.54	10.36	76.45	19.58			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)					33.60	36.82	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

County Ditch 42 (-551) had four nitrate samples taken from 2001-2016. These values ranged from 5.2-26 mg/L with an average value of 17.55 mg/L. Quantile regression analysis of Class 5 streams showed that when nitrate values exceeded 24.1 mg/L, the probability for a macroinvertebrate impairment was 90%. Additionally, if the value was 18.1 mg/L, the probability of a macroinvertebrate impairment was greater than 75%. Three of the collected nitrate samples exceeded 18.1 mg/L.

Drain tiles were also present in this reach. Drain tiles can be an easy pathway for nitrates to reach a stream system.

Table 154. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
01MN028	**7.89**	**59.68**	**0.32**	**3.32**
14MN220	**10.00**	**88.79**	**0.00**	**3.91**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*10.99*	*57.02*	*0.30*	*3.22*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

Biologically, the macroinvertebrate community scored below average in all of the nitrogen related metrics when compared to all other Class 5 Southern Streams RR stations that met the MIBI Modified Use Threshold. The high number of nitrogen tolerant taxa, very few nitrogen intolerant taxa, as well as few Trichoptera and a below average TIV score all indicate that the macroinvertebrate assemblage is being negatively impacted by the Nitrate concentrations.

Based on the very high nitrate values of the samples collected, the quantile regression analysis, as well as the poorly scoring nitrate related biological metrics, Nitrates are a stressor to the impaired macroinvertebrate community in County Ditch 42 (-551).

Candidate Cause: Sediment

From 2001-2016, a total of four TSS samples were taken along this reach. These sample values ranged from 4.8-92 mg/L with an average TSS concentration of 48.2 mg/L. One of the samples was above the 65 mg/L standard for TSS. Additionally, seven secchi tube readings were taken along this reach. These readings ranged from 26-60 cm, with an average value of 64.14 cm. No secchi tube measurements fell below the 10 cm standard.

The HSPF model also calculated daily TSS concentrations for this reach from 1996-2012. These values ranged from 3.5-514.1 mg/L with an average TSS concentration of 21.8 mg/L. The model predicted 564 (9.08%) instances in which the daily TSS concentration was above the 65 mg/L TSS standard.

Table 155. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
01MN028	**20.14**	**0.00**	**11.81**	**5.21**	**14.93**	**0.00**	**23.96**	**0.00**	**0.00**	**15.87**
14MN220	**9.76**	**0.00**	**0.00**	**9.76**	**0.00**	**0.00**	**2.89**	**0.00**	**0.00**	**19.58**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 42 scored below average in nine (01MN028) and ten (14MN220) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 155). Site 01MN028 did have a slightly above average number of herbivorous individuals, but scored poorly in the remaining metrics.

Table 156. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
01MN028	**15.98**	**0**	**14**	**40.97**	**5.52**	**0.00**
14MN220	**17.19**	**0**	**7**	**44.24**	**25.45**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*16.10*	*1.16*	*10.53*	*36.67*	*22.05*	*0.10*
Expected response to stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in four (14MN220) and five (01MN028) of the six evaluated metrics related to suspended sediment when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 156). Both sites lacked TSS intolerant and Plecoptera taxa, while also having a high amount of TSS tolerant individuals.

Based on the low observed TSS and secchi tube values, and the rather low standard exceedance rate predicted by the model, suspended sediment is not a stressor to aquatic life in County Ditch 42 (-551) at this time. It is likely that other stressors are negatively impacting the biotic communities resulting in lower metric scores.

Candidate Cause Habitat

County Ditch 42 (-551) had qualitative habitat assessment take place at its biological monitoring sites, 01MN028 and 14MN220, during the fish and macroinvertebrate sampling events in 2001 and 2014. The average MSHA score from these visits was 44.65 (Fair) at 01MN028 and 48.12 (Fair) at 14MN220. Limiting the habitat at these sites was the row crop and open pasture dominating the local land use, no riparian buffer, moderate to severe bank erosion (Figure 91), no stream shading, sand and clay substrates, and moderate channel stability. These sites did seem to have an ample amount of fish cover while in the stream. A breakdown of the MSHA category scores for this site can be seen in Figure 92.

Figure 91. Severe erosion at site 14MN220 (July 14, 2014)

Figure 92. Habitat metrics

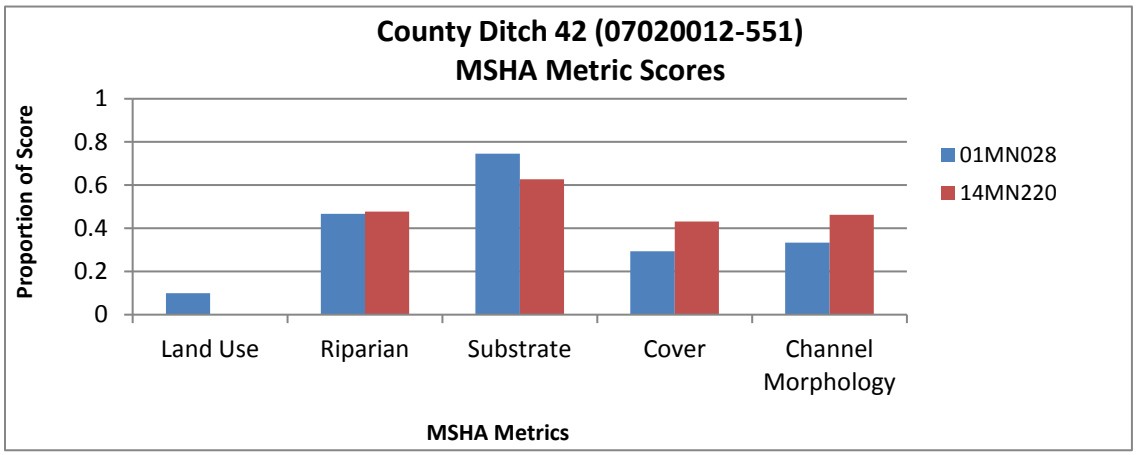


Table 157. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
01MN028	**5.21**	**23.96**	**5.21**	**14.93**	**0.00**	**40.28**	**82.64**	**23.26**
14MN220	**9.76**	**2.89**	**9.76**	**0.00**	**0.00**	**17.32**	**90.24**	**93.46**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 42 (-551) scored below average in all of the habitat related metrics at both sites (except PioneerPct at 01MN028), when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold. Two of the most commonly found species at both sites were fathead minnows and brook sticklebacks. These species are very tolerant to degraded habitat conditions and are often found in larger numbers where the habitat conditions are poor.

Table 158. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN028	**30.52**	**28.25**	**6.17**	**23.05**	**75.00**	**16.23**
14MN220	**3.64**	**23.03**	**33.03**	**51.82**	**43.33**	**30.61**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*6.43*	*19.88*	*38.44*	*27.84*	*44.43*	*18.90*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 42 (-551) scored below average in six (01MN028) and one (14MN220) of the eight evaluated habitat metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use threshold (TABLE). Site 01MN028 had much higher amounts of burrower and legless individuals, which corresponds to the fine substrates found at the site. This site also had much fewer EPT individuals, which is another indicator of habitat stress.

Based on the many below average habitat related metric scores at both sites (except macroinvertebrates at 14MN220), the fair MSHA scores, and the photographic evidence of a severely degraded system, habitat is a stressor to the impaired biological communities in this reach in County Ditch 42 (-551).

Candidate Cause Chloride/Ionic strength

No chloride values are available. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 623 to 1,039 µS/cm. Continuous data collected during July of 2016 had a range of values from 580 to 1,015 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the small dataset was greater than 1,000 µS/cm.

Table 159. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN220	30	2	29.39	29.39	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	36.82	*4.43*	*17.02*	*33.60*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was just below the class average, while the mayfly (Ephemeroptera) percentage was higher than the class average. The taxa count was slightly below the class average. The macroinvertebrate community was comprised of 75.45% conductivity tolerant individuals and no intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 66% of the fish community. There were some elevated specific conductance values present, but Ephemeroptera is the only lowered metric making ionic strength currently inconclusive as a stressor in County Ditch 42 (-551).

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 19% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 73.17% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 85.37% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 42 (-551).

Conclusions and recommendations

The impaired macroinvertebrate community in County Ditch 42 (-551) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity (Table 160). Chloride was inconclusive as a stressor at this time. Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 160. Stressors on County Ditch 42 (-551)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 42	07020012-551	●	●	●	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.5 County Ditch 49 (-677)

County Ditch 49 (-677) is located in western Sibley County. This 1.27 mile long channelized stream section connects an Unnamed ditch to County Ditch 22. This stream section is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN074, along this stream reach.

Biology

Fish

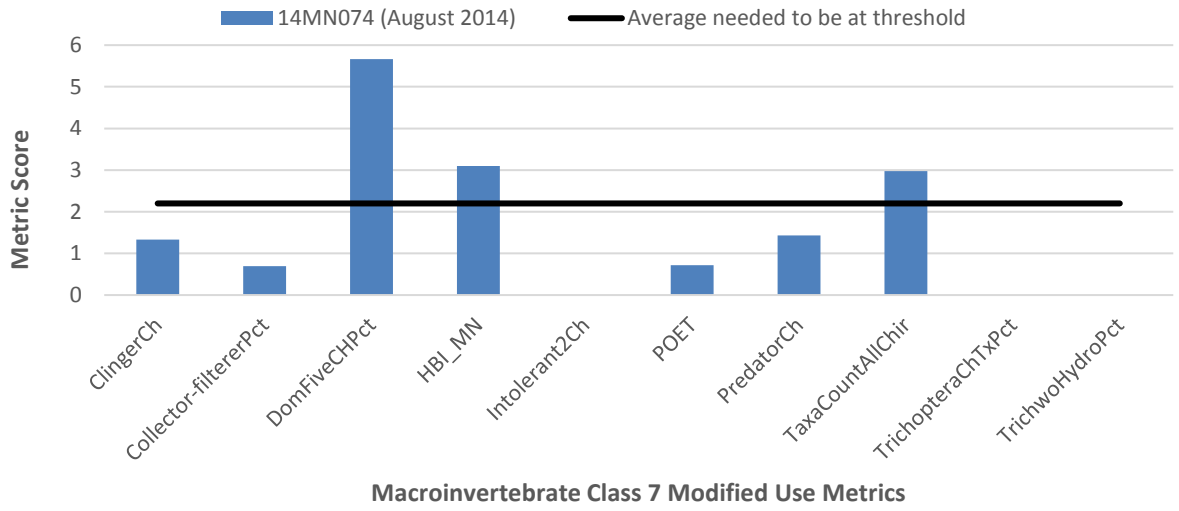
County Ditch 49 (-677) was sampled for fish at site 14MN074 in July of 2014. The FIBI score was 0 at this Fish Class 7 Low Gradient Modified Use stream station. This score is well below the class threshold of 15. This fish assemblage was comprised of three very tolerant species including Brook Sticklebacks, Fathead Minnows, and Creek Chubs.

Macroinvertebrates:

A macroinvertebrate sample was collected at 14MN074 in August of 2014. This site had a MIBI score of 15.9 which is below the macroinvertebrate Class 7 Prairie Streams GP Modified Use threshold of 22. This site scored above the average needed to reach the MIBI threshold for this class in just three of the ten

metrics that comprise the MIBI (DomFiveCHPct, HBI_MN, TaxaCountAllChir). The remaining seven metrics especially Intolerant2CH, TrichoperaCHTxPct, and TrichwoHydroPct scored especially poor. (Figure 93).

Figure 93. Biological metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016), all data were collected from station 14MN074. Concentrations ranged from 5.79 mg/L to 12.93 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.1 mg/L with 35% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was right at the class average for sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised over 97% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 52.12% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 5.79 mg/L. Based on the preponderance of evidence of a lack of individuals that reproduce at a mature age, the number of fish taxa which were all very tolerant to low DO, and low DO tolerant macroinvertebrates indicate low DO is a stressor. More DO samples would be helpful to better characterize the DO regime in County Ditch 49 (-677).

Table 161. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN074	0	27.16	3	52.12	7.92	0	5.54
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**4.38**	**28.58**	**11.74**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.058 to 0.324 mg/L. The highest value was collected in August at station 14MN074. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-2.9 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, BOD, DO flux, and chlorophyll-a data were not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Typical daily pH fluctuations in streams are 0.2-0.3 (Heiskary et al., 2013). pH values ranged from 7.65 to 8.28. Continuous pH data showed daily values all below 7.9 with daily pH fluctuations at station 14MN074 ranging from 0.15 to 0.35.

Figure 94. Algal growth at site 14MN074 (September 30, 2013 on left, July 21, 2016 on right)

Sensitive and darter individuals were not present at station 14MN074. The entire fish sample was tolerant due to all individuals sampled being one of three tolerant fish (brook stickleback, creek chub, and fathead minnow). Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was above the class average for stations meeting

the modified standard. Individuals of EPT species were present at very low levels. EPT require healthy oxygen levels. The biological communities are showing the effects of the elevated phosphorus values. Eutrophic conditions are a stressor to the macroinvertebrate and fish communities in County Ditch 49 (-677).

Table 162. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN074	0	0	100	27.16	29	4.56	40.72
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**16.71**	**6.74**	**55.88**	**16.77**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

County Ditch 49 (-677) had three nitrate samples taken from 2014-2016. These nitrate concentrations ranged from 5.6-23 mg/L with an average value of 13.53 mg/L. A quantile regression analysis of Class 7 macroinvertebrate sites showed that when nitrate concentrations exceeded 11.5 mg/L, there was a 90% probability that the stream would be impaired. County Ditch 49 (-677) exceeded this level twice with samples of 12 mg/L and 23 mg/L.

Drain tiles were also present in this reach and are an easy pathway for nitrates to enter a stream system.

Table 163. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN074	**0.00**	**56.03**	**0.00**	**3.72**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 49 (-677) scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 163). Site 14MN074 completely lacked any nitrate intolerant and Trichoptera taxa, while also having a poor Nitrogen TIV score. These results are common in streams being negatively impacted by nitrate concentrations.

Based on the high observed values, the quantile regression analysis, as well as the majority of the nitrate related metrics in the macroinvertebrate community being below average, nitrates are a stressor to aquatic life in County Ditch 49 (-677) at this time.

Candidate Cause Sediment

From 2014-2016, a total of three TSS samples were taken from County Ditch 49 (-677). These values ranged from 7.6-23 mg/L with an average TSS concentration of 16.87 mg/L. Two secchi tube readings were also taken in 2014. These values were 37 cm on August 18, 2014 and 63 cm on July 15, 2014.

Additionally, the HSPF model calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 3.5-337.9 mg/L with an average TSS concentration of 25.8 mg/L. Of these calculations, 717 (11.55%) were above the 65 mg/L standard.

Table 164. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN074	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**16.95**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 49 (-677) scored below average in all 10 of the suspended sediment related metrics at site 14MN074 when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 164). Only three different species were sampled at this site, Brook Stickleback, Creek Chub, and Fathead Minnow, and all are considered to be very tolerant species.

Table 165. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN074	**14.33**	**0**	**6**	**16.61**	**2.93**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 49 (-677) scored below average in three of the six suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold. The site completely lacked TSS intolerant and Plecoptera taxa, while also having a low amount of collector-filterer individuals. This community did have a good TSS index score, and a low amount of both TSS tolerant taxa and TSS tolerant individuals.

Based on the observed chemical data, as well as some of the good scoring macroinvertebrate metrics including TSS index score, and the low presence of TSS tolerant taxa/individuals, suspended sediment is not a stressor to aquatic life in this reach. The numerous other stressors found in this reach are likely driving the aquatic life impairment in County Ditch 49 (-677).

Candidate Cause Habitat

County Ditch 49 (-677) had a qualitative habitat assessment take place at biological monitoring site, 14MN074, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 34.75 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, a narrow to moderate riparian buffer, light stream shading, sand and silt substrates, a complete lack of course substrates, moderate channel stability, poor sinuosity (Figure 95), and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 96.

Figure 95. Site 14MN074 (July 15, 2014)

Figure 96. Habitat metrics

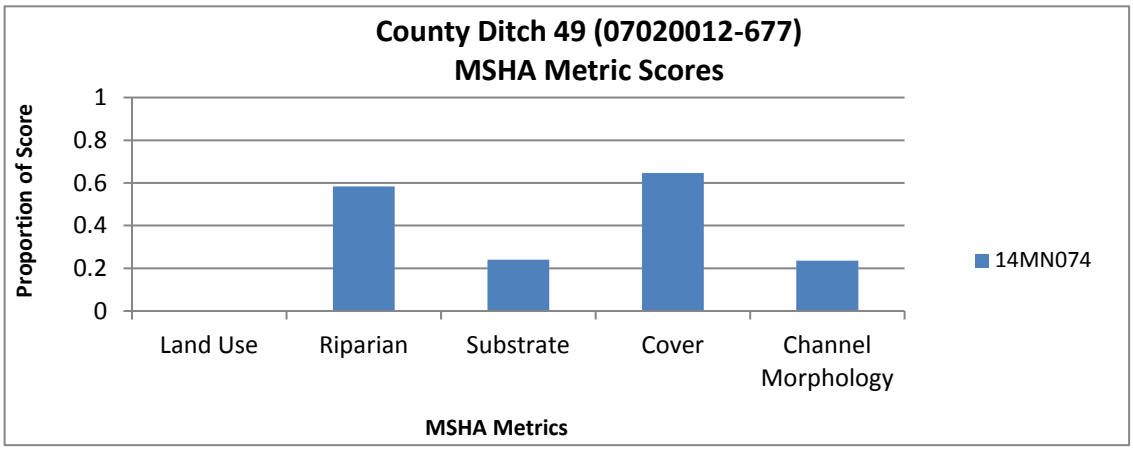


Table 166. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN074	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.47**	**100.00**	**29.63**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 49 (-677) at site 14MN074 scored below average in all eight habitat related metrics when compared to all other Class 7 Low Gradient sites that meet the FIBI Modified Use Threshold (Table 166). The fish community was comprised of only three species: brook sticklebacks, creek chubs, and fathead minnows. All of these species very tolerant of degraded habitat conditions.

Table 167. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN074	**33.88**	**13.36**	**7.49**	**4.56**	**59.61**	**40.07**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

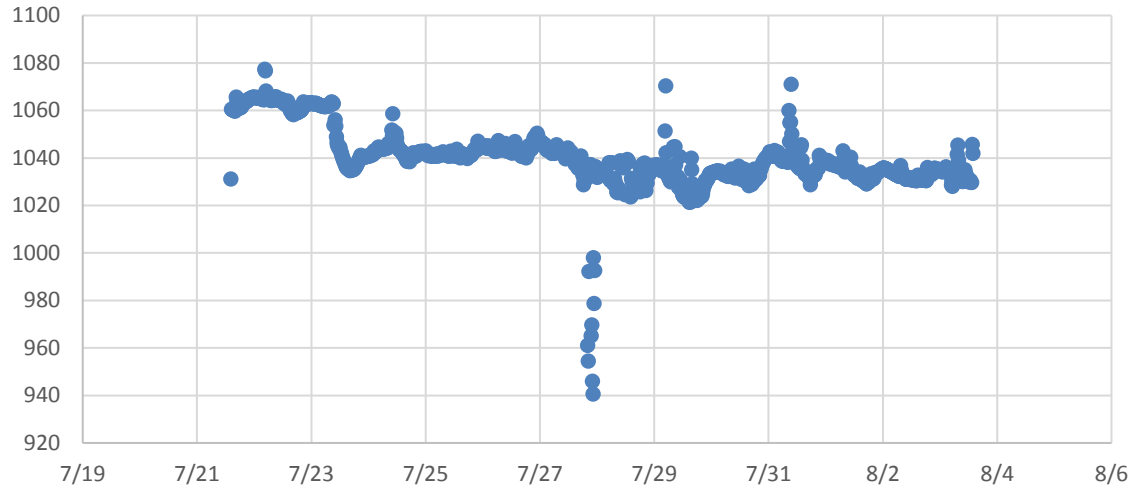
The macroinvertebrate assemblage at site 14MN074 scored below average in six of the seven habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 167). The high amount of burrower and legless individuals often signal the presence of many fine sediments, which are common in degraded streams. This stream also had a very low amount of EPT individuals, which is another sign of a stressed community.

Based on the poor scoring fish and macroinvertebrate habitat related metrics, the poor MSHA score, as well as the photographic evidence of poor habitat at the sampling site, the lake of habitat is a stressor to the impaired biological communities in County Ditch 49 (-677).

Candidate Cause Chloride/Ionic strength

No chloride values are available. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 1,029 to 1,078 µS/cm. Continuous data collected during July of 2016 had a range of values from 866 to 1,015 µS/cm. Continuous data collected in July of 2016 produced daily values over 1,000 µS/cm (Figure 97). A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Two values in the small dataset was greater than 1,000 µS/cm.

Figure 97. Continuous specific conductance data



Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was far below the class average, while the mayfly (Ephemeroptera) percentage and taxa counts were both slightly lower than the class average. The macroinvertebrate community was comprised of 49.84% conductivity tolerant individuals and no intolerant individuals.

Table 168. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN074	29	2	4.56	4.56	0
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)					***4.38***
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 98% of the fish community. Based on the daily elevated specific conductance values present, the lowered EPT%, and the prevalence of conductivity tolerant fish and macroinvertebrates, ionic strength is a stressor in County Ditch 49 (-677).

Candidate Cause: Altered Hydrology/Connectivity

The reach and the upstream watershed is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 52% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 29.63% of the population. The numbers of nest guarder species are also positively correlated with increased low flows.

The nest guarder species had a population comprising of 97.53% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 6.8% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 49 (-677).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 49 (-677) are being stressed by Dissolved Oyxgen, Eutrophication, Nitrates, Habitat, Flow Alteration/Connectivity, and Chloride (Table 169). Suspended Sediment was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 169. Stressors on County Ditch 49 (-677)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 49	07020012-677	●	●	●	---	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.6 County Ditch 44 (-786)

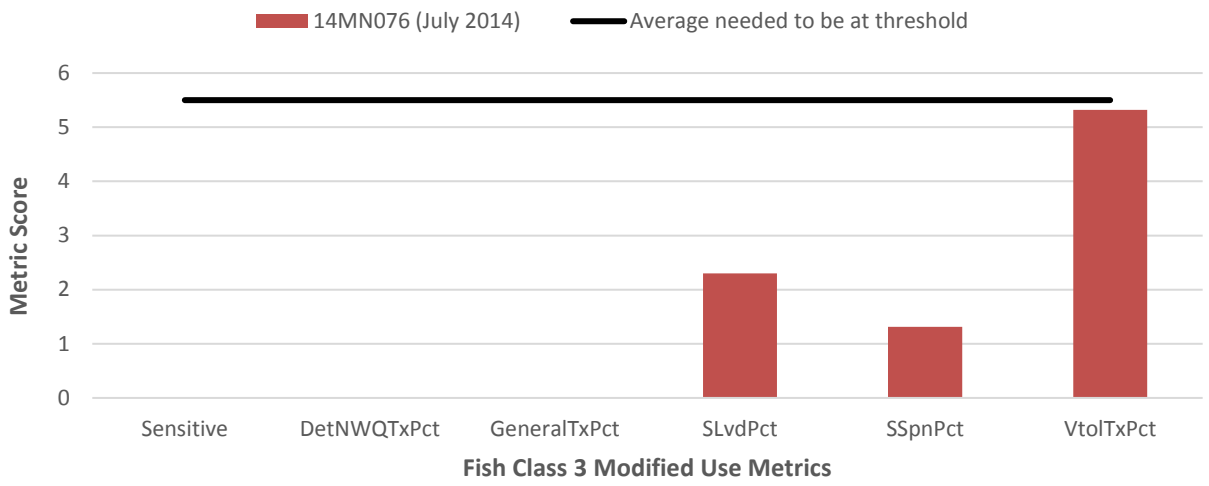
County Ditch 44 (-786) is a 5.74 mile modified reach that flows into the Middle Branch Rush River. Located in Sibley County, the reach is impaired for both fish and macroinvertebrates. There is one biological station, 14MN076, located on this reach.

Biology

Fish

County Ditch 44 (-786) was sampled for fish in July of 2014 at biological monitoring station 14MN076. This site had an FIBI score of 8.9, which is far below the Fish Class 3 Southern Headwaters Modified Use threshold of 33. The fish community in this site scored below average or poorly in all six of the metrics comprising the Class 3 FIBI. The assemblage was dominated by primarily tolerant fish taxa including Fathead Minnows, Brook Sticklebacks, Creek Chubs, White Suckers, and Bluntnose Minnows.

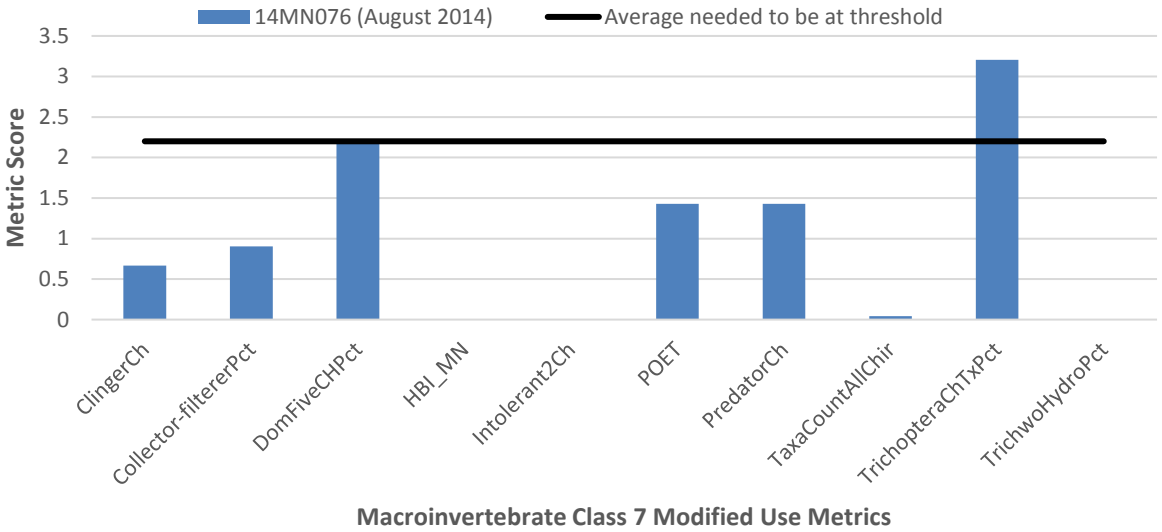
Figure 98. Fish metric scores



Macroinvertebrates

The macroinvertebrate community in County Ditch 44 (-786) was sampled in August of 2014 at site 14MN076. This site had a MIBI score of 9.9, which is low when compared to the Macroinvertebrate Class 7 Prairie Streams GP Modified Use threshold of 22. The site scored at or above the average needed to reach the threshold in just two of the metrics (DomFiveCHPct, TrichopteraChTxPct) in this class MIBI. The remaining eight metrics comprising the MIBI scored below average or very poorly. (Figure 99)

Figure 99. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016), all data was collected from station 14MN076. Concentrations ranged from 6.62 mg/L to 11.25 mg/L with no recorded values below the water quality standard of 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.6 mg/L with 22% of values below the water quality standard of 5 mg/L.

Table 170. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN076	0	70.86	5	34.04	8.88	0	6.19
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was six times the class average for sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised over 85% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 34.04% of the population, just above the class average. All DO values in the small dataset were above 5 mg/L with a low value of 6.62 mg/L. Based on the preponderance of evidence of a lack of individuals that reproduce at a mature age, the number of fish taxa very tolerant to low DO, and low DO tolerant macroinvertebrates indicate low DO is a stressor in County Ditch 44 (-786). More DO samples would be helpful to better characterize the DO regime on this stream.

4.15.10 Candidate Cause Eutrophication

Only one phosphorus value is available on this stream, 0.152 mg/L. The value was collected in July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-2.2 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 8.14 to 8.24. Algae growth was seen at station 14MN076 (Figure 100).

Figure 100. Algal growth at site 14MN076 (September 9, 2016)

Sensitive and darter individuals were not present at station 14MN076. The entire fish sample was tolerant. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was above the class average for stations meeting the modified standard. Individuals of EPT species were present at very low levels. EPT require healthy oxygen levels. Macroinvertebrate taxa was low and the community was dominated by two species, but other stressors can also effect these factors. The biological communities are showing the effects of eutrophic conditions. Eutrophication is a stressor to the macroinvertebrate and fish communities in County Ditch 44 (-786).

Table 171. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN076	0	0	100	72.57	19	4.78	49.47
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

There were two nitrate samples taken from 2014-2016 at County Ditch 44 (-786). These samples were 18 mg/L on July 29, 2014 and 25 mg/L onSeptember 9, 2016. Both of these values are very high. Quantile regression analysis of macroinvertebrate Class 7 streams showed that when nitrate values exceeded 11.5 mg/L, the probability for a macroinvertebrate impairment was 90%. The average nitrate value along this reach was 21.5 mg/L.

Table 172. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN076	**5.26**	**89.89**	**0.00**	**6.70**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN076 scored below average in all of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI modified use threshold. (Table 172). The TIV value for this site was very high as were the number of nitrate tolerant individuals in this reach.

Based on the chemical data collected, the quantile regression analysis, as well as the nitrate related biological metrics, elevated nitrates are a stressor to the biological communities in County Ditch 55 (-786).

Candidate Cause Sediment

One TSS sample was taken from County Ditch 44 (-786) in 2014. This value was 69 mg/L and was collected on July 29, 2014. This value is above the 65 mg/L standard for TSS. Additionally, two secchi tube measurements were taken along this reach. These values were 18 cm on July 29, 2014 and 7 cm on August 18, 2014 with one value being below the 10 cm minimum standard for secchi tube measurements.

Also, the HSPF model calculated daily TSS values for this subwatershed from 1996-2012. These values ranged from 3.0-383.1 mg/L with an average value of 21.5 mg/L. Of these calculations, 221 (3.56%) were above the 65 mg/L standard for TSS.

Table 173. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN076	**2.29**	**0.00**	**0.00**	**0.00**	**2.29**	**0.00**	**2.29**	**0.00**	**0.00**	**21.33**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 44 (-786) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 173). The site, 14MN076, lacked many species sensitive to high levels of suspended sediment and had a very poor TSS index score.

Table 174. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plectoptera Pct
14MN076	**22.95**	**0**	**8**	**78.19**	**3.72**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN076 scored below average in five of the six suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 174). This reach did have a lower amount of TSS tolerant taxa; however, this reach also had a high percentage of TSS tolerant individuals, a poor TSS index score, low amounts of collector-filterer individuals, as well as a complete lack of TSS intolerant and Plecoptera taxa. These results often signal a stream being negatively impacted by elevated levels of TSS.

The observed data set in this reach is very minimal, however the one TSS sample collected exceeded the standard and a secchi tube measurement taken on a different day fell below the minimum standard set for transparency. The HSPF model calculated a relatively low amount of exceedances, however the fish and macroinvertebrate metrics related to suspended sediment scored very poorly. Therefore, suspended sediment is a stressor to aquatic life in County Ditch 44 (-786) at this time.

Candidate Cause: Habitat

County Ditch 44 (-786) had a qualitative habitat assessment take place at biological monitoring site, 14MN076, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 29 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, a narrow to very narrow riparian buffer, light stream shading, a predominant silt substrate, completely lacking course substrates, little depth variability, poor sinuosity (Figure 101), and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 102.

Figure 101. Site 14MN076 (July 29, 2014)

Figure 102. Habitat metrics

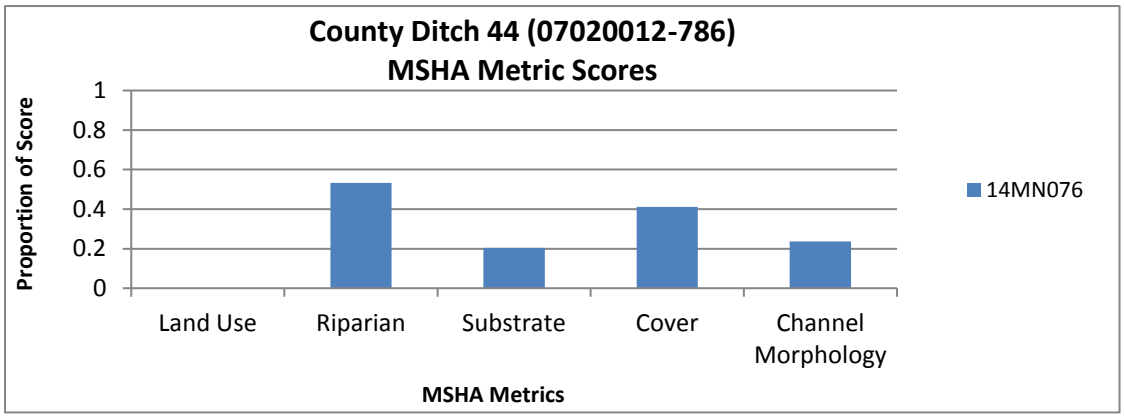


Table 175. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN076	**0.00**	**2.29**	**0.00**	**2.29**	**0.00**	**14.86**	**100.00**	**83.43**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN076 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 175). The fish assemblage was comprised of only five different species, Brook Stickleback, Fathead Minnow, Creek Chub, White Sucker and Bluntnose Minnow, all of which are tolerant to degraded habitat conditions.

Table 176. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN076	**6.91**	**52.13**	**1.60**	**4.79**	**62.77**	**35.64**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold. The site did have above average amounts of both sprawler and climber species, which tends to be a good sign. However, the community had a large amount of legless individuals, while having few EPT and clinger species. These results often signal habitat stress.

Based on the very poor scoring fish habitat related metrics, the poor MSHA score, the photographic evidence, as well as many below average macroinvertebrate metric scores, habitat is a stressor to the impaired biological communities in County Ditch 44 (-786).

Candidate Cause Chloride/Ionic strength

No chloride values are available. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 680 to 992 µS/cm. A study of Minnesota biological data and stressor linkages found sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Table 177. Metrics related to ionic strength

Station	**TaxaCountAllChir**	**EphemeropteraCh**	**EphemeropteraPct**	**EPTPct**	**Cent-TolPct**
14MN076	19	2	4.26	4.78	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					***1***
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT, mayfly (Ephemeroptera), and taxa count were all below the class averages. The macroinvertebrate community was comprised of 86.17% conductivity tolerant individuals and no intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 85.14% of the fish community. There were no elevated specific conductance values present in the small dataset, but some of the biology is indicative of stress, making ionic strength currently inconclusive as a stressor in County Ditch 44 (-786).

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% modified according to the MPCA altered watercourse layer. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 25% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow. The ditch went dry in September 2013 (Figure103).

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 85.71% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The stream went dry in September 2013, which affects connectivity.

Figure 103. Site 14MN076 went dry during the fall of 2013 (September 24, 2013)

The nest guarder species had a population comprising of 85.14% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 27.13% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 44 (-786) are being stressed by Dissolved Oyxgen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 178) Chloride is inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 178. Stresors on County Ditch 44 (-786)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 44	07020012-786	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

7.7 County Ditch 50 (-796)

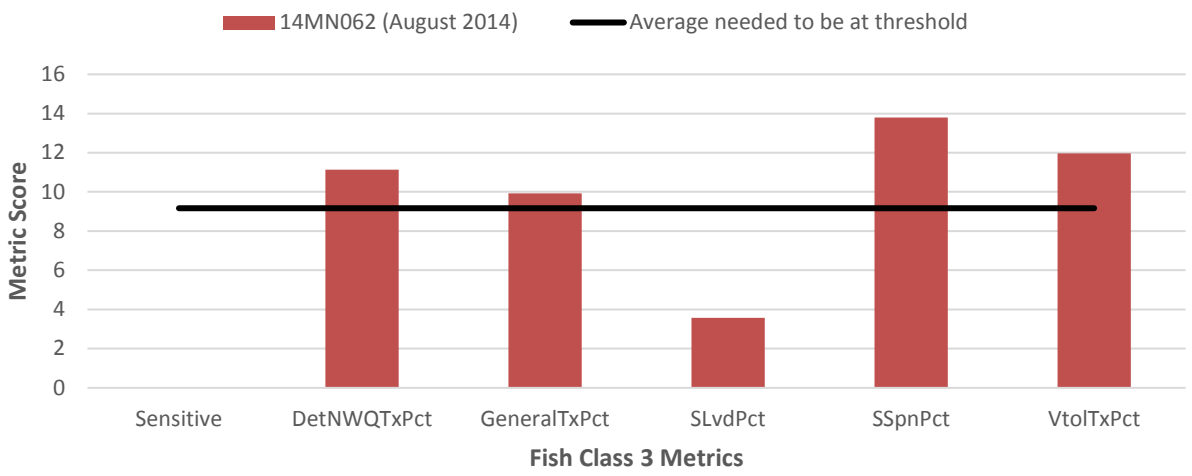
County Ditch 50 (-796) is a 1.62 mile long reach located in southeastern Sibley county. This reach extends from County Road 62 to the confluence with Rush River. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN062, located along this reach.

Biology

Fish:

County Ditch 50 (-796) was sampled for fish at biological monitoring station 14MN062 in August of 2014. The FIBI score during this visit was 50.4, which is slightly below the Fish Class 3 Southern Headwaters General Use threshold of 55. This site scored above the average needed to reach the threshold in four of the six FIBI metrics. However, the site lacked sensitive taxa and had a higher amount of short-lived individuals, which limited the FIBI score along this reach (Figure 104).

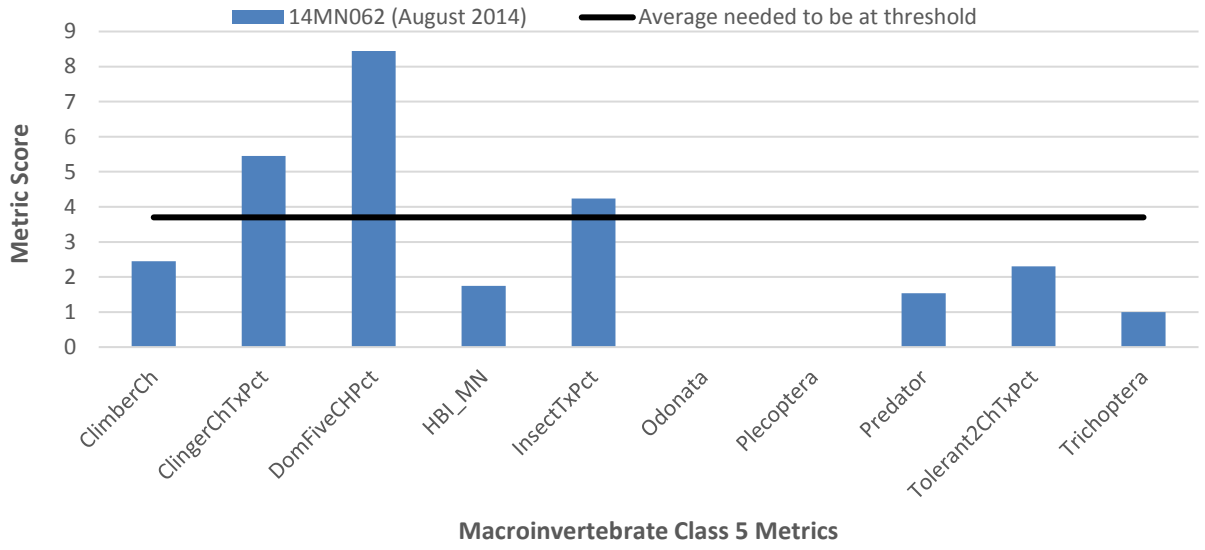
Figure 104. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 14MN062. This sample had an MIBI score of 27.2 which is below the macroinvertebrate Class 5 Southern Streams RR General Use threshold of 37. This site scored above the average needed to reach the threshold in three of the ten metrics, while scoring poorly in the remaining seven metrics. The lack of Odonata and Plecoptera taxa especially lowered the MIBI score (Figure 105).

Figure 105. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016), all data were collected from station 14MN062. Concentrations ranged from 7.03 mg/L to 8.32 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.4 mg/L with 41% of values below the water quality standard of 5 mg/L.

Table 179. DO Relevant Metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN062	0	13.41	6	15.43	7.75	3	6.65
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**15.09**	**25.34**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was below the class average for sites meeting the general standard. Species that are very tolerant to low DO conditions comprised 19.5% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Three macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 15.43% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 7.03 mg/L. While there was a lack of individuals that reproduce at a mature age, the low number of DO tolerant fish and macroinvertebrates, and low number of serial spawner individual DO is not a stressor to the biological communities in County Ditch 50 (-796).

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream in recent years, ranging from 0.150 to 0.497 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-3.6 mg/L with a mean of 0.4 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data are available. As a result of eutrophication, pH values also increase. pH values ranged from 7.66 to 7.72.

Sensitive individuals were not present at station 14MN062 while darter species were present at numbers greater than the class average of sites meeting the general standard, the darter individuals were all johnny darters which are more tolerant. Tolerant individuals composed more than 80% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was just below the class average. Individuals of EPT species were present at levels below the class average and the two most common macroinvertebrate species sampled comprised only about a quarter of the population. While there was a lack of sensitive individuals and an increase in tolerant individuals these could be due to other stressors. The small

dataset included elevated phosphorus values but there is not a consistent biological response. Eutrophication is inconclusive as a stressor on County Ditch 50 (-796).

Table 180. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN062	0	16.20	83.80	13.41	41	23.79	25.40
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.55**	**12.08**	**70.64**	**14.62**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

County Ditch 50 (-796) had two nitrate samples taken from 2014-2016. These values were 8.2 mg/L on August 5, 2014 and 18 mg/L onAugust 18, 2016. Quantile regression analysis of macroinvertebrate Class 5 streams showed that sites with nitrate values at 18.1 mg/L or higher had a greater than 75% chance of being impaired. Site 14MN062 had a measurement just under this reading from an August visit. Often, higher nitrate values are observed May-July.

Table 181. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN062	**7.32**	**55.31**	**0.96**	**3.79**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 50 (-796) scored at or below average in all of the nitrate related metrics when compared to all other Class 5 Southern Streams RR station that did meet the MIBI General Use Threshold. (Table 181)

Based on the elevated nitrate concentrations observed, the quantile regression analysis, in additions to the below average nitrate related macroinvertebrate metrics, nitrates are a stressor to aquatic life in County Ditch 50 (-796) at this time.

Candidate Cause Sediment

From 2014-2016, a total of two TSS samples were taken along County Ditch 50 (-796). These samples were 7 mg/L on August 5, 2014 and 3.2 mg/L onAugust 18, 2016. Additionally, two secchi tube readings were taken along this reach. These values were 92 cm on August 11, 2014 and 42 cm on August 5, 2014.

The HSPF model also calculated daily TSS concentrations for this reach from 1996-2012. These values ranged from 1.5-563.6 mg/L with an average TSS concentration of 41.3 mg/L. Of these calculations, 1461 (23.53%) were above the 65 mg/L standard for TSS. This is a very high rate of exceedance.

Table 182. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN062	**20.11**	**0.00**	**3.91**	**16.20**	**3.91**	**0.00**	**58.10**	**0.00**	**0.00**	**13.20**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 50 (-796) at site 14MN062 scored below average in seven of the 10 suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 182). This reach had an above average amount of Perciformid (perch-like) and simple lithophilic individuals, while also having a good TSS index score. However, the site scored poorly in the remaining metrics.

Table 183. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN062	**18.57**	**0**	**14**	**45.02**	**10.61**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in all six of the suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 183). These poor scores are often a sign of stress.

While there were very few observed TSS and secchi tube measurements, no exceedances of the standards occurred. However, the vast majority of the fish and macroinvertebrate metrics related to suspended sediment scored poorly, especially the macroinvertebrate community. Also, the HSPF model predicted a very high rate of exceedance of TSS concentrations. The small data set of observed data does not seem to reflect the true conditions in this reach. Therefore, suspended sediment is a stressor to aquatic life in County Ditch 50 (-796).

Candidate Cause Habitat

County Ditch 50 (-796) had a qualitative habitat assessment take place at its biological monitoring site, 14MN062, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 50.25 (Fair). Limiting the habitat at this site was the row crop agriculture as the primary land use, no riparian buffer, heavy bank erosion, a moderate amount of silt as a substrate (Figure 106), nearly absent fish cover, and moderate channel stability. Further MSHA analysis can be seen in Figure 107.

Figure 106. Bank erosion (right) and fine substrates (left) at station 14MN062

Figure 107. habitat scores

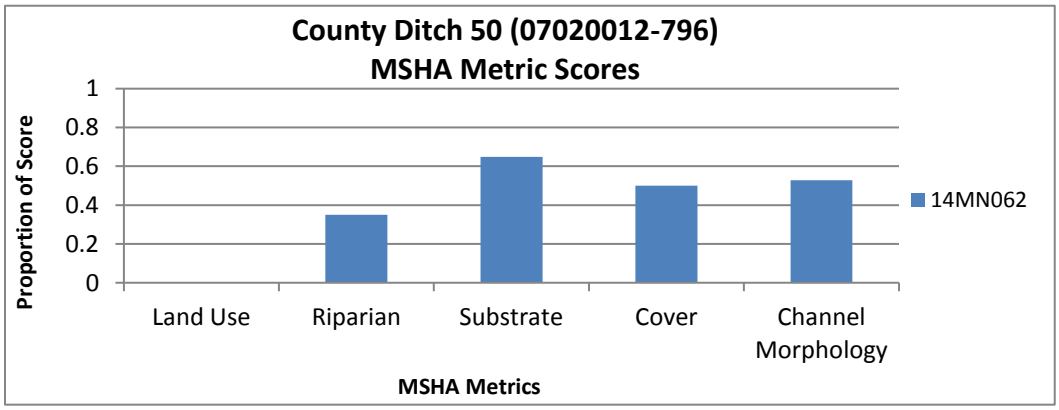


Table 184. Habitat related fish metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN062	**9.00**	**13.83**	**40.51**	**23.79**	**49.84**	**14.47**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 50 (-796) scored below average in four of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that do meet the FIBI General Use Threshold (Table 184). The fish community was comprised of a lot of blacknose dace (104) and fathead minnows (24). These two species are tolerant of degraded habitat conditions and can signal stress in higher numbers. The site also showed a good amount of johnny darter individuals (29), which are less tolerant to poor habitat conditions.

Table 185. Habitat related macroinvertebrate metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN062	**16.20**	**58.10**	**16.20**	**3.91**	**0.00**	**64.25**	**83.80**	**31.84**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN062 scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 185). The higher amounts of burrower and legless individuals, as well as the low amounts of EPT taxa may correlate with the high presence of a silt substrate commonly found in streams with sediment issues and degraded habitat.

Based on many of the habitat related metrics for both the fish and macroinvertebrate communities, the fair MSHA score, and the photographic evidence of a stream channel covered in fine sediment, the habitat conditions in County Ditch 50 (-796) are a stressor to the impaired biological communities at this time.

Table 186. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN062	41	6	19.94	23.79	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					***0.89***
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause Chloride/Ionic strength

No chloride values are available. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 789 to 1,002 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the small dataset was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both below class average, but the taxa count was right at the class averages. The macroinvertebrate community was comprised of 53.38% conductivity tolerant individuals and one intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 23.46% of the fish community. There was one elevated specific conductance value in the small dataset, and while the EPT percentage was lowered the other metrics were close to class averages. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 50 (-796).

Candidate Cause: Altered Hydrology/Connectivity

The reach is 100% natural according to the MPCA altered watercourse layer, but the entire upstream watershed is channelized. Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods (Figure 108), both of which affect biological communities. Increased peak flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat.

Figure 108. The stream was dry during September 2013 (September 24, 2013)

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 52% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow. The stream went dry in September 2013 which affects connectivity.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 73.74% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 35.75% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 50 (-796).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 50 (-796) are being stressed by Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. (Table 187) Eutrophication and Chloride are inconclusive as stressors at this time. Dissolved Oxygen was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Middle Branch Rush River HUC 10 watershed, please see page 204.

Table 187. Stressors on County Ditch 50 (-796)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 50	07020012-796	---	o	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Middle Branch Rush River HUC 10 Conclusion and Recommendations

The Middle Branch Rush River subwatershed has seven biological impaired streams that are being negatively impacted by a multitude of stressors throughout the watershed. Stressors found in at least four of the seven impaired reaches include Dissolved Oxygen, Nitrate, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. Additional monitoring for Phosphorus (Eutrophication) and Chloride is needed to better determine the extent and impact of those stressors.

The predominant land use in this subwatershed especially the headwaters is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities. Much of the Dissolved Oxygen, Eutrophication, and Flow Alteration/Connectivity issues occurred in the headwaters, while habitat and nitrates were problems throughout.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

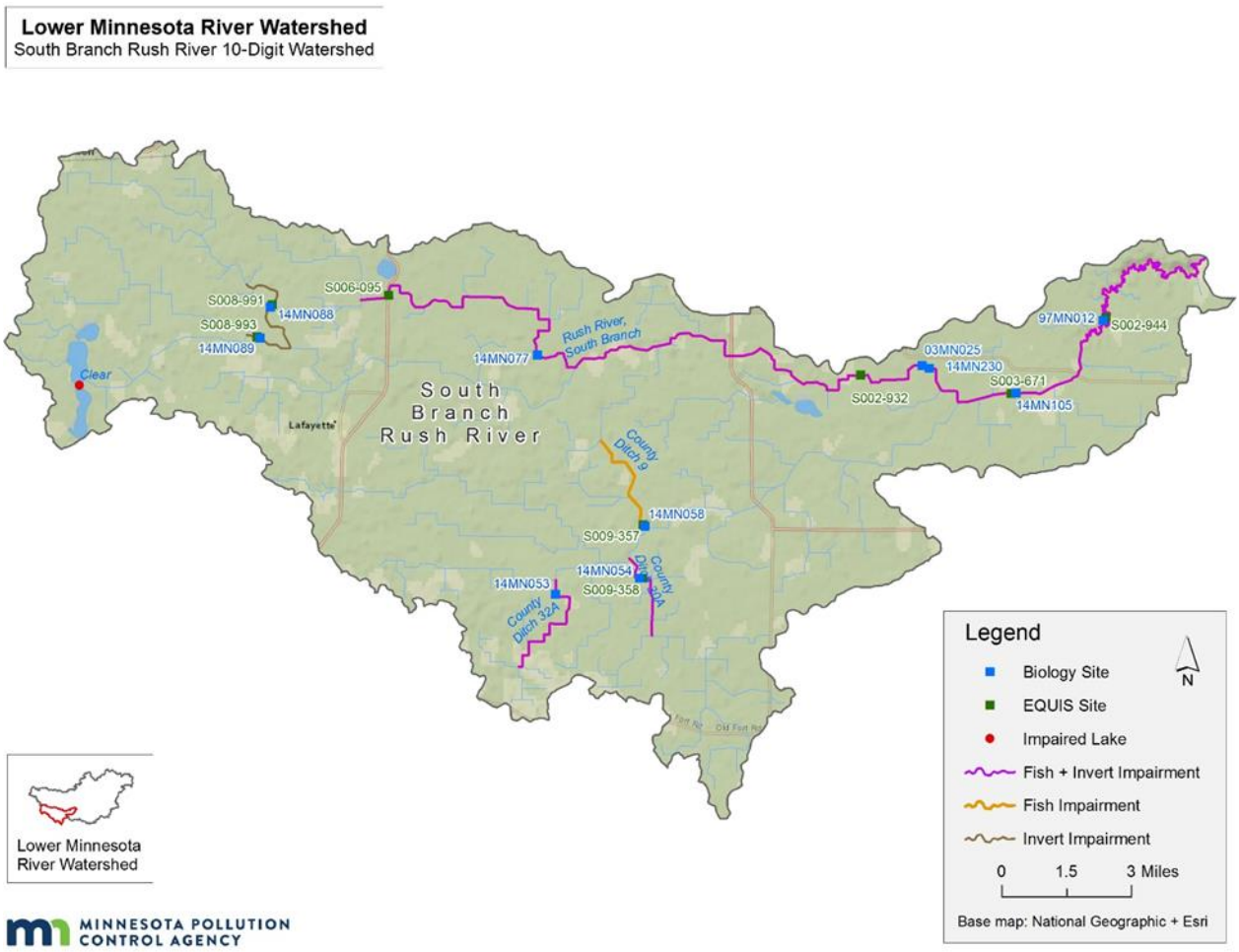
A large effort is needed in the Middle Branch Rush River watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing Best Management Practices (BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting dissolved oxygen issues as well.

Table 188. Stressors in the Middle Branch Rush River HUC

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Rush River	07020012-521	---	o	●	●	●	---	---
Rush River	07020012-548	●	o	●	●	●	---	o
Rush River, Middle Branch (County Ditch 23 and 24)	07020012-586	---	o	●	---	●	●	---
County Ditch 42	07020012-551	●	●	●	---	●	●	o
County Ditch 49	07020012-677	●	●	●	---	●	●	●
County Ditch 44	07020012-786	●	●	●	●	●	●	o
County Ditch 50	07020012-796	---	o	●	●	●	●	o

8. South Branch Rush River HUC 10 (0702001203)

Figure 109. Sampling sites in the South Branch Rush River HUC



8.1 South Branch Rush River (-825)

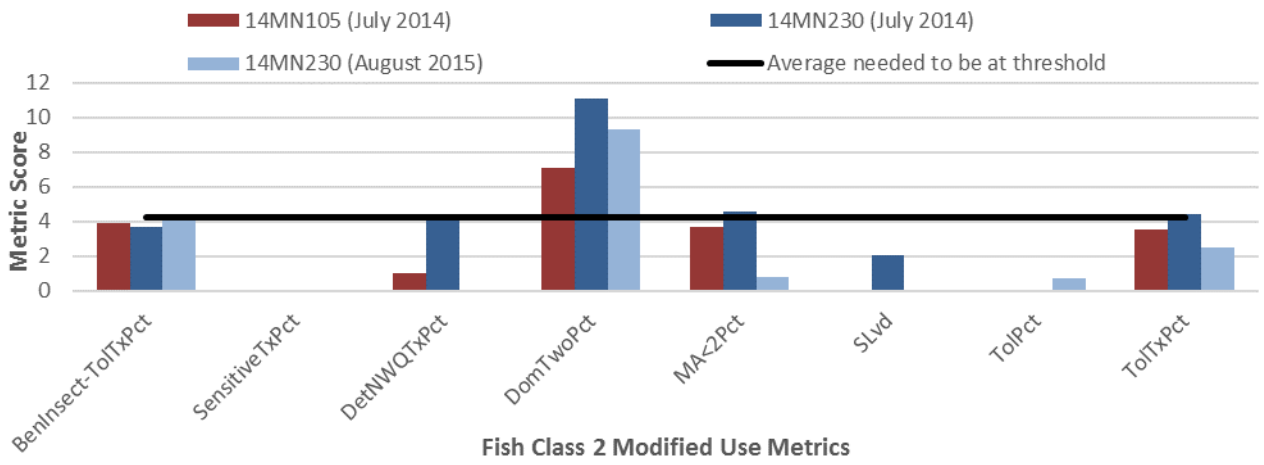
County Ditch 40 Branch A/South Branch Rush River (-825) is a 23.14 mile long modified stream reach that is located in southern Sibley county. This stream reach runs from an unnamed ditch and extends to the unmodified reach of the South Branch Rush River near CSAH 17. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There are three biological monitoring stations, 14MN077, 14MN105, 14MN230 located along this stream reach.

Biology

Fish

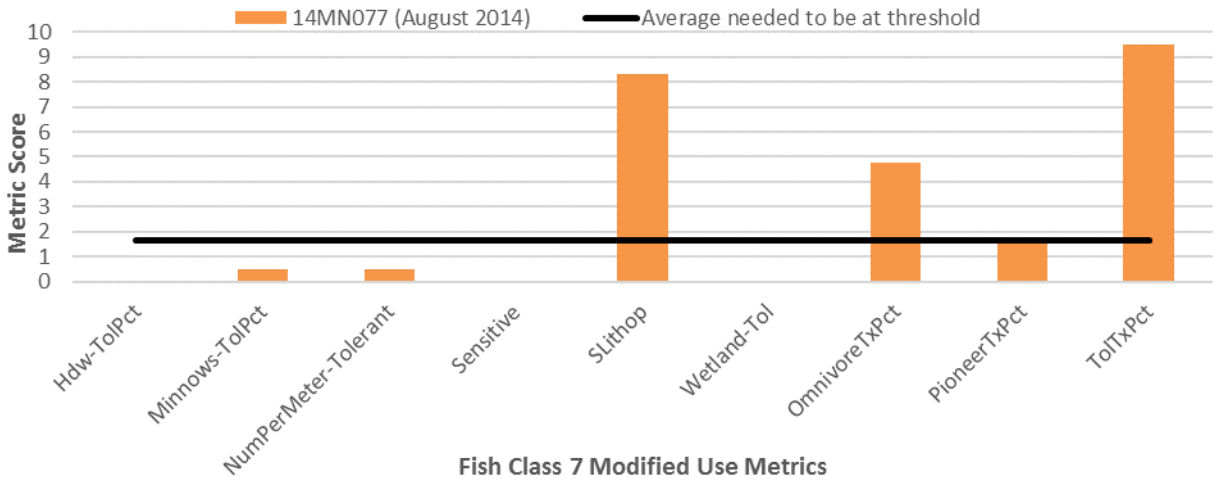
South Branch Rush River (-825) was sampled for fish three times at its two biological monitoring stations, 14MN104 and 14MN230. Site 14MN105 was sampled in July of 2014 and had a FIBI score of 19.3, while the July 2014 visit at site 14MN230 had a score of 30.1 and the August 2015 visit had a score of 17.6. All of these visits had FIBI scores below the Fish Class 2 Southern Streams Modified Use Threshold of 35. For a breakdown of the FIBI metric scores for these visits, see Figure 110.

Figure 110. Fish metric scores in Class 2



Site 14MN077 was sampled for fish in August of 2014. This visit had a FIBI score of 15.2 which is just above the Fish Class 7 Low Gradient Modified Use Threshold of 15. Three of the nine metrics at this site scored above the average needed to reach the threshold. This site still did have three metrics scoring zero, which limited the FIBI. (Figure 111) This site was boosted by the presence of six walleyes sampled.

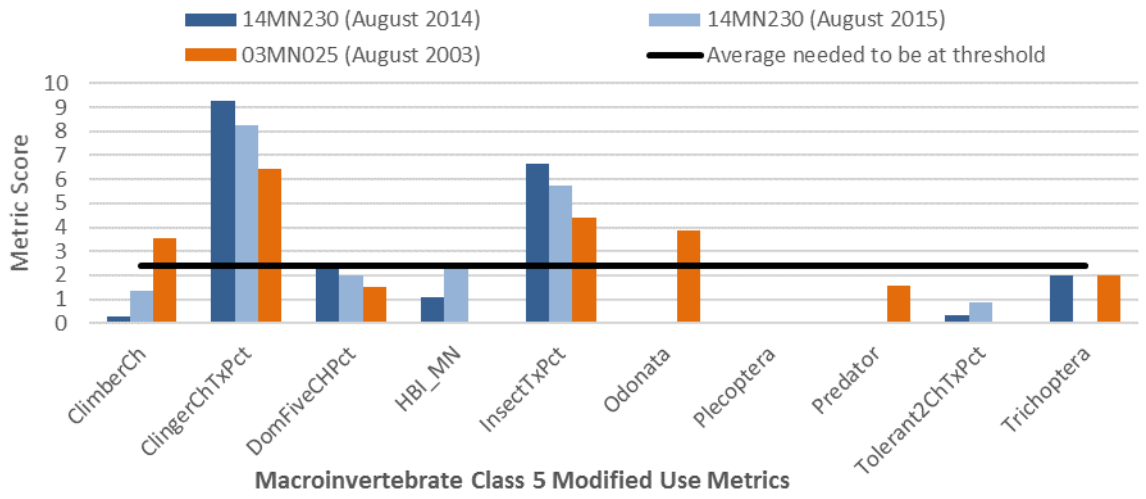
Figure 111. Fish metric scors in Class 7



Macroinvertebrates

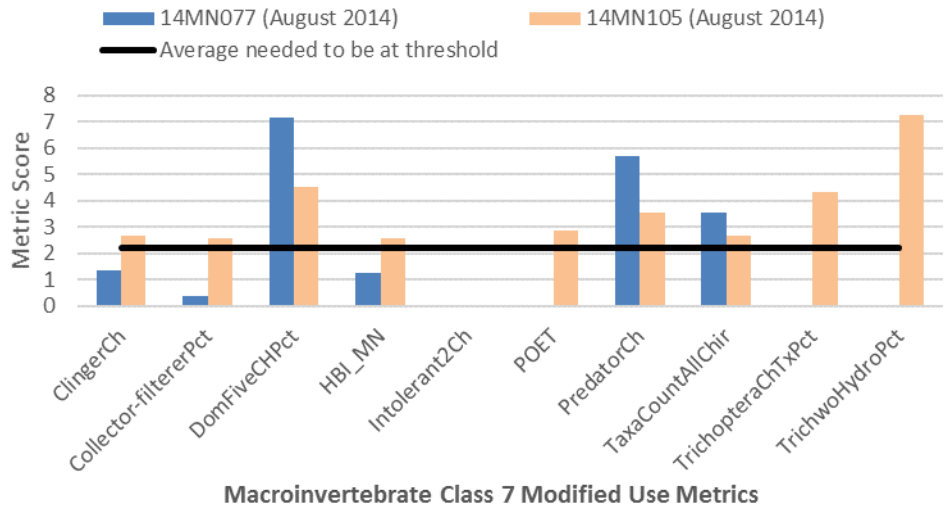
This reach was sampled for macroinvertebrate three times at its two biological monitoring stations, 03MN025 and 14MN230. Site 03MN025 was sampled in August of 2003 and had a MIBI score of 23.4, while the August 2014 visit at site 14MN230 had a score of 22.0 and the August 2015 visit had a score of 20.5. All of these visits had FIBI scores below the macroinvertebrate Class 5 Southern Streams RR Modified Use Threshold of 24. For a breakdown of the MIBI metric scores for these visits, see Figure 112.

Figure 112. Macroinvertebrate metric scores in Class 5



Site 14MN077 and 14MN105 were also sampled for macroinvertebrates in August of 2014. Site 14MN077 had a MIBI score of 19.4 and site 14MN105 had a MIBI score of 33.0. The MIBI score at site 14MN077 did fall below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22.0. For a breakdown of the MIBI metric scores for these sites, see Figure 113.

Figure 113. Macroinvertebrate metric scores in Class 7



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 7.02 mg/L to 18.33 mg/L without any recorded values below 5 mg/L. Values were collected throughout the reach. The elevated value of 18.33 is an indicator of possible daily DO fluctuations.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-14.2 mg/L with 9% of values below the water quality standard of 5 mg/L. The largest concentration of values below 5 mg/L were in the headwaters of the South Branch Rush River.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals ranged from 27.91-55.66%. The highest percentage was at station 14MN105 which is located in the downstream section of the reach. Species that are very tolerant to low DO conditions comprised over from 4% (14MN230) to 60.5% (14MN077) of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected at stations 14MN077 and 14MN105 and DO tolerant individuals comprised 52.12% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 7.02 mg/L. Based on the preponderance of evidence of a lack of individuals that reproduce at a mature age, the number of fish taxa which were all very tolerant to low DO, and low DO tolerant macroinvertebrates indicate low DO is a stressor. More DO samples would be helpful to better characterize the DO regime in South Branch Rush River (-825).

Table 189. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN077	13.95	27.91	7	48.84	8.49	0	6.03
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**4.38**	**28.58**	**11.74**				
14MN105	0.27	55.66	16	30.23	8.08	0	6.80
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
14MN230 (2014)	3.04	39.57	17	6.86	7.98	4	7.27
14MN230 (2015)	0	34.07	15	1.27	7.58	6	7.32
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**15.09**	**25.34**	**14.52**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)				**18.23**	**7.57**	**4.51**	**6.75**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Phosphorus values ranged from 0.032 to 0.348 mg/L with 35% of values over the southern standard of 0.150 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake.

Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 9% in September to 100% in June and an average of 62%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.1 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data are available. As a result of eutrophication, pH values also increase. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.79 to 8.75.

Sensitive individuals were not present on this section of the South Branch Rush River. Two visits in the southern streams class both had darter percentages below the class average of sites that met the modified standard. Station 14MN230 had a visit with 24.10% darter individuals where johnny darters were the most dominant species collected (287), which are a more tolerant darter species. While darter species were present at numbers greater than the class average of sites at station 14MN077, the percentage is inflated due to the low fish count. Five of the 43 fish were darters. Tolerant individuals composed more than 72% of the community at each station. Along with tolerant species, a positive

relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was only above the class average at station 14MN077. Individuals of EPT species were present at levels below the class average at stations 14MN077 and 14MN105. Station 14MN230 had higher EPT individuals but were dominated by Cheumatopsyche, a tolerant caddisfly that can tolerate eutrophic conditions. The two most common macroinvertebrate community comprised about half of the population at each visit. Based on the preponderance of evidence of elevated phosphorus and pH values, lack of sensitive, darter, and EPT individuals, and increased tolerant individuals, eutrophication is a stressor on the South Branch Rush River (-825).

Table 190. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN077	0	11.63	72.09	60.47	31	0	48.53
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**17.28**	**6.56**	**56.03**	**16.39**			
14MN105	0	3.86	94.67	8.26	28	17	49.0
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
14MN230 (2014)	0	7.83	83.91	20.87	25	49.18	55.73
14MN230 (2015)					29	43.77	44.73
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.38**	**13.57**	**46.38**	**25.54**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)					**33.60**	**36.82**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2003-2016, a total of 75 nitrate samples were taken from South Branch Rush River (-825). Nitrate concentrations ranged from 0.14-37 mg/L with an average value of 17.85 mg/L. This value is very high. A quantile regression of nitrate concentrations at macroinvertebrate Class 5 sites showed that when nitrate values exceed 18.1 (Class 5) there was 75% probability of impairment. If the nitrate value exceeded 11.5 mg/L in Class 7 sites, there was a 90% probability of impairment. Nitrate samples were above 11.5 mg/L 72% of the time and were above 18.1 mg/L 60% of the time.

Table 191. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN025	**13.33**	**80.89**	**0.00**	**4.09**
14MN230	**11.45**	**84.04**	**0.00**	**4.01**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*10.99*	*57.02*	*0.30*	*3.22*
14MN105	**7.14**	**69.77**	**0.33**	**4.14**
14MN077	**0.00**	**49.83**	**0.00**	**3.58**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in South Branch Rush River (-825) scored below average in three of the four nitrate related metrics in the Class 5 sites when compared to all other Class 5 Southern Streams RR stations meeting the MIBI Modified Use Threshold (Table 191). Also, the two Class 7 sites, 14MN105 and 14MN077 were below average in two (14MN105) and three (14MN077) of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold.

Based on the very high observed nitrate values in this stream reach, the quantile regression analysis, as well as the majority of the macroinvertebrate nitrate related metrics at all four sites, nitrates are a stressor to aquatic life in South Branch Rush River (-825).

Candidate Cause: Sediment

From 2003-2015, a total of 74 TSS samples were taken along this reach. These values ranged from 2-180 mg/L with an average TSS concentration of 37.48 mg/L. Ten of the samples were above the 65 mg/L standard for TSS. Additionally, from 2003-2016, 85 secchi tube measurements were taken from this reach. These readings ranged from 8-100 cm with an average value of 42.75 cm. Four of the measurements were below the 10 cm standard.

Table 192. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffIePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN025	29.14	0.00	18.06	11.18	17.96	0.00	6.13	0.00	0.54	20.43
14MN105	25.83	0.00	30.89	4.13	22.10	0.00	3.46	0.00	5.46	23.60
14MN230	30.33	0.00	13.39	17.27	15.13	0.00	17.20	0.00	4.51	19.60
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
14MN077	9.30	0.00	0.00	25.58	0.00	0.00	18.60	0.00	46.51	27.71
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in South Branch Rush River (-825) scores below average in eight (14MN077, 14MN230, 14MN105) and nine (03MN025) of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations and Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 192). All four of the sites lacked intolerant, Centrarchid, and sensitive individuals, while all sites also had low numbers of simple lithophilic individuals and poor TSS index scores.

Table 193. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN025	**20.20**	**0**	**13**	**77.71**	**28.53**	**0.00**
14MN230	**17.77**	**0**	**6.5**	**55.60**	**36.09**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*16.10*	*1.16*	*10.53*	*36.67*	*22.05*	*0.10*
14MN105	**19.54**	**1**	**14**	**61.79**	**10.00**	**0.00**
14MN077	**22.74**	**0**	**15**	**67.99**	**1.66**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in South Branch Rush River (-825) scored below average in four (14MN105, 14MN230), five (03MN025) and six (14MN077) of the six suspended sediment related metrics when compared to Class 5 Southern Streams RR stations and Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 193). All four sites had poor TSS index scores, a high abundance of TSS tolerant individuals, and a complete lack of Plecoptera species. These results can signal potential stress related to suspended sediment.

Based on the high number of standard exceedances from the TSS data set, in addition to the majority of the fish and macroinvertebrate metrics related to suspended sediment scoring below average, especially the index scores for both assemblages, suspended sediment is a stressor to aquatic life in South Branch Rush River (-825).

Candidate Cause Habitat

South Branch Rush River (-825) had qualitative habitat assessments take place at its biological monitoring sites (upstream to downstream), 14MN077, 03MN025, 14MN230, and 14MN105, during the fish and macroinvertebrate sampling events in 2014.The average MSHA score from these visits was 33.68 (Poor) at 14MN077, 52.8 (Fair) at 03MN025, 41 (Poor) at 14MN230, and 34.25 (Poor) at 14MN105. Generally, habitat conditions were poor to fair throughout this long stream reach. Limiting the MSHA at these sites was the row crop agriculture as a dominant land use, narrow riparian buffer, moderate bank erosion, clay and silt substrates, moderate embeddedness, sparse fish cover, poor sinuosity, and fair channel development. A breakdown of the MSHA category scores for these sites can be seen in Figure 114.

Figure 114. Habitat metric scores

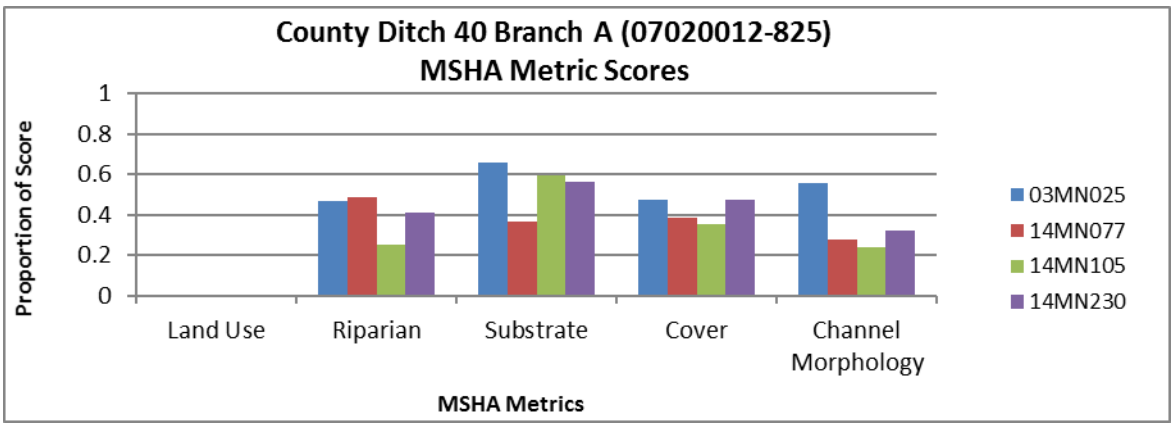


Table 194. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN025	**11.18**	**6.13**	**11.18**	**17.96**	**0.11**	**25.16**	**88.06**	**64.95**
14MN105	**3.86**	**3.46**	**3.86**	**22.10**	**0.27**	**26.23**	**94.67**	**7.86**
14MN230	**15.96**	**17.20**	**15.96**	**15.13**	**1.52**	**42.67**	**78.11**	**38.97**
Statewide average for Class 2 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
14MN077	**11.63**	**18.6**	**11.63**	**0.00**	**13.95**	**30.23**	**72.09**	**48.84**
Statewide average for Class7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The four biological monitoring stations along South Branch Rush River (-825) scored below average in eight, (03MN025), six (14MN105), seven (14MN230) and four (14MN077) of the habitat related biological metrics when compared to all other sites that meet the Modified Use threshold in their respective classes (Table 194). Site 14MN077 had the best number of habitat metric scores and was located in the headwaters of the watershed. The scores quickly lowered moving downstream. This reach contained many habitat tolerant fish species, while also having fewer species requiring unique habitat conditions.

Table 195. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN025	**1.60**	**39.10**	**34.29**	**49.68**	**44.87**	**17.95**
14MN230	**13.21**	**27.17**	**26.42**	**24.96**	**49.65**	**22.09**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*6.43*	*19.88*	*38.44*	*27.84*	*44.43*	*18.90*
14MN105	**6.67**	**45.67**	**13.67**	**17.00**	**62.00**	**27.33**
14MN077	**28.48**	**27.81**	**18.87**	**0.00**	**83.44**	**7.95**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in the South Branch Rush River (-825) scored below average in three (03MN025, 14MN105) and four (14MN230, 14MN077) of the six habitat related metrics when compared to all other stations in either a Class 5 Southern Streams RR or Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 195). All of the sites had below average number of clinger taxa and had above average numbers of legless individuals. These results are both common in streams with degraded habitat conditions.

Based on the relatively poor MSHA scores present at the four sites, as well as the majority of the habitat related metrics for both of the fish and macroinvertebrate communities scoring below average, the current habitat conditions in the South Branch Rush River (-825) are a stressor to the impaired biological communities.

Candidate Cause Chloride/Ionic strength

No chloride values are available. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 569 to 841 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. Station 14MN230 located in the middle of the reach had high percentages of EPT and mayfly (Ephemeroptera) individuals, but stations 14MN077 and 14MN105 were lower, below class average. The taxa counts were all below class average. The macroinvertebrate community was

comprised of a range of 51.59%-77.23% conductivity tolerant individuals and all stations had 0 intolerant individuals except for the 1 found at station 14MN105.

Table 196. Metrics relating to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN077	31	0	0	0	0
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)					**4.38**
14MN105	28	5	6.67	17	0
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	**33.59**	**3.45**	**16.52**	**20.58**	
14MN230 (2014)	25	7	11.80	49.18	0
14MN230 (2015)	29	3	19.17	43.77	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					**6.17**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	**36.82**	***4.43***	***17.02***	***33.60***	
Expected response to increased DO stress	↓	↑	↓	↑	↑

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at any station. Species that are tolerant to conditions with high ionic strength comprised a range of 27% to 63% of the fish community. There were no elevated specific conductance value in the small dataset, and while the biological communities at stations 14MN077 and 14MN105 indicated that ionic strength might be a stressor, other stressors could be affecting the EPT, mayfly, and taxa count. Ionic strength is currently inconclusive as a stressor in South Branch Rush River (-825).

Candidate Cause: Altered Hydrology/Connectivity

The reach and upstream watershed is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 11% of the time, with the upper reach of the river experiencing the most low flow events during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 12.38% to 42.48% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 7.32% to 64.78% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population at each visit. Based on extended low flow periods in the upper reach of the river shown in the models and the preponderance of biological evidence, altered hydrology is a stressor that is also affecting habitat in South Branch Rush River (-825).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in South Branch Rush River (-825) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 197) Chloride was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 197. Stressors on South Branch Rush River (-825)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
South Branch Rush River	07020012-825	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.2 South Branch Rush River (-826)

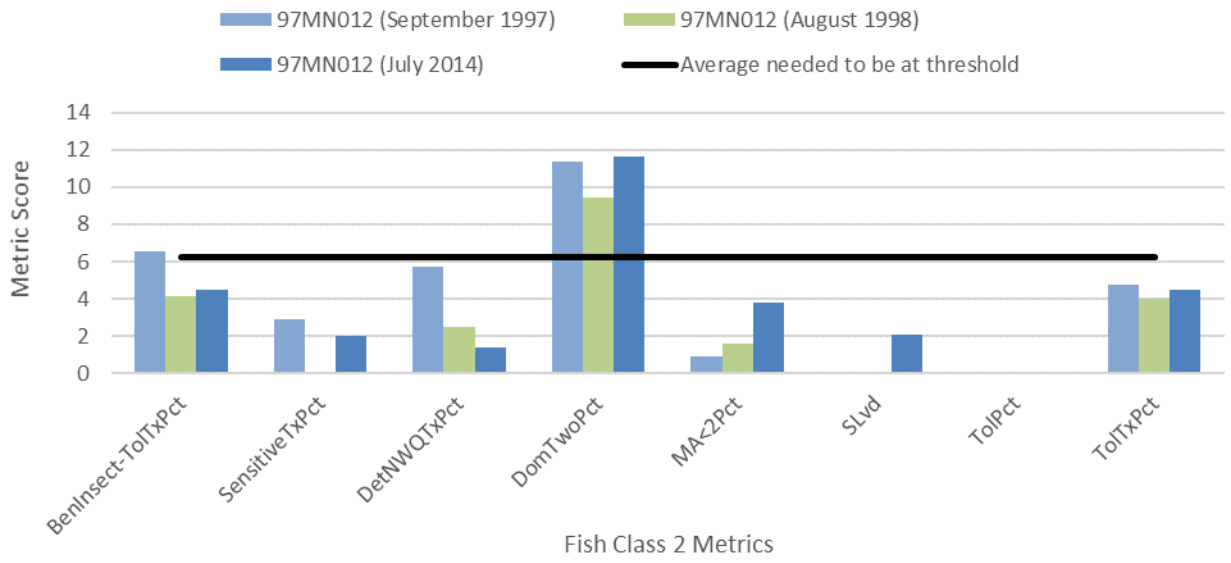
South Branch Rush River (-826) is an 9.51 mile long stream reach that is located where the South Branch transitions from channelized to a natural channel near CSAH 17 and extends to the confluence with the Rush River. This reach is impaired for biology due to both its fish and macroinvertebrate assemblages. There is one biological monitoring location along this reach, 97MN012.

Biology

Fish

South Branch Rush River (-826) was sampled for fish in July of 2014 at biological monitoring station 97MN012. The FIBI score for this visit was 29.8, which is well below the Fish Class 2 Southern Streams General Use Threshold of 50. Only one of the eight metrics (DomTwoPct) had a metric score above the average needed to reach the threshold. The fish community in this reach was dominated by tolerant species (Figure 115).

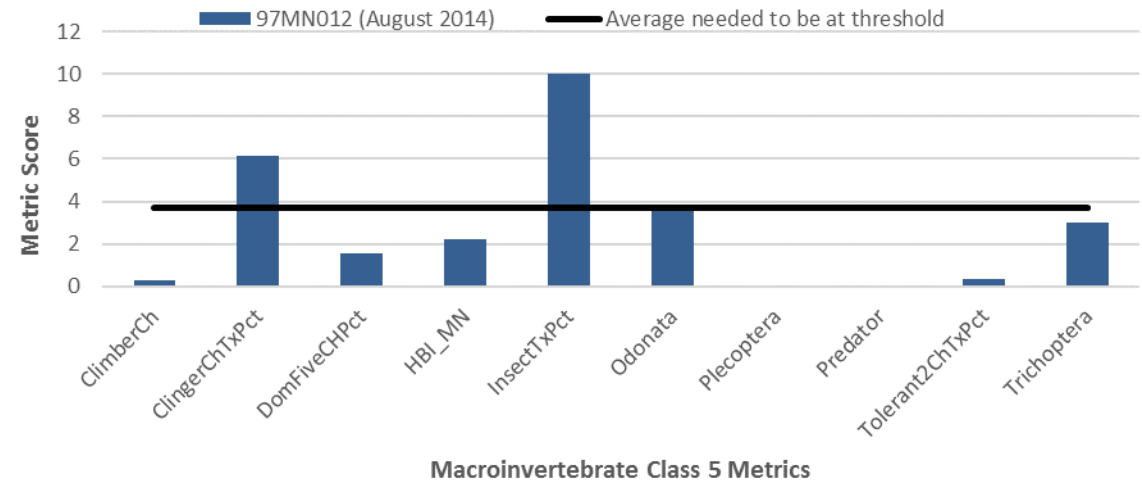
Figure 115. Fish metric scores



Macroinvertebrates

The macroinvertebrate assemblage was sampled at 97MN012 in August of 2014. The MIBI score from this visit was 27.5, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Just three of the ten metrics comprising the MIBI for this class reached the average needed to meet the threshold (ClingerChTxPct, InsectTxPct, Odonata). The remaining metrics scored below average or poorly with two metrics scoring zero (Plecoptera, Predator). (Figure 116).

Figure 116. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 7.11 mg/L to 18.33 mg/L without any recorded values below 5 mg/L. All values were collected at biological station 97MN012. The range in data indicates possible DO fluctuations.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.1-14.2 mg/L with less than 0.25% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Less than one percent of the community was comprised of individuals that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were higher than the class average for sites meeting the general standard. Species that are very tolerant to low DO conditions comprised over 45% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Five macroinvertebrate intolerant taxa were collected while DO tolerant individuals comprised only 4.09% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 7.11 mg/L. Low DO is not a stressor to the macroinvertebrate community. While there is some evidence of stress to the fish community, both recorded and modelled values were well above 5 mg/L. Lowered values could be due to other stressors. DO is not a stressor to the fish community. More DO samples would be helpful to better characterize the DO regime in South Branch Rush River (-826).

Table 198. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
97MN012	0.87	44.59	14	4.09	7.59	5	7.51
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Phosphorus values range from 0.045 0.54 mg/L with 55% of values over the southern standard of 0.150 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.0 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, BOD, DO flux, and chlorophyll-a data were not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.82 to 8.79.

Less than one percent of the community was comprised of sensitive individuals. Darter individuals were higher but were less than the class average of sites meeting the general standard. Tolerant individuals composed more than 85% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was just above the class

average. Individuals of EPT species were present at levels above the class average but were dominated by Cheumatopsyche, a tolerant caddisfly that can tolerate eutrophic conditions. The two most common macroinvertebrate species sampled comprised almost half of the population. The biological communities are showing the effects of the elevated phosphorus values. Eutrophication is a stressor on this section of the South Branch Rush River (-826).

Table 199. Metrics related to eutrohication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
97MN012	0.43	4.33	85.28	20.78	25	53.94	46.06
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2015 a total of 11 nitrate samples were taken from South Branch Rush River (-826). The nitrate concentrations of these samples ranged from 0.82-32.4 mg/L with an average value of 17.33 mg/L. A quantile regression analysis of macroinvertebrate Class 5 sites showed that sites with a nitrate concentration above 18.1 mg/L had a 75% probability of being impaired. This stream reach had seven (63.64%) nitrate concentrations exceeding 18.1 mg/L.

Table 200. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
97MN012	**20.00**	**66.67**	**0.00**	**3.62**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in three of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 200). Site 97MN012 did have a good amount of Trichoptera taxa, however

the site did also have a high amount of nitrate tolerant species, zero nitrate intolerant taxa, and a poor nitrogen TIV score.

Based on the high observed nitrate values, the quantile regression analysis, as well as the majority of the nitrate related macroinvertebrate metrics scoring below average, nitrates are a stressor to aquatic life in South Branch Rush River (-826).

Candidate Cause Sediment

From 2014-2015 a total of 11 TSS samples were taken from this reach. These sample values ranged from 13-181 mg/L with an average TSS concentration of 51.55 mg/L. Two of the eleven TSS samples exceeded the 65 mg/L daily standard for TSS. Also, from 2003-2015 a total of 70 secchi tube measurements were taken from this reach. These values ranged from 0-63 cm, with an average reading of 27.06 cm. Of these measurements, 7 (10%) were at or below the 10 cm standard for transparency.

Additionally, the HSPF model calculated daily TSS concentrations for this reach from 1996-2012. These values ranged from 4.4-1,376.4 mg/L, with an average value of 60.3 mg/L. The model calculated that during this time frame, 1680 (27.09%) days would have a TSS concentration that exceeds the 65 mg/L TSS standard.

Table 201. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
97MN012	**16.39**	**0.00**	**13.27**	**4.04**	**13.35**	**0.28**	**25.10**	**0.00**	**4.46**	**22.81**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in South Branch Rush River (-826) at site 97MN012 scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 201). The reach did have an above average amount of herbivorous individuals, but score poorly in the remaining metrics.

Table 202. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
97MN012	**18.20**	**0**	**10**	**53.14**	**54.89**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 202). Site 97MN012, did have a lower amount of TSS tolerant taxa and a high amount of collector-filterer individuals, however the community scored poorly in the remaining metrics, which is common in a stream being negatively impacted by elevated levels of TSS.

Based on the multiple observed TSS and secchi tube standard exceedances, the high rate of exceedance predicted by the HSPF model, as well as the majority of the suspended sediment related metrics of the fish and macroinvertebrate communities scoring below average, suspended sediment is a stressor to aquatic life in South Branch Rush River (-826).

Candidate Cause Habitat

South Branch Rush River (-826) had a qualitative habitat assessment take place at biological monitoring site, 97MN012, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 51.95 (Fair). Limiting the MSHA score at this site was the presence of row crop agriculture as a significant nearby land use, heavy bank erosion (Figure 117), narrow to moderate riparian buffer, sand substrates, light embeddedness, and moderate channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 118.

Figure 117. Eroding banks at site 97MN012 (August 12, 2014)

Figure 118. Habitat metric scores

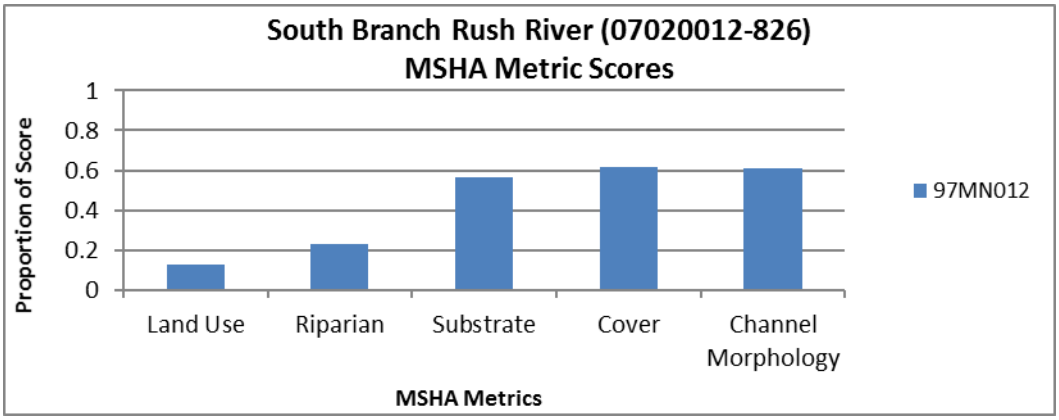


Table 203. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
97MN012	4.15	25.10	4.15	13.35	0.44	45.14	88.73	29.94
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in South Branch Rush River (-826) scored below average in all eight of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 203). There was a lack of many habitat specializing species at site 97MN012 during the three fish sampling events, while many tolerant species like central stonerollers, bigmouth shiners, sand shiners, and fathead minnows were abundant.

Table 204. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
97MN012	**1.26**	**16.09**	**62.78**	**53.94**	**22.71**	**7.57**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach fared much better than the fish assemblage as just one metric score was below average when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 204). Site 97MN012 only had a below average number of sprawler individuals present.

The MSHA score in this reach was fair, along with the mixed habitat related biological metric results from the fish and macroinvertebrate communities, it is inconclusive if habitat is a stressor to the impaired biological assemblages at this time in South Branch Rush River (-826).

Candidate Cause Chloride/Ionic strength

A small dataset of chloride values are available on this reach, ranging from 24.3 to 40.3 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 335 to 890 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Table 205. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
97MN012	25	7	22.08	53.94	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**6.17**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**36.82**	***4.43***	***17.02***	***33.60***	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. EPT and mayfly (Ephemeroptera) individuals were both above class average, but the taxa count was below class average. The macroinvertebrate community was comprised of 51.57% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at any station. Species that are tolerant to conditions with high ionic strength comprised 59% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, and the preponderance of biological communities indicated that ionic strength is not a stressor in South Branch Rush River (-826).

Candidate Cause: Altered Hydrology/Connectivity

This reach is 100% natural according to the MPCA altered watercourse layer, but the entire upstream watershed is channelized. There were no known connectivity issues. Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 1.5% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised of 40.69% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 18.61% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present. There are some indicators that the upstream channelization of the river is affecting the biology, however altered hydrology is currently inconclusive as a stressor in South Branch Rush River (-826).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in South Branch Rush River (-826) are being stressed by Eutrophication, Nitrates, and Suspended Sediment (Table 206). Habitat and Flow Alteration/Connectivity are inconclusive as stressors at this time while Dissolved Oxygen and Chloride were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 206. Stressors on the South Branch Rush River (-826)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
South Branch Rush River	07020012-826	●	●	●	●	o	---	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.3 County Ditch 13 (-636)

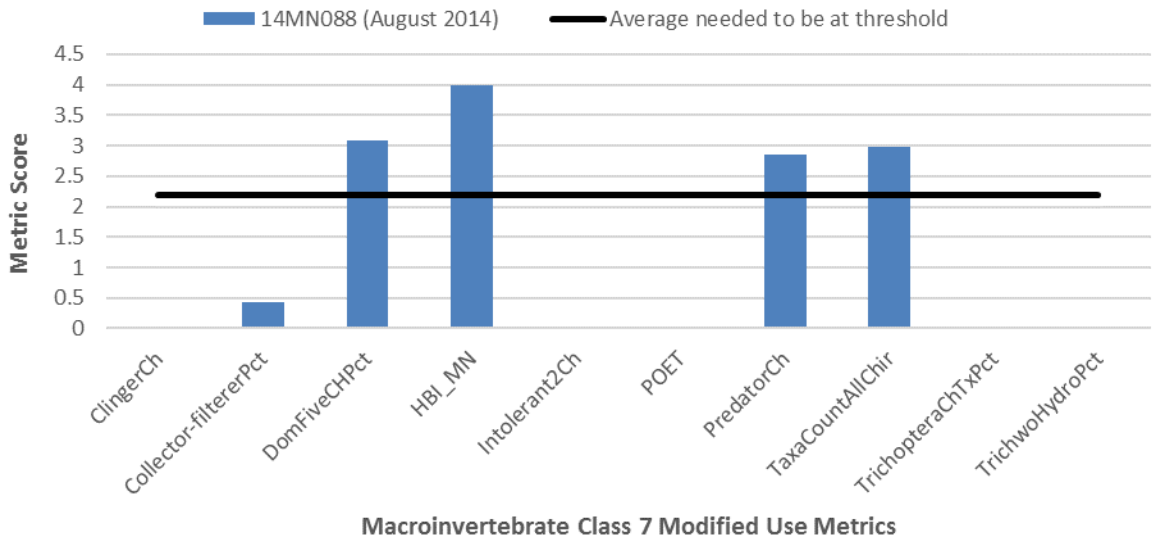
County Ditch (-636) is an 2.5 mile long channelized stream reach that extends from CR 53 to Judicial Ditch 1 at CSAH 8. This reach is impaired for biology due to the macroinvertebrate assemblage collected at the biological monitoring station, 14MN088, located along this stream reach.

Biology

Macroinvertebrates

County Ditch 13 (-636) had a macroinvertebrate sample taken at site 14MN088 in August of 2014. This sample had an MIBI score of 13.3, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use threshold of 22. Four of the ten metrics in this reach scored above the average needed to meet the MIBI threshold, while the remaining six scored very poorly. Five of those metrics at this site scored a 0. (Figure 119).

Figure 119. Biological metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 5.79 mg/L to 10.12 mg/L and were all collected at biological station 14MN088.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.1 mg/L with less than 43% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The percentage of individuals that reproduce at a mature age was four times the class average of sites that meet the modified standard. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were just below the class average. Species that are very tolerant to low DO conditions comprised over 70% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 46.13% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 5.79 mg/L. While there was a bit of a mixed response, the preponderance of evidence indicates low DO is inconclusive as a stressor to the biological communities. More DO samples would be helpful to better characterize the DO regime in County Ditch 13 (-636).

Table 207. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN088	16.67	25	8	46.13	7.65	0	4.24
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)	**4.38**	**28.58**	**11.74**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.058 to 0.21 mg/L. The highest value was collected during July at station 14MN088 near Lafayette. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-6.5 mg/L with a mean of 0.4 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.38 to 8.24. Thick algae was located at station 14MN088 (Figure 120).

Figure 120. Algae at station 14MN088 (September 24, 2013)

Sensitive individuals were not present at station 14MN088. Darter individuals were higher but the percentage was inflated based on a small number of fish collected. Four of 48 were darter individuals. Tolerant individuals composed 75% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was much higher than the class average of sites meeting the modified standard. Individuals of EPT species were present at low levels and the two most common macroinvertebrate species sampled comprised about half of the population. The biological communities are showing the effects of the elevated phosphorus values and algal growth. Eutrophication is a stressor on County Ditch 13 (-636).

Table 208. Metrics relating to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN088	0	8.33	75	72.92	29	4.52	51.29
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Threshold (15.0)	17.28	6.56	56.03	16.39			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.58	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

Three nitrate samples were taken from County Ditch 13 (-636) from 2014-2016. These sample values ranged from 19-22 mg/L with an average nitrate concentration of 21 mg/L. A quantile regression analysis of macroinvertebrate Class 7 sites showed that when the nitrate concentration exceeded 11.5 mg/L, there was a 90% probability for impairment. In County Ditch 13 (-636) all three nitrate samples easily exceeded this level. Drain tiles were also present in this reach and are a likely source of high nitrates.

Table 209. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN088	**0.00**	**28.71**	**0.00**	**2.57**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 13 (-636) at site 14MN088 scored below average in two of the four nitrate related metrics. The site completely lacked any Trichoptera and nitrate intolerant taxa. These results may indicate possible nitrate stress. The site did have a low amount of nitrate tolerant taxa and had a relatively good nitrogen TIV score.

Based on the high observed nitrate values, the quantile regression analysis, the presence of drain tiles in the stream reach, as well as the lack of Trichoptera and nitrate intolerant species concludes that nitrates are a stressor to aquatic life in County Ditch 13 (-636).

Candidate Cause Sediment

From 2014-2016, a total of three TSS samples were taken from County Ditch 13 (-636). These values were 3.6, 6.0, and 200 mg/L. Additionally, two secchi tube measurements were taken along this reach in 2014. These readings were 9 and 11 cm. One TSS sample and one secchi tube reading violated the standards for TSS concentration and secchi tube transparency.

The HSPF model also calculated daily TSS concentrations for this reach from 1996-2012. These values ranged from 1.7-374.4 mg/L with an average TSS concentration of 39.7 mg/L. Of these calculations, 1,352 (21.77%) were above the 65 mg/L standard for TSS. This is a very high rate of exceedance.

Table 210. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN088	**8.33**	**0.00**	**0.00**	**25.00**	**2.08**	**0.00**	**20.83**	**0.00**	**60.42**	**30.91**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 13 (-636) scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 210). The site, 14MN088, did have an above average amount of Perciformid (perch-like), simple lithophilic, and long lived individuals. This reach scored poorly in the remaining seven metrics, especially the TSS index score.

Table 211. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN088	**12.66**	**0**	**12**	**22.26**	**1.94**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six suspended sediment related metrics in County Ditch 13 (-636) at site 14MN088 when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 211). This reach had a good TSS index

score and a lower amount of TSS tolerant individuals. The rest of the metrics evaluated scored below average.

Based on the majority of the fish and macroinvertebrate suspended sediment related metrics scoring below average, an observed value exceeding the standard in the small data set, as well as the high rate of standard exceedances predicted by the HSPF model, suspended sediment is a stressor to aquatic life in County Ditch 13 (-636).

Candidate Cause Habitat

County Ditch 13 (-636) had a qualitative habitat assessment take place at biological monitoring site, 14MN088, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 24.75 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, the narrow stream riparian buffer, the lack of stream shading, the high abundance of silt that has covered many course substrates, moderate embeddedness, sparse fish cover, very little depth variability, moderate channel stability, poor channel sinuosity (Figure 121) and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 122.

Figure 121. Lack of sinuosity at site 14MN088

Figure 122. Habitat metric scores

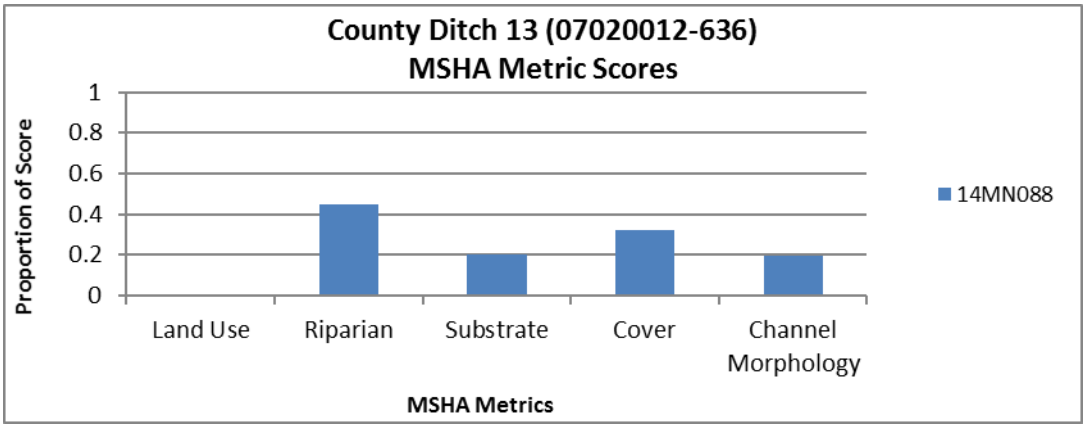


Table 212. Habitat related fish metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN088	19.03	20.00	0.32	4.52	47.10	55.16
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 13 (-636) scored below average in four of the eight habitat related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 212). The site, 14MN088, was mainly dominated by two very tolerant species, common carp, and fathead minnows. These two species comprised 68.75% of the fish sample. The site did have eight young walleyes sampled, which has helped boost the score of many of the metrics.

Table 213. Habitat related macroinvertebrate metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN088	**8.33**	**20.83**	**8.33**	**2.08**	**16.67**	**22.92**	**75.00**	**33.33**
Statewide average for Class 7 Low Gradient stations that are meeting the Modified Use FIBI Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six habitat related metrics evaluated when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table). Site 14MN088 did have a high amount of burrower species which may signal a problem of too much fine sediment. Additionally, the low amount of EPT individuals can signal a degraded stream condition.

Based on the poor MSHA score, as well as the majority of the macroinvertebrate and half of the fish habitat related metrics scoring below average, habitat is a stressor to the biotic communities in County Ditch 13 (-636).

Table 214. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN088	29	2	4.52	4.52	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**4.38**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	**33.59**	**3.45**	**16.52**	**20.58**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause Chloride/Ionic strength

One chloride value was available on this reach, a value of 39.2 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 877 to 983 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. EPT and mayfly (Ephemeroptera) individuals were both well below the class average, but the taxa count was only slightly below class average. The macroinvertebrate community was comprised of 27.42% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at station 14MN088. Species that are tolerant to conditions with high ionic strength comprised 71% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 13 (-636).

Candidate Cause: Altered Hydrology/Connectivity

The reach and entire upstream watershed was 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 44% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 75% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 31.25% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 7.74% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 13 (-636).

Conclusions and recommendations

The impaired macroinvertebrate community in County Ditch 13 (-636) are being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 215) Dissolved Oxygen and Chloride were inconclusive as stressors at this time. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 215. Stressors on County Ditch 13 (-636)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 13	**07020012-636**	o	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.4 County Ditch 32A (-783)

County Ditch 32A (-783) is a 3.38 mile modified reach that flows out of an unnamed lake and into Judicial Ditch 1A. Located in Nicollet County, the reach is impaired for both fish and macroinvertebrates. There is one biological station, 14MN053, located on this reach.

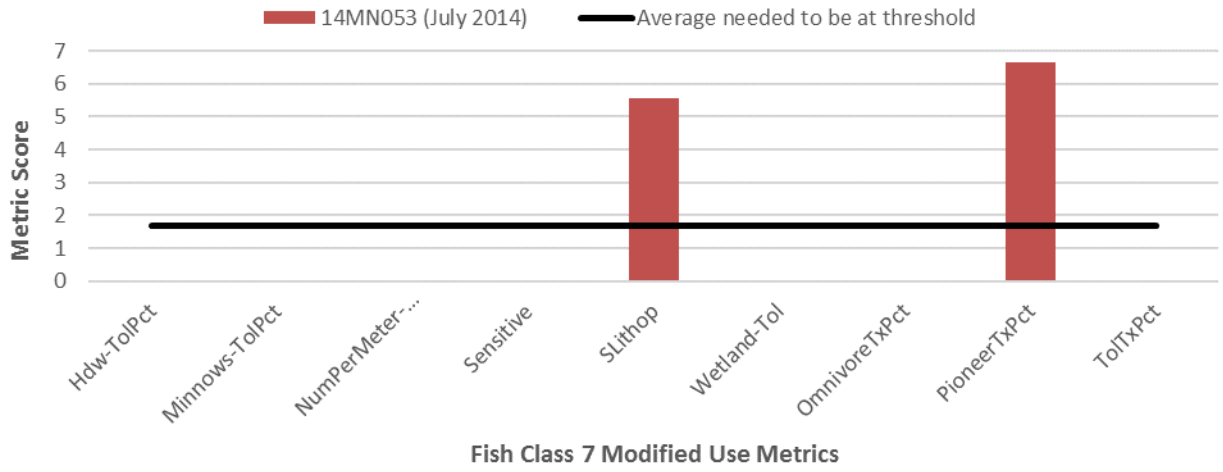
Biology

Fish

County Ditch 32 A (-783) had a fish sample event take place at site 14MN053 in July of 2014. This visit had and FIBI score of 7.2, which is below the Fish Class 7 Low Gradient Modified Use threshold of 15. This site only scored well in two of the FIBI metrics, whiles scoring poorly in the remaining seven. The

fish assemblage consisted of five species (brook stickleback, fathead minnow, white sucker, common carp, blacknose dace) that are considered to be tolerant.

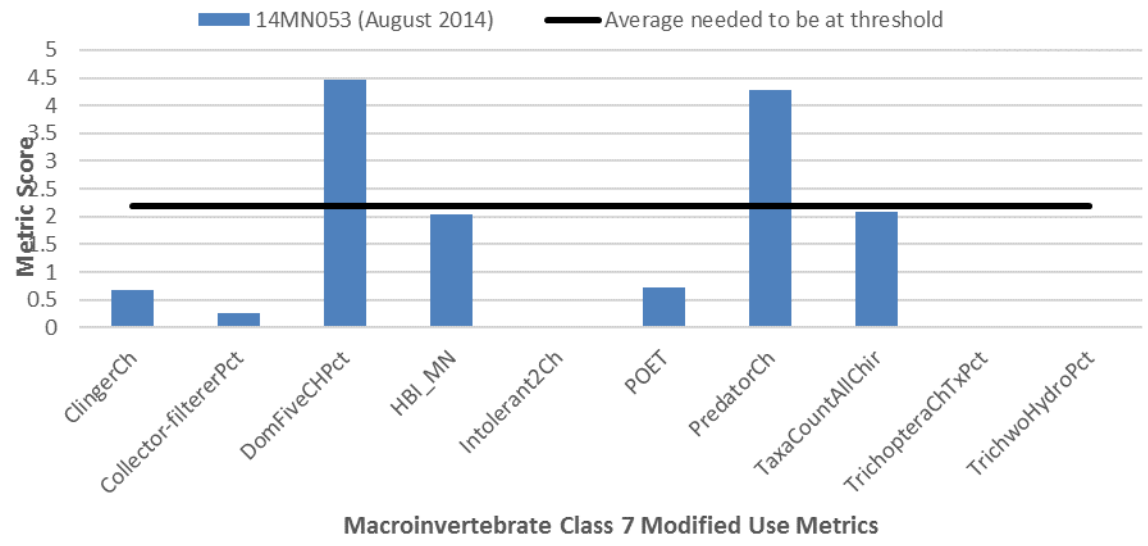
Figure 123. Fish metric scores



Macroinvertebrates

This reach was sampled for macroinvertebrates at site 14MN053 in August of 2014. The MIBI score for this site was 14.5, which is also well below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use threshold of 22. This site scored above the average needed to reach the threshold in two of the ten metrics for this class (DomFiveCHPct, PredatorCh), while scoring below average or very poorly in the remaining metrics. (Figure 124).

Figure 124. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 6.05 mg/L to 10.4 mg/L and were all collected at biological station 14MN053. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.1-13.4 mg/L with 19% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals that reproduce at a mature age was were present. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were just above the class average. Species that are very tolerant to low DO conditions comprised over 86% of the fish community.

Table 216. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN053	0	30.86	5	31.39	8.25	0	6.12
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)	4.38	28.58	11.74				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 31.39% of the population. All DO values in the small dataset were above 5 mg/L with a low value of 5.79 mg/L. While there was a bit of a mixed response, the preponderance of evidence indicates low DO is inconclusive as a stressor to the biological communities. More DO sample would be helpful to better characterize the DO regime in County Ditch 32A (-783).

Candidate Cause Eutrophication

Only one phosphorus value was available on this stream, 0.061 mg/L. The value was collected during July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-6.6 mg/L with a mean of 0.5 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.79 to 7.8. Algal growth was noted during biological sampling.

Sensitive and darter individuals were not present at station 14MN053. Tolerant individuals composed 100% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was much higher than the class average of sites meeting the modified standard. Individuals of EPT species were present at levels just

below the class average. The two most common macroinvertebrate species sampled comprised less than half of the population. Based on the biological communities, the modelled phosphorus values, and the algal growth eutrophication is a stressor in County Ditch 32A (-783).

Table 217.Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN053	0	0	100	49.4	26	13.6	**44.7**
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	17.3	6.6	56	16.5			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					33.59	20.6	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

One nitrate sample was taken from County Ditch 32A (-783). This sample was taken on July 14, 2014 and had a nitrate concentration of 29 mg/L, which is very high. A quantile regression analysis of macroinvertebrate Class 7 sites showed that when the nitrate concentration exceeded 11.5 mg/L, there was a 90% probability for impairment. In County Ditch 32A (-783) the nitrate sample taken more than doubled this concentration. Drain tiles were also present in this reach and are a likely source of high nitrates (Figure 125).

Figure 125. Drain tiles at site 14MN053 (August 19, 2014)

Table 218. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN053	0.00	74.76	0.00	4.35
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 32 A (-783) at site 14MN053 scored below average in all of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 218). The stream reach had a very poor nitrogen TIV score, a complete lack of both Trichoptera and nitrate intolerant taxa, as well as a high amount of nitrate tolerant species. All of these results indicate likely nitrate stress.

Based on the poor scoring macroinvertebrate metrics related to nitrates, the high observed value, the quantile regression analysis as well as the presence of drain tiles, nitrates are a stressor to aquatic life in County Ditch 32A (-783).

Candidate Cause: Sediment

One TSS sample was collected from County Ditch 32A (-783) in 2014. This value was 17 mg/L and was collected onJuly 14, 2014. Additionally, two secchi tube measurements were made in 2014 along this reach. These values were 38 cm on July 14, 2014 and 11 cm onAugust 14, 2014. Both of these readings are above the 10 cm minimum standard for transparency.

Also, the HSPF model calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 4.09-868.16 mg/L with an average TSS concentration of 17.34 mg/L. Of these calculations, 381 (6.14%) were above the 65 mg/L standard for TSS.

Table 219. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN053	12.96	0.00	0.00	0.00	12.96	0.00	13.58	0.00	5.56	18.71
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in this reach scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 7 Low Gradient station that meet the FIBI Modified Use Threshold (Table 219). The site, 14MN053, did have a higher amount of riffle dwelling and benthic feeder individuals, but scored poorly in the remaining metrics. These results are common in a stream being negatively impacted by suspended sediment conditions.

Table 220. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN053	**20.39**	**0**	**13**	**73.79**	**1.29**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 32A (-783) scored below average in all six of the suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 220). The site, 14MN053, had a very high amount of TSS tolerant individuals, while also having a poor TSS index score.

Of the very small observed data set, no exceedances of the standard were observed for both TSS and secchi tube measurements. The HSPF model predicted a rather low rate of exceedance as well. The poor scoring fish and macroinvertebrate metrics related to suspended sediment are likely being caused by other stressors. Therefore, suspended sediment is not a stressor in County Ditch 32A (-783) at this time.

Candidate Cause: Habitat

County Ditch 32A (-783) had a qualitative habitat assessment take place at biological monitoring site, 14MN053, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 25.9 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, the narrow stream riparian buffer, heavy bank erosion (Figure 126), light stream shading, the high abundance of silt, no course substrates, sparse fish cover, very little to no depth variability, moderate channel stability, poor channel sinuosity and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 127.

Figure 126. Eroding banks at site 14MN053 (August 19, 2014)

Figure 127. Habitat metric scores

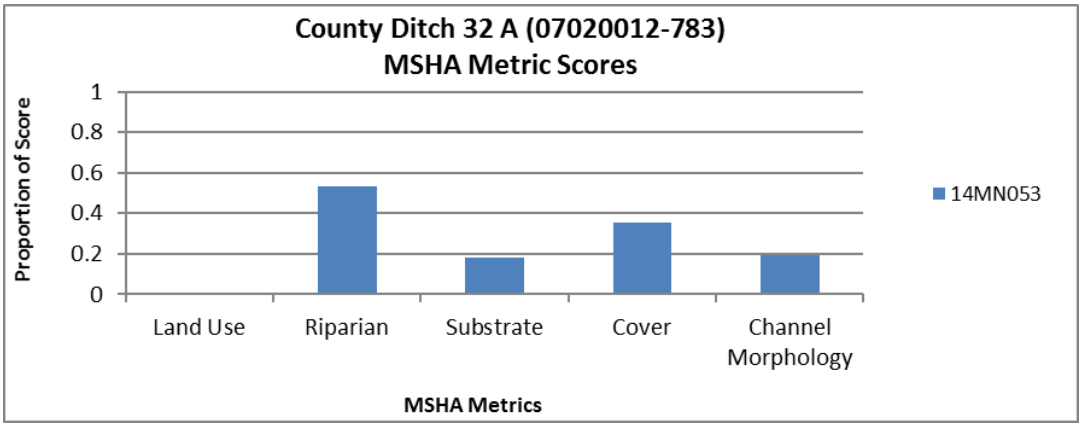


Table 221. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN053	0.00	13.58	0.00	12.96	0.00	13.58	100.00	30.86
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 32A (-783) scored below average in seven of the eight habitat metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 221). The fish assemblage present consisted of all species that are very tolerant of degraded habitat conditions. These species include: fathead minnow, brook stickleback, white sucker, common carp, and blacknose dace.

Table 222. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN053	**3.56**	**32.04**	**3.24**	**13.59**	**32.69**	**22.01**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	***9.74***	***24.34***	***20.62***	***15.52***	***59.46***	***22.88***
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN053 scored below average in three of the six habitat related metrics when compared to all other Class 7 Prairies streams GP stations that met the MIBI Modified Use Threshold (Table 222). The macroinvertebrate community consisted of a high amount of Sigara species. Sigara are a tolerant macroinvertebrate that can be present in large numbers in degraded habitat situations. The site also had many Physella (51) which are a tolerant snail that tends to feed on algae and detritus and is also found in poor habitat conditions.

Based on the poor MSHA score as well as the many below average scoring habitat related fish metrics and the high presence of some very tolerant macroinvertebrate species, habitat is a stressor to the impaired biological communities in County Ditch 32A (-783).

Candidate Cause Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 882 to 973 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Table 223. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN053	26	2	13.59	13.59	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**4.38**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	**33.59**	**3.45**	**16.52**	**20.58**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. EPT, mayfly (Ephemeroptera) individuals were all below the class average. The macroinvertebrate community was comprised of 54.69% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at station 14MN053. Species that are tolerant to conditions with high ionic strength comprised 86% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 32A (-783).

Candidate Cause: Altered Hydrology/Connectivity

The reach and upstream watershed was 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 24% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 50% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 80.86% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 4.53% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 32A (-783).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 32A (-783) are being stressed by Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity.(Table 224) Dissolved Oxygen and Chloride were inconclusive as stressors at this time, while Suspended Sediment was rule out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 224. Stressors on County Ditch 32A (-783)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivit
County Ditch 32A	07020012-783	o	●	●	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.5 County Ditch 9 (-784)

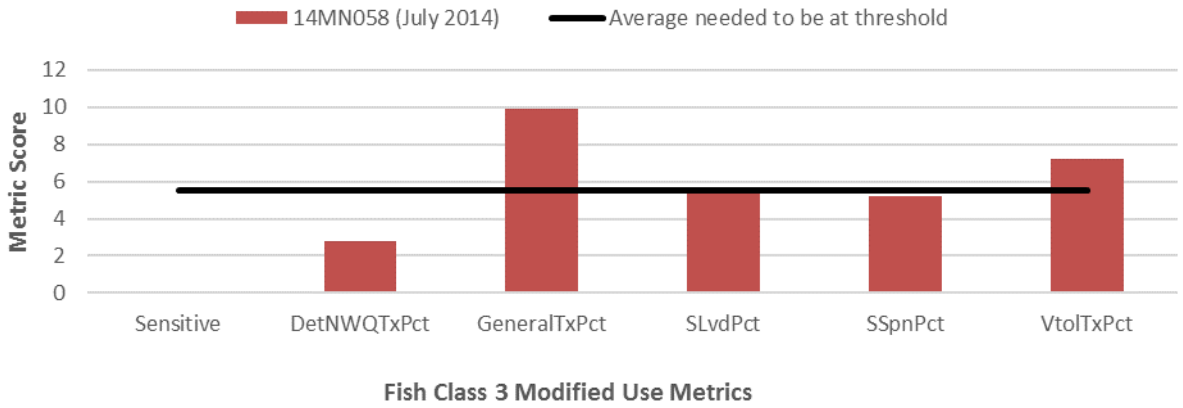
County Ditch 9 (-784) is a 2.66 mile modified reach that flows into Judicial Ditch 1A. Located in Nicollet County, the reach is impaired for fish. Macroinvertebrates were not sampled on this reach, because no habitat was available for sampling. There is one biological station, 14MN058, located on this reach.

Biology

Fish

County Ditch 9 (-784) was sampled for fish at biological monitoring station, 14MN058, in July of 2014. The FIBI score from this visit was 30.6, which is slightly below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. Two of the six FIBI metrics scored above the average needed to reach the threshold (GeneralistTxPct, VtolTxPct), and two metrics scored just below this level (SLvdPct, SSpnPct). This site also lacked any sensitive fish species, which limited the FIBI as well. (Figure 128)

Figure 128. Fish metrics scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 6.54 mg/L to 12.83 mg/L and were all collected at biological station 14MN058. The lowest value was sampled in August. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-12.7 mg/L with 48% of values below the water quality standard of 5 mg/L.

Table 225. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO	DO Tolerant Index Score
14MN058	0	52.90	12	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals that reproduce at a mature age was were present. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were five times above the class average. Species that are very tolerant to low DO conditions comprised over 86% of the fish community. Macroinvertebrates were not sampled. While there were no recorded DO values below 5 mg/L in the small database, biological information is indicative of possible low DO stress to the fish community. Low DO is currently inconclusive as a stressor. More DO samples would be helpful to better characterize the DO regime in County Ditch 9 (-784).

Candidate Cause Eutrophication

Only a small amount of phosphorus values were available on this stream, ranging from 0.120 to 0.123 mg/L. The value was collected during July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.6 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 8.06 to 8.19.

Table 226, Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN058	**0**	**1.61**	**91.61**	**35.48**	**NA**	**NA**	**NA**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals were not present at station 14MN058, and darter individuals were present at low levels and were all johnny darters, which are the most tolerant of darter species. Tolerant individuals composed more than 90% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was higher than the class average of sites meeting the modified standard. Macroinvertebrates were not sampled at this station. Based on the fish community and the modelled phosphorus values, eutrophication is a stressor in County Ditch 9 (-784).

Candidate Cause: Nitrate

One nitrate sample was taken from County Ditch 9 (-784). The sample result was 30 mg/L and was taken onJuly 14, 2014. This sample result is very high and was taken during a time when nitrate values tend to be declining from typical late spring peaks. Site 14MN058 also had the presence of drain tiles (Figue 129). Drain tiles are a common pathway for nitrates to enter a stream system from nearby crops.

Figure 129. Drain tiles at site 14MN058 (July 14, 2014)

The HSPF model calculated daily nitrate concentrations for County Ditch 9 (-784) from 1996-2012. These values ranged from 0.1-24.5 mg/L with an average nitrate concentration of 5.6 mg/L. The model also calculated that nitrate concentrations exceed 11.5 mg/L 5.6% of the time. A quantile regression analysis showed that macroinvertebrate Class 7 sites that exceed 11.5 mg/L of nitrates would have a 90% probability of being impaired.

Based on the very high observed nitrate value that was taken at a time when nitrates are commonly on the decline, the presence of drain tiles, the quantile regression analysis, as well as the high HSPF calculations, nitrates are indeed a stressor to aquatic life in County Ditch 9 (-784).

Candidate Cause: Sediment

One TSS sample was taken from County Ditch 9 (-784) in 2014. This sample was 14 mg/L on July 14, 2014. Also, two secchi tube readings were taken in 2014. These readings were 85 cm on July 14, 2014 and 28 cm on August 14, 2014.

Table 227.Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN058	**18.71**	**0.00**	**20.65**	**1.61**	**17.10**	**0.00**	**9.35**	**0.00**	**7.10**	**21.36**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

Additionally, the HSPF model calculated daily TSS values for this reach from 1996-2012. These values ranged from 2.7-300.9 mg/L with an average TSS concentration of 31.2 mg/L. Of these calculations, 1150 (18.52%) were above the 65 mg/L standard for TSS. This is a rather high exceedance rate.

The fish community in County Ditch 9 (-784) scored below average in eight of the ten suspended sediment related metrics at site 14MN058 when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 127). The reach did have an above average number of herbivorous and long-lived individuals, however it scored poorly in the remaining metrics.

The very small observed data set does not indicate potential issues regarding TSS. However, the HSPF model predicted a rather high exceedance rate. The majority of the suspended sediment related metrics in the fish assemblage also score below average when compared to streams in a similar class that pass their respective IBI threshold. Therefore, suspended sediment is a stressor to aquatic life in County Ditch 9 (-784) at this time.

Candidate Cause: Habitat

County Ditch 9 (-784) had a qualitative habitat assessment take place at biological monitoring site, 14MN058, during the fish sampling event in 2014. The MSHA score from this visit was 34.1 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, light stream shading, the abundance of sand and silt substrates, sparse fish cover, very little to no depth variability, moderate channel stability, poor channel sinuosity (Figure 130) and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 131.

Figure 130. Poor sinuosity at site 14MN058.

Figure 131. Habitat metic scores

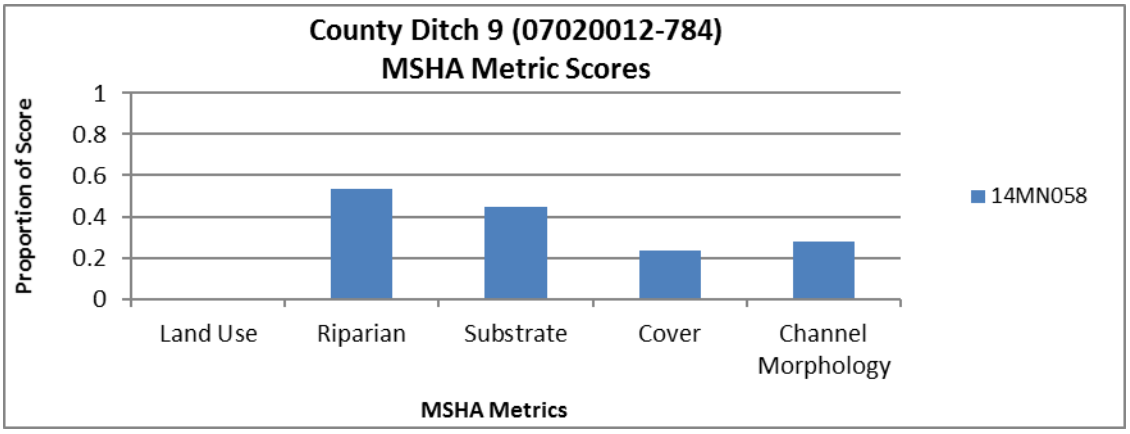


Table 228. Habita related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN058	**1.61**	**9.35**	**1.61**	**17.10**	**0.00**	**27.42**	**91.61**	**35.48**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 9 (-784) at biological station 14MN058 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 228). The most predominant fish species sampled was the fathead minnow (88). Fathead minnows are known to be very tolerant of degraded habitat conditions. To see this many fathead minnows at a site can be a signal for habitat stress.

There was not a macroinvertebrate sample taken at 14MN058 due to no habitat available to sample.

Based on the lack of habitat available, the poor MSHA score, as well as the below average fish habitat related metric scores in all eight categories, habitat is a stressor to aquatic life in County Ditch 9 (-784).

Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 969 to 1,030 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the small dataset was greater than 1,000 µS/cm.

Table 229. Metrics related to ionic strength

Station	**TaxaCountAllChir**	**EphemeropteraCh**	**EphemeropteraPct**	**EPTPct**	**Cent-TolPct**
14MN058	NA	NA	NA	NA	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**1**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 71% of the fish community. There was only one elevated specific conductance value in the small dataset. Without macroinvertebrate data it is hard to make any determinations. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 9 (-784).

Candidate Cause: Altered Hydrology/Connectivity

The reach and upstream watershed was 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 48% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 50.32% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 41.94% of the fish community. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat.

Conclusions and recommendations

The impaired fish community in County Ditch 9 (-784) is being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 230) Dissolved Oxygen and Chloride were inconclusive as stressors at this time. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 230. Stressors on County Ditch 9 (-784)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 9	07020012-784	o	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.6 Judicial Ditch 1(-785)

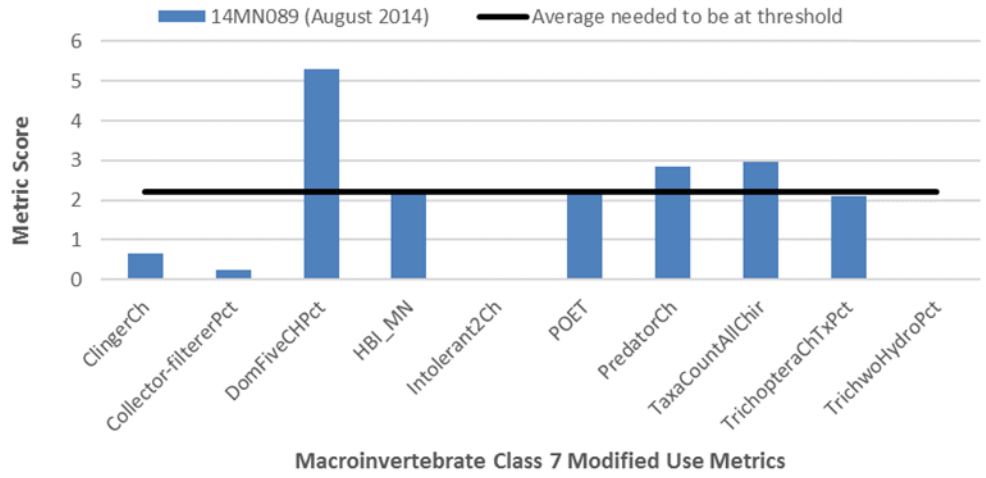
Judicial Ditch 1 (-785) is a 1.07 mile long reach located in southwestern Sibley county. This reach extends from CR 53 to the confluence with County Ditch 13. This reach is impaired for biology due to the macroinvertebrate assemblage found at its lone biological monitoring station 14MN089.

Biology

Macroinvertebrates

Judicial Ditch 1 (-785) was sampled for macroinvertebrates at biological monitoring station, 14MN089, in August of 2014. The MIBI during this visit was 16.1, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Three of the 10 metrics comprising the MIBI scored above the average needed to reach the threshold, however the remaining seven metrics scored below average or very poorly. Two of the metrics scored zero (Intolerant2Ch, TrichwoHydroPct), which severely limited the MIBI score. (Figure 132)

Figure 132. Biological metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 7.2 mg/L to 10.44 mg/L and were all collected at biological station 14MN089. The lowest value was sampled in July. Additionally, the HSPF model calculated daily minimum DO values in May-September

from 1996-2012. These values ranged from 0-14.0 mg/L with 12% of values below the water quality standard of 5 mg/L.

Table 231. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN089	23.53	5.88	6	33.19	8.21	1	4.64
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)	4.38	28.58	11.74				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				31.37	8.0	1.78	6.19
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The percentage of individuals that reproduce at a mature age was five times the class average of sites that meet the modified standard. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were far below the class average. Species that are very tolerant to low DO conditions comprised over 62% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. One macroinvertebrate intolerant taxa was collected and DO tolerant individuals comprised 33.19% of the population. Both the tolerant and intolerant macroinvertebrate numbers were right at the class averages of modified sites. Based on the preponderance of evidence, low DO is not a stressor. More DO samples would be helpful to better characterize the DO regime in Judicial Ditch 1 (-785).

Candidate Cause: Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.082 to 0.18 mg/L. The highest value was collected during July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-2.3 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.52 to 8.21.

Sensitive and darter individuals were not present at station 14MN089, which have a negative relationship with eutrophication. Tolerant individuals composed over 76% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was much higher than the class average of sites meeting the modified standard. Individuals of EPT species were present at low and the two most common macroinvertebrate species sampled comprised almost half of the population. The biological communities are showing the effects of the elevated phosphorus values and algal growth. Eutrophication is a stressor on Judicial Ditch 1 (-785).

Table 232. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN089	0	0	76.47	73.53	29	2.10	41.18
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**17.28**	**6.56**	**56.03**	**16.39**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

Three nitrate samples were taken from Judicial Ditch 1 (-785) from 2014-2016. These sample values ranged from 12-22 mg/L with an average nitrate concentration of 17.67 mg/L. A quantile regression analysis of macroinvertebrate Class 7 sites showed that when the nitrate concentration exceeded 11.5 mg/L, there was a 90% probability for impairment. In Judicial Ditch 1 (-785) exceeded this value in all three samples. Drain tiles were also present in this reach and are a likely source of high nitrates.

Table 233. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN089	**3.45**	**52.52**	**0.00**	**4.38**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Judicial Ditch 1 (-785) at site 14MN089 scored below average in three of the four nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 233). The stream reach had very few Trichoptera taxa, zero nitrate intolerant species, as well as a very poor Nitrogen TIV score. These results generally indicate a stream being negatively impacted by high nitrate levels.

Based on the high observed nitrate concentrations, the quantile regression analysis, the presence of drain tiles, as well as the majority of the nitrate related macroinvertebrate metrics, nitrates are a stressor to aquatic life in Judicial Ditch 1 (-785).

Candidate Cause: Sediment

From 2014-2016, a total of three TSS samples were taken from Judicial Ditch 1 (-785). These sample values ranged from 2.8-130 mg/L with an average value of 53.93 mg/L. Additionally, two secchi tube measurements were taken in 2014. These measurements were 16 cm on July 29, 2014 and 42 cm on August 18, 2014.

The HSPF model also calculated daily TSS concentrations for this subwatershed. These values ranged from 3.4-1,269 mg/L with an average value of 75.4 mg/L. Of these calculations, 1971 (31.74%) were above the 65 mg/L standard for TSS. This is a very high exceedance rate when compared to other areas in the Lower Minnesota River Watershed.

Table 234. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN089	**14.71**	**0.00**	**0.00**	**23.53**	**14.71**	**0.00**	**38.24**	**0.00**	**64.71**	**31.21**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 1 (-785) scored below average in five of the ten suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 234). The site, 14MN089, did have above average numbers of benthic feeder, riffle dwelling, perciformid (perch-like), simple lithophilic, and long lived individuals. However, the reach scored poorly in the remaining metrics and had a very poor TSS index score.

Table 235. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN089	**16.50**	**0**	**12**	**48.74**	**1.26**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN089 scored below average in all six of the suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 235). This reach completely lacked any TSS Intolerant and Plecoptera species, while also having few collector-filterer individuals. The TSS index score was slightly below average and there were many TSS tolerant taxa and individuals.

The very small observed data set in this reach did have a TSS sample that far exceeded the standard. The HSPF model also predicted a very high exceedance rate. While the fish community did score well in half of the suspended sediment related metrics, it also scored poorly in many of them including the index score. The macroinvertebrate assemblage scored poorly in all the metrics. Based on this information, suspended sediment is a stressor to aquatic life in Judicial Ditch 1 (-785).

Candidate Cause: Habitat

Judicial Ditch 1 (-785) had a qualitative habitat assessment take place at biological monitoring site, 14MN089, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 29.58 (Poor). Limiting the habitat conditions at this site was the land use, which was dominated by row crop agriculture, a very narrow riparian buffer, light stream shading, presence of silt and sand as substrates, no coarse substrates, heavy siltation, sparse fish cover, little depth variability, poor sinuosity (Figure 133), and poor channel development. See Figure 134 for a further breakdown of the MSHA category scores.

Figure 133. Lack of sinuosity at site 14MN089 (July 29, 20914)

Figure 134. Habitat metric scores

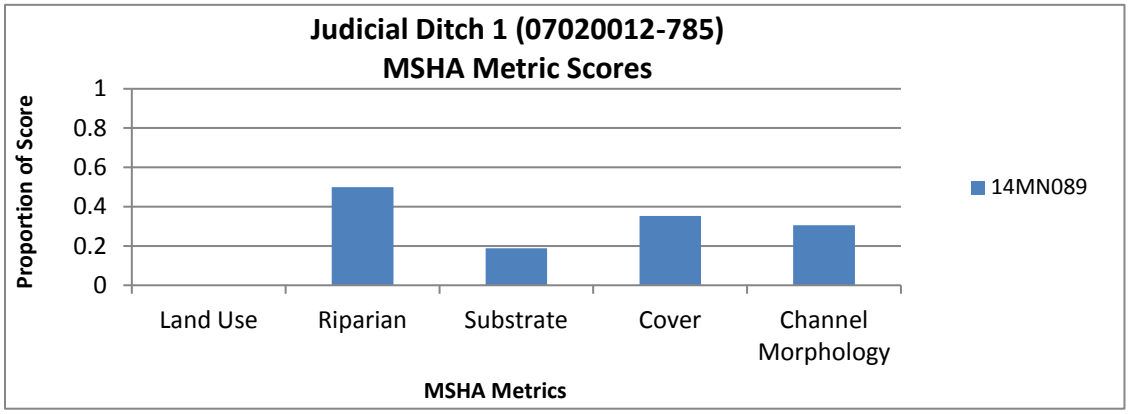


Table 236. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN089	**0.00**	**38.24**	**0.00**	**14.71**	**23.53**	**38.24**	**76.47**	**5.88**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 1 (-785) scored below average in three of the eight habitat related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 236). The fish assemblage consisted of predominantly tolerant species but was aided by the presence of eight young of the year Walleyes, which boosted many of the habitat metric scores.

Table 237. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN089	**23.53**	**55.04**	**1.26**	**2.10**	**84.87**	**10.08**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this stream reach scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 237). The community consisted of many legless individuals, primarily Physella. Physella are type of snail that generally feeds on algae and detritus, which is commonly found in degraded stream systems.

Based on the poor MSHA score and the majority of the macroinvertebrate habitat related metrics being below average, habitat is a stressor to the impaired macroinvertebrate community in Judicial Ditch 1 (-785). The fish community, minus the eight walleye captured, also resembles an assemblage likely impacted by degraded habitat conditions.

Candidate Cause: Chloride/Ionic strength

One chloride value was available on this reach, a result of 31.3 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 669 to 905 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000

µS/cm rarely meet the biological thresholds for streams (MBI, 2012). No values in the small dataset was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. EPT and mayfly (Ephemeroptera) individual percentages were far below the class average, while the taxa count were just slightly below the class average. The macroinvertebrate community was comprised of 56.30% conductivity tolerant individuals and 0 intolerant individuals.

Table 238. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN089	29	1	1.68	2.10	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**4.38**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	**33.59**	**3.45**	**16.52**	**20.58**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at any station. Species that are tolerant to conditions with high ionic strength comprised 62% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in Judicial Ditch 1 (-785).

Candidate Cause: Altered Hydrology/Connectivity

The reach and upstream watershed was 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 11% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 73.53% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 8.82% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 5.04% of the population. Based on extensive channelization, increased generalist fish, and decreased long-lived macroinvertebrates, altered hydrology is a stressor that is also affecting habitat in Judicial Ditch 1 (-785).

Conclusions and recommendations

The impaired macroinvertebrate community in Judicial Ditch 1 (-785) is being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 239) Chloride was inconclusive as a stressor at this time, while Dissolved Oxygen was ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see page 264.

Table 239. Stressors on Judicial Ditch 1 (-785)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 1	07020012-785	---	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

8.7 County Ditch 30 Branch A (-801)

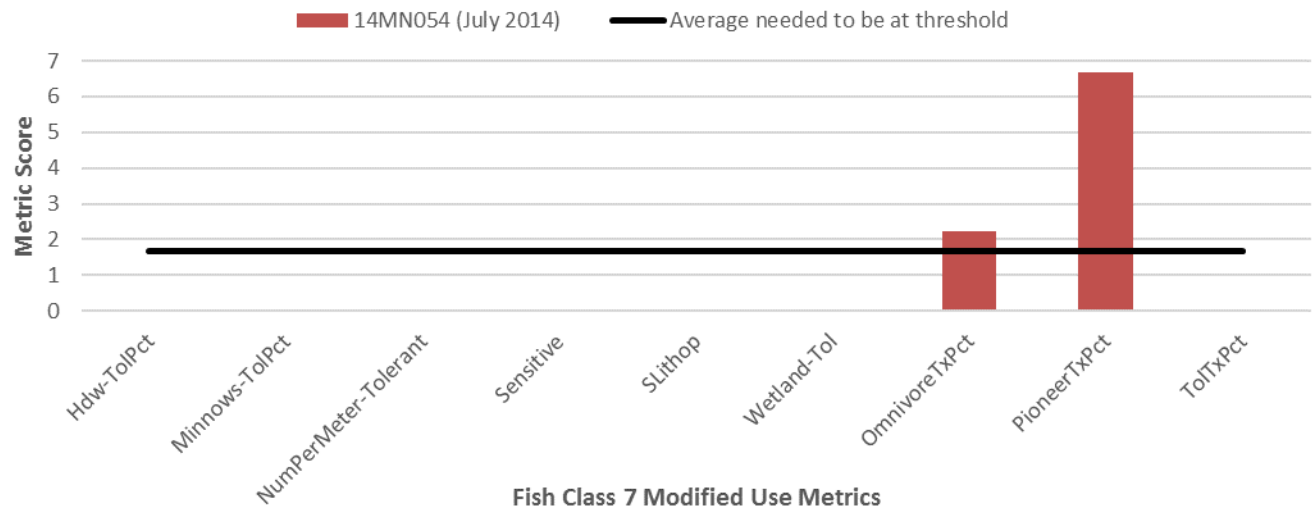
County Ditch 30 Branch A (-801) is a 2.19 mile long channelized stream reach that is located in central Nicollet county. This stream reach runs from an unnamed ditch to the confluence with Judicial Ditch 1A. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN054, located along this stream reach.

Biology

Fish

County Ditch 30 Branch A (-801) was sampled for fish at its biological monitoring station, 14MN054, in July of 2014. The FIBI score from this visit was 8.9, which is below the Fish Class 7 Low Gradient Modified Use Threshold of 15. Two of the nine metrics scored above the average needed to reach the threshold (OmnivoreTxPct, PioneerTxPct), while the remaining seven metrics comprising the FIBI scored zero. (Figure 135).

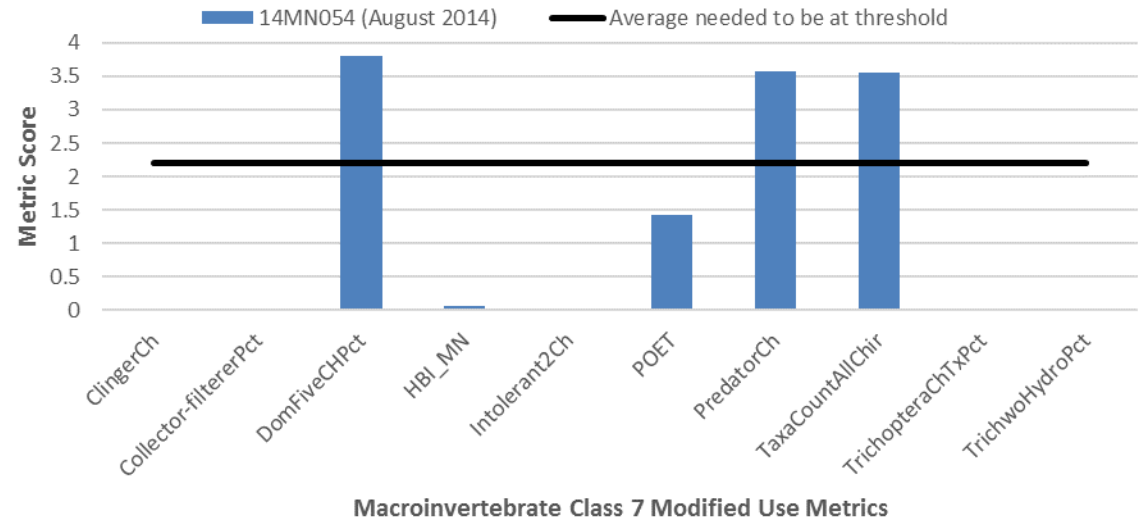
Figure 135. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled along this reach in August of 2014 at site 14MN054. The MIBI score for this visit was 12.4, which is below the Macroinvertebrate Class 7 Prairie Streams GP Modified Use Threshold of 22. Three of the ten metrics comprising the MIBI scored above the average needed to reach the threshold, however, of the seven metrics that did not reach this level, five metrics scored zero which severely limited the MIBI score. (Figure 136)

Figure 136. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset on this reach in recent years. Concentrations ranged from 3.51 mg/L to 10.7 mg/L. Continuous data was recorded at station 14MN054 in 2016, values below 5 mg/L each day during deployment (Figure 137). The lowest value recorded during deployment was 1.77 mg/L.

Figure 137. Continuous DO data on site 14MN054

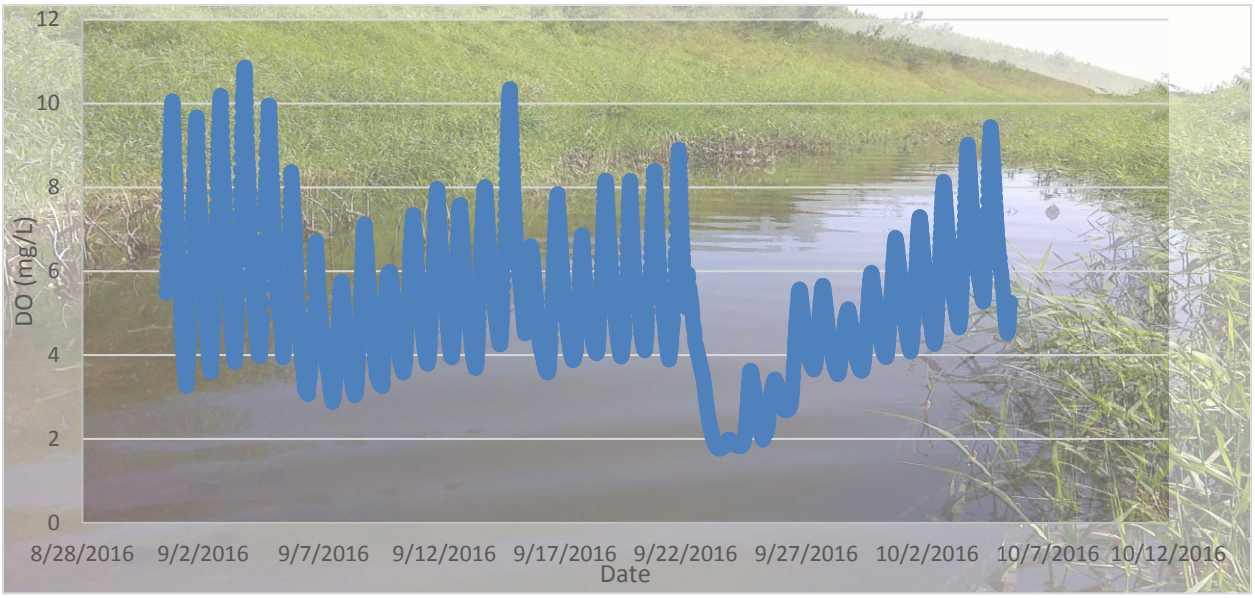


Table 240. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN054	0	20.91	5	30.23	8.85	0	4.91
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**4.38**	**28.58**	**11.74**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-13.1 mg/L with 29% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals that reproduce at a mature age were present. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were just below the class average. Species that are very tolerant to low DO conditions comprised over 99% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 30.23% of the

population. DO had a low value of 1.77 mg/L. The preponderance of evidence indicates low DO is a stressor to the biological communities in County Ditch 30 Branch A (-801).

Candidate Cause: Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.11 to 0.324 mg/L. The highest value was collected during August. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-2.1 mg/L with a mean of 0.28 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, DO flux, and chlorophyll-a data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.42 to 8.15. Thick algae and macrophytes were located at the site (Figure 138).

Figure 138. Algae at site 14MN054 (August 31, 2016)

Sensitive and darter individuals were not present at station 14MN054, which have a negative relationship with eutrophication. Tolerant individuals composed over 100% of the community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was higher than the class average of sites meeting the modified standard. Individuals of EPT species were present at lower than class average, and the two most common macroinvertebrate species sampled comprised less than half of the population. The biological communities are showing the effects of the elevated phosphorus values and algal growth. Eutrophication is a stressor on County Ditch 30 Branch A (-801).

Table 241. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN054	**0**	**0**	**100**	**34.55**	**31**	**11.58**	**40.19**
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**17.28**	**6.56**	**56.03**	**16.39**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

County Ditch 30 Branch A had two nitrate samples taken from 2014-2016. The values of these samples were 12 mg/L on July 30, 2014 and 36 mg/L on October 5, 2016. Both of these values are elevated. Quantile regression analysis for a macroinvertebrate Class 7 stream showed that when nitrate levels exceeded 11.5 mg/L, there was a 90% probability for a macroinvertebrate impairment. Both nitrate samples were above this and one sample was over three times that value. Additionally, the monitoring location has drain tile (Figure 139), which is a common source for higher concentrations of nitrates.

The HSPF model also calculated daily nitrate concentrations for this reach from 1996-2014. These values ranged from 0.2-24.5 mg/L with an average nitrate concentration of 5.8 mg/L. The model calculated nitrate values that were above 11.5 mg/L in this reach 5.1% of the time.

Figure 139. Drain tiles at site 14MN054 (July 30, 2014)

Table 242. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN054	**0.00**	**67.20**	**0.00**	**4.93**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN054 scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold. (Table 242). The nitrogen TIV score was very indicative of a community affected by high nitrate levels. Additionally, the lack of nitrate intolerant species and Trichoptera were also strong signals of nitrate issues.

Based on the collected sample values, the quantile regression analysis, the poor scoring nitrogen related metrics, and the presence of drain tiles all strongly indicate that nitrates are a stressor to the impaired biological communities in County Ditch 30 Branch A (-801).

Candidate Cause: Sediment

One TSS sample was taken from County Ditch 30 Branch A (-801) in 2014. This value was 14 mg/L on July 30, 2014. Also, two secchi tube readings were taken along this reach in 2014. These values were 58 cm on July 30, 2014 and 9 cm on August 14, 2014. The latter sample was below the 10 cm standard for transparency.

Additionally, the HSPF model calculated daily TSS concentrations from 1996-2012 along this reach. These values ranged from 3.5-242.4 mg/L with an average value of 22.9 mg/L. Of these calculations, 549 (8.84%) were above the 65 mg/L standard for TSS.

Table 243. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN054	**0.91**	**0.00**	**2.73**	**0.00**	**0.91**	**0.00**	**0.00**	**0.00**	**13.64**	**19.90**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in this reach at site 14MN054 scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 243). This reach did have an above average number of long-lived individuals, but scored poorly in the remaining metrics.

Table 244. Sediment related macroinvertbrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN054	**17.51**	**0**	**12**	**49.52**	**0.32**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 30 Branch A (-801) scored below average in all six of the suspended sediment related metrics when compared to all other Class 7 Prairies Streams GP stations that meet the MIBI Modified Use Threshold (Table 244). The site, 14MN054, completely lacked any TSS intolerant and Plecoptera taxa, while also having a high number of TSS tolerant taxa and TSS tolerant individuals. The TSS index score was also below average.

The observed data set is very limited in this reach. One of the secchi tube measurements did fall below the 10 cm standard. The HSPF model predicated a moderate amount of standard exceedances. Also, the vast majority of the suspended sediment related metrics in both of the fish and macroinvertebrate communities scored below average. Therefore, suspended sediment is a stressor to aquatic life in County Ditch 30 Branch A (-801).

Candidate Cause: Habitat

County Ditch 30 Branch A (-801) had a qualitative habitat assessment take place at its biological monitoring site, 14MN054, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 25 (Poor). Limiting the habitat at this site was row crop agriculture as the predominant land use, a narrow riparian buffer, moderate bank erosion, light stream shading, sand and silt substrates, no course substrates, limited depth variability, moderate channel stability, poor sinuosity (Figure 140), and poor channel development. Further MSHA analysis can be seen in Figure 141.

Figure 140. Lack of sinuosity at site 14MN054 (July 30, 2014)

Figure 141. Habitat metric scores

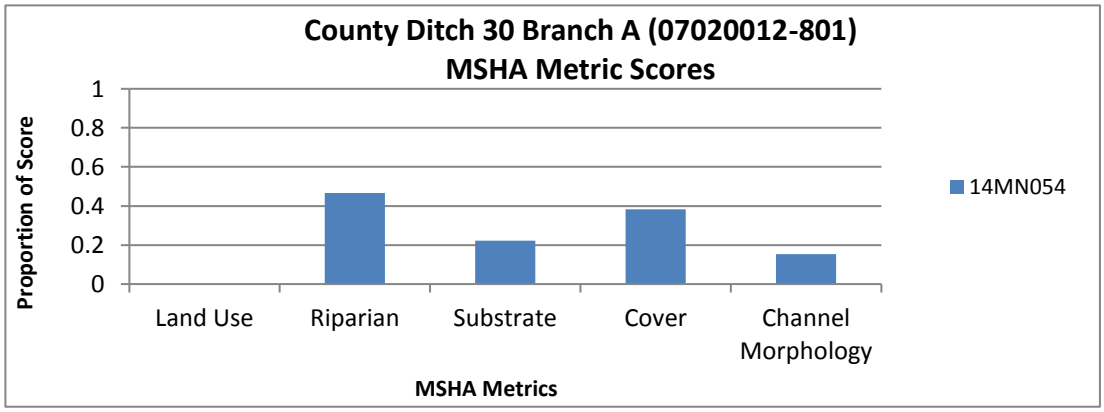


Table 245. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN054	**0.00**	**0.91**	**0.00**	**0.91**	**0.00**	**0.91**	**100.00**	**20.91**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN054 scored below average in all of the habitat related metrics when compared to all other Class 7 Low Gradient stations that met the FIBI Modified Use Threshold (Table 245). The fish assemblage was dominated by brook sticklebacks, fathead minnows, and common carp. All of these species are tolerant of limited or degraded habitat conditions.

Table 246. Habitat related macroinvertebrate metrics

Station	**BurrowerPct**	**ClimberPct**	**ClingerPct**	**EPTPct**	**LeglessPct**	**SprawlerPct**
14MN054	**8.68**	**55.31**	**0.64**	**11.58**	**62.70**	**27.65**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage in County Ditch 30 A (-801) scored below average in half of the habitat related macroinvertebrate metrics when compared to other Class 7 Prairie Streams GP stations that did meet the MIBI modified use threshold. (Table 246). The macroinvertebrate community consisted of high number of Branchiobdellida (a parasitic annelid) and Physella (type of snail) that can be very common in streams with degraded conditions and fine substrates.

Based on the poor MSHA score as well as the many poor scoring fish and macroinvertebrate habitat related metrics in addition to the photographic evidence of degraded conditions in this modified reach, habitat is a stressor to the biological communities in County Ditch 30 Branch A (-801).

Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 917 to 1,155 µS/cm. Continuous daily data collected in September 2016 contained 90% of values over 1,000 µS/cm with a high of 1,160 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than

1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Two values in the small dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. EPT and mayfly (Ephemeroptera) individual percentages were both below the class average, while the taxa count was just slightly below the class average. The macroinvertebrate community was comprised of 73% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at any station. Species that are tolerant to conditions with high ionic strength comprised 98% of the fish community. There were numerous elevated specific conductance values in the daily continuous dataset, and the biological communities had indications of stress, particularly the number of conductivity tolerant fish and macroinvertebrates. Taking chloride values throughout the year would be helpful, currently ionic strength is inconclusive as a stressor.

Table 247. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN054	31	2	11.58	11.58	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**4.38**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	**33.59**	**3.45**	**16.52**	**20.58**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

The reach and upstream watershed was 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this

section is experiencing low flow at less than 1 cfs 34% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 34.55% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 83.64% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 15.43% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in County Ditch 30 Branch A (-801).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 30 Branch A (-801) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Habitat, and Flow Alteration/Connectivity.(Table 248) Chloride was inconclusive as a stressor at this time. For further information on the stressors and recommendations to fixing the stressors in the South Branch Rush River HUC 10 watershed, please see below.

Table 248. Stressors on County Ditch 30 Branch A (-801)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 30 Branch A	07020012-801	●	●	●	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

South Branch Rush River HUC 10 Conclusions and Recommendations

The South Branch Rush River subwatershed has seven biological impaired streams that are being negatively impacted by many stressors throughout the watershed. Stressors found in at least six of the seven impaired reaches include Eutrophication, Nitrate, Suspended Sediment, Habitat, and Flow Alteration/Connectivity. Additional monitoring for Dissolved Oxygen and Chloride is needed to better determine the extent and impact of those stressors.

Like the previous watersheds mentioned, the predominant land use in this subwatershed is row crop agriculture. This is a significant contributor to the stressors found in these reaches. The land use combined with the channelization of these stream reaches and their tributaries are a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

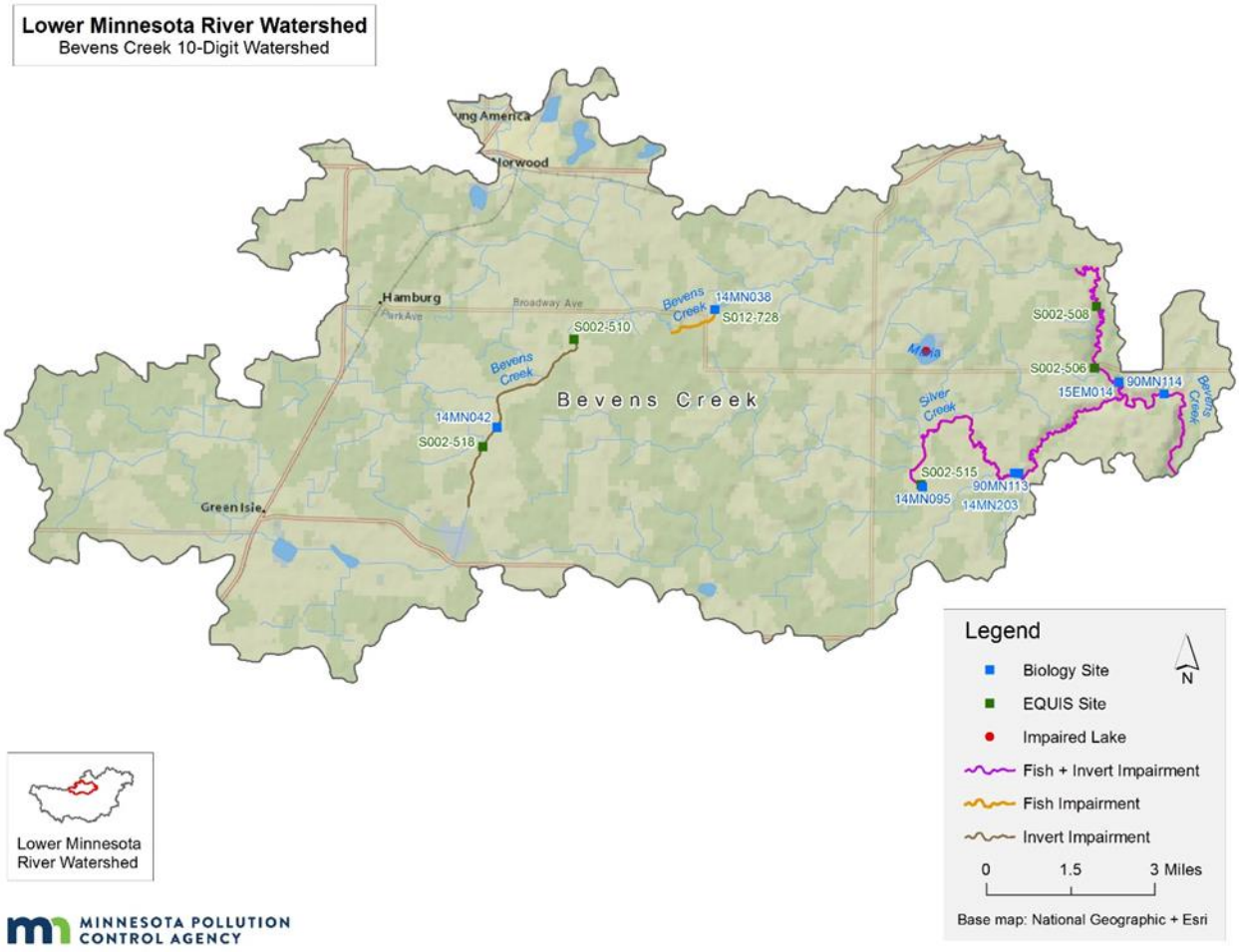
A large effort is needed in the South Branch Rush River watershed to improve biological conditions in the many impaired streams found throughout. A high priority in this watershed should be to better manage the flow alteration and the effects of it. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Also, utilizing a variety of nutrient reducing Best Management Practices (BMPs) including: cover crops, nutrient management, saturated buffers, etc., will also help in the nitrate and phosphorus reduction. This could also help with the eutrophication and resulting dissolved oxygen issues as well.

Table 249. Stressors on streams in the South Branch Rush River HUC 10

		Stressors:						
Stream Name	AUID	Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
South Branch Rush River	07020012-825	●	●	●	●	●	●	o
South Branch Rush River	07020012-826	---	●	●	●	o	o	---
County Ditch 13	07020012-636	o	●	●	●	●	●	o
County Ditch 32A	07020012-783	o	●	●	---	●	●	o
County Ditch 9	07020012-784	o	●	●	●	●	●	o
Judicial Ditch 1	07020012-785	---	●	●	●	●	●	o
County Ditch 30 Branch A	07020012-801	●	●	●	●	●	●	o

9. Bevens Creek HUC 10 (0702001207)

Figure 142. Sampling sites in the Bevens Creek HUC



9.1 Bevens Creek (-514)

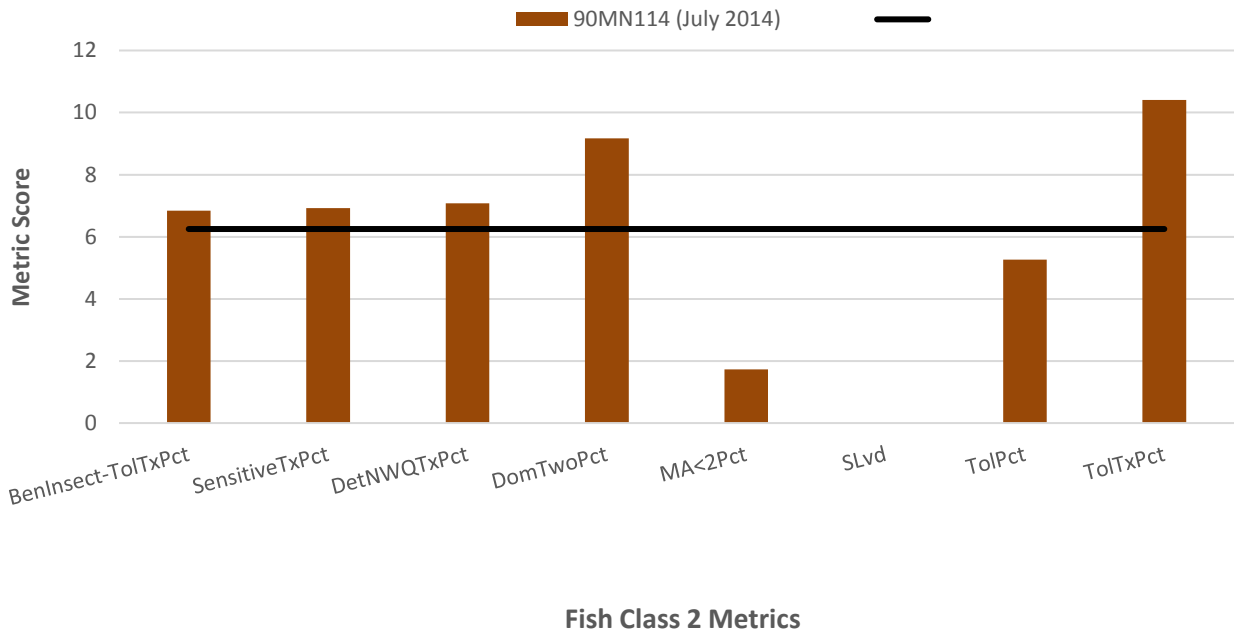
Bevens Creek (-514) is a 3.62 mile stream reach that extends from Silver Creek to the confluence with the Minnesota River in southern Carver county. The stream section is impaired for biology due to both its fish and macroinvertebrate assemblages. There are two biological monitoring stations, 00MN012 and 90MN114, located along this reach. This reach is also impaired for Turbidity.

Biology

Fish

Bevens Creek (-514) was sampled for fish at biological monitoring station, 90MN114, in July of 2014. This visit had an FIBI of 47.4, which is slightly below the Fish Class 2 Southern Streams General Use Threshold of 50. Five of the eight metrics comprising the FIBI scored above the average needed to reach the threshold. The high presence of early maturing (MA<2Pct) and short-lived (SLvd) individuals resulted in lower metric scores limiting the FIBI (Figure 143).

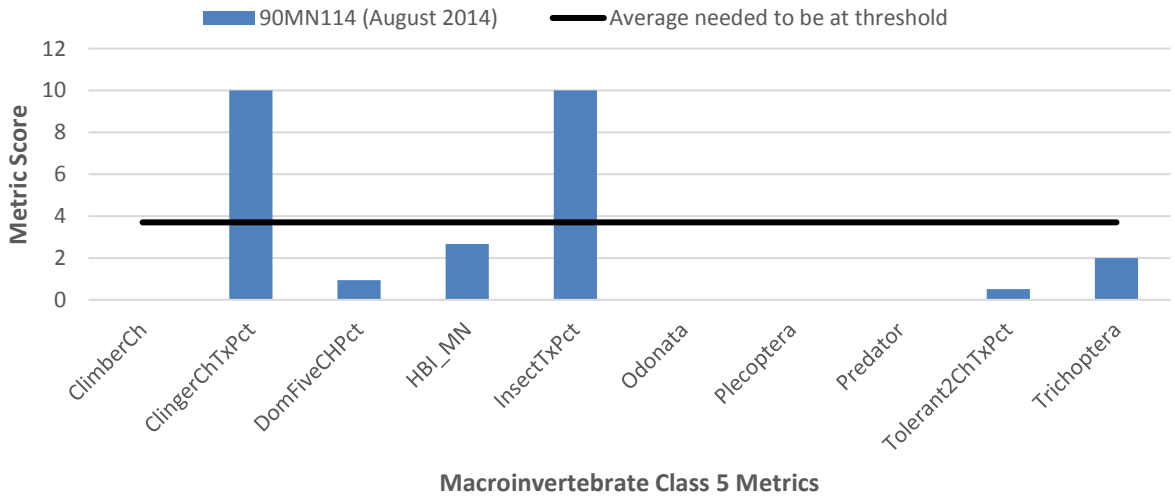
Figure 143. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled at site 90MN114 in August of 2014. The MIBI score during this visit was 26.1, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Only two of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold (ClingerChTxPct, InsectTxPct). Four of the eight metrics falling below the average needed to reach the threshold scored zero severely limiting the MIBI score for this site. (Figure 144).

Figure 144. Macroinvertebrarte metric scores



Candidate Cause Dissolved Oxygen

There is a considerable DO dataset on this reach during 2004-2015. Concentrations ranged from 1.23 mg/L to 14.75 mg/L with two values below the DO standard of 5 mg/L. All values were collected at CSAH 40. The range of values is an indication of possible DO fluctuations.

Table 250. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
90MN114	5.13	65.81	32	0.93	7.44	6	7.75
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 5.5-14.2 mg/L without any values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. A low number of individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were more than two times the class average of those sites meeting the general standard. Species that are very tolerant to low DO conditions comprised 16.4% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Six macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised less than 1% of the population. Low DO is not a stressor to the macroinvertebrate community. While there was one very low DO value collected in 2004 (1.23 mg/L), the biological evidence is mixed. Low DO as a stressor is inconclusive for the fish community. The DO values of 1.23 mg/L and 14.75 mg/L were both collected in 2004, and are indicative of eutrophication. Collecting continuous DO data would be helpful.

Candidate Cause Eutrophication

Phosphorus values ranged from 0.054 to 2.93 mg/L with over 50% of values over the southern standard of 0.150 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 8% in May to 97% in September and an average of 70%. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. The dataset of chlorophyll-a samples had a range of values from 1.2 to 120, with 14 values over

the southern standard of 40. The range of BOD values was from 1 to 15 with 25 values over the southern standard of 3.5 mg/L. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 6.85 to 8.87 with 22 values over 8.5

Table 251. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
90MN114	8.3	2.81	55.19	7.33	23	67.60	47.35
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The percentage of sensitive individuals in the fish community was right at the class average for those sites meeting the general standard. The darter percentage was lower than the class average. Tolerant individuals composed just more than half of the community, less than the class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was also less than the class average. Individuals of EPT species were present at levels above the class average but were dominated by Cheumatopsyche and Ceratopsyche, caddisflies that can tolerate eutrophic conditions. The two most common macroinvertebrate species sampled comprised almost half of the population. The macroinvertebrate community is showing the effects of the elevated phosphorus, chlorophyll-a, pH, and BOD values while the fish response is more mixed. Eutrophication is a stressor on this section of Bevens Creek (-514).

Candidate Cause Nitrate

From 2004-2014 a total of 19 nitrate samples were collected from Bevens Creek (-514). These values ranged from 0.51-22.2 mg/L with an average value of 7.15 mg/L. Eleven of the samples were taken in 2014 and their average value was 3.68 mg/L.

Table 252. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
90MN114	17.39	56.07	0.00	3.41
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in three of the four nitrate related metrics evaluated when compared to all other Class 5 Southern Streams RR stations that met the MIBI General Use Threshold (Table 252). The site, 90MN114, did have an above average amount of Trichoptera individuals; however, the site did also have higher numbers of nitrate tolerant individuals, zero nitrate intolerant species, and a poor scoring nitrate TIV score.

Nitrate concentrations in Bevens Creek (-514) do get elevated at times, which is likely resulting in the lack of nitrate intolerant species, as well as the high amount of nitrate tolerant taxa observed. The nitrogen TIV score also indicates a macroinvertebrate community that is generally tolerant to high levels of nitrates. Nitrates are a stressor to aquatic life in Bevens Creek (-514) at this time.

Candidate Cause Sediment

From 2007-2014, a total of 19 TSS samples were taken from Bevens Creek (-514). These samples ranged from 4-552 mg/L with an average TSS concentration of 117.21 mg/L. Eight of the samples were above the 65 mg/L TSS standard. Additionally, 52 secchi tube measurements were taken along this reach from 2000-2015. These values ranged from 3-100 cm, with an average reading of 43.02 cm. Four of the measurements were at or below the 10 cm standard. This reach was listed as impaired for turbidity from a 2002 assessment.

Table 253. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
90MN114	**42.44**	**0.26**	**33.33**	**8.67**	**41.33**	**8.65**	**20.26**	**0.79**	**6.52**	**30.83**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-514) scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 253). The site, 90MN114, did have an above average amount of benthic feeder, riffle dwelling, and herbivorous individuals; however, this site scored poorly in the other metrics likely indicating stress.

Table 254. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
90MN114	**17.22**	**0**	**10**	**41.43**	**63.24**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in four of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 254). The site, 90MN114, did have a lower amount of TSS tolerant taxa and an above average amount of collector-filterer individuals; however, this reach had a poor TSS index score, a high amount of TSS tolerant individuals, as well as a complete lack of TSS intolerant and Plecoptera taxa. These results are common in streams being negatively impacted by suspended sediment.

Based on the high observed TSS values, with many exceeding the standard, the majority of both of the fish and macroinvertebrate metrics related to suspended sediment falling below average, as well as the current turbidity impairment along this reach, suspended sediment is a stressor to aquatic life in Bevens Creek (-514).

Candidate Cause Habitat

Bevens Creek (-514) had a qualitative habitat assessment take place at its biological monitoring site, 90MN114, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 58.58 (Fair). Limiting the MSHA was the presence of some row crops in the nearby land use, severe bank erosion (Figure 146), light stream shading, some sandy substrates, and moderate to low channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 147.

Figure 145. Eroded bank at site 90MN114.

Figure 146. Habitat metric scores

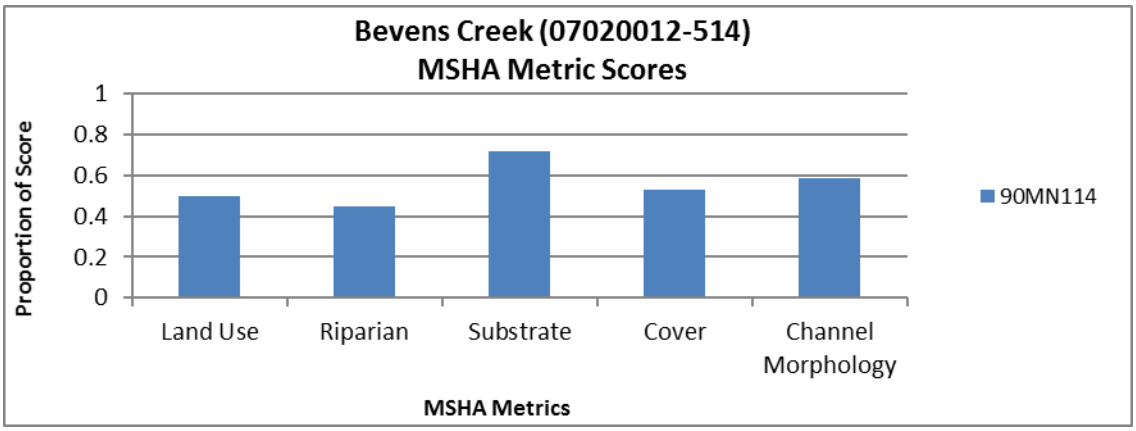


Table 255. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
90MN114	**15.03**	**20.26**	**9.99**	**41.33**	**1.97**	**55.88**	**67.35**	**10.27**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-514) scored below average in six of the eight habitat related metrics when compared to all other Class 2 Southern Streams that meet the FIBI General Use Threshold (Table 255). While site 90MN114, did have some habitat specializing species the numbers of these specialists were low. The site instead had many tolerant taxa.

Table 256. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
90MN114	**1.56**	**12.77**	**76.95**	**67.60**	**21.50**	**1.56**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at Bevens Creek (-514) scored below average in just one of the six evaluated habitat metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 256). The monitoring site, 90MN114, only had a below average amount of Sprawler Individuals.

The habitat related metrics in the fish and macroinvertebrate communities scored very differently as many fish metrics suggested a habitat stressor and most macroinvertebrate metrics did not. The MSHA score at this site scored Fair. While habitat may be contributing to some stress, it is inconclusive if habitat should be considered a stressor with the current data set in Bevens Creek (-514).

Candidate Cause: Chloride/Ionic strength

Numerous chloride values were available on this reach, ranging from 11.6 to 92 mg/L, all values below the water quality standard of 128 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 339 to 932 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset were greater than 1,000 µS/cm.

Table 257. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
90MN114	23	8	17.13	67.60	0.61
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**36.82**	***4.43***	***17.02***	***33.60***	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) percentage was more than double the class average and the EPT percentage was right at the class average, while the taxa count was below the class average. The macroinvertebrate community was comprised of 45% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Less than 1% of Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 18% of the fish community. There were no elevated chloride or specific conductance values in the dataset, and the preponderance of biological data indicates ionic strength is not a stressor in Bevens Creek (-514).

Candidate Cause: Altered Hydrology/Connectivity

The reach of Bevens Creek is 100% natural, however an analysis of the MPCA altered watercourse layer measured 86.39% of the Bevens Creek sub-watershed as channelized. Upstream channelization and tile drainage alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities. There were no known connectivity issues.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 19.90% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 7.20% of the fish community. Long-lived

macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. Based on the lack of low flow periods shown in the models and the preponderance of evidence, altered hydrology is not a stressor in Bevens Creek (-514).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Bevens Creek (-514) are being stressed by Eutrophication, Nitrates, and Suspended Sediment.(Table 258) Habitat was inconclusive as a stressor at this time, while Dissolved Oxygen, Flow Alteration/Connectivity, and Chloride were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Bevens Creek HUC 10 watershed, please see page 311.

Table 258. Stressors on Bevens Creek (-514

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Bevens Creek	07020012-843	o	●	●	●	o	---	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

9.2 Bevens Creek (-843)

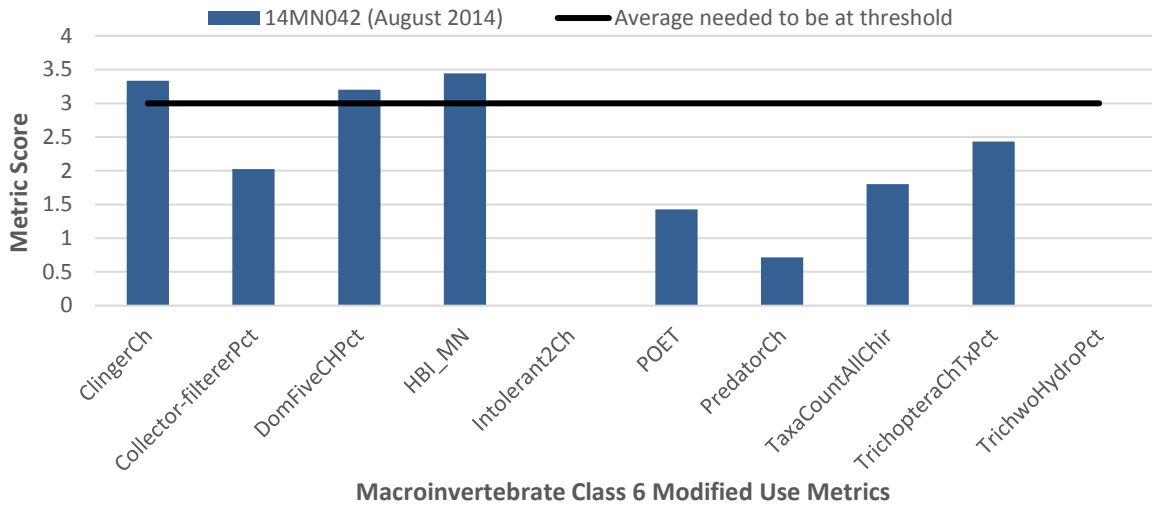
Bevens Creek (-843) is a 4.12 mile stream reach that extends from Washington Lake to the 154th Street at the border of Carver and Sibley counties. The stream section is impaired for biology due to its macroinvertebrate assemblage. There is one biological monitoring stations, 14MN042, located along this reach. This reach is also impaired for nutrients/eutrophication.

Biology

Macroinvertebrates

Bevens Creek (-843) was sampled for macroinvertebrates at biological monitoring station, 14MN042, in August of 2014. The MIBI during this visit was 18.4, which is below the Macroinvertebrate Class 6 Southern Forest Streams GP Modified Use Threshold of 30. Three of the ten metrics comprising this MIBI scored above the average needed to reach the threshold (ClingerCh, DomFiveCHPct, HBI_MN) while the remaining seven metrics scored below average. Two of the metrics (Intolerant2Ch, TrichwoHydroPct) scored zero limiting the MIBI score at this site (Figure 147).

Figure 147. Biological metric scores



Candidate Cause Dissolved Oxygen

There is a considerable DO dataset on this reach in recent years. Concentrations ranged from 3.27 mg/L to 12.97 mg/L with 32% of values below a value of 5 mg/L. Continuous data were recorded at station 14MN042 in 2016 with a low value of 3.28 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.6-13.7 mg/L with 11% of values below the water quality standard of 5 mg/L. The majority of low-modelled values were in the upper section of the reach just downstream of Washington Lake.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There were no fish present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was two times the class average of those sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised 63% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised more than 73% of the population. The biological communities are showing the effects of the low DO values. DO is a stressor is on this section of Bevens Creek (-843).

Table 259. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN042	0	20.44	10	73.73	7.82	0	6.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Phosphorus values ranged from 0.044 to 3.65 mg/L with over 80% of values over the southern standard of 0.150 mg/L taken at station 14MN042 sampled during 2004-2016. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 8% in May to 97% in September and an average of 70%. Additionally, the HSPF model calculated daily mean TP concentrations from 1996-2012. These values ranged from 0-0.8 mg/L with a mean of 0.2 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. The dataset of chlorophyll-a samples had a range of values from 32 to 99, with 6 values over the southern standard of 40. BOD and DO flux data were not available. As a result of eutrophication, pH values also increase. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values range from 7.62 to 8.53 with one value over 8.5. Algal growth was recorded at station 14MN042 (Figure 149).

Figure 148. Alagal grow at site 14MN042

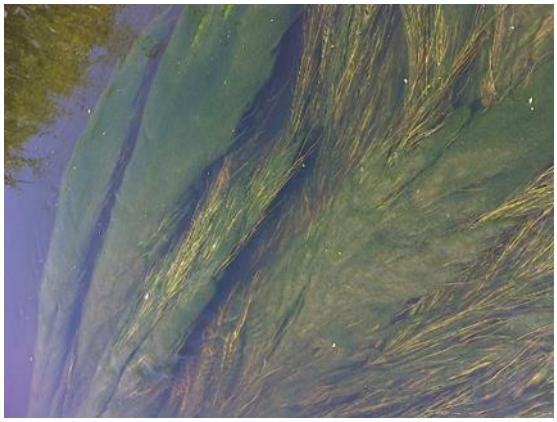


Table 260. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN042	0	5.35	94.34	33.96	25	2.54	56.19
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					**36.65**	**18.11**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

There were no sensitive individuals in the fish community. The darter percentage was lower than the class average for those sites meeting the modified standard. Tolerant individuals composed just more than 94% of the community, more than the class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was also more than the class average. Individuals of EPT species were present at low levels. The two most common macroinvertebrate species sampled comprised more than half of the population. The macroinvertebrate community is showing the effects of the elevated phosphorus and chlorophyll-a values while the fish response is more mixed. Eutrophication is a stressor on this headwater section of Bevens Creek (-843).

Candidate Cause Nitrate

From 2004-2016, 144 nitrate samples were taken from Bevens Creek (-843). These sample values ranged from 0.05-25.8 mg/L, with an average nitrate concentration of 4.59 mg/L. Additionally, the HSPF model calculated daily nitrate values for this reach from 1996-2012. These values ranged from 1.0-18.9 mg/L with an average nitrate concentration of 5.2 mg/L.

Table 261. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN042	**4.00**	**31.33**	**0.00**	**2.72**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Bevens Creek (-843) scored below average in two of the four nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 261). The stream had a good nitrogen TIV score, while also having a low amount of nitrate tolerant taxa. The reach did also lack nitrate intolerant species and had a low amount of Trichoptera taxa.

Based on the good Nitrogen TIV score, the low numbers of nitrate tolerant taxa, the low observed and modeled averages, nitrates are not a stressor to aquatic life in Bevens Creek (-843). Nitrate values in this reach can reach elevated levels during the spring months and may need to be further monitored to determine long term impacts on aquatic life in Bevens Creek (-843).

Candidate Cause: Sediment

From 2004-2016, a total of 156 TSS samples were taken from Bevens Creek (-843). These values ranged from 1-1,780 mg/L with an average TSS concentration of 49.08 mg/L. Seventeen (10.9%) of the TSS samples were in excess of the 65 mg/L TSS standard. Additionally, from 2004-2015 a total of 97 secchi tube measurements were made along this reach. These values ranged from 9-100 cm with an average reading of 44.41 cm. Only one of the measurements was below the 10 cm standard for transparency.

The HSPF model also calculated daily TSS values for this reach. These values ranged from 1.5-567.3 mg/L with an average TSS concentration of 15.3 mg/L. Only 1.53% of the calculations were above the 65 mg/L TSS standard.

Table 262. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN042	**19.50**	**0.00**	**3.14**	**5.35**	**14.15**	**0.00**	**15.41**	**0.00**	**0.00**	**16.33**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-843) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 263). These poor scores are a strong signal for suspended sediment stress.

Table 263. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN042	**16.31**	**0**	**12**	**21.20**	**7.94**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in five of the six suspended sediment related metrics at site 14MN042 when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 264). The reach did have a lower amount of TSS tolerant individuals, but had a high amount of TSS tolerant taxa. The reach also had few collector-filterer individuals, a complete lack of a Plecoptera and TSS intolerant taxa, as well as a poor TSS index score.

Based on the higher exceedance rate from the observed TSS data, along with the vast majority of the suspended sediment related metrics scoring poorly in the fish and macroinvertebrate communities, suspended sediment is indeed a stressor to aquatic life in Bevens Creek (-843). scores.

Candidate Cause: Habitat

Bevens Creek (-5843) had a qualitative habitat assessment take place at biological monitoring site, 14MN042, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 45 (Poor). Limiting the MSHA was the presence of some row crops in the nearby land use; narrow to moderate riparian buffers, light stream shading, some silt and sand substrates, poor sinuosity (Figure 149) and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 150.

Figure 149. Lack of sinuosity at site 14MN042 (August 6, 2014

Figure 150. Habitat metric scores

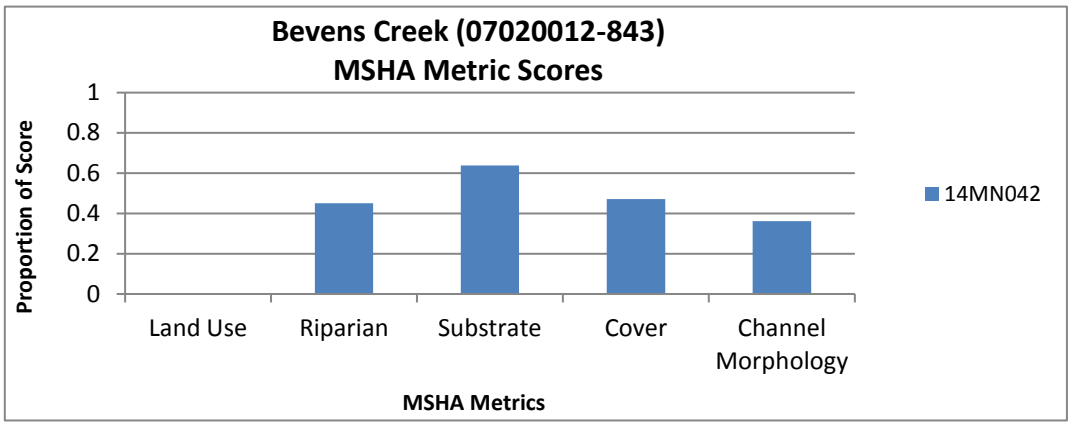


Table 264. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN042	**5.35**	**15.41**	**5.35**	**14.15**	**0.00**	**31.76**	**94.34**	**41.51**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-843) at site 14MN042 scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 265). The five most abundant species found: central mudminnow, fathead minnow, brook stickleback, creek chub, and white sucker are all species that are tolerant of degraded habitat conditions.

Table 265. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN042	**22.22**	**5.71**	**19.05**	**2.54**	**46.98**	**45.08**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**11.49**	**23.84**	**24.46**	**14.44**	**61.44**	**22.59**
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN042 scored below average in four of the six evaluated habitat metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 266). The low amount of EPT, clinger, and climber taxa as well as the increased number of burrower individuals can all signal poor habitat conditions.

Based on the majority of the habitat related metrics in both of the fish and macroinvertebrate communities as well as the poor MSHA score signals that the biological communities are indeed stressed by the habitat conditions in Bevens Creek (-843).

Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 398 to 1,024 µS/cm. Daily continuous data collected in July 2016 contained all values below 450 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the dataset was greater than 1,000 µS/cm.

Table 266. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN042	25	2	2.54	2.54	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	36.65	*3.27*	*12.38*	*18.10*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages and taxa count were all below class average. The macroinvertebrate community was comprised of 44.62% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 40% of the fish community. There was one elevated specific conductance value in the dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in Bevens Creek (-843).

Candidate Cause: Altered Hydrology/Connectivity

This reach of Bevens Creek is 100% modified according to the MPCA altered watercourse layer, which also measured 86.39% of the Bevens Creek sub-watershed as channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 21% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 51.57% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising of 44.34% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. Based on extended low flow periods shown in the models and the biological communities, altered hydrology is a stressor that is also affecting habitat in Bevens Creek (-843).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Bevens Creek (-843) are being stressed by Eutrophication, Nitrates, and Suspended Sediment.(Table 267) Habitat was inconclusive as a stressor at this time, while Dissolved Oxygen, Flow Alteration/Connectivity, and Chloride were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Bevens Creek HUC 10 watershed, please see page 311.

Table 267. Stressors on Bevens Creek (-843)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Bevens Creek	07020012-843	●	●	---	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

9.3 Bevens Creek (-845)

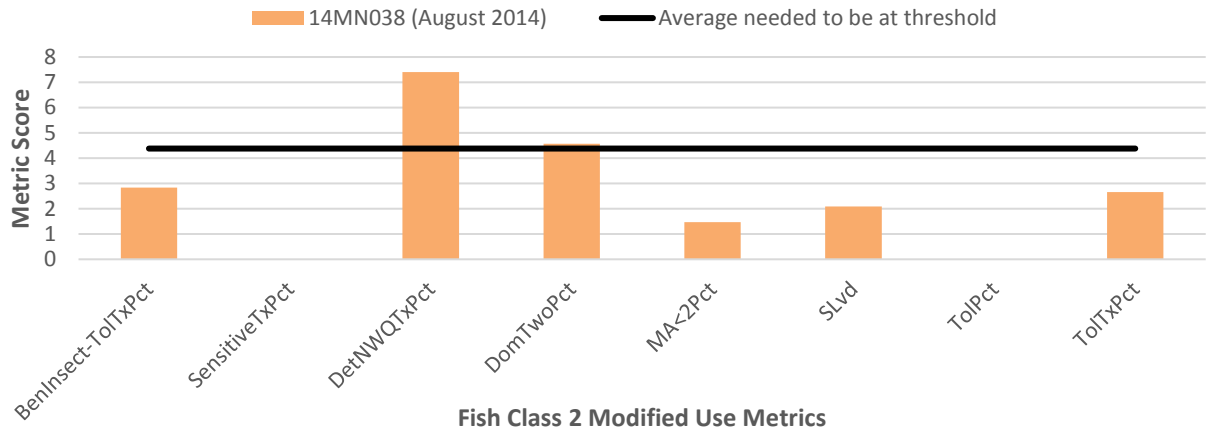
Bevens Creek (-845) is a 1.01 mile channelized stream reach that extends from just downstream of County Ditch 4A to 150th Street where the stream transitions to a natural stream, located in Carver County. The stream section is impaired for biology due to its fish assemblage. There is one biological monitoring station, 14MN038, located along this reach.

Biology

Fish

Bevens Creek (-845) was sampled for fish at biological monitoring station, 14MN038, in August of 2014. The FIBI score for this visit was 21.0, which is below the Fish Class 2 Southern Streams Modified Use Threshold of 35. Two of the eight metrics comprising the FIBI scored above the average needed to reach the threshold. This site was devoid of sensitive fish taxa and contained many tolerant individuals resulting in a zero for that respective metric score, which limited the FIBI for this stream. (Figure 151).

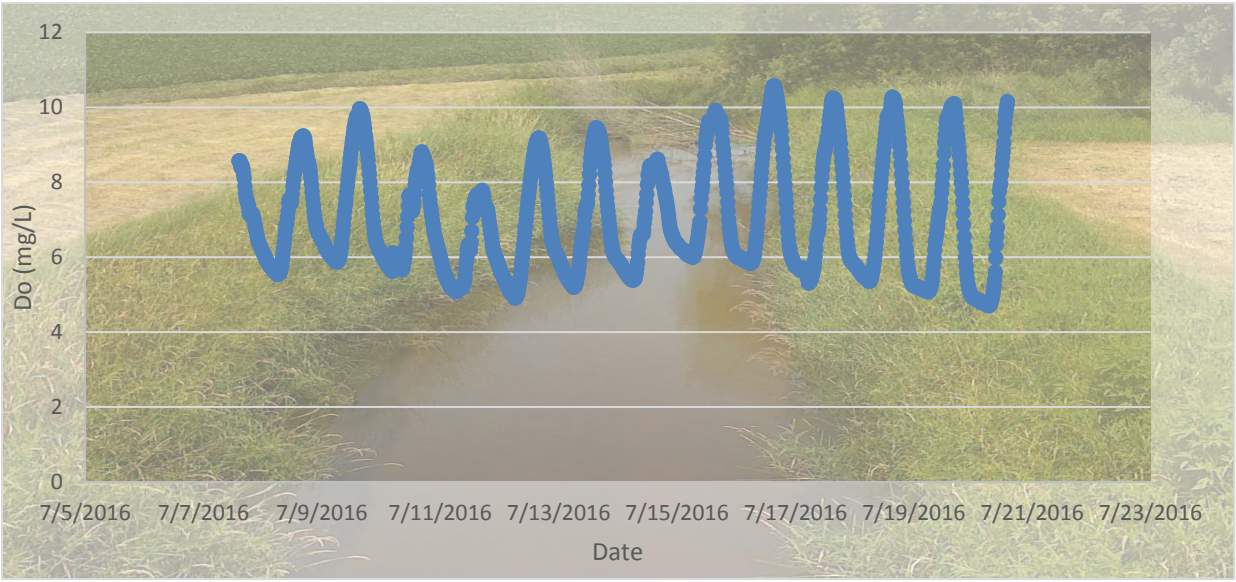
Figure 151. Biological metric scores



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach. Concentrations ranged from 5.51 mg/L to 9.99 mg/L with continuous data recorded at station 14MN038 in 2016 (Figure 152). A low value of 4.77 mg/L was recorded during deployment with values near 5 mg/L each day.

Figure 152. Continuous DO data at site 14MN038



Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.7-13.8 mg/L with <1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There were no fish present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals was slightly higher than the class average of those sites meeting the modified standard. Species that are very tolerant to low DO conditions comprised 30% of the fish community.

Table 268. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN038	0	36.25	11	12.42	7.78	2	6.85
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**15.09**	**25.34**	**14.52**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↓	↑	↑	↓	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Two macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised 12.42% of the population. While there were a few low DO values, the preponderance of evidence shows DO is not a stressor on this section of Bevens Creek (-845).

Candidate Cause Eutrophication

There was a small phosphorus dataset in recent years on this section of Bevens Creek; values ranged from 0.145 to 0.706 mg/L with four of the five values over the southern standard of 0.150 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.7 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, chlorophyll-a and BOD data were not available. As a result of eutrophication, pH values also increase. pH values range from 7.37 to 8.42. Continuous pH data at station 14MN038 showed daily fluxes ranging from 0.25 to 0.52 with values ranging from 7.65 to 8.28. Typical daily pH fluctuations are 0.2-0.3 (Heiskary et al., 2013). Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox and Nagels 2001). Continuous DO data produced daily flux values that were elevated to 5.16 mg/L. The water quality standard for DO flux in the south region of the state is 5 mg/L. Elevated DO flux is caused by increased algae and macrophyte production, which in turn increases photosynthesis, respiration, and decomposition. Station 14MN038 had thick algal growth (Figure 153).

Figure 153. Algal growth (July 20, 2016)

There were no sensitive individuals in the fish community. The darter percentage was lower than the class average for those sites meeting the modified standard. Tolerant individuals composed just more than 90% of the community, more than the class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was also more than the class average. Individuals of EPT species were present at levels just below the class average; however many of the EPT species present are tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised far less than half of the population. The biological communities is showing the effects of the elevated phosphorus and DO fluctuations. Eutrophication is a stressor on this headwater section of Bevens Creek (-845).

Table 269. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN038	0	4.06	91.56	39.38	38	15.34	8.63
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					36.65	18.11	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2016 a total of five nitrate samples were taken from Bevens Creek (-845). These values ranged from 1.7-9.0 mg/L with an average nitrate concentration of 5 mg/L. The nitrate concentrations are the highest in the late spring months, while decreasing throughout the summer.

Table 270. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN038	**10.53**	**63.06**	**0.00**	**3.49**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Bevens Creek (-845) at site 14MN038 scored below average in three of the four nitrate related metrics evaluated when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 270). The stream reach had a good number of Trichoptera taxa for a channelized stream, however there was also a high amount of nitrate tolerant taxa, and a complete lack of nitrate intolerant species.

The observed nitrate concentrations in Bevens Creek (-845) are relatively low given the proximity of the site to intensive row crop agriculture. The biological station did show a healthy amount of Trichoptera taxa, which tend to decrease in streams with excessive nitrate values. It is likely that other factors, like habitat, is causing poor scores in the other metrics. Nitrates are not a stressor to aquatic life in Bevens Creek (-845) at this time.

Candidate Cause: Sediment

From 2014-2016, a total of five TSS samples were taken from Bevens Creek (-845). These samples ranged from 4-22 mg/L with an average value of 9.36 mg/L. These values were all well under the 65 mg/L standard for TSS. Also, two secchi tube measurements were taken in 2014. These values were 32 cm on 08/11/2014 and 24 cm on 09/03/2014.

The HSPF model also calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 2.2-639.3 mg/L with an average TSS concentration of 19.6 mg/L. Of these calculations, 98 (1.58%) were above the 65 mg/L standard for TSS. This is a rather low exceedance rate.

Table 271. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN038	**14.38**	**0.00**	**2.50**	**4.06**	**10.31**	**0.00**	**24.69**	**0.00**	**0.00**	**19.56**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-845) at site 14MN038 scored below average in all ten of the suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 271). This reach lacked many species that would be intolerant to elevated suspended sediment conditions.

Table 272. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN038	**17.08**	**0**	**12**	**42.68**	**25.56**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in five of the six suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 272). This reach did have an above average amount of collector-filterer individuals, but scored poorly in the remaining metrics. There was an increase in TSS tolerant taxa and TSS tolerant individuals in this site.

The limited observed data along this reach does not indicate any issues related to suspended sediment. The HSPF model also predicted a very low exceedance rate. The majority of the fish and macroinvertebrate suspended sediment related metrics score below average in this reach. Based on the conflicting data results, it is inconclusive if suspended sediment is a stressor in this reach. Additional chemical monitoring is recommended to better determine the conditions in Bevens Creek (-845) regarding suspended sediment.

Candidate Cause: Habitat

Bevens Creek (-845) had a qualitative habitat assessment take place at its biological monitoring site, 14MN038, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 43.6 (Poor). Limiting the MSHA was the presence of some row crops in the nearby land use, heavy to moderate bank erosion (Figure 154), some silt and sand substrates, severe embeddedness, moderate channel stability, fair sinuosity and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 155.

Figure 154. Bank eroision at site 14MN038 (September 3, 2014)

Figure 155. Habitat metrics

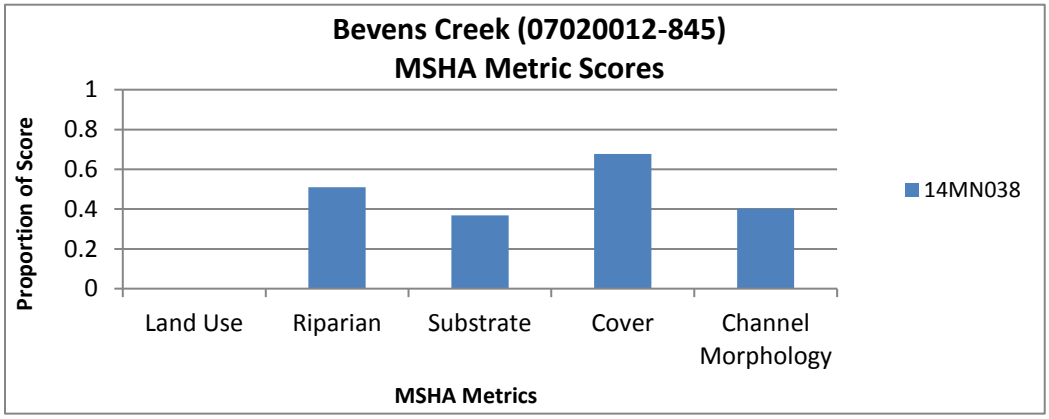


Table 273. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN038	**4.06**	**24.69**	**4.06**	**10.31**	**0.00**	**55.63**	**91.56**	**64.06**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-845) at site 14MN038 scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Stream stations that meet the FIBI Modified Use Threshold (Table 273). The two most abundant fish species sampled were creek chubs and fathead minnows. These species are known to be very tolerant of degraded habitat conditions.

Table 274. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN038	**7.99**	**34.19**	**36.74**	**15.34**	**75.72**	**8.95**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*11.49*	*23.84*	*24.46*	*14.44*	*61.44*	*22.59*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN038 scored below average in two of the six evaluated habitat related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 274). The high amount of legless individuals sampled likely corresponds to the amount of aggradation and fine substrates observed at this site.

Based on the poor MSHA score, the photographic evidence of heavy bank erosion, the observed locations of aggradation, as well as the majority of the habitat related fish metrics, the habitat conditions in Bevens Creek (-845) are a stressor to the impaired fish community at this time.

Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 577 to 686 µS/cm. Continuous daily values collected in July 2016 contained all values less than 750 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset was greater than 1,000 µS/cm.

Table 275. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN038	38	3	10.22	15.33	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	36.65	*3.27*	*12.38*	*18.10*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both slightly below class average, while the taxa count was above class average. The macroinvertebrate community was comprised of 49.04% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 28% of the fish community. There were no elevated specific conductance value in the dataset, and the biological communities did not have strong indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is not currently a stressor in Bevens Creek (-845).

Candidate Cause: Altered Hydrology/Connectivity

This reach of Bevens Creek is 100% modified according to the MPCA altered watercourse layer, which also measured 86.39% of the Bevens Creek sub-watershed as channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprised 84.69% of the population. The numbers of nest guarder species are also positively correlated with increased low flows.

The nest guarder species had a population comprising of 35.31% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. While there was a lack of extended low flow periods shown in the models, the biological communities were indicative of stress. Altered hydrology is a contributing stressor to habitat in Bevens Creek (-845).

Conclusions and recommendations

The impaired fish community in Bevens Creek (-845) is being stressed by, Eutrophication, Habitat, and Flow Alteration/Connectivity.(Table 276) Suspended Sediment was inconclusive as a stressor at this time, while Dissolved Oxygen, Nitrates, and Chlorides were all ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Bevens Creek HUC 10 watershed, please see page 311.

Table 276. Stressors on Bevens Creek (-845)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Bevens Creek	07020012-845	---	●	---	o	●	---	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

9.4 Bevens Creek (-848)

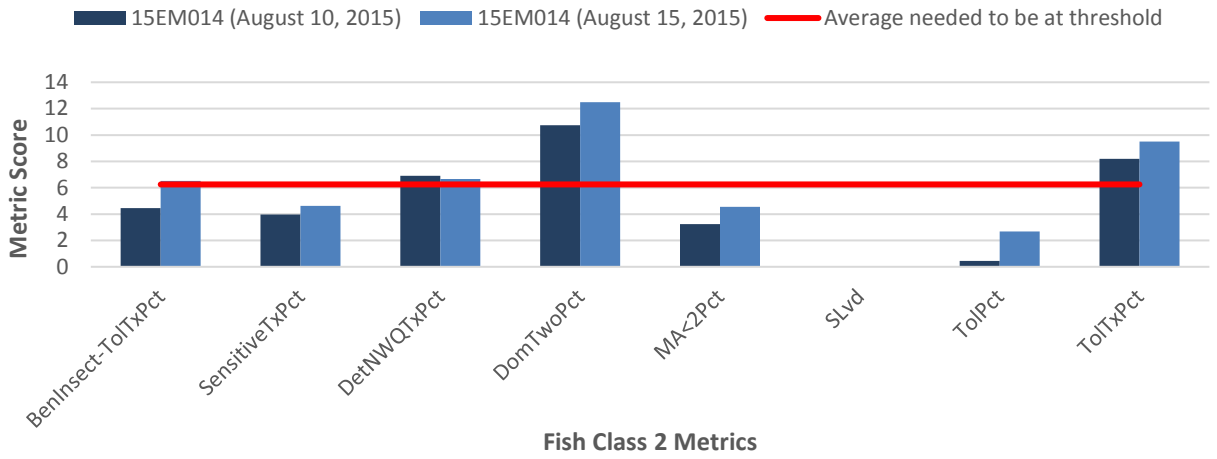
This section of Bevens Creek is a 4.94 mile section that is upstream of where Bevens and Silver Creek merge. This section is impaired for both the fish and macroinvertebrate assemblages. This reach is also impaired for Turbidity and nutrients/eutrophication.

Biology

Fish

Bevens Creek (-848) was sampled for fish twice in August of 2015 at biological monitoring station, 15EM014. The FIBI scores from these visits were 47 and 37.9, which are both below the Fish Class 2 Southern Streams General Use Threshold of 50. Both visits contained a large number of short-lived (SLvd) and tolerant (TolPct) individuals, which resulted in lower FIBI metric scores limiting the FIBI. For more information regarding the FIBI metric scores for this reach, see (Figure 156).

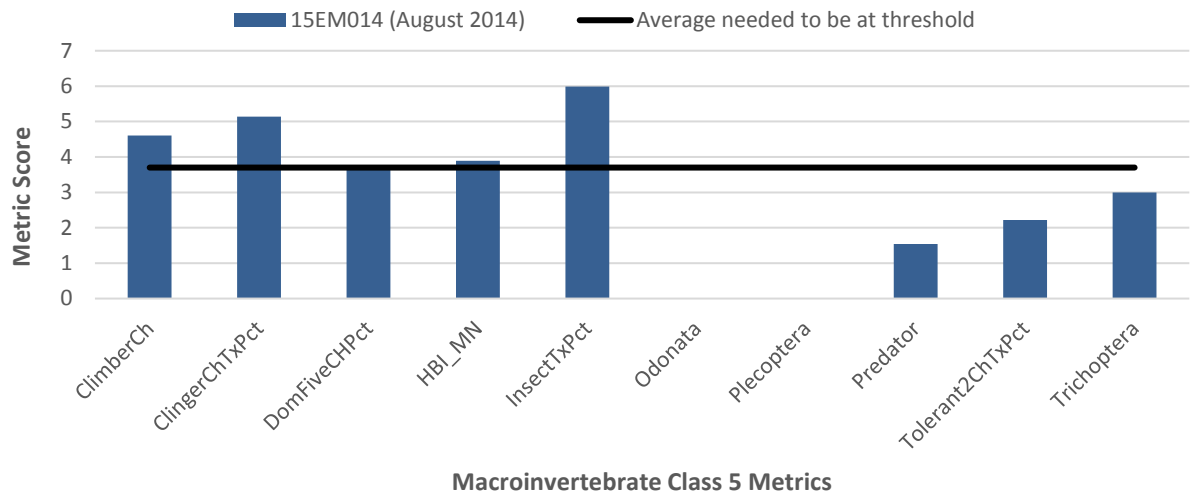
Figure 156. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 15EM014. This visit had a MIBI score of 30.0, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Four of the metrics comprising the MIBI for this class scored above the average needed to reach the threshold, while another (DomFiveCHPct) scored very slightly below this level. The remaining five metrics scored much worse with Odonata and Plecoptera both scoring zero that limited the MIBI score in this reach (Figure 157).

Figure 157. Macroinvertebrate metric scores



Candidate Cause: Dissolved Oxygen

Three DO measurements were recorded in 2014 and 2015; 10.08, 10.25, and 12 mg/L, respectively. Concentrations from 2004 ranged from 1.9 to 20 mg/L. A low value of 4.77 mg/L was recorded during deployment with values near 5 mg/L each day. The lowest value (1.9 mg/L) was recorded in August. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 5.0-14.2 mg/L with 0% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. While there were fish present that reproduce at a mature age, both visits had percentages lower than the class average of sites that met the standard. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were both slightly higher than the class average. Species that are very tolerant to low DO conditions comprised less than 1% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Eleven macroinvertebrate intolerant taxa were collected and DO tolerant individuals comprised less than 1% of the population. While there were a few low DO values recorded in 2004, low DO is not a stressor to the macroinvertebrate community. The fish community has some indication that low DO could be a stressor, but it is currently inconclusive as a stressor in Bevens Creek (-848).

Table 277. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
10EM014 (8/10/15)	2.91	29.61	21	0.93	7.02	11	6.95
10EM014 (8/24/15)	5.59	29.19	24	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Eutrophication

There was a small phosphorus dataset in recent years on this section of Bevens Creek; values ranged from 0.121 to 0.393 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.3 mg/L with a mean of 0.3 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, chlorophyll-a, BOD, and DO flux data were not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values range from 8.04 to 8.55.

Sensitive individuals comprised less than 6% of the fish community at both visits**.** The darter percentages were both slightly lower than the class average for those sites meeting the general standard. Tolerant individuals composed more than 65% of the community, more than the class average. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was close to the class average. Individuals of EPT species were present at levels above the class average, however many of the EPT species present are tolerant to eutrophic conditions.

The two most common macroinvertebrate species sampled comprised just less than half of the population. Based on the preponderance of biological evidence and the eutrophication stress to the upstream and downstream sections of Bevens Creek, eutrophication is a stressor on this section of Bevens Creek (-848).

Table 278. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
15EM014 (8/10/15)	5.83	9.71	73.30	10.19	30	77.57	42.99
15EM014 (8/24/15)	4.66	11.49	64.91	17.70	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	18.65	11.68	44.85	16.53			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					41.92	43.90	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2004-2015, Bevens Creek (-848) had nine nitrate samples taken. These sample values ranged from 0.09-3.05 mg/L with an average value of 0.93 mg/L. These values are very low when compared across the Lower Minnesota River Watershed.

Table 279. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
15EM014	**16.67**	**21.50**	**0.31**	**2.36**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Bevens Creek (-848) at site 15EM014 scored below average in one of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 279). The stream reach showed a low amount of nitrate intolerant species, however, the stream also had a good amount of Trichoptera taxa, a good nitrogen TIV score, as well as a low amount of nitrate tolerant species.

Based on the low observed nitrate values, as well as the macroinvertebrate assemblage that scored well in three of the four nitrate related metrics, nitrates are not a stressor to aquatic life in Bevens Creek (-848) at this time.

Candidate Cause: Sediment

From 2004-2014, a total of 11 TSS samples were collected from Bevens Creek (-848). These sample values ranged from 12-150 mg/L with an average TSS concentration of 46.73 mg/L. Of these samples, three were above the 65 mg/L standard for TSS. Additionally, from 2004-2015, 31 secchi tube measurements were made along this reach. These readings ranged in value from 9-67 cm, with an average reading of 26.02 cm. Only one of these readings was below the 10 cm standard for transparency. This reach was determined to be impaired for turbidity during a 2002 assessment. This impairment was confirmed during the 2016 assessment as well.

Table 280. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
15EM014	**31.54**	**2.08**	**13.92**	**13.23**	**25.16**	**5.24**	**35.81**	**0.00**	**6.33**	**26.43**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Bevens Creek (-848) scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 280). The site, 15EM014, did have an above average amount of herbivorous individuals, however, the remaining metrics scored poorly. The TSS index score was especially poor.

Table 281. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
15EM014	**14.88**	**1**	**15**	**34.89**	**65.73**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in three of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 281). The reach did have an above average TSS index score, as well as higher numbers of collector-filterer individuals, while also having a slightly below average amount of TSS tolerant individuals. However, this reach had a high amount of TSS tolerant species, while also having few TSS intolerant taxa and no Plecoptera taxa. Those results can signal potential stress from suspended sediment.

Based on the higher rate of standard exceedance from the TSS samples, the majority of the suspended sediment related metrics in the biotic communities, especially fish, as well as the current turbidity impairment along this reach concludes that suspended sediment is indeed a stressor to aquatic life in Bevens Creek (-848).

Candidate Cause: Habitat

Bevens Creek (-848) had a qualitative habitat assessment take place at biological monitoring site, 15EM014, during the fish and macroinvertebrate sampling events in 2015. The average MSHA score from these visits was 69.4 (Good). Limiting the MSHA was sand substrates, moderate embeddedness, and moderate channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 158.

Figure 158. Habitat metric scores

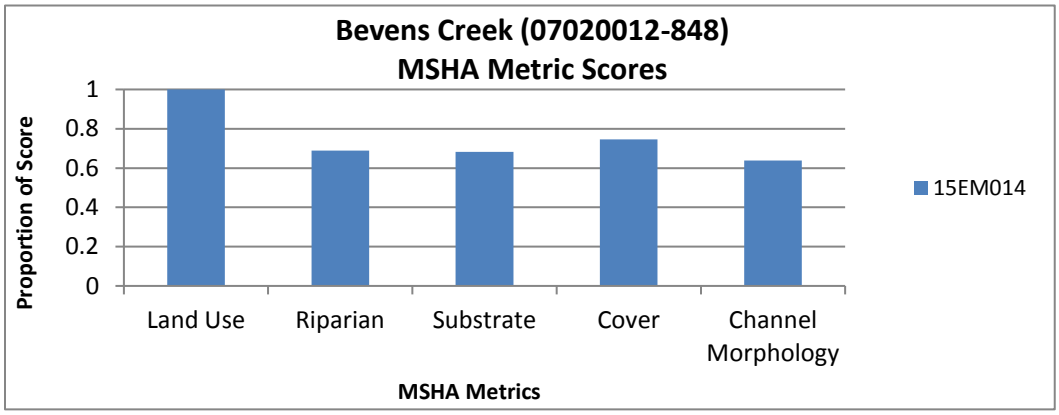


Table 282. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
15EM014	**13.06**	**35.81**	**13.06**	**25.16**	**1.90**	**58.51**	**69.10**	**26.25**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bevens Creek (-848) scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 282). The fish sample did have a fair amount of habitat specializing species, but the number of emerald shiners present (444) lowered many of the individuals percentages.

Table 283. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
15EM014	**12.15**	**3.43**	**73.52**	**77.57**	**16.82**	**3.12**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Bevens Creek (-848) at site 15EM014 scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 283). The high amount of clinger and EPT individuals, as well as the lower amount of legless individuals signal that habitat is not a stressor to the macroinvertebrate community.

The MSHA scores at 15EM104 were consistently good, while many of the macroinvertebrate metrics scored above average. Habitat is not a stressor to aquatic life in Bevens Creek (-848) at this time. It is likely other stressors causing the fish habitat related metrics to score below average.

Candidate Cause: Chloride/Ionic strength

Chloride values on this reach ranged from 16.4 to 126 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 126 to 1,698 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Five values in the dataset were greater than 1,000 µS/cm.

Table 284. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
15EM014 (8/10/15)	30	5	13.39	77.57	2.91
15EM014 (8/24/15)	NA	NA	NA	NA	1.24
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*41.93*	*6.04*	*22.91*	*43.90*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was much higher than the class average, while the mayfly (Ephemeroptera) percentage and taxa count were both below class average. The macroinvertebrate community was comprised of 13.71% conductivity tolerant individuals and one intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Less than 3% of Centrarchidae (sunfish) were collected during both visits. Species that are tolerant to conditions with high ionic strength ranged from 14 to 17% of the fish community. There were elevated specific conductance values in the dataset, and based on the preponderance of evidence biological communities ionic strength is not currently a stressor in Bevens Creek (-848).

Candidate Cause: Altered Hydrology/Connectivity

This reach of Bevens Creek is predominantly natural according to the MPCA altered watercourse layer; however, 86.39% of the Bevens Creek sub-watershed is channelized. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Channelized tributaries and contributing tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranged from 50.96 to 53.88% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranged from 18.45 to 22.05% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 2.18% of the population. Based on the lack of extended low flow periods shown in the models and the biological communities, altered hydrology is not a stressor in Bevens Creek (-848).

Conclusions and Recommendations

The impaired fish and macroinvertebrate communities in Bevens Creek (-848) are being stressed by Eutrophication and Suspended Sediment (Table 285). Dissolved Oxygen was inconclusive as a stressor at this time, while Nitrates, Habitat, Flow Alteration/Connectivity and Chlorides were all ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Bevens Creek HUC 10 watershed, please see page 311.

Table 285. Stressors on Bevens Creek (-848)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Bevens Creek	07020012-848	o	●	---	●	---	---	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

9.5 Silver Creek (-813)

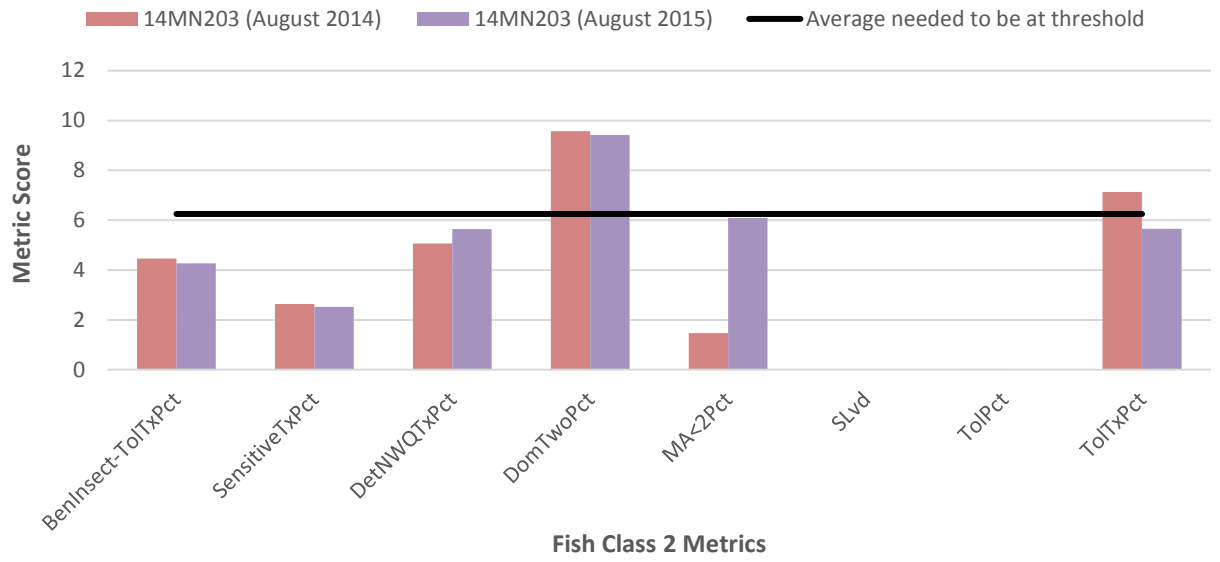
Silver Creek (-813) is a 8.61 mile long tributary to Bevens Creek in Carver County. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages found at biological monitoring stations, 14MN095 and 14MN203 along this reach. This reach was found to be impaired for the herbicide Acetechlor and Turbidity. Acetechlor is used for weed control that works by inhibiting or disrupting cell division (MDA). Herbicides affect plants more directly than fish or macroinvertebrates, and while herbicides can reduce abundance of biological communities, it is hard to separate effects of herbicides from other stressors (EPA).

Biology

Fish

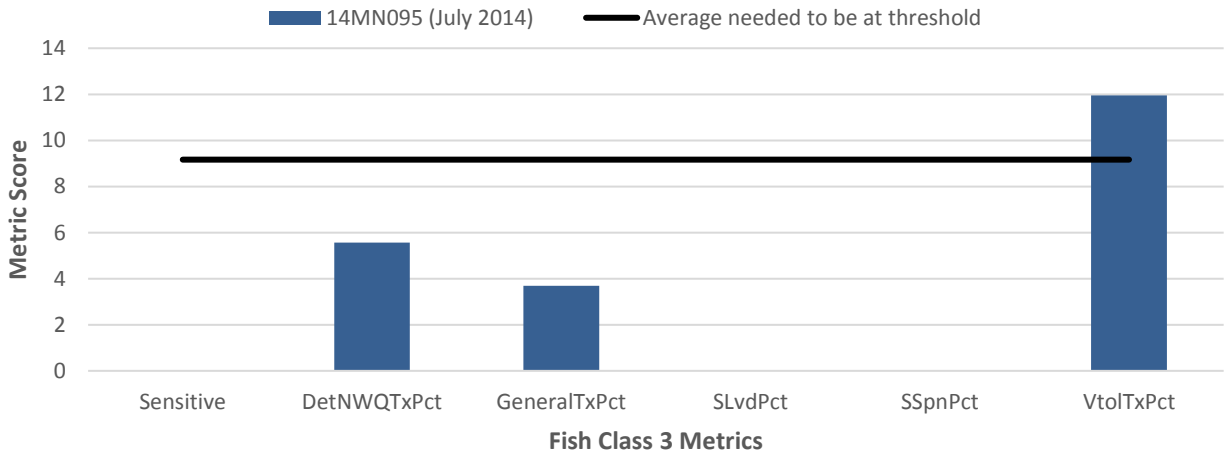
Silver Creek (-813) was sampled for fish at biological sites, 14MN203 and 14MN095. Site 14MN203 was sampled in August of 2014 and 2015 and had FIBI scores of 30.4 (2014) and 33.6 (2015). Both of these scores are well below the Fish Class 2 Southern Streams General Use Threshold of 50. Both visits at this site had a high percentage of both tolerant taxa and short-lived fish individuals resulting in very low metric scores limiting the overall FIBI score (Figure 159).

Figure 159. Class 2 fish metric score



Site 14MN095 was sampled for fish in July of 2014. This visit had a FIBI score of 21.2, which is far below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Only one of the six metrics comprising this FIBI scored above the average needed to reach the threshold. The remaining five metrics scored below average or zero. See Figure 160 for a breakdown of the metric scores for this site visit.

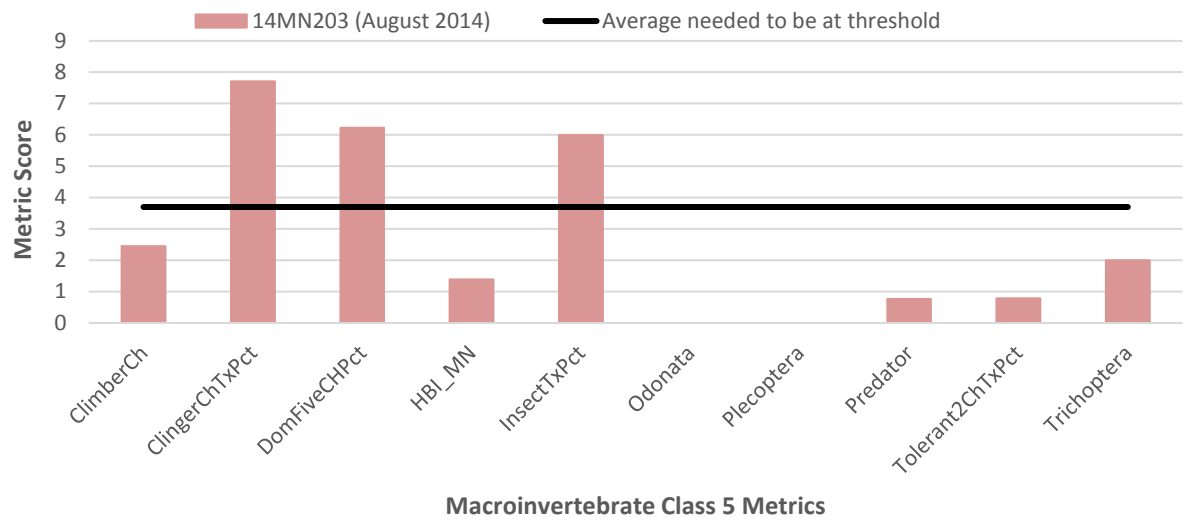
Figure 160. Class 3 fish metric scores



Macroinvertebrates

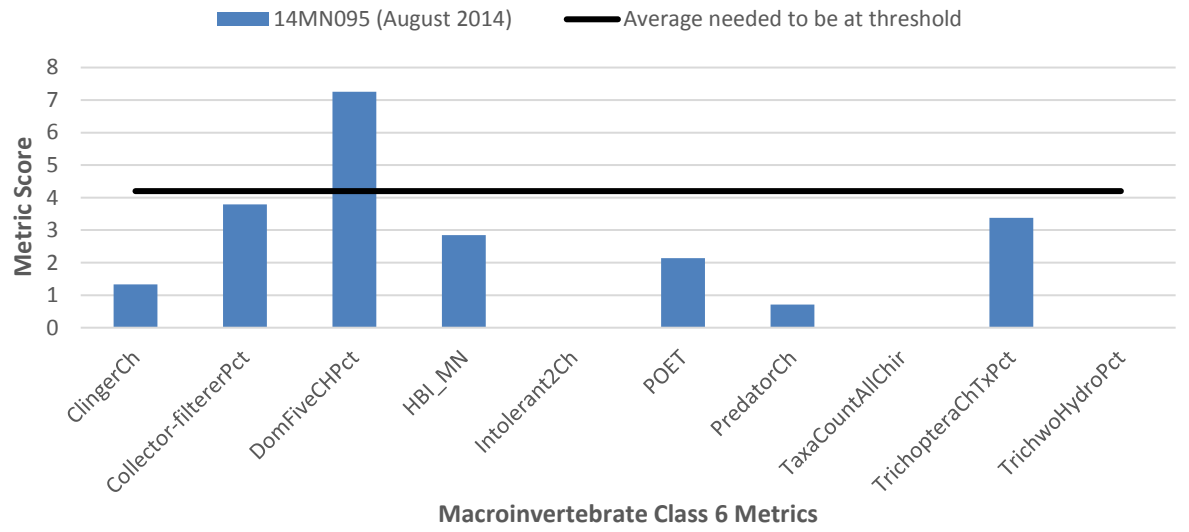
The macroinvertebrate community was also sampled at both sites, 14MN203 and 14MN095. Site 14MN203 was sampled in August of 2014 and had an MIBI score of 27.3, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Three of the metrics comprising the MIBI for this class scored above the average needed to reach the threshold (ClingerChTxPct, DomFiveCHPct, InsectTxPct), while the remaining seven metrics scored below average or poorly. Two of the metrics (Odonata and Plecoptera) scored zero limiting the MIBI score for this site (Figure 161).

Figure 161. Class 5 macroinvertebrate metrics scores



Site 14MN095 was sampled for macroinvertebrates in August of 2014. The MIBI score for this visit was 21.5, which falls below the Macroinvertebrate Class 6 Southern Forest Streams GP General Use Threshold of 43. This visit only had one of the ten metrics above the average needed to reach the threshold (DomFiveCHPct), while the remaining metrics scored below average or very poorly. Three of the metrics scored zero severely limiting the MIBI score for this site (Figure 162).

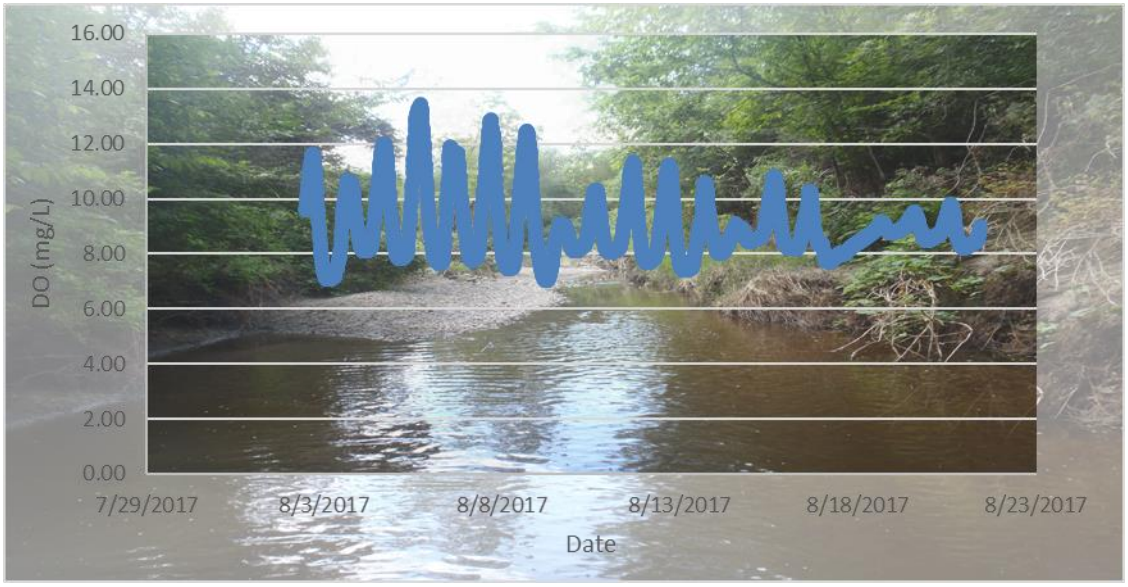
Figure 162. Class 6 macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a large DO dataset sampled 2004-2016. Concentrations ranged from 1.57 mg/L to 16.71mg/L with continuous data recorded at station 14MN203 in 2017 (Figure 163). All values recorded during deployment were above the warmwater standard of 5 mg/L with a low value of 7.07 mg/L.

Figure 163. DO continuous data at site 14MN023



Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 5.0-13.9 mg/L with 0% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There were no fish present that reproduce at a mature age at station 14MN095. The two visits at station 14MN203 had values of 2.06 and 0.14%, all below class averages. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were all lower than the class average with no serial spawners present at station 14MN095. Species that are very tolerant to low DO conditions ranged from 9.6% to 20% of the fish community at station.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. One macroinvertebrate intolerant taxa was collected at station 14MN095 and five were collected at station 14MN203, both below class averages. DO tolerant individuals comprised 27.08% of the population at station 14MN095 and only 6.23% at station 14MN203. While there were a few low DO values, the preponderance of evidence shows DO is not a stressor on Silver Creek (-813).

Table 286. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate	DO Tolerant Index Score
14MN095	**0**	**0**	**6**	**27.08**	**8.00**	**1**	**5.92**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**15.09**	**25.34**	**12.16**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**18.23**	**7.57**	**4.51**	**6.80**
14MN203 (2014)	**2.06**	**16.46**	**21**	**6.23**	**7.87**	**5**	**7.13**
14MN203 (2015)	**0.14**	**12.21**	**22**	**NA**	**NA**	**NA**	**NA**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

There was a large phosphorus dataset in recent years (2005-2016); values ranged from 0.121 to 1.08 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a values ranged from 2.1 to 17 mg/L, all below the southern standard of 40 mg/L. BOD, and DO flux data were not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 6.58 to 8.58.

Sensitive individuals comprised less than 2% of the fish community at all visits. The darter percentages were higher at station 14MN203 than at station 14MN095 where no darters were collected. Tolerant individuals composed more than 70% of the community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was higher than the class average at station 14MN095, but lower than the class average in 2014 and right at the average in 2015. Individuals of EPT species were present at levels close to the class average at both stations. The two most common macroinvertebrate species sampled comprised less than half of the population. The stress is more pronounced at the upstream station 14MN095; however, the biological results are mixed. Eutrophication is inconclusive as a stressor on Silver Creek (-813).

Table 287. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN095	0	0	100	20	18	33.33	31.25
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
14MN203 (2014)	**1.23**	**6.79**	**74.90**	**4.53**	**30**	**39.56**	**17.13**
14MN203 (2015)	**0.34**	**3.72**	**76.69**	**16.84**	**NA**	**NA**	**NA**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2004-2016 a total of 154 nitrate samples were taken from Silver Creek (-813). These sample values ranged from 0.05-25.2 mg/L with an average nitrate concentration of 10.47 mg/L. A quantile regression analysis showed that when macroinvertebrate Class 5 sites exceed 18.1 mg/L, there is a 75% probability of impairment. The nitrate concentrations in Silver Creek were at or in excess of 18.1 mg/L 20 (12.99%) times.

Table 288. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN203	**13.33**	**76.64**	**0.00**	**4.15**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
14MN095	**5.56**	**70.83**	**0.00**	**4.01**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Silver Creek (-813) scored below average in three (14MN203) and four (14MN095) of the nitrate related metrics when compared to all other sites in Class 5 Southern Streams RR stations or Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Thresholds (Table 288). Both sites had poor nitrogen TIV scores, a complete lack of nitrate intolerant species, and high numbers of nitrate tolerant taxa. Those results often signal nitrate stress.

Based on the poor scoring nitrate related macroinvertebrates, as well as the high values observed with an extensive data set, as well as the quantile regression analysis, nitrates are a stressor to aquatic life in Silver Creek (-813).

Candidate Cause: Sediment

From 2004-2016, a total of 144 TSS samples were taken from Silver Creek (-813). These sample values ranged from 1-676 mg/L with an average TSS concentration of 46.35 mg/L. Of these samples, 22 (15.28%) were above the 65 mg/L standard for TSS. Additionally, 134 secchi tube readings were taken during this same time period. These values ranged from 6-100 cm with an average reading of 44.74 cm. These measurements had ten that were at or below the 10 cm standard for transparency. This reach was also determined to be impaired for turbidity during 2006. This impairment was also confirmed during the 2016 assessment of this reach.

Table 289. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN095	30.00	0.00	15.00	0.00	30.00	0.00	25.00	0.00	5.00	16.63
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
14MN203	22.09	0.22	16.00	6.23	17.60	0.81	35.94	0.00	1.29	17.85
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Silver Creek (-813) scored below average in seven (14MN095) and nine (14MN203) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters and Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 289). Both sites had low levels of benthic feeder, Centrarchid, Perciformid (perch-like), sensitive, simple lithophilic, and intolerant individuals, while also having below average TSS index scores.

Table 290. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN203	18.65	0	10	52.02	23.99	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
14MN095	23.44	0	11	75.00	14.58	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Silver Creek (-813) scored below average in five (14MN203) and six (14MN095) of the six suspended sediment related metrics when compared to Class 5 Southern Streams RR stations and Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 290). Site 14MN203 did have a lower amount of TSS tolerant taxa, but scored poorly in the remaining metrics. Site 14MN095 had a very poor TSS index score and a very high amount of TSS tolerant individuals.

The high rate of exceedances from the TSS samples, the current turbidity impairment, as well as the majority of the suspended sediment related metrics for both biological communities scoring below average concludes that suspended sediment is indeed a stressor to aquatic life in Silver Creek (-813).

Candidate Cause: Habitat

Silver Creek (-813) had qualitative habitat assessments take place at its biological monitoring sites, 14MN095 and 14MN203, during the fish and macroinvertebrate sampling events in 2014 and 2015.The average MSHA scores from these visits were 39.8 (Poor) at 14MN095 and 55.76 (Fair) at 14MN203. Limiting the MSHA at these sites was the row crop agriculture as a dominant land use, moderate to heavy bank erosion, sand and silt substrates, moderate embeddedness, moderate channel stability, fair sinuosity, and fair channel development. A breakdown of the MSHA category scores for these sites can be seen in Figure 164.

Figure 164. Habitat metric scores

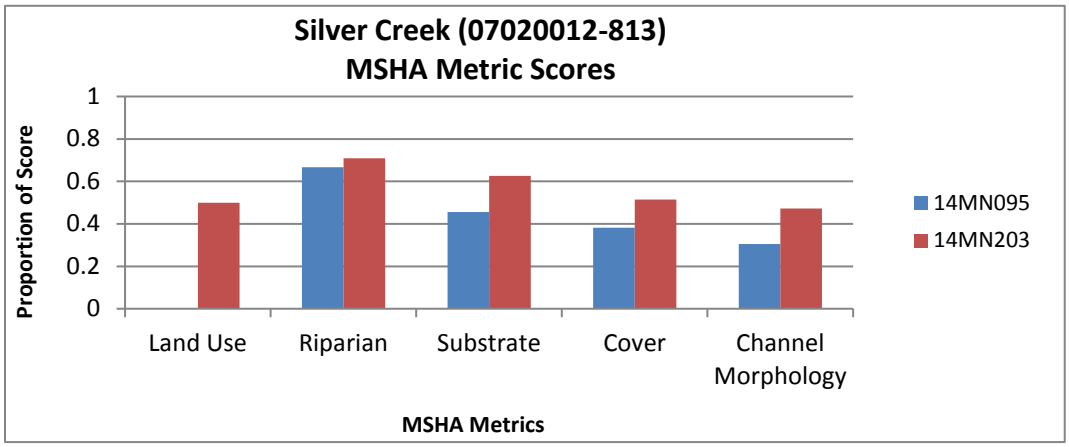


Table 291. Fish related habitat metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN095	0.00	25.00	0.00	30.00	0.00	90.00	100.00	50.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
14MN203	5.41	35.94	5.41	17.60	0.89	69.12	80.58	36.78
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Silver Creek (-813) scored below average in seven (14MN203) and six (14MN095) of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters (14MN095) and Class 2 Southern Streams (14MN203) stations that meet the FIBI General Use Threshold (Table 291). Site 14MN095 had a community consisting of only 20 individuals. This low sample size may skew some of the habitat metrics, however, all of the species sampled are considered tolerant to degraded habitat conditions. Site 14MN203 had many species and individuals sampled. This site had many tolerant individuals, while lacking many habitat specializing species. These results can be a sign of habitat degradation.

Table 292. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN203	**12.15**	**27.73**	**44.55**	**39.56**	**55.76**	**2.18**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
14MN095	**16.67**	**12.50**	**29.17**	**33.33**	**35.42**	**16.67**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in five (14MN203) and four (14MN095) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR (14MN203) and Class 6 Southern Forest Streams GP (14MN095) stations that meet the MIBI General Use Threshold (Table 292). Both of the site had high numbers of burrower individuals, while having below average numbers of clinger and sprawlers. These results signal potential stress from the habitat conditions.

Based on the poor to fair MSHA scores, in addition to the majority of the habitat related metrics for both of the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Silver Creek (-813).

Candidate Cause: Chloride/Ionic strength

Chloride values on this reach ranged from 17.2 to 43.9 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 176 to 1,045 µS/cm. Continuous data collected in August 2016 contained all values below 850 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). Three values in the dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were higher than class averages at the upstream station 14MN095, but below class averages at the downstream station 14MN203. Taxa counts at each station were below class average. The macroinvertebrate community was comprised of a range of 52.08% to 60.75% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected at station 14MN095, and less than 0.65% at station 14MN203. Species that are tolerant

to conditions with high ionic strength ranged from 17 to 32% of the fish community. While there were a few elevated specific conductance values in the dataset, the biological data was mixed. Ionic strength is currently inconclusive as a stressor in Silver Creek (-813).

Table 293. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN095	18	4	25	33.33	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
14MN203 (2014)	30	7	20.87	20.87	0.62
14MN203 (2015)	NA	NA	NA	NA	0.05
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach of Silver Creek is predominantly natural according to the MPCA altered watercourse layer. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 6% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 54.73 to 80% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 5 to 12.02% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of

0 to 8.33% of the population. Based on the lack of extended low flow periods shown in the models and the preponderance of biological evidence, altered hydrology is not a stressor in Silver Creek (-813).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Silver Creek (-813) are being stressed by Nitrates, Suspended Sediment and Habitat.(Table 294) Eutrophication and Chloride were inconclusive as stressors at this time, while Dissolved Oxygen and Flow Alteration/Connectivity were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Bevens Creek HUC 10 watershed, please see below.

Table 294. Stressors n Silver Creek (-813)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Silver Creek	07020012-813	---	o	●	●	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Bevens Creek HUC 10 Conclusions and Recommendations

The Bevens Creek subwatershed contains five biologically impaired stream reaches. The stressors found in these reaches were much less abundant than in the watersheds previously mentioned. Stressors found in at least four of the five impaired reaches were Eutrophication and Suspended Sediment. Lack of habitat (3), Nitrates (2), Flow Alteration/Connectivity (2) were found to be a contributing stressor in much fewer stream reaches. Dissolved Oxygen was found to be a stressor in one reach, while Chloride was not found to be a stressor in this watershed, however, more chloride data are needed in a few reaches to better determine the impact of this stressor.

Row crop agriculture is still the dominant land use present in this watershed, however, there is more of a presence of hay/pasture as a land use. The headwaters of Bevens Creek is still being impacted by the effects of channelization of the streams and contributing tributaries. This is a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

As Table 295 shows, both Eutrophication (excess Phosphorus) and suspended sediment are the most common stressors found in this subwatershed.

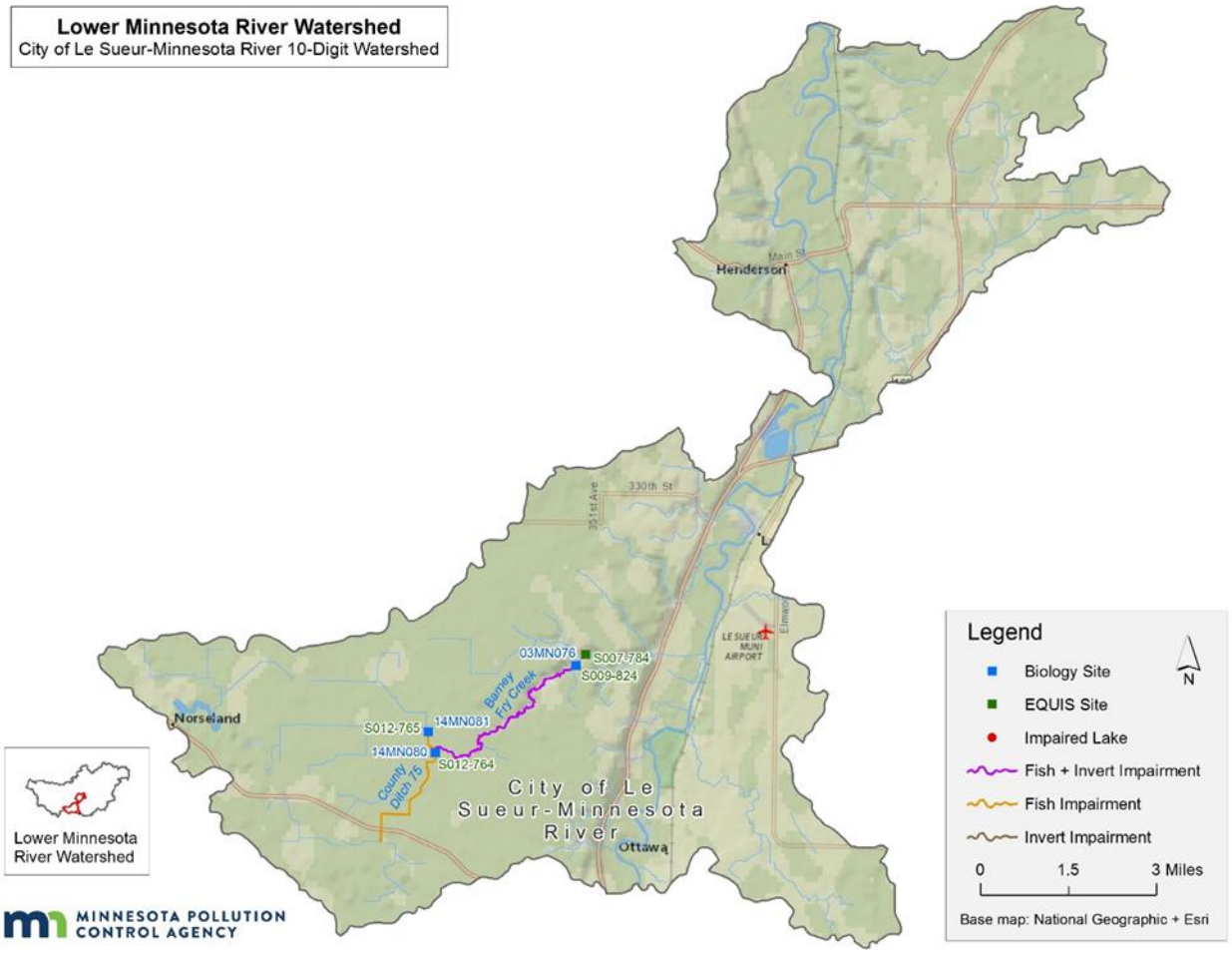
Improvements in the Bevens Creek watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Another significant focus should be to reducing the amount of phosphorus entering the stream system. This can be achieved through BMPs like: cover crops, nutrient management, and saturated buffers.

Table 295. Stressors on streams in the Bevens HUC

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Bevens Creek	07020012-514	---	●	●	●	o	---	---
Bevens Creek	07020012-843	●	●	---	●	●	●	o
Bevens Creek	07020012-845	---	●	---	o	●	●	---
Bevens Creek	07020012-848	o	●	---	●	---	---	---
Silver Creek	07020012-813	---	o	●	●	●	---	o

10. City of Le Sueur-Minnesota River HUC 10 (0702001205)

Figure 165. Sampling sites in the City of Le Sueur Minnesota River HUC



10.1 Barney Fry Creek (-602)

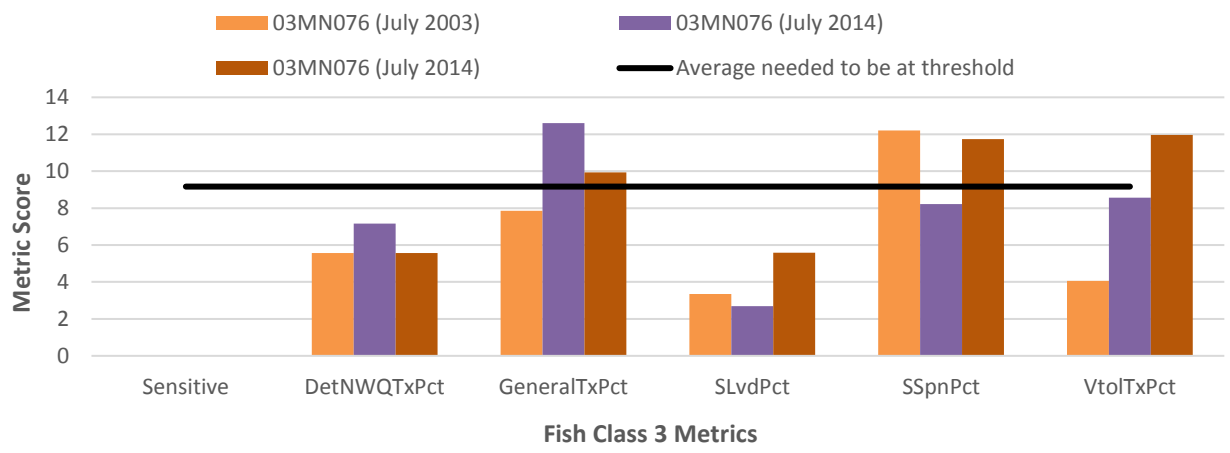
Barney Fry Creek (-602) is a 4.48 mile long stream section located in northeastern Nicollet County. This stream reach extends from County Ditch 47A to the confluence with County Ditch 35. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages found at the biological monitoring station, 03MN076, along this reach.

Biology

Fish

Barney Fry Creek (-602) was sampled for fish three times from 2003-2014 at biological monitoring station, 03MN076. The FIBI scores from these visits were 33.0 (2003), 39.3 (2014), 44.8 (2015). The FIBI scores from all of these visits are below the Fish Class 3 Southern Headwaters General Use Threshold of 55. All three visits completely lacked sensitive fish species resulting in a metric score of zero, which severely limited the FIBI scores for this reach. (Figure 166).

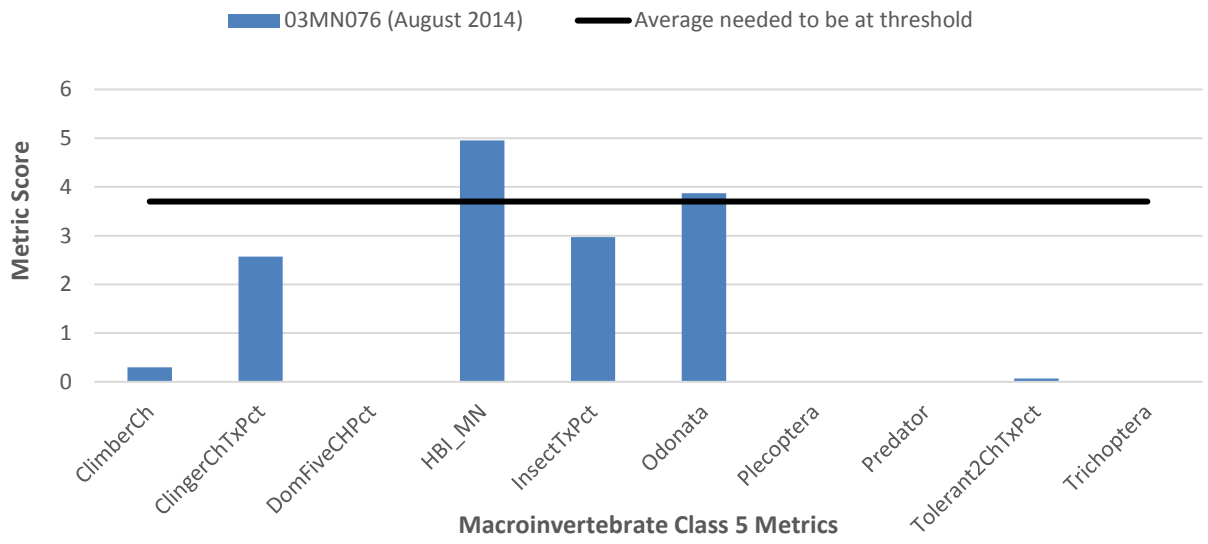
Figure 166. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled at site 03MN076 in August of 2014. The MIBI score from this visit was 14.7, which is well below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This visit scored above the average needed to reach the threshold in just two of the ten metrics comprising the MIBI in this class. The MIBI was severely limited by four metric categories scoring zero (DomFiveCHPct, Plecoptera, Predator, Trichoptera). (Figure 167)

Figure 167. Macroinvertebrate metrics scores



Candidate Cause Dissolved Oxygen

There is a small DO dataset sampled in recent years 2014-2016. DO concentrations ranged from 6.71 mg/L to 10.6 mg/L on this reach in recent years with no recorded values below 5 mg/L. All values recorded were above the warmwater standard of 5 mg/L. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.7-13.7 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There were less than 2% of fish present that reproduce at a mature age at

during the two visits at station 03MN076. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawner individuals were both below 40%, higher than the class average. Species that are very tolerant to low DO conditions ranged from 3% to 20% of the fish community at station.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Three macroinvertebrate intolerant taxa were collected during the one visit. DO tolerant individuals comprised only 7.72% of the population. DO is not a stressor on Barney Fry Creek (-602).

Table 296. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN076 (2014)	1.56	39.06	7	1.53	6.66	3	7.72
03MN076 (2015)	0	22.86	6	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.046 to 0.408 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.86 to 8.63. BOD, chlorophyll-a, and DO flux data were not available.

Sensitive individuals were not present at either of the visits. Darters were not collected in 2014, and in 2015 they were all johnny darters, which are more tolerant darters. Tolerant individuals composed more than 97% of the community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. The omnivorous fish percentage was low in 2014, but increases to higher than average in 2015. Individuals of EPT species were present at levels much lower than the class average. The two most common macroinvertebrate species sampled comprised more than half of the population. Based on the phosphorus values and biological evidence, eutrophication is a stressor in Barney Fry Creek (-602).

Table 297. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN076 (2014)	0	0	98.44	3.13	15	14.55	79.57
03MN076 (2015)	0	2.86	97.14	20			
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2003-2016, Barney Fry Creek had a total of 16 nitrate samples taken. These samples ranged from 1.2-30 mg/L with an average nitrate concentration of 16 mg/L. Quantile regression analysis showed that when nitrate concentrations exceeded 18.1 mg/L in a macroinvertebrate Class 5 stream, there was a 75% probability that the macroinvertebrate community would be impaired. Barney Fry Creek (-602) had six values in excess of 18.1 mg/L.

Table 298. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN076	**13.33**	**26.07**	**0.00**	**2.93**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Barney Fry Creek (-602) at site 03MN076 scored below average in one of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 298). The site completely lacked nitrate intolerant species, but did have a higher amount of Trichoptera taxa, an above average nitrogen TIV score and lower amounts of nitrate tolerant taxa. These results do not reflect a stream negatively impacted by high nitrate values.

Despite the high nitrate values observed in this stream, the macroinvertebrate community had good nitrate scoring metrics. The higher amounts of Trichoptera taxa, above average nitrogen TIV score, and the relatively low amount of nitrate tolerant species all signal that nitrates are not a stressor to aquatic life in Barney Fry Creek (-602) at this time. While the high nitrate values observed in this reach do not appear to be directly impacting aquatic life at this time, it is essential that these values are reduced to prevent further stress to the biological communities.

Candidate Cause Sediment

From 2014-2015, a total of 15 TSS samples were collected from Barney Fry Creek (-602). These sample values ranged from 2-260 mg/L with an average TSS concentration of 64.64 mg/L. Of these samples, three were above the 65 mg/L standard for TSS. Additionally, 22 secchi tube measurements were made during this same time period. These values ranged from 7-100 cm, with an average readings of 48.14 cm. Two of the secchi tube readings were below the 10 cm minimum standard for transparency.

Table 299. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN076	5.40	0.00	4.11	1.81	4.11	0.00	48.81	0.00	0.52	16.24
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 03MN076 in Barney Fry Creek (-602) scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 299). This reach did have an above average number of simple lithophilic individuals, but scored poorly in the remaining metrics.

Table 300. Sediment related macroinvertebratre metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN076	14.06	0	6	10.43	73.99	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in two of the suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet

the MIBI General Use Threshold (Table 300). This reach lacked TSS intolerant and Plecoptera taxa, but did have a good TSS index score, while also having a large amount of collector-filterer individuals, and low numbers of TSS tolerant taxa and individuals.

While the observed data did have some standard exceedances, some of the collections were immediately following rain events resulting in elevated concentrations. The macroinvertebrate data strongly suggests that suspended sediment is not a stressor as it scored well in the majority of the suspended sediment related metrics. Therefore, suspended sediment is not a stressor to aquatic life at this time in Barney Fry Creek (-602). Since the macroinvertebrate community strongly suggests that sediment is not a stressor in this reach, it is likely that other stressors are negatively impacting the fish community resulting in lower metric scores.

Candidate Cause Habitat

Barney Fry Creek (-602) had a qualitative habitat assessment take place at biological monitoring site, 03MN076, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 72.7 (Good). Limiting the habitat at this site was moderate to heavy bank erosion (Figure 168). This site did have a substantial amount of stream shading, extensive fish cover, and a variety of course substrates as well. A breakdown of the MSHA category scores for this site can be seen in Figure 169.

Figure 168. Erosion at site 03MN076 (July 29, 2014)

Figure 169. Habitat metric scores

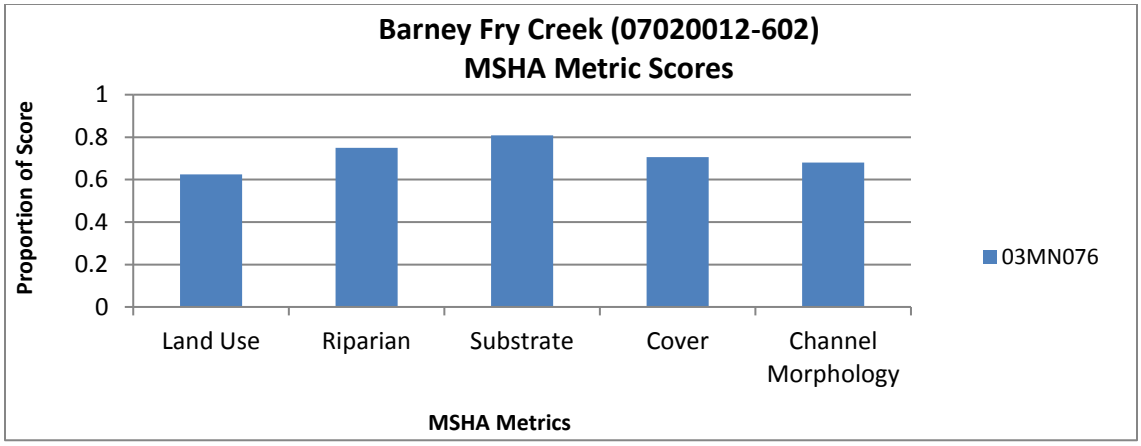


Table 301. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN076	1.29	48.81	1.29	4.11	0.52	70.88	98.19	30.45
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Barney Fry Creek scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 301). The site did have some habitat specializing species present as it scored well in the SLithopPct and LithFrimPct categories. Site 03MN076 did not have increased pioneering individuals. These species are often present in higher numbers in streams with poor habitat conditions.

Table 302. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN076	0.31	8.36	78.64	14.55	12.69	2.79
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in three of the six evaluated habitat metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 302). The site, 03MN076, had lower numbers of both burrower and legless individuals, which can often indicate that there is not a sedimentation issue. The lower amounts of EPT individuals can signal a degraded system as well.

The habitat related metrics for the biological communities was rather mixed considering that the MSHA score for 03MN076 was good. It is inconclusive at this point if habitat is a stressor to the impaired biological communities in Barney Fry Creek (-602).

Candidate Cause: Chloride/Ionic strength

Chloride values on this reach ranged from 10.8 to 30.7 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 474 to 856 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000

µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages and the taxa count were much lower than class averages. The macroinvertebrate community was comprised of 10.43% conductivity tolerant individuals and 0 intolerant individuals.

Table 303. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
03MN076 (2014)	15	4	13.31	14.55	0
03MN076 (2015)	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength ranged from 29 to 36% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in Barney Fry Creek (-602).

Candidate Cause: Altered Hydrology/Connectivity

This reach of Barney Fry Creek is 100% natural according to the MPCA altered watercourse layer, but the entire upstream watershed is channelized. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 10% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 56.25 to 88.57% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 3.13 to 22.86% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. Long-lived macroinvertebrates were not present. There was a lot of instability at station 03MN076 likely impacted by high flows exacerbated by upstream channelization. Altered hydrology is a contributing stressor that is also impacting habitat in Barney Fry Creek (-602).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Barney Fry Creek (-602) are being stressed by Eutrophication and Flow Alteration/Connectivity. (Table 304) Habitat and Chloride were inconclusive as stressors, while Dissolved Oxygen, Nitrates, and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Le Sueur-Minnesota River HUC 10 watershed, please see page 337.

Table 304. Stressor on Barney Fry Creek (-602)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Barney Fry Creek	**07020012-602**	---	●	---	---	o	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

10.2 County Ditch 47A (-792)

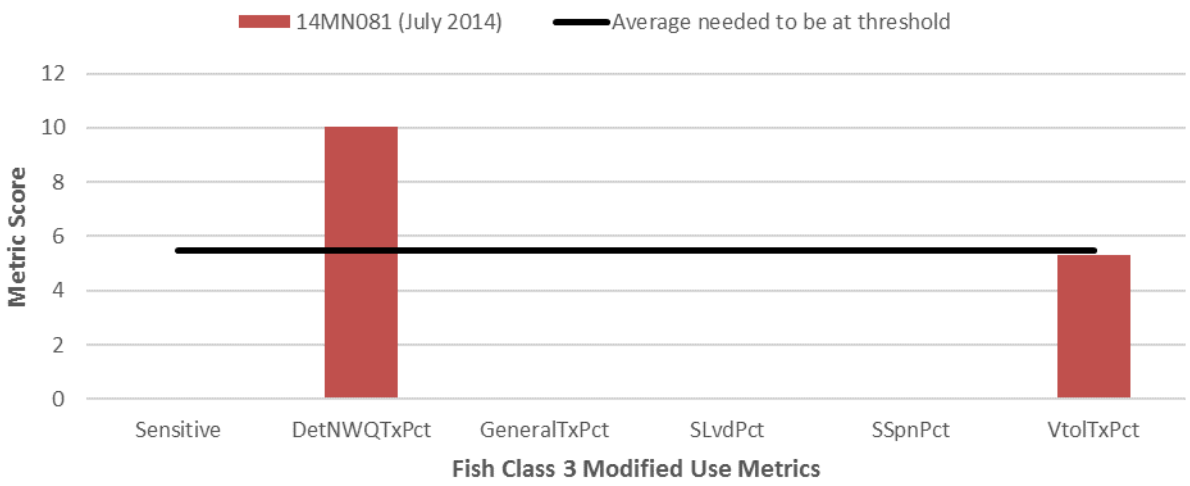
County Ditch 47A (-792) is a 0.43 mile long stream reach located in northeastern Nicollet county. This reach extends from an unnamed ditch located just downstream of 370th St. and flows in a southerly direction until reaching County Ditch 75 (-793). This heavily channelized stream reach is impaired for biology due to its fish community. One biological monitoring station, 14MN081, is located along this reach.

Biology

Fish:

County Ditch 47A (-792) was sampled for fish at its biological monitoring station, 14MN081, in July of 2014. The FIBI score from this visit was 15.3, which is far below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. Only one of the six metrics (DetNWQTxPct) scored above the average needed to reach the FIBI threshold (Figure 170). The stream fish community was comprised of 5 tolerant fish species and dominated by fathead minnows.

Figure 170. Fish metric scores



Candidate Cause: Dissolved Oxygen

There is limited DO data available on this reach. During fish and macroinvertebrate sampling in 2014, DO values of 4.81 mg/L and 4.24 mg/L were recorded. An additional value taken in 2016 was 6.19 mg/L. Continuous data were not available.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No fish were collected that take three years or longer to mature. Low DO values also correspond with increased serial spawning fish percentage. The fish population was comprised of 97.58% serial spawning fish. This is reinforced by fish tolerant to low DO conditions, where 98% of the population was comprised of DO tolerant fish individuals.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No intolerant macroinvertebrate taxa were collected and the percentage of DO tolerant individuals was 67.19%. Low DO is a stressor to County Ditch 47A (-792).

Table 305. Metrics related to eutrophication

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN081	**0**	**97.58**	**5**	**67.19**	**9.03**	**0**	**5.75**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.063 to 0.128 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data were available. As a result of eutrophication, pH values also increase. pH values ranged from 7.54 to 7.99. Thick algal growth was noted at station 14MN081 (Figure 171).

Figure 171.Algae at site 14MN081 (July 29, 2014)

Sensitive and darter individuals were not present. Tolerant individuals comprised 100% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised more than 97% of the population. Individuals of EPT species were present at levels much lower than the class average. EPT require healthy oxygen levels. The two most common macroinvertebrate species sampled comprised just less than half of the population. Based on the phosphorus values, algal growth, and biological evidence, eutrophication is a stressor in County Ditch 47A (-792).

Table 306. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa
14MN081	0	0	100	97.58	36	7.64	48.73
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

Two nitrate samples were taken from County Ditch 47A (-792) from 2014-2016. These values were 6.5 mg/L from a sample taken on July 29, 2014 and 20 mg/L from a sample taken on June 30, 2016. A quantile regression analysis showed that when macroinvertebrate Class 7 exceed 11.5 mg/L, there is a 90% probability for impairment.

Table 307. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN081	5.56	66.56	0.00	4.52
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 47A (-792) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 307). The site, 14MN081, had few Trichoptera taxa, zero nitrate intolerant species, a high amount of nitrate tolerant species, and a very poor nitrogen TIV score. All of these results suggest that nitrates are negatively impacting this stream reach.

Based on the high nitrate values observed in this reach, as well as the downstream reach, Barney Fry Creek (-602), the quantile regression analysis, and the poor scoring macroinvertebrate metrics related to nitrates all suggest that nitrates are indeed a stressor to aquatic life in County Ditch 47A (-792).

Candidate Cause: Sediment

From 2014-2016, two TSS samples were collected from County Ditch 47A (-792). These values were 31 mg/L on 07/29/2014 and 3.2 mg/L on June 30, 2016. Also, two secchi tube measurements were taken in 2014. These results were 20 cm on July 29, 2914 and 30 cm on August 12, 2014.

Additionally, the HSPF model also calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 3.2-454.2 mg/L with an average TSS concentration of 14.8 mg/L. Of these calculations, 154 (2.48%) were above the 65 mg/L standard for TSS.

Table 308. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN081	**0.12**	**0.00**	**0.12**	**0.00**	**0.12**	**0.00**	**1.96**	**0.00**	**0.00**	**23.56**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 47A (-792) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 308). The TSS index score was especially poor at this reach. These results tend to indicate a community being negatively impacted by suspended sediment.

Table 309. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN081	**18.66**	**0**	**15**	**36.94**	**0.32**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach at site 14MN081 scored below average in all six of the suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 309). These results tend to indicate a community being negatively impacted by suspended sediment.

The observed data set in this reach is very small. There were no standard exceedances in TSS or secchi tube measurements. The HSPF model calculated a very low level of exceedances for TSS, while the biological indicators strongly suggest stressor. More observed data from this stream reach are needed to better determine the impacts that suspended sediment is having on this reach, therefore, suspended sediment is inconclusive as a stressor in County Ditch 47A (-792) at this time.

Candidate Cause: Habitat

County Ditch 47A (-792) had a qualitative habitat assessment take place at its biological monitoring site, 14MN081, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 20.7 (Poor). Limiting the habitat at this site was the row crop agriculture as the primary land use (Figure 172), a narrow riparian buffer, moderate erosion severe embeddedness, no stream shading, sand and silty substrates, sparse fish cover, poor channel sinuosity, poor channel development, no depth variability and moderate channel stability. Further MSHA analysis can be seen in Figure 173.

Figure 172. Erosion at site 14MN081 (August 12, 2014)

Figure 173. Habitat related fish metrics

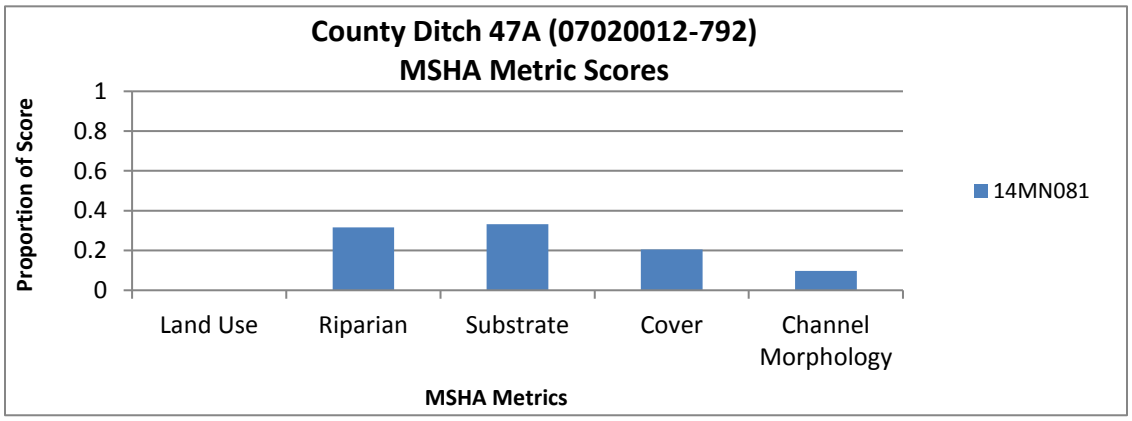


Table 310.Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN081	**0.00**	**1.96**	**0.00**	**0.12**	**0.00**	**2.31**	**100.00**	**97.92**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 47A (-792) scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 310). The fish community was completely dominated by fathead minnows (97.58%). Fathead minnows are known to be one of the most tolerant fish species of poor habitat conditions.

Table 311. Habitat related macroinvertebrate metrics

Station	**BurrowerPct**	**ClimberPct**	**ClingerPct**	**EPTPct**	**LeglessPct**	**SprawlerPct**
14MN081	**3.50**	**60.19**	**3.18**	**7.64**	**66.24**	**15.92**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four of the six habitat related metrics when compared to all other Class 7 Prairie Streams GP stations that met the MIBI Modified Use Threshold (Table 312). Site 14MN081 had a large amount of legless individuals, while having fewer EPT, clinger, and sprawler individuals. These results can signal habitat stress.

Based on the poor MSHA score, as well as the majority of the fish and macroinvertebrate habitat related metrics scoring below average, habitat is a stressor in County Ditch 47A (-792).

Candidate Cause: Chloride/Ionic strength

One chloride value was available on this reach with a value of 27.1 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 470 to 988 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset were greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both far below average, while the taxa count were just lower than class average. The macroinvertebrate community was comprised of 69.43% conductivity tolerant individuals and 0 intolerant individuals.

Table 312. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN081	36	3	7.00	7.64	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					1
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 98% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, but the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 47A (-792).

Candidate Cause: Altered Hydrology/Connectivity

This is 100% modified according to the MPCA altered watercourse layer, as is the upstream watershed. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 10% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising almost the entire population at 99.88%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 97.69% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. The biological evidence indicates that altered hydrology is a contributing stressor that is also impacting habitat in County Ditch 47A (-792).

Conclusions and recommendations

The impaired fish community in County Ditch 47A (-792) is being stressed by Dissolved Oxygen, Eutrophication, Nitrates, Habitat and Flow Alteration/Connectivity. (Table 313) Suspended Sediment and Chloride were inconclusive as stressors. For further information on the stressors and recommendations to fixing the stressors in the City of Le Sueur-Minnesota River HUC 10 watershed, please see page 337.

Table 313. Stressors on County Ditch 47A (-792)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 47 A	**07020012-792**	●	●	●	o	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

10.3 County Ditch 75 (-793)

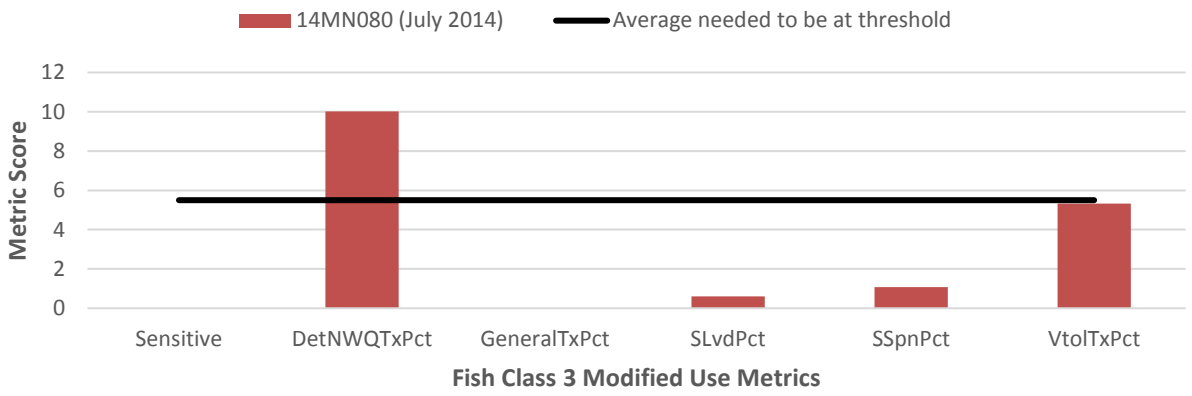
Also located in northeastern Nicollet county is County Ditch 75 (-793). This reach is extends from an unnamed ditch that is located just upstream of Highway 22 and down to the confluence with County Ditch 47A (-792). Similar to County Ditch 47A (-792), this reach is impaired for biology due to the fish assemblage. There is one biological monitoring station, 14MN080, located along this stream section.

Biology

Fish

County Ditch 75 (-793) was sampled for fish at biological monitoring site, 14MN080, in July of 2014. The FIBI score for this visit was 17, which is far below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. Only one of the six metrics (DetNWQTxPct) scored above the average needed to meet the threshold. This site had a lack of sensitive fish individuals and a high amount of generalist feeding taxa resulting in a metric score of zero, which limited the FIBI score. (Figure 174)

Figure 174. Biological metric scores



Candidate Cause: Dissolved Oxygen

There is very limited DO data available on this reach. During fish and macroinvertebrate sampling in 2014, DO values of 7.07 mg/L and 7.62 mg/L were recorded. An additional value taken in 2016 was 8.48 mg/L. Continuous data were not available.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.7-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No fish were collected that take three years or longer to mature. Low DO values also correspond with increased serial spawning fish percentage. The fish population was comprised of 71.95% serial spawning fish. This is reinforced by fish tolerant to low DO conditions, where 89% of the population was comprised of DO tolerant fish individuals.

Table 314. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrate	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN080	**0**	**71.95**	**5**	**32.67**	**8.35**	**0**	**6.16**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)				**31.37**	**8.0**	**1.78**	**6.19**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No intolerant macroinvertebrate taxa were collected and the percentage of DO tolerant individuals was 32.67%, just above the class average. The fish community has some indication that low DO could be a stressor, but it is currently inconclusive as a stressor. More DO samples would be helpful to better characterize the DO regime in County Ditch 75 (-793).

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.128 to 0.311 mg/L. The highest value was collected in July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data were available. As a result of eutrophication, pH values also increase. pH values ranged from 7.85 to 8.08. Thick algal growth was noted at station 14MN080 (Figure 175).

Figure 175. Algal growth at sit 14MN080 (July 5, 2016)

Sensitive and darter individuals were not present. Tolerant individuals comprised 100% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised more than 71% of the population. Individuals of EPT species were present at levels lower than the class average. EPT require healthy oxygen levels. The two most common macroinvertebrate species sampled comprised less than half of the population. Based on the phosphorus values, algal growth, and biological evidence, eutrophication is a stressor in County Ditch 75 (-793).

Table 315. Mertrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN080	0	0	100	71.95	39	15.33	20
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)					**33.59**	**20.58**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

Three nitrate samples were taken from County Ditch 75 (-793) at site 14MN080 from 2014-2016. These nitrate samples ranged in value from 19-27 mg/L with an average nitrate concentration of 22 mg/L. A quantile regression analysis of macroinvertebrate Class 7 sites showed that when nitrate concentrations

exceeded 11.5 mg/L that there was a 90% probability for impairment. This reach easily exceeded this level in all three nitrate samples.

Table 316. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN080	**5.13**	**79.67**	**0.00**	**3.92**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*5.71*	*62.54*	*0.00*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 75 (-793) scored below average in all four of the nitrate related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 316). Site 14MN080 had few Trichoptera taxa, zero nitrate intolerant species, while also having a high amount of nitrate tolerant taxa and a poor nitrogen TIV score. All of these results indicate a stream being negatively impacted by high nitrate concentrations.

Based on the very high nitrate concentrations observed, the quantile regression analysis, as well as the poor scoring nitrate related macroinvertebrate metrics, nitrates are a stressor to aquatic life in County Ditch 75 (-793).

Candidate Cause Sediment

Three TSS samples were taken from County Ditch 75 (-793) from 2014-2016. These sample values ranged from 2-74 mg/L with an average TSS concentration of 26.93 mg/L. One of the samples collected was above the 65 mg/L standard for TSS. Additionally, two secchi tube measurements were made along this reach in 2014. These values were 14 cm on 07/29/2014 and 21 cm on 08/12/2014.

Additionally, the HSPF model also calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 3.2-454.2 mg/L with an average TSS concentration of 14.8 mg/L. Of these calculations, 154 (2.48%) were above the 65 mg/L standard for TSS.

Table 317. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN080	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**7.32**	**0.00**	**0.00**	**21.11**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in County Ditch 75 (-793) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 317). This fish community at site 14MN080 was not very diverse as only five different species were sampled and all are tolerant of poor suspended sediment conditions.

Table 318. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN080	**17.40**	**0**	**15**	**45.00**	**7.00**	**0.00**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*16.02*	*0.60*	*10.98*	*35.60*	*9.91*	*0.02*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 75 (-793) scored below average in all six of the suspended sediment related metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 318). The site, 14MN080, had a high amount of TSS tolerant species and individuals, while also lacking in collector-filterer individuals, TSS tolerant and Plecoptera taxa, as well has having a poor TSS index score.

The HSPF model did not predict a high standard exceedance rate for TSS. The very small observed data did have one exceedance. Both of the fish and macroinvertebrate communities scored poorly in all of the suspended sediment related metrics in this reach. Therefore, suspended sediment is a stressor to aquatic life in County Ditch 75 (-793) at this time.

Candidate Cause: Habitat

County Ditch 75 (-793) had a qualitative habitat assessment take place at its biological monitoring site, 14MN080, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 28.05 (Poor). Limiting the habitat at this site was the row crop agriculture as the primary land use (Figure 176), a narrow riparian buffer, moderate embeddedness, sand and silty substrates, sparse fish cover, poor channel sinuosity, fair channel development, and moderate channel stability. Further MSHA analysis can be seen in Figure 177

Figure 176. Site 14MN080 (July 5, 2016)

Figure 177. Habitat related fish metrics

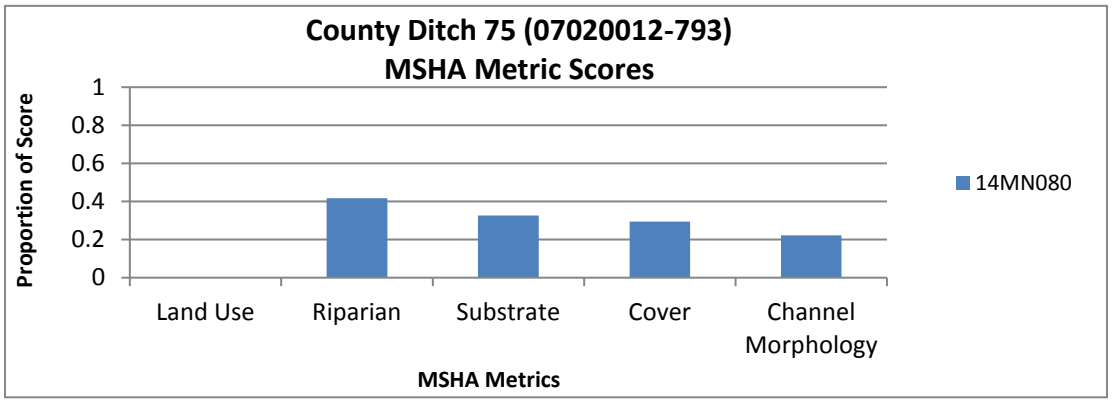


Table 319. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN080	**0.00**	**7.32**	**0.00**	**0.00**	**0.00**	**10.98**	**100.00**	**76.83**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN080 in County Ditch 75 (-793) scored below average in all of the habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 319). The fish assemblage consisted of all species that are very tolerant of poor habitat conditions including: fathead minnows, creek chubs, blacknose dace, green sunfish, and brook sticklebacks. The site also lacked any habitat specializing species, which is a strong signal that habitat is a stressor in this stream reach.

Table 320. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN080	**13.00**	**45.00**	**12.00**	**15.33**	**74.00**	**24.33**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	*9.74*	*24.34*	*20.62*	*15.52*	*59.46*	*22.88*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN080 scored below average in four of the six habitat metrics when compared to all other Class 7 Prairie Streams GP stations that meet the MIBI Modified Use Threshold (Table 320). The assemblage had many burrower and legless individuals that correspond to the sand and silty substrates found in this reach.

Based on the poor MSHA score, as well as the majority of the fish and macroinvertebrate habitat related metrics scoring below average, habitat is a stressor to the impaired biological communities in County Ditch 75 (-793).

Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 775 to 863 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). No values in the dataset were greater than 1,000 µS/cm.

Table 321. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN080	39	1	14.67	15.33	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 7 Prairie Streams GP stations that are meeting the MIBI Modified Use Threshold (22.0)	33.59	3.45	16.52	20.58	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both below average, while the taxa count was higher than the class average. The macroinvertebrate community was comprised of 73.33% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Only one Centrarchidae (a green sunfish) was collected, which is tolerant to pollution. No intolerant Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 88% of the fish community. There were no elevated chloride or specific conductance values in the small dataset, and the biological communities had indications of stress. Taking chloride values throughout the year would be helpful, but ionic strength is currently inconclusive as a stressor in County Ditch 75 (-793).

Candidate Cause: Altered Hydrology/Connectivity

This is 100% modified according to the MPCA altered watercourse layer, as is the upstream watershed. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 10% of the time during the spring-fall months. Flow conditions seem to be affecting the biology due to extended periods of low flow.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 84.15% of the

population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 89.02% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 3% of the population.

Figure 178. Perched culvert at site 14MN080 (July 19, 2014)

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. County Ditch 75 has a perched culvert (Figure 178) between station 14MN080 and Barney Fry Creek, which is affecting fish migration. Based on the high numbers of generalist and nest guarding species and the presence of the perched culvert, altered hydrology is a stressor in County Ditch 75 (-793).

Conclusions and recommendations

The impaired fish community in County Ditch 75 (-793) is being stressed by Eutrophication, Nitrates, Suspended Sediment, Habitat and Flow Alteration/Connectivity. (Table 322) Dissolved Oxygen and Chloride were inconclusive as stressors. For further information on the stressors and recommendations to fixing the stressors in the City of Le Sueur-Minnesota River HUC 10 watershed, please see below.

Table 322. Stressors on County Ditch (-793)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 75	**07020012-793**	**o**	**●**	**●**	**●**	**●**	**o**	**●**

● = stressor; o = inconclusive stressor; --- = not an identified stressor

City of Le Sueur-Minnesota River HUC 10 Conclusions and Recommendations

The City of LeSueur-Minnesota River subwatershed contains three biologically impaired stream reaches. Eutrophication and Altered Hydrology/Connectivity were the major stressors in this watershed as they were determined to be stressing aquatic life at all three impaired reaches. High levels of nitrates and poor habitat are also issues in this subwatershed as they were found to be a stressor in two of the three reaches, while dissolved oxygen and suspended sediment are stressors in one stream each. More Chloride data are needed to better determine the impact of this potential stressor is in this subwatershed.

Row crop agriculture is the dominant land use present in this watershed. There are also some areas of hay/pasture, development, and deciduous forests near the Minnesota River valley. The headwaters of this subwatershed are being impacted by the effects of channelization of the streams and contributing tributaries. This is a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

As Table 323 shows, Altered Hydrology/Connectivity and Eutrophication (excess phosphorus) are the most common stressors found in this subwatershed.

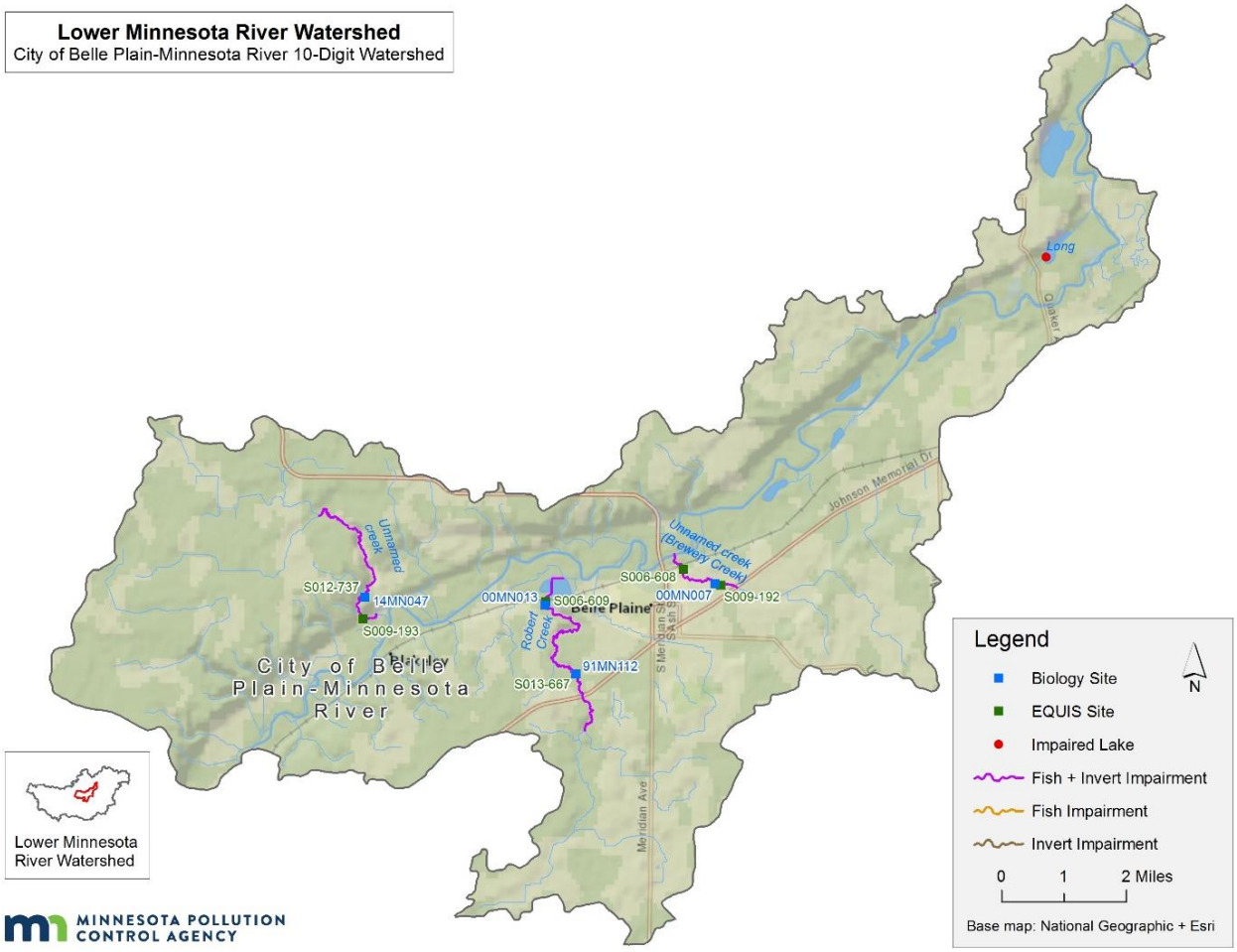
Improvements in the City of Le Sueur-Minnesota River watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. Another significant focus should be to reduce the amount of phosphorus entering the stream system. This can be achieved through BMPs like: cover crops, nutrient management, and saturated buffers.

Table 323. Stressors on streams in the city of Le Sueur Minnesota River HUC

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Barney Fry Creek	07020012-602	---	●	---	---	o	●	o
County Ditch 47 A	07020012-792	●	●	●	o	●	●	o
County Ditch 75	07020012-793	o	●	●	●	●	●	o

11. City of Belle Plain-Minnesota River HUC 10 (0702001209)

Figure 179. Sampling sites in the city of Belle Plain Minnesota River HUC



11.1 Robert Creek (-575)

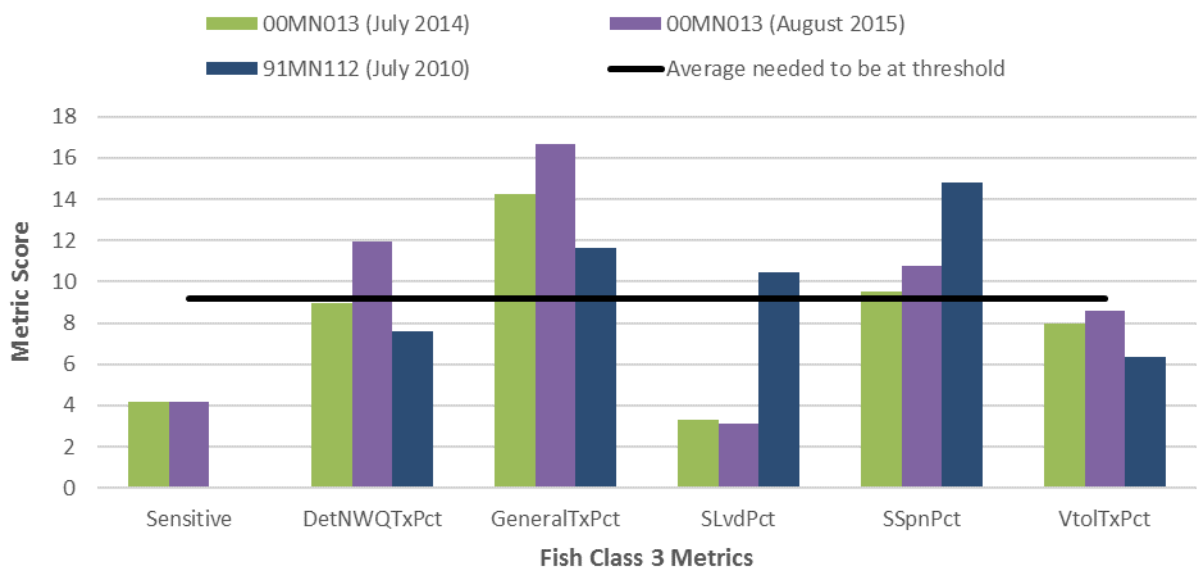
Located in southwestern Scott county, Robert Creek (-575) is a 4.65 mile long stream reach that extends from just upstream of U.S. Highway 169 to the confluence with an Unnamed Creek at the Belle Plaine Sewage ponds. This reach is impaired for biology due to the fish and macroinvertebrate assemblages at the two biological monitoring stations, 00MN013 and 91MN112, located along this stream section. The reach is also impaired for TSS.

Biology

Fish

Robert Creek (-575) was sampled for fish three times at two biological monitoring stations, 00MN013 and 91MN112. Site 00MN013 was sampled in July of 2014 and again in August of 2015 and had FIBI scores of 48.2 (2014) and 55.2 (2015). Site 91MN112 was sampled in July of 2010 and had an FIBI score of 14.7. All visits except for the August 2015 visit at 00MN013 were under the Fish Class 3 Southern Headwaters General Use Threshold of 55. The 2014 visit took place after flooding which widened the stream channel. Mainly limiting the FIBI during this visits were the lack of sensitive fish individuals and the abundance of short-lived individuals present. (Figure 180)

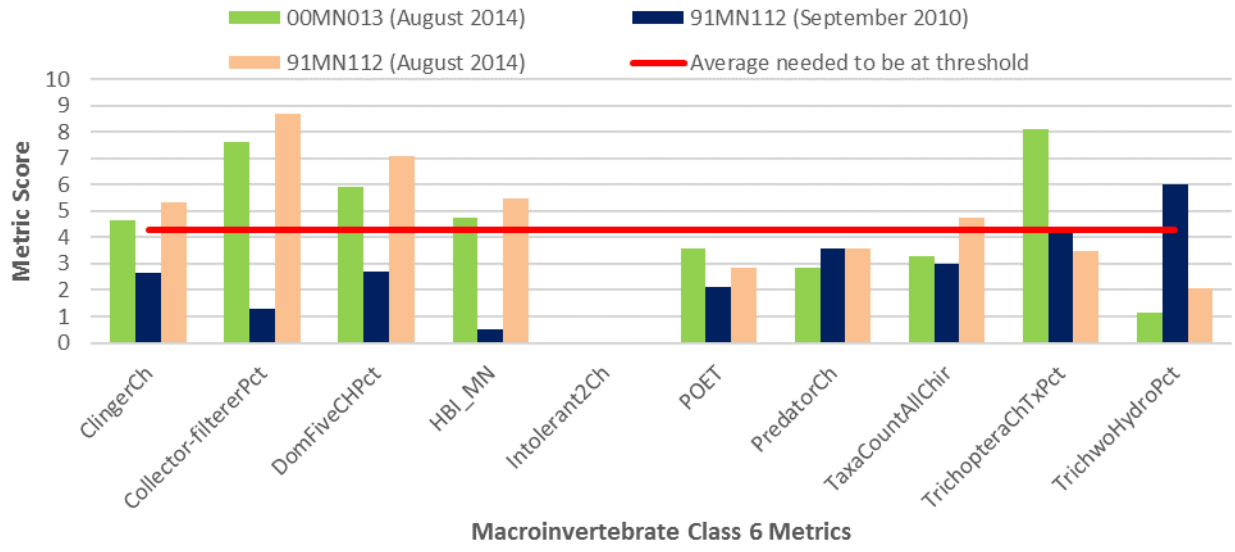
Figure 180. Fish metric scores



Macroinvertebrates

The macroinvertebrate community along this reach was sampled twice from 2010-2014. Site 00MN013 was sampled in August of 2014 and had an MIBI score of 41.9 while site 91MN112 was sampled in September of 2010 and had a MIBI score of 43.3. The MIBI score at 00MN013 fell below the Macroinvertebrate Class 6 Southern Forest Streams GP General Use Threshold of 43. Each visit scored above the average needed to reach the threshold in five of the metrics. (Figure 181)

Figure 181. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a considerable DO dataset on this reach in recent years. Concentrations ranged from 6.84 mg/L to 11.29 mg/L with no recorded values below 5 mg/L. Continuous data were not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.6-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 324. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
91MN112	0	8.61	11	0.67	7.19	4	6.95
00MN013 (2014)	2.20	32.97	13	0.97	7.43	6	7.16
00MN013 (2015)	0	27.45	7	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All visits had percentages at or below the class average of fish that take three years or longer to mature. Values ranged from zero to 2.20%. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner percentages increased from 3.02% in 2000 to 32.97% and 27.45% in 2014 and 2015, respectively. Species that are very tolerant to low DO conditions ranged from 8% to 24% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at all stations. Intolerant macroinvertebrate taxa collected ranged from four to six. The percentage of DO tolerant individuals were both less than 1%. These values show macroinvertebrate communities that are not being limited by low DO conditions. Based on the preponderance of evidence, DO is not a stressor to the biological communities in Roberts Creek (-575).

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.042 to 0.615 mg/L with 52% over 0.150 mg/L. The highest value was collected during June just upstream of the Minnesota River and the Belle Plaine Sewage Disposal Ponds (station S006-609). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L.

Figure 182. Algae at site 91MN112 (July 24, 2001)

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in

chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water (Figure182). The small dataset of chlorophyll-a samples had a range of values from 1 to 25.8, without any values over the southern standard of 40. There are no DO flux or BOD data available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.74 to 8.52.

Table 325. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
91MN112	0	9.25	90.75	7.34	35	32.33	31
00MN013 (2014)	1.1	2.2	86.81	10.44	30	16.88	40.58
00MN013 (2015)	3.92	3.92	92.16	1.96			
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individual percentages ranged from 0 to 3.92% and darter individual percentages ranged from 2.2 to 9.25%. Darter individuals at station 91MN112 were all johnny darters, which are more tolerant darters. Tolerant individuals comprised more than 86% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised less than 11% of the population. Individuals of EPT species were present at levels lower than the class average at station 00MN013 and just above at station 91MN112. EPT require healthy oxygen levels. While EPT individuals were higher at station 91MN112, the community was dominated by species that are tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised less than half of the population. Based on the phosphorus values, algal growth, and biological evidence, eutrophication is a stressor in Roberts Creek (-575).

Candidate Cause Nitrate

From 2010-2016, a total of 34 nitrate samples were taken from Robert Creek (-575). These values ranged from 4.44-17.2 mg/L with an average value of 9.60 mg/L.

Table 326. Nitrate related metrics

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
00MN013	**13.33**	**63.75**	**0.00**	**3.56**
91MN112	**7.23**	**65.07**	**1.35**	**3.52**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Robert Creek (-575) scored below average in three (00MN113) and four (91MN112) of the nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (TABLE). Both sites had a high amount of nitrate tolerant taxa, very few nitrate intolerant species, and a below average nitrogen TIV score.

Based on the majority of the nitrate related biological metrics, as well as some elevated nitrate values observed, nitrates are a stressor to Robert Creek (-575) at this time.

Candidate Cause Sediment

Robert Creek (-575) had 34 TSS samples taken from 2010-2016. These TSS concentrations ranged from 2-2,030 mg/L with an average value of 123.29 mg/L. Of these samples, ten (29.41%) were above the 65 mg/L standard for TSS. Additionally, from 2010-2015 a total of 49 secchi tube measurements were taken along this reach. These values ranged from 1.5-100 cm with an average value of 53.13 cm. Of these measurements, 12 were below the 10 cm standard set for secchi tube measurements.

This reach was also determined to be impaired for TSS during the 2016 assessment.

Table 327. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
00MN013	15.79	0.00	13.87	2.77	13.40	1.67	54.65	0.00	0.73	14.07
91MN112	16.44	0.00	7.70	7.97	8.59	0.00	18.75	0.00	0.12	16.38
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Robert Creek (-575) scored below average in seven (00MN013) and ten (91MN112) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 327). Site 00MN013 did have above average TSS index score and amounts of simple lithophilic and herbivorous individuals, but scored poorly in the remaining metrics.

Table 328. Macroinvertebrate metrics related to sediment

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
00MN013	15.86	0.00	6	35.92	28.90	0.00
91MN112	15.43	0.00	6.67	37.45	17.38	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Robert Creek (-575) scored below average in four (00MN013) and five (91MN112) of the six suspended sediment related metrics when compared to all other Class 6 Southern Streams GP stations that meet the MIBI General Use Threshold (Table 328). Both sites did have a lower amount of TSS tolerant taxa, and site 00MN013 had an above average amount of collector-filterer individuals, the remaining metrics scored poorly at both sites.

Based on the majority of the fish and macroinvertebrate suspended sediment related metrics scoring below average, the high suspended sediment and secchi tube exceedance rates as well as the new suspended sediment impairment, suspended sediment is a stressor to aquatic life in Robert Creek (-575).

Candidate Cause Habitat

Robert Creek (-575) had qualitative habitat assessments take place at biological monitoring sites, 00MN013 and 91MN112, during the fish and macroinvertebrate sampling events in 2001, 2010, 2014 and 2015. The average MSHA scores from these visits was 36.58 (Poor) at 00MN013 and 61.13 (Fair) at 91MN112. Limiting the habitat at these sites are moderate bank erosion, sand and silt substrates, severe embeddedness, sparse fish cover, limited depth variability, low to moderate channel stability and poor channel development at site 00MN013. Site 91MN112 did score better in those attributes, but was still limited by sparse fish cover and the presence of sandy substrates. A breakdown of the MSHA category scores for this site can be seen in Figure 183.

Figure 183. Habitat metric scores

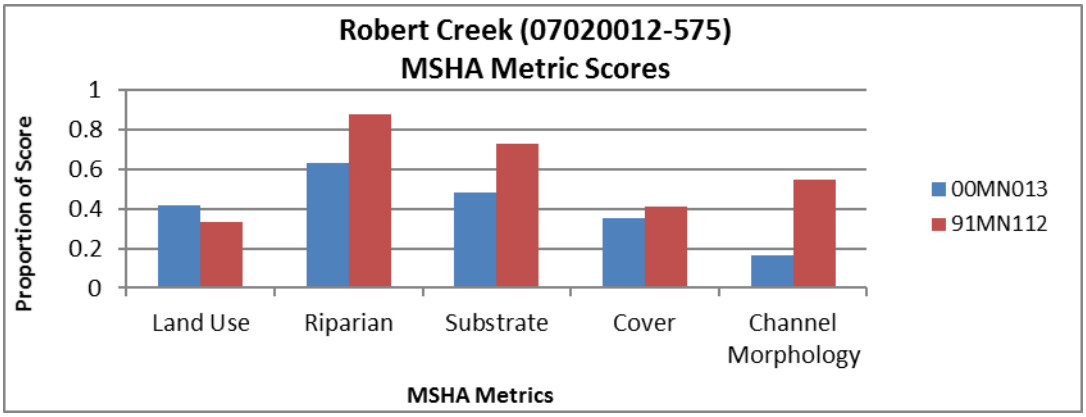


Table 329. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
00MN013	**4.05**	**54.65**	**2.04**	**13.4**	**0.73**	**73.26**	**92.99**	**8.94**
91MN112	**7.85**	**18.75**	**7.85**	**8.59**	**0.00**	**70.40**	**92.03**	**69.43**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Robert Creek scored below average in five (00MN013) and seven (91MN112) of the eight evaluated habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 329). Fathead minnows, creek chubs, and blacknose dace, were consistently found in greater numbers at these sites. Those species are very tolerant of poor habitat conditions. The lack of habitat specialist species is also a sign of degraded habitat conditions.

Table 330. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
00MN013	**11.69**	**28.90**	**39.29**	**16.88**	**70.13**	**9.42**
91MN112	**7.51**	**32.87**	**27.05**	**31.04**	**58.98**	**15.37**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Robert Creek (-575) scored below average in four of the six habitat related metrics at both sites, 00MN013 and 91MN112, when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 330). Both sites had elevated numbers of both burrower and legless individuals. This occurrence tends to happen in streams with higher amounts of sand and other fine substrates common of degraded habitat conditions.

Based on the fair to poor MSHA scores, as well as the majority of both of the fish and macroinvertebrate habitat related metrics scoring below average, habitat is indeed a stressor to the biological communities in Robert Creek (-575).

Candidate Cause: Chloride/Ionic strength

Chloride values available on this reach ranged from 14.5 to 47.6 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 378 to 1,053 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the dataset was greater than 1,000 µS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both below average at the downstream station 00MN013, but above average at the upstream station 91MN112. Both taxa counts were below the class average. The macroinvertebrate community was comprised of a range of 26.67 to 42.72% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidae (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised a range of 10 to 25% of the fish community. There was one elevated specific conductance value in the dataset, while the biological data were mixed. Station 00MN013 had stronger indications of stress. Ionic strength is currently inconclusive as a stressor in Roberts Creek (-575).

Table 331. Mecrtics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
91MN112	35	2	18.67	32.33	0
00MN013 (2014)	30	4	11.36	16.88	0
00MN013 (2015)	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach of Robert Creek is predominantly natural except for the most downstream section which flows into the Belle Plain WWTP, according to the MPCA altered watercourse layer, while the majority of the upstream watershed is modified. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. The stream went dry in 2009 and experienced flooding in 2014 (Figure 184).

Figure 184. Flood impacts at site 00MN013 (July 28, 2014)

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 56.86 to 69.22% of the fish community. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 7.84 to 18.98% of the fish

community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0 to 1% of the population. The stream went dry in 2009, but based on the preponderance of evidence, altered hydrology is not currently a contributing stressor in Roberts Creek (-575).

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Robert Creek (-575) are being stressed by Eutrophication, Nitrates, Suspended Sediment, and Habitat. (Table 332) Chloride was inconclusive as a stressor, while Dissolved Oxygen and Flow Alteration/Connectivity were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Belle Plain-Minnesota River HUC 10 watershed, please see page 366.

Table 332. Stressors on Robert Creek (-575)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Robert Creek	07020012-575	---	●	●	●	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

11.2 Unnamed Creek (-798)

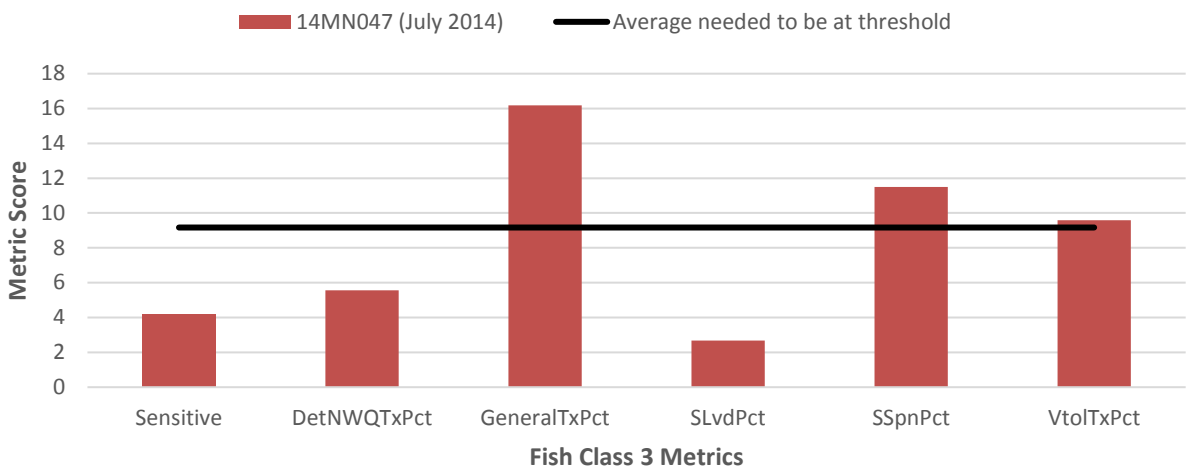
Located in northeastern Sibley county, Tributary to Minnesota River (-798) is a 3.2 mile long reach that runs from Unnamed Creek to the confluence with the Minnesota River. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN047, located along this reach.

Biology

Fish

Unnamed Creek (-798) was sampled for fish at biological monitoring site, 14MN047, in July of 2014. The FIBI score for this visit was 49.7, which is far below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Three of the six metrics (GeneralTxPct, SSpnPct, VtolTxPct) scored above the average needed to meet the threshold. This site had few sensitive, detritivorous, and short lived fish individuals which limited the FIBI score (Figure 185).

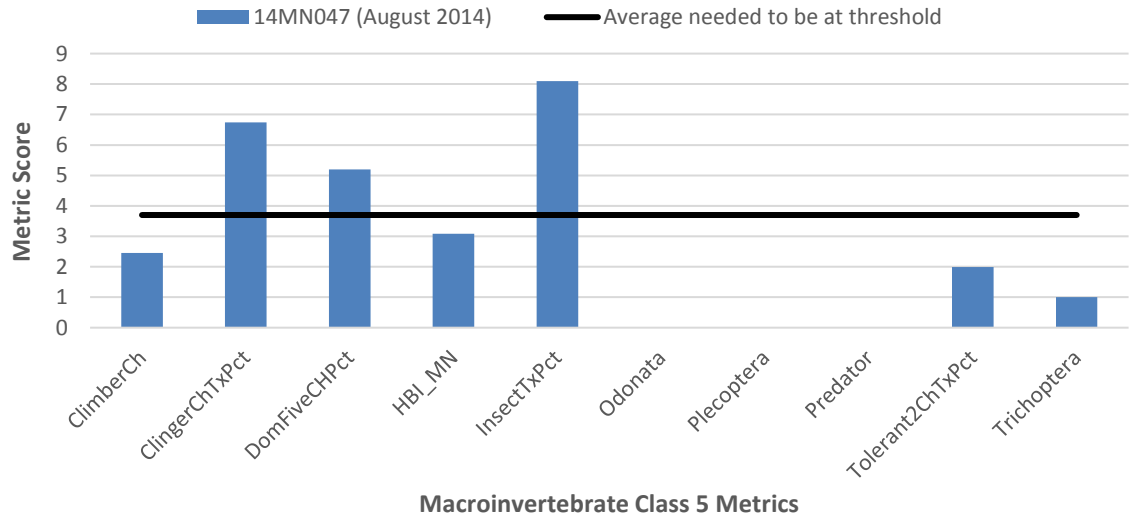
Figure 185. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was also sampled at site 14MN047 in August of 2014. The MIBI score for this visit was 28.6, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Just three of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold (ClingerChTxPct, DomFiveCHPct, InsectTxPct), while the remaining seven metrics scored below average to poorly with three metrics scoring zero (Figure 186).

Figure 186. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a considerable DO dataset on this reach in recent years. Concentrations ranged from 8.37 mg/L to 9.88 mg/L with no recorded values below 5 mg/L. Continuous data were not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.3-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Four intolerant macroinvertebrate taxa were collected. The percentage of DO tolerant individuals was very low, at 2.84%. These values show macroinvertebrate communities that are not being limited by low DO

conditions. Based on the preponderance of evidence, DO is not a stressor to the biological communities in Unnamed Creek (-798).

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No fish were present that take three years or longer to mature to reproductive age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage was 23.95%, just above the class average of stations that met the threshold. Species that are very tolerant to low DO conditions comprised 16% of the fish community.

Table 333. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN047	0	23.95	12	2.84	7.29	4	7.27
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	2.06	17.09	12.16				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				8.62	7.04	8.97	7.10
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.028 to 0.289 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.3 mg/L.

Table 334. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN047	0.53	0.79	97.89	4.74	32	33.12	27.44
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of these data were available. As a result of eutrophication, pH values also increase. pH values ranged from 7.78 to 8.38.

Sensitive and darter individuals both comprised less than 1% of the fish community. Tolerant individuals comprised more than 97% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised only 4.74% of the population. Individuals of EPT species were present at levels lower than the class average. EPT require healthy oxygen levels. The two most common macroinvertebrate species sampled comprised less than half of the population. Based on the mixed response, eutrophication is inconclusive as a stressor in Unnamed Creek (-798).

Candidate Cause Nitrate

Unnamed Creek (-798) had three nitrate samples taken from 2014-2016. These values ranged from 3.8-21 mg/L. The average nitrate value was 15.27 mg/L. Two of the three nitrate samples were very high. Quantile regression analysis of Class 5 streams showed that when nitrate values exceeded 18.1 mg/L, the probability of a macroinvertebrate impairment was greater than 75%.

Table 335. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN047	9.38	70.66	0.32	3.65
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (-798) scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 335). Site 14MN047 lacked many nitrate intolerant species, while also having a large amount of taxa that are tolerant to elevated levels of nitrates. This site also had few Trichoptera taxa, which tend to be more abundant in streams with low nitrate levels.

Based on the high observed nitrate levels, the quantile regression analysis, as well as the strong biological indicators, nitrates are a stressor to aquatic life in Unnamed Creek (-798).

Candidate Cause Sediment

From 2014-2016, two TSS samples were taken from Unnamed Creek (-798). These samples were 6.8 mg/L on 07/28/2014 and 400 mg/L taken on 06/01/2016. Additionally, two secchi tube measurements were taken along this reach with these readings being 22 and 100 cm.

The HSPF model also calculated daily TSS values for this reach from 1996-2012. These values ranged from 2.4-539.3 mg/L, with an average TSS concentration of 17.3 mg/L. Of these calculations, 289 (4.65%) were above the 65 mg/L standard for TSS. This percentage is rather low.

Table 336. Fish metrics related to sediment

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN047	**14.47**	**1.32**	**22.89**	**2.11**	**14.21**	**0.53**	**49.74**	**0.00**	**1.32**	**15.18**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek scored below average in six of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 336). This reach did have above average numbers of herbivorous; Centrarchid, and simple lithophilic individuals as well as having an above average TSS index score. These results are common in streams not being negatively impacted by suspended sediment levels.

Table 337. Macroinvertebrate metrics related to sediment

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN047	**15.77**	**0**	**9**	**27.76**	**25.24**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN047 scored below average in three of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 337). This reach had a good TSS index score, while also having low amounts of TSS tolerant taxa and individuals. This reach did however lack TSS intolerant taxa, Plecoptera taxa, as well as having a low amount of collector-filterer individuals.

The limited water chemistry data shows rather mixed results with one value being very high, while the other TSS value being very low. It is possible the high value was collected following a rain event. The HSPF model had a low standard exceedance rate and the biological metrics generally scored pretty well, especially the index scores when evaluating the suspended sediment related metrics. Based on this

information, suspended sediment is not a stressor to aquatic life in Unnamed Creek (-798) at this time. It is likely that other stressors are causing the lower metric scores in the biotic communities.

Candidate Cause Habitat

Unnamed Creek (-798) had a qualitative habitat assessment take place at biological monitoring site, 14MN047, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 46.88 (Fair). Limiting the habitat at this site was severe bank erosion (Figure 187), moderate to light stream shading, sand and silt substrates (Figure 188), light embeddedness, low channel stability, and little depth variability. Further MSHA analysis can be seen in Figure 189.

Figure 187.Bank eroision at site 14MN047 (August 19, 2014) Figure 188. Fine sediment substrate at site 14MN047 (June 1, 2016)

Figure 189. Habitat metric scores

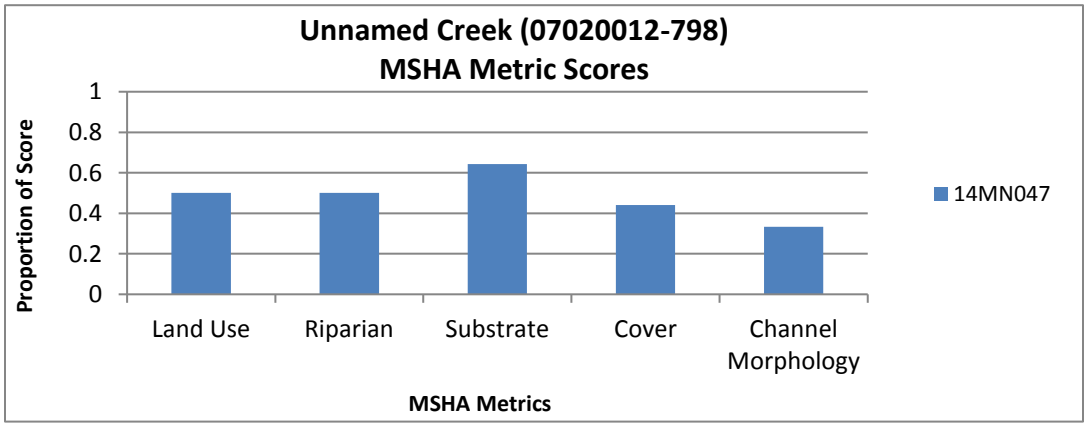


Table 338. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN047	**0.79**	**49.74**	**0.79**	**14.21**	**1.32**	**63.42**	**97.89**	**4.47**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN047 in Unnamed Creek (-798) scored below average in 6 of the 8 habitat related metrics when compared to other Class 3 Southern Headwaters site that do meet the FIBI General Use Threshold (Table 338). The fish assemblage consisted of a high amount of blacknose dace and bigmouth shiners (68.7% combined), which both tend to be fairly tolerant of degraded habitat conditions.

Table 339. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN047	**5.36**	**18.61**	**54.26**	**33.12**	**54.57**	**3.47**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage fared better than the fish as it scored below average in half of the habitat related biological metrics when compared to other Class 5 Southern Stream stations that did meet the MIBI General Use Threshold (Table 339). The high amounts of legless individuals, while having lower amount of both EPT and sprawler species limited the macroinvertebrate metric scores.

Based on the high amount of below average scoring habitat related metrics in the biotic communities (especially the fish), the fair MSHA score, and the photographic evidence of degraded conditions, lack of habitat is a stressor to the fish and macroinvertebrate communities in Unnamed Creek (-798).

Candidate Cause: Chloride/Ionic strength

Chloride values available on this reach ranged from 14.5 to 47.6 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 378 to 1,053 µS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for General Use streams (MBI, 2012). One value in the dataset were greater than 1,000 µS/cm.

Table 340. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN047	32	4	27.13	33.12	1.32
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages and the taxa count were all below average. The macroinvertebrate community was comprised of 37.85% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) values were higher than the class average. Species that are tolerant to conditions with high ionic strength comprised 16% of the fish community. There was one elevated specific conductance value in the dataset, while the biological data were mixed. Ionic strength is currently inconclusive as a stressor in Unnamed Creek (-798).

Candidate Cause: Altered Hydrology/Connectivity

This reach is 100% natural according to the MPCA altered watercourse layer, while parts of the upstream watershed are modified. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Construction was occurring at CSAH during the summer of 2016 and the creek went completely dry (Figure X). HSPF models show this section is experiencing low flow at less than 1 cfs 16% of the time during the spring-fall months. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. Flow conditions seem to be affecting the biology due to extended periods of low flow. The stream went dry in September 2013, which affects connectivity.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 53.95% of the fish community. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 4.74% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population. Based on the visual evidence of the stream running dry in 2017, and the preponderance of the biological communities, altered hydrology is a contributing stressor in Unnamed Creek (-798).

Figure 190. Site 14MN047 went dry in 2016 (September 26, 2013)

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed Creek (-798) are being stressed by Nitrates, Habitat and Flow Alteration/Connectivity. (Table 341) Eutrophication and Chloride were inconclusive as stressors, while Dissolved Oxygen and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Belle Plain-Minnesota River HUC 10 watershed, please see page 366.

Table 341. Stressors on Unnamed Creek (-798)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek	07020012-798	---	o	●	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

11.3 Brewery Creek (-830)

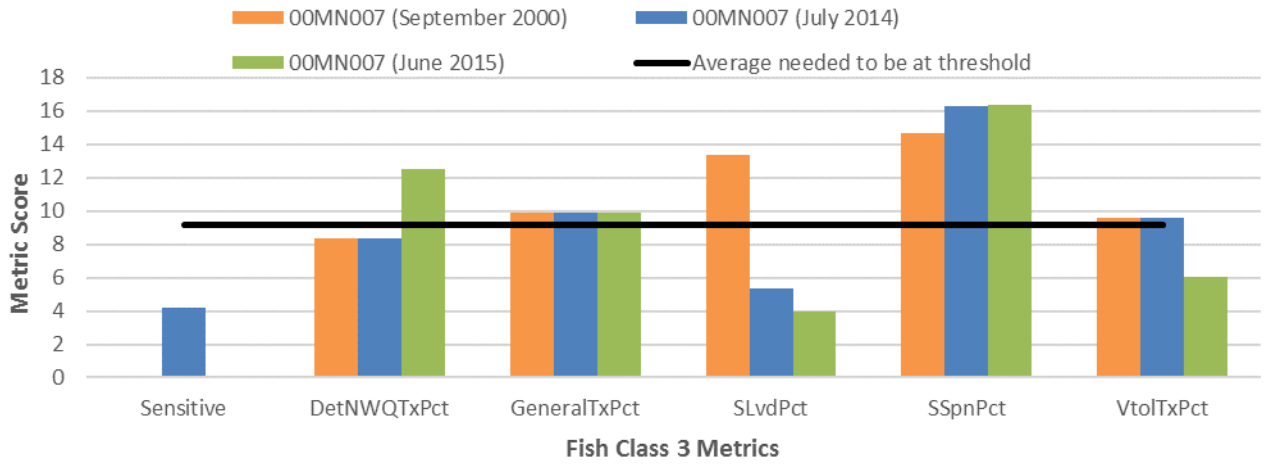
Brewery Creek is a 1.52 mile long stream reach that extends from US Highway 169 to the confluence with the Minnesota River. This reach is located in southwestern Scott County and contains one biological monitoring station, 00MN007. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages.

4.22.9 Biology

Fish

Brewery Creek (-830) was sampled for fish at biological monitoring station three times from 2000-2015. The FIBI scores from these visits were 55.9 (2000), 53.7 (2014), and 48.8 (2015). The visit in 2000 was the only visit to score above the Fish Class 3 Southern Headwaters General Use Threshold of 55. The FIBI score at this site has been trending downward since the initial fish sampling event in 2000, however the stream experienced intense rain in 2014. For a breakdown of the metric scores for these visits, see Figue 191.

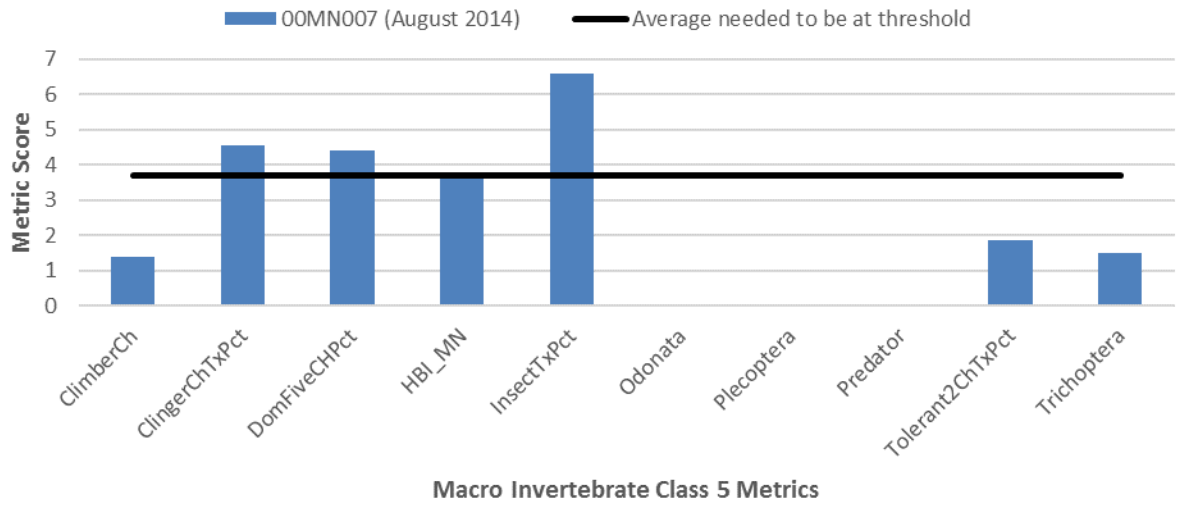
Figure 191. Bioloigcal metric scores



Macroinvertebrates

The macroinvertebrate assemblage was sampled in August of 2014 at site 00MN007. The MIBI score for this visit was 24.1, which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This visit had four of the ten metrics comprising the MIBI for this class score above the average needed to reach the threshold. The lack of Odonata, Plecoptera, and predator individuals limited the MIBI score for this reach. These MIBI metrics all scored zero (Figure 192).

Figure 192. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a considerable DO dataset on this reach in recent years (2011-2016). Concentrations ranged from 8.26 mg/L to 12.32 mg/L with no recorded values below 5 mg/L. Continuous data were not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.6-15.6 mg/L with no values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both visits lacked any fish that take three years or longer to mature. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner percentages were both less than 2%, far below the class average. Species that are very tolerant to low DO conditions ranged from 1% to 14% of the fish community.

Table 342. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
00MN007 (2014)	0	1.73	8	2.29	7.22	9	7.59
00MN007 (2015)	0	1.36	8	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at all stations. Nine intolerant macroinvertebrate taxa were collected and the percentage of DO tolerant individuals was 2.29%. These values show DO is not a stressor to the fish and macroinvertebrate communities.

Candidate Cause Eutrophication

Phosphorus values ranged from 0.024 to 1.23 mg/L with 21% over 0.150 mg/L. The highest value was collected during May in Belle Plaine just upstream of the Minnesota River (station S006-608). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.1 mg/L with a mean of 0.2 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. The small dataset of chlorophyll-a samples had a range of values from 1 to 25.9, without any values over the southern standard of 40. There is no DO flux or BOD data available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 8 to 8.52.

Table 343. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
00MN007 (2014)	2.31	5.2	94.22	1.16	34	13.50	45.86
00MN007 (2015)	2.04	11.56	88.44	1.36	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals comprised less than 2.5% of the fish community on both visits. The number of sensitive species decreased from 10.35% in 2000 to 2.31% in 2014 and 2.04% in 2015. Darter individuals comprised 5.2% of the community in 2014 and increased to 11.56% in 2015 but all of the darters collected were johnny darters, which are a more tolerant darter. Tolerant individuals comprised more than 88% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised less than 2% of the population. Individuals of EPT species were present at levels lower than the class average. EPT require healthy oxygen levels. The two most common macroinvertebrate species sampled comprised slightly less than half of the population. While there is evidence indicating biological stress, based on the preponderance of evidence, eutrophication is inconclusive as a stressor.

Candidate Cause Nitrate

From 2011-2016 a total of 25 nitrate samples were taken from Brewery Creek (-830). These samples ranged in value from 3.61-10.5 mg/L with an average value of 5.97 mg/L.

Table 344. Nitratqe related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
00MN007	10.57	62.43	0.16	3.55
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 00MN007 along Brewery Creek (-830) scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 344). The site had very few nitrate intolerant species, while also have a larger amount of nitrate tolerant taxa. These results as well as the below average nitrogen TIV score and low amount of Trichoptera taxa present all signal potential nitrate stress.

The nitrate related biological metrics signal that there could be some potential stress from excess nitrates in the system, however, the data set shows relatively low nitrate values with many samples taken from late spring and early summer when nitrate concentrations tend to be the highest. It is likely that other stressors are limiting the macroinvertebrate community resulting in poor metric scores. Nitrate is not a stressor to Brewery Creek (-830) at this time.

Candidate Cause Sediment

From 2011-2016 a total of 24 TSS samples were taken from Brewery Creek (-830). These sample values ranged from 2-1530 mg/L. The overall average was skewed heavily towards the highest value. The median TSS concentration for this reach was 10 mg/L. Two of the TSS sample were above the 65 mg/L standard. From 2011-2015 a total of 36 secchi tube measurements were taken along this reach. These readings ranged from 1.5-100 cm, with an average value of 67.74 cm. Of these readings, two were below the 10 cm standard for transparency.

Table 345. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
00MN007	**13.12**	**0.00**	**2.09**	**10.54**	**2.77**	**0.19**	**44.92**	**0.00**	**0.00**	**13.46**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 00MN007 along Brewery Creek (-830) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 345). The reach did have a higher number of simple lithophilic individuals and an above average TSS Index Score, but scored poorly in the remaining metrics.

Table 346. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
00MN007	14.40	0	5.5	21.94	32.92	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in two of the six metrics related to suspended sediment when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 346). The site, 00MN007, lacked TSS Intolerant and Plecoptera taxa, but did have a good TSS index score, low amounts of TSS Tolerant taxa and individual, as well as a high amount of collector filterer individuals.

Based on the very few observed TSS and Secchi tube measurements that exceed their respective standard, in addition to the majority of the macroinvertebrate community scoring above average in suspended sediment related metrics, suspended sediment is not a stressor to aquatic life at this time. It is likely that other stressors are limiting the fish metrics.

Candidate Cause Habitat

Brewery Creek (-830) had a qualitative habitat assessment take place at its biological monitoring site, 00MN007, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 60.8 (Fair). Limiting the MSHA score at this site was the presence of row crop agriculture as a significant nearby land use, severe bank erosion (Figure 193), moderate riparian buffer, sand substrates, moderate embeddedness, and moderate channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 194.

Figure 193. Severe bank erosion at site 00MN007 (August 19,2014)

Figure 194. Habitat metric scores

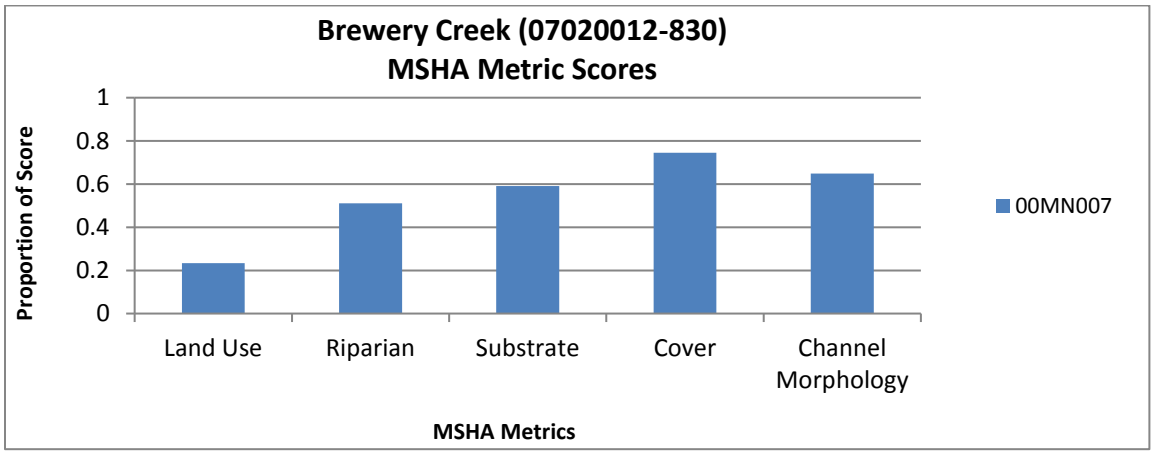


Table 347. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
00MN007	**10.54**	**44.92**	**10.54**	**2.77**	**0.00**	**79.61**	**89.26**	**45.76**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Brewery Creek (-830) at site 00MN007 scored below average in six of the eight habitat related metrics when compared to other Class 3 Southern Headwaters stations that met the FIBI General Use Threshold (Table 347). Between the three visits to this station, the site was dominated by

either creek chubs or blacknose dace, which both are known to be relatively tolerant to poor habitat conditions.

T**able 348. Habitat related macroinvertebrate metrics**

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
00MN007	**9.45**	**19.07**	**47.65**	**12.17**	**60.36**	**20.32**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage along this reach scored below average in four of the six evaluated habitat related metrics when compared to other Class 5 Southern Streams RR station that met the MIBI General Use Threshold (Table 348). The high amounts of legless individuals, while also having lower numbers of EPT individuals are often a strong indicators of degraded habitat conditions.

Based on the many of the habitat related biological metrics scoring below average in both assemblages, as well as the fair MSHA score, and the photographic evidence of degraded conditions in and/or immediately surrounding the stream, the lack of habitat in Brewery Creek (-830) is indeed a stressor to the fish and macroinvertebrate communities.

4.31.15 Candidate Cause: Chloride/Ionic strength

No chloride values were available on this reach ranged. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 266 to 808 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). No values in the dataset were greater than 1,000 uS/cm.

Table 349. Metrics related to ionic strengthl

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
00MN007 (2014)	34	1	6.75	13.50	0
00MN007 (2015)	32	3	5.41	10.83	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were well below the class averages. The taxa counts were also below average. The macroinvertebrate community was comprised of a range of 28.34% to 41.48% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidaes (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised a range of 5 to 14% of the fish community. There were no elevated specific conductance value in the dataset; however, there were indications of biological stress. Ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

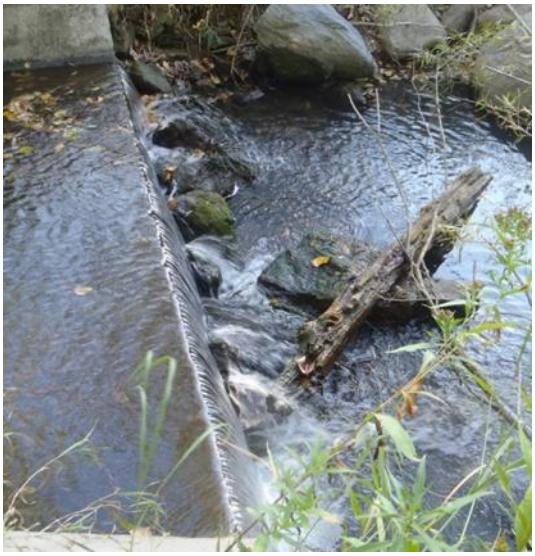
The reach is 100% natural according to the MPCA altered watercourse layer, however part of the upstream watershed is altered. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Upstream channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A perched culvert is present at station 00MN007 (Figure 195). The culvert is creating a fish barrier to the upstream watershed.

Figure 195. Perched culvert at site 00MN007 (September 26, 2013)



Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish ranging from 74.83-89.60%. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population ranging from 5.78-24.49%. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were present at either visit. The upstream channelized reach is likely contributing to lack of habitat and is a contributing stressor to the biological communities. The perched culvert is also acting as a fish barrier with altered hydrology acting as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Brewery Creek (-830) are being stressed by Eutrophication, Habitat and Flow Alteration/Connectivity. (Table 350) Chloride was inconclusive as a stressors, while Dissolved Oxygen, Nitrates and Suspended Sediment were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the City of Belle Plain-Minnesota River HUC 10 watershed, please see page 366.

Table 350. Stressors on Brewery Creek (-830)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Brewery Creek	07020012-830	---	o	---	---	●	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

City of Belle Plain-Minnesota River HUC 10 Conclusions and Recommendations

The City of Belle Plain-Minnesota River subwatershed contains three biologically impaired stream reaches. Stressors found in at least two of the three impaired reaches were Nitrates, Habitat and Altered Hydrology/Connectivity. Suspended Sediment was found to be a contributing stressor in one of the stream reaches while Dissolved Oxygen was not found to be a stressor in this watershed. More Chloride data is needed to better determine the impact of this potential stressor.

Row crop agriculture is the dominant land use present this watershed followed by hay/pasture, development and deciduous forests mostly in the Minnesota River valley. The headwaters of this watershed are being impacted by the effects of channelization of the streams and contributing tributaries. This is a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat (most abundant stressor) and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. The natural bluff setting of these streams can lead to possible intermittent or insufficient flow conditions.

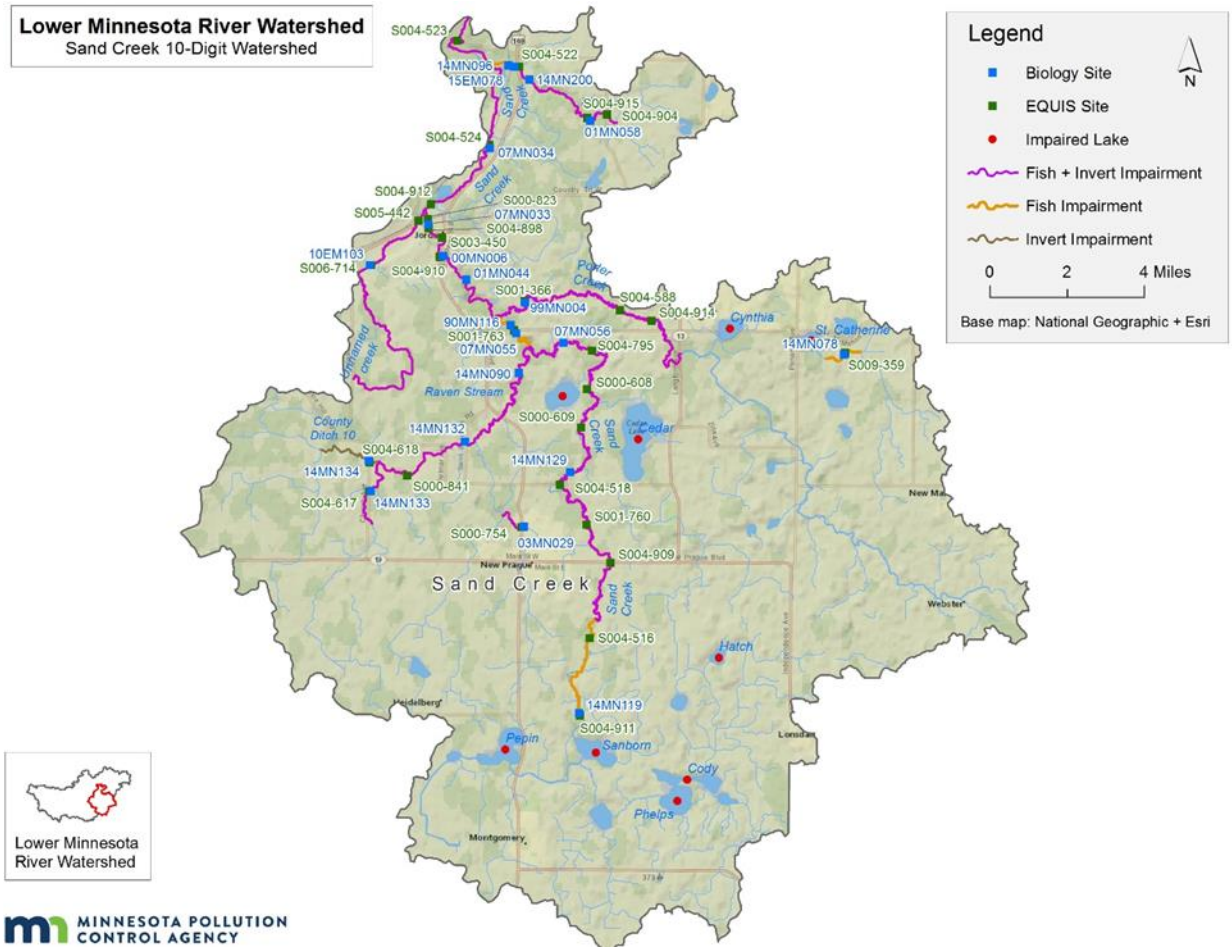
Improvements in the City of Belle Plain-Minnesota River watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. These improvements can both be applied to the agricultural and developed areas to this watershed. Another significant focus should be to reducing the amount of Phosphorus entering the stream system. This can be achieved through BMPs like: cover crops, nutrient management, and saturated buffers.

Table 351. Stressors on streams in the city of Belle Plain Minnesota River HUC

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Robert Creek	07020012-575	---	●	●	●	●	---	o
Unnamed Creek	07020012-798	---	o	●	---	●	●	o
Brewery Creek	07020012-830	---	o	---	---	●	●	o

12. Sand Creek HUC 10 (0702001208)

Figure 196. Sampling sites in the Sand Creek HUC



12.1 Sand Creek (-513)

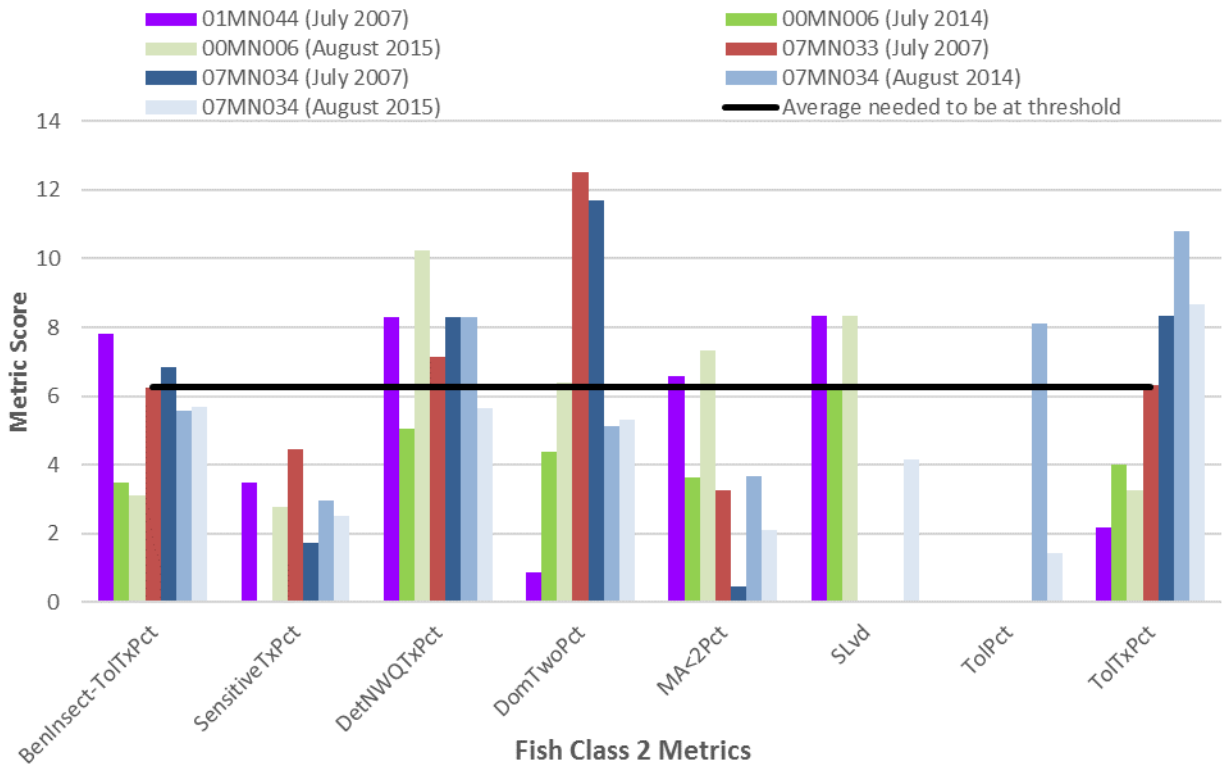
Sand Creek (-513) is an 13.39 mile long stream reach located downstream of the mouth of Porter Creek and extending to the Minnesota River. This reach is impaired for biology due to its fish and macroinvertebrate assemblage. There are four biological monitoring locations along this reach, 00MN006, 07MN033, 07MN034 and 01MN044. This reach is impaired for Turbidity, Nutrients/eutrophication, and chloride. A Stressor ID Report was completed in 2009 by Barr Engineering which identified habitat fragmentation as a stressor (Barr, 2009).

Biology

Fish

Sand Creek (-513) was sampled many times for fish from 2007-2015 at its four biological monitoring stations (00MN006, 07MN033, 07MN034 and 01MN044). The average FIBI scores for these sites were 34.1 (00MN006), 27.88 (01MN044), 39.91 (07MN033), 39.13 (07MN034). All of these average FIBI scores are below the Fish Class 2 Southern Streams General Use Threshold of 50. For a further breakdown of the metric scores during the different fish visits at these sites, see Figure 197.

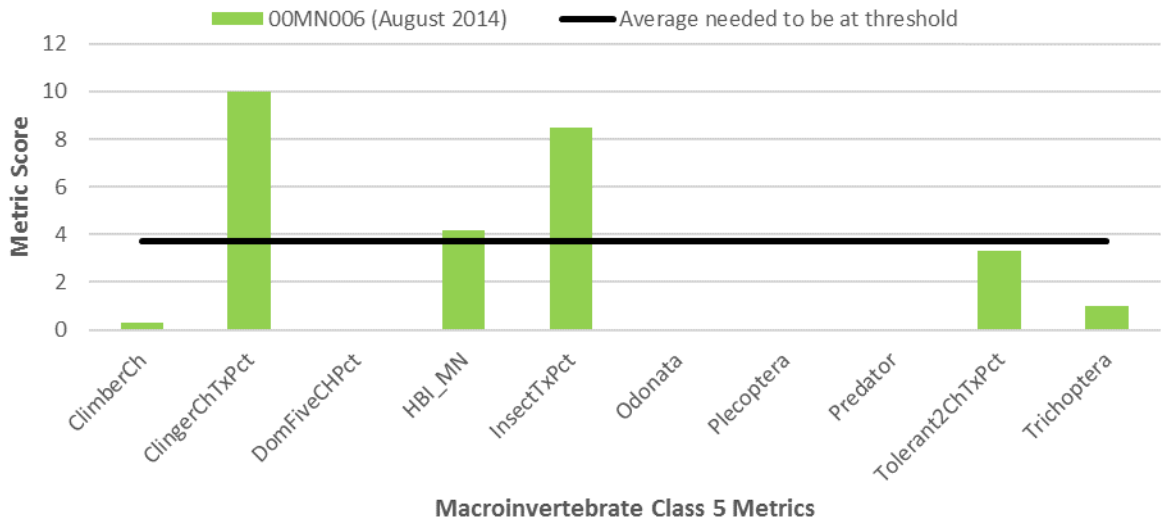
Figure 197. Fish metric scores



Macroinvertebrates

Site 00MN006 was sampled for macroinvertebrates in August of 2014 and had a MIBI score of 27.3. This score is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Just three of the ten metrics comprising the MIBI for this class reached the average needed to achieve the threshold (ClingerCHTxPct, HBI_MN, InsectTxPct). The remaining seven metrics scored below average or poorly including four metrics scoring zero. (Figure 198)

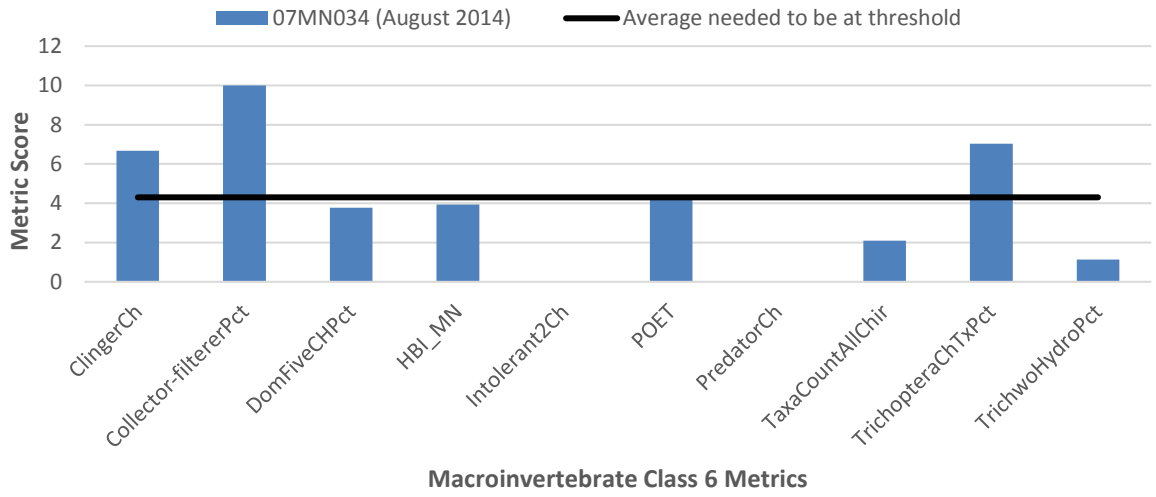
Figure 198. Class 5 macroinvertebrate metric scores



Site 07MN034 was also sampled for macroinvertebrates in August of 2014. The MIBI score for this site was 38.9 which is just below the Macroinvertebrate Class 6 Southern Forest Streams GP General Use

Threshold of 43. Three of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold and another three metrics scored just slightly below this level. (Figure 199)

Figure 199. Class 6 macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on Sand Creek in recent years; values ranged from 1.17 mg/L (within the Louisville Swamp) at station S004-523 to 14.59 mg/L in Jordan at station S004-898. The lowest values were collected in August. Two values outside of the Louisville swamp were also below 5 mg/L (4.06 and 4.79 respectively). Including values within the swamp, 5% of values along the reach were below 5 mg/L.

Table 352. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
00MN006 (2014)	0.67	52.67	9	0.32	6.92	5	7.71
00MN006 (2015)	3.25	29.67	10	NA	NA	NA	NA
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
07MN034 (2007)	2.01	61.22	32	NA	NA	NA	NA
07MN034 (2014)	12.70	70.02	28	1.29	7.67	3	7.55
07MN034 (2015)	2.69	69.66	22	NA	NA	NA	NA
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
01MN044	0.91	0.91	8	NA	NA	NA	NA
07MN033	0.92	40.43	25	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All visits were far below the class average except for the 2014 visit at station 07MN034 which was just above the class average. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner percentages ranged from 0.91% to 69.66%. Species that are very tolerant to low DO conditions ranged from less than 1% to 41% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at both stations. The number of intolerant macroinvertebrate taxa ranged from 3 to 5, and the percentage of DO tolerant individuals ranged from 0.32 to 1.29%. These values indicate DO is not a stressor to the macroinvertebrate communities. The stress to the fish community is more pronounced but is still mixed. The strongest effects are in the upper section of the reach at stations 07MN034 and 07MN033 which are located just downstream of the Louisville Swamp system where low DO values were also found. This section is influenced by upstream wetland flushing, but DO is inconclusive as a stressor to the fish community.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.065 to 0.667 mg/L with 64% over 0.150 mg/L. The highest value was collected during August in Jordan (station S004-898). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.22 mg/L.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. As a result of eutrophication, pH values also increase. As interacting variables to eutrophication, pH, BOD, and chlorophyll-a values were compared to standards. Of 71 BOD values, 90% were over the southern standard of 3.5 mg/L. The greater the BOD, the faster oxygen is consumed and the less that is available for fish and macroinvertebrates. Chlorophyll-a values ranged from less than 1 to 140 mg/L with 27% of 211 values over the southern standard of 40 mg/L. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 6.73 to 8.78, with 2% of values over 8.5. There is no DO flux data available.

Table 353. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
00MN006 (2014)	0	0.67	98	60.67	23	40.32	56.83
00MN006 (2015)	2.03	0	93.09	50	NA	NA	NA
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
07MN034 (2007)	2.01	6.39	82.94	19.43	26	53.72	35.28
07MN034 (2014)	6.98	6.98	44.39	3.32	NA	NA	NA
07MN034 (2015)	1.44	5.75	69.66	17.77	NA	NA	NA
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
01MN044	0.91	5.59	93.5	5.4	NA	NA	NA
07MN033	0	17.37	75.66	23.42	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**19**	**11.47**	**45.1**	**17**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals ranged from 0 to 6.98% and darters ranged from 0 to 17.37%. Tolerant individuals comprised more than 75% of the fish community at each station except for two visits at station 07MN034. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised a range of 3.32 to 60.67% of the population. Where

macroinvertebrates were collected, EPT individuals were present at levels higher than the class average; however, the communities were dominated by species tolerant to eutrophic conditions. EPT require healthy oxygen levels. The two most common macroinvertebrate species sampled comprised slightly more than half of the population at station 00MN006 but less than half at station 07MN034. The water chemistry data and preponderance of biological evidence indicate eutrophication is a stressor.

Candidate Cause Temperature

Temperatures in Sand Creek can get very high during the summer months, with 3% of the 258 values over 27°C. The highest value was collected in July of 2007, downstream of the dike within the Louisville Swamp with a value of 33.44°C. The elevated water temperatures are likely affecting the low DO levels recorded, as water can hold less DO at warmer temperatures.

Effects on aquatic communities in warm-water systems are not as clear as is in cold-water systems. CADDIS (2012) describes changes in growth and thermal stress, and impaired fish and macroinvertebrate assemblages. A publication by EPA (1986) shows a maximum weekly temperature of 28 ^{o}C for optimum white sucker growth and 29 degrees ^{o}C for optimum smallmouth bass growth. In a study in the Minnesota River basin, Feist and Niemela (2005) found significant relationships between increased temperatures and temperature fluctuations and a decrease in top carnivores and sucker species and an increase in the number of minnow species. Minnow individuals were elevated at each site. The number of minnows collected was highest at station 01MN044. Carnivores were lowest at station 07MN034, which had the warmest temperature. Sucker species were mixed, including at station 07MN034 where temperatures were highest. Temperature may be having an effect but is not a stressor, rather an indirect stressor to other stressors it is affecting like eutrophication. Temperature is inconclusive as a stressor.

Candidate Cause: Nitrate

From 2007-2016, a total of 94 nitrate samples were taken from Sand Creek (-513). These sample values ranged from 0.05-10.9 mg/L with an average nitrate concentration of 2.88 mg/L. This result is relatively low compared to areas in the western portion of the Lower Minnesota River Watershed.

Table 354. Nitrate related metrics

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
00MN006	13.04	40.82	0.32	3.12
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
07MN034	11.54	67.74	0.00	3.61
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Sand Creek scored below average in three of the four nitrate related metrics at both sites, 00MN006 and 07MN034, when compared to all other Class 5 Southern Streams RR stations and Class 6 Southern Streams GP stations that meet the MIBI General Use Threshold (Table 354). Site 00MN006 did have a low amount of nitrate tolerant taxa which does not signal nitrate stress, while having lower numbers of Trichoptera and nitrate intolerant species does. Site 07MN034 did have a higher than average amount of Trichoptera taxa, but did score below average in the other metrics.

The extensive chemical data set shows that the nitrate concentrations in Sand Creek (-513) stays relatively low. It is likely that other stressors are negatively impacting this stream reach causing some lower metric scores. Nitrates are not a stressor in Sand Creek (-513) at this time.

Candidate Cause Sediment

From 2007-2015, a total of 93 TSS samples were taken from Sand Creek (-513). These values ranged from 1.0-411.0 mg/L with an average TSS concentration of 52.86 mg/L. Twenty one (22.58%) of the 93 samples collected for TSS were above the 65 mg/L standard. Additionally, from 2004-2015, 181 secchi tube measurements were taken along this reach. These values ranged from 4.8-100 cm, with an average value of 41.12 cm. This reach was assesses and determined to be impaired for turbidity in 2002. Of all of the major tributaries to the Minnesota River, data from 2000-2008 shows Sand Creek to have the second largest TSS yield after only the Le Sueur River (MRBDC 2009).

Table 355. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffIePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
01MN044	**30.32**	**0.00**	**22.62**	**4.57**	**25.75**	**2.58**	**23.54**	**0.00**	**0.00**	**15.58**
00MN006	**25.17**	**1.22**	**3.03**	**2.63**	**24.39**	**1.35**	**32.00**	**0.00**	**1.85**	**18.79**
07MN033	**31.83**	**0.36**	**15.89**	**17.85**	**23.50**	**12.05**	**22.22**	**6.97**	**0.20**	**25.96**
07MN034	**12.26**	**1.58**	**5.05**	**9.62**	**8.30**	**3.47**	**9.75**	**2.09**	**11.33**	**30.34**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Sand Creek (-513) scored below average in eight (01MN044, 07MN033) and ten (00MN006, 07MN034) of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 355). Sites 01MN044 and 07MN033 did have above average numbers of herbivorous individuals, while scoring poor in the remaining metrics except for TSS Index score at 01MN044 and intolerant individuals at 07MN034.

Table 356. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
00MN006	15.35	1	6	23.73	60.00	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
07MN034	19.70	0	11	57.42	41.10	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average at two (00MN006) and five (07MN034) of the six suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 356). Both Sites had low levels of TSS intolerant species and completely lacked Plecoptera taxa. Site 00MN006, did score much higher in the remaining metrics.

Based on the high number of TSS values exceeding the standard, the vast majority of the suspended sediment related metrics of the fish and macroinvertebrate communities scoring below average, as well as the current turbidity impairment along this reach, suspended sediment is a stressor to aquatic life in Sand Creek (-513).

Candidate Cause Habitat

Sand Creek (-513) had qualitative habitat assessments take place at its biological monitoring sites, 01MN044, 00MN006, 07MN033, and 07MN034, during the fish and macroinvertebrate sampling events in 2001, 2007, 2014, and 2015. The average MSHA scores from these visits was 68.3 (Good) at 01MN044, 69.9 (Good) at 00MN006, 54.2 (Fair) at 07MN033, and 56.43 (Fair) at 07MN034. Sites 07MN033 and 07MN034 were the two most downstream sites located on this stream reach. Limiting the MSHA scores at these sites were developed land use primarily in the two downstream sites, narrow to moderate riparian buffers, places of little to heavy bank erosion, light to moderate embeddedness, some areas with sandy substrates, and low channel stability especially at sites 01MN044 and 07MN034. A breakdown of the MSHA category scores for this site can be seen in Figure 200. Fine sediments and a lack of habitat complexity were found near the mouth of the channel (Inter-fluve, 2008).

Figure 200. Habitat metric scores

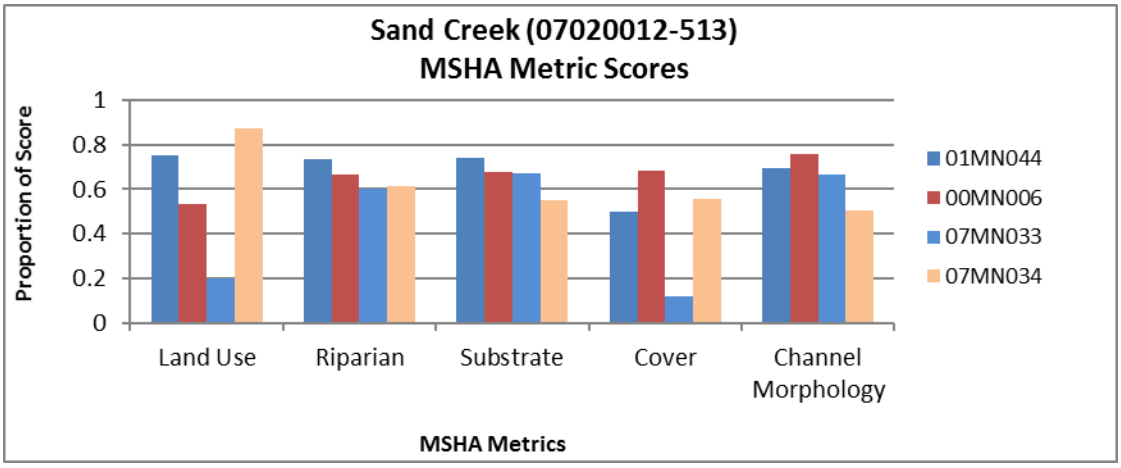


Table 357. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
01MN044	**7.15**	**23.54**	**4.57**	**25.75**	**0.00**	**86.23**	**92.85**	**48.56**
00MN006	**2.13**	**32.00**	**0.78**	**24.39**	**0.63**	**51.12**	**95.80**	**53.17**
07MN033	**18.17**	**22.22**	**17.37**	**23.50**	**0.20**	**52.76**	**75.66**	**45.48**
07MN034	**10.11**	**12.87**	**9.88**	**12.10**	**3.81**	**24.07**	**68.16**	**26.20**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The impaired fish community along Sand Creek (-513) scored below average in all of the habitat related metrics at all sites except one when compared to other Class 2 Southern Stream stations that did meet the FIBI General Use Threshold (Table 357). Site 01MN044 did have a larger amount of Lithophilic spawning individuals which can indicate stable and course gravel present that is not covered by fine substrates.

Table 358. Habitat related macroinvertebratae metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
00MN006	**0.63**	**9.21**	**80.00**	**40.32**	**15.87**	**1.27**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
07MN034	**2.27**	**13.27**	**65.37**	**53.72**	**25.57**	**14.24**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community (not impaired) was not as affected by the habitat conditions as the fish. Site 00MN006 scored below average in half of the habitat related metrics when compared to other

Class 5 Southern Streams RR stations meeting the MIBI General Use Threshold, while site 07MN034 scored below average in two metrics compared to Class 6 Southern Forest Streams GP meeting the MIBI General Use Threshold (Table 358).

The MSHA scores in Sand Creek went from Good in the headwaters to fair further downstream. The fish assemblage scored poorly throughout the reach when evaluating the habitat related metrics. With the degrading habitat conditions and the low scoring fish metrics throughout, the lack of habitat is indeed a stressor to the impaired fish community in Sand Creek.

Candidate Cause: Chloride/Ionic strength

Sand Creek has been impaired for chloride since 2014. A large dataset of chloride values ranged from 11 to 409 mg/L with 6% of values over 230 mg/L. The highest values were collected in February. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 346 to 1684 uS/cm. The ecoregion norm for the Western Corn Belt Plain (based on the 75th percentile of annual specific conductance values) is 820 (McCollor et. al, 1993). A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Of all values, 20% were over 1,000 uS/cm.

Table 359. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
00MN006 (2014)	23	5	26.98	40.32	0
00MN006 (2015)	NA	NA	NA	NA	3.66
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
07MN034 (2007)	NA	NA	NA	NA	0.82
07MN034 (2014)	26	8	32.69	53.72	1.95
07MN034 (2015)	NA	NA	NA	NA	1.97
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
01MN044	NA	NA	NA	NA	0
07MN033	NA	NA	NA	NA	0.36
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were near or above the class averages. The taxa counts were below average. The macroinvertebrate community was comprised of a range of 20.57% to 54.19% conductivity tolerant individuals and 0 to 2 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) ranged from 0 to 3.66% and increased over time at stations 00MN006 and 07MN034. Species that are tolerant to conditions with high ionic strength comprised a range of 15 to 41% of the fish community. There were numerous elevated chloride and specific conductance values in the dataset, and while the fish community is showing stronger effects than the macroinvertebrate community, ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach of Sand Creek had a mixture of natural and modified sections. An analysis of the MPCA altered watercourse layer measured 74.60% of the Sand Creek sub-watershed as channelized. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A 15 foot natural waterfall exists 10 miles from the mouth of Sand Creek (Barr, 2009), which was modified into a dam in 1860 and limits connectivity within the stream and natural fish migrations (Figure 201). Twenty unique species were identified below the dam that were not observed upstream of the dam (MPCA). A fish kill occurred on the stream in the 1990s, and the dam prevents recolonization as a fish ladder is no longer present (Paul Nelson, personal communication, July 25 2018). The dam is a fish barrier, making altered hydrology a stressor on this reach of Sand Creek.

Figure 201. Sand Creek dam

Table 360. Migratory fish sampled on Sand Creek

CommonName	01MN044	00MN006		07MN033	07MN034
blackside darter				X	X
central stoneroller	X	X		X	X
golden redhorse					X
greater redhorse					
Iowa darter					
shorthead redhorse					X
silver lamprey			Dam		
slenderhead darter				X	X
silver redhorse					
spottail shiner					
quillback					X
walleye		X			
white bass					X
white sucker	X	X		X	X

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Sand Creek (-513) are being stressed by Eutrophication, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 361). Dissolved Oxygen and Chloride were inconclusive as stressors, while Nitrates were ruled out as a stressor to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 361. Stressors on Sand Creek (-513)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity	Temperature
Sand Creek	07020012-513	o	●	---	●	●	o	●	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.2 Sand Creek (-538)

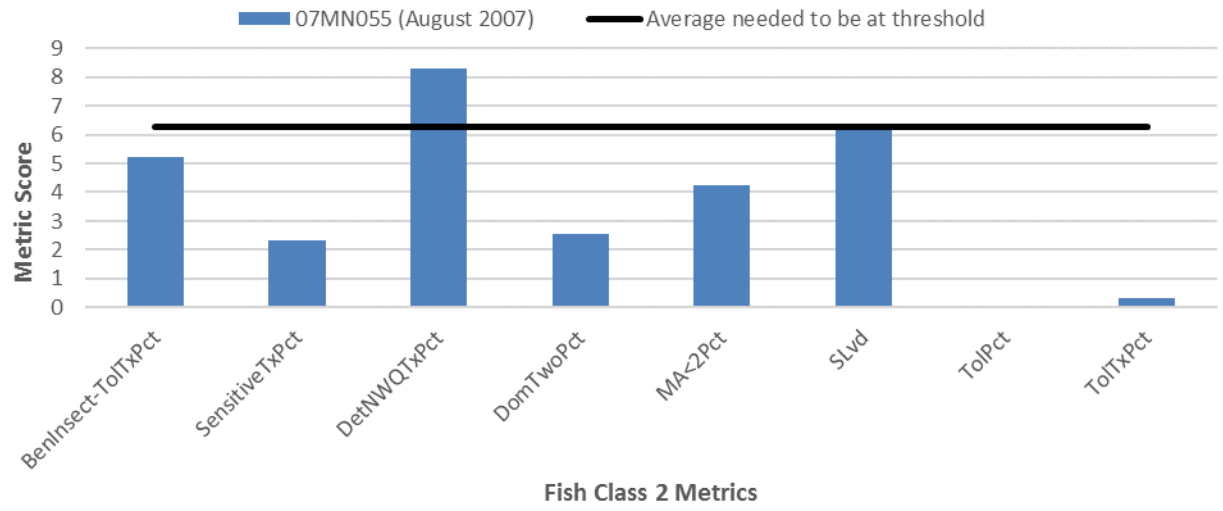
Sand Creek (-538) is a 1.77 mile long stream reach located in central Scott county. This section runs from the confluence with Raven Stream to the confluence with Porter Creek. This reach is impaired for biology due to its fish community. There are two biological monitoring stations, 07MN055 and 90MN116, located along this reach. This reach is also impaired for Turbidity. A Stressor ID Report was completed in 2009 by Barr Engineering, which identified habitat fragmentation as a stressor (Barr, 2009).

Biology

Fish

Sand Creek (-538) was sampled for fish at its biological monitoring station, 07MN055, in August of 2007. The FIBI score for this visit was 29.2, which is far below the Fish Class 2 Southern Streams General Use Threshold of 50. Only two of the eight metrics (DetNWQTxPct, SLvd) scored at or above the average needed to reach the threshold. The high amount of tolerant and very tolerant species resulted in very low metric scores especially limiting the FIBI score in this reach (Figure 202). Macroinvertebrates were not sampled.

Figure 202. Biological metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2007-2016); values ranged from 4.99 mg/L to 12.36 mg/L at station S001-763. The lowest values were collected in July. Of 16 values, 6.25% of values were below 5 mg/L, with two other values below 5.5 mg/L (5.2 and 5.4 mg/L respectively). Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 5.5-14.2 mg/L with no values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The one visit had a value of 1.01%, much lower than the class average. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage was 3.91%, much lower than the class average. Species that are very tolerant to low DO conditions comprised 1.4% of the fish community. The preponderance of data indicates DO is not a stressor to the fish community.

Table 362. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	Tolerant Macroinvertebrate Taxa
07MN055	1.01	3.91	12	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.080 to 0.372 mg/L. The highest value was collected during August just downstream of Raven Stream. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, none of this data is available on this reach of the stream. As a result of eutrophication, pH values also increase. pH values ranged from 7.88 to 8.43.

Table 363. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
07MN055	1.01	6.18	92.81	1.01	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals were present at 1.01% and darters were present at 6.18%, however all of the darters present were johnny darters which are a tolerant darter. Tolerant individuals comprised 92.81% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish comprised only 1.01% of the population. Macroinvertebrates were not collected. While there are some indications of stress, eutrophication is currently inconclusive as a stressor.

Candidate Cause Nitrate

Two nitrate samples were taken from Sand Creek (-538) from 2007-2016. These values were 0.1 mg/L on 08/02/2007 and 8.5 mg/L on 06/01/2016.

The amount of nitrate data from Sand Creek (-538) is rather sparse. However, large nitrate datasets exist on both upstream and downstream portions of Sand Creek. The average nitrate concentration from the downstream reach, Sand Creek (-513), was 2.88 mg/L and the average nitrate concentration from the upstream reach, Sand Creek (-840), was 2.02 mg/L.

Based on the limited nitrate samples, nitrate concentrations appear to be relatively low in Sand Creek (-538). It is likely that the concentrations are similar to those of the surrounding reaches, where nitrates were determined not to be stressors. Nitrates are not a stressor in Sand Creek (-538) at this time.

Candidate Cause Sediment

From 2007-2016, two TSS samples were taken from Sand Creek (-538). These samples were 8.8 mg/L taken on 08/02/2007 and 31 mg/L taken on 06/01/2016. Additionally, from 2004-2007, 70 secchi tube measurements were taken along this reach. These values ranged from 3-60 cm, with an average value of 29.74 cm. This reach was assessed and determined to be impaired for turbidity in 2010. This listing was confirmed again during the 2016 assessment of this reach.

Table 364. Sediment related to fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07MN055	**31.53**	**0.00**	**23.96**	**6.18**	**25.35**	**1.01**	**22.07**	**0.00**	**0.00**	**15.09**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Sand Creek (-538) scored below average in eight of the ten suspended sediment related metrics at site 07MN055 when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 364). This reach did have a good TSS Index score and an above average amount of herbivorous individuals, however, the remaining metrics scored below average in this reach.

The majority of the suspended sediment related metrics in the fish community scored well below average compared to like streams that are not impaired. The secchi tube data also suggests potential issues with suspended sediment. This information, along with the current turbidity listing for this reach concludes that suspended sediment is a stressor to aquatic life in Sand Creek (-538).

Candidate Cause Habitat

Sand Creek (-538) had a qualitative habitat assessment take place at its biological monitoring site, 07MN055, during the fish sampling event in 2007. The MSHA score from this visit was 68.7 (Good). Limiting the MSHA was the presence of some sand as a substrate, moderate embeddedness, sparse fish cover, fair channel sinuosity, and moderate channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 203. A geomorphic assessment found the reach to be relatively intact (Inter-fluve, 2008).

Figure 203. Habitat metric scores

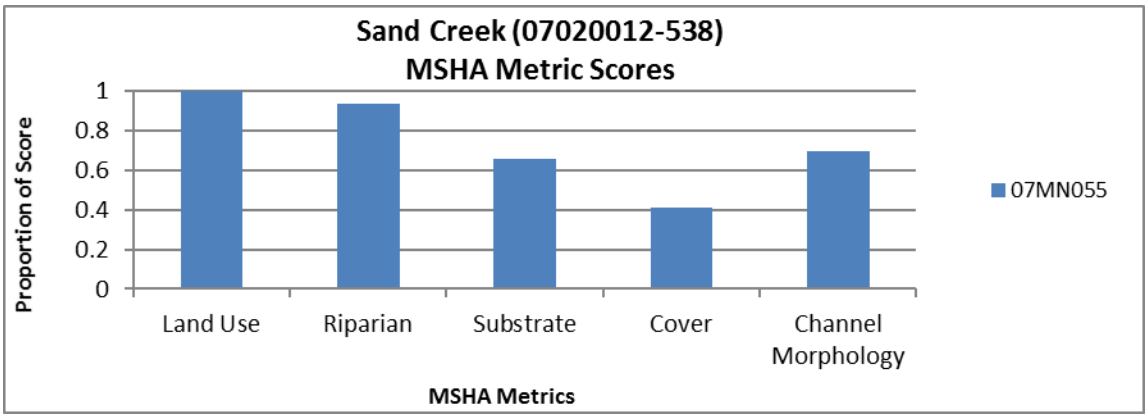


Table 365. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
07MN055	7.19	22.07	6.18	25.35	0.00	88.65	92.81	49.94
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The community in Sand Creek (-538) scored below average in all but one of the habitat related metrics when compared to other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 365). The fish assemblage was dominated by some fairly tolerant species including Creek Chubs, Central Stonerollers, and Blacknose Dace.

This section of Sand Creek did not have a macroinvertebrate sampling event.

Sand Creek (-538) had a good MSHA score; however the fish community metrics related to habitat scored poorly. This could be due to other stressors. Based on this conflicting data, habitat is inconclusive as a stressor in this reach.

Candidate Cause: Chloride/Ionic strength

While this section of Sand Creek is not impaired for chloride, both the upstream and downstream reaches have chloride available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 563 to 1684 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Two of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005), however macroinvertebrates were not sampled on this reach. Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidaes (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 24% of the fish community. While a few specific conductance values were elevated, without macroinvertebrate data a determination of chloride as a stressor is not possible. Ionic strength is currently inconclusive as a stressor.

Table 366. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
07MN055	NA	NA	NA	NA	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach is natural according to the MPCA altered watercourse layer, except for the altered areas around roads. 74.60% of the Sand Creek sub-watershed was measured as channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Upstream channelization and tile drainage alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 65.95% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 6.94% of the fish community. Based on the lack of flow events, and the preponderance of the biological communities, altered hydrology is a not a stressor.

Conclusions and recommendations

The impaired fish community in Sand Creek (-538) is being stressed by Suspended Sediment and Habitat. (Table 367) Eutrophication and Chloride were inconclusive as stressors, while Dissolved Oxygen, Nitrates, and Flow Alteration/Connectivity were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 367. Stressors on Sand Creek (-538)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Sand Creek	07020012-538	---	o	---	●	o	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.3 Sand Creek (-839)

Located in northeastern Le Sueur county is the 3.12 mile stream reach, Sand Creek (-839). This stream section extends from Downstream of CR 28 to just downstream of Sand Creek Lane. This reach is impaired for biology due to its fish assemblage. There is one biological monitoring station, 14MN119, located along this reach. This reach is also impaired for Turbidity, nutrients/eutrophication, and chloride. A Stressor ID Report was completed in 2009 by Barr Engineering, which identified habitat fragmentation as a stressor (Barr, 2009).

Biology

Fish

Sand Creek (-839) was sampled for fish in September of 2014 at its biological monitoring station, 14MN119. The FIBI score for this visit was 0. Fish diversity at this site was low, and dominated by tolerant species, including brook stickleback, fathead minnow and central mudminnow.

Table 368. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN119	**0**	**59.52**	**4**	**34.6**	**7.88**	**1**	**6.78**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**15.09**	**25.34**	**14.52**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Dissolved Oxygen

There was a large dataset on this section of Sand Creek in recent years; values ranged from 0.61 mg/L to 15.24 mg/L at station S004-516. The lowest value was collected in August. The range of values is indicative of possible diurnal DO fluctuations. Tweny-five percent of the DO values were below the water quality standard of 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.8-13.9 mg/L with less than 1% below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. No individuals were present that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage was twice the class average that met the modified threshold. Species that are very tolerant to low DO conditions comprised 83% of the fish community and was dominated by fathead minnows and central mudminnows.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was one low DO intolerant taxa present and the percentage of DO tolerant individuals was 34.6%. Very low values of DO have been found on this reach and the biological response is indicative of DO stress to the biological communities.

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.011 to 0.937 mg/L. The highest value was collected during August. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. Chlorophyll-a values taken in 2007 and 2008 ranged from 8.9 to 280 ug/L with 69% of values over the southern standard of 40 ug/L. BOD and DO flux data are not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. The pH values ranged from 7.36 to 8.52.

Table 369. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN119	0	0	100	42.86	25	34.07	50.16
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	**8.24**	**13.32**	**45.53**	**25.1**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					**36.65**	**18.11**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

No sensitive or darter individuals were collected on this reach of Sand Creek. Tolerant species comprised 100% of the fish community. Along with tolerant species, a positive relationship exists between

eutrophication and omnivorous fish. Omnivorous fish comprised 42.86% of the population, higher than the class average of sites that met the modified threshold. EPT individuals were present at levels higher than the class average; however, the second most prevalent EPT species collected is tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised half of the population. The water chemistry data and preponderance of biological evidence indicate eutrophication is a stressor.

Candidate Cause Nitrate

From 2007-2016, a total of 41 nitrate samples were taken from Sand Creek (-839). These sample values ranged from 0.05-10.8 mg/L with an average value of 2.21 mg/L, which is relatively low compared to other subwatersheds within the Lower Minnesota watershed.

Drain tiles were present along this reach and are a common pathway for nitrates to enter a stream system.

Table 370. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN119	12.00	50.31	0.00	3.55
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at 14MN119 along Sand Creek (-839) scored below average in two of the four nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 370). This site had a high amount of Trichoptera taxa, while also having lower numbers of nitrate tolerant taxa.

Based on the very low nitrate concentrations from the extensive data set, as well as the macroinvertebrate assemblage showing above average amounts of Trichoptera taxa and below average numbers of nitrate tolerant taxa, nitrate is not a stressor in Sand Creek (-839).

Candidate Cause Sediment

From 2007-2016, a total of 44 TSS samples were taken from Sand Creek (-839). These sample values ranged from 6-152 mg/L with an average value of 42.30 mg/L. Seven of the 44 samples were above the 65 mg/L TSS standard. Additionally, from 2007-2014 a total of 51 secchi tube measurements were taken from this reach. These readings ranged in value from 6-90 cm, with an average reading of 25.57 cm. Also, this reach was assessed in 2010 and determined to be impaired for turbidity.

Table 371. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN119	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**18.09**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*30.08*	*6.17*	*2.88*	*28.69*	*19.54*	*8.38*	*26.17*	*0.86*	*21.25*	*19.19*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Sand Creek (-839) scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI Modified Use Threshold (Table 371). The site, 14MN119, did have an above average TSS Index Score; however, it scored very poorly in the remaining metrics.

Table 372. Macroinvertebrate metrics related to sediment

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN119	19.82	0	7	41.51	26.50	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in four of the six suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 372). The reach did have a low amount of TSS tolerant taxa, while also having an above average amount of collector filterer individuals, but scored poorly in the remaining metrics.

Based on the high exceedance of the TSS samples, the majority of the suspended sediment related metrics for both biological communities scoring below average, in addition to the current turbidity listing along this reach, suspended sediment is a stressor to aquatic life in Sand Creek (-839).

Candidate Cause Habitat

Sand Creek (-839) had a qualitative habitat assessment take place at its biological monitoring site, 14MN119, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 27.98 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, light stream shading, heavy bank erosion, sand substrates, no course substrates, sparse fish cover, very little depth variability, low channel stability, poor channel sinuosity (Figure 204) and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 205. A geomorphic assessment along the reach found cutbanks and pointbars (Inter-fluve, 2008).

Figure 204. Poor sinuosity at 14MN119

Figure 205. Habitat metric scores

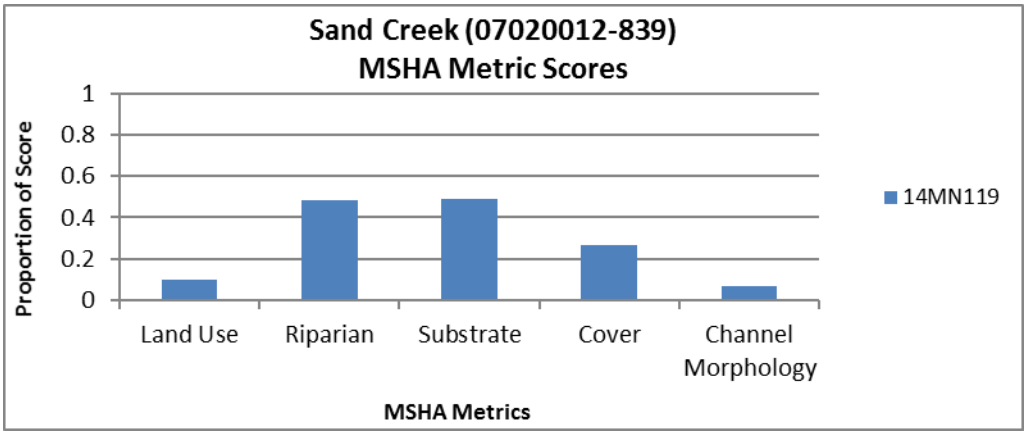


Table 373. Fish metrics related to habitat

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN119	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**100.00**	**42.86**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)	*19.05*	*26.17*	*16.45*	*19.54*	*8.02*	*35.59*	*46.38*	*23.58*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community along this section of Sand Creek (-839) scored below average in all of the habitat related metrics when compared to other Class 2 Southern Streams stations that did meet the FIBI Modified Use Threshold (Table 373). The fish assemblage consisted of four species all of which are tolerant of degraded habitat conditions: fathead minnow, central mudminnow, bigmouth shiner, and brook stickleback.

Table 374. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN119	**3.79**	**9.78**	**50.16**	**34.07**	**23.66**	**33.75**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**11.49**	**23.84**	**24.46**	**14.44**	**61.44**	**22.59**
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community, that is not impaired, fared much better than the fish assemblage by only scoring below average in one habitat related metric when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 374).

Given the poor MSHA score, the photographic evidence of degraded conditions, the lack of diversity in the fish assemblage as well as the poor scoring habitat related metrics, the lack of habitat is a stressor to the impaired fish community at this time.

Candidate Cause: Chloride/Ionic strength

This section of Sand Creek is impaired for chloride. Chloride values were available on this reach from 2007-2008, ranging from 14 to 1297 mg/L with the highest value in July. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 278 to 5150 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Thirty-five percent of the values were over 1,000 uS/cm.

Table 375. Metrics related by ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN119	25	4	20.82	34.07	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI Modified Use Threshold (35.0)					**6.17**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	36.65	*3.27*	*12.38*	*18.10*	
Expected response to increased stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were above the class averages. The taxa count was below average. The macroinvertebrate community was comprised of 45.28% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. No Centrarchidaes (sunfish) were collected. Species that are tolerant to conditions with high ionic strength comprised 45% of the fish community. There were elevated specific conductance and chloride values in the dataset, while the biological indications were mixed. Ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach is 100% modified according to the MPCA altered watercourse layer, and 74.60% of the Sand Creek sub-watershed was measured as channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 42.86% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 45.24% of the fish community. Long-lived

macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. No long-lived macroinvertebrates were sampled at this station. The channelization is likely contributing to lack of habitat and is a contributing stressor to the biological communities. Based on the preponderance of the biological communities, altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish community in Sand Creek (-839) is being stressed by Dissolved Oxygen, Eutrophication, Suspended Sediment, Habitat, and Altered Flow/Connectivity (Table 376). Nitrates and Chloride were ruled out as stressors to aquatic life. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 376. Stressors on Sand Creek (-839)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Sand Creek	07020012-839	●	●	---	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.4 Sand Creek (-840)

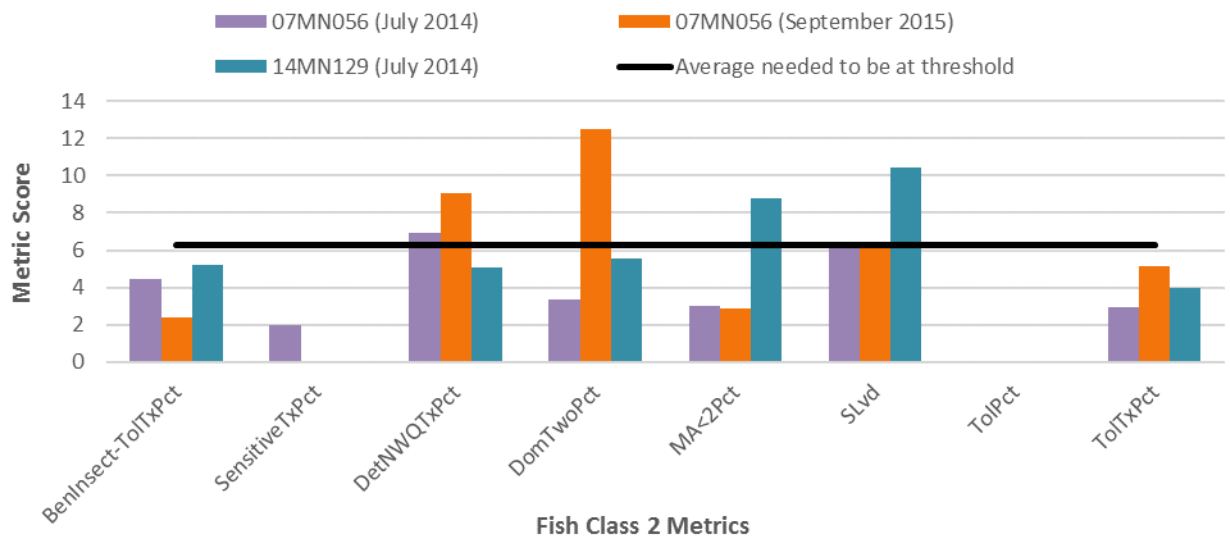
Sand Creek (-840) is a 17.6 mile stream reach that flows from northeastern Le Sueur county into south central Scott County. This reach extends just downstream of Sand Creek Lane and ends at the confluence with Raven Stream. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There are two biological monitoring stations, 07MN056 and 14MN129, located along this reach. This reach is also impaired for Turbidity, nutrients/eutrophication, and chloride. A stressor ID Report was completed in 2009 by Barr Engineering which identified habitat fragmentation as a stressor (Barr, 2009).

Biology

Fish

Sand Creek (-840) was sampled for fish three different times between the two biological monitoring stations, 07MN056 and 14MN129, located along this reach. The FIBI scores during these fish visits were 28.9 (07MN056- 2014), 38.2 (07MN056- 2015), and 39.0 (14MN129). All three of these fish visits had FIBI scores below the Fish Class 2 Southern Streams General Use Threshold of 50. All three of the visits had a low amount of sensitive fish taxa, while also having a high amount of tolerant individuals resulting in lower FIBI scores (Figure 206).

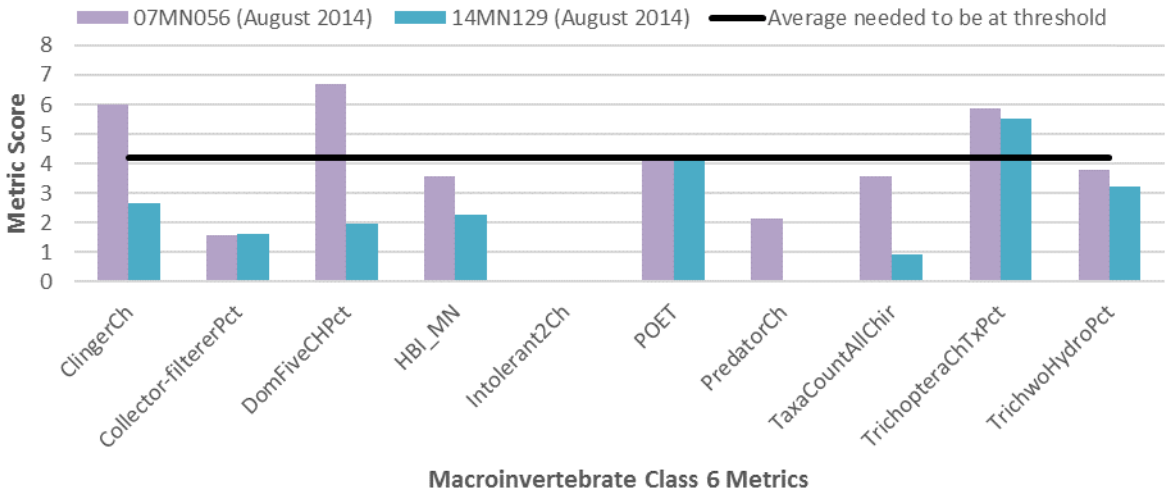
Figure 206. Fish metric scores



Macroinvertebrates

The macroinvertebrate community in this reach was sampled in August of 2014 at sites 07MN056 and 14MN129. The MIBI scores from these visits were 37.5 (07MN056) and 22.5 (14MN129). Both of these MIBI scores fell below the Macroinvertebrate Class 6 Southern Forest Streams GP General Use Threshold of 43. Site 07MN056 had four metric score above the average needed to reach the MIBI threshold for this class, while site 14MN129 only reached this level in two of its metrics (Figure 207).

Figure 207. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this section of Sand Creek in recent years; values ranged from 1.79 mg/L at station S004-909 to 16.03 mg/L at station S004-518. The lowest value was collected in August. The range of values is indicative of possible diurnal DO fluctuations. 2.4% of the DO values were below the water quality standard of 5 mg/L.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.8-14.0 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All visits at station 07MN056 were far below the class average, while the percentage at station 14MN129 was just below the class average of stations that met the threshold. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage increased from 2007 (27.77%) to 2014 (61.29%) at station 07MN056. The percentage of individual serial spawning fish was just above the class average at station 14MN129. Species that are very tolerant to low DO conditions ranged from 11 to 36% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was two low DO intolerant taxa present at station 14MN129 and five taxa present at station 07MN056. The percentage of DO tolerant individuals was 45.5% at station 14MN129 and 24.07% at station 07MN056. Very low values of DO have been found on this reach and the biological response is indicative of DO stress to the macroinvertebrate community at station 14MN129.

Table 377. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN129	11.11	32.22	6	45.50	8.18	2	6.62
07MN056 (2007)	0.42	27.77	15	NA	NA	NA	NA
07MN056 (2014)	2.15	61.29	14	24.07	7.79	5	6.96
07MN056 (2015)	1.96	36.93	13	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**					
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.148 to 1.24 mg/L. The highest value was collected during October. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. Chlorophyll-a values taken 2007-2008 ranged from 3.5 to 240 ug/L with 70% of values over the southern standard of 40 ug/L, and BOD values taken in 2004-2006 ranged from 1.4 to 13 mg/L with 71% over the southern standard of 3.5 mg/L. DO flux data is not available. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.14 to 8.86, with three values above 8.5.

Table 378. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN129	0	1.11	87.78	53.33	22	43.29	62.19
07MN056 (2007)	0.42	15.71	82.05	7.57	NA	NA	NA
07MN056 (2014)	0.54	1.61	95.16	24.73	31	63.55	27.73
07MN056 (2015)	0	6.54	84.97	30.39	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

No sensitive individuals were collected on this reach of Sand Creek. Darters ranged from 1.11 to 6.54%. From 2007 to 2014, darter percentage decreased from 15.71 to 6.54% at station 07MN056. Tolerant species comprised more than 84% of the fish community at both stations. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at both stations at levels higher than the class average of sites meeting the modified threshold. The percentage of omnivore species increased from 7.57% in 2007 to 30.39% in 2014. EPT individuals were present at levels higher than the class average. The two most common macroinvertebrate species sampled comprised more than half of the population at station 14MN129, but only 27.73% at station 07MN056. Based on the water chemistry data, preponderance of biological evidence and the increase in omnivore and decrease in darters from 2007 to 2014, eutrophication is a stressor.

Candidate Cause Nitrate

From 2004-2015, a total of 133 nitrate samples were taken from Sand Creek (-840). These nitrate concentrations ranged from 0.05-10.2 mg/L with an average value of 2.02 mg/L. This average is very similar to that of Sand Creek (-839) and is relatively low compared to other subwatersheds.

Table 379. Nitrate related metrics

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
07MN056	9.68	61.42	0.00	3.40
14MN129	9.09	52.89	0.00	3.57
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Sand Creek (-840) scored below average in all four nitrate related metrics at both sites, 07MN056 and 14MN129, when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (TABLE). Both sites completely lacked nitrate intolerant species, while having abundant numbers of nitrate tolerant taxa.

Based on the extensive chemical data set, the nitrate concentrations are, for the most part, very minimal. Other stressors are likely impacting the biological metrics causing the low metric scores. Nitrate is not a stressor at this time in Sand Creek (-840).

Candidate Cause Sediment

From 2004-2015, a total of 140 TSS samples were taken from Sand Creek (-840). These samples ranged in value from 1-576 mg/L with an average TSS concentration of 75.18 mg/L. Of these samples, 55 (39.29%) were above the 65 mg/L TSS standard. Additionally, from 2001-2015, 141 secchi tube measurements were taken along this reach. These readings ranged from 4-100 cm, with an average value of 31.25 cm. five of these measurements were below the transparency standard. Sand Creek (-840) was determined to be impaired for turbidity during a 2010 assessment.

Table 380. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07MN056	20.68	2.77	3.46	11.91	12.69	0.32	19.89	0.00	3.86	18.06
14MN129	40.00	0.00	0.00	12.22	38.89	0.00	50.00	0.00	11.11	19.21
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Sand Creek (-840) scored below average in seven (14MN129) and all ten (07MN056) of the suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 380). Site 14MN129 did have good numbers of riffle, simple lithophils, and benthic feeding individuals, while scoring poorly in the remaining metrics.

Table 381. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
07MN056	**21.36**	**0**	**12**	**59.57**	**6.23**	**0.00**
14MN129	**21.50**	**0**	**10**	**39.21**	**6.40**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Sand Creek scored below average in five (14MN129) and six (07MN056) of the suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold. (Table 381). Site 14MN129 did have a lower amount of TSS tolerant taxa, but scored poorly in the remaining metrics.

Based on the vast majority of the suspended sediment related metrics scoring below average for both the fish and macroinvertebrate communities, the high exceedance rate of the collected TSS samples, as well as the current turbidity impairment on this reach, suspended sediment is a stressor to aquatic life in Sand Creek (-840).

Candidate Cause Habitat

Sand Creek (-840) had qualitative habitat assessments take place at its biological monitoring sites, 07MN056 and 14MN129, during the fish and macroinvertebrate sampling events in 2007, 2014, and 2015. The average MSHA score from these visits was 60.61 (Fair) at 07MN056 and 48 (Fair) at 14MN129. Limiting the habitat at these sites was the row crop agriculture dominating the local land use, moderate to severe bank erosion (Figure 208), a sometimes narrow riparian buffer especially at 14MN129, sand and silt substrates, moderate embeddedness, fair channel development at 14MN129, and low to moderate channel stability. A geomorphic survey found areas with stable banks and good aquatic habitat, but also found areas of instability and incision were found in the reach, with some headcuts, areas lacking riffles, and fine sediments built up near where Raven Creek enters the stream (Inter-fluve, 2008).

Figure 208. Bank erosion at site 14MN129 (July 28, 2014)

Figure 209. Habitat metrics

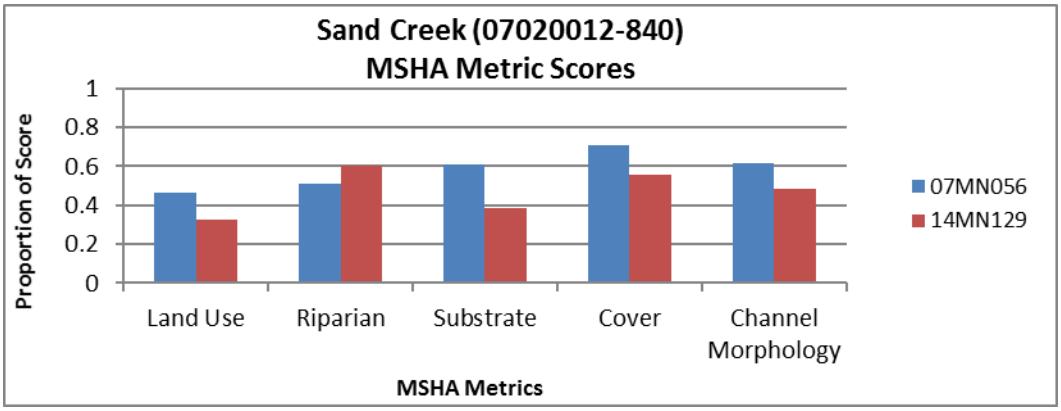


Table 382. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
07MN056	**8.32**	**19.89**	**7.95**	**12.68**	**1.72**	**41.11**	**87.39**	**41.98**
14MN129	**1.11**	**50.00**	**1.11**	**38.89**	**11.11**	**66.67**	**87.78**	**32.22**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Sand Creek (-840) scored below average in eight (07MN056) and four (14MN129) of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 382). Both sites had high amounts of tolerant and pioneer species individuals, while also lacking more benthic insectivore and darter/sculpin/sucker species individuals, which require more diverse habitat conditions. These results signal potential habitat stress.

Table 383. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
07MN056	**9.35**	**7.79**	**38.94**	**63.55**	**13.40**	**24.61**
14MN129	**1.52**	**4.88**	**39.94**	**43.29**	**5.18**	**51.52**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Sand Creek (-840) scored below average in three (07MN056) and one (14MN129) of the six evaluated habitat related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 383). Both sites had lower amounts of Climber individuals, while site 07MN056 had a higher number of Burrower individuals, which may be related to the higher amount of sand and silt substrates present.

The MSHA scores along this reach were fair, while the habitat related metrics for the fish and macroinvertebrate communities were relatively mixed (Fish-majority were below average, Macroinvertebrates-majority were above average). It appears that the habitat conditions could be improved, but these conditions are not a primary stressor in this reach. Habitat is a secondary stressor to the biological communities at this time.

Candidate Cause Chloride/Ionic Strength

This section of Sand Creek is impaired for chloride. Chloride values were available on this reach ranging from <2 to 724 mg/L with the highest value in July. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 244 to 4439 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). 17% of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were above the class averages while the taxa counts were below average. The macroinvertebrate community was comprised of a range of 41.36 to 49.85% conductivity tolerant individuals and 0 intolerant individuals.

Table 384. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN129	22	6	39.63	43.29	0
07MN056 (2007)	NA	NA	NA	NA	1.68
07MN056 (2014)	31	7	59.81	63.55	1.08
07MN056 (2015)	NA	NA	NA	NA	5.56
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidae (sunfish) increased over time from 2007 to 2015, while no Centrarchidae were collected at station 14MN129. Species that are tolerant to conditions with high ionic strength comprised a range of 12.9 to 14.4% of the fish community. There were elevated specific conductance and chloride values in the dataset, while the biological indications were mixed. Ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach has a majority of natural stretches according to the MPCA altered watercourse layer, with 74.60% of the Sand Creek sub-watershed measured as channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage in contriubuting tributaries alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 38.71 to 70% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 12.90 to 40.53% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. Long-lived macroinvertebrates ranged from 1.56 to 8.54% of the population. The upstream channelization is likely contributing to lack of habitat and is a contributing stressor to the biological communities. The dam located on the downstream section of Sand Creek is also preventing fish migration from the Minnesota River to this upstream section of Sand Creek. 20

unique species were identified below the dam that were not observed upstream of the dam (MPCA). The biological communities were mixed, making altered hydrology inconclusive as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Sand Creek (-840) are being stressed by Dissolved Oxygen, Eutrophication, Suspended Sediment, and Habitat. (Table 385) Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point, while Nitrates were ruled out as a stressor. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 385. Stressors on Sand Creek (-840)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Sand Creek	07020012-840	●	●	---	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.5 Unnamed Creek (Picha Creek) (-579)

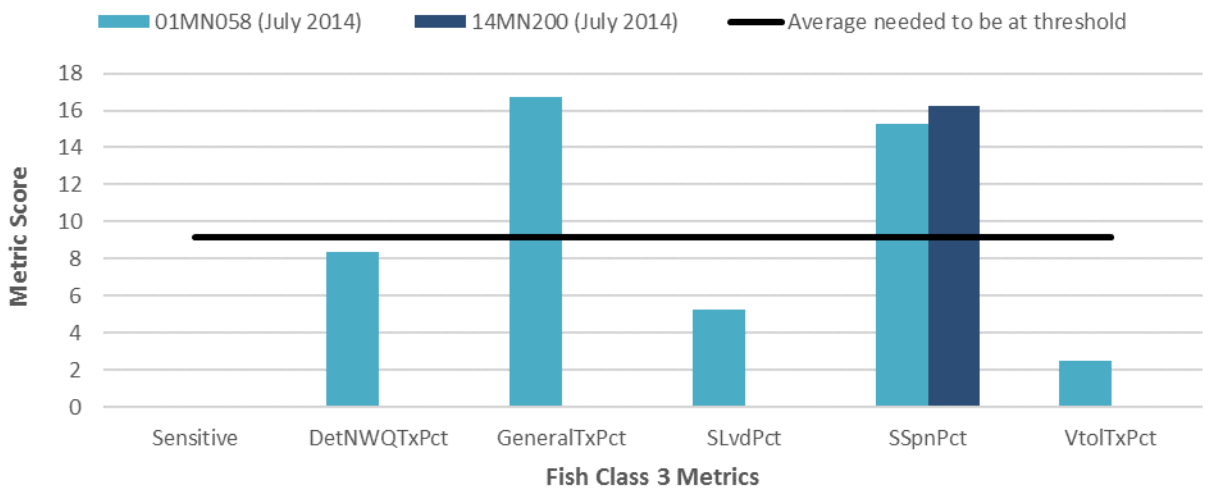
Unnamed Creek (Picha Creek) (-579) is a 3.98 mile long reach that is located in northwestern Scott county. This reach runs from an Unnamed Creek located 0.1 miles upstream of Zumbro Avenue to the confluence with another Unnamed Creek located upstream of Highway 169. This reach has two biological monitoring stations, 01MN058 and 14MN200. This reach is impaired for biology due to both the fish and macroinvertebrate communities. A Stressor ID Report was completed in 2009 by Barr Engineering, which identified inadequate base flow, sediment, habitat, and habitat fragmentation as stressors (Barr, 2009).

Biology

Fish

Unnamed Creek (Picha Creek) (-579) has two biological monitoring stations (01MN058, 14MN200) that were monitored for fish. Both of these stations were classified as Fish Class 3 Southern Headwaters stations. Site 01MN058 was sampled in July of 2014 and had an FIBI score of 48.1, which is below the Fish Class 3 general use threshold of 55. This site scored above average in two of the class metrics (General TxPct, SSpnPct), while scoring below the average needed to reach the class threshold in the remaining four metrics. Site 14MN200 was also sampled in July 2014 and had a FIBI score of 16.3, which is well below the class threshold of 55. The fish community only scored well in one metric (SSpnPct) comprising the FIBI, while scoring very poorly in the remaining five metrics. This site was dominated by very tolerant taxa including blacknose dace, fathead minnow, and brook stickleback.

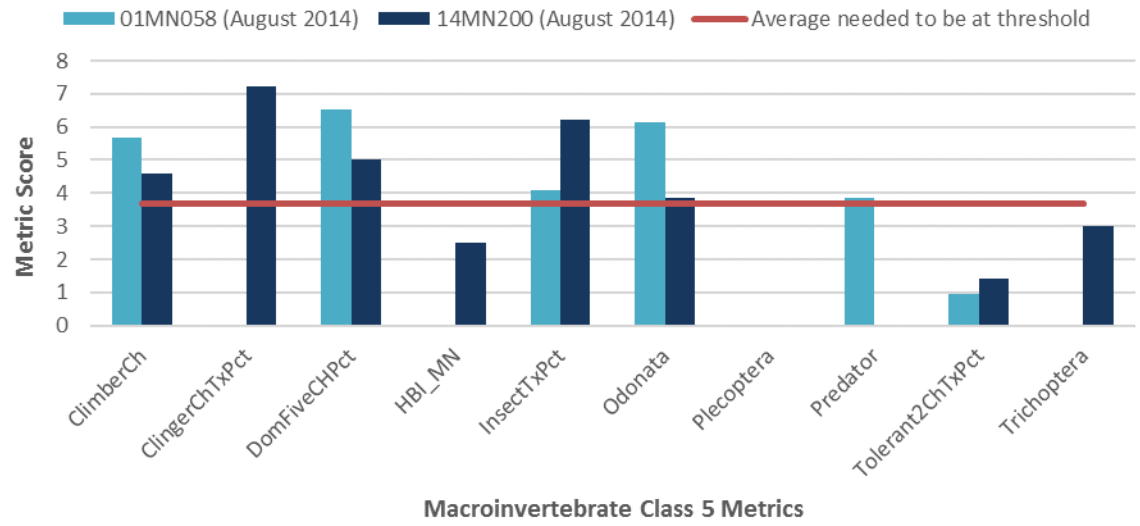
Figure 210. Fish metrics scores



Macroinvertebrates

This stream reach is also impaired for aquatic life due to the macroinvertebrate assemblage present at both sites, 01MN058 and 14MN200. Both of these sites are Macroinvertebrate Class 5 Southern Streams RR stations. Site 01MN058 was sampled in August 2014 and had an MIBI score of 27.2. This is below the Class 5 general use threshold of 37. This site scored above the average needed to reach the MIBI threshold in five of the ten metrics (ClimberCh, DomFiveCHPct, InsectTxPct, Odonata, Predator), while scoring poorly in the remaining five metrics. Site 14MN200 had an MIBI score of 33.8 during the August 2014 sampling event. This is score is just below the threshold of 37. This site also scored well in half of the class metrics (ClimberCh, ClingerChTxPct, DomFiveCHPct, InsectTxPct, Odonata), while scoring below average in the remaining metrics.

Figure 211. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years; values ranged from 0.18 mg/L at station S004-904 to 14.39 mg/L at station 14MN200. The lowest value was collected in July. The range of values is indicative of possible diurnal DO fluctuations. Twenty-nine percent of the DO values were below the

water quality standard of 5 mg/L. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.5-13.4 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 386. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
01MN058 (2008)	0	24.07	2	NA	NA	NA	NA
01MN058 (2014)	0	6.45	4	39.09	8.42	2	6.32
14MN200	0	2.04	3	9.40	7.49	3	6.95
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. All visits at on this reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage decreased from 2008 (24.07%) to 2014 (6.45%) at station 01MN058. The two fish visits from 2014 both had percentages of individual serial spawning fish far below the class average of sites that met the threshold. Species that are very tolerant to low DO conditions ranged from 1.1 at station 14MN200 to 100% at both visits at station 01MN058.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was two low DO intolerant taxa present at station 01MN058 and three taxa present at station 14MN200. The percentage of DO tolerant individuals was 39.09% at station 01MN058 and 9.4% at station 14MN200. Very low values of DO have been found on this reach and the biological response is indicative of limited DO stress to the biological communities at station 01MN058.

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.17 to 0.52 mg/L. The highest value was collected in July at station 01MN058. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Elevated DO flux is caused by increased algae (Figure X) and macrophyte production, which in turn increases photosynthesis, respiration, and decomposition. There is no available DO flux, BOD, or chlorophyll-a data. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.31 to 8.63.

Figure 212. Alage at site 01MN058 (July 28, 2008)

No sensitive or darter individuals were collected on this reach. Tolerant species comprised more than 93% of the fish community at both stations. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at levels lower than the class average of sites meeting the general threshold. EPT individuals were present at levels lower than the class average. The two most common macroinvertebrate species sampled comprised less than half of the population at both stations. Based on the water chemistry data, algal growth, and preponderance of biological evidence, eutrophication is a stressor.

Table 387. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
01MN058	0	0	93.55	6.45	46	7.27	36.67
14MN200	0	0	100	2.04	31	23.17	28.25
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2001-2014, a total of five nitrate were taken from Unnamed Creek (Picha Creek) (-579), These nitrate values ranged in concentration from 0.54-5.4 mg/L with an average value of 2.35 mg/L. This average value and the nitrate concentrations observed are consistent with the other reaches within this subwatershed and their more extensive nitrate monitoring.

Table 388. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
01MN058	6.09	70.14	0.00	3.84
14MN200	16.13	65.20	0.00	4.25
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (-579) scored below average in three (14MN200) and four (01MN058) of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 388). Site 14MN200 did have an above average amount of Trichoptera taxa present, while scoring poorly in the remaining categories.

The nitrate concentrations were low with the small number of samples; however, that data was consistent with the nearby reaches in the subwatershed. Other stressors are likely causing the biological metrics to score poorly. Nitrate is not a stressor to aquatic life at this time.

Candidate Cause Sediment

From 2001-2014, a total of five TSS samples were collected from Unnamed Creek (Picha Creek) (-579). These values ranged from 10-76 mg/L, with an average value of 28.4 mg/L. One of the samples was above the 65 mg/L TSS standard. Additionally, seven secchi tube measurements were taken during this same time period. These values ranged from 8-100 cm, with an average value reading of 36.83 cm. One of the measurements was below the 10 cm standard for secchi tube.

The HSPF model also calculated daily TSS concentrations for this reach. These values ranged from 1.9-737.7 mg/L with an average value of 14.3 mg/L. Of these calculations, 77 (1.24%) were above the 65 mg/L standard. This exceedance rate is relatively low when compared throughout the Lower Minnesota River Watershed.

Table 389. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
01MN058	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.82**	**0.00**	**1.61**	**14.40**
14MN200	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**96.94**	**0.00**	**0.00**	**10.94**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in this reach scored below average in eight (14MN200) and nine (01MN058) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 389). Both sites had above average TSS index scores and site 14MN200 had a very high amount of simple lithophilic individuals. The remaining metrics all scored below average.

Table 390. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
01MN058	**16.83**	**0.00**	**13.50**	**32.72**	**11.09**	**0.00**
14MN200	**16.83**	**0.00**	**11**	**39.18**	**28.89**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (Picha Creek) (-579) scored below average in four (14MN200) and five (01MN058) of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 390). Site 14MN200 did have a lower amount of TSS tolerant taxa, while also having an above average amount of Collector filterer individuals, while site 01MN058 did have a lower amount of TSS tolerant individuals. These sites scored poorly in the other suspended sediment related metrics.

The observed data only had one TSS and secchi measurement that exceeded the standard, while the HSPF model predicted a very low exceedance rate. Therefore, suspended sediment is not a stressor to aquatic life in this reach at this time. The overall fish and macroinvertebrate communities lack diversity, but this is likely due to other stressors.

Candidate Cause Habitat

Unnamed Creek (-579) had qualitative habitat assessments take place at its biological monitoring sites, 01MN058 and 14MN200, during the fish and macroinvertebrate sampling events in 2001, 2008, and 2014. The average MSHA scores from these visits was 56.06 (Fair) at 01MN058 and 53.2 (Fair) at 14MN200. Limiting the MSHA scores at these sites was row crop agriculture has the prominent nearby land use, a limited riparian buffer, little to moderate bank erosion, sand substrates, light embeddedness, as well as fair sinuosity and channel development at 14MN200.

Figure 213. Habitat metric scores

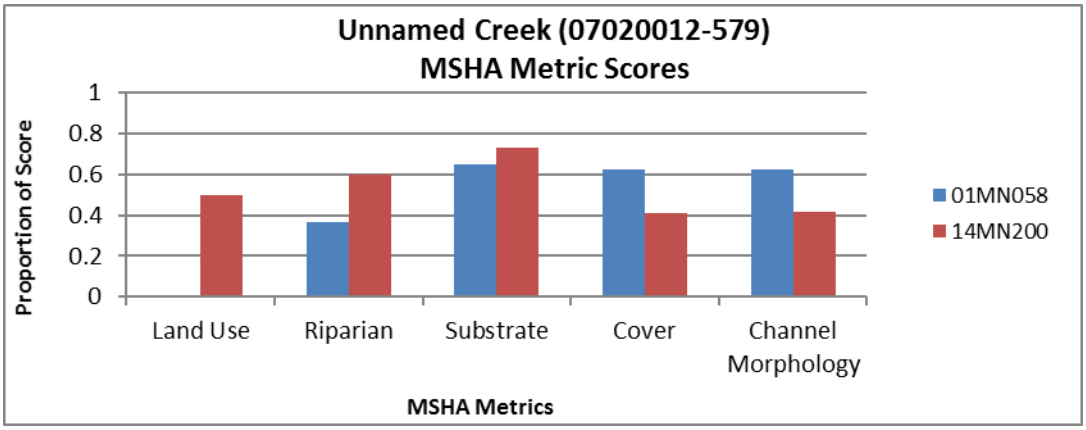


Table 391. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
01MN058	**0.00**	**8.82**	**0.00**	**0.00**	**1.61**	**29.72**	**98.39**	**28.84**
14MN200	**0.00**	**96.94**	**0.00**	**0.00**	**0.00**	**96.94**	**100.00**	**2.04**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community scored below average in seven (01MN058) and five (14MN200) habitat related biological metrics when compared to all other Class 3 Southern Headwaters stations that met the FIBI General Use Threshold (Table 391). The high amount of tolerant individuals as well as the lack of some other habitat specialists can signal some habitat degradation.

Table 392. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN058	**20.47**	**20.18**	**32.96**	**19.43**	**72.90**	**8.22**
14MN200	**4.44**	**31.75**	**53.02**	**23.17**	**75.87**	**2.54**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in five (01MN058) and three (14MN200) in the habitat related metrics when compared to all other Class 5 Southern Streams RR stations that met the MIBI General Use Threshold (Table 392). The lower number of EPT individuals, the high numbers of legless individuals, and the high amount of burrowers at site 01MN058, are strong signals of potential habitat degradation.

Based on the majority of the habitat related biological metrics for both assemblages, as well as the fair MSHA scores, the lack of habitat is a stressor to the impaired biological communities in Picha Creek at this time.

Candidate Cause Chloride/Ionic Strength

Chloride values were not available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 465 to 2040 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Nine percent of the values were over 1,000 uS/cm.

Table 393. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
01MN058 (2008)	NA	NA	NA	NA	0
01MN058 (2014)	46	3	6.36	7.27	0
14MN200	31	3	8.25	23.17	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were all below the class averages. The taxa counts were above average at station 01MN058 and below average at station 14MN200. The macroinvertebrate community was comprised of a range of 47.34 to 72.72% conductivity tolerant individuals (the percentage went up at station 01MN058 from 29.93 in 2002 to 72.72% in 2014) and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present at any of the visits. Species that are tolerant to conditions with high ionic strength comprised a range of 0 to 67.7% of the fish community. There were elevated specific conductance values in the dataset, but the biological indications were mixed. Ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach has a majority of natural stretches according to the MPCA altered watercourse layer. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. The stream was found to be dry in 2007 (Barr, 2009), and to frequently have no flow or very low flow (Paul Nelson, personal communication, July 25, 2018).

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A perched culvert is present at station 01MN058 (Figure 214). The culvert is creating a fish barrier to the upstream watershed.

Figure 214. Perched culvert at site 01MN058

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 6.45 to 98.98% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 3.06 to 100% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. Long-lived macroinvertebrates ranged from 0 to 1.52% of the population. The upstream channelization is likely contributing to lack of habitat and is a contributing stressor to the biological communities. The periods of low flow and the fish barrier are effecting the biological communities making altered hydrology a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed Creek (Picha Creek) (-579) are being stressed by Dissolved Oxygen, Eutrophication, and Habitat. (Table 394) Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 394. Stressors on Unnamed Creek (Picha Creek) (-579)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek (Picha Creek)	07020012-579	●	●	---	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.6 Unnamed Creek (Picha Creek) (-580)

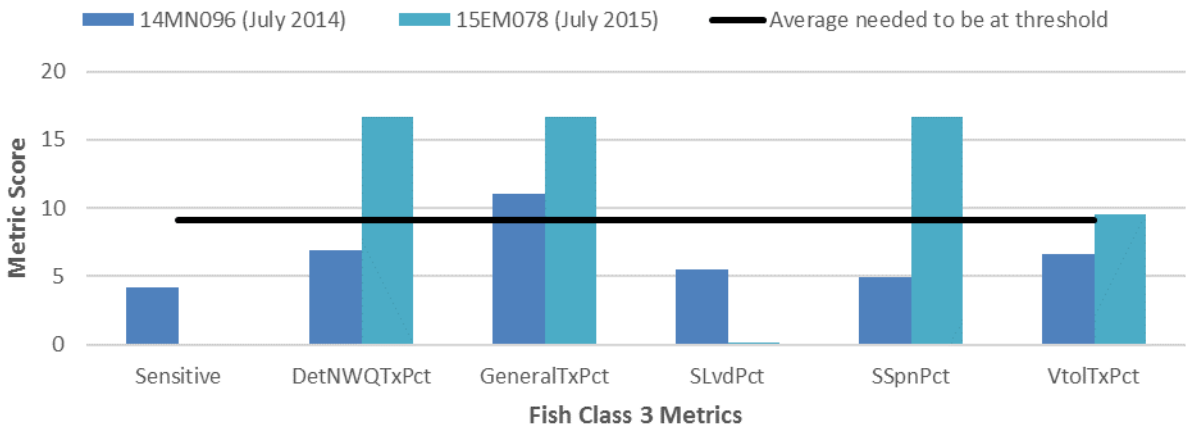
Unnamed Creek (Picha Creek) (-580) is a 0.97 mile long reach that is located in Scott County, extending from Unnamed Creek at Hwy 169 to Sand Creek and the Louisville Swamp. This reach has two biological monitoring stations, 14MN096 and 15EM078. This reach is impaired for biology due to the fish community. A Stressor ID Report was completed in 2009 by Barr Engineering, which identified inadequate base flow, sediment, habitat, and habitat fragmentation as stressors (Barr, 2009).

Biology

Fish

Unnamed Creek (Picha Creek) (-580) had fish sampling events at both biological monitoring sites (14MN096, 15EM078) located along this reach. Both sites were classified as Fish Class 3 Southern Headwaters stations. Site 14MN096 was sampled during July of 2014 and had a FIBI score of 39.3 which is below the Fish Class 3 general use threshold of 55. This site had a lower amount of Generalist Feeding taxa resulting in the only class metric score above the average needed to reach the threshold. The remaining five metrics scored poorly at this site. Site 15EM078 had a FIBI score of 59.9 during the July 2015 visit. This score is above the class threshold of 55. This site scored well in four class metrics (DetNWQTxPct, GeneralTxPct, SSpnPct, VtolTxPct). This site did lack sensitive fish species, but also had many short lived individuals that did limit the FIBI score.

Figure 215. Biological metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this reach in recent years (2007-2016); values ranged from 6.08 mg/L to 14.5 mg/L at station S004-522. The lowest value was collected in September. No values were recorded below the water quality standard of 5 mg/L. The range of values is indicative of possible diurnal DO fluctuations. No continuous data was available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.3-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Station 14MN096 lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage was 54.12%, well above the class average for sites meeting the general threshold. Species that are very tolerant to low DO conditions comprised 82% of the fish population.

Table 395. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN096	0	54.12	17	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrates were not sampled on this reach. Low values of DO have been found on this reach and the biological response is indicative of DO stress to the fish community. Other stressors could be affecting the results, DO is inconclusive as a stressor.

Candidate Cause Eutrophication

A large dataset of phosphorus values are available on this stream, ranging from 0.012 to 1.02 mg/L. The highest value was collected in July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a values ranged from 1.4 to 19 ug/L, all below the southern standard of 40 ug/L. There is no available DO flux or BOD data. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 8 to 8.72. Thirteen of the values were above 8.5.

Table 396. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
15EM078	0	0	99.60	0	30	33.33	39.39
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

No sensitive or darter individuals were collected on this reach. Tolerant species comprised more than 99% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were not present. EPT individuals were present at

levels lower than the class average. The two most common macroinvertebrate species sampled comprised less than half of the population at both stations. The chemistry and biological evidence was mixed, making eutrophication currently inconclusive as a stressor.

Candidate Cause: Nitrate

A total of 29 nitrate samples were taken from Unnamed Creek (Picha Creek) (-580) from 2007-2015. These samples ranged in value from 1.61-9.42mg/L with an average nitrate concentration of 3.78 mg/L. This value is consistent with other sampling along different sections of Picha Creek as well as nitrate sampling throughout the subwatershed.

Table 397. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
15EM078	13.33	70.61	0.00	4.84
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 15EM078 scored below average in three of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use threshold. The site did have a slightly above average amount of Trichoptera taxa, which tend to decrease in streams negatively impacted by nitrates. However, there was large presence of nitrate tolerant taxa, a lack of nitrate intolerant taxa, and a poor scoring TIV score.

The nitrate concentration in Picha Creek (-580) was relatively low. Other nitrate sampling in different reaches of Picha Creek and others in the subwatershed all revealed similarly low concentrations of nitrates. It is likely that other stressors are negatively impacting the biological metrics. Nitrates are not a stressor to aquatic life at this time.

Candidate Cause: Sediment

From 2007-2015, a total of 31 TSS samples were taken from Unnamed Creek (Picha Creek) (-580). These sample values ranged from 1-380 mg/L with an average TSS concentration of 19.19 mg/L. Only one of these samples was above the 65 mg/L standard for TSS. Also, 55 secchi tube measurements were taken from this reach during the same time period. These values ranged from 9.8-100 cm, with an average readings of 58.81 cm. Only one of these readings fell below the 10 cm minimum standard for transparency.

Table 398. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
15EM078	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**97.20**	**0.00**	**0.40**	**10.69**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage at site 15EM078 in Unnamed Creek (Picha Creek) (-580) scored below average in eight off the 10 suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 398). This reach did have a very good TSS index score and a very high amount of simple lithophilic individuals, however, the remaining metrics did not score well at all.

Table 399. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
15EM078	**18.78**	**0**	**7**	**71.52**	**35.45**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (Picha Creek) (-579) scored below average in four of the six sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table). The site, 15EM078, did have a lower amount of TSS tolerant taxa and an above average number of Collector Filterer individuals. However, this reach did have a poor TSS Index score, a high number of TSS tolerant individuals, and a complete lack of TSS intolerant taxa and Plecoptera species. Those results are common in streams being negatively impacted by excess amounts of suspended sediment.

The extensive observed data set only had one standard exceedance from both the TSS sample and secchi tube measurements. This exceedance rate was very low. Some of the fish and macroinvertebrate metrics related to suspended sediment scored well, while most did not. This is likely due to other stressors as suspended sediment is not a stressor to aquatic life in this reach.

Candidate Cause: Habitat

Unnamed Creek (Picha Creek) (-579) had qualitative habitat assessments take place at its biological monitoring site, 15EM078, during the fish and macroinvertebrate sampling events in 2015. The average MSHA score from these visits was 49.63 (Fair). Limiting the MSHA scores at this site was sand substrates, severe embeddedness, sparse fish cover, moderate channel stability, very limited depth variability, as well as fair channel development. A breakdown of the MSHA category scores for these sites can be seen in Figure 216.

Figure 216. Habitat metric scores

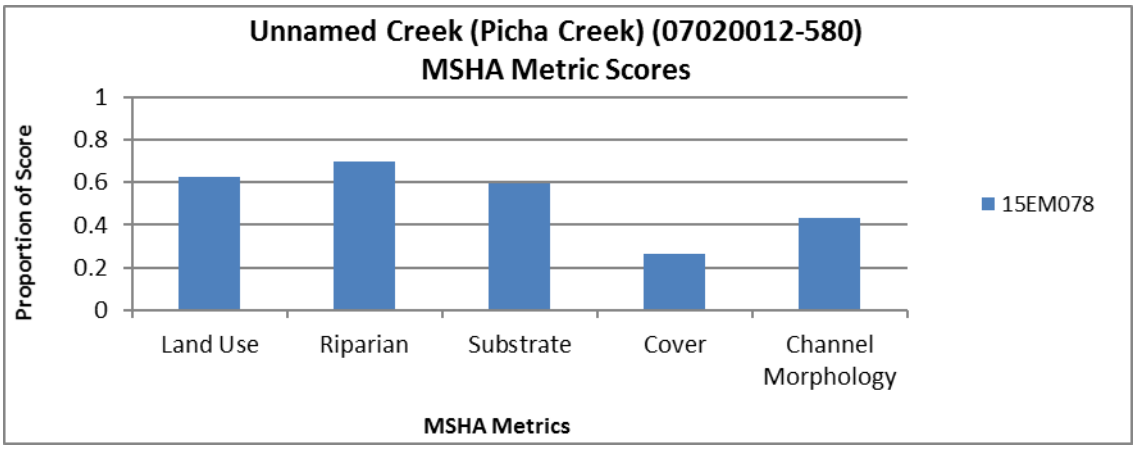


Table 400. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
15EM078	**0.00**	**97.20**	**0.00**	**0.00**	**0.40**	**97.20**	**99.60**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 15EM078 located along Picha Creek (-580) scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that did meet the FIBI General Use Threshold (Table 400). The fish community consisted primarily of blacknose dace (97.2%). Blacknose dace are a tolerant fish species that can be found in larger numbers in streams with degraded habitat conditions. The overall lack of diversity in fish is concerning as well.

Table 401. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
15EM078	**8.48**	**43.94**	**42.42**	**33.33**	**60.00**	**3.64**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Picha Creek scored below average in five of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that do meet the MIBI General Use Threshold (Table 401). The most commonly found macroinvertebrate was Physella (74). Physella is a small snail that generally feeds on detritus and algae and is commonly found in larger numbers in degraded stream systems.

Based on the majority of both the fish and macroinvertebrate habitat related metrics, as well as the fair MSHA score, habitat is a stressor to the impaired biological communities in Unnamed Creek (Picha Creek) (-580) at this time.

Candidate Cause Chloride/Ionic Strength

Chloride values on this on this reach were collected from 2007-2008 and ranged from 17 to 43.5 mg/L . Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 471 to 818 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Macroinvertebrates were not sampled. Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were slightly above average. Species that are tolerant to conditions with high ionic strength comprised 78.8% of the fish community. Chloride and specific conductance values were not elevated. Macroinvertebrate data was not available, and while Centrarchidaes were slightly elevated, ionic strength is currently inconclusive as a stressor.

Table 402. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN096	NA	NA	NA	NA	1.10
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach is natural except for the Highway 169 road crossing according to the MPCA altered watercourse layer. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 5% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 89.84% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 51.92% of the fish community. The upstream channelization is likely contributing to lack of habitat. While there were some indications of stress in the biological community, making altered hydrology is currently inconclusive as a stressor.

Conclusions and recommendations

The impaired fish community in Unnamed Creek (Picha Creek) (-580) is being stressed by Habitat. (Table 403) Dissolved Oxygen, Eutrophication, Chloride, and Flow Alteration/Connectivity were inconclusive as stressors at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 403. Stressors on Unnamed Creek (Picha Creek) (-580)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek (Picha Creek)	07020012-580	o	o	---	---	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.7 County Ditch 10 (-628)

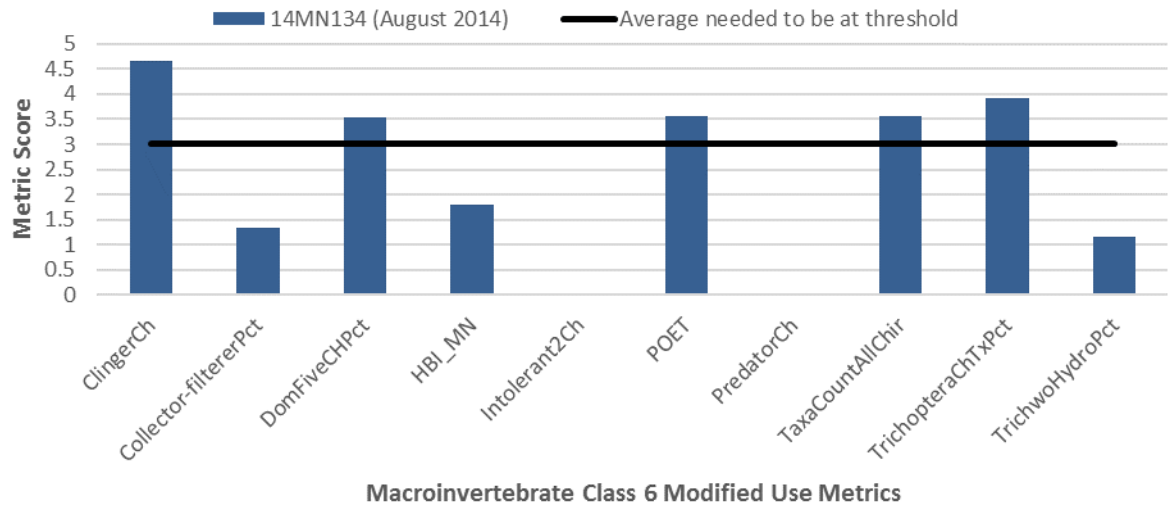
County Ditch 10 (-628) is a 2.1 mile long stream reach that is located in southwestern Scott County. This reach extends from County Ditch 3 to the confluence with Raven Stream. This reach is impaired for biology due to the macroinvertebrate assemblage present at the biological monitoring station, 14MN134, located along this stream reach.

Biology

Macroinvertebrates

County Ditch 10 (-628) had one macroinvertebrate sample taken in August 2014 from its biological monitoring station 14MN134. The MIBI score during this visit was 23.6, which is well below the MIBI Class 6 Southern Forest Streams GP modified use threshold of 30. This site did score above the average needed to reach this threshold in five of the class metrics (ClingerCh, DomFiveCHPct, POET, TaxaCountAllChir, TrichopteraChTxPct), while scoring poorly in the remaining five metrics.

Figure 217. Bioloigcal metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years; values ranged from 1.7 mg/L to 12.51 mg/L at station S004-618. The lowest value was collected in July. 25% of the DO values were below the water quality standard of 5 mg/L. Continuous data collected over a two week period produced a low value of 6

mg/L. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.8-13.2 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with an increased serial spawning fish percentage. The serial spawner percentage at the one visit was 1.23%, well below the class average of sites that met the modified threshold. Species that are very tolerant to low DO conditions comprised to 25% of the fish community.

Table 404. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN134	0	1.23	8	12.71	8.32	4	6.96
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was four low DO intolerant taxa and 12.71% of DO tolerant individuals present. While some very low values of DO have been found on this reach, the biological response is not indicative of DO stress.

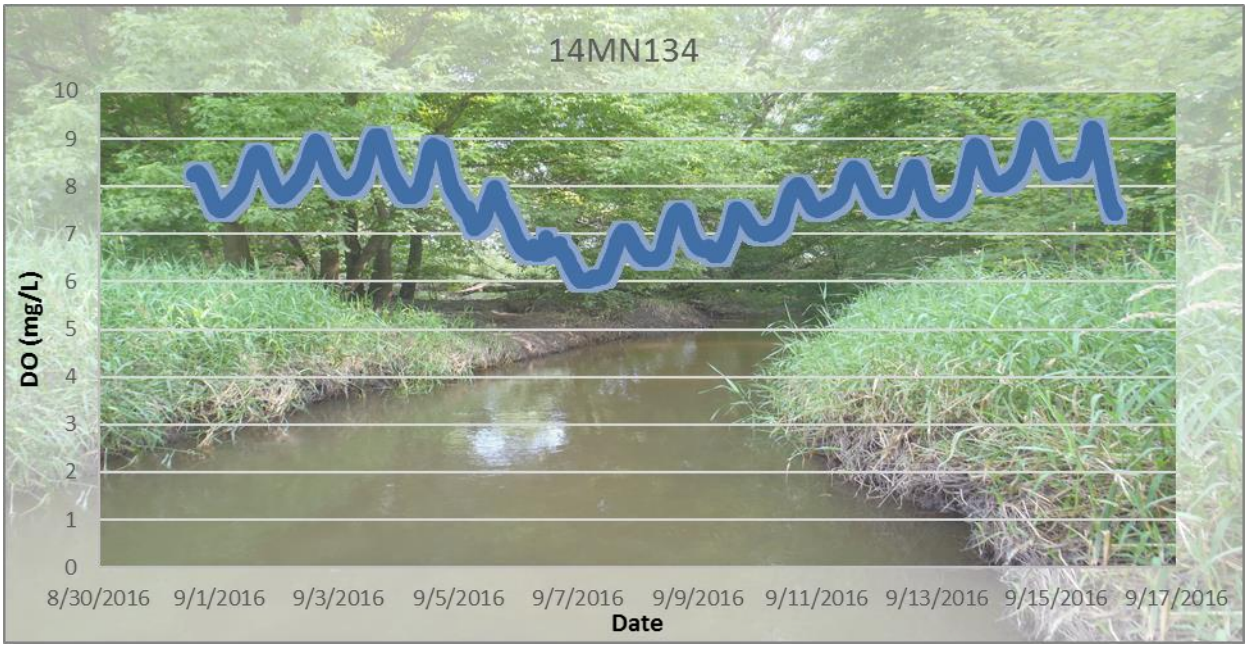
Candidate Cause Eutrophication

The majority of phosphorus values on this reach were taken in 2007 and 2008 with a few samples in 2014 and 2016. Phosphorus values ranged from 0.019 to 0.676 mg/L with 57% over 0.150 mg/L. The highest value was collected in August of 2016 at station S004-618 (just upstream of Raven Creek). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.3 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 12% in June of 2008 to 100% in June of 2007. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD and chlorophyll-a values were taken in 2007 and 2008. BOD values ranged from 1 to 7.2 mg/L with 25% over the southern standard of 3.5 mg/L. Chlorophyll-a values ranged from 1.8 to 28 mg/L with no values over the southern standard of 40 mg/L.

Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Typical daily pH fluctuations in streams are 0.2-0.3 (Heiskary et al., 2013). pH values ranged from 7.4 to 8.27. Continuous

pH data showed daily fluxes elevated only on two days after more than 0.5 inches of rain. Streams dominated with submerged macrophytes experience the largest swings in DO and pH (Wilcox and Nagels 2001). The water quality standard for DO flux in the south region of the state is 4.5 mg/L. Continuous DO data collected in September 2016 values were not elevated (Figure 218).

Figure 218. Continuous DO data at site 14MN134



No sensitive individuals were collected on this reach. Darter individuals were present at 4.29% but all the darters were johnny darters, which is a more tolerant darter. Tolerant species comprised more than 95% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at 22.09%, just above the class average of sites meeting the modified threshold. EPT individuals were present at levels just lower than the class average. The two most common macroinvertebrate species sampled comprised just less than half of the population. The chemistry and biological evidence was mixed, making eutrophication currently inconclusive as a stressor.

Table 405. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN134	0	4.29	95.09	22.09	31	26.09	49.16
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2007-2016, a total of 35 nitrate samples were taken from County Ditch 10 (-628). These sample values ranged from 0.08-23.2 mg/L with an average value of 10.51 mg/L.

Drain tiles were also present along this reach and are a common pathway for nitrates to enter a stream system.

Table 406. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN134	**6.45**	**84.95**	**0.00**	**4.30**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*10.99*	*57.02*	*0.30*	*3.22*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN134 scored below average in all four of the evaluated nitrate metrics when compared to all other Class 6 Southern Forest Streams GP stations that met the MIBI Modified Use Threshold. Additionally, quantile regression analysis showed that Class 6 sites with 85.62% nitrate tolerant individuals had a 90% probability of being impaired. Site 14MN134 fell just below this with 84.95% nitrate intolerant individuals. This site had few Trichoptera and nitrate intolerant individuals, while having a poor scoring Nitrogen TIV.

Given the high sampled values of nitrates, as well as the high average value, the presence of drain tiles, in addition to the poor scoring nitrate related biological metrics, nitrates are a stressor to the impaired biological communities in County Ditch 10 (-628).

Candidate Cause Sediment

From 2007-2016, a total of 35 TSS samples were collected from County Ditch 10 (-628). These sample values ranged from 1-88 mg/L with an average TSS concentration of 19.03 mg/L. Two of these samples were above the 65 mg/L standard for TSS. Additionally, 30 secchi tube measurements were taken along this reach with values ranging from 19-60 cm with an average reading of 44.92 cm. No secchi tube readings fell below the transparency standard.

Table 407. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN134	**34.36**	**0.00**	**9.20**	**4.29**	**30.06**	**0.00**	**26.38**	**0.00**	**0.00**	**15.24**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 10 (-628) scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 407). The site, 14MN134, did have an above average amount of benthic feeder and riffle dwelling individuals, while also having a good TSS Index Score. However, the reach did score poorly in the remaining metrics related to suspended sediment.

Table 408. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN134	**19.10**	**0**	**12**	**50.84**	**5.35**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN134 in County Ditch 10 (-628) scored below average in all six of the suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 408). This reach lacked many collector filterer individuals, TSS intolerant and Plecoptera taxa, while also having a high amount of TSS Tolerant taxa and individuals, as well as a poor TSS Index Score.

Many of the suspended sediment related metrics for both of the fish and macroinvertebrate communities scored below average when compared to like stream stations that pass their respective threshold. However, the larger data set available for this reach had just two instances in which the TSS standard was exceeded. It is likely that other stressors are negatively impacting this stream resulting in lower metric scores, therefore, suspended sediment is not a stressor to aquatic life in this reach at this time.

Candidate Cause Habitat

County Ditch 10 (-628) had a qualitative habitat assessment take place at its biological monitoring site, 14MN134, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 46.65 (Fair). Limiting the habitat at this site was the narrow stream riparian buffer, moderate embeddedness, large amounts of silt (Figure 219), moderate channel stability, fair channel sinuosity, and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 220.

Figure 219. Silt substrate at site 14MN134

Figure 220. Habitat metric scores

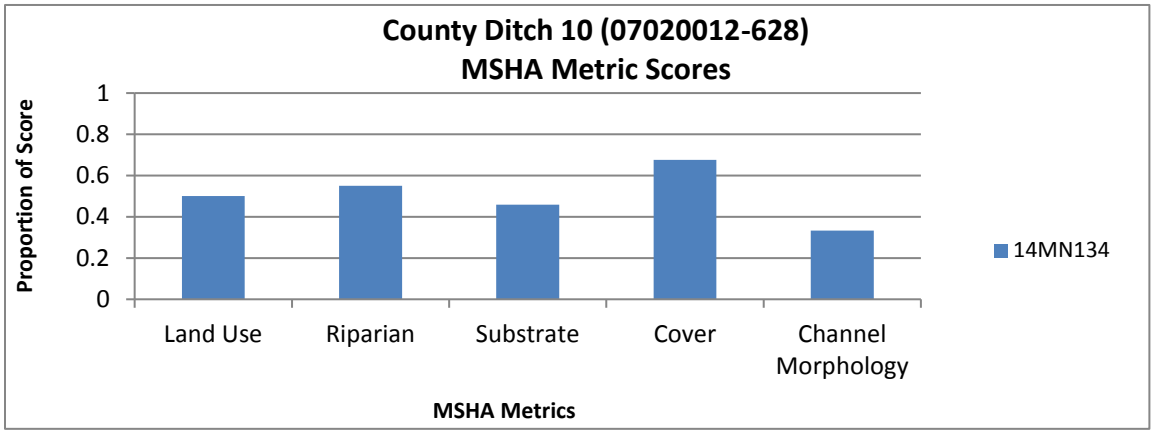


Table 409. Habitat related macroinvertebrate metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN134	**4.29**	**26.38**	**4.29**	**30.06**	**0.00**	**71.17**	**95.09**	**41.10**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage at site 14MN134 in County Ditch 10 (-628) scored below average in six of the eight evaluated habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold. The fish community, while not impaired, did have many tolerant individuals, while also lacking many habitat specialist species, which can signal potential stress from degraded habitat conditions.

Table 410. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN134	**7.36**	**30.43**	**18.73**	**26.09**	**61.54**	**21.07**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**11.49**	**23.84**	**24.46**	**14.44**	**61.44**	**22.59**
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The impaired macroinvertebrate community in County Ditch 10 (-628) scored below average in half of the habitat related metrics when compared to other Class 6 Southern Forest Streams GP stations that did meet the MIBI Modified Use Threshold. The high amount of legless individuals corresponds to the large amount of silt found in this stream and is a sign of habitat degradation.

Given the poorly scoring fish and macroinvertebrate habitat related metrics, the fair MSHA score, as well as the high amount of siltation found in this site, the current habitat conditions are a stressor to the biological communities.

Candidate Cause Chloride/Ionic Strength

Chloride values on this on this reach were collected from 2007-2008 and ranged from 11 to 45 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 313 to 969 uS/cm. Continuous data for two weeks in 2016 showed all values below 856 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentages were both above the class average. The taxa count was just below average. The macroinvertebrate community was comprised of 61.54% conductivity tolerant individuals and 0 intolerant individuals.

Table 411. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN134	31	7	21.74	26.09	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	36.65	*3.27*	*12.38*	*18.10*	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised 33.7% of the fish community. There were no elevated specific conductance or chloride values in the dataset, and the biological communities did not reflect stress. Ionic strength is not a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach is entirely modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 1.5% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 63.19% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 28.83% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 12% of the population. The channelization is likely contributing to lack of habitat. While there were some indications of stress in the biological community, altered hydrology is currently inconclusive as a stressor.

Conclusions and recommendations

The impaired macroinvertebrate community in County Ditch 10 (-628) is being stressed by Nitrates and Habitat. (Table 412) Eutrophication and Flow Alteration/Connectivity were inconclusive as stressors at this point, while Dissolved Oxygen, Suspended Sediment, and Chloride were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 412. Stressor on County Ditch 10(-628)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 10	07020012-628	---	o	●	---	●	---	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.8 Raven Stream (-716)

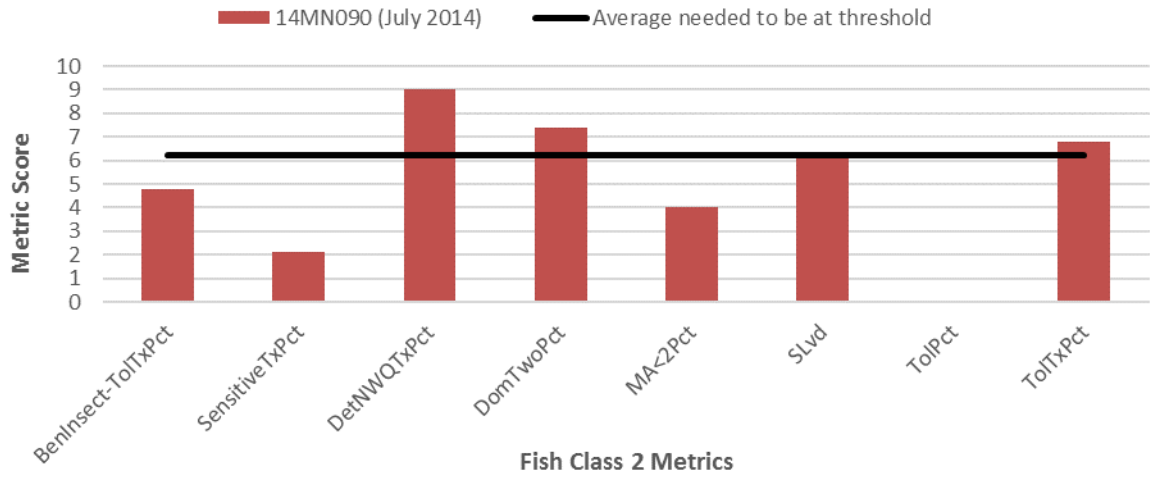
Located in south central Scott county, Raven Stream (-716) is a 4.87 mile long stream reach that connects East Branch Raven Stream to Sand Creek. This reach is impaired for biology due to both its fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN090, along this stream section. This reach is also impaired for chloride.

Biology

Fish

Raven Stream (-716) had a fish sampling event take place in July of 2014 at its biological monitoring station 14MN090. This site had a FIBI score of 40.5, which is below the Fish Class 3 Southern Streams general use threshold of 50. This site scored at or above the average needed to reach the threshold in four of the eight metrics (DetNWQTxPct, DomTwoPct, SLvd, TolTxPct), while scoring below average or poorly in the remaining four metrics comprising the Fish Class 3 IBI (Figure 221).

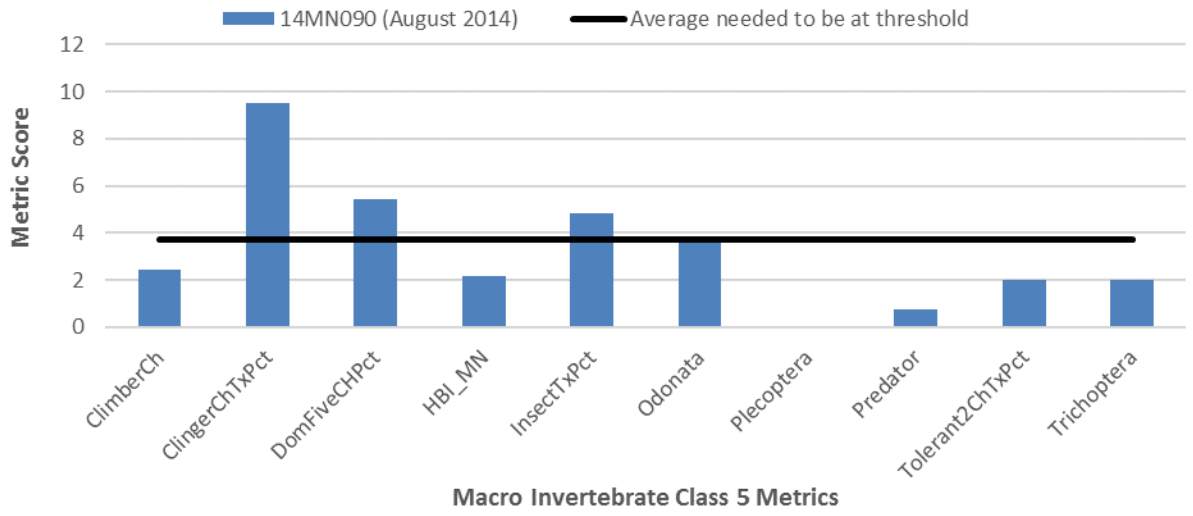
Figure 221. Fish metric scores



Macroinvertebrates

This reach had a macroinvertebrate sample taken during August of 2014 at biological monitoring station 14MN090. This site had a MIBI score of 33.1, which is slightly below the Macroinvertebrate Class 5 General Use Threshold of 37. Site 14MN090 scored above the average needed in four of the ten class metrics to reach the MIBI threshold (ClingerChTxPct, DomFiveCHPct, InsectTxPct, Odonata), while scoring below average or poorly in the remaining six metrics comprising the MIBI. (Figure 222)

Figure 222. Macroinveretebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this reach in recent years (2007-2016); values ranged from 4.56 mg/L to 13.48 mg/L at station S001-764. The lowest value was collected in August. Only one DO value was below the water quality standard of 5 mg/L. No continuous data is available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.6-13.9 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 413. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN090	3.18	30.50	13	0.96	7.61	7	7.26
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach had 3.18% of fish that reproduce at a mature age, below the class

average. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage at the one visit was 30.50%, right above the class average of sites that met the general threshold. Species that are very tolerant to low DO conditions comprised less than 1% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was four low DO intolerant taxa and 0.96% of DO tolerant individuals present. While there was one low DO value recorded in 2007, the preponderance of evidence indicates DO is not a stressor.

Candidate Cause Eutrophication

A large dataset exists on this reach, with phosphorus values ranging from 0.055 to 1.32 mg/L with 85% over 0.150 mg/L. The highest value was collected in August near Pleasant Lake. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.3 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 14% in June to 100% in September and an average of 80%.

Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Current BOD information is not available, but values ranged from 1 to 4.7 in 2005 and 2006. Chlorophyll-a values ranged from 2.4 to 44, with only 1 value over the southern standard of 40 ug/L. There is no DO flux data available. As a result of eutrophication, pH values also increase. pH values ranged from 7.02 to 8.49.

Table 414. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN090	0.27	6.63	86.47	13	38	46.13	32.58
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Less than 1% of sensitive individuals were collected on this reach. Darter individuals were present at 6.63% but all the darters were johnny darters which is a more tolerant darter. Tolerant species comprised more than 86% of the fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at 13%, just below the class average of sites meeting the general threshold. EPT individuals were present at levels just higher than the class average; however, the community was dominated by species tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised less than half of the population. Based on the phosphorus and orthophosphorus values as well as the preponderance of biological evidence, eutrophication is a stressor.

Candidate Cause: Nitrate

From 2006-2014 a total of 102 nitrate samples were taken from Raven Stream (716). These values ranged from 0.05-16.3 mg/L with an average value of 7.12 mg/L.

Drain tiles were also present in this reach and are a common pathway for nitrates to enter a stream system.

Table 415. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN090	10.53	51.92	0.00	3.44
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Raven Stream (-716) at station 14MN090 scored below average in all four of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 415). Site 14MN090 completely lacked nitrate intolerant species, while also had low Trichoptera taxa. Additionally, this reach had a high amount of nitrate tolerant species. These results all indicate likely stress from excessive nitrates.

Nitrate concentrations in Raven Stream can get quite high as 14 samples exceeded 12 mg/L. These higher values appear to be impacting the macroinvertebrate assemblage as all four of the nitrate related metrics scored below average at site 14MN090. Based on this data, as well as the presence of drain tiles, nitrates are a stressor to aquatic life in Raven Stream (-716) at this time.

Candidate Cause Sediment

From 2005-2014, a total of 105 TSS samples were taken from Raven Stream (-716). These samples ranged in value from 1-636 mg/L, with an average TSS concentration of 49.85 mg/L. Of these samples, 22 were at or above the 65 mg/L standard for TSS. Also, from 2001-2015 a total of 234 secchi tube measurements were taken along this reach. These readings ranged in value from 3-100 cm, with an average reading of 49.62 cm. Of this dataset, ten samples were at or below the 10 cm standard for transparency.

Table 416. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN090	**26.53**	**1.33**	**11.94**	**10.88**	**19.89**	**0.27**	**28.12**	**0.00**	**3.18**	**16.71**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

The fish community in Raven Stream at site 14MN090 scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 416). The reach did have an above average TSS Index Score and a higher amount of herbivorous individuals, while scoring poorly in the remaining metrics.

Table 417. Sediment metrics related to macroinvertebrate

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN090	**17.60**	**2**	**13**	**56.09**	**50.32**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in five of the six metrics related to suspended sediment when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 417). Site 14MN090 did have an above average amount of Collector Filterer individuals, while scoring poorly in the remaining metrics.

During the assessment process, it was noted that many of the TSS samples were collected following rain events, resulting in a higher number of standard exceedances. However, both the fish and macroinvertebrate communities scored below average in most of their respective metrics associated with suspended sediment. At this time, suspended sediment is a stressor to aquatic life in Rave Stream (-716).

Candidate Cause Habitat

Raven Stream (-716) had a qualitative habitat assessment take place at its biological monitoring site, 14MN090, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 58.25 (Fair). Limiting the habitat at this site was the row crop agriculture as the dominant land use, heavy bank erosion (Figure 223), sand substrates, light embeddedness and moderate channel stability. Further MSHA analysis can be seen in Figure 224. Over widening and sand point, bars were found in areas (Inter-fluve, 2008).

Figure 223. Heavy bank erosion at site 14MN090 (August 18, 2014)

Figure 224. Habitat metric scores

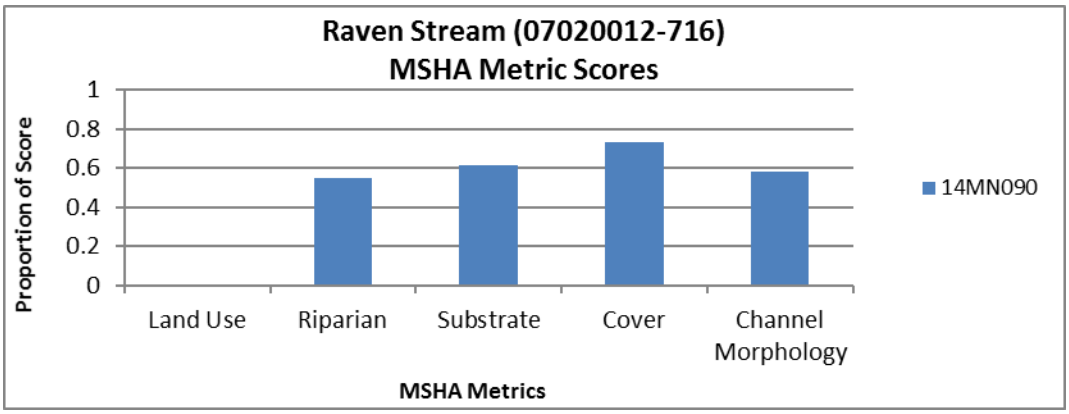


Table 418. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN090	6.90	28.12	6.63	19.89	4.24	57.29	86.47	29.18
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Raven Stream (-716) at site 14MN090 scored below average in all of the habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI

General Use Threshold (Table 418). The fish assemblage was dominated by bigmouth shiners, creek chubs, white suckers, and blacknose dace. These species are fairly tolerant of degraded habitat conditions.

Table 419. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN090	**2.90**	**16.77**	**66.13**	**46.13**	**37.42**	**9.03**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*. 42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this stream reach scored below average in two of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that did meet the MIBI General Use Threshold. (Table 419). This reach did have a decreased amount of sprawler individuals, while also having a higher number of legless individuals, which can indicate potential habitat stress.

Given how poorly the habitat related fish metrics scored, the poor MSHA, as well as the heavy bank erosion and channel instability present at site 14MN090, habitat is a stressor to aquatic life in Raven Stream (-716).

Candidate Cause Chloride/Ionic Strength

Raven Stream is impaired for chloride. Chloride values on this on Raven Stream ranged from 8.4 to 781 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 190 to 2188 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Thirty four percent of the values were over 1,000 uS/cm.

Table 420. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN090	38	9	7.10	46.13	1.33
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was far below class average while the mayfly (Ephemeroptera) percentage was just above the class average. The taxa count was just below average. The macroinvertebrate community was comprised of 47.76% conductivity tolerant individuals and one intolerant individual.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present below the class average. Species that are tolerant to conditions with high ionic strength comprised less than 1% of the fish community. There were numerous elevated specific conductance and chloride values in the dataset, but the biological communities were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This majority of this reach is natural according to the MPCA altered watercourse layer. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 1.5% during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 47.75% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 9% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions

change. The percentage of long-lived macroinvertebrates comprised 12.26% of the population. The lack of low flow events and the biological communities indicate altered hydrology is currently not a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Raven Stream (-716) are being stressed by Eutrophication, Nitrates, Suspended Sediment, and Habitat. (Table 421) Chloride was inconclusive as a stressor at this point, while Dissolved Oxygen and Flow Alteration/Connectivity were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 421. Stressors on Raven Stream (-716)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Raven Stream	07020012-716	---	●	●	●	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.9 Unnamed Creek (-732)

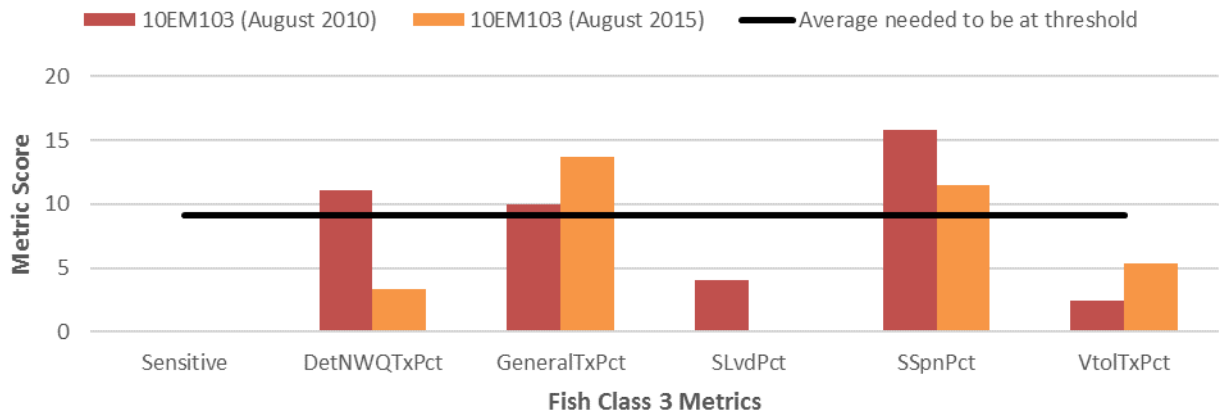
Unnamed Creek (-732) is a 9.04 mile long reach that is a tributary to Sand Creek. This reach is located in Scott County and located just southwest of the city of Jordan. The reach is impaired for biology due to both the fish and macroinvertebrate assemblages present at the biological monitoring station, 10EM103.

Biology

Fish

Unnamed Creek (-732) had two fish sampling events at its biological monitoring station 10EM103. These samples took place in August of 2010 and again in 2015. The FIBI score from the 2010 visit was 43.5, which is below the Fish Class 3 Southern Headwaters IBI general use threshold of 55. This visit did score well in half of the metric categories, but had an abundance of short lived and very tolerant taxa while also lacking sensitive species that lowered the FIBI score. The fish sample from 2015 had FIBI score of 33.8. This visit scored much worse than the 2010 visit. Only two of the class metrics scored above the average needed to reach the FIBI threshold (GeneralTxPct, SSpnPct) while the other metrics scored very low (Figure 225).

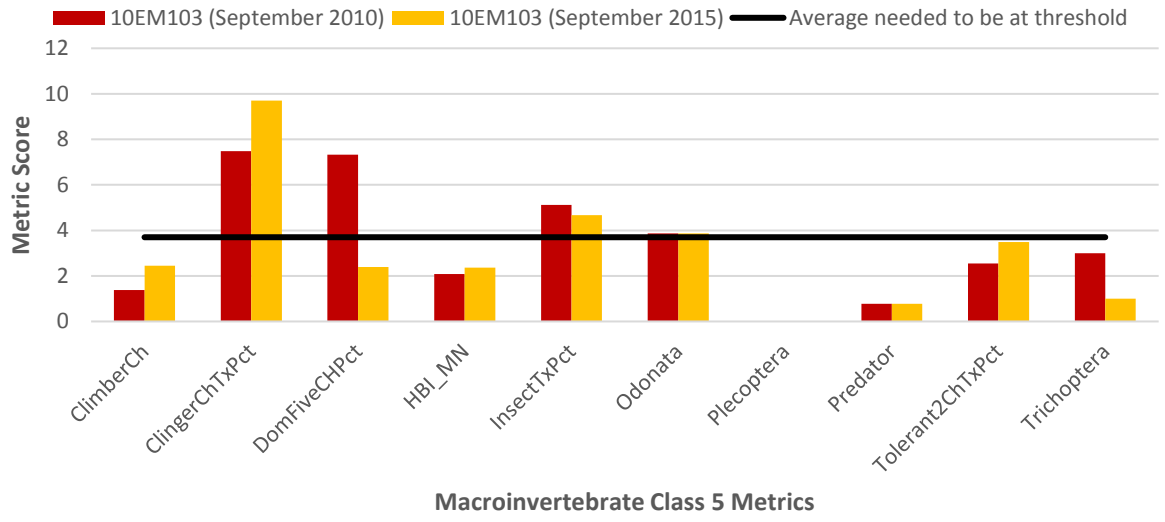
Figure 225. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was also sampled twice at 10EM103 in this reach. The September 2010 macroinvertebrate sample had an MIBI score of 30.7, which is below the macroinvertebrate Class 5 Southern Streams RR general use threshold of 37. During this visit, four of the ten metric scores were above the average needed to reach the MIBI Threshold (ClingerCHTxPct, DomFiveCHPct, InsectTxPct, Odonata). The September 2015 macroinvertebrate sample scored slightly better with an MIBI score of 33.6, but this score was still below the threshold. This sample only scored above the average needed to meet the threshold in just three of the ten metrics (ClingerCHTxPct, InsectTxPct, Odonata). (Figure 226)

Figure 226. Macroinvertebrate metric scores



Candidate Cause: Dissolved Oxygen

There was a small dataset on this reach in recent years (2008-2016); values ranged from 1.45 mg/L at station S005-442 to 10.12 mg/L at station S006-714. The lowest value was collected in July with 4 of 9 values below the water quality standard of 5 mg/L. No continuous data was available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.3-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 422. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
10EM103 (2010)	0	4.04	6	8.91		5	4.56
10EM103 (2015)	0	24.09	5	2.59		3	7.17
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)				**18.23**	**7.57**	**4.51**	**6.75**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Neither visit at station 10EM103 had any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage in 2010 was 4.04%, well below the class average of sites that met the modified threshold. However, in 2015 the same site had an increased percentage (24.09%) of serial spawning fish, which was twice the class average. Species that are very tolerant to low DO conditions comprised less than 1% of the fish community during both years.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. The range of low DO intolerant taxa ranged from 3 to 5, and the DO tolerant individuals present ranged from 2.59 to 8.91%. DO is not a stressor to the macroinvertebrate community. There were some low DO values recorded and indication of DO stress to the fish community in 2010; the 2014 serial spawner data was improved. DO, as a stressor to the fish community is inconclusive.

Candidate Cause Eutrophication

A small dataset exists on this reach, with phosphorus values ranging from 0.106 to 0.124 mg/L without any of the small dataset over 0.150 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however this data was not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.54 to 8.43.

Table 423. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
10EM103 (2010)	0	0	100	3.42	33	29.70	55.45
10EM103 (2015)	0	0	100	0.45	31	21.68	55.99
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**5.54**	**10.36**	**76.45**	**19.58**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)					**33.60**	**36.82**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter individuals were not collected on this reach. Tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at low levels, well below the class average of sites meeting the modified threshold. EPT individuals were present at levels lower than the class average; however, the community was dominated by species tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised more than half of the population at both visits. While the limited chemical dataset did not have any values above the 0.150 mg/L, the biological evidence has some evidence of stress. Eutrophication is currently inconclusive as a stressor.

Candidate Cause: Nitrate

There were two nitrate samples taken from Unnamed Creek (-732) from 2010-2016. These values ranged from 3.5-13 mg/L with an average value of 8.43 mg/L. Additionally, the HSPF model calculated daily nitrate values for this subwatershed from 1996-2012. These values ranged from 0.9-22.2 mg/L, with an average value of 5.3 mg/L. A quantile regression analysis of Class 5 macroinvertebrate stations showed that sites that exceed 18.1 mg/L of nitrates have a 75% probability of being impaired. The HSPF model calculated that this level would be exceeded in this subwatershed 0.45% of the time. This rate is fairly low.

Table 424. Nitrate related metric scores

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
10EM103	12.41	76.10	1.81	4.82
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek scored below average in three of the four nitrate related metrics when compared to other Class 5 Southern Streams RR station that met the MIBI General Use Threshold. The site did have more nitrate intolerant taxa, which is good, however, there were also very many nitrate tolerant individuals. The Nitrogen TIV score was fairly poor too.

The nitrate data at Unnamed Creek is fairly limited, the nitrate related biological metrics do signal potential stress, however the HSPF data does not indicate that nitrate levels get very elevated in this subwatershed. Therefore, nitrates are inconclusive as a stressor in Unnamed Creek (-732) at this time.

Candidate Cause: Sediment

From 2010-2016, a total of three TSS samples were taken from Unnamed Creek (-732). These values ranged from 4-12mg/L, with an average TSS concentration of 9.33 mg/L. Also, from 2010-2015 three secchi tube readings were taken along this reach. All three of these readings were 100 cm, which is as high as the equipment will read.

Table 425. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
10EM103	**0.00**	**0.00**	**0.23**	**0.00**	**0.00**	**0.00**	**59.82**	**0.00**	**0.00**	**12.91**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek (-732) at site 10EM103, scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 425). The reach had an above average amount of simple lithophilic individuals, and also a good TSS Index Score, but the remaining metrics scored poorly.

Table 426. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
10EM103	17.85	0.00	6.00	47.26	15.84	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in five of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 426). The site, 10EM103, did have a low amount of TSS tolerant taxa, but the remaining metrics did not score well.

The limited chemical data set does not indicate potential issues with suspended sediment, but the majority of the biological metrics related to suspended sediment for both of the biological communities score below average. At this point, suspended sediment is inconclusive as a stressor. Further monitoring of suspended sediment will need to be done to further determine the impacts of this potential stressor.

Candidate Cause: Habitat

Unnamed Creek (-732) had a qualitative habitat assessment take place at its biological monitoring site, 10EM103, during the fish and macroinvertebrate sampling events in 2010 and 2015. The average MSHA score from these visits was 55.37 (Fair). Limiting the habitat at this site was the row crop agriculture as the dominant land use, sand and silt substrates, light embeddedness, and sparse fish cover. Further MSHA analysis can be seen in Figure 227.

Figure 227. Habitat metric scores

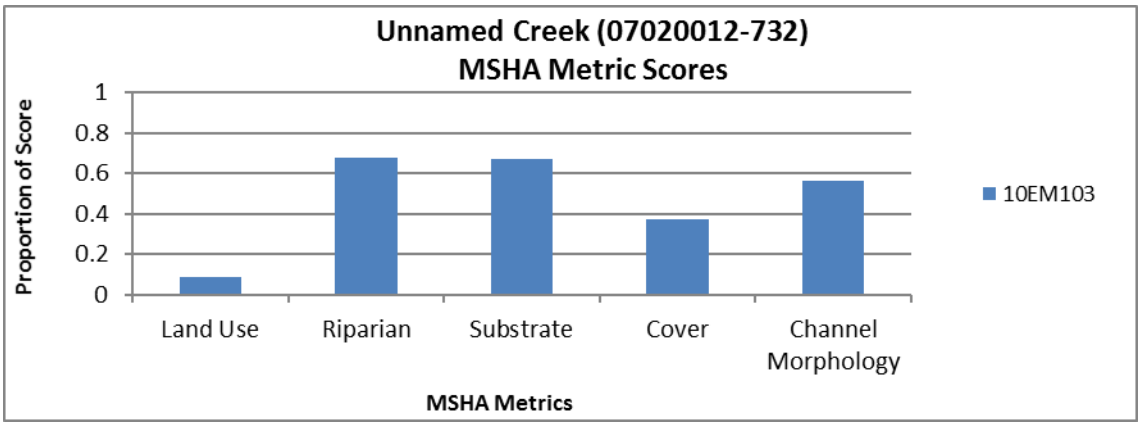


Table 427. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
10EM103	**0.00**	**59.82**	**0.00**	**0.00**	**0.00**	**70.22**	**100.00**	**12.34**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek 9-732) at site 10EM103 scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 427). The fish sample consisted of six species (blacknose dace, creek chub, brook stickleback, central mudminnow, fathead minnow, and bigmouth shiner), all of which are tolerant to degraded habitat conditions.

Table 428. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
10EM103	**5.55**	**36.33**	**42.87**	**25.69**	**57.30**	**13.45**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (-732) scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 428). Site 10EM103 was dominated by Physella (131 individuals). Physella are a tolerant snail that prefers feeding on detritus and algae, and are commonly found in degraded habitat conditions.

Based on the fair MSHA score along with the majority of the habitat related metrics for both of the fish and macroinvertebrate communities scoring below average, habitat is a stressor to aquatic life in Unnamed Creek (-732).

Candidate Cause Chloride/Ionic Strength

Chloride values were not available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 660 to 824 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and (Ephemeroptera) percentages were just above or below the class averages. Both the EPT and Ephemeroptera percentages decreased from 2010 to 2015. The taxa counts were also below average. The macroinvertebrate community was comprised of a range of 54.46 to 67.96% conductivity tolerant individuals and one intolerant individual at each visit.

Table 429. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
10EM103 (2010)	33	3	20.79	29.70	0
10EM103 (2015)	31	4	7.44	21.68	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	***36.82***	***4.43***	***17.02***	***33.60***	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised a range of 10 to 20% of the fish community. Elevated specific conductance were not present in the dataset, but the biological communities were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This majority of this reach is natural according to the MPCA altered watercourse layer. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 66.36 to 77.95% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 10 to 20.18% of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 14.24 to 17.16% of the population. The lack of low flow events and the mixed biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed Creek (-732) are being stressed by Habitat. (Table 430) Dissolved Oxygen, Eutrophication, Nitrates, Suspended Sediment, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 430. Stressors on Unnamed Creek (-732)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek	**07020012-732**	**o**	**o**	**o**	**o**	**●**	**o**	**o**

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.10 Porter Creek (-817)

Porter Creek (-817) is a 10.45 mile long stream reach located in central Scott county. This reach extends from Langford Rd/MN Hwy 13 to Sand Creek (-538). This reach is impaired for biology due to both the fish and macroinvertebrate communities. There is one biological monitoring station, 99MN004, located on this stream section. This reach is also impaired for Turbidity and nutrients/eutrophication. A Stressor

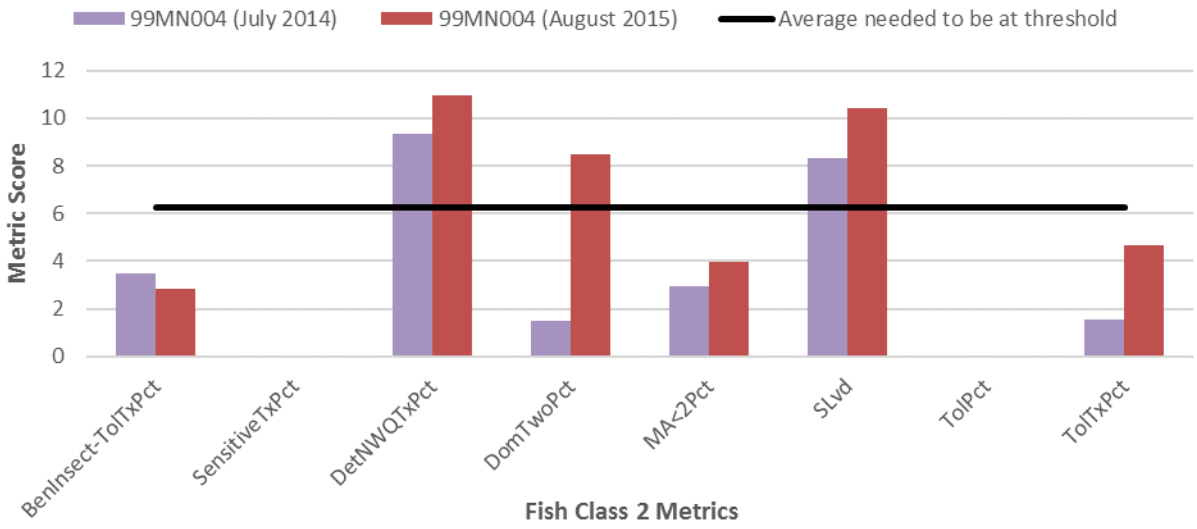
ID Report was completed in 2009 by Barr Engineering, which identified inadequate base flow, sediment, habitat, low DO, and habitat fragmentation as stressors (Barr, 2009).

Biology

Fish

Porter Creek (-817) had two fish sampling events take place in July 2014 and August 2015 at biological monitoring station 99MN004. The July 2014 visit had a FIBI score of 27.2, which is well below the Fish Class 2 Southern Streams general use threshold of 50. This visit did have lower numbers of detritivorous taxa and short lived individuals, which helped raise the FIBI score. However, this visit scored poorly in the remaining six metrics comprising the FIBI. The August 2015 visit had a FIBI score of 41.3, which is much better than the 2014 visit, but still under the class threshold. This visit scored above average in three of the eight metrics (DetNWQTxPct, DomTwoPct, SLvd). (Figure 228)

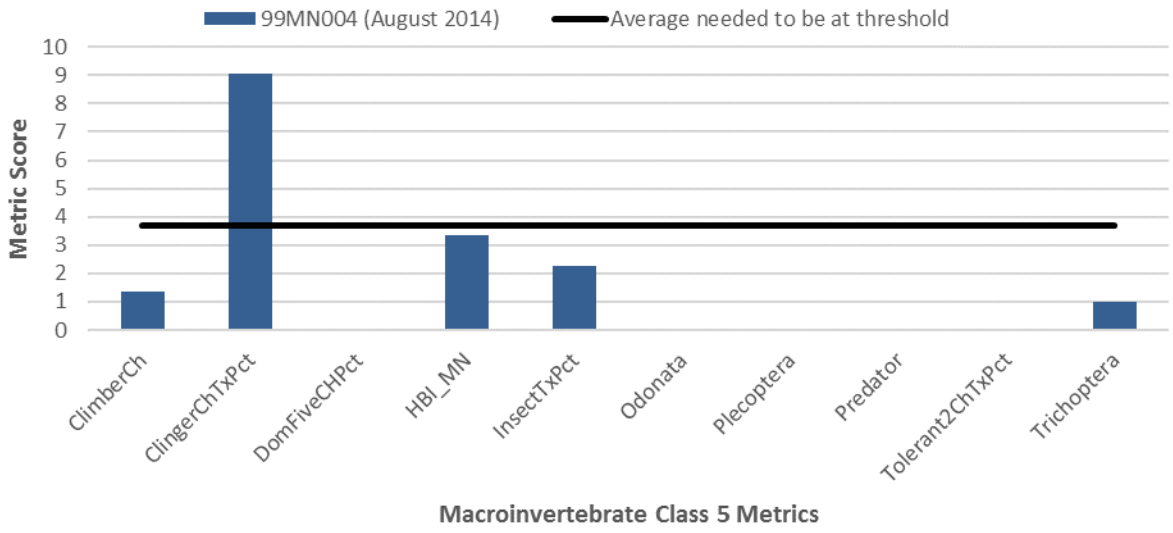
Figure 228. Fish metric scores



Macroinvertebrates

Porter Creek (-817) had a macroinvertebrate sample taken during August of 2014. This visit had a MIBI score of 17.0, which is well below the macroinvertebrate Class 5 Southern Streams RR general use threshold of 37. This site had a high number of clinger chironomid taxa, but scored poorly in the remaining nine metrics that comprise the macroinvertebrate class 5 IBI. (Figure 229)

Figure 229. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this reach in recent years (2008-2016); values ranged from 3.61 mg/L to 13.48 mg/L at station S001-764. The lowest value was collected in August and 6% of values were below the water quality standard of 5 mg/L. Continuous data recorded in 2016 was all above 5 mg/L with a low value of 6.93 mg/L (Figure 230).

Figure 230. Continuous DO data at site 99MN004

Table 431. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
99MN004 (2014)	1.7	3.74	9	2.29	7.21	3	7.54
99MN004 (2015)	0.58	29.64	11	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	12.36	28.72					
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				8.62	7.04	8.97	7.10
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.5-13.9 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both visits had less than 2% of fish that reproduce at a mature age, below the class average. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage in 2014 was 3.74%, well below the class average of sites that met the general threshold. However, in 2015 the same site had an increased percentage (29.64%) of serial spawning fish, which was just above the class average. Species that are very tolerant to low DO conditions comprised less than 1% of the fish community in 2014 but increased to 48% in 2015, a large increase.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was 3 low DO intolerant taxa and 2.29% of DO tolerant individuals present. While there were some low DO values recorded and some indication of DO stress to the fish community, the continuous data and preponderance of biological data indicates DO is not a stressor on Porter Creek.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.087 to 3.0 mg/L during the summer with 85% over the southern standard of 0.150 mg/L. The highest value was collected during June at station 99MN004 just upstream of Sand Creek. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD samples from 2004 to 2006 had a range of values from 1 to 8.1 mg/L, but there are no recent samples. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. The water was noted to be green during sampling in 2015 (Figure 231). Chlorophyll-a samples ranged from 1 to 105 ug/L, with 14% of values over the southern standard of 40 ug/L.

Figure 231. Algal growth at site 99MN004 (July 25, 2016)

Table 432. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
99MN004 (2014)	0	6.12	92.18	11.9	23	39.54	63.07
99MN004 (2015)	0	1.16	94.77	48.84	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Typical daily pH fluctuations in streams are 0.2-0.3 (Heiskary et al., 2013). pH values ranged from 6.93 to 8.64. Continuous pH data showed daily fluxes ranging from 0.13 to 0.33 at station 99MN004. Continuous DO data produced daily flux values ranging from 0.098 to 2.35 mg/L. The water quality standard for DO flux in the south region of the state is 5 mg/L.

Sensitive individuals were not collected on this reach. Darter individual numbers were higher, but all were johnny darters which are a more tolerant darter. Tolerant species comprised more than 92% of the

fish community during both visits. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at low levels in 2014 but increased to almost half the population in 2015. EPT individuals were present at levels slightly lower than the class average. The two most common macroinvertebrate species sampled comprised more than half of the population. While elevated phosphorus, pH, and chlorophyll-a values were present are of concern, eutrophication is not a clear stressor at this time.

Candidate Cause Nitrate

From 2004-2016 a total of 115 nitrate samples were taken from Porter Creek (-817). These sample values ranged from 0.05-4.01 mg/L with an average nitrate concentration of 1.08 mg/L. This result is minimal, especially when compared to the more western areas of this watershed.

Table 433. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
99MN004	13.04	32.68	0.00	3.21
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Porter Creek (-817) scored below average in three of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 433). The site, 99MN004, did have a lower amount of nitrate tolerant species. However, the site did have a poor Nitrogen TIV Score, a complete lack of nitrate intolerant taxa, and low numbers of Trichoptera species.

Based on the very low observed nitrate values with an extensive data set, nitrates are not a stressor to aquatic life in Porter Creek (-817). Other factors or stressors are likely negatively impacting the macroinvertebrate community resulting in low metric scores.

Candidate Cause Sediment

From 2004-2016, a total of 121 TSS samples were taken from Porter Creek (-817). These values ranged from 1-1800 mg/L. The average value was skewed by the highest concentration. The median TSS concentration was 38 mg/L. Of these samples, 32 (26.45%) were above the 65 mg/L TSS standard. Also, from 2006-2015, a total of 113 secchi tube readings were taken from this reach. These readings ranged in value from 2-100 cm, with an average value of 34.98 cm. This reach was also determined to be impaired for turbidity during a 2010 assessment.

Table 434. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
99MN004	**22.30**	**2.11**	**5.05**	**6.21**	**18.96**	**0.23**	**20.90**	**0.00**	**3.52**	**18.17**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Porter Creek (-817) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 434). The majority of these metrics score were well below the average threshold.

Table 435. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
99MN004	17.12	0	10	33.33	67.97	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 99MN004 in Porter Creek (-817) scored below average in three of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 435). This reach had low amounts of TSS tolerant taxa and individuals, while also having a high amount of collector filterer individuals. However, the reach also lacked any TSS intolerant and Plecoptera species, while also having a poor TSS Index Score.

Based on the majority of the suspended sediment related metrics scoring below average for both fish and macroinvertebrate assemblages, the high exceedance rate of the TSS samples with a large data set, as well as the current turbidity listing in this reach, suspended sediment is a stressor to aquatic life in Porter Creek (-817).

Candidate Cause Habitat

Porter Creek (-817) had a qualitative habitat assessment take place at its biological monitoring site, 99MN004, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 63.43 (Fair). Limiting the habitat at this site was severe bank erosion (Figure 232), moderate to light stream shading, sand substrates, light embeddedness, and moderate channel stability. Further MSHA analysis can be seen in Figure 233.

Figure 232. Erosion at site 99MN004 (July 7, 2016)

Figure 233. Habitat metric scores

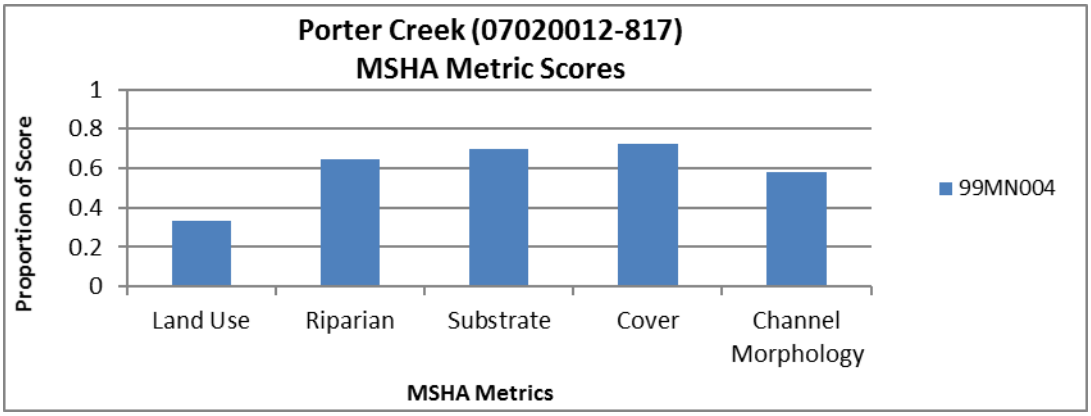


Table 436. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
99MN004	**3.57**	**20.90**	**3.34**	**18.96**	**1.18**	**59.65**	**92.91**	**63.71**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Porter Creek (-817) scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 436). Many habitat tolerant species were sampled at site 99MN004 including green sunfish, creek chubs, white suckers, and bigmouth shiners.

Table 437. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
99MN004	2.29	4.25	87.58	39.54	9.48	2.94
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in half of the habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 437). The community had low numbers of burrower and legless individuals, which is a positive sign, but also had few sprawler, climber, and EPT individuals, which can signal degraded habitat conditions.

Given the very poor scoring fish metrics and the average scoring macroinvertebrate habitat related metrics, along with the fair MSHA score, and the photographic evidence of heavy erosion and degraded stream conditions, habitat is a stressor to aquatic life in Porter Creek (-817).

Candidate Cause Chloride/Ionic strength

Chloride values available on this reach ranged from 9 to 88 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 222 to 948 uS/cm. Continuous data collected in 2016 included all values below 542 uS/cm. A study of Minnesota biological data and

stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and (Ephemeroptera) percentages were both close to the class averages. The taxa count was well below average. The macroinvertebrate community was comprised of a range of 28.43% conductivity tolerant individuals and 0 intolerant individuals.

Table 438. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
99MN004 (2014)	23	6	23.20	39.54	0
99MN004 (2015)	NA	NA	NA	NA	2.91
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present in 2014, but increased to 2.91% in 2015. Species that are tolerant to conditions with high ionic strength comprised a range of 13 in 2014 and increased in 2015 to 31% in the fish. Elevated specific conductance were not present in the dataset, but the biological communities were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This majority of this reach is natural according to the MPCA altered watercourse layer. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 77.55 to 93.60% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 10.20 to 48.84% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are

not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 1% of the population at both visits. The lack of low flow events and the mixed biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Porter Creek (-817) are being stressed by Eutrophication, Suspended Sediment, and Habitat. (Table 440) Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen and Nitrates were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 439. Stressors on Porter Creek (-817)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Porter Creek	07020012-817	---	o	---	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.11 Unnamed Creek (-822)

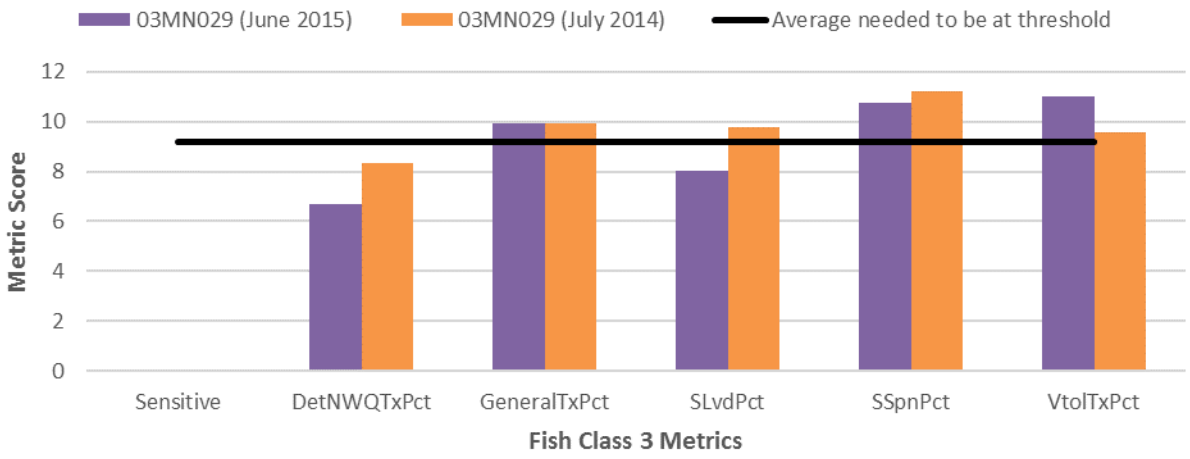
Unnamed Creek (-822) is a 0.98 mile long reach that is a tributary to the East Branch of Raven Stream. This reach is located in Scott County and is impaired for biology due to both the fish and macroinvertebrate assemblages at biological monitoring station, 03MN029, located along this stream reach.

Biology

Fish

The impaired fish community in Unnamed Creek (-822) was sampled in 2014 and 2015 at biological monitoring station 03MN029. The FIBI scores from these visits were 48.9 (2014) and 46.4 (2015). Both of these FIBI scores are below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Both visits lacked sensitive fish taxa, which was a main limiting factor of the FIBI (Figure 234).

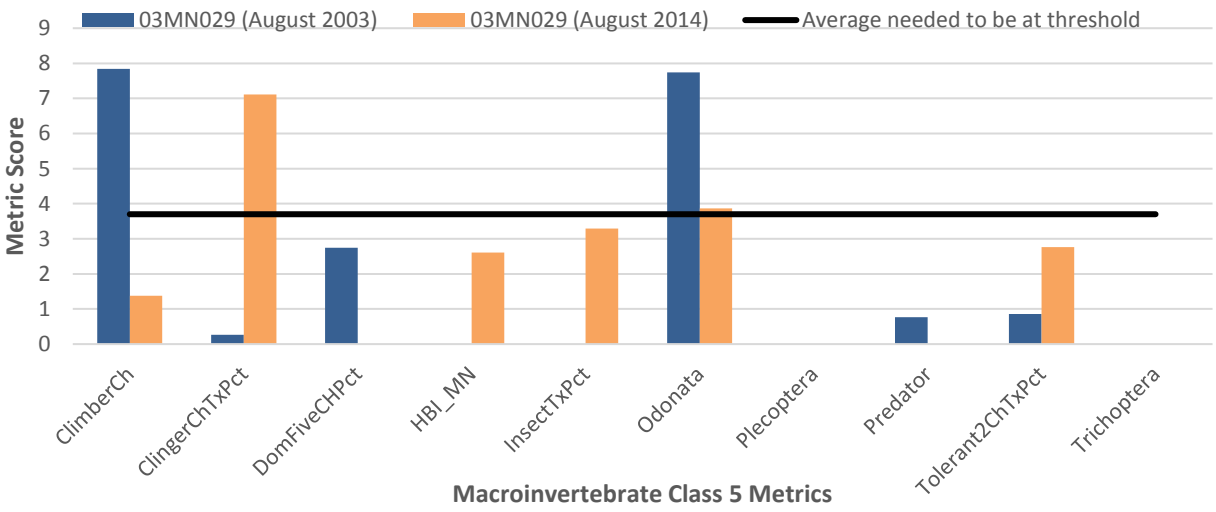
Figure 234. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled twice at site 03MN029 along this reach. The MIBI scores from these visits were 20.2 (August 2003) and 21.0 (August 2014). Both of these scores are below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Both sites had two metric scores that were above the average needed to reach the threshold. The remaining eight metrics comprising the MIBI for this class scored poorly (Figure 235).

Figure 235. Macroinvertebrate metric scores



Candidate Cause: Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 1.99 mg/L to 13.09 mg/L at station 03MN029. The lowest value was collected in June with one value of the limited dataset below the water quality standard of 5 mg/L. No continuous data was available, but the range of values are indicative of possible diurnal fluctuations. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.7-13.4 mg/L with 3% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Neither visit at station 03MN029 had any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentages were both above the class average of sites that met the general threshold. Species that are very tolerant to low DO conditions ranged from 44 to 48% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. The number of low DO intolerant taxa was two and the DO tolerant individuals present was 6.69%. There were one low DO value recorded and indication of DO stress, but DO as a stressor to the biological communities is currently inconclusive.

Table 440. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN029 (6/10/14)	0	14.29	6	NA	NA	NA	NA
03MN029 (7/8/14)	0	25.15	8	6.69	7.46	2	7.22
03MN029 (2015)	0	27.27	10	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A small dataset exists on this reach, with phosphorus values ranging from 0.203 to 0.563 mg/L with all of the small dataset over 0.150 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.1 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however this data was not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.73 to 8.32.

Sensitive individuals were not collected on this reach. Darter individual numbers were higher, but all were johnny darters which are a more tolerant darter. Tolerant species comprised more than 92% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at a range of 28.57-36.26% of the community, all above the class average of sites meeting the general threshold. EPT individuals were present at a low level. The two most common macroinvertebrate species sampled comprised almost the entire community at 90.21%. All of the values in the limited chemical dataset were above 0.150 mg/L, and the biological evidence is indicative of stress. Eutrophication is a stressor.

Table 441. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN029 (6/10/14)	0	7.14	92.86	28.57	26	7.34	90.21
03MN029 (7/8/14)	0	4.68	95.32	36.26	NA	NA	NA
03MN029 (2015)	0	1.98	97.23	30.04	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.55**	**12.08**	**70.64**	**14.62**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2003-2015, four nitrate samples were taken from Unnamed Creek (-822). These sample values ranged from 5.5-9 mg/L with an average nitrate concentration of 7.18 mg/L.

Drain tiles were also present along this reach and are a common pathway for nitrates to enter a stream system.

Table 442. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN029	7.29	67.06	0.00	3.57
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (-822) scored below average in all of the nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 442). The site, 03MN029, had a low amount of Trichoptera taxa, zero nitrate intolerant species, as well as a poor Nitrogen TIV score and a high amount of nitrate tolerant species.

Based on the small dataset and modelling data unavailable, it is inconclusive if the nitrate levels are negatively impacting the nitrate related metrics of the macroinvertebrate community. While all of the

nitrate related scored below average, the few nitrate sample values don't suggest nitrate stress. Therefore, nitrates are inconclusive as a stressor at this time in Unnamed Creek (-822). More nitrate monitoring is recommended to better gage the impact nitrates are having on aquatic life.

Candidate Cause: Sediment

From 2003-2015, a total of four TSS samples were taken from Unnamed Creek (-822). These samples ranged in value from 3.2-19 mg/L with an average TSS concentration of 9.2 mg/L. Additionally, five secchi tube readings were taken from this same time period. These values ranged from 39.5-100 cm, with an average reading of 87.9 cm. Both the TSS sampling and secchi tube measurements were well within their respective standards.

Table 443. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffIePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN029	**13.77**	**0.26**	**2.26**	**4.50**	**9.53**	**0.00**	**25.32**	**0.00**	**0.26**	**18.38**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek (-822) at site 03MN029 scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 443). These results signal potential stress from suspended sediment.

Table 444. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN029	15.82	0.50	7.50	34.72	23.31	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in three of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 444). The site, 03MN029, had a good TSS Index score and also had lower amounts of TSS tolerant taxa and individuals. This reach did however, have a lower amount of collector filterer individuals, while also lacking TSS Intolerant and Plecoptera taxa.

The limited chemical data set does not show any indication of potential stress caused by suspended sediment. The macroinvertebrate community scores fairly well in many metrics including Index score and low amounts of species tolerant of TSS. Based on this information, suspended sediment is not a stressor to aquatic life in this reach. The fish community is likely being negatively impacted by other stressors at this time resulting in lower scores.

Candidate Cause: Habitat

Unnamed Creek (-822) had a qualitative habitat assessment take place at its biological monitoring site, 03MN029, during the fish and macroinvertebrate sampling events in 2003, 2010, 2014 and 2015. The average MSHA score from these visits was 61.64 (Fair). Limiting the habitat at this site was the developed surrounding land use, moderate bank erosion, light embeddedness, sparse fish cover and moderate channel stability. Further MSHA analysis can be seen in Figure 236. A geomorphic survey found a stable reach with incision in some areas (Inter-fluve, 2008).

Figure 236. Habitat metric scores

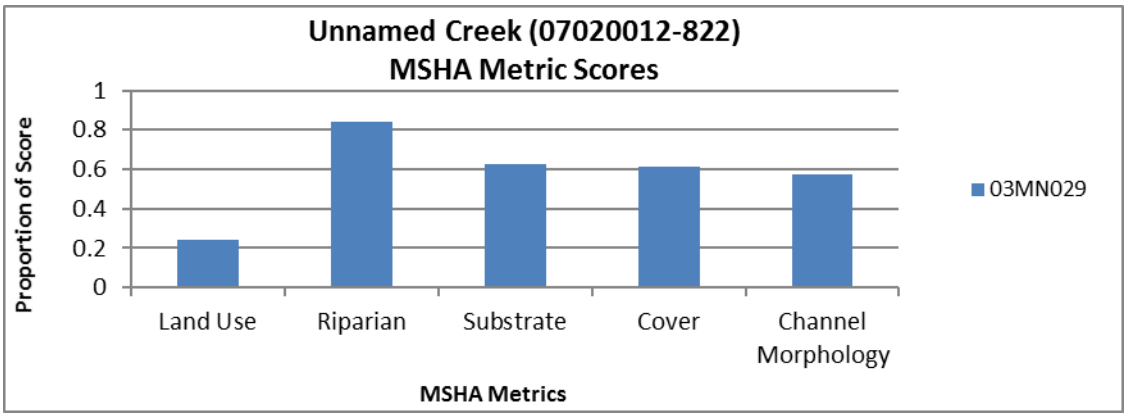


Table 445. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN029	**4.24**	**25.32**	**4.24**	**9.53**	**0.00**	**59.68**	**95.44**	**70.31**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek (-822) scored below average in all eight of the habitat related metrics when compared to all other Class 3 Southern Headwaters Stations that meet the FIBI General Use Threshold (Table 445). Creek chubs, fathead minnows, and blacknose dace were consistently the three most abundant fish species sampled between the visits. These species are tolerant of degraded habitat conditions.

Table 446. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN029	**3.15**	**38.99**	**48.43**	**8.92**	**82.37**	**1.74**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at 03MN029 scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 446). This reach had a high amount of legless individuals, while also having very low amounts of EPT and Sprawler individuals. These results are a signal for potential stress from degraded habitat conditions.

Based on the majority of the below average scoring habitat related metrics of both the fish and macroinvertebrate assemblages, along with the fair MSHA and the noted sparse fish cover available at the sampling site, habitat is a stressor to the impaired biological communities in Unnamed Creek (-822) at this time.

Candidate Cause Chloride/Ionic strength

No recent chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 785 to 2240 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Four of the five recent values were over 1,000 uS/cm.

Table 447. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
03MN029 (6/10/14)	NA	NA	NA	NA	0
03MN029 (7/8/14)	26	1	1.83	7.34	0
03MN029 (2015)	NA	NA	NA	NA	0.79
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and (Ephemeroptera) percentages were both far below the class averages. The taxa count was also below average. The macroinvertebrate community was comprised of 45.29% conductivity tolerant individuals and 0 intolerant individuals.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at less than 1% at each visit. Species that are tolerant to conditions with high ionic strength comprised a range of 28 to 30% in the fish. The small dataset included highly elevated specific conductance values, and the biological indicators reflected stress. Based on the highly elevated values and the biological response, ionic strength is a stressor to the biological community but more samples would be helpful.

Candidate Cause: Altered Hydrology/Connectivity

This small reach is less than 1 mile in length and is about evenly split between natural and modified according to the MPCA altered watercourse layer, but the entire upstream section is modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 90.12 to 92.86% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 28.57 to 43.87% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised less than 2% of the population at both visits. The upstream channelization is likely contributing to lack of habitat and is a contributing stressor to the biological communities. The biological results indicate altered hydrology is a stressor.

Conclusions and recommendations

The impaired macroinvertebrate community in Unnamed Creek (-628) is being stressed by Eutrophication, Habitat, Flow Alteration/Connectivity, and Chloride. (Table 449) Dissolved Oxygen was inconclusive as a stressor at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 447.

Table 448. Stressors on Unnamed Creek (-822)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek	07020012-822	o	●	---	---	●	●	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.12 West Branch Raven Stream (-842)

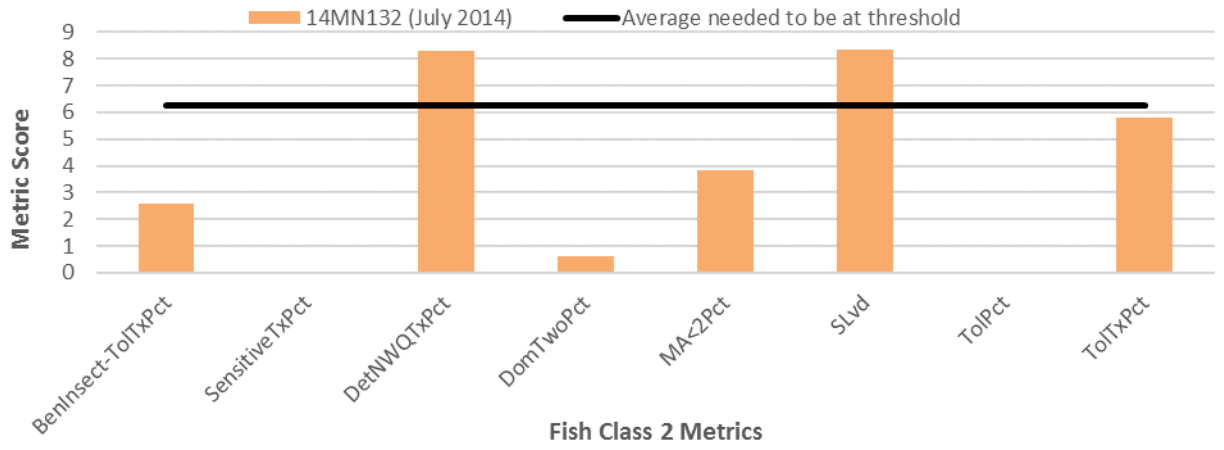
West Branch Raven Stream (-842) is a 6 mile long stream reach located in southern Scott county. This reach extends from 270th St E to the confluence with East Branch Raven Stream and is impaired for biology due to both the fish and macroinvertebrate assemblages. There are two biological monitoring stations, 14MN132 and 14MN133, located along this reach.

Biology

Fish

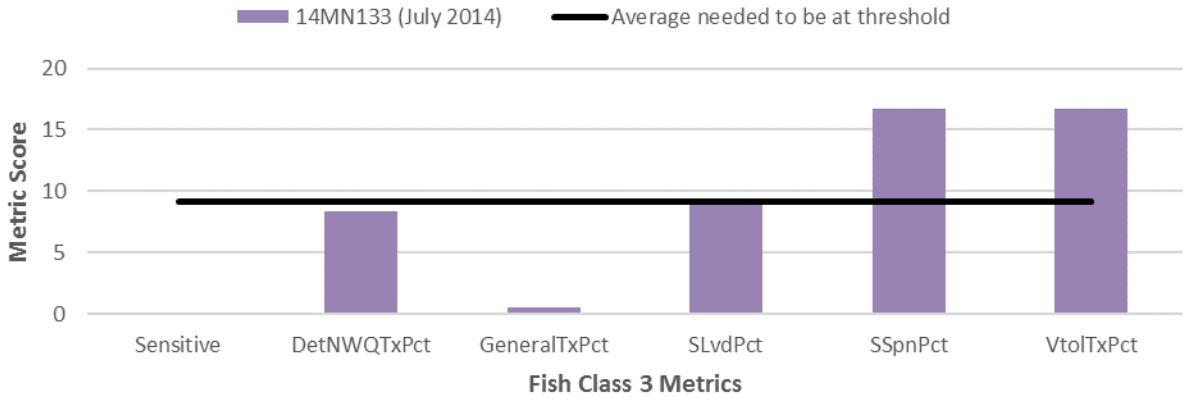
West Branch Raven Stream (-842) had one Fish Class 2 (Southern Streams) station, 14MN132, located along this reach. This site had a fish IBI score of 29.5, which is well below the FIBI Class 2 general use threshold of 50. Of the eight metrics comprising this IBI, this station only scored well in two of them (DetNWQTxPct, SLvd) (Figure 237.) Very poor metric scores were a result of the high amount of tolerant species present and a complete lack of sensitive fish taxa.

Figure 237. Fish metric scores for Class 2 sites



This stream reach also had one site, 14MN133, classified as a Fish Class 3 (Southern Headwaters) station. The FIBI score at this site was 51.8 during the July 2014 fish sampling event. This score was just below the Class 3 general use threshold of 55. This station scored well in three of the six fish class metrics (SLvdPct, SSpnPct, VtolTxPct), while scoring slightly below the average needed to reach the threshold in one metric (DetNWQTxPct). This station also had a large amount of Generalist feeding and a complete lack of sensitive fish species resulting in low metric scores. (Figure 238)

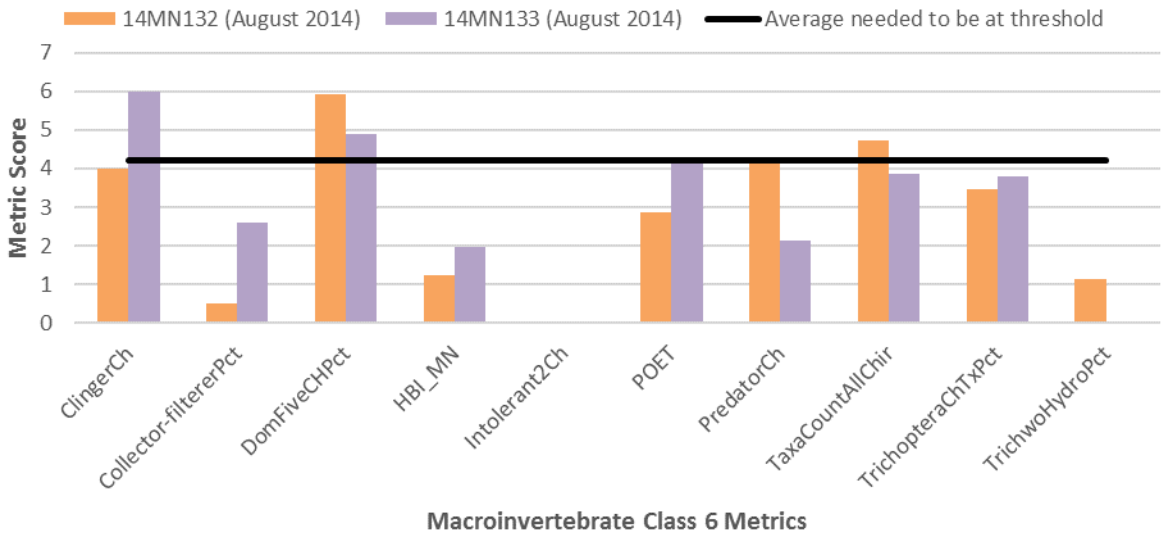
Figure 238. Fish metric scores for Class 3 sites



Macroinvertebrates

Both biological monitoring stations along West Branch Raven Stream (-842) were classified as Macroinvertebrate Class 6 (Southern Forest Streams GP) stations. Site 14MN132 was sampled in August of 2014 and had an MIBI score of 28.1, which is below the Class 6 threshold of 43. This site reached the average needed to reach the MIBI threshold in just three of the ten class metrics (DomFiveCHPct, PreadtorCH, TaxaCountAllChir). Site 14MN133 was also sampled for macroinvertebrates in August 2014. This site had an MIBI score of 29.5, and again was well below the general use class threshold of 43. This site also scored well in just three of the class metrics (ClingerCH, DomeFiveCHPct, POET), while having poor metric scores in the remaining seven metric comprising the Class 6 MIBI. These results combined with those at site 14MN132 resulted in the macroinvertebrate impairment designation.

Figure 239. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this reach in recent years (2007-2016); values ranged from 0.35 mg/L at station S001-732 to 11.39 mg/L at station S004-618. The lowest value was collected in July with 29% of values below the water quality standard of 5 mg/L. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.5-13.6 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both stations had percentages less than 3% of fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentages were both well below the class average of sites that met the general threshold. Species that are very tolerant to low DO conditions ranged from 23 to 38% of the fish community.

Table 449. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN132	2.94	5.66	12	59.42	8.49	0	6.34
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
14MN133	0	0	4	18.18	8.27	3	6.84
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. No low DO intolerant taxa were found at station 14MN132 and three were found at station 14MN133. Station 14MN132 had 59.42% of the community tolerant to low DO, while station 14MN133 had 18.18%. There were numerous low DO values recorded at station S001-732 (14MN132), the downstream section of the reach. This station is downstream of a wetland complex which is likely influencing the DO values. The macroinvertebrate stress is more pronounced at station 14MN132, making DO a limited stressor to the downstream section of the reach.

Candidate Cause Eutrophication

A large dataset exists on this reach, with phosphorus values ranging from 0.048 to 0.937 mg/L with 75% over 0.150 mg/L. The highest value was collected in August at Church Avenue in the upper part of the reach. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.3 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 14% in June to 100% in September and an average of 80%.

Chlorophyll-a, BOD, and DO fluctuations values are proximate measurements of eutrophication and have more direct impacts on biology than phosphorus. Current BOD information is not available, but values ranged from 1 to 7.6 in 2007 and 2008 with 38% of values over the standard of 3.5 ug/L. Chlorophyll-a values are also available from 2007 and 2008 with a range from 1 to 27, without any values over the southern standard of 40 ug/L. There is no DO flux data available. As a result of eutrophication, pH values also increase. pH values ranged from 7.24 to 8.39.

Table 450. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN132	0	0.84	95.6	25.16	35	28.89	38.96
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
14MN133	0	0	100	30.36	32	16.23	48.05
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.55**	**12.08**	**70.64**	**14.62**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive individuals were not collected on this reach. Darter individual numbers were both below 1%. Tolerant species comprised more than 95% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at a range of 25.16-30.36% of the community, both above the class average of sites meeting the general threshold. EPT individuals were present at levels lower than the class average and the species were predominantly tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised less than half of the community at both visits. Based on the elevated phosphorus values and the preponderance of biological evidence, eutrophication is a stressor.

Candidate Cause: Nitrate

From 2007-2016 a total of 28 nitrate samples were taken from West Branch Raven Stream (-842). These sample values ranged from 0.27-11.1 mg/L with an average value of 6.57 mg/L. Additionally, a tile line flowing into this reach was sampled on 03/03/2016 and had a nitrate concentration of 29 mg/L. Drain tiles are a common pathway for nitrates to enter a stream system.

Table 451. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN132	**5.71**	**73.70**	**0.65**	**4.20**
14MN133	**6.25**	**90.58**	**0.00**	**4.38**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in West Branch Raven Stream (-842) scored below average in all four of the nitrate related metrics at both sites, 14MN132 and 14MN133, when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 451). Both sites had poor numbers of Trichoptera and nitrate intolerant taxa, a very poor Nitrogen TIV score, and high number of nitrate tolerant species.

Based on the very poor scoring macroinvertebrate metrics, the average observed nitrate concentrations, as well as the presence of a tile line with high nitrates entering this stream system, nitrates are a stressor to aquatic life in West Branch Raven Stream (-842).

Candidate Cause Sediment

From 2007-2016, a total of 32 TSS samples were taken from West Branch Raven Stream (-842). These samples ranged from 1-83 mg/L with an average value of 18.13 mg/L. Of these samples, only one was above the 65 mg/L standard for TSS. Additionally, from 2004-2014, a total of 134 secchi tube measurements were taken along this reach. These values ranged from 6-60 cm with an average value of 48.74 cm. Only one reading was below the 10 cm standard for secchi tube measurements.

The HSPF model also calculated daily TSS concentrations from 1996-2012 for this subwatershed. These values ranged from 3.3-1360.8 mg/L with an average value of 18.0 mg/L. Of these calculations, 89 (1.38%) were above the 65 mg/L standard for TSS. This is a very low exceedance rate.

Table 452. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN133	30.36	0.00	0.00	0.00	30.36	0.00	35.71	0.00	0.00	14.93
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
14MN132	20.75	0.21	14.68	3.98	19.92	0.00	22.85	0.00	3.14	18.45
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in West Branch Raven Stream (-842) scored below average in seven (14MN133) and nine (14MN132) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters and Class 2 Southern streams stations that meet the FIBI General Use Threshold (Table 452). Site 14MN133 did have a good TSS Index score, while also having above average amounts of riffle dwelling and simple lithophilic individuals. However, this site scored poorly in the remaining metrics. Site 14MN132 had a good amount of herbivorous individuals, but lacked many other species that are normally present in streams not being impacted by suspended sediment.

Table 453. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN132	21.19	0	17	47.08	2.27	0.00
14MN133	18.54	0	10	54.55	10.06	0.00
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in West Branch Raven Stream (-842) scored below average in five (14MN133) and six (14MN132) of the six suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold

(Table 453). Site 14MN133 did have a low amount of TSS tolerant taxa, but scored poorly in the remaining metrics. Site 14MN132 did have a very high amount of TSS Tolerant taxa present.

The observed and modelled exceedance rates for this reach were very low in regards to TSS concentrations. It is likely that other stressors are causing the fish and macroinvertebrate metrics to score poorly as suspended sediment is not a stressor to aquatic life in this reach.

Candidate Cause Habitat

West Branch Raven Stream (-842) had qualitative habitat assessments take place at its biological monitoring sites, 14MN132 and 14MN133, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 38.4 (Poor) at 14MN132 and 47.2 (Fair) at 14MN133. Limiting the habitat at these sites was the row crop agriculture dominating the local land use, moderate bank erosion, sand and silt substrates, light embeddedness, limited depth variability, fair sinuosity, poor to fair channel development, and moderate channel stability. Gully erosion was recorded in areas (Inter-fluve, 2008).

Figure 240. Habitat metric scores

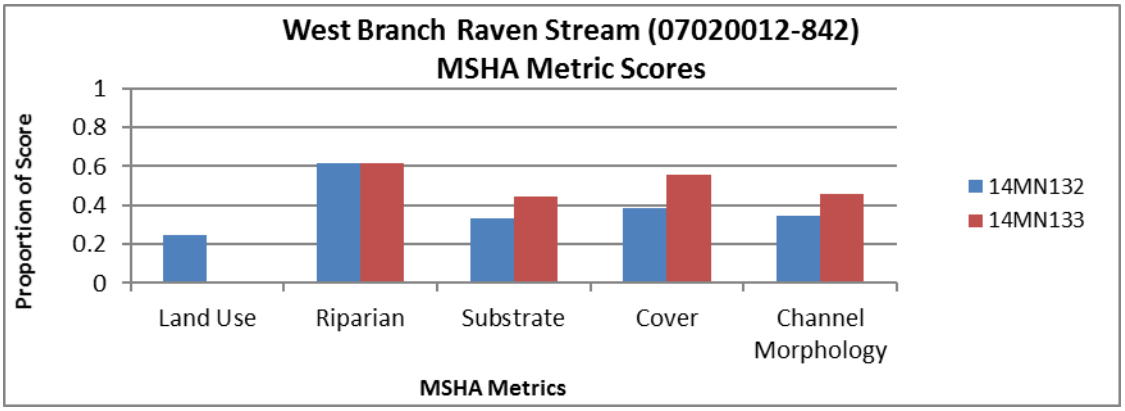


Table 454. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN133	0.00	35.71	0.00	30.36	0.00	62.50	100.00	26.79
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
14MN132	0.84	22.85	0.84	19.92	3.14	76.31	95.60	59.54
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in West Branch Raven Stream (-842) scored below average in six (14MN133) and seven (14MN132) of eight habitat related metrics when compared to all sites in similar classes that meet the respective threshold. (Table 454). The high amount of tolerant species, while lacking many habitat specialist species can often signal poor habitat conditions.

Table 455. Habitat related metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN132	22.73	21.43	7.14	28.90	54.55	37.01
14MN133	6.17	39.61	20.78	16.23	70.45	19.16
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in three (14MN132) and four (14MN133) of the six evaluated habitat related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 455). The high amount of both legless and burrower individuals may signal an abundance of fine sediment, which is commonly found in degraded systems.

Based on the Poor and Fair MSHA scores, as well as the agreement with the majority of both the fish and macroinvertebrate habitat related metrics scoring below average, habitat is a stressor to aquatic life in West Branch Raven Stream (-842).

Candidate Cause Chloride/Ionic strength

Chloride values were available on this reach from 2007-2008 that ranged from 19 to 45 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 401 to 906 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 456. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN132	35	3	28.25	28.89	0.21
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					**4.89**
14MN133	32	4	9.74	16.23	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and (Ephemeroptera) percentages were both far below the class average at station 14MN133, but were close to or above average at station 14MN132. The taxa counts were both below average. The macroinvertebrate community was comprised of a range of 70.45 to 78.89% conductivity tolerant individuals and 0 intolerant individuals at both stations.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at less than 0.5% at each visit. Species that are tolerant to conditions with high ionic strength comprised less than 1% of the fish community at both stations. The dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach is almost entirely modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. Discharge data showed no measurable flow for almost 40% of the days recorded over eight years (Inter-fluve, 2008).

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising a range of 62.50 to 78.83% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 8.39 to 37.5% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 7.14 to 9.42% of the population. The channelization is likely contributing to lack of habitat, however the biological community data was mixed. The biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in West Branch Raven Stream (-842) are being stressed by Dissolved Oxygen, Eutrophication, Nitrates and Habitat. (Table 458) Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point, while Suspended Sediment was ruled out as a stressor. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 457. Stressors on West Branch Raven Stream (-842)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
West Branch Raven Stream	07020012-842	●	●	●	---	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

12.13 Unnamed Creek (-849)

Unnamed Creek (-849) is a 1.13 mile long reach that is a tributary to St. Catherine Lake. This reach is located in Scott County and is impaired for biology due to the fish assemblage present at the biological monitoring station, 14MN078. Macroinvertebrates were not sampled at this station due to lack of flow.

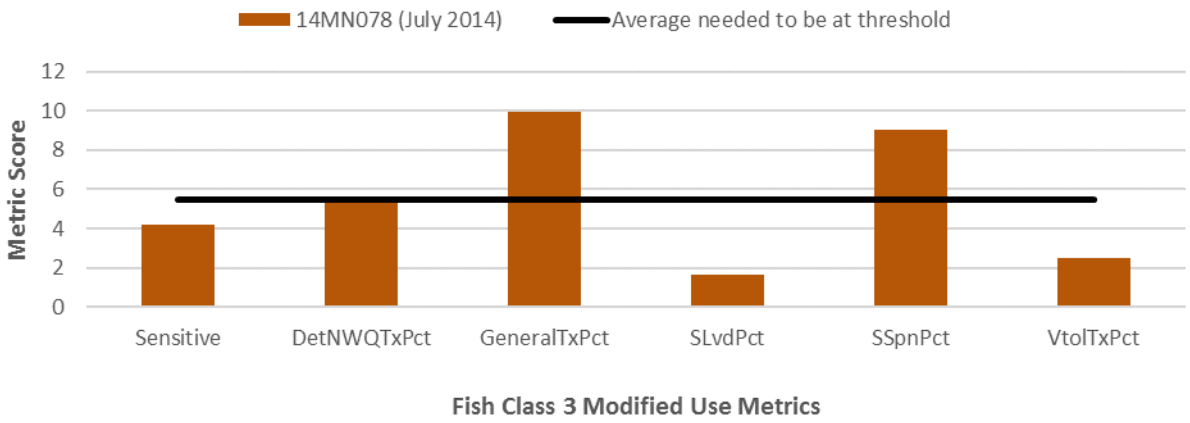
This reach is located in Scott County and is impaired for biology due to both the fish and macroinvertebrate assemblages present at the biological monitoring station, 03MN029.

Biology

Fish

Unnamed Creek (-849) had one fish sample taken from biological monitoring station 14MN078. This station was classified as a Fish Class 3 (Southern Headwaters) station that had a FIBI score of 32.9 during the July 2014 fish sampling event. This FIBI score was well below the Class 3 modified use threshold of 33. Three of the class metrics met the average needed to reach that threshold (DetNWQTxPct, GeneralTxPct, SspnPct). This site also had lower amounts of sensitive fish species, while having abundant numbers of short lived and very tolerant taxa resulting in lower class metric scores (Figure 241).

Figure 241. Fish metric scores



Candidate Cause: Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 3.82 mg/L to 7.45 mg/L at station 14MN078. The lowest value was collected in August. The macroinvertebrate crew sampled water chemistry but did not sample for biology due to stagnant water. One of the three DO values was below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.6-13.4 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage at the one visit was 35.21%, three times the class average of sites that met the modified threshold. Species that are very tolerant to low DO conditions comprised 99% of the fish community.

Table 458. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	DO Intolerant Macroinvertebrate Taxa	DO Tolerant Index Score
14MN078	0	35.21	6	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrates were not sampled. There was one low DO value in the very limited dataset. The fish community is indicative of low DO stress in the number of individuals that reproduce at a mature age, are serial spawners, and were tolerant to low DO. DO is a stressor to the fish community.

Candidate Cause: Eutrophication

A small dataset exists on this reach, with phosphorus values ranging from 0.156 to 0.276 mg/L with both values over the southern standard of 0.150 mg/L. The highest value was collected in August. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of this data was available. As a result of eutrophication, pH values also increase. pH values ranged from 7.45 to 8.12.

Table 459.Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2
14MN078	17.60	0	82.40	18.09	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**6.02**	**1.48**	**76.7**	**19.80**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Darter individuals were not collected on this reach, while the sensitive individuals were much higher than the class average at 17.60%. Tolerant species comprised more than 95% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at levels just below the class average of sites meeting the modified threshold. Macroinvertebrates were not sampled. While the limited dataset of phosphorus values were elevated, the biological evidence was mixed. Eutrophication is inconclusive as a stressor.

Candidate Cause: Nitrate

Only one nitrate sample was collected from Unnamed Creek (-822). This nitrate concentration was 2.7 mg/L and collected on 07/09/2014 during the fish sampling visit.

With the lack of macroinvertebrate data, only one nitrate sample, and no modelling data available, it is inconclusive if nitrates are a stressor to aquatic life in Unnamed Creek (-849) at this time. Further biological monitoring and water chemistry sampling is recommend to better understand the impacts, if any, that nitrates are having on the fish and macroinvertebrate communities.

Candidate Cause: Sediment

One TSS samples was collected from Unnamed Creek. The TSS concentration of this sample was 14 mg/L and it was collected on July 9, 2014. Also, two secchi tube measurements were taken from this reach. These values were 54 cm on July 9, 2014 and 63 cm on August 26, 2014. Both of these samples were well above the 10 cm minimum standard for transparency.

Table 460. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN078	**0.49**	**0.00**	**17.60**	**0.00**	**0.49**	**17.60**	**0.49**	**0.00**	**0.00**	**14.91**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek (-849) at site 14MN078 scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold. The reach did have a good TSS Index score, while also having above average amounts of sensitive and herbivorous individuals. However, the reach did score poorly in the remaining metrics.

With the very limited chemical data set, and the rather mixed fish metric results related to suspended sediment, it is inconclusive if suspended sediment is a stressor to aquatic life or not. Additional information will need to be collected during base flow conditions to better gage the impacted suspended sediment is having on both the fish and macroinvertebrate communities in this reach.

Candidate Cause: Habitat

Unnamed Creek (-849) had a qualitative habitat assessment take place at its biological monitoring site, 14MN078, during the fish sampling event in 2014. The MSHA score from these visits was 47.8 (Fair). Limiting the MSHA was moderate bank erosion, sand and silt substrates, light embeddedness, sparse fish cover, fair sinuosity, fair channel development and low channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 242.

Figure 242. Habitat metric scores

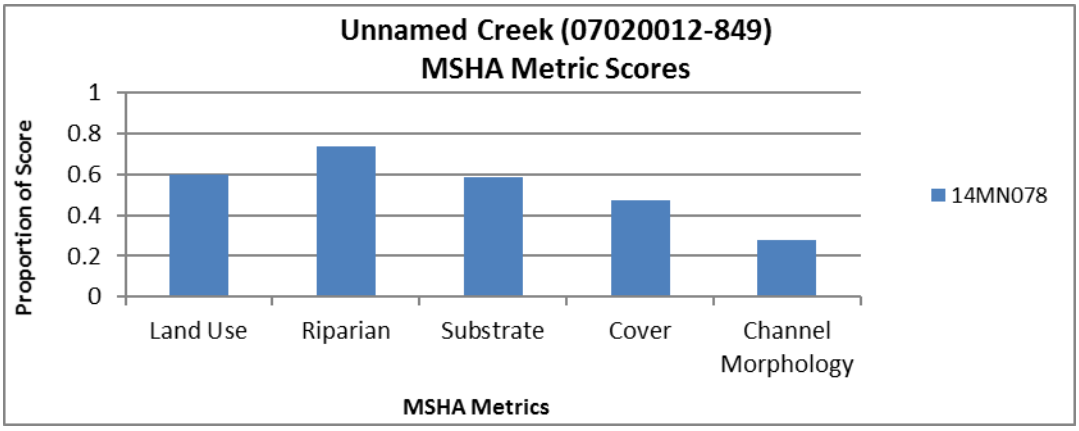


Table 461. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN078	0.00	0.49	0.00	0.49	0.00	0.49	82.40	17.85
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community present in Unnamed Creek (-849) scored below average in seven of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 461). The fish sample consisted of many habitat tolerant species including Brook Sticklebacks, Fathead Minnows, and Central Mudminnows. The high presence of these species, while also lack of species requiring specialized habitat conditions is a signal that the community is stressed by the degraded habitat conditions.

There was not a macroinvertebrate sample taken along this reach.

Based on the majority of the habitat related metrics scoring below average in the fish community as well as the fair MSHA score, habitat is a stressor to aquatic life in Unnamed Creek (-849).

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 597 to 725 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Macroinvertebrates were not sampled. Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised 71% of the fish community. Specific conductance values were not elevated. Since macroinvertebrate data was not available, ionic strength is currently inconclusive as a stressor.

Table 462. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN078	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					1
Expected response to increased DO stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach is 100% modified according to the MPCA altered watercourse layer. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 7% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 18.34% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 71.64% of the fish community. The channelization is likely contributing to lack of habitat, however the biological community data was mixed. Macroinvertebrates were not sampled due to lack of flow, which was likely influenced by drainage. However, the biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and Recommendations

The impaired fish community in Unnamed Creek (-849) is being stressed by Dissolved Oxygen and Habitat (Table 464). Eutrophication, Nitrates, Suspended Sediment, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the Sand Creek HUC 10 watershed, please see page 477.

Table 463. Stressors on Unnamed Creek (-849)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed Creek	07020012-849	●	o	o	o	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Sand Creek HUC 10 Conclusions and Recommendations

The Sand Creek subwatershed contains twelve biologically impaired stream reaches. Stressors found in at least four of the twelve impaired reaches were Dissolved Oxygen (5), Eutrophication (8), Nitrates, Suspended Sediment (6), Habitat (12) and Altered Hydrology/Connectivity (4). Nitrates were found to be a contributing stressor in three of the stream reaches while Chloride was found to be a stressor in one reach.

Row crop agriculture is the dominant land use present in the western portion of this watershed, while hay/pasture is more prevalent in the eastern half of the watershed. There are also pockets of developed areas throughout the subwatershed, with three WWTP discharges to the watershed (Jordan, New Prague, and Montgomery). Significant issues in this watershed are related to the amount of phosphorus entering the stream system. This excess phosphorus is causing eutrophication of stream systems resulting in algae blooms and unstable dissolved oxygen levels.

Also, the headwaters in the agricultural and developed portions of this watershed are being impacted by the effects of channelization of the streams and contributing tributaries.

This is a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat (most abundant stressor) and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species. Erosion also occurs as Sand, Porter, and Raven Creek flow through the steep bluffs along the Minnesota River valley (Inter-fluve, 2008).

Improvements in the Sand Creek watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. These improvements can both be applied to the agricultural and developed areas to this watershed. Another significant focus should be to reducing the

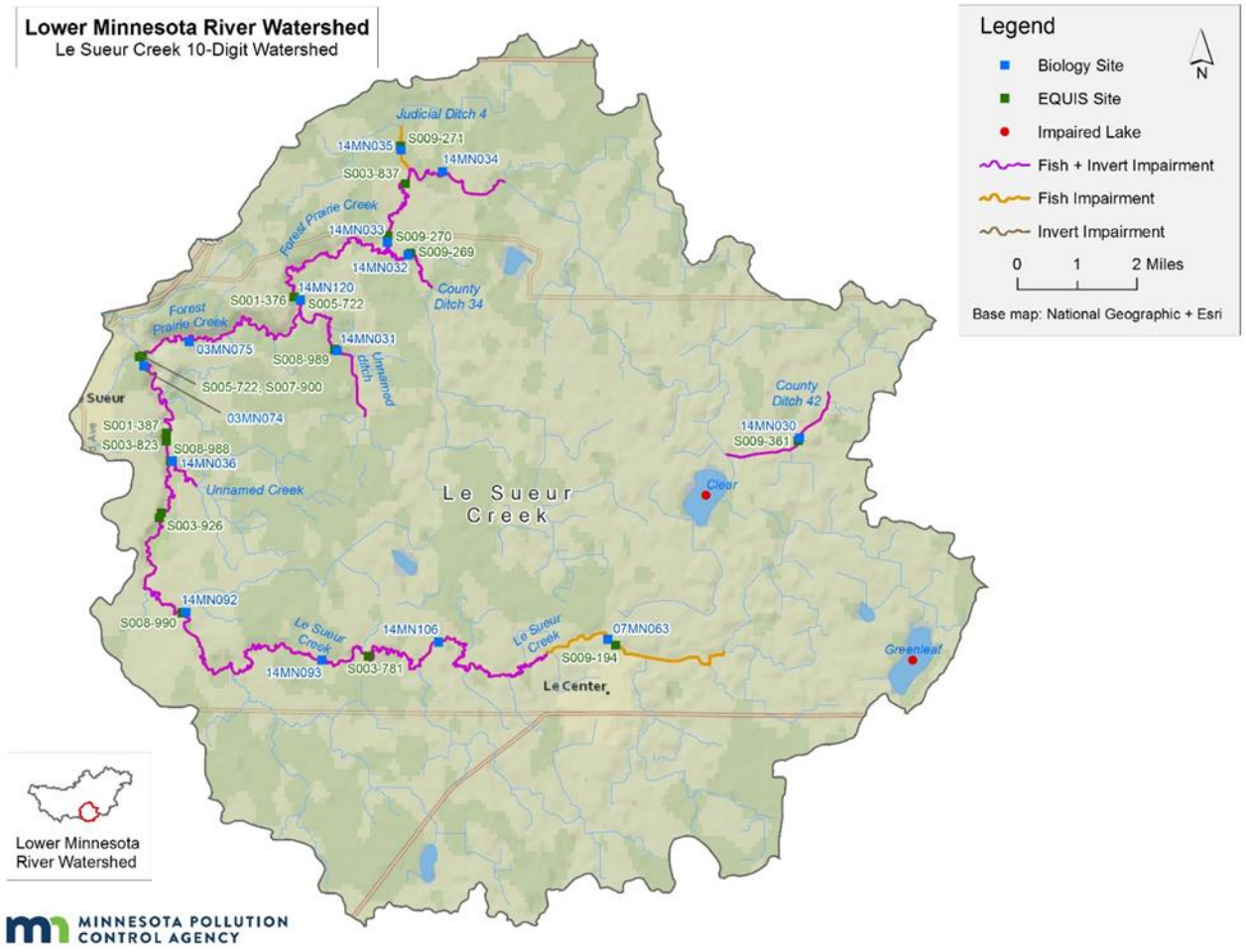
amount of Phosphorus entering the stream system. This can be achieved through BMPs like cover crops, nutrient management, and saturated buffers.

Table 464. Stressors on the Sand Creek HUC 10

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Sand Creek	07020012-513	o	●	---	●	●	●	o
Sand Creek	07020012-538	---	o	---	●	o	---	o
Sand Creek	07020012-839	●	●	---	●	●	●	---
Sand Creek	07020012-840	●	●	---	●	●	o	o
Unnamed Creek (Picha Creek)	07020012-579	●	●	---	---	●	●	o
Unnamed Creek (Picha Creek)	07020012-580	o	o	---	---	●	o	o
County Ditch 10	07020012-628	---	o	●	---	●	o	---
Raven Stream	07020012-716	---	●	●	●	●	---	o
Porter Creek	07020012-817	---	●	---	●	●	o	o
Unnamed Creek	07020012-822	o	●	---	---	●	●	●
West Branch Raven Stream	07020012-842	●	●	●	---	●	o	o
Unnamed Creek	07020012-849	●	o	o	o	●	o	o

13. Le Sueur Creek 10 (0702001201)

Figure 243. Sampling sites in the Le Sueur Creek HUC 10



13.1 Le Sueur Creek (-823)

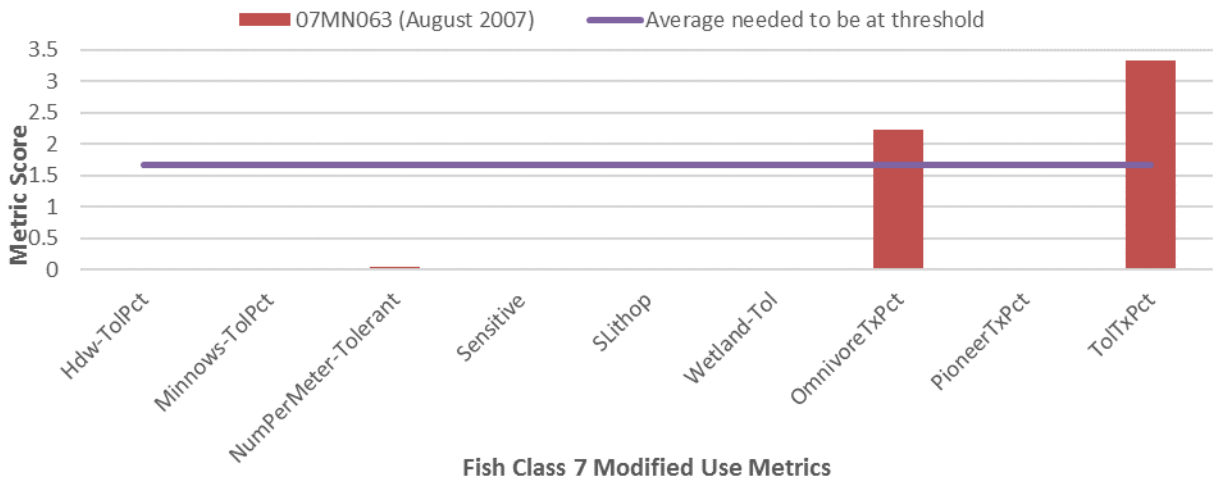
This section of Le Sueur Creek is near the headwaters of the stream and is located just north of the city of Le Center. The reach is 3.67 miles and is impaired for the fish community. Macroinvertebrates were not sampled.

Biology

Fish

Le Sueur Creek (-823) had a fish sampled collected from its biological monitoring station, 07MN063, in August of 2007. The FIBI score for this visit was 5.6, which is far below the Fish Class 7 Low Gradient modified use threshold of 15. This site did have above average numbers of both omnivore and low numbers of tolerant taxa resulting in higher FIBI metric scores, however, the remaining metrics scored very poorly resulting in the fish impairment (Figure 244).

Figure 244. Fish metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 1.6 mg/L to 7.39 mg/L. The lowest value was collected in August. Only one of the limited DO values was below the water quality standard of 5 mg/L. Continuous data was not available.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.8-13.9 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 465. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
07MN063	0	2.30	5	NA	NA	NA	NA
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**4.38**	**28.58**	**11.74**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentage was low (2.30%) well below the class average that met the modified threshold. Species that are very tolerant to low DO conditions comprised 94% of the fish community. Macroinvertebrates were not sampled. One low DO value was collected during the fish sample. The fish biological response is not indicative of DO stress. DO is not a stressor to the fish community.

Candidate Cause: Eutrophication

A small dataset exists on this reach, with phosphorus values ranging from 0.130 to 0.139 mg/L with both values under the southern standard of 0.150 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.0 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, there is no available DO flux, BOD, or chlorophyll-a data. As a result of eutrophication, pH values also increase. pH values ranged from 7.43 to 7.72. Thick macrophytes and algae growth were present at station 07MN063 (Figure 245).

Figure 245. Algal growth at site 07MN063 (August 16, 2007)

Sensitive individuals were not collected on this reach, and one individual darter was collected. Tolerant species comprised more than 98% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at three times the class average of sites meeting the modified threshold. Macroinvertebrates were not sampled. While the limited dataset of phosphorus values were not elevated, the biological evidence and algal growth indicate eutrophication is a stressor.

Table 466. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
07MN063	0	1.15	98.85	66.67	NA	NA	NA
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	**16.71**	**6.74**	**55.88**	**16.77**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

Two nitrate samples were taken in Le Sueur Creek (-823) from 2007-2016. These sample values ranged from 5.9-9.0 mg/L. Additionally, a nitrate sample was taken from a drain tile flowing into the stream on June 1, 2016. This value was 3.8 mg/L. Additionally, an HSPF model calculated daily nitrate

concentrations for this reach from 1996-2012. These values ranged from 0.1-24.2 mg/L with an average nitrate concentration of 5.0 mg/L.

The presence of drain tile is a common pathway for nitrates to enter this stream. However, the nitrates observed did not show significantly elevated nitrate values and the model calculated a lower daily average. The downstream reach, Le Sueur Creek (-824), has three sites sampled for macroinvertebrates that all suggest stress from nitrates. That downstream reach also has more abundant nitrate sampling, showing elevated nitrates values. While plausible to assume nitrate stress is present without a macroinvertebrate sample and conclusive nitrate sampling data, it is inconclusive that nitrates are a stressor to aquatic life in this reach.

Candidate Cause: Sediment

From 2007-2016, two TSS samples were taken from Le Sueur Creek (-823). These values were 4.4 mg/L on 06/01/2016 and 18 mg/L on 08/16/2007. There was also a secchi tube reading on 08/16/2007 and that value was 53 cm.

Additionally, the HPSF model calculated daily TSS values for this subwatershed from 1996-2012. These values ranged from 2.9-925.1 mg/L with an average TSS concentration of 32.7 mg/L. Of these calculations, 13.72% were above the 65 mg/L standard for TSS.

Table 467. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
07MN063	**1.15**	**0.00**	**0.00**	**1.15**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**25.27**
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*12.20*	*4.38*	*8.17*	*13.36*	*7.35*	*17.28*	*20.49*	*3.61*	*7.09*	*14.09*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Le Sueur Creek (-823) scored below average in all 10 of the suspended sediment related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 467). The TSS Index Score for this reach at site 07MN063 was especially poor.

There was no macroinvertebrate sample at site 07MN063 or along this reach.

The very limited data set did not have an exceedance of the TSS or transparency standard, however, the HSPF model calculated a high rate of exceedance for this subwatershed and all of the fish metrics related to suspended sediment were very poor. Suspended sediment is a stressor to aquatic life in this reach. A macroinvertebrate sample is recommended to better determine the impact that suspended sediment is having on this community.

Candidate Cause: Habitat

Le Sueur Creek (-823) had qualitative habitat assessment take place at its biological monitoring site, 07MN063, during the fish sampling event in 2007. The average MSHA score from these visits was 32 (Poor). Limiting the habitat at this site was the residential row crop agriculture dominating the local land use, a moderate riparian buffer, light stream shading, sand and silt substrates, sparse fish cover, poor sinuosity (Figure 246), poor channel development, and moderate channel stability.

Figure 246. Lack of sinuosity at site 07MN063 (August 17, 2007)

Figure 247. Habitat metric scores

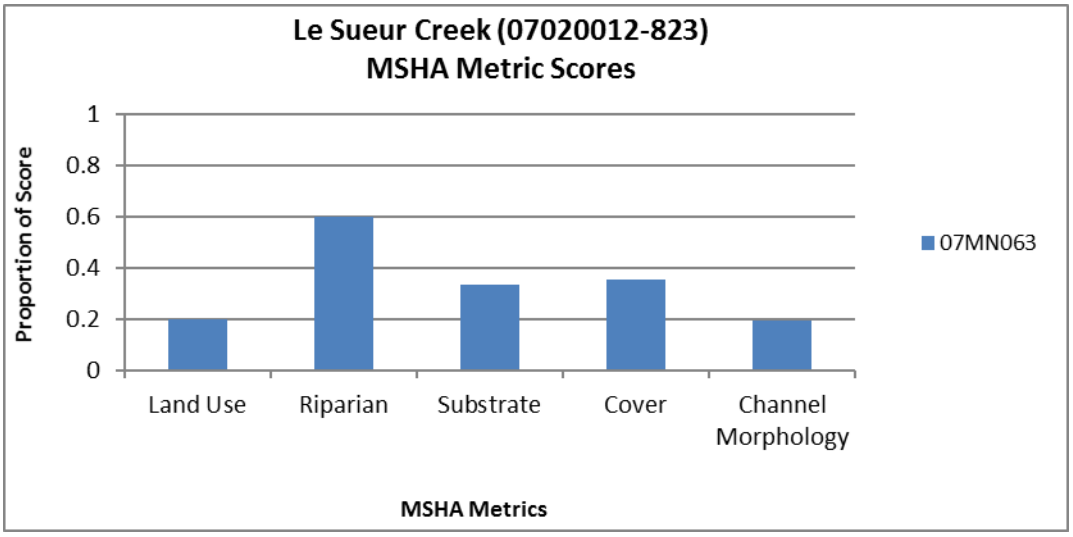


Table 468. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
07MN063	1.15	0.00	1.15	0.00	0.00	4.60	98.85	35.63
Statewide average for Class 7 Low Gradient stations that are meeting the FIBI Modified Use Threshold (15.0)	*7.06*	*20.49*	*6.80*	*7.35*	*3.67*	*25.67*	*56.03*	*19.20*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Le Sueur Creek (-823) scored below average in all eight of the habitat related metrics when compared to all other Class 7 Low Gradient stations that meet the FIBI Modified Use Threshold (Table 468). The fish assemblage present consisted of almost entirely habitat tolerant species including Black Bullheads, Green Sunfish, Creek Chubs, Fathead Minnows, and Johnny Darters (not

tolerant). This high percentage of tolerant species and very few habitat specializing species is a strong indicator of habitat stress.

Based on the poor MSHA score as well as the all of the habitat related metrics in the fish community, habitat is a stressor in Le Sueur Creek (-823).

Candidate Cause Chloride/Ionic Strength

A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 598 to 755 uS/cm. None of the values were over 1,000 uS/cm.

Table 469. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
07MN063	NA	NA	NA	NA	0
Statewide average for channelized Class 7 Low Gradient stations that are meeting the FIBI Modified Threshold (15.0)					**4.38**
Expected response to increased DO stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. Macroinvertebrates were not sampled. Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised 67% of the fish community. Specific conductance values were not elevated. Since macroinvertebrate data was not available, ionic strength is currently inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

This reach is 100% modified according to the MPCA altered watercourse layer with a measured 64.46% of the Le Sueur Creek sub-watershed channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 1% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The site had a population of generalist fish comprising 98.85% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 31.03% of the fish community. The channelization is likely contributing to lack of habitat, however the biological community data was mixed. The biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish community in Le Sueur Creek (-823) is being stressed by Eutrophication, Suspended Sediment and Habitat (Table 470). Nitrates, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen was ruled out as a stressor. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 470. Stressors on Le Sueur Creek (-823)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Le Sueur Creek	07020012-823	---	●	o	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.2 Le Sueur Creek (-824)

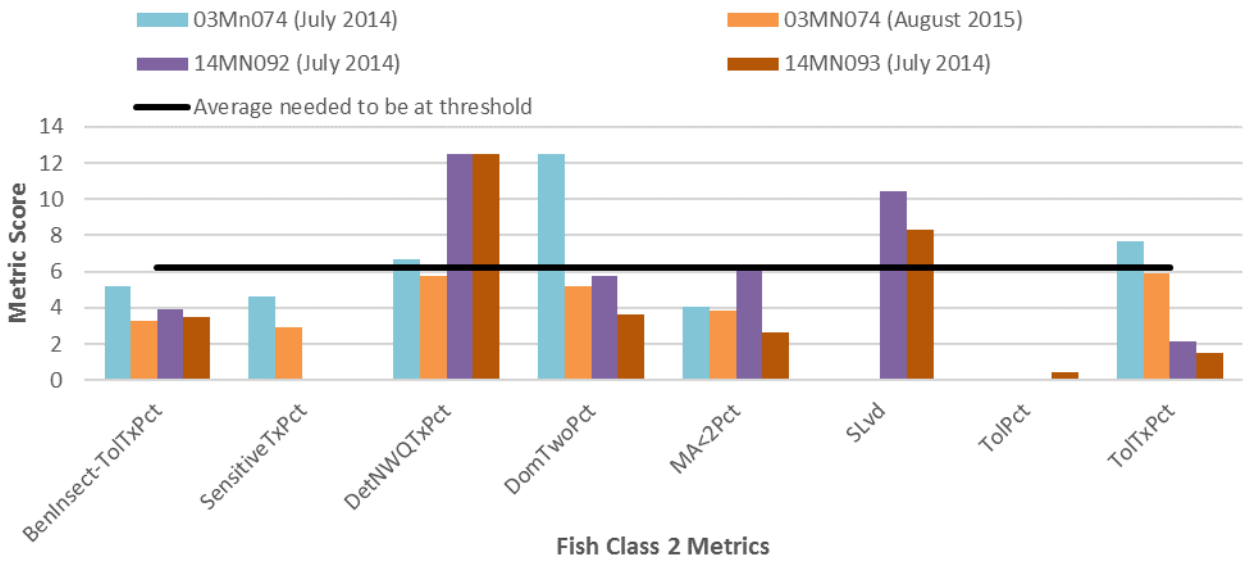
Le Sueur Creek (-824) is a 21.05 mile long stream reach located in western Le Sueur County. This stream reach extends from the intersection with West Prairie Street to the confluence with Forest Prairie Creek. This stream section is impaired for biology due to the fish and macroinvertebrate assemblages found at the four biological monitoring stations along this stream (03MN074, 14MN092, 14MN093, and 14MN106).

Biology

Fish

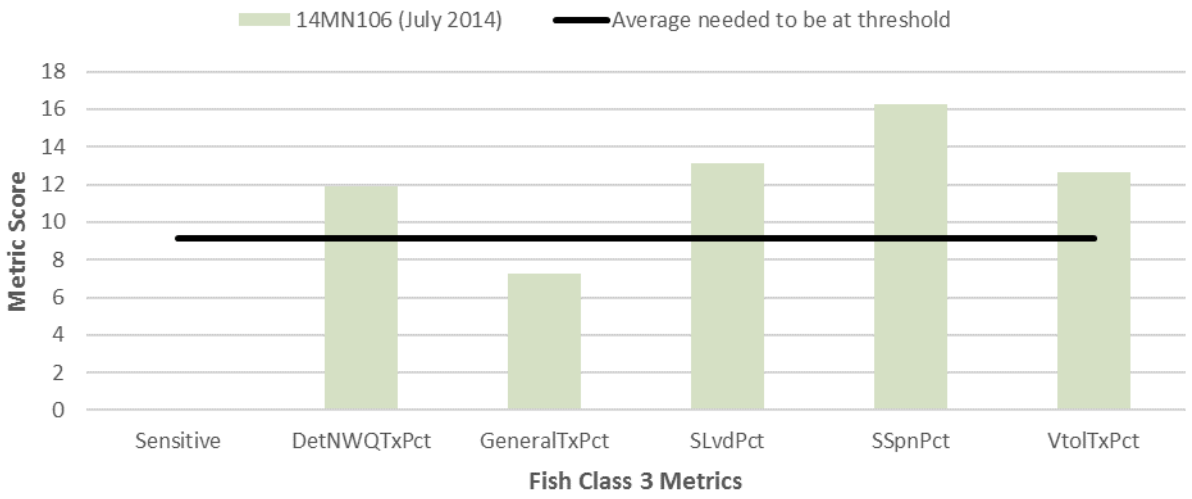
Le Sueur Creek (-824) was sampled for fish at all four of the biological monitoring stations present along this reach. Site 03MN074 was sampled in July 2014 and August of 2015 and had FIBI scores of 40.7 (2014) and 26.9 (2015). While sites 14MN092 and 14MN093 were both sampled during July of 2014 and had FIBI scores of 41.0 (14MN092) and 32.6 (14MN093). All of the FIBI scores from these visits are below the Fish Class 2 Southern Streams General Use Threshold of 50. For a breakdown of all of the FIBI metric scores for these visits, see Figure 248.

Figure 248. Fish metric scores in Class 2



Site 14MN106 was sampled for fish in July of 2014. This visit had an FIBI score of 61.2, which is above the Fish Class 3 Southern Headwaters General Use Threshold of 55. This visit had four of the six metrics scoring above the average needed to reach the threshold. The higher amount of generalist feeding taxa and lack of sensitive species resulting in lower metric scores (Figure 249).

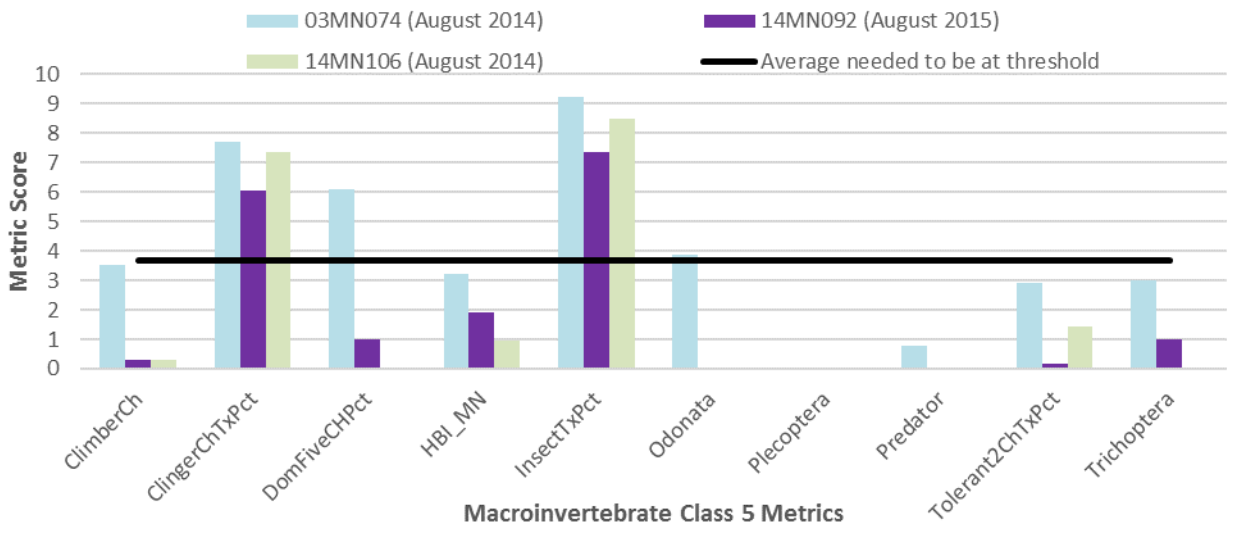
Figure 249. Fish metric scores in Class 3



Macroinvertebrates

The macroinvertebrate community was also sampled along this reach at biological monitoring stations 03MN074, 14MN092, and 14MN106. The MIBI scores at these sites are 40.4 (03MN074), 17.8 (14MN092), and 19.6 (14MN106). The MIBI score at at 03MN074 was above the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37, while sites 14MN092 and 14MN106 fell way below this level. For a breakdown of the different metric scores between these three biological sites, see Figure 250.

Figure 250. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 6.7 mg/L to 10.87 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.8-13.9 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

Table 471. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN074 (2014)	1.74	29.62	24	6.64	7.25	9	7.41
03MN074 (2015)	0	16.80	19	NA	NA	NA	NA
14MN092	0	7.32	8	5.94	7.69	8	7.31
14MN093	0	5.84	9	NA	NA	NA	NA
14MN106	0	2.13	7	4.15	8.01	4	7.26
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**					
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age except for the 2014 visit at station 03MN074, which had less than 2%. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentages ranged from 2.13% to 29.62%, all at or below the class average that met the general threshold. Species that are very tolerant to low DO conditions ranged from less than 1% (stations 14MN092 and 14MN093) to 16% (station 03MN074).

Macroinvertebrates were not sampled at all stations. Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; low DO tolerant taxa ranged from four to eight and low DO tolerant percentages ranged from 4.15 to 6.64%. No low values of DO have been found on this reach, and the preponderance of biological responses is not indicative of DO stress. DO is not a stressor to the fish community.

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.052 to 0.344 mg/L with eight of the fifteen values over the southern standard of 0.150 mg/L. The highest value was collected during June. Elevated values were taken throughout the reach. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.0 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, there is no available DO flux, BOD, or chlorophyll-a data. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.13 to 8.53.

Sensitive individuals were only present on the downstream section of the reach, while darter individuals ranged from 0 to 25.55%. The number of darters increased from 0.93% in 2003 to 8.36% in 2014 at station 03MN074. Tolerant species comprised more than 73% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values lower than the class average at all visits except at station 14MN106 which is the most upstream station. Along with darters increasing, omnivore species decreased from to 2003 to 2014. EPT individuals were higher than the class average at station 14MN092, but lower at the others, at each station the species were predominantly tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised less than half of the community at station but higher at stations 14MN092 and 14MN106. Based on the elevated phosphorus values and the preponderance of biological evidence, eutrophication is a stressor that is more pronounced in the upper section of the reach.

Table 472. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN074 (2014)	8.36	9.06	80.66	4.18	40	27.57	27.57
03MN074 (2015)	4.10	3.91	92.38	11.91	NA	NA	NA
14MN092	0	7.32	91.46	13.41	28	58.62	53.61
14MN093	0	25.55	73.36	7.66	NA	NA	NA
14MN106	0	0	89.36	20.21	23	40.26	63.26
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2014-2016 a total of 14 nitrate samples were taken from Le Sueur Creek (-824). These sample values ranged from 4.33-21.4 mg/L with an average nitrate concentration of 9.66 mg/L. A quantile regression analysis showed that macroinvertebrate Class 5 streams with nitrate values exceeding 18.1 mg/L, have a 75% probability of being impaired. Le Sueur Creek (-824) had one reading exceeding this value (21.4 mg/L).

Drain tiles were also present along this reach and are a common pathway for nitrates to enter a stream system.

Table 473. Nitrate related metric scores

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN074	**12.61**	**58.70**	**0.66**	**3.20**
14MN092	**10.71**	**73.44**	**0.00**	**3.75**
14MN106	**13.04**	**83.39**	**0.00**	**4.15**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Le Sueur Creek (-824) scored below average in all four nitrate related metrics at the three biological monitoring stations when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 473). These sites had very few nitrate intolerant taxa while containing a high amount of nitrate tolerant species.

Based on the high observed nitrate values, the quantile regression analysis, the presence of drain tiles, as well as the below average macroinvertebrate metrics related to nitrate, nitrates are a stressor to aquatic life in Le Sueur Creek (-824).

Candidate Cause Sediment

From 2003-2016, a total of 16 TSS samples were taken from Le Sueur Creek (-824). These sample values ranged from 2-63 mg/L with an average TSS concentration of 19.85 mg/L. No values were above the 65 mg/L standard for TSS. Furthermore, 232 secchi tube readings were taken along this reach from 2003-2015. These values ranged from 2-100 cm with an average value of 39.89 cm. Of these readings, 30 were at or below the 10 cm transparency standard.

Table 474. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN106	**32.98**	**0.00**	**12.77**	**0.00**	**32.98**	**0.00**	**36.17**	**0.00**	**0.00**	**15.13**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
14MN093	**41.61**	**0.00**	**9.12**	**25.55**	**16.06**	**0.00**	**15.33**	**0.00**	**0.00**	**14.72**
14MN092	**39.02**	**0.00**	**23.17**	**7.32**	**31.71**	**0.00**	**24.39**	**0.00**	**0.00**	**15.64**
03MN074	**20.83**	**0.34**	**17.72**	**5.55**	**21.18**	**4.50**	**38.59**	**0.00**	**2.02**	**20.78**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Le Sueur Creek (-824) scored below average in seven (14MN106, 14MN092, 14MN093) and nine (03MN074) of the 10 suspended sediment related metrics when compared to all other Class 3 Southern Headwaters and Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 474). Three of the four sites, did have a good TSS Index Score, which likely does not occur in a stream reach being negatively impacted by suspended sediment.

Table 475. Habitat related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN074	**15.61**	**1.5**	**14.50**	**34.06**	**24.58**	**0.17**
14MN092	**17.80**	**0**	**10**	**60.31**	**53.92**	**0.00**
14MN106	**19.24**	**0**	**8**	**72.20**	**44.73**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

The macroinvertebrate assemblage scored below average in four of the six metrics at all three biological stations (03MN074, 14MN092, 14MN106) when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 475). All three sites lacked or had very few TSS intolerant and Plecoptera species and individuals. The remaining metrics were rather metric results were rather mixed between the three sites.

Based on the observed TSS samples without an exceedance, the majority of the TSS Index scores in the fish community, and the macroinvertebrate community not showing a clear signal for suspended sediment stress, suspended sediment is not a stressor to aquatic life at this time.

Candidate Cause Habitat

Le Sueur Creek (-824) had qualitative habitat assessments take place at its biological monitoring sites (Upstream to downstream), 14MN106, 14MN093, 14MN092, and 03MN074, during the fish and macroinvertebrate sampling events in 2003, 2014 and 2015. The average MSHA scores from these visits were 47.8 (Fair) at 14MN106, 53.2 (Fair) at 14MN093, 47.7 (Fair) at 14MN092 and 69.46 (Good) at 03MN074. Habitat conditions somewhat improved further downstream on this reach. This appears to be related to the land use as there is more of a forested land use present (along with row crops) instead of areas completely dominated by row crop agriculture. The downstream area does not have some of the eroded banks and general instability that the three sites further upstream have. A breakdown of the MSHA category scores for these sites can be seen in Figure 251. The DNR study found the stream channel to be deeply incised that is slightly over-widened and with poor stability (DNR, 2017a). Due to over-widening, the riffle cross section has developed a mid-channel bar. “There were some historical terraces within the reach that were contributing high amounts of sediment which could result in high turbidity and habitat loss downstream in reaches that cannot transport the excess amount of sediment” (DNR, 2017a).

Figure 251. Habitat metric scores

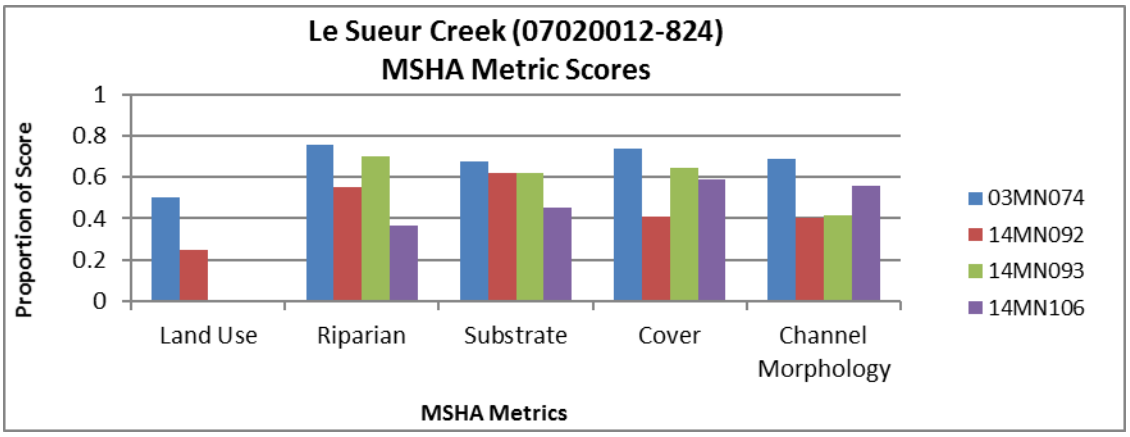


Table 476. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN106	**0.00**	**36.17**	**0.00**	**32.98**	**0.00**	**84.04**	**89.36**	**35.11**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
14MN093	**25.55**	**15.33**	**25.55**	**16.06**	**0.00**	**62.04**	**73.36**	**63.14**
14MN092	**7.32**	**24.39**	**7.32**	**31.71**	**0.00**	**80.49**	**91.46**	**40.24**
03MN074	**5.44**	**38.59**	**5.40**	**21.18**	**1.25**	**58.93**	**88.95**	**25.78**
Statewide average for Class 2 Southern Headwaters stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Le Sueur Creek (-824) scored below average in four (14MN106), five (14MN093), and seven (14MN092, 03MN074) of the eight habitat related metrics when compared their respective Fish Classes (2 or 3) and the stations that meet the General Use Thresholds (Table 476). All of the sites had a high amount of tolerant individuals and many of the sites lacked large numbers of species required specialized habitat conditions. These results can often signal stressed caused by the habitat conditions.

Table 477. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN106	**5.43**	**34.19**	**52.08**	**40.26**	**57.51**	**1.28**
14MN092	**5.64**	**19.12**	**61.44**	**58.62**	**41.07**	**4.39**
03MN074	**10.13**	**15.95**	**45.68**	**29.24**	**55.32**	**18.27**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in two (14MN092), three (14MN106), and four (03MN074) of the habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 477). All of the sites had high amounts of legless individuals, who are often present in high numbers in degraded stream reaches. There was not a macroinvertebrate sample taken at 14MN093.

Based on the majority of habitat related in the fish community, many in the macroinvertebrate assemblage, as well as the mostly fair MSHA scores along this reach, habitat is a stressor to aquatic life at this time. It is likely a secondary stressor, but is still having a negative impact on the biological communities present. The DNR states that riparian vegetation is necessary in achieving stream stability (DNR, 2017a).

Candidate Cause Chloride/Ionic Strength

Chloride values were available on this reach ranged from 22.1 to 31.7 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 461 to 808 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) percentages were all below the class average while two of the three visits had EPT percentages close to or above the class average. The taxa count was close to average at station 03MN074 during 2014, but below at the other two visits. The macroinvertebrate community was comprised of 53.49% conductivity tolerant individuals. During the 2003 visit, two conductivity intolerant individuals were collected, but this decreased to 0 in 2014.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at less than 1% at each visit. Species that are tolerant to conditions with high ionic strength

comprised a range of 13 to 34% of the fish community. The dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Table 478. Metric related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
03MN074 (2014)	40	5	13.95	27.57	0.52
03MN074 (2015)	NA	NA	NA	NA	0.39
14MN092	28	7	19.44	58.62	0
14MN093	NA	NA	NA	NA	0
14MN106	23	4	6.39	40.26	0
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

This reach is almost entirely natural. An analysis of the MPCA altered watercourse layer measured 64.46% of the Le Sueur Creek sub-watershed as channelized and that more than 80% of lake and wetland storage has been lost to landuse changes (DNR, 2017a). Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelized tributaries to this reach and contributing tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 1% of the time during the spring-fall months, however the reach was dry during the summer of 2016 at station 14MN092 (Figure 252), which also affects connectivity.

Figure 252. Site 14MN092 went dry during the summer of 2016 (September 23, 2013)

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising a range of 34.5% to 66% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 5 to 8.36% of the fish community, down from 42% in 2003. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0 to 8.97% of the population.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. Biological station 03MN074 is bracketed by manmade fish barriers above and below the sampling reach (Figure 253). Species counts are highest at this downstream station (19 – 29 across 3 visits) and diminish moving upstream of the barriers to 8 species and down to 5 species at the upstream most station (MPCA 2017). The barriers are fish barrier, making altered hydrology a stressor on this reach of Le Sueur Creek.

Figure 253. Low head dam near site 03MN074. Photo credit DNR

Table 479. Migratory fish and impoundments on Le Sueur Creek

CommonName	MN River		03MN074		14MN092	14MN093	14MN106
blackside darter	X						
central stoneroller			X		X	X	X
golden redhorse	X						
greater redhorse							
Iowa darter							
shorthead redhorse	X	Dam		Dam			
silver lamprey							
slenderhead darter	X		X				
silver redhorse							
spottail shiner							
walleye	X		X				
white sucker			X		X	X	X

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Le Sueur Creek (-824) are being stressed by Eutrophication, Nitrates, Habitat, and Flow Alteration/Connectivity (Table 480). Chloride was inconclusive as a stressor at this point, while Dissolved Oxygen and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 480. Stressors on Le Sueur Creek (-824)

		Stressors:						
Stream Name	**AUID**	**Dissolved Oyxgen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Chloride**	**Flow Alteration/Connectivity**
Le Sueur Creek	07020012-824	---	●	●	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.3 Forest Prairie Creek (-725)

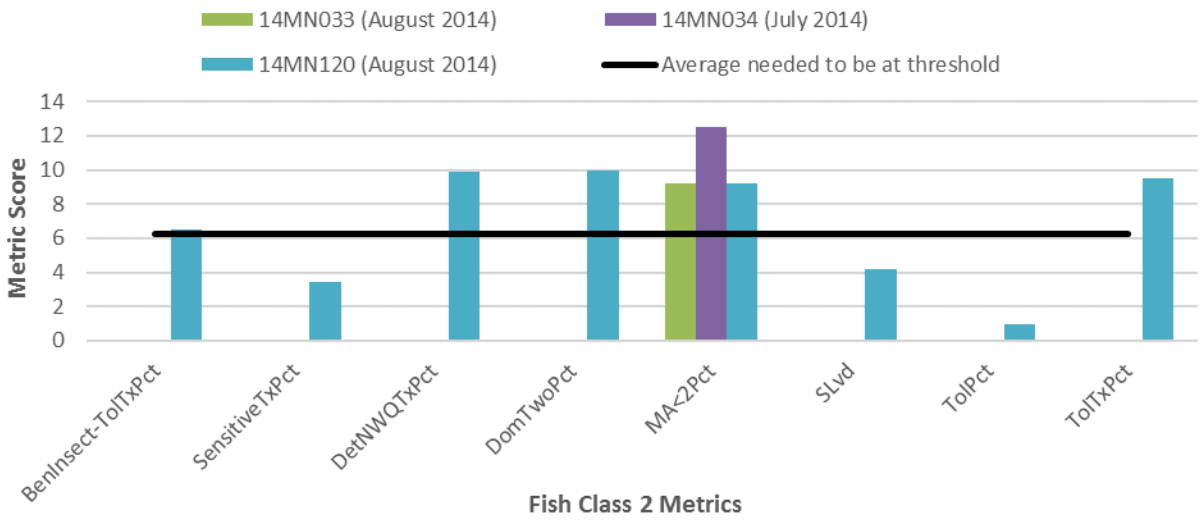
Located in the northwest portion of Le Sueur county, Forest Prairie Creek (-725) is a 13.72 mile long reach extending from County Ditch 29 to the confluence with Le Sueur Creek. This reach is impaired for biology due to its fish and macroinvertebrate assemblages. There are four biological monitoring stations along this reach: 03MN075, 14MN033, 14MN034, and 14MN120.

Biology

Fish

Forest Prairie Creek (-725) was sampled for fish at three of its biological monitoring sites in 2014. The FIBI scores from these visits were 9.2 (14MN033), 12.5 (14MN034), 48.7 (14MN120). All of these FIBI scores are below the Fish Class 2 Southern Streams General Use Threshold of 50. For more information regarding the FIBI metric scores, see Figure 254. FIBI scores on the mainstem of Forest Prairie Creek generally increase moving downstream in the watershed with highest scores observed below the dam.

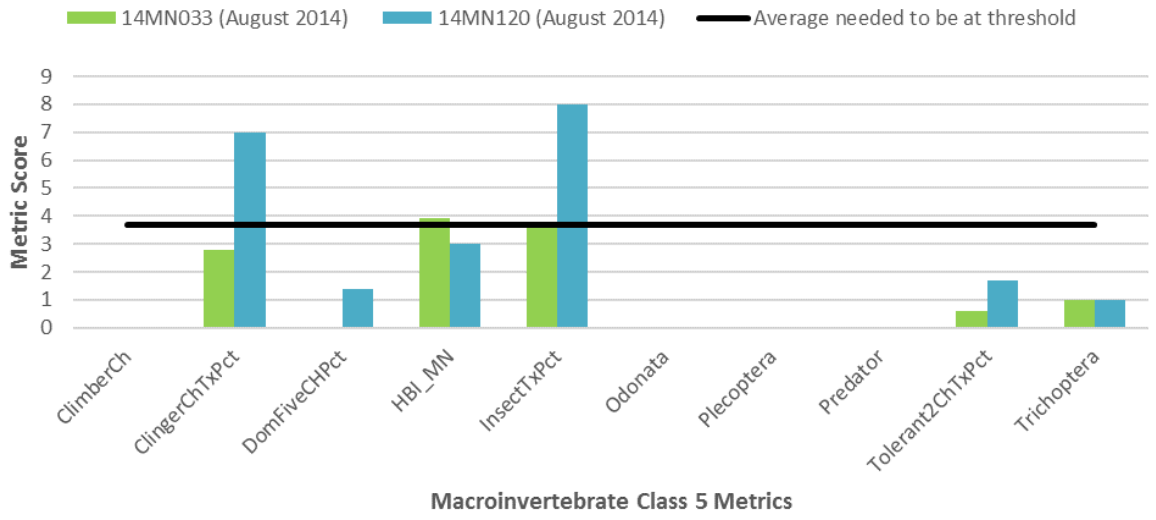
Figure 254. Fish metric scores in Class 2



Macroinvertebrates

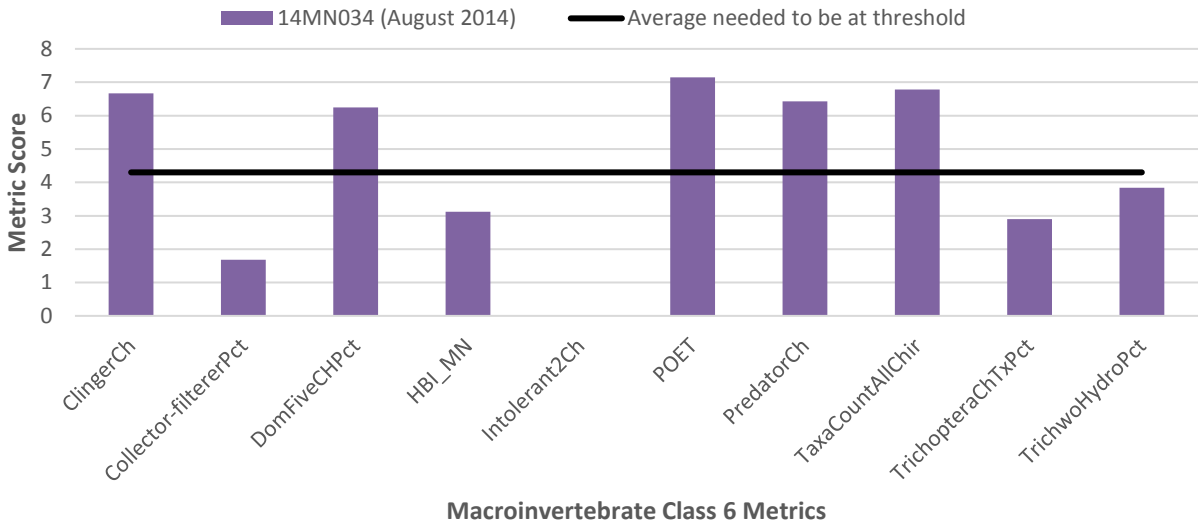
The macroinvertebrate community was also sampled along this reach at biological monitoring stations 14MN033, 14MN034, and 14MN120. The MIBI scores for sites 14MN033 and 14MN120 were 12.1 (14MN033) and 22.1 (14MN120). Both of these scores are well below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Both sites scored above the average needed to reach the threshold in two of the metrics comprising the MIBI for this class; however, the remaining eight metrics scored either below average or very poorly. (Figure 255)

Figure 255. Fish metric scores in Class 5



Site 14MN034 had a MIBI of 44.8, which is above the Macroinvertebrate Class 6 Southern Prairie Streams GP General Use Threshold of 43. Five of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold. The Intolerant2Ch metric had a score of zero limiting the MIBI for this site (Figure 256).

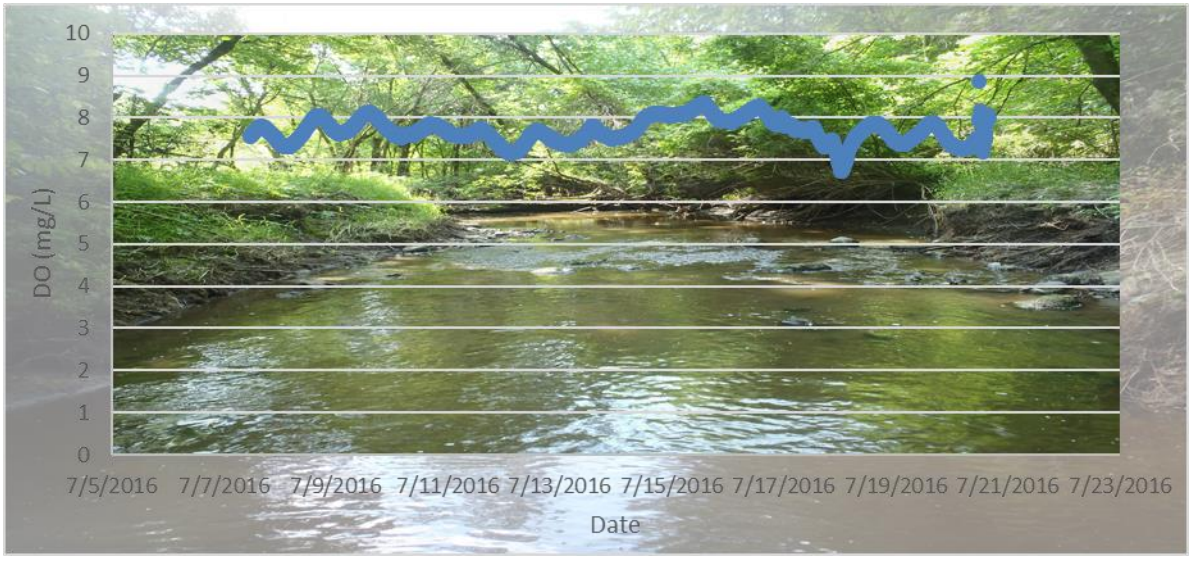
Figure 256. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 5.01 mg/L to 10.61 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous DO data produced daily values above 6.0 mg/L at station 14MN033 with a low value of 6.74 mg/L (Figure 257).

Figure 257. Continuous DO data at site 14MN033



Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.0-14.2 mg/L with 8% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Each visit on this reach had less than 3% of fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentages ranged from 3.51% to 16.67%, all below the class average that met the general threshold. Species that are very tolerant to low DO conditions ranged from less than 1% (stations 14MN033) to 33% (station 14MN120).

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; low DO tolerant taxa ranged from two to seven and low DO tolerant percentages ranged from 0.94 to 15.51%. No low values of DO have been found on this reach, and the preponderance of biological response is not indicative of DO stress. DO is not a stressor to the fish and macroinvertebrate communities.

Table 481. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN033	0	3.51	4	1.58	7.01	2	7.50
14MN120	2.69	16.67	24	0.94	7.33	5	7.61
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
14MN034	0.77	15.38	5	15.51	7.92	7	6.82
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause Eutrophication

Phosphorus values ranged from 0.029 to 1.59 mg/L with 62% over the southern standard of 0.150 mg/L. The highest value was collected during June at station S005-722 near the outlet to Le Sueur Creek. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged

from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. The small dataset of chlorophyll-a samples had a range of values from 1.4 to 12.1, without any values over the southern standard of 40.

As a result of eutrophication, pH values also increase. pH values ranged from 5.99 to 9.43. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Typical daily pH fluctuations in streams are 0.2-0.3 (Heiskary et al., 2013). Continuous pH data showed daily values below 8.5 and without high daily fluxes at station 14MN033. Continuous DO data also produced low daily fluctuations.

Table 482. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN034	0	0	99.23	87.69	42	56.65	44.62
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
14MN033	0	0	98.25	56.14	22	25.08	74.60
14MN120	6.45	12.63	71.24	44.09	21	35.85	48.43
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter individuals were only present on the downstream section of the reach, while the two most upstream stations had none. Tolerant species comprised more than 71% of the fish community at each visit. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the respective class average at all stations. EPT individuals were higher than the class average at station 14MN034, but lower at the others. The two most common macroinvertebrate species sampled comprised close to half of the community at stations 14MN034 and 14MN120, but much higher at station 14MN033. While phosphorus values were elevated, continuous data did not show elevated DO or pH fluctuations. The biological data was also mixed, making phosphorus inconclusive as a stressor.

Candidate Cause: Nitrate

From 2003-2014, Forest Prairie Creek had 27 nitrate samples taken that ranged from 0.98-18.8 mg/L, with an average value of 6.89 mg/L. There were nine samples above 10 mg/L, with the majority of the high samples coming in May-July. A quantile regression analysis of macroinvertebrate Class 5 sites showed that if the nitrate concentration exceeded 18.1 mg/L, there was a 75% probability of an impairment. Forest Prairie Creek (-725) had one sample exceeding this level.

Additionally, the HSPF model calculated daily nitrate values for Forest Prairie Creek (-725) from 1996-2012. These nitrate concentration values ranged from 0.1-23.9 mg/L with an average value of 5.4 mg/L.

Table 483. Nitrate related metrics

Station	TrichopteraChTx Pct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TlV
14MN033	**13.64**	**34.70**	**0.00**	**3.15**
14MN120	**4.76**	**78.16**	**0.32**	**4.33**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
14MN034	**4.76**	**78.16**	**0.32**	**4.33**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Forest Prairie Creek (-725) scored below average in two (14MN033) and four (14MN120, 14MN034) of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations and Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 483).

Based on the majority of the nitrate related metrics for the macroinvertebrate community scoring below average across multiple sites, the high observed nitrate values, as well as the quantile regression analysis, nitrates are a stressor to aquatic life in Forest Prairie Creek (-725).

Candidate Cause Sediment

From 2003-2014 a total of 38 TSS samples were taken from Forest Prairie Creek. These samples ranged from 2-2590 mg/L. taking away the outlier value of 2590 mg/L, the average TSS reading was 19.92 mg/L. In total, six (15.79%) samples were above the 65 mg/L standard for TSS. Additionally, 378 transparency/secchi tube measurements were taken along this reach from 2003-2015. These values had an average reading of 36.16 cm, with just 13 of the readings falling below the 10 cm transparency standard.

Table 484. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN075	8.79	0.37	2.56	2.56	13.92	6.96	22.34	0.00	1.83	20.81
14MN120	22.58	0.27	6.18	14.78	23.92	6.45	30.91	0.00	3.49	22.00
14MN033	52.63	0.00	0.00	0.00	52.63	0.00	52.63	0.00	1.75	15.96
14MN034	72.31	0.00	0.00	0.77	72.31	0.00	72.31	0.00	0.77	16.80
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Forest Prairie Creek (-725) scored below average in six (14MN033, 14MN034) and ten (03MN075, 14MN120) of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 485). All four sites had low numbers of Centrarchid, herbivorous, perciformid (perch-like), sensitive, intolerant, and long-lived individuals.

Table 485. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN033	15.78	0	9	30.28	77.46	0.00
14MN120	16.32	0	7	33.54	42.14	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
14MN034	23.94	0	20	71.52	6.65	0.32
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in two (14MN033), three (14MN120), and six (14MN034) of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations and Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold. All three sites completely lacked any TSS Intolerant and Plecoptera taxa. Sites 14MN033 and 14MN120 both had a low amount of TSS tolerant taxa, TSS tolerant individuals, and a high amount of collector filterer individuals. These can be signs of stations not being negatively impacted by elevated levels of suspended sediment.

While the exceedance rate of TSS is close to the impairment threshold, it was determined during assessment that many of the high samples were targeted following rain events. The very large secchi tube data set better reflects the clarity conditions in this reach. The suspended sediment related metrics in both fish and macroinvertebrate assemblages were a bit mixed as some sites scored fairly well, while others did not. This could be due to other stressors having a greater impact on the poor scoring sites as suspended sediment is not a stressor to aquatic life in Forest Prairie Creek (-725).

Candidate Cause Habitat

Forest Prairie Creek (-725) had qualitative habitat assessments take place at its biological monitoring sites (Upstream to downstream), 03MN075, 14MN120, 14MN033, and 14MN034, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 73.45 (Good) at 03MN075 and 66.53 (Good) at 14MN120, 69.48 (Good) at 14MN033, and 53.05 (Fair) at 14MN034. Generally, habitat conditions trended downward the further downstream on this reach. Land use conditions went from a more forested area in the headwaters to an area dominated with row crop agriculture at the downstream portion of this reach. The sites further downstream tended to see more sand and silt substrates, had more embeddedness, more bank erosion Figure 258, and less channel stability. A breakdown of the MSHA category scores for these sites can be seen in Figure 259. A geomorphic study by the DNR found the stream to be deeply incised with poor stability (DNR, 2017a). The Forest Prairie Creek site had fairly steep riffles, large cobbles and gravels, and deep pools which would indicate habitat should not be limiting for fish and macroinvertebrate communities (DNR, 2017a).

Figure 258. Bank erosion at site 14MN120 (August 28, 2014)

Figure 259. Habitat related fish metrics

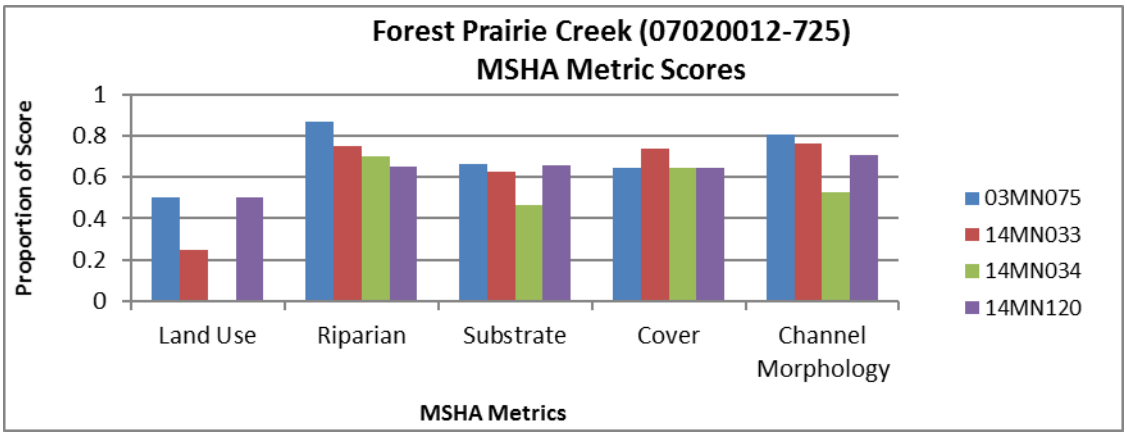


Table 486. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN075	**2.56**	**22.34**	**2.56**	**13.92**	**0.73**	**40.29**	**84.25**	**41.76**
14MN120	**13.44**	**30.91**	**13.44**	**23.92**	**1.88**	**94.74**	**71.24**	**15.59**
14MN033	**0.00**	**52.63**	**0.00**	**52.63**	**1.75**	**94.74**	**98.25**	**45.61**
14MN034	**0.00**	**72.31**	**0.00**	**72.31**	**0.00**	**73.85**	**99.23**	**16.92**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Forest Prairie Creek (-725) scored below average in eight (03MN075), six (14MN120), five (14MN033), and four (14MN034) of the eight evaluated habitat related metrics when compared to all other Class 2 Southern Streams Stations that meet the FIBI General Use Threshold (Table 486). All four sites had high amounts of tolerant individuals, while also having low amounts of Benthic Insectivore, darter/sculpin/sucker, and Piscivore individuals. These results signal potential habitat stress.

Table 487. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN120	1.26	18.87	60.69	35.85	33.33	4.09
14MN033	2.22	8.57	82.22	25.08	14.29	3.49
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
14MN034	5.06	10.76	37.66	56.65	31.96	21.52
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage along this reach fared better than the fish community as two (14MN120, 14MN034), and three (14MN033) of the habitat related metrics were below average when

compared to the corresponding class of each site and the sites that meet the threshold in the respective class. All three of the sites had below average amounts of burrower and legless individuals, which are common in higher numbers in streams with sedimentation issues. Two of the sites also had above average numbers of clinger species, which can signal that habitat is not a stressor.

Based on the generally good MSHA scores throughout the entire reach, and the many above average scoring macroinvertebrate metrics, habitat is not a stressor in Forest Prairies Creek (-725) at this time. It appears that the fish community is being negatively impacted by another stressor. The DNR suggests that based on the channel incision there is a potential to lose the available habitat.

Candidate Cause Chloride/Ionic Strength

Chloride values were available on this reach ranged from 12.4 to 29.4 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 323 to 806 uS/cm. Continuous data collected in 2016 included all values below 745 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 488. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN034	42	7	54.43	56.65	0
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	39.46	5	18.26	30.93	
14MN033	22	6	9.52	25.08	0
14MN120	21	7	24.84	35.85	0.27
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased Ionic stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below the class average at station 14MN033, while they were both above average at station 14MN034. Station 14MN120 was just below average for EPT percentage, while just above for mayflies. Taxa count was just above average at station 14MN034, the most upstream station while the taxa counts were below average at stations 14MN033 and 14MN120. The macroinvertebrate community was comprised of a range of 30.91 to 64.24% conductivity tolerant individuals. No conductivity intolerant individuals were collected at stations 14MN033 or 14MN120, while 1 intolerant individuals was collected at station 14MN034.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at less than 1% at each visit. Species that are tolerant to conditions with high ionic strength comprised a range of 0 to 44.39% of the fish community. The dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured Forest Prairie Creek almost entirely natural. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 4% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising a range of 64.52% to 98.25% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 3.52 to 25.38% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0 to 7.28% of the population.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. There is a dam, a weir, and a perched culvert on Forest Prairie Creek that are acting as fish barriers (Figure 260. The weir was added in 2015 so its effects are not seen in the 2014 fish results below (Table 489), but will further impede fish migration in the future. FIBI scores are lowest above the dam where 2-5 species were captured during MPCA surveys, while species counts below the dam range from 21-24 (barrier located between biological stations 14MN120 and 14MN033) (MPCA 2017). The barriers are fish barrier, making altered hydrology a stressor on Forest Prairie Creek.

Figure 260. Perched culvert at site (August 7 2014)

Table 489. Migratory fish and impoundments on Forest Prairie Creek

CommonName	03MN075	14MN120		14MN033		14MN034
blackside darter		X				
central stoneroller	X	X				
golden redhorse						
greater redhorse						
Iowa darter						
shorthead redhorse	X	X	Perched culvert		Dam	
silver lamprey						
slenderhead darter		X				
silver redhorse						
spottail shiner						
walleye	X	X				
white sucker	X	X		X		X

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Forest Prairie Creek (-725) are being stressed by Nitrates and Flow Alteration/Connectivity (Table 490). Eutrophication and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen, Suspended Sediment, and Habitat were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 490. Stressors on Forest Prairie Creek (-725)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Forest Prairie Creek	**07020012-725**	---	o	●	---	---	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.4 Unnamed ditch to Forest Prairie Creek (-763)

The Unnamed ditch to Forest Prairie Creek (-763) is located in Northwestern Le Sueur County and is 3 miles in length. The stream reach begins upstream of CR 116 and flows in a northwesterly direction before connecting with Forest Prairie Creek just downstream of CR 115. This predominantly channelized reach is impaired for aquatic life due to both fish and macroinvertebrate communities. There is one biological monitoring station, 14MN031, located along this reach.

Biology

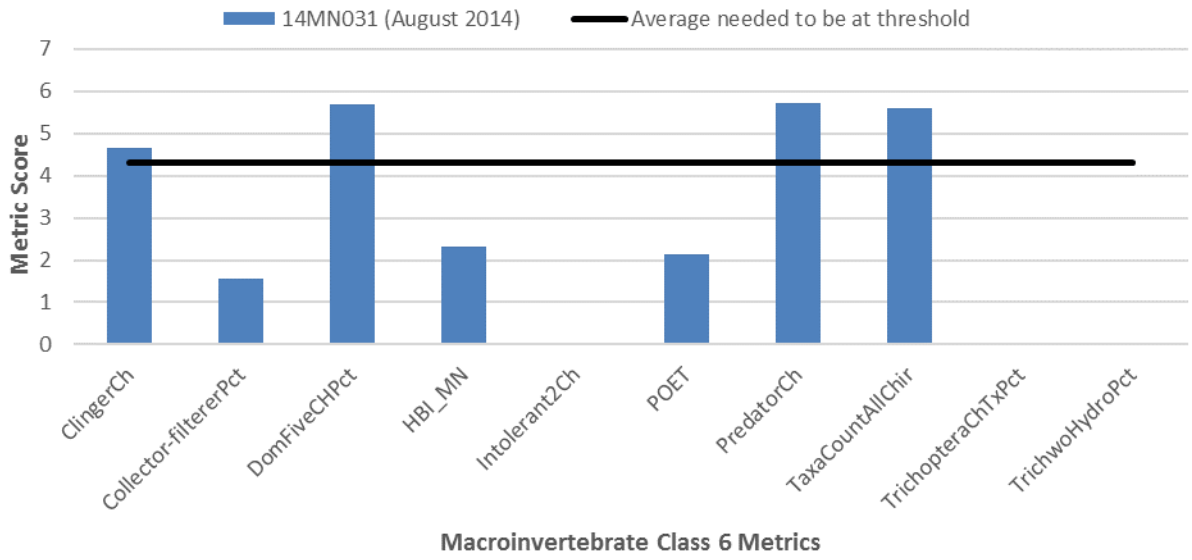
Fish

Unnamed ditch to Forest Prairie Creek (-763) was sampled for fish in July of 2014 at its biological monitoring station 14MN031. This visit had a FIBI score of 0. Only four individual fish were sampled and consisted of very tolerant species (creek chub, white sucker, blacknose dace).

Macroinvertebrates

The macroinvertebrate community was sampled at site 14MN031 during August of 2014. This visit had an MIBI score of 27.7 which is below the Macroinvertebrate Class 6 Southern Forest Streams GP general use threshold of 43. During this visit, four of the ten class metric scores were above the average needed to reach the MIBI threshold (ClingerCh, DomFiveCHPct, PredatorCh, TaxaCountAllChir). The remaining six metrics scored below average or very poorly. Three metrics scored zero (Intolerant2Ch, TrichopteraChTxPct, TrichwoHydroPct) (Figure 261).

Figure 261. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 6.65 mg/L to 14.04 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.0-14.2 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. No serial spawners percentage were present Species that are very tolerant to low DO conditions comprised none of the fish community, however only 4 fish individuals were collected.

Table 491. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN031	0	0	3	24.51	8.16	3	6.51
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)				**16.56**	**7.12**	**5.38**	**6.80**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; three low DO tolerant taxa were present and the low DO tolerant percentage was 24.51%. No low values of DO have been found on this reach, but the biological response is indicative of some DO stress. DO is inconclusive as a stressor to the biological communities.

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.047 to 0.177 mg/L with eight of the fifteen values over the southern standard of 0.150 mg/L. The highest value was collected during June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, there is no available DO flux, BOD, or chlorophyll-a data. As a result of eutrophication, pH values also increase. pH values ranged from 7.83 to 8.04.

Table 492. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN031	0	0	100	25	38	3.92	48.04
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.55**	**12.08**	**70.64**	**14.62**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter individuals were not present while tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the class average of sites that met the general threshold. EPT individuals were much lower than the class average at station 14MN031. The two most common macroinvertebrate species sampled comprised just less than half of the community. One of the phosphorus values in the limited dataset was elevated and the biological data was indicative of eutrophication stress however only four fish were collected likely inflating the fish metrics. Other metrics could be impacting the lack of fish collected, making eutrophication inconclusive as a stressor.

Candidate Cause Nitrate

From 2014-2016, a total of four nitrate samples were taken from water chemistry station, S008-989 (14MN031). These values ranged from 22-27 mg/L., with an average value of 24.75 mg/L. Additionally, a drain tile feeding into this stream was sampled on June 30, 2016 and had a reading of 38 mg/L. These values are all very high.

Drain tiles were located along this reach and are a common pathway for nitrates to enter a stream system.

Table 493. Nitrate related metrics

Station	TrichopteraChTxPct	% Tolerant Taxa	% Intolerant Taxa	Nitrogen TIV
14MN031	**0.00**	**83.33**	**0.00**	**4.21**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*10.71*	*44.69*	*1.42*	*2.87*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN031 along Unnamed Ditch to Forest Prairie Creek (-763) scored below average in all four of the nitrate related metrics evaluated when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 494). The very high amount of nitrate tolerant taxa as well as the poor scoring Nitrogen TIV score both strongly indicate nitrate stress.

Based on the elevated measured values, the presence of drain tiles with high nitrate concentrations, as well as the below average nitrate related metric scores, nitrates are a stressor to aquatic life in this stream reach.

Candidate Cause Sediment

From 2014-2016, a total of four TSS samples were taken from Unnamed ditch to Forest Prairie Creek (-763). These samples ranged from 4.4-75 mg/L with an average TSS concentration of 23.75 mg/L. One of the values was above the 65 mg/L standard for TSS. Also, four secchi tube measurements were taken along this reach during the same time period. These values ranged from 15-100 cm, with an average value of 65 cm.

The HSPF model also calculated daily TSS concentrations for the subwatershed from 1996-2012. These values ranged from 3.48-536.45 mg/L with an average value of 22.2 mg/L. Of these calculations, 489 (7.87%) were above the 65 mg/L standard for TSS.

Table 494. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffliePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN031	**25.00**	**0.00**	**0.00**	**0.00**	**25.00**	**0.00**	**50.00**	**0.00**	**0.00**	**14.62**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed ditch to Forest Prairie Creek (-763) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 494). Site 14MN031 did have a high percentage of simple lithophilic individuals and a good TSS Index score, however the remaining metrics scored poorly and the reach lacked many species that are intolerant of elevated suspended sediment levels. Only four fish individuals were collected in this reach, which can severely skew the data.

Table 495. Sediment rleated macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN031	**17.09**	**0**	**11**	**47.39**	**6.21**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*15.11*	*2.07*	*10.84*	*28.89*	*24.22*	*0.36*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in all six of the suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 495). The site, 14MN031, had a high amount of TSS tolerant individuals while having few or completely lacking collector filterer, TSS intolerant, and Plecoptera taxa.

The available data set for this reach is rather minimal. One of the four TSS samples did exceed the TSS standard. The model did predict a fair amount of standard exceedances. The fish and macroinvertebrate communities both had many metrics related to suspended sediment score below average, however,

with only four fish individuals sampled it is difficult to gage the impact suspended sediment is having on that assemblage. Therefore, suspended sediment is inconclusive as a stressor in this reach.

Candidate Cause Habitat

Unnamed ditch to Forest Prairie Creek (-763) had a qualitative habitat assessment take place at its biological monitoring site, 14MN031, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 53.2 (Fair). Limiting the habitat conditions at this site was the row crop agriculture as the dominant land use (Figure 262), a narrow to moderate riparian buffer, little to moderate bank erosion, moderate embeddedness, sand and silt substrates, sparse fish cover, and moderate channel stability. See Figure 263 for a further breakdown of the MSHA category scores.

Figure 262. Surrounding land use at site 14MN031 (June 10, 2014)

Figure 263. Habitat metric scores

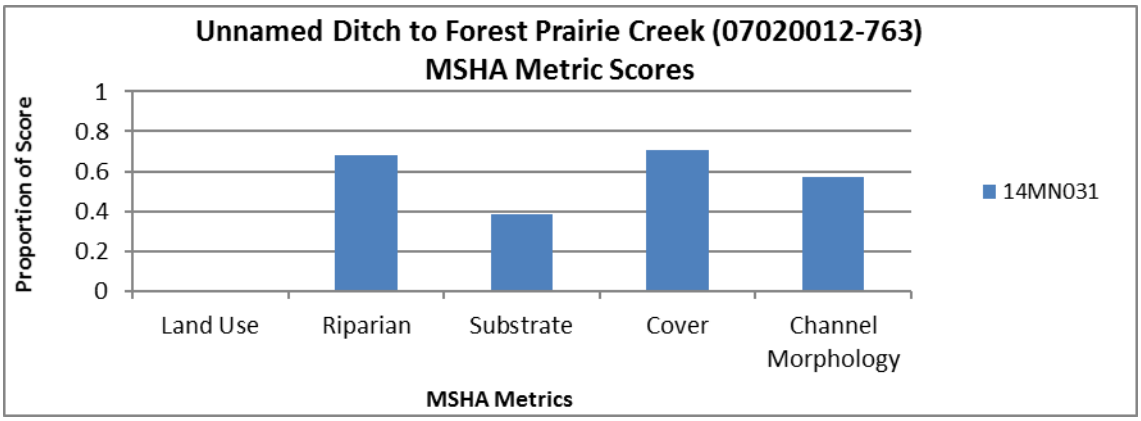


Table 496. Habitat related fish metrics

Station	BenInsect-TolPct	SlithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN031	0.00	50.00	0.00	25.00	0.00	100.00	100.00	50.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Unnamed ditch to Forest Prairie Creek (-763) scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 496). Despite two fish samples, very few fish were collected at site 14MN031. Zero fish were sampled in June 2014, while only four were present during the July

2014 sample. These low sample results can skew the metric data. The species present at this site were creek chubs, white sucker, and blacknose dace, all of which are tolerant to degraded habitat conditions.

Table 497. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN031	**11.44**	**37.58**	**24.84**	**3.92**	**91.83**	**10.13**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	*5.92*	*15.89*	*39.00*	*27.05*	*43.40*	*18.81*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN031 scored below average in five of the six habitat related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI General Use Threshold (Table 497). The site did have a good number of climber individuals, but scored poorly in the other categories.

The MSHA in this stream reach was fair. The habitat in this stream is viable enough for a more populous fish community to be present. With only four fish individuals captured between two sampling visits, it is likely that other factors are causing the fish population in this stream to be extremely low. The macroinvertebrate assemblage had the majority of its habitat related metrics score below average leading to the conclusion that while many habitat issues exist in this reach, it is a secondary stressor and there is another stressor that is having a greater impact on the biological communities.

Candidate Cause Chloride/Ionic Strength

One chloride value was available on this reach with a value of 28.3 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 752 to 829 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were both below class average. Taxa count was just below average at station. The macroinvertebrate community was comprised of 72.22% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Table 498. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN031	38	4	3.92	3.92	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	**39.46**	**5**	**18.26**	**30.93**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

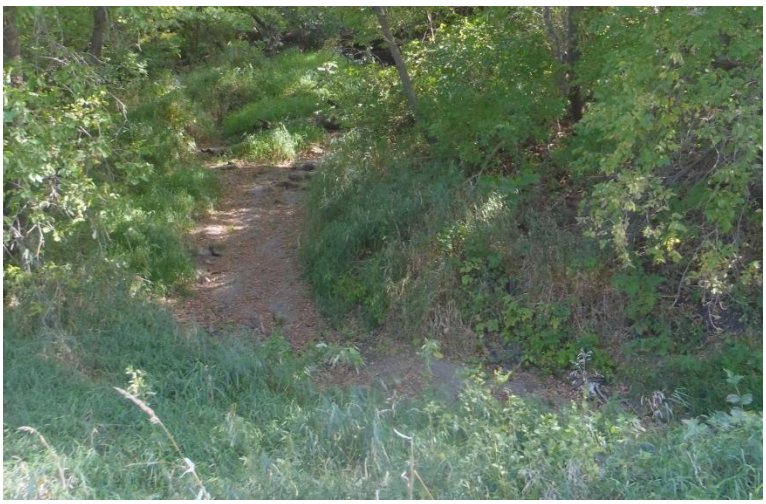
Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised none of the fish community. The small dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this tributary to be about evenly split between natural and modified. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 1% of the time during the spring-fall months; however, the stream was observed dry in September 2013 (Figure 264), which also affects connectivity.

Figure 264. Site went dry during the summer of 2013 (September 23, 2013)



Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising 100% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species were not present as part of the fish community. Long-lived macroinvertebrates decrease with flow changes, as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.63% of the population. The channelization is likely contributing to lack of habitat, however the biological community data was mixed. The biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed ditch to Forest Prairie Creek (-763) are being stressed by Nitrates and Habitat. (Table 500) Dissolved Oxygen, Eutrophication, Suspended Sediment, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 499. Stressors on Unnamed ditch (-763)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed ditch to Forest Prairie Creek	07020012-763	o	o	●	o	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.5 County Ditch 34 (-764)

Also located in the northwestern part of Le Sueur County is County Ditch 34 (-764). This stream reach is 1.69 miles long and extends from Unnamed ditch to Forest Prairie Creek (-765) to Forest Prairie Creek (-

725). This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN032, along this stream.

Biology

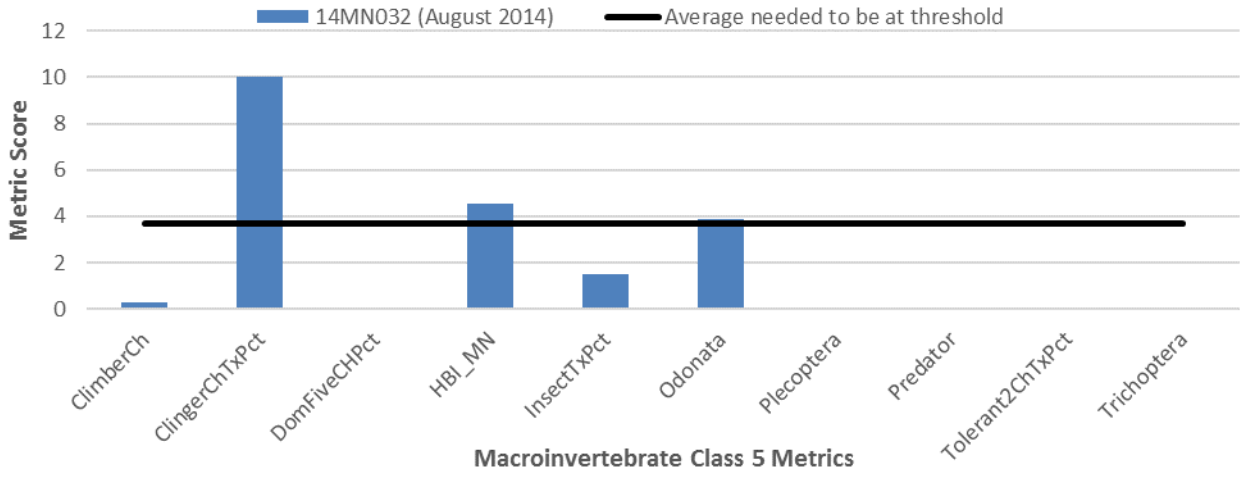
Fish

County Ditch 34 (-764) was sampled for fish in July of 2014 at its biological monitoring station 14MN032. This visit had a FIBI score of 0. Only four individual fish were sampled and consisted of very tolerant species (creek chub, white sucker).

Macroinvertebrates

A macroinvertebrate sample was collected in August of 2014 at site 14MN032. This visit had an MIBI score of 20.3, which is well below the Macroinvertebrate Class 5 Southern Streams RR general use threshold of 37. Three of the ten metrics scored above the average needed to reach the class 5 MIBI threshold (ClingerChTxPct, HBI_MN, Odonata). However, the remaining seven metric scores scored poorly, with five of them scoring zero. (Figure 265)

Figure 265. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 7.9 mg/L to 8.62 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.4-13.4 mg/L with less than 2% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner's percentage were not present. Species that are very tolerant to low DO conditions were not present in the fish community, however only two species were collected (white suckers and creek chubs).

Table 500. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN032	0	0	2	0.65	6.79	2	7.28
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; two low DO tolerant taxa were present and the low DO tolerant percentage was 0.65%. No low values of DO have been found on this reach, but the biological response is indicative of some DO stress. DO is inconclusive as a stressor to the biological communities.

Candidate Cause: Eutrophication

A small dataset of phosphorus values ranged from 0.171 to 0.231 mg/L with eight of the fifteen values over the southern standard of 0.150 mg/L. The highest value was collected during August. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.3 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, there is no available DO flux, BOD, or chlorophyll-a data. As a result of eutrophication, pH values also increase. pH values ranged from 7.81 to 8.18.

Sensitive and darter individuals were not present while tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the class average of sites that met the general threshold. EPT individuals were much lower than the class average at station 14MN032. The two most common macroinvertebrate species sampled more than 75% of the community. Phosphorus values were elevated and the biological data was indicative of eutrophication stress however only four fish were collected likely inflating the fish metrics. Other metrics could be impacting the lack of fish collected, making eutrophication inconclusive as a stressor.

Table 501. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN032	0	0	100	25	17	9.80	76.14
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	8.55	12.08	70.64	14.62			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					41.92	43.90	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2014-2016, two nitrate samples were taken from County Ditch 34 (-764). The results of these samples were 14 mg/L from a sample taken on July 19, 2014 and 8.9 mg/L from a sample taken on August 18, 2016. Additionally, from 1996-2012 HSPF modeling calculated daily nitrate values for County Ditch 34 (-764). These nitrate values ranged from 0.29-24.47 mg/L with an average nitrate concentration of 5.46 mg/L.

Table 502. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN032	**5.88**	**20.52**	**0.00**	**2.93**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 34 (-764) at station 14MN032 scored below average in two of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 502). The reach had low numbers of Trichoptera taxa and completely lacked nitrate intolerant species. However, the Nitrogen TIV score was above average and there was a low amount of nitrate tolerant species sampled.

Based on the low amount of nitrate tolerant taxa, the good Nitrogen TIV score, the relatively low nitrate average from the HSPF model, as well as the wooded area in the immediate riparian area, all signal that nitrates are not a stressor to County Ditch 34 (-764) at this time.

Candidate Cause Sediment

From 2014-2016, two TSS samples were taken from County Ditch 34 (-764). These values were 17 mg/L on 07/09/2014 and 30 mg/L on 08/18/2016. Also, one secchi tube measurement was taken on 08/11/2014 and was 50 cm. None of these samples or readings exceeded their respective standards.

Additionally, the HSPF model calculated daily TSS concentrations for this subwatershed. These values ranged from 3.4-344.6 mg/L with an average TSS concentration of 19.5 mg/L. Of these calculations, 593 (9.55%) were above the 65 mg/L standard for TSS.

Table 503. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN032	**25.00**	**0.00**	**0.00**	**0.00**	**25.00**	**0.00**	**25.00**	**0.00**	**0.00**	**16.04**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 34 (-764) scored below average in all ten of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 503). Only four fish individuals were sampled, which can skew the metric results.

Table 504. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN032	**14.15**	**0**	**5**	**12.70**	**76.80**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in two of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 504). The site, 14MN032, completely lacked TSS Intolerant and Plecoptera taxa, but scored well in the remaining metrics. This likely signals an assemblage not being negatively impacted by suspended sediment concentrations.

The observed data set in this reach is rather minimal and the few samples collected did not violate the respective standards. The HSPF model did predict a high exceedance rate. However, the macroinvertebrate community scored very well in the majority of its metrics related to suspended

sediment. This typically does not occur in a stream with high sediment levels. Therefore, suspended sediment is not a stressor to aquatic life in County Ditch 34 (-764) at this time. Further monitoring of the fish community is needed during base flow conditions to better assess any impact that suspended sediment is having on this assemblage.

Candidate Cause Habitat

County Ditch 34 (-764) had a qualitative habitat assessment take place at its biological monitoring site, 14MN032, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 68.98 (Good). Limiting the habitat conditions at this site was the row crop agriculture as the dominant land use, moderate bank erosion (Figure 266), light embeddedness, and sand and silt substrates. See Figure 267 for a further breakdown of the MSHA category scores.

Figure 266. Erosion at site 14MN032

Figure 267. Habitat metric scores

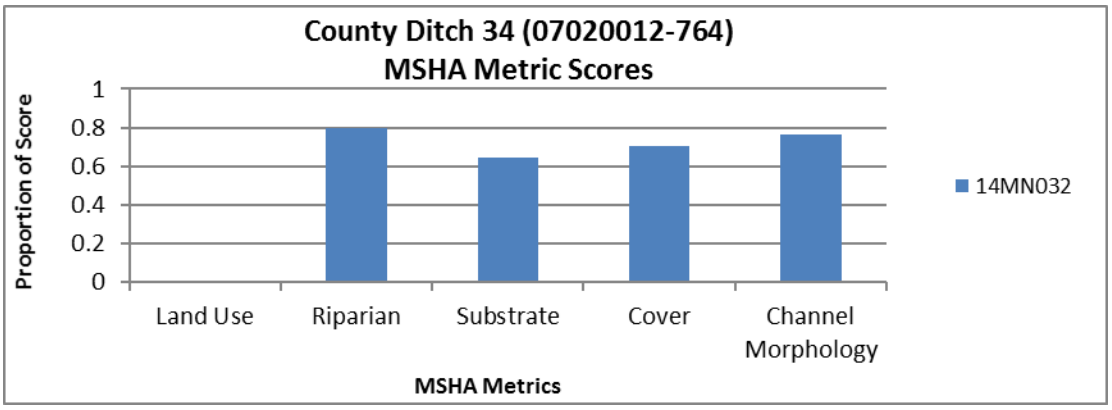


Table 505. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN032	0.00	25.00	0.00	25.00	0.00	100.00	100.00	75.00
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 34 at site 14MN032 scored below average in seven of the eight habitat metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 505). Only four individual fish were captured, (3 Creek Chubs, 1 White Sucker). This low sample size can skew the fish metrics, however, the fact that only four fish were captured, and were all tolerant, may also indicate poor habitat conditions.

Table 506. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN032	0.33	6.86	83.66	9.80	13.40	1.31
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 506).

The biological results in County Ditch 34 were rather mixed. The fish community only consisted of four individuals, while the macroinvertebrate community scored below average in half of the habitat related metrics. The MSHA at the sampling site was good. At this point, habitat is inconclusive as a stressor.

Candidate Cause Chloride/Ionic Strength

No chloride value was available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 712 to 760 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 507. Metric related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN032	17	3	7.19	9.80	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were both far below class average. Taxa count was also well below the average. The macroinvertebrate community was comprised of 14% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength were not present in the fish community. The small dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this ditch to be 100% natural; however, the entire upstream reach is channelized. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels. Channelization and tile drainage in the upstream watershed alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 21% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising 100% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species were not present in the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.96% of the population. The upstream channelization is likely

contributing to the extended low flow conditions; however, the biological community data was mixed. The biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

Currently, more information is needed to better determine the stressors for the impaired fish and macroinvertebrate communities in County Ditch 34 (-764) (Table 508). Dissolved Oxygen, Eutrophication, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point, while Nitrates, Suspended Sediment, and habitat were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 508. Stressors on County Ditch 34 (-764)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 34	07020012-764	o	o	---	---	---	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.6 Judicial Ditch 4 (-767)

Judicial Ditch 4 (-767) is a 0.77 mile long stream reach located in northwestern Le Sueur county. This reach extends from an unnamed ditch to the confluence with Forest Prairie Creek. This reach is impaired for biology due to the fish assemblage present at the biological monitoring station, 14MN035, located along this stream section.

Biology

Fish

Judicial Ditch 4 (-767) was sampled for fish in July of 2014 at its biological monitoring station 14MN035. This visit had a FIBI score of 0. Only five individual fish were sampled and consisted of just white suckers which are a very tolerant species.

Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 5.14 mg/L to 7.66 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.0-13.8 mg/L with less than 2% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. No serial spawners were present. Species

that are very tolerant to low DO conditions were not present in the fish community, however only one species was collected (white sucker).

Table 509. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN035	0	0	1	3.56	8.16	5	6.93
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; five low DO tolerant taxa were present and the low DO tolerant percentage was 3.56%. No low values of DO have been found on this reach, but the biological response is indicative of some DO stress. DO is inconclusive as a stressor to the biological communities.

Candidate Cause Eutrophication

There is a small dataset on this reach, with phosphorus values ranged from 0.265 to 0.412 mg/L. The highest value was collected during July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of this information is available. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.48 to 7.63.

Sensitive and darter individuals were not present while tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the class average of sites that met the general threshold. EPT individuals were much lower than the class average at station 14MN035. The two most common macroinvertebrate species sampled comprised almost half of the community. Phosphorus values were elevated and the biological data was indicative of eutrophication stress however only five fish were collected likely inflating the fish metrics. Other metrics could be impacting the lack of fish collected, making eutrophication inconclusive as a stressor.

Table 510. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN035	0	0	100	100	34	2.59	47.89
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	6.02	1.48	76.7	19.80			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					39.46	30.92	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrates

From 2014-2016, two nitrate samples were taken from Judicial Ditch 4 (-767). These nitrate concentrations were 14 mg/L on 07/09/2014 and 8.1 mg/L on 08/18/2016.

Drain tiles were also present in this reach and can be a direct path for nitrates to enter the stream system.

Table 511. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN035	5.88	89.97	0.00	5.55
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Judicial Ditch 4 (-767) at site 14MN035 scored below average in all four of the nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 511). This reach showed few Trichoptera taxa, no nitrate intolerant species, a high amount of nitrate tolerant taxa, and a poor Nitrogen TIV score.

Based on the high observed values despite limited sampling, the presence of drain tiles, as well as the consistently very poor scoring macroinvertebrate metrics, nitrates are a stressor to aquatic life in Judicial Ditch 4 (-767).

Candidate Cause: Sediment

Two TSS samples were taken from Judicial Ditch 4 (-767) from 2014-2016. These values were 85 mg/L on July 8, 2014 and 3.2 mg/L on August 18, 2016. One of these values was above the 65 mg/L standard for TSS. Also, two secchi tube measurements were taken from 2014-2015. These values were 13 cm on 07/09/2014 and 50 cm on August 3, 2015.

Additionally, the HSPF model calculated TSS concentrations for this subwatershed from 1996-2012. These values ranged from 3.2-545.6 mg/L with an average value of 20.6 mg/L. Of these calculations, 585 (9.42%) were above the 65 mg/L standard.

Table 512. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN035	**100.00**	**0.00**	**0.00**	**0.00**	**100.00**	**0.00**	**100.00**	**0.00**	**0.00**	**15.21**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 4 (-767) scored below average in six of the suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 512). Only five fish individuals were sampled, which can skew the metric results.

Table 513. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN035	18.73	0	11	54.37	7.12	0.32
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN035 scored below average in five of the six suspended sediment related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 513). This reach did have a slightly above average amount of Plecoptera individuals, however, it also had high amounts of TSS tolerant taxa and individuals, while lacking TSS Intolerant taxa, low levels of collector filterer individuals, and a poor TSS index Score.

The very limited data set has one of the TSS samples exceeding the standard, while both secchi tube measurements were both above the 10 cm minimum standard for transparency. The HSPF model did predict a higher exceedance rate and the macroinvertebrate community mostly signaled an assemblage commonly found in streams being impacted negatively by suspended sediment. Therefore, suspended sediment is a stressor to aquatic life in Judicial Ditch 4 (-767). The fish community may need to be sampled again in base flow conditions to better gauge the impact that suspended sediment is having on this assemblage.

Candidate Cause: Habitat

Judicial Ditch 4 (-767) had a qualitative habitat assessment at its biological monitoring site, 14MN035, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 36.87 (Poor). Limiting the habitat at this site was the row crop agriculture as the dominant land use, narrow riparian buffers, no stream shading, sand and silt substrates, moderate embeddedness, nearly absent fish cover, poor sinuosity (Figure 268) and poor channel development. Further MSHA analysis can be seen in Figure 269.

Figure 268. Poor Sinuosity at site 14MN035.

Figure 269. Figure 270. Habitat metric scores

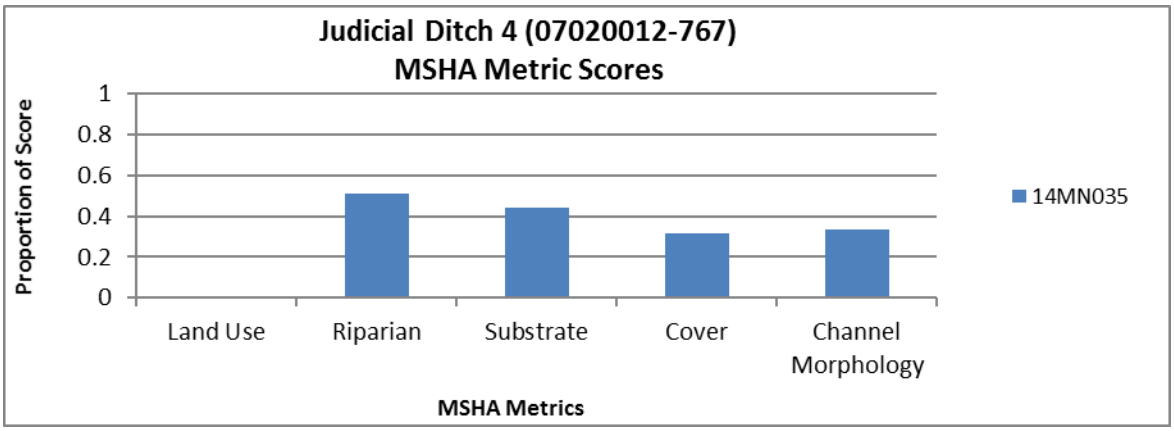


Table 514. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN035	**0.00**	**100.00**	**0.00**	**100.00**	**0.00**	**100.00**	**100.00**	**0.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Judicial Ditch 4 (-767) scored below average in four of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 514). The fish sample at site 14MN035 had a low sample size as only five white suckers were sampled during the visit. This low sample can skew the metric results. White suckers are a fish species that is tolerant to poor habitat conditions.

Table 515. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN035	**9.39**	**50.81**	**9.39**	**2.59**	**90.29**	**17.15**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**11.49**	**23.84**	**24.46**	**14.44**	**61.44**	**22.59**
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN035 scored below average in four of the six habitat related metrics when compared to all other Class 6 Southern Forest Strems GP stations that meet the MIBI Modified Use Threshold (Table 515). The site had a very few EPT individuals, while also having a significant number of legless individuals. These results are commonly associated in streams with degraded habitat conditions.

Based on the majority of the macroinvertebrate habitat related metrics and the poor MSHA score, habitat is indeed a stressor to the biological communities in Judicial Ditch 4 (-767). The low sample size of the fish community may also be indicative of habitat stress.

Candidate Cause Chloride/Ionic Strength

No chloride value was available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 740 to 919 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were both far below class average. Taxa count was just below the average. The macroinvertebrate community was comprised of 66.34 % conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength were not present. The small dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Table 516. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN035	34	2	1.62	2.59	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI General Use Threshold (43.0)	39.46	5	18.26	30.93	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this ditch to be 100% modified. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). There were no known connectivity issues. Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 8% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising 100% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species were not present. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 4.21% of the population. The channelization is likely contributing to the lack of habitat, however the biological community data was mixed. The biological results indicate altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish community in Judicial Ditch 4 (-767) is being stressed by Nitrates, Suspended Sediment, and Habitat (Table 517). Dissolved Oxygen, Eutrophication, Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 517. Stressors on Judical Ditch 4 (-767)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Judicial Ditch 4	07020012-767	o	o	●	●	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.7 Tributary to Le Sueur Creek (-768)

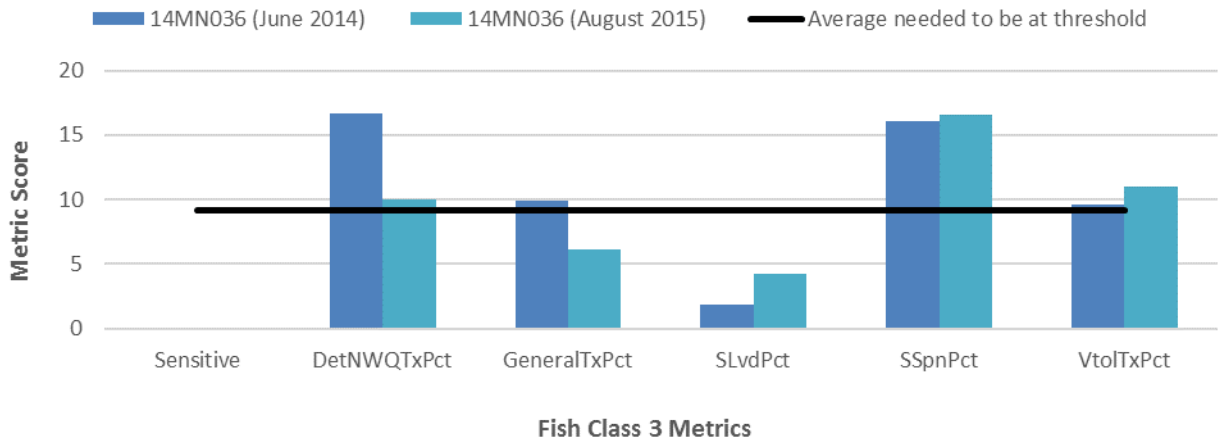
Located in western Le Sueur county is Tributary to Le Sueur Creek (-768). This 0.98-mile long reach is located between County Ditch 56 and the confluence with Le Sueur Creek. This stream section is impaired for biology due to both the fish and macroinvertebrate communities. There is one biological monitoring station, 14MN036, located along this reach.

Biology

Fish

Tributary to Le Sueur Creek (-768) was sampled for fish twice at its biological monitoring site, 14MN036. The first visit was in June of 2014 and had an FIBI score of 54.2, while the second visit in August of 2015 had an FIBI score of 48. Both of these scores are just below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Both visits completely lacked any sensitive fish taxa and also contained many short-lived species resulting in low metric scores. (Figure 270)

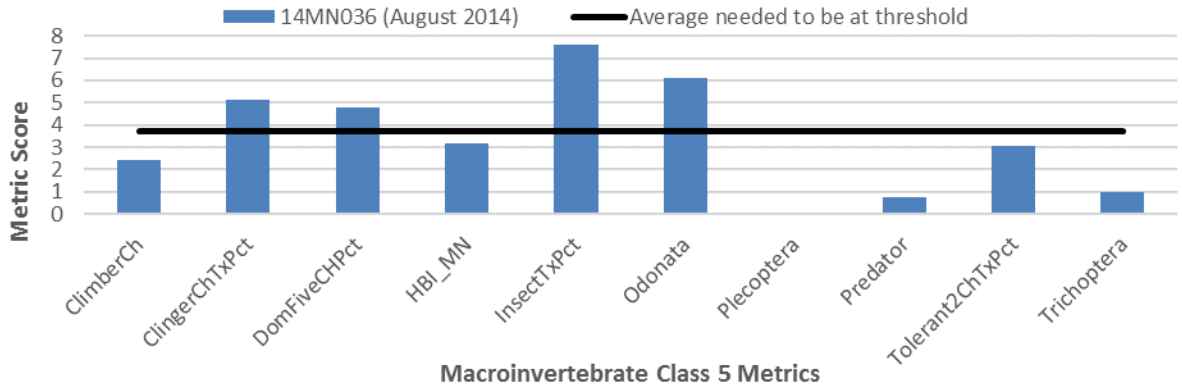
Figure 271. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 14MN036. The MIBI score for this visit was 34.1, which is slightly below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Four of the ten metrics comprising the MIBI for this class scored above the average needed to reach the threshold, while the remaining six scored below average or poorly. (Figure 271)

Figure 272. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years; values ranged from 8.66 mg/L to 13.65 mg/L at station S004-618. The lowest value was collected in August. None of the DO values in the limited dataset were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.5-14.2 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both visits lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The serial spawner percentages were both below 3%, well below the class average of sites that met the modified threshold. Species that are very tolerant to low DO conditions were not present as part of the fish community.

Table 518. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN036 (2014)	0	2.98	4	2.79	7.27	12	7.36
14MN036 (2015)	0	0.51	5	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There were 12 low DO intolerant taxa and only 2.79% of DO tolerant individuals present. No low DO values were present in the small dataset, and the preponderance of evidence indicates DO is not a stressor to the biological communities.

Candidate Cause Eutrophication

There is a small dataset on this reach, with phosphorus values ranging from 0.132 to 0.157 mg/L. The highest value was collected during August. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of this information is available. As a result of eutrophication, pH values also increase. pH values ranged from 8.19 to 8.4.

Table 519. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN036 (2014)	0	0.60	99.40	0	39	9.38	38.13
14MN036 (2015)	0	0	100	2.05	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.55**	**12.08**	**70.64**	**14.62**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter individuals were not present while tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the class average of sites that met the general threshold. EPT individuals were much lower than the class average at station 14MN036. The two most common macroinvertebrate species sampled comprised almost half of the community. Phosphorus values were elevated and the biological data was indicative of eutrophication stress however only five fish were collected likely inflating the fish metrics. Other metrics could be impacting the lack of fish collected, making eutrophication inconclusive as a stressor.

Candidate Cause Nitrate

Four nitrate samples were taken from Tributary to Le Sueur Creek (-768) from 2014-2016. These sample values ranged from 17-22 mg/L with an average nitrate concentration of 19.75 mg/L. The samples taken were from different times of the year and were consistently elevated. Quantile regression analysis of macroinvertebrate class 5 streams showed that when nitrate levels exceeded 18.1 mg/L, there was 75% probability of impairment. Three out of the four nitrate samples collected along this reach exceeded 19 mg/L.

Table 520. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN036	**7.69**	**62.42**	**0.00**	**3.65**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Tributary to Le Sueur Creek (-768) at site 14MN036 scored below average in all four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 520). This site completely lacked any nitrate intolerant species, while also having low numbers of Trichoptera taxa. This site also had a high number of nitrate tolerant species. These results all indicate likely stress from nitrates.

Based on the high observed nitrate values, the quantile regression analysis, in addition to the poor scoring macroinvertebrate metrics related to nitrates, nitrates are indeed a stressor to aquatic life in Tributary to Le Sueur Creek (-768).

Candidate Cause Sediment

From 2014-2016, four TSS samples were taken from Tributary to Le Sueur Creek (768). These sample values ranged from 6-88 mg/L with an average TSS concentration of 29.5 mg/L. One of these samples was above the 65 mg/L maximum standard for TSS. Additionally, four secchi tube measurements were taken from this reach from 2014-2016. These measurements ranged from 65-100 cm, with an average value of 81.5 cm.

The HSPF model also calculated daily TSS values for this subwatershed. These TSS concentrations ranged from 3.16-920.79 mg/L with an average concentration of 30.89 mg/L. Of these calculations, 825 (13.29%) were above the 65 mg/L standard for TSS. This is a high rate of exceedance.

Table 521. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN036	**2.35**	**0.00**	**1.03**	**0.30**	**2.05**	**0.00**	**79.95**	**0.00**	**0.00**	**11.83**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Tributary to Le Sueur Creek (-768) at site 14MN036 scored below average in eight of the ten metrics related to suspended sediment when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 521). This reach did have an above average amount of simple lithophilic individuals, while also having a good TSS Index Score. However, the remaining metrics scored well below average.

Table 522. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN036	15.17	0	7	27.02	31.56	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in two of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 522). This reach lacked TSS intolerant and Plecoptera taxa, but did score well in the remaining metrics.

The observed data set is fairly limited, however, one of the four TSS samples did exceed the 65 mg/L standard. The rate of exceedance predicated by the HSPF model is also very high for this subwatershed. The reach immediately downstream, Le Sueur Creek (-824) had a more extensive suspended sediment data set and did not indicate potential issues regarding suspended sediment. While the majority of the fish community metrics related to this parameter scored below average, the TSS Index score was good and there were a high amount of simple lithophilic individuals. These metrics scoring well is uncommon in streams being negatively impacted by suspended sediment. The macroinvertebrate assemblage also had a high amount of metrics scoring above average. Based on all of this information, suspended sediment is not a stressor to aquatic life in Tributary to Le Sueur Creek (-768) at this time.

Candidate Cause Habitat

Tributary to Le Sueur Creek (-768) had a qualitative habitat assessment take place at its biological monitoring site, 14MN036, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 70.5 (Good). Limiting the habitat conditions at this site was the presence of some silt and sand as substrates, light embeddedness, and moderate/high channel stability. See Figure 273 for a further breakdown of the MSHA category scores.

Figure 273. Habitat metric scores

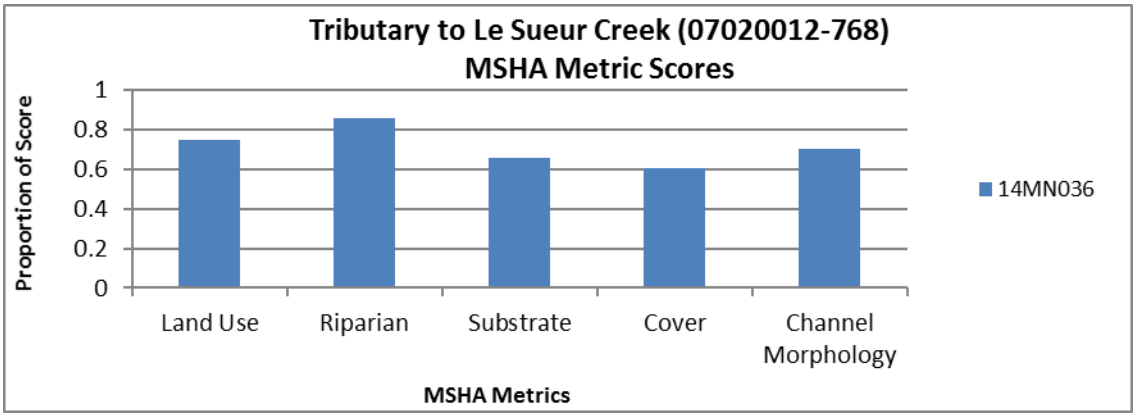


Table 523. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN036	**0.30**	**79.95**	**0.30**	**2.05**	**0.00**	**97.96**	**99.70**	**17.28**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN036 along Tributary to Le Sueur Creek (-768) scored below average in five of the eight evaluated habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 523). The site consisted of only four species (blacknose dace, creek chub, bigmouth shiner, and johnny darter) and with exception of the johnny darter; all of the species are tolerant of degraded habitat conditions.

Table 524. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN036	**9.38**	**24.06**	**45.63**	**9.38**	**80.31**	**17.50**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in four of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold. The amounts of both legless and burrower individuals corresponds to the sand and silt substrates that were observed.

Both of the fish and macroinvertebrate habitat related metrics scored below average for the most part. However, the MSHA score was measured as good after multiple visits. It is possible that other factors are causing the decline in metric scores given the good habitat available. Therefore, it is inconclusive if habitat is a stressor to the impaired biological communities in Tributary to Le Sueur Creek (-768) at this time.

Candidate Cause Chloride/Ionic Strength

One chloride value was available on this reach, a value of 30.2 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 779 to 873 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 525. Metrics related to Ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN036 (2014)	39	2	4.69	9.38	0
14MN036 (2015)	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were both far below class average. Taxa count was just below the average. The macroinvertebrate community was comprised of 42.86% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidae (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised less than 1% of the fish community at both visits. The small dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this tributary to be about evenly split between modified and natural. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). There were no known connectivity issues. Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 1% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising a range of 96.43 to 97.44% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising less than 1% of the fish community during both visits. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.56% of the population.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. There is a perched culvert present at station 14MN036, which is affecting fish colonization from Le Sueur Creek. Altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Tributary to Le Sueur Creek (-768) are being stressed by Nitrates and Flow Alteration/Connectivity (Table 526). Eutrophication, Habitat, and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 546.

Table 526. Stressors on Tributary to Le Sueur Creek (-768)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Tributary to Le Sueur Creek	07020012-768	---	o	●	---	o	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

13.8 County Ditch 42 (-772)

Located in central Le Sueur county is the 2.34 mile long reach, County Ditch 42 (-772). This reach extends from School Lake to Clear Lake outlet. This stream is impaired for biology due to fish and macroinvertebrate assemblages. There is one biological monitoring station, 14MN030, along this stream reach.

Biology

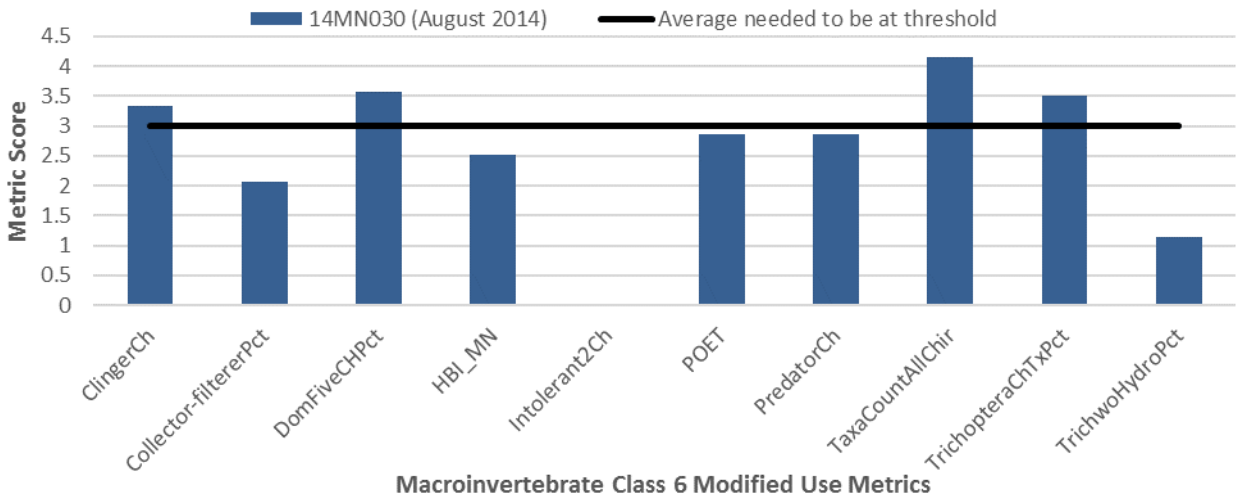
Fish

County Ditch 42 (-772) was sampled for fish in July of 2014 at its biological monitoring station 14MN030. This visit had a FIBI score of 0. Only six individual fish were sampled and consisted of very tolerant species (creek chub, white sucker).

Macroinvertebrates

The macroinvertebrate community was sampled in August of 2014 at site 14MN030. The MIBI score during this visit was 29.9, which is just below the Macroinvertebrate Class 6 Southern Forest Streams GP modified use threshold of 30.0. Four of the ten class metrics scored above the average needed to reach the threshold with a few metrics scoring just below. The MIBI score was limited with the Intolerant2Ch metric scoring zero (Figure 274).

Figure 274. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years; values ranged from 4.0 mg/L to 8.98 mg/L at station S004-618. The lowest value was collected in August. Two of the three values were below the water quality standard of 5 mg/L. Continuous data was not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.0-13.8 mg/L with less than 2% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Both visits lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawners were not present, falling well below the class average of sites that met the modified threshold. Species that are very tolerant to low DO conditions were not present in the fish community, however only 6 fish individuals were collected (creek chub and white sucker).

Table 527. DO related metrics	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN030	0	0	2	59	8.12	2	5.82
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. There was two low DO intolerant taxa and 59% of DO tolerant individuals present. Two of the three values were below 5 mg/L, and the macroinvertebrate community indicates DO stress. The fish response is more mixed, but DO is a stressor to the biological communities.

Candidate Cause Eutrophication

There is a small dataset on this reach, with phosphorus values ranging from 0.251 to 0.324 mg/L. The highest value was collected during July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.8 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of this information is available. As a result of eutrophication, pH values also increase. Values of pH over 8.5 are tied to eutrophication. pH values ranged from 7.5 to 8.06.

Table 528. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN030	0	0	100	33.33	37	5.99	56.47
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**6.02**	**1.48**	**76.7**	**19.80**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter individuals were not present while tolerant species comprised the entire fish community. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values higher than the class average of sites that met the general threshold. EPT individuals were much lower than the class average at station 14MN030. The two most common macroinvertebrate species sampled comprised slightly more than half of the community. Phosphorus values were elevated and the biological data was indicative of eutrophication stress however only six fish were collected likely inflating the fish metrics. Other metrics could be impacting the lack of fish collected, making eutrophication inconclusive as a stressor.

Candidate Cause: Nitrate

One nitrate sample was taken from County Ditch 42 (-772). This sample was 10 mg/L and was taken on 07/19/2014. Additionally, the HSPF model calculated daily nitrate values for this minor watershed from 1996-2012. These values ranged from 0.1-24.4 mg/L with an average nitrate concentration of 5.35 mg/L.

Table 529. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN030	5.78	37.56	0.00	3.25
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in County Ditch 42 (-772) at site 14MN030 scored below average in two of the four nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 529). Site 14MN030 did completely lack nitrate intolerant species and had a lower amount of Trichoptera taxa. These results can indicate possible nitrate stress. However, the site did have an above average Nitrogen TIV score, and the amount of nitrate tolerant taxa present was much less than other modified stream sites.

The HSPF model predicts that nitrate levels can reach some high concentrations, but for the most part the average nitrate concentration was relatively low for this minor watershed. The low percentage of nitrate tolerant taxa and the above average Nitrogen TIV score also indicate that nitrates are not a stressor to aquatic life in County Ditch 42 (-772) at this time.

Candidate Cause Sediment

One TSS sample was taken from County Ditch 42 (-772) in 2014. This value was 18 mg/L on July 9, 2014. Two secchi tube readings were also taken from this reach. These values were 37 cm on July 9, 2014 and 10 cm on August 13, 2014.

The HSPF model also calculated daily TSS values for this subwatershed from 1996-2012. These values ranged from 3.2-545.6 mg/L with an average TSS concentration of 20.6 mg/L. Of these calculations, 585 (9.42%) were above the 65 mg/L standard for TSS.

Table 530. Sediment related metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN030	**33.33**	**0.00**	**0.00**	**0.00**	**33.33**	**0.00**	**33.33**	**0.00**	**0.00**	**15.95**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 42 (-772) scored below average in seven of the ten suspended sediment related metrics at site 14MN030 when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 530). This reach had very few fish sampled (6), so the metric results are skewed.

Table 531. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN030	**18.31**	**0.00**	**12.50**	**72.55**	**8.14**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in County Ditch 42 (-772) scored below average in all six of the suspended sediment related metrics at site 14MN030 when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Use Threshold. This site had a very high amount of TSS tolerant taxa and TSS tolerant individuals, which often signals a stream being negatively impacted by suspended sediment.

The observed data set for this reach is very small, one of the secchi tube measurements was right at the minimum 10 cm. The HSPF model did predict a fairly high exceedance rate. The macroinvertebrate community in this reach scored very poorly in all of the metrics related to suspended sediment. While the fish assemblage scored poorly, albeit a small sample size. Based on this information, suspended sediment is a stressor to aquatic life.

Candidate Cause Habitat

County Ditch 42 (-772) had a qualitative habitat assessment take place at its biological monitoring site, 14MN030, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 28.85 (Poor). Limiting the habitat conditions at this site was the row crop agriculture as the dominant land use (Figure 275), a narrow riparian buffer, moderate bank erosion, severe embeddedness, light stream shading, sand and silt substrates, sparse fish cover, little depth variability, poor channel development, fair stream sinuosity, and moderate channel stability. See Figure 276 for a further breakdown of the MSHA category scores.

Figure 275. Site 14MN030 (August 31, 2016)

Figure 276. MSHA metric scores

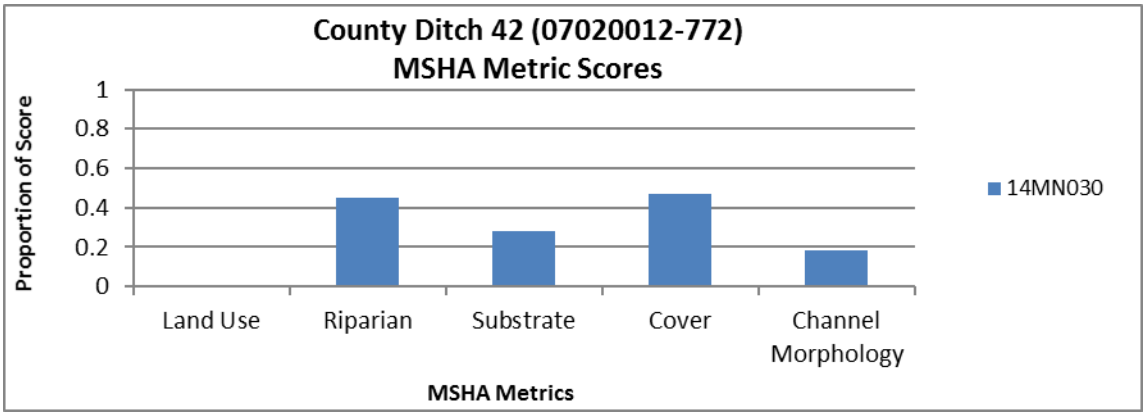


Table 532. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN030	**0.00**	**33.33**	**0.00**	**33.33**	**0.00**	**100.00**	**100.00**	**66.67**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 42 at site 14MN030 scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 532). The fish sample had a small sample size has only six individual fish were caught (4 Creek Chubs, 2 White Suckers). The small number of fish sampled may skew the metrics results. Both of the fish species caught are very tolerant. The low sample size may also be limited because of the poor habitat conditions present.

Table 533. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN030	**7.59**	**6.13**	**4.04**	**5.16**	**72.20**	**23.80**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**11.49**	**23.84**	**24.46**	**14.44**	**61.44**	**22.59**
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN030 scored below average in four of the six habitat related metrics when compared to all other Class 6 Southern Forest Streams GP station that meet the MIBI Modified Use Threshold (Table 533). The site contained many legless and EPT individuals, which can be a strong signal of degraded habitat conditions. The site also lacked climber and clinger individuals that are found more in abundance in streams with good habitat.

Based on the poor MSHA score, the poor scoring macroinvertebrate habitat related metrics, in addition to the very tolerant and barely present fish community, the lack of habitat is a stressor to the biological communities in County Ditch 42 (-772).

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 712 to 845 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 534. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN030	29	2	4	4.33	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					**1**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	36.65	*3.27*	*12.38*	*18.10*	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were both far below class average. Taxa count was just below the average. The macroinvertebrate community was comprised of 78.37% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength were not present in the fish community. The small dataset did not include highly elevated specific conductance or chloride values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this ditch to be 100% modified. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 8% of the time during the spring-fall months, however a downstream station went dry in 2013.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 100% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. Nest guarder species were not present in the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 8.67% of the population.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. There is a perched culvert present at station 14MN030 (Figure 277), which is affecting fish colonization from Forest Prairie Creek. Altered hydrology is a stressor.

Figure 277. Perched culvert at site 14MN030 (August 31, 2016)

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in County Ditch 42 (-772) are being stressed by Dissolved Oxygen, Suspended Sediment, Habitat, and Flow Alteration/Connectivity (Table 535). Eutrophication and Chloride were inconclusive as stressors at this point, while nitrates were ruled out as a stressor. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 547.

Table 535. Stressors on County Ditch 42 (-772)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 42	07020012-772	●	o	---	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Le Sueur Creek HUC 10 Conclusions and Recommendations

The Le Sueur Creek subwatershed contains eight biologically impaired stream reaches. Stressors found in at least three of the eight impaired reaches were Nitrates (5), Suspended Sediment (3), Habitat (5) and Altered Hydrology/Connectivity (4). Eutrophication was found to be a contributing stressor in two of the stream reaches while Dissolved Oxygen was found to be a stressor in one reach (Table 536).

Row crop agriculture is the dominant land use present in this watershed, Hay/pasture as well as developed areas are also in this subwatershed.

Significant issues in this watershed are related to the amount of nitrates entering the stream system. Often times, drain tiles are present in the areas with elevated nitrate levels and provide an easy pathway for nitrates to enter the stream system. Also, the headwaters in the agricultural and developed portions of this watershed are being impacted by the effects of channelization of the streams and contributing tributaries.

This is a major reason why these streams are impaired for aquatic life. These practices often lead to high nitrate and phosphorus levels through excessive use of fertilizers that can quickly reach the stream system by drain tiles and field runoff. These elevated phosphorus levels will also impact the dissolved oxygen conditions resulting in many more tolerant fish and macroinvertebrate communities.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat (most abundant stressor) and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

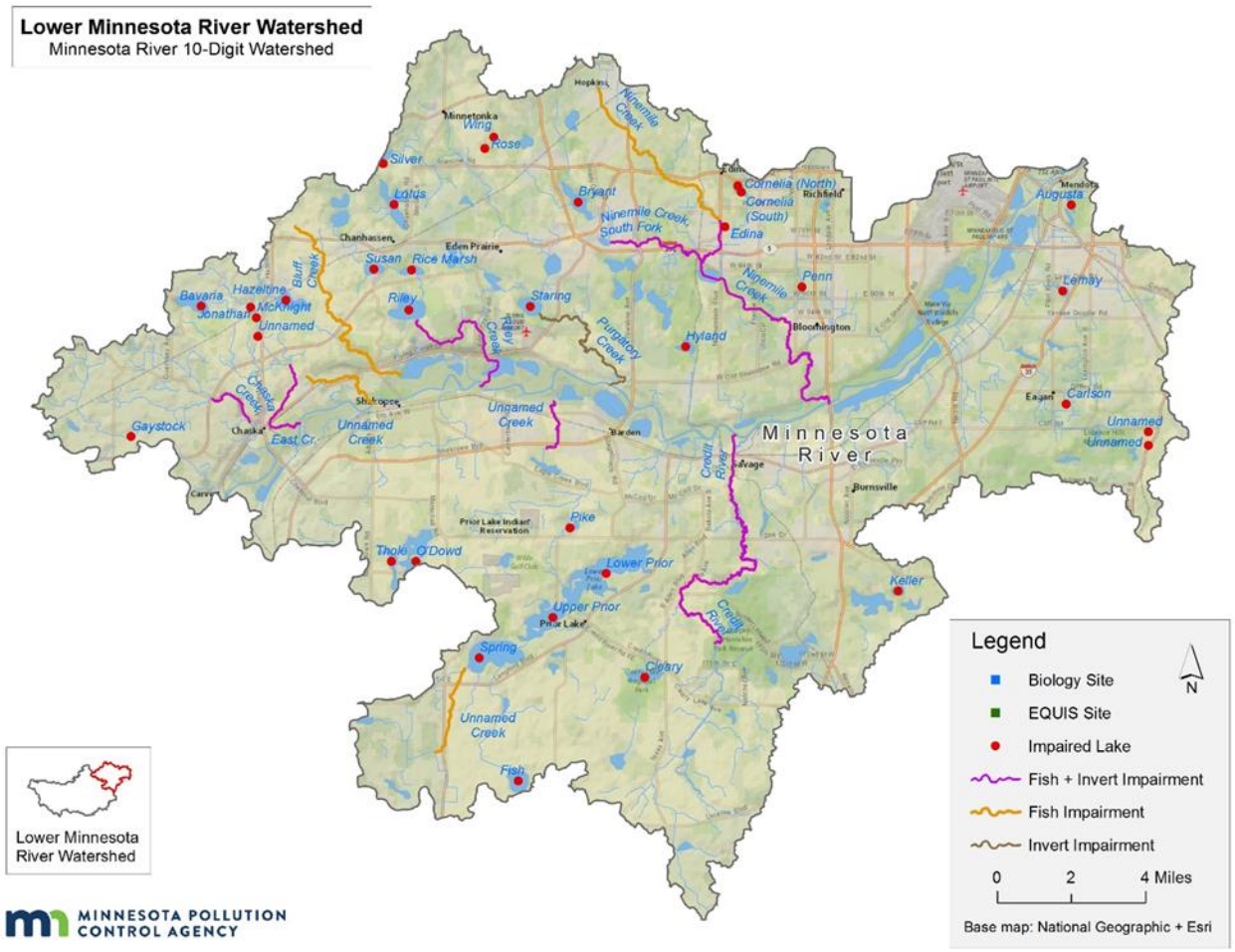
Improvements in the Le Sueur Creek watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the amount of nitrates being applied to the landscape and removing easy pathways for nitrates to enter the stream system. Also, there is a need to address flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. These improvements can both be applied to the agricultural and developed areas to this watershed.

Table 536. Stressors on the streams in the Le Sueur HUC 11

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Le Sueur Creek	07020012-823	---	●	o	●	●	o	o
Le Sueur Creek	07020012-824	---	●	●	---	●	●	o
Forest Prairie Creek	07020012-725	---	o	●	---	---	●	o
Unnamed ditch to Forest Prairie Creek	07020012-763	o	o	●	o	●	o	o
County Ditch 34	07020012-764	o	o	---	---	---	o	o
Judicial Ditch 4	07020012-767	o	o	●	●	●	o	o
Tributary to Le Sueur Creek	07020012-768	---	o	●	---	o	●	o
County Ditch 42	07020012-772	●	o	---	●	●	●	o

14. Minnesota River HUC 10 (0702001211)

Figure 278. Impaired streams in the Minnesota River HUC 11



14.1 Riley Creek (-511)

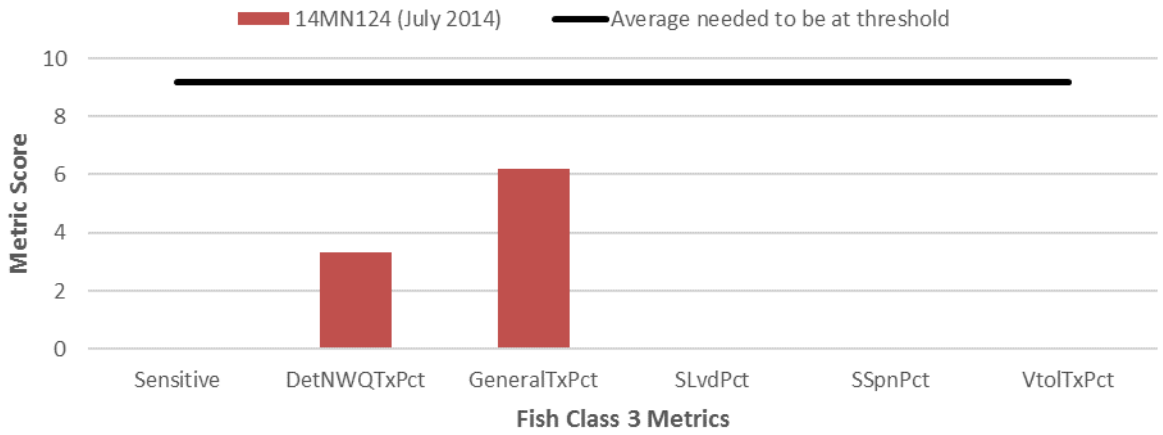
Riley Creek (-511) is a 4.98 mile long stream reach located in southwestern Hennepin county. This stream reach extends from Riley Lake to the Minnesota River. This reach is impaired for biology due to both its fish and macroinvertebrate assemblages, and is also impaired for Turbidity. The upstream Riley Lake is also impaired for nutrients and biology due to its fish community. This stream section has one biological monitoring station, 14MN124, located along it.

Biology

Fish

Riley Creek (-511) was sampled for fish at its biological monitoring station 14MN124 in July of 2014. The FIBI score from this visit was 0 and was limited by the presence of DELTs in two of the fish collected. DELTs are classified as deformities, eroded fin, lesions, or tumors found in the fish collected. For more information on the metric scoring please see Figure 279.

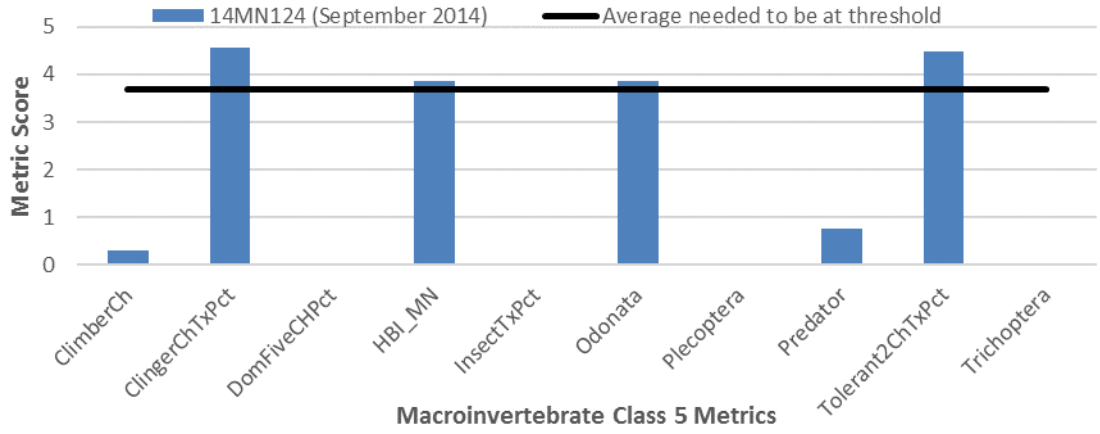
Figure 279. Fish metric scores



Macroinvertebrates

The macroinvertebrate community in Riley Creek (-511) was sampled in September of 2014 at site 14MN124. The MIBI score from this visit was 17.8, which is well below the Macroinvertebrate Class 5 Southern Streams RR general use threshold of 37. This site did have four metrics scoring above the average needed to reach the MIBI threshold, however, six metrics scored below average with four of those six scoring zero (Figure 280).

Figure 280. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a large dataset on this reach in recent years (2013-2016); values ranged from 5.8 mg/L to 13.3 mg/L. The lowest value was collected in July. None of the DO values were below the water quality standard of 5 mg/L. Continuous data is not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0-14.1 mg/L with 17% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach lacked any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner individuals comprised 50% of the population, well above the class average that met the general threshold. Species that are very tolerant to low DO conditions comprised 75% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; six low DO tolerant taxa were present and less than 1% of DO tolerant individuals. While the fish response is indicative of stress, DO is not a stressor to the macroinvertebrate community. DO as a stressor to the biological communities is currently inconclusive.

Table 537. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN124	0	50	5	0.63	7.03	6	7.65
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased TP stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause: Eutrophication

Phosphorus values are available on this stream from 2013 to 2016, ranging from 0.027 to 0.522 mg/L with 6% of values over the southern standard of 0.150 mg/L. The highest value was collected during May in Eden Prairie (station S009-332). The upstream Riley Lake is impaired for excess nutrients, which the DNR considers the most likely stressor to the fish community in the lake (DNR, 2017b). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.2 mg/L with a mean of 0.1 mg/L. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a values ranged from less than 1 to 63 mg/L with one value over the southern standard of 40 mg/L. BOD and DO flux data were not available. BOD values ranged from 1 to 5.3 with two values over the standard of 3.5 mg/L. As a result of eutrophication, pH values also increase. pH values ranged from 7.21 to 9.04. Values of pH over 8.5 are tied to eutrophication and 13% of pH values were over 8.5 out of 48 values.

Sensitive and darter individuals were not present on Riley Creek. Tolerant species comprised 65% of the fish community, less than the class average of sites meeting the general threshold. Along with tolerant species, a positive relationship exists between eutrophication and omnivorous fish. Omnivorous fish were present at values more than 4 times higher than the class average of sites that met the general threshold. EPT individuals were present at values higher than the class average at station 14MN124, however the most common macroinvertebrate collected is tolerant to eutrophic conditions. The two most common macroinvertebrate species sampled comprised slightly more than half of the community. Phosphorus and pH values were elevated and the biological data was indicative of eutrophication stress, however chlorophyll-a values were low. Based on the mixed chemistry, eutrophication is currently inconclusive as a stressor.

Table 538. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN124	0	0	65	65	22	57.86	51.26
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2005-2015, a total of 48 nitrate samples were taken from Riley Creek (-511). These nitrate values range from 0.13-2.16 mg/L with an average value of 1.44 mg/L. This a low value, especially compared to the western areas of the Lower Minnesota River Watershed.

Table 539. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN124	**9.09**	**49.22**	**0.00**	**2.97**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Riley Creek scored below average in three of the four nitrate related macroinvertebrate metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 539). The site completely lacked intolerant taxa, while having few Trichoptera species as well. The site did have slightly more nitrate tolerant taxa than average, but the nitrogen TIV score was above average.

Based on the very low observed nitrate data, with a sizeable data set, as well as an above average nitrogen TIV score and the other nitrate related metrics scoring near the average of similar sites passing the MIBI threshold, nitrates are not a stressor at this time along Riley Creek (-511).

Candidate Cause: Sediment

From 2013-2016, a total of 49 TSS samples were taken from Riley Creek (-511). These samples ranged from 2-180 mg/L with an average TSS concentration of 22.95 mg/L. Of these samples, five were at or above the 65 mg/L standard for TSS. Additionally, 85 secchi tube measurements were made along this reach from 2005-2015 with readings ranging from 2-100 cm, with an average value of 70.22 cm.

This reach was assessed and determined to be impaired for turbidity in 2002 and this impairment was confirmed again in 2016.

Table 540. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN124	**0.00**	**35.00**	**0.00**	**35.00**	**0.00**	**0.00**	**0.00**	**0.00**	**45.00**	**22.10**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Riley Creek (-511) at site 14MN124 scored below average in seven of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 540). This reach did have a large number of Centrarchid, long-lived, and Perciformid (perch-like) individuals, however the rest of the metrics scored poorly, especially the TSS Index score.

Table 541. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN124	16.09	0	5	43.57	45.91	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage along this reach scored below average in four of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 541). This reach did have an above average amount of collector filterer individuals and a low amount of TSS tolerant taxa, however the reach also had a high amount of TSS tolerant individuals, a complete lack of TSS intolerant and Plecoptera taxa, as well as a slightly below average TSS Index Score.

Based on the higher exceedance rate of the observed TSS samples, the majority of the suspended sediment related metrics in the fish and macroinvertebrate communities scoring subpar, as well as the current turbidity impairment along this reach concludes that suspended sediment is a stressor to aquatic life in Riley Creek (-511).

Candidate Cause: Habitat

Riley Creek (-511) had a qualitative habitat assessment take place at its biological monitoring site, 14MN124, during the fish and macroinvertebrate sampling events in 2014. The MSHA score from this visit was 73.2 (Good). Reducing the MSHA score at the habitat at this site was light embeddedness, some sand substrates, little to moderate bank erosion (Figure 281), and a sometimes narrow stream riparian buffer. Further MSHA analysis can be seen in Figure 282. In addition, Barr Engineering found tall eroding banks during a survey (RPBCWD, 2015).

Figure 281. Erosion and sedimentation at site 14MN124 (July 10, 2014)

Figure 282. Habitat metric scores

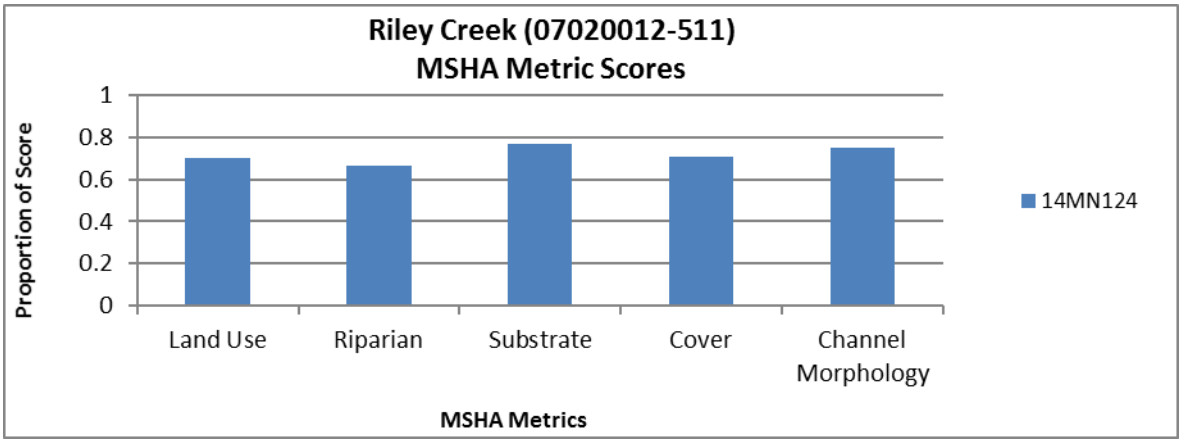


Table 542. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN124	**0.00**	**0.00**	**0.00**	**0.00**	**10.00**	**0.00**	**65.00**	**25.00**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at site 14MN124 was rather sparse and scored below average in five of the eight habitat related metrics when compared to Class 3 Southern Headwaters stations that met the FIBI General Use threshold (Table 542). These results may be a bit skewed due to the low sample size.

Table 543. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN124	0.94	6.60	66.67	57.86	11.32	24.53
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Riley Creek had only one below average habitat related metric score when compared to other Class 5 Southern Streams RR stations that met the MIBI General Use Threshold (Table 543). High amounts of EPT, clinger, and sprawler individuals along with lower amounts of burrower and legless individuals are all indicative of good habitat conditions.

Given the Good MSHA score and the majority of the macroinvertebrate habitat related metric scores, habitat is not a stressor in Riley Creek (-511). Other stressors are likely causing the low sample size in the fish community.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 506 to 870 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) percentage was just below the class average, while the EPT percentage was above the class average. Taxa count was far below the average. The macroinvertebrate community was comprised of 6.58% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Table 544. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN124	22	1	19.81	57.86	35
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were well above the class average. Species that are tolerant to conditions with high ionic strength comprised 65% of the fish community. The dataset did not include highly elevated specific conductance values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this creek to be 100% natural, while the upstream watershed is predominantly channelized. There were no known connectivity issues. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels. Channelization and tile drainage in the upstream watershed alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 26% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 65% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 60% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.89% of the population. While the reach has not been channelized, the upstream channelization seems to be influencing the frequent low flow periods, and the biological communities. Altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Riley Creek (-511) are being stressed by Suspended Sediment and Flow Alteration/Connectivity (Table 545). Dissolved Oxygen, Eutrophication, and Chloride were inconclusive as stressors at this point, while Nitrates and Habitat were ruled out as

stressors. For further information on the stressors and recommendations to fixing the stressors in the Le Sueur Creek HUC 10 watershed, please see page 653.

Table 545. Stressors on Riley Creek (-511)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Riley Creek	07020012-511	o	o	---	●	---	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.2 East Creek (-581)

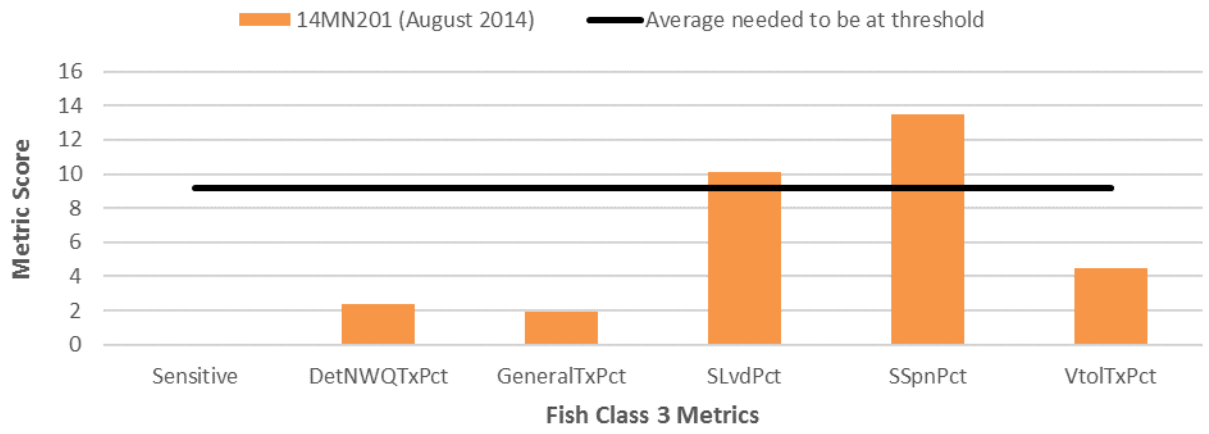
East Creek (-581) is a 3.09 mile long stream reach located in eastern Carver county. This reach extends approximately 1.25 miles upstream of Engler Road down to the confluence with the Minnesota River. This reach is impaired for biology due to the fish and macroinvertebrate assemblages found at the three biological monitoring sites (01MN008, 14MN125, 14MN201) located along this reach.

Biology

Fish

East Creek (-581) was sampled for fish at biological monitoring stations 01MN008 and 14MN201. The FIBI scores for these sites were 33.4 (01MN008) and 32.4 (14MN201). Both of these scores are well below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Site 14MN201 did score above the average needed to reach the threshold in two of the six metrics, while site 01MN008 scored below this level in all six of the metrics. Both sites lacked the presence of sensitive fish taxa limiting the FIBI score (Figure 283).

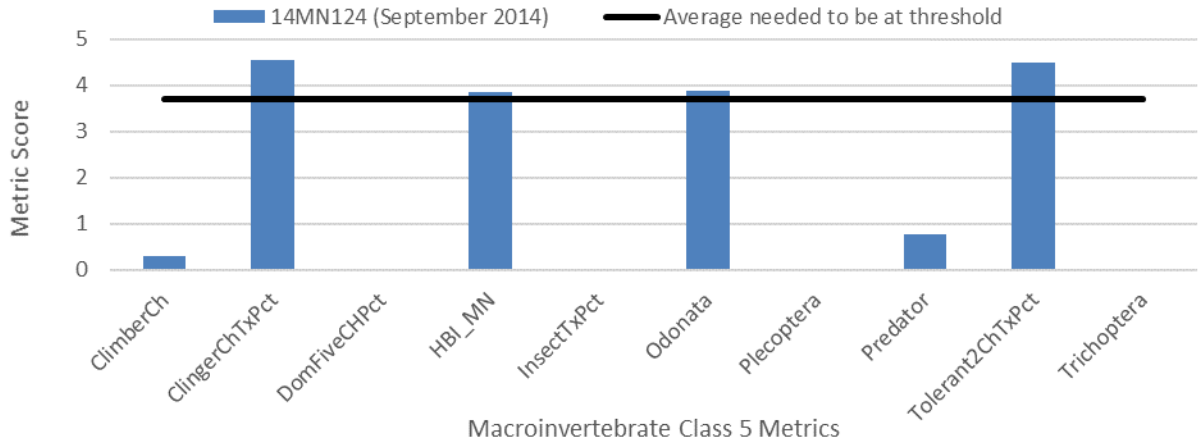
Figure 283. Fish metric scores



Macroinvertebrates

The macroinvertebrate community was sampled at all three sites along this reach. The MIBI scores from these visits were 29.0 (01MN008), 20.8 (14MN125), 29.6 (14MN201). All of these MIBI scores were below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. MIBI scores at each of the sites were limited by the lack of Plecoptera individuals present. See FIGURE for a further breakdown of the metric scores along East Creek (-581).

Figure 284. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 7.84 mg/L to 8.14 mg/L. The lowest value was collected in August. None of the limited DO values were below the water quality standard of 5 mg/L. Continuous data is not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.1-14.0 mg/L with 6% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach had no fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner individuals comprised 14.67% of the fish population, just below the class average that met the general threshold. Species that are very tolerant to low DO conditions comprised 19% of the fish community.

Table 546. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN201	0	14.67	7	0	6.94	7	7.62
14MN125	1.10	57.14	13	0.6	7.13	6	7.66
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; a range of 6-7 low DO tolerant taxa were present and less than 1% of DO tolerant individuals were present. No low DO values were collected in the small dataset, and the preponderance of the evidence indicates DO is not a stressor to the biological communities.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.01 to 1.86 mg/L with 18% over 0.150 mg/L. The highest value was collected in September in Chaska (station S001-761). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.2 mg/L with a mean of 0.2 mg/L.

Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range from 16% to 100% and an average of 58%. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. As a result of eutrophication, pH values also increase. pH values ranged from 7.66 to 8.3. BOD and DO flux data were not available. A small number of chlorophyll-a values ranged from 2.7 to 44 ug/L, with one chlorophyll-a value above the southern standard of 40 ug/L.

The two stations lacked any sensitive or darter species. Tolerant individuals comprised the entire fish community at both stations. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was slightly higher than the class average at station 14MN201, but was much lower at station 14MN125.

More than half of the macroinvertebrate sample was dominated by two species at both stations. The EPT percentages were both lower than the class average of sites that met the general threshold. Based on phosphorus and chlorophyll-a values and the preponderance of biological evidence eutrophication is a stressor.

Table 547. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN201	0	0	100	18.40	19	29.87	62.01
14MN125	0	0	100	2.04	23	27.88	54.85
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause Nitrate

From 2001-2015, a total of 243 nitrate samples were taken from Unnamed Creek/East Creek (-581). These values ranged from 0.05-15.5 mg/L, with an average value of 0.66 mg/L. This average value is very small compared to many of the western subwatersheds within the Lower Minnesota River Watershed.

Table 548. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
01MN008	5.71	73.20	0.34	4.17
14MN125	8.70	55.45	0.00	3.37
14MN201	10.53	28.57	0.00	2.88
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in four (01MN008, 14MN125) and two (14MN201), of the nitrate related biological metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 548). All three of the sites had low numbers of Trichoptera and nitrate intolerant taxa. However, site 14MN201 also had lower amounts of nitrate tolerant species, while also having a good nitrogen TIV score.

The extensive nitrate dataset, strongly suggests that the nitrate concentrations remain minimal for the majority of the time. It is likely that other stressors are causing some of the macroinvertebrate metric

scores to be lower. Nitrates are not a stressor to aquatic life in Unnamed Creek/East Creek (-581) at this time.

Candidate Cause Sediment

From 2005-2015, a total of 186 TSS samples were taken from Unnamed Creek/East Creek (-581). These sample values ranged from 1-1060 mg/L with an average TSS concentration of 45.22 mg/L. Twenty of the TSS samples were at or above the 65 mg/L standard for TSS. Additionally, from 2006-2015, 204 secchi tube measurements were taken along this reach. These readings ranged in value from 6-100 cm with an average value 63.85 cm. This reach was determined to be impaired for Turbidity during an assessment in 2008.

Table 549. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
01MN008	0.71	0.26	0.00	0.26	0.71	0.00	12.09	0.00	0.21	14.40
14MN125	0.27	0.00	0.00	0.00	0.27	0.00	23.73	0.00	3.47	n/a
14MN201	7.69	0.00	2.20	1.10	7.69	24.18	17.58	10.99	1.10	16.84
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in this reach scored below average in eight (14MN201) and nine (01MN008, 14MN125) of the ten metrics related to suspended sediment when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold. (Table 549). Site 14MN201 had above average numbers of sensitive and intolerant individuals, while scoring poorly in the remaining metrics. Site 01MN008 did have a good TSS Index Score, but scored below average in the other evaluated metrics.

Table 550. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
01MN008	17.14	0	12	65.98	9.31	0.00
14MN125	15.51	0	6	30.91	38.79	0.00
14MN201	15.43	0	6	33.77	74.35	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in two (14MN125, 14MN201) and six (01MN008) of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 550). All three sites completely lacked TSS intolerant and Plecoptera taxa. Site 01MN008 scored much worse in these metrics than the other two sites.

Based on the high number of TSS sample exceedances, the current turbidity impairment, and many of the biological metrics related to suspended sediment scoring below average, especially at site 01MN008, suspended sediment is a stressor to aquatic life in Unnamed Creek/East Creek (-581) at this time.

Candidate Cause Habitat

East Creek (-581) had qualitative habitat assessments take place at its biological monitoring sites, 01MN008, 14MN125, and 14MN201, during the fish and macroinvertebrate sampling events in 2001 and 2014. The average MSHA scores from these visits was 54.75 (Fair) at 01MN008, 54.6 (Fair) at 14MN125, and 66.63 (Good) at 14MN201. Limiting the MSHA scores at these sites was a narrow to moderate riparian buffer, little to moderate bank erosion, sand substrates, low to moderate channel stability, and poor sinuosity, especially at site 14MN125. A breakdown of the MSHA category scores for these sites can be seen in Figure 285.

Figure 285. Habitat metric scores

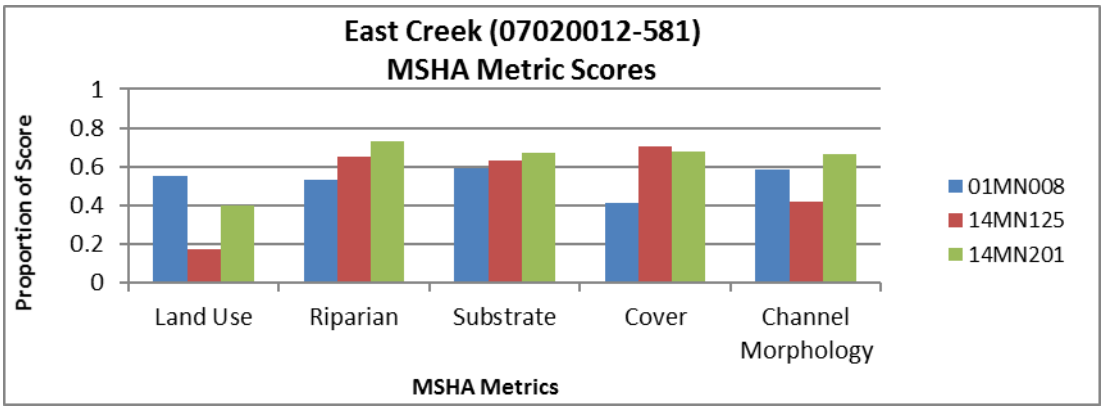


Table 551. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
01MN008	**0.00**	**12.09**	**0.00**	**0.71**	**0.21**	**56.07**	**99.74**	**85.04**
14MN125	**0.00**	**17.58**	**0.00**	**7.69**	**0.00**	**28.57**	**46.15**	**26.37**
14MN201	**0.00**	**23.73**	**0.00**	**0.27**	**0.00**	**80.80**	**100.00**	**71.73**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (50.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Unnamed Creek/East Creek (-581) scored below average in at least six of the eight habitat related metrics in the three sites sampled along this reach when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 551). The sampled sites lacked a lot of fish species that require specialized habitat conditions and instead consisted of many tolerant species.

Table 552. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
01MN008	9.31	61.72	11.03	9.31	74.14	13.45
14MN125	5.45	24.24	62.73	27.88	37.88	6.06
14MN201	0.97	8.77	86.69	29.87	16.56	3.25
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek/East Creek (-581) scored below average in three (14MN125, 14MN201) and five (01MN008) of the six evaluated habitat metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 552). All of the sites on this reach showed lower amounts of EPT and Sprawler individuals. This commonly occurs in degraded streams.

The MSHA scores along this reach ranged from fair to good, however the majority of the fish metrics related to habitat scored below average and to a slightly lesser extent, the macroinvertebrates did as well. Habitat is a stressor to the biological communities in this reach.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 374 to 1258 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). 19% of the values were over 1,000 uS/cm.

Table 553. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN201	19	2	8.77	29.87	0
14MN125	23	1	22.42	27.88	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below class averages, while the taxa count was also far below the average. The macroinvertebrate community was comprised of a range of 19.16 to 30% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised 19% of the fish community. The dataset did not include highly elevated specific conductance values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this creek to be almost entirely modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 20% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised a range of 45.05 to 98.33% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 15.47 to 17.58% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0.90 to 3.57% of the population. The channelization is likely contributing to the lack of habitat and seems to be influencing the frequent low flow periods. The biological results indicate altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in East Creek (-581) are being stressed by Eutrophication, Suspended Sediment, Habitat and Flow Alteration/Connectivity. (Table 555) Chloride was inconclusive as a stressor at this point, while Dissolved Oxygen and Nitrates were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 554. Stressors on East Creek (-581)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
East Creek	07020012-581	---	●	---	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.3 Assumption Creek (-582)

Assumption Creek (-582) is a 2.78 mile long stream reach located in northeastern Carver county. This stream reach begins just southeast of Falls Curve in Chaska and extends to the confluence with the

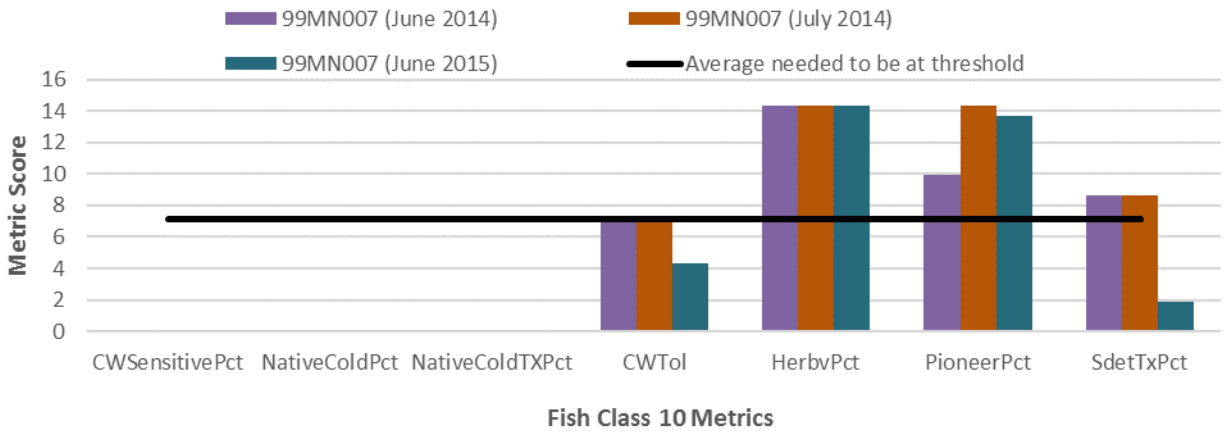
Minnesota River. This reach is impaired for biology due to the fish assemblage at the one biological monitoring station, 99MN007, located along this stream section. Assumption is a DNR designated trout stream.

Biology

Fish

Assumption Creek (-582) was sampled for fish three different times, June and July of 2014 and June of 2015, at its biological monitoring site 99MN007. The FIBI scores for these visits were 39.9 (June 2014), 44.3 (July 2014), and 34.2 (June 2015). All three visits scored well in the HerbvPct and PioneerPct metrics, but also scored poorly in three metrics due to the lack of coldwater sensitive individuals, native coldwater individuals, and native coldwater taxa (Figure 286).

Figure 286. Fish metric scores



Candidate Cause Dissolved Oxygen

There is a limited DO dataset on this reach in recent years. Concentrations ranged from 7.64 mg/L to 8.54 mg/L. In the limited dataset, no values were below the coldwater standard of 7 mg/L. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 4.6-16.0 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There was a range of 0 to 6.67% during three visits, all much lower than class averages. Individuals that mature at greater than 3 years of age was 17.53% in 1999 and decreased to 0 at one visit in 2014 and the visit in 2015. Low DO values also correspond with increased serial spawning fish percentage. The two visits were in 2014 were zero, while the 2015 had a percentage slightly higher than the class average with 2.33%. Fish taxa decreased from 11 in 1999 to 4 in 2014 and 5 in 2015. In coldwater streams however, fish diversity tends to be lower and restricted to coldwater species.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed from the one sample collected in 2014. Station 99MN007 had a high number of intolerant species and the number of individuals tolerant to low DO was 0. In the limited DO dataset there were no low DO values, however there was a value of 7.64 mg/L. Low DO is not a stressor to the macroinvertebrate community. Low DO as a stressor to the fish community is inconclusive. While serial spawner species are very low indicating a lack of disturbance, the number of species that reproduce at a mature age was very low. While these species could be affected by other stressors, that fact that the numbers have decreased since 1999 indicate conditions are changing for the worst.

Table 555. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
99MN007 (6/11/14)	0	0	4	0	6.49	10	7.83
99MN007 (7/7/14)	6.67	0	4	NA	NA	NA	NA
99MN007 (2015)	0	2.33	5	NA	NA	NA	NA
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	**60.28**	**1.79**	**5.69**				
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)				**1.66**	**0**	**10.32**	**7.44**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.024 to 0.038 mg/L. The highest value was collected in July at station 99MN007. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.0 mg/L with a mean of 0.2 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. As a result of eutrophication, pH values also increase. pH values ranged from 7.66 to 8.3. The coldwater standard for pH is a range of 6.5-8.5. BOD, chlorophyll-a, and DO flux data were not available.

Table 556. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
99MN007 (6/11/14)	33.33	0	66.67	0	17	12.10	74.84
99MN007 (7/7/14)	6.67	0	80	0	NA	NA	NA
99MN007 (2015)	46.51	41.86	53.49	2.33	NA	NA	NA
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	**74**	**3.27**	**22.46**	**14.51**			
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)					**29.48**	**40.36**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Station 99MN007 lacked any darters in 2014 but the number increased to 46.51% in 2015 based on 18 Iowa darters collected. Sensitive species ranged from 6.67 to 46.51%, all below the class average of sites meeting the general threshold. Tolerant individuals ranged from 53.49 to 80% of the fish community, all above the class average. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was less than 3% during each visit. The macroinvertebrate community was sampled once. More than 74% of the macroinvertebrate sample was dominated by two species. The EPT percentage was much lower than the class average. Phosphorus values in the limited dataset were all low while the biological evidence was mixed. Eutrophication was inconclusive as a stressor.

Candidate Cause Nitrate

From 2014-2015, a total of three nitrate samples were taken from Assumption Creek (-582). These nitrate concentrations ranged from 0.23-0.35 mg/L with an average value of 0.29 mg/L. This value is very low especially when compared to other parts of the Lower Minnesota River Watershed.

Table 557. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
99MN007	17.65	29.30	0.32	2.94
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*66.67*	*58.72*	*0.63*	*3.08*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 99MN007 in Assumption Creek (-582) scored below average in two of the four nitrate related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 557). This reach had lower amounts of Trichoptera and nitrate intolerant taxa. However, the nitrogen TIV score was above average and there were fewer Nitrate tolerant species, which can signal a stream not negatively impacted by excessive nitrates.

Based on the very low observed nitrate concentrations, as well as the low numbers of nitrate tolerant macroinvertebrate species and good Nitrogen TIV score, nitrates are not a stressor in Assumption Creek (-582).

Candidate Cause Sediment

From 2014-2015, a total of three TSS samples were collected from Assumption Creek (-582). These sample values ranged from 4.4-12 mg/L with an average TSS concentration of 7.6 mg/L. Additionally, four secchi tube measurements were taken along this reach from 2014-2015. All four of these readings were 100 cm, indicating no issues with suspended sediment.

Table 558. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
99MN007	9.02	0.26	0.00	19.49	6.56	26.01	0.77	15.29	9.00	14.35
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	*28.37*	*0.53*	*0.32*	*3.85*	*34.82*	*72.53*	*21.06*	*26.00*	*53.81*	*10.39*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Assumption Creek (-582) scored below average in nine of the ten suspended sediment related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 558). The site, 99MN007, did have a higher amount of Perciformid (perch-like) individuals, but scored below average in the remaining metrics.

Table 559. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
99MN007	**13.66**	**1**	**1**	**8.28**	**66.56**	**0.00**
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*13.56*	*2.33*	*5.49*	*13.36*	*32.86*	*0.26*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in this reach scored below average in three of the six suspended sediment related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 559). This reach had a low amount of TSS tolerant taxa and individuals, while also having a high amount of collector filterer individuals.

Based on the groundwater-fed nature of this stream, the chemical data showed no indication of suspended sediment related stress as all TSS measurements were very low and the secchi tube readings were as high as the equipment reads. The biological metrics are likely being negatively impacted by other metrics as suspended sediment is not a stressor to aquatic life in this reach.

Candidate Cause Habitat

Assumption Creek (-582) had qualitative habitat assessments take place at its biological monitoring site 99MN007 during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 65.49 (Fair). The MSHA score was limited at this site due to sand and silt substrates, light to moderate embeddedness, moderate channel stability, and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 287.

Figure 287. Habitat metric scores

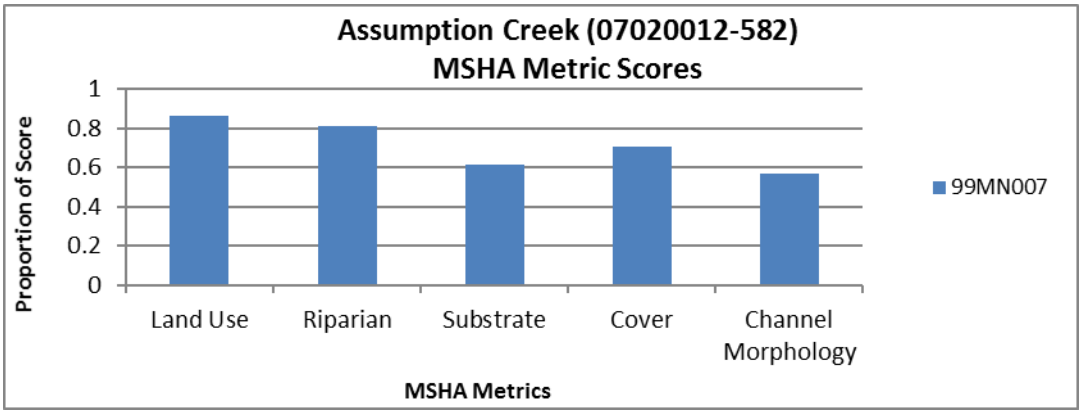


Table 560. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
99MN007	18.97	0.77	18.97	6.56	8.75	12.53	56.48	17.12
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	*21.41*	*21.06*	*18.34*	*34.82*	*53.58*	*76.14*	*23.90*	*4.80*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage at site 99MN007 in Assumption Creek (-582) scored below average in seven of the eight habitat related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 560). The site did have an above average amount of darter/sculpin/sucker individuals, which normally does not occur in a stream with degraded habitat conditions.

Table 561. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
99MN007	0.32	8.92	76.75	12.10	13.38	13.69
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*3.23*	*7.24*	*44.78*	*39.30*	*23.21*	*19.10*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 99MN007 scored below average in two of the six habitat related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 561). The site did have lower numbers of EPT and sprawler individuals, however it did have higher numbers of clinger and climber species while having fewer burrower and legless taxa which are much more present in degraded systems.

The MSHA score at 99MN007 is fair, but scored just below the value considered to be Good, and the macroinvertebrate community, while not impaired, did not show many signals to being impacted by poor habitat conditions. It is likely that another factor is driving the fish metric scores lower and habitat is not a stressor to Assumption Creek (-582) at this time.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 650 to 720 uS/cm. All continuous data

collected in 2017 was below 780 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values were over 1,000 uS/cm.

Table 562. Metrics related to ionic strength

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below class averages, while the taxa count was also below the average. The macroinvertebrate community was comprised 8.92% conductivity tolerant individuals. One conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised a range of 26 to 33% of the fish community. The dataset did not include highly elevated specific conductance values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this creek to be about evenly distributed between natural and modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is not experiencing low flow at less than 1 cfs during the spring-fall months.

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
99MN007 (6/11/14)	**17**	**1**	**9.55**	**12.01**	**0**
99MN007 (7/7/14)	NA	NA	NA	NA	0
99MN007 (2015)	NA	NA	NA	NA	0
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)					**0.58**
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	**29.48**	**2.37**	**22.15**	**40.86**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised a range of 2.33 to 19.59% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 25.48 to 43.59% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 0.64% of the population. Based on the lack of low flow periods and the mixed biological results, altered hydrology is inconclusive as a stressor.

Conclusions and recommendations

The impaired fish community in Assumption Creek (-582) currently does not have a conclusive stressor (Table 563). Dissolved Oxygen, Eutrophication, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point, while Nitrates, Suspended Sediment, and Habitat were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 563. Stressors on Assumption Creek (-582)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Assumption Creek	07020012-582	o	o	---	---	---	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.4 Unnamed Creek (County Ditch 13) (-604)

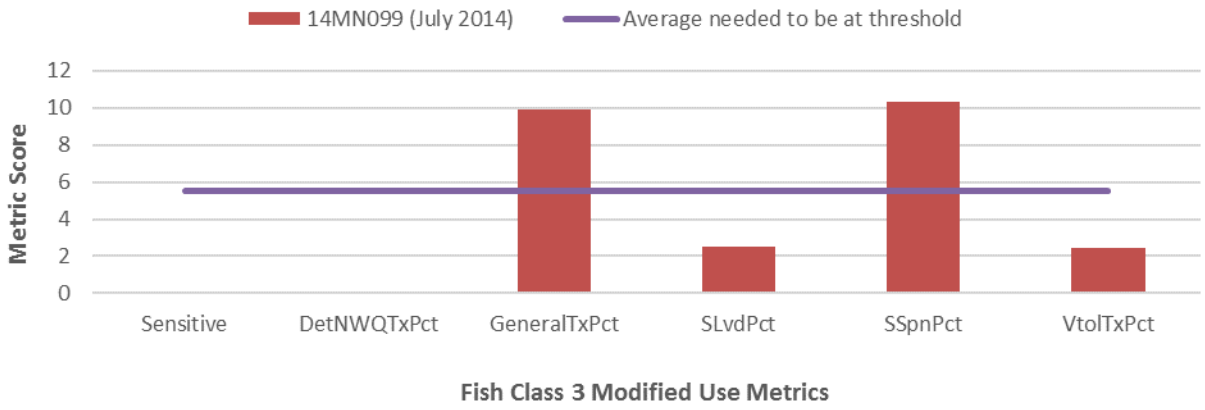
Unnamed Creek (County Ditch 13) (-604) is a 2.77 mile long reach located in central Scott County, and is a tributary to Spring Lake. This reach extends from an unnamed ditch to the confluence with Spring Lake located in the City of Prior Lake. This reached is impaired for biology due to the fish assemblage at the one biological monitoring station, 14MN099, located along this reach.

Biology

Fish

County Ditch 13 was sampled for fish at its biological monitoring site, 14MN099, in July of 2014. The FIBI score during this visit was 25.3, which is below the Fish Class 3 Southern Headwaters modified use threshold of 33. This visit did have lower numbers of serial spawning and generalist feeding taxa which resulted in high FIBI metric scores. However, the other four metrics comprising the Class 3 IBI scored poorly (Figure 288).

Figure 288. Fish metric scores



Candidate Cause Dissolved Oxygen

There was a small dataset on this reach in recent years (2014-2016); values ranged from 5.11 mg/L to 8.4 mg/L. The lowest value was collected in July. None of the limited DO values were below the water quality standard of 5 mg/L, but 33% of values collected in 2002 were below 5 mg/L (0.5-4.9 mg/L). Continuous data is not available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.7-12.9 mg/L with 7% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach had no fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. Serial spawner individuals comprised 29.29% of the fish population, twice the class average that met the general threshold. Species that are very tolerant to low DO conditions comprised 87% of the fish community.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; one low DO tolerant taxa were present and 25.16% of DO tolerant individuals were present. No low DO values were collected recently, but the preponderance of the evidence indicates DO is a stressor to the biological communities.

Table 564. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN099	0	29.29	4	25.16	7.91	1	6.37
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**					
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)				**24.32**	**7.66**	**3.20**	**6.39**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.196 to 1.69 mg/L with 65% over 0.150 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.7 mg/L with a mean of 0.2 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range from 5% to 92% and an average of 53%. Chlorophyll-a, BOD, and DO fluctuations values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. As a result of eutrophication, pH values also increase. pH values ranged from 7.1 to 8.63. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. BOD, chlorophyll-a, and DO flux data were not available.

Table 565. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN099	0	0	98.44	3.13	44	13.69	34.71
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)					**39.46**	**30.92**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The biological station lacked any sensitive or darter species. Tolerant individuals comprised almost the entire fish community. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was much lower than the class average at station 14MN099.

Less than half of the macroinvertebrate sample was dominated by two species. The EPT percentage was lower than the class average of sites that met the modified threshold. Based on phosphorus and pH values, and the preponderance of biological evidence eutrophication is a stressor.

Candidate Cause Nitrate

Unnamed Creek (-604) had one nitrate sample taken on 07/28/2014. This nitrate concentration was 1.1 mg/L. No drain tiles were found during the sampling of this stream. The HSPF model calculated daily nitrate values for this subwatershed from 1996-2012. These values ranged from 1.3-19.1 mg/L with an average readings of 5.0 mg/L.

Table 566. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN099	4.55	66.24	0.00	3.47
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*6.67*	*61.18*	*0.31*	*3.30*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Unnamed Creek (County Ditch 13) (-604) scored below average in all four of the nitrate related metrics when compared to all other Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 566). The biological station, 14MN099, had zero nitrate intolerant species, while having a high amount of nitrate tolerant species. The site also had few Trichoptera taxa.. These results suggest that the reach is being stressed by nitrates.

The macroinvertebrate data in this reach suggests that nitrates are a stressor. However, the only observed nitrate concentration was very low and the modeling information does not strongly signal that nitrates are an issue. Additional chemistry data is needed to confirm any impacts that nitrates are having on aquatic life in this stream reach. Nitrates are inconclusive as a stressor at this time.

Candidate Cause Sediment

From 2000-2014, a total of 107 TSS samples were taken from County Ditch 13 (-604), with the majority being between (2000-2002). These sample values ranged from 4-130 mg/L with an average TSS concentration of 19.86 mg/L. Of these samples, four were above the 65 mg/L standard for TSS. Also, in 2014, two secchi tube measurements were made along this reach. These readings were 22 cm on July 28, 2014 and 42 cm on August 26, 2014.

Additionally, the HSPF model calculated daily TSS concentrations for this subwatershed from 1996-2012. These values ranged from 2.4-595.7 mg/L with an average TSS concentration of 17.7 mg/L. Of these calculations, 415 (6.68%) were above the 65 mg/L standard for TSS.

Table 567. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN099	13.13	0.00	0.00	0.00	13.13	0.00	13.13	0.00	0.00	17.15
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in County Ditch 13 (-604) scored below average in all ten of the suspended sediment related metrics when compared to all other fish Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 567). These metric results are a signal for likely suspended sediment stress.

Table 568. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN099	**17.55**	**0**	**18**	**45.54**	**15.92**	**0.00**
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	*15.13*	*0.80*	*9.91*	*27.50*	*15.86*	*0.06*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN099 scored below average in five of the six suspended sediment related metrics when compared to all other macroinvertebrate Class 6 Southern Forest Streams GP stations that meet the MIBI Modified Use Threshold (Table 568). This reach did have a slightly above average number of collector filterer individuals, however, it scored poorly in the remaining metrics and especially had a high number of TSS tolerant taxa.

The observed data set, showed just a few exceedances of the TSS and secchi tube standards. The model also calculated a relatively low standard exceedance rate. Therefore, suspended sediment is not a stressor to aquatic life at this time. The fish and macroinvertebrate communities are likely being negatively impacted by other stressors resulting in lower metric scores.

Candidate Cause Habitat

County Ditch 13 (-604) had a qualitative habitat assessment take place at its biological monitoring site, 14MN099, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 33.8 (Poor). Limiting the habitat at this site was the row crop agriculture comprising the majority of the land use, the narrow stream riparian buffer, sand and silt substrates that has covered many course substrates, severe embeddedness, sparse fish cover, limited depth variability, moderate channel stability, fair channel sinuosity, and poor channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 289.

Figure 289. Habitat metric scores

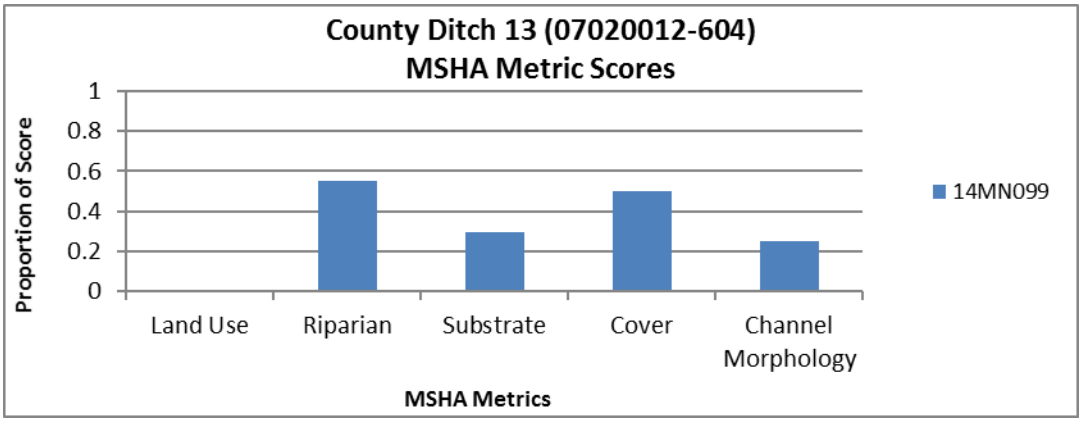


Table 569. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffliePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN099	**0.00**	**13.13**	**0.00**	**13.13**	**0.00**	**13.13**	**100.00**	**29.29**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage at the channelized biological station, 14MN099, along County Ditch 13 (-604) scored below average in 7 out of 8 habitat related metrics when compared to all other Class 3 Southern Headwaters Modified Use streams. Many of these metric scores were well below the scores achieved at sites meeting the designated use threshold.

Table 570. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN099	21.02	24.84	22.93	13.69	79.62	9.24
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	11.49	23.84	24.46	14.44	61.44	22.59
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

While the macroinvertebrate assemblage in County Ditch 13 (-604) is currently not impaired, the majority of the habitat related metrics scored below the average of sites meeting the Class 6 Southern Forest Streams GP Modified Use threshold (Table 570). The high amount of both burrower and legless macroinvertebrates often signals the presence of organic matter and lack of course substrates.

Given the high amount of poor scoring habitat metrics in both the fish and macroinvertebrate communities as well as the poor scoring MSHA at site 14MN099, habitat is indeed a stressor to the impaired fish assemblage in County Ditch 13 (-604)

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 520 to 653 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values in the small dataset were over 1,000 uS/cm.

Table 571. Metrics related to ionic strength

	TaxaCountAllChir	**EphemeropteraCh**	**EphemeropteraPct**	**EPTPct**	**Cent-TolPct**
14MN099	44	4	8.92	13.69	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					1
Statewide average for Class 6 Southern Forest Streams GP stations that are meeting the MIBI Modified Use Threshold (30.0)	**36.65**	**3.27**	**12.38**	**18.10**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors.

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below class averages, while the taxa count was above average. The macroinvertebrate community was comprised of 46.82% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised 84% of the fish community. The dataset did not include elevated specific conductance values, while the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured this creek to be 100% modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 25% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 42.42% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised 83.84% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.59% of the population. The channelization is likely contributing to the lack of habitat and seems to be influencing the frequent low flow periods. The biological results indicate altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish community in County Ditch 13 (-604) is being stressed by Dissolved Oxygen, Eutrophication, Habitat and Flow Alteration/Connectivity (Table 572). Nitrates and Chloride were inconclusive as stressors at this point, while Suspended Sediment was ruled out as a stressor. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 572. Stressors on Unnamed Creek (County Ditch 13 -604)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
County Ditch 13	07020012-604	●	●	o	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.5 Bluff (-710)

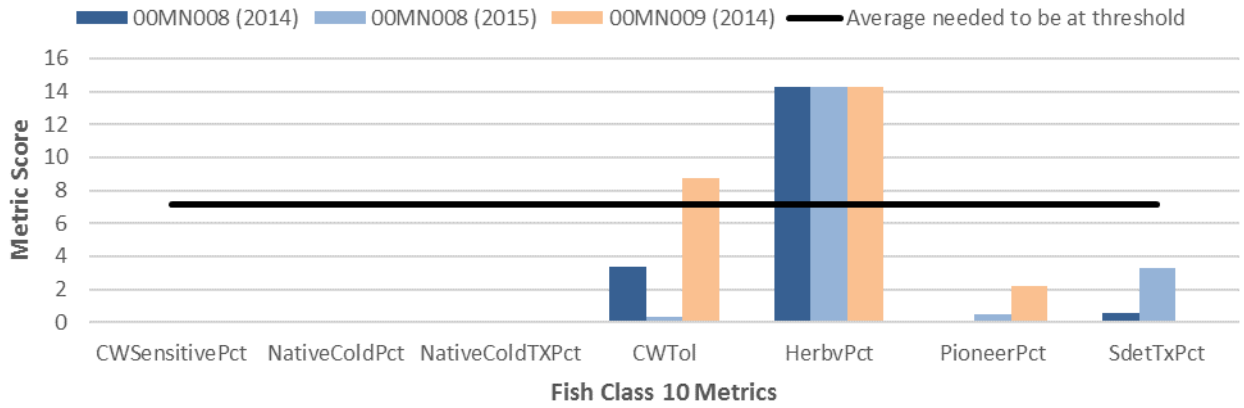
Bluff Creek (-710) is a 7.17 mile long stream reach located in northeastern Carver county. This stream section extends from just upstream of County Highway 117 and extends to Rice Lake. This reach is impaired for biology due to the fish assemblage. There are two biological monitoring stations, 00MN008 and 00MN009, located along this reach. A Stressor ID Report was completed in 2010 by Barr Engineering which identified habitat fragmentation, sediment, flow, and metal contamination as stressors (Barr 2010).

Biology

Fish

Bluff Creek (-710) was sampled for fish four times since 2014 at its biological monitoring stations 00MN008 and 00MN009. Site 00MN008 was sampled both in 2014 and 2015 (twice) and had FIBI scores of 18.2 (2014) had an average FIBI score of 18.4 during the 2015 visits. Site 00MN009 had a FIBI score of 25.2 during its fish sampling visit in 2014. All of these scores are well below the Fish Class 10 Southern Coldwater streams general use threshold of 50. These visits lacked many coldwater species and the community remains overwhelmingly dominated by tolerant species and is more indicative of a warmwater stream, demonstrating evidence of severe degradation of the fish community" (MPCA 2017).

Figure 290. Fish metric scores



Candidate Cause Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years. Concentrations ranged from 0.91 mg/L to 12.25 mg/L with 47% of values under the coldwater DO standard of 7 mg/L. All eight water chemistry stations throughout the entire reach had low DO values. The lowest values were sampled at station S009-308 (00MN009) in July.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.1-13.7 mg/L with 6% of values below the water quality standard of 7 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There was a range of 0 to 7.14% during three visits, all much lower than the class average. Individuals that mature at greater than 3 years of age was zero at station 00MN009, and 7.14 and zero during the 2014 and 2015 visits at station 00MN008. Low DO values also correspond with increased serial spawning fish percentage. The three visits all had percentages much higher than the class average. 86%-100% of the fish community was comprised of fish species that are very tolerant to low DO conditions at the three fish visits.

Table 573. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
00MN008 (2014)	7.14	14.29	6	0	6.36	5	7.78
00MN008 (2015)	1.10	25.37	13	NA	NA	NA	NA
00MN009	0	46.67	2	0	6.46	6	7.86
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	**60.28**	**1.79**	**5.69**				
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)				**1.66**	**0**	**10.32**	**7.44**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed. Station 99MN007 had a high number of intolerant species and the number of individuals tolerant to low DO was 0. Low DO is not a stressor to either the fish or macroinvertebrate communities.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.031 to 1.8 mg/L with 45% over 0.150 mg/L. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.4 mg/L with a mean of 0.3 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range from 19% in January to 100% in June and an average of 74%.

Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a samples had a range of values from 1 to 60, with one value over the southern standard of 40. BOD values ranged from 1 to 12 with 11% of values over the standard of 3.5 mg/L. As a result of eutrophication, pH values also increase. pH values ranged from 6.87 to 8.58. The coldwater standard for pH is a range of 6.5-8.5. Continuous DO data collected in 2017 showed daily fluctuations ranging from 0.16 to 1.18 mg/L. pH daily fluctuations ranged from 0.04 to 0.55. The only elevated pH fluctuation (0.55) was after a 2.35 in rainfall.

The two stations had lower than average sensitive or darter species. Tolerant individuals comprised more than 85% of the fish community. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentages were all higher than the class average.

More than three quarters of the macroinvertebrate communities were dominated by two species at both stations. The EPT percentages were lower than the class average of sites that met the general threshold. Based on phosphorus, BOD, and chlorophyll-a values and the preponderance of biological evidence eutrophication is a stressor.

Table 574. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
00MN008 (2014)	7.14	7.14	85.71	28.57	12	5	91.56
00MN008 (2015)	5	4.29	95	55.71	0		
00MN009	0	0	100	46.67	15	5.41	83.76
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	**74**	**3.27**	**22.46**	**14.51**			
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)					**29.48**	**40.36**	
Expected response to increased DO stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

From 2004-2015, a total of 134 nitrate samples were taken from Bluff Creek (-710). These sample values ranged from 0.05-8.68 mg/L with an average value of 1.48 mg/L. All of the samples had nitrate concentrations below three mg/L except for one.

Table 575. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
00MN008	**0.00**	**17.81**	**0.31**	**2.77**
00MN009	**6.67**	**34.29**	**0.00**	**3.02**
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*66.67*	*58.72*	*0.63*	*3.08*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Bluff Creek scored below average in two of the four nitrate related biological metrics at both sites, 00MN008 and 00MN009, when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold. These sites both had few nitrate intolerant species and Trichoptera taxa, but did also have a low amount of Nitrate tolerant taxa. The nitrate TIV score was also above average for both of the sites.

Given the very low nitrate concentrations with a large chemical data set, the low presence of nitrate tolerant taxa, as well as the above average Nitrogen TIV score, the biological community is not being stressed by nitrates at this time.

Candidate Cause Sediment

From 2008-2016, a total of 152 TSS samples were taken from Bluff Creek (-710). These values ranged from 1-458 mg/L with an average TSS concentration of 21.09 mg/L. Of these samples, 59 were at or above the 10 mg/L standard for TSS in a coldwater stream. This is a very high rate of exceedances. Additionally, from 2005-2015, a total of 48 secchi tube measurements were taken. These values ranged from 7.5-100 cm, with an average reading of 63.43 cm. Of these measurements, seven were below the 55 cm standard for a coldwater reach. This reach was assessed and determined to be impaired for turbidity in 2002. The 2016 assessment of this reach confirmed this impairment as well.

Table 576. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RifflePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
00MN008	0.45	0.37	0.00	19.30	0.18	17.05	4.38	0.45	2.43	20.79
00MN009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.91
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	*28.37*	*0.53*	*0.32*	*3.85*	*34.82*	*72.53*	*21.06*	*26.00*	*53.81*	*10.39*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Bluff Creek (-710) scored below average in 9 (00MN008) and 10 (00MN009) of the 10 suspended sediment related metrics when compared to all other Class 10 Southern Coldwater stations that meet the FIBI General Use Threshold (Table 576). Site 00MN008, did have an above average amount of Perciformid (perch-like) individuals, however, the reach scored poorly in the remaining metrics similar to site 00MN009.

Table 577. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
00MN008	**13.24**	**1**	**3**	**1.56**	**80.94**	**0.31**
00MN009	**13.81**	**1**	**5**	**6.98**	**64.33**	**0.00**
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*13.56*	*2.33*	*5.49*	*13.36*	*32.86*	*0.26*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Bluff Creek (-710) scored below average in one (00MN008) and three (00MN009) of the six suspended sediment related metrics when compared to all other Class 9 Southern Coldwater stations that meet the MIBI General Use Threshold (Table 577). Both of these sites had low amounts of TSS Tolerant taxa and TSS Tolerant individuals, while also having a high amount of collector filterer individuals.

While the macroinvertebrate community scores very well in this reach, the fish community does not as almost all 10 the suspended sediment related metrics score below average. This reach also exceeds the standards for TSS and secchi tube measurements at a high rate and is impaired for turbidity. Based on this information, suspended sediment is a stressor to the fish assemblage in Bluff Creek (-710) at this time.

Candidate Cause Habitat

Bluff Creek (-710) had qualitative habitat assessments take place at its biological monitoring sites, 00MN008 and 00MN009, during the fish and macroinvertebrate sampling events in 2014 and 2015. The average MSHA score from these visits was 55.78 (Fair) at 00MN008 and 56.4 (Fair) at 00MN009. Limiting the habitat at these sites was a narrow to wide riparian area at 00MN008, sand substrates, moderate embeddedness, sparse fish cover, fair channel development, and moderate channel stability (Figure 291). A breakdown of the MSHA category scores for these sites can be seen in Figure 292. In addition, Barr Engineering found reaches with significant degradation of stream stability during a survey; resulting from stream incision, eroding banks, and gully formation (RPBCWD, 2015).

Figure 291. Erosion along Bluff Creek (July 5, 2016)

Figure 292. Habitat metric scores

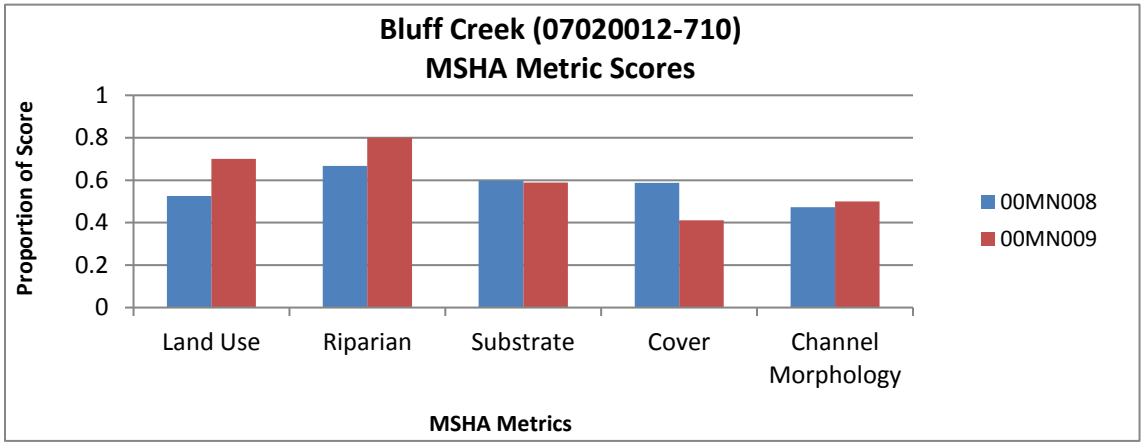


Table 578. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
00MN008	16.87	4.38	16.87	0.18	0.28	5.01	78.68	51.81
00MN009	0.00	0.00	0.00	0.00	0.00	0.00	100.00	27.18
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)	*21.41*	*21.06*	*18.34*	*34.82*	*53.58*	*76.14*	*23.90*	*4.80*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community at both sites along Bluff Creek (-710) scored below average in all of the habitat related metrics when compared to other Class 10 Southern Coldwater stations that did meet the FIBI General Use Threshold (Table 578). The assemblage at these sites often consisted of species tolerant of degraded habitat conditions like fathead minnows, brook sticklebacks, green sunfish, and black bullheads.

Table 579. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
00MN008	0.63	1.25	86.56	5.00	2.81	11.56
00MN009	0.64	5.73	71.97	5.41	8.60	21.66
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	*3.23*	*7.24*	*44.78*	*39.30*	*23.21*	*19.10*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage along this reach was not considered to be impaired. The community scored below average in three of the six (00MN008) and two of the six (00MN009) habitat related metrics when compared to other Class 9 Southern Coldwater Streams that met the MIBI General Use Threshold. These two sites were dominated by Simulium (black flies) and Gammarus (Amphipods), which are fairly common to see in coldwater streams.

Based on the Fair MSHA scores and the relative impact it appears to be having on the habitat related metrics in the fish community, the photographic evidence of degraded conditions, as well as documentation noting the raw banks, lack of channel development, and prevalent erosion problems in the watershed (CRAS), habitat is a stressor to the impaired fish community in Bluff Creek (-710).

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 378 to 1732 uS/cm. All continuous data collected in 2017 was below 640 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). 25% of the values in the dataset were over 1,000 uS/cm.

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below class averages, while the taxa counts were also below average. The macroinvertebrate community was comprised of a range of 1.89 to 8.25% conductivity tolerant individuals. A range of zero to 1 conductivity intolerant individuals were collected.

Table 580. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
00MN008 (2014)	12	1	4.69	5	0
00MN008 (2015)	NA	NA	NA	NA	1.47
00MN009	15	2	5.10	5.41	0
Statewide average for Class 10 Southern Coldwater stations that are meeting the FIBI General Use Threshold (50.0)					**0.58**
Statewide average for Class 9 Southern Coldwater stations that are meeting the MIBI General Use Threshold (43.0)	**29.48**	**2.37**	**22.15**	**40.86**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at arrange of 0 to 1.47%. Species that are tolerant to conditions with high ionic strength comprised a range of 29 to 100% of the fish community. The dataset included 25% elevated specific conductance values; however, no elevated values were recorded during the continuous deployment while the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

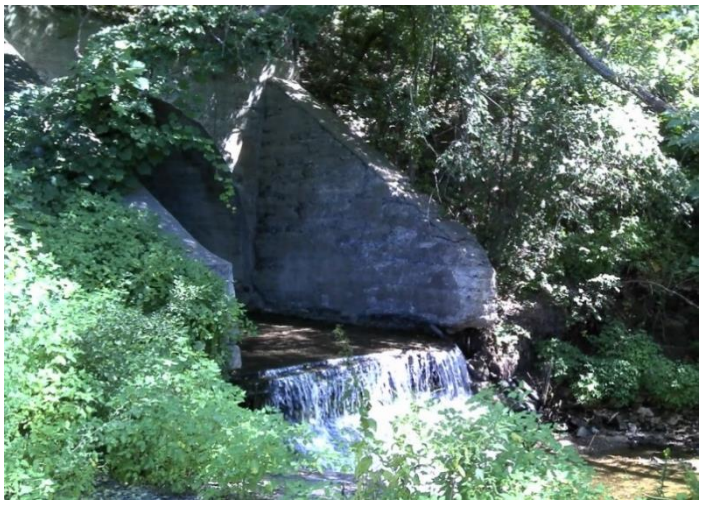
An analysis of the MPCA altered watercourse layer showed this creek to be predominantly modified. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through

the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 28% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised of a range of 46.67 to 85.71% of the population, up from 7.69% (00MN009) and 27.56% (00MN008) in 2000. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised a range of 56.62 to 100% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0.63 to 1.59% of the population.

Figure 293. Perched culvert at site 00MN008 (August 3, 2015)



Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A perched culvert is located between biological monitoring stations 00MN008 and 00MN009 creating a fish barrier. Station 00MN008 is also downstream of 8-foot barrier falls (Figure 293). The channelization is likely contributing to the lack of habitat and seems to be influencing the frequent low flow periods. “The large vertical distance impedes aquatic organism passage and was identified as the primary cause of the habitat fragmentation impairment in the Bluff Creek TMDL” (RPBCWD 2015). Altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish community in Bluff Creek (-581) are being stressed by Eutrophication, Suspended Sediment, Habitat and Flow Alteration/Connectivity (Table 581). Chloride was inconclusive as a stressor at this point, while Dissolved Oxygen and Nitrates were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 581. Stressors on Bluff Creek (-710)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Bluff Creek	07020012-710	---	●	---	●	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.6 South Fork Ninemile Creek (-723)

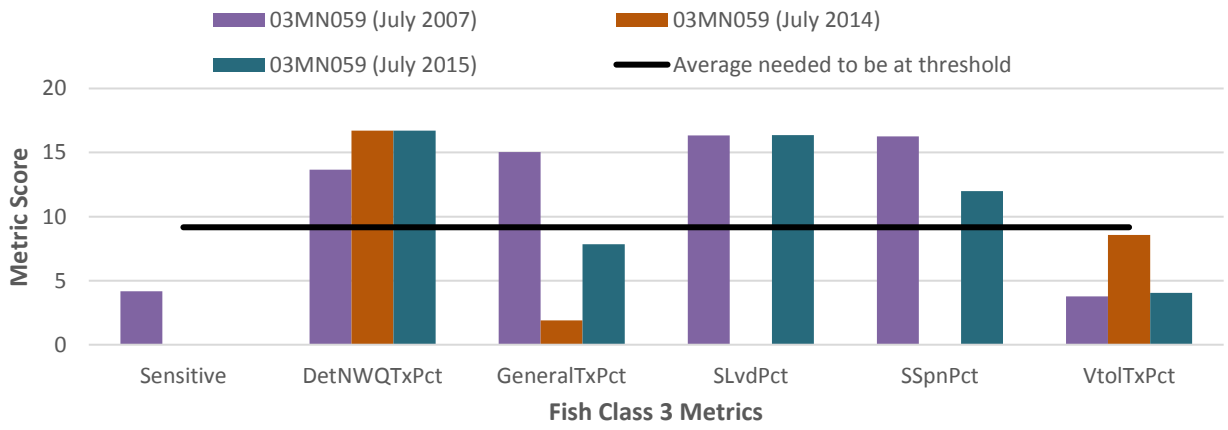
Located in the city of Eden Prairie, the Unnamed Creek (-723) is a 3.77 mile long reach extending from Smetana Lake to Ninemile Creek. This reach is impaired for both the fish and macroinvertebrate assemblages based on sampling at the two biological monitoring sites, 03MN059 and 03MN097.

Biology

Fish

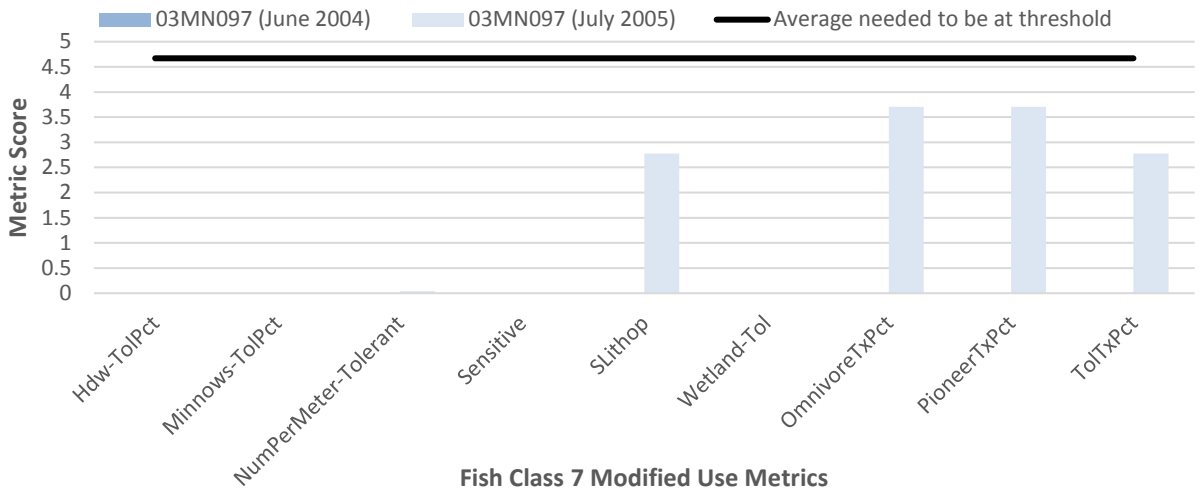
South Fork Ninemile Creek (-723) was sampled for fish five times since 2007 at its biological monitoring sites 03MN059 and 03MN097. Site 03MN059 was sampled in July of 2007, 2014, and 2015. The FIBI scores during these visits were 69.3 (2007), 17.2 (2014), and 56.9 (2015). Two of the three visits to this site were above the Fish Class 3 Southern Headwaters general use threshold of 50. For the breakdown of metric scores see (Figure 294).

Figure 294. Fish Class 3 .metric scores



Site 03MN097 was sampled for fish in 2004 and 2005. The FIBI scores for this site were 0 (2004) and 13.0 (2005). All of the metric scores for this site scored below the average needed to reach the threshold for a Fish Class 7 Low Gradient modified use stream (15). (Figure 295) In each visit at this site, low numbers of fish were sampled and the fish that were sampled were generally tolerant taxa.

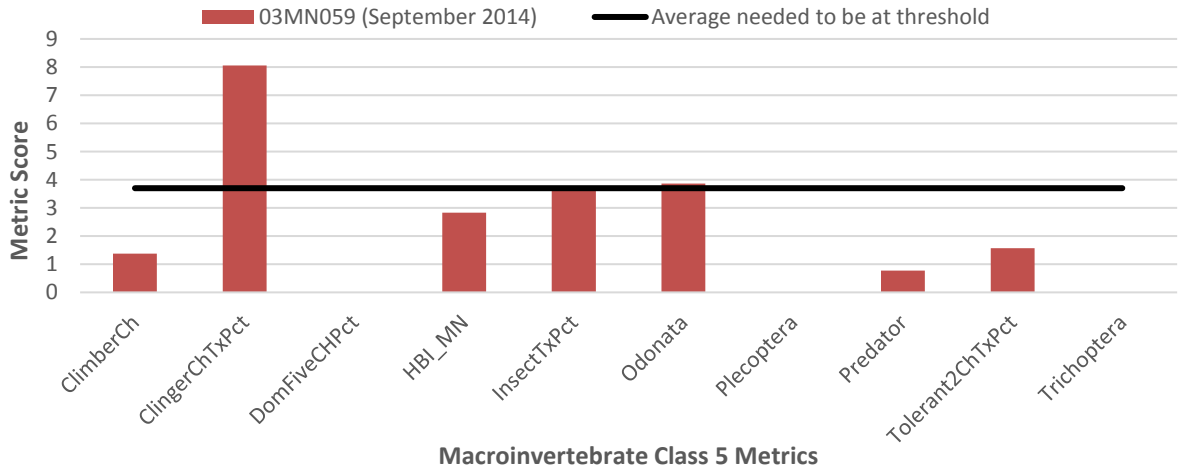
Figure 295. Fish Class 7 metric scores



Macroinvertebrates

South Fork Ninemile Creek (-723) was also sampled for macroinvertebrates at site 03MN059 in September of 2014. This visit had a MIBI score of 22.2 which is below the macroinvertebrate Class 5 Southern Streams RR general use threshold of 37. Three of ten metrics comprising the Class 5 MIBI scored above the average needed to reach the MIBI threshold (ClingerChTxPct, InsectTxPct, Odonata), while the remaining seven metrics scored below average or poorly (Figure 296).

Figure 296. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years. Concentrations ranged from 5.67 mg/L to 6.47 mg/L with no values under the DO standard of 5 mg/L. The lowest values were sampled in July. No continuous data was available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.3-14.2 mg/L with 17% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. None of the visits had any fish that reproduce at a mature age. Low DO values

also correspond with increased serial spawning fish percentage. The number of serial spawning individuals increased significantly from 2007 (2.01%) to 2014 and 2015 (21.43 and 21.74%). Values in 2014 and 2015 were higher than the class average. The fish community was comprised of less than 1% of individuals that are very tolerant to low DO conditions in 2007, but increased to 43% in 2014 and 83% in 2015.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; one low DO tolerant taxa was present and 78.21% of DO tolerant individuals were present. Based on the number of fish that reproduce at a mature age, serial spawners, and low DO tolerant macroinvertebrates DO is a stressor. The large increases in serial spawners and low DO tolerant fish reinforce that DO is a stressor.

Table 582. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN059 (2007)	0	2.01	11	NA	NA	NA	NA
03MN059 (2014)	0	21.43	7	78.21	7.38	1	6.14
03MN059 (2015)	0	21.74	9	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR station that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

Only a small number of phosphorus values are available on this stream, ranging from 0.069 to 0.21 mg/L. The highest value was collected in July. The upstream Bryant Lake is impaired for excess nutrients, which the DNR considers the most likely stressor to the fish community in the lake (DNR, 2017b). Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.4 mg/L with a mean of 0.1 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however this data was not available. As a result of eutrophication, pH values also increase. pH values ranged from 7.53 to 7.75, and were not elevated.

Table 583. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN059 (2007)	0.25	11.28	86.22	1.75	NA	NA	NA
03MN059 (2014)	0	0	73.91	21.43	22	0.96	77.56
03MN059 (2015)	0	0	99.82	28.26	NA	NA	NA
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter species both decreased from 2007 to 2014 and were lacking in both 2014 and 2015. Tolerant individuals comprised the entire fish community at both stations. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was less than 2% in 2007 but increased to over 20% in 2014 and 2015. The omnivore percentage was higher than the class average in 2014 and 2015.

More than three quarters of the macroinvertebrate sample was dominated by two species. The EPT percentage was very low, and decreased significantly from 2003 when the percentage was 24.29%. Based on some elevated observed and modeled phosphorus values, the biological response, and the changes in the fish communities from 2003 and 2007 to 2014 and 2015, eutrophication is a stressor.

Candidate Cause: Nitrate

From 2003-2015, a total of four nitrate samples were taken from South Fork Ninemile Creek (-723). These nitrate sample values ranged from 0.05-0.11 mg/L with an average value of 0.065 mg/L. This value is very low when compared to other areas in the watershed.

Table 584. Nitrtate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN059	5.05	13.81	0.85	2.13
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in South Fork Ninemile Creek (-723) scored below average in two of the four nitrate related biological metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold. The site, 03MN059, had very few nitrate intolerant and Trichoptera taxa. The site did have a small amount of nitrate tolerant taxa and had a good scoring Nitrate TIV.

The nitrate concentrations in South Fork Ninemile Creek are very low and the macroinvertebrate community had a very high scoring TIV and had a small number of nitrate tolerant taxa. Both of these metrics combined with the low nitrate concentrations conclude that nitrates are not a stressor to the impaired biological communities in South Fork Ninemile Creek (-723).

Candidate Cause: Sediment

From 2007-2015, a total of three TSS samples were taken from South Fork Ninemile Creek (-723). These values ranged from 3.2-5.59 mg/L with an average TSS concentration of 4.13 mg/L. Additionally, four secchi tube measurements were taken from this reach from 2007-2015. These values ranged from 57-100 cm, with an average value of 89.25 cm.

Table 585. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffIePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN059	8.01	9.47	0.00	13.47	0.12	0.06	0.12	0.00	14.24	17.73
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in South Fork Ninemile Creek (-723) scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters Stations that meet the FIBI General Use Threshold (Table 585). The site, 03MN059, did have an above average amount of Centrarchid and long lived individuals, but did score poorly in the remaining metrics.

Table 586. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN059	15.79	0.50	10.00	32.31	21.06	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in this reach scored below average in three of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 586). The site, 03MN059, had a below average amount of Plecoptera and collector filterer individuals, as well as few TSS intolerant taxa. This reach did have an above average TSS Index Score, as well as a lower amount of TSS tolerant taxa and TSS tolerant individuals. Those results can indicate a stream not being negatively impacted by high suspended sediment concentrations.

The observed TSS concentrations and secchi tube readings give no indication of stress from suspended sediment. The macroinvertebrate community had a good scoring Index score and had few TSS tolerant taxa and individuals. The fish community had a couple metrics score well, but was likely being stressed by other parameters resulting in lower scores. Suspended sediment is not a stressor to aquatic life in this reach at this time.

Candidate Cause: Habitat

South Fork Ninemile Creek (-723) had a qualitative habitat assessment take place at the biological monitoring site, 14MN123, during the fish and macroinvertebrate sampling events in 2003, 2007, 2014, and 2015. The average MSHA score from these visits was 62.33 (Fair). Limiting the MSHA at this site was the urban/industrial land use, sand substrate, severe embeddedness and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 297. A qualitative habitat assessment was not done at site 03MN097.

Figure 297. Habitat metric scores

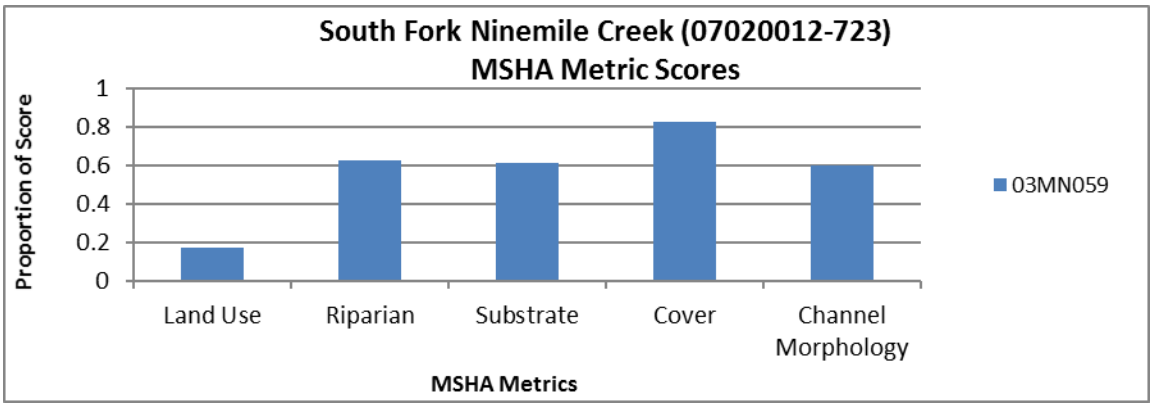


Table 587. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN059	**4.00**	**0.12**	**4.00**	**0.12**	**6.67**	**38.37**	**70.61**	**62.25**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in South Fork Ninemile Creek (-723) scored below average in six of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 587). Site 03MN059 lacked many habitat specializing species, which may indicate potential habitat stress.

Table 588. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN059	6.87	17.04	22.56	12.62	25.75	44.44
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 588). The community did have higher numbers of burrower individuals and low numbers of EPT individuals, which may be an indicator of habitat stress.

Based on the majority of the fish and many of the macroinvertebrate habitat related metrics, as well as the consistently fair MSHA score, habitat in South Fork Ninemile Creek is a stressor to aquatic life at this time.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 583 to 1087 uS/cm. A study of Minnesota

biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). Two of the six values of the values in the small dataset were over 1,000 uS/cm.

Table 589. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
03MN059 (2007)	NA	NA	NA	NA	2.51
03MN059 (2014)	22	2	0.64	0.96	7.14
03MN059 (2015)	NA	NA	NA	NA	6.52
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					0.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were far below class averages, while the taxa counts were also below average. The macroinvertebrate community was comprised 5.77% conductivity tolerant individuals. One conductivity intolerant individuals was collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at a range of 2.51 to 7.14%. Species that are tolerant to conditions with high ionic strength comprised less than 1% of the fish community at each visit. The small dataset included two of the six values with elevated specific conductance values, however the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be predominantly modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 24% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised of a range of 76.09 to 84.46% of the population, up from 57.08% in 2003. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised a range of 16.29 to 58.69% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 7.69% of the population. The channelization is likely contributing to the lack of habitat and seems to be influencing the frequent low flow periods. The biological results indicate altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in South Fork Ninemile Creek (-723) are being stressed by Dissolved Oxygen, Habitat and Flow Alteration/Connectivity (Table 590). Eutrophication and Chloride were inconclusive as stressors at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 590. Stressors on South Fork Ninemile Creek (-723)

Stream Name	AUID	Stressors: Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
South Fork Ninemile Creek	07020012-723	●	●	---	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.7 Unnamed creek (Prior Lake Outlet Channel) (-728)

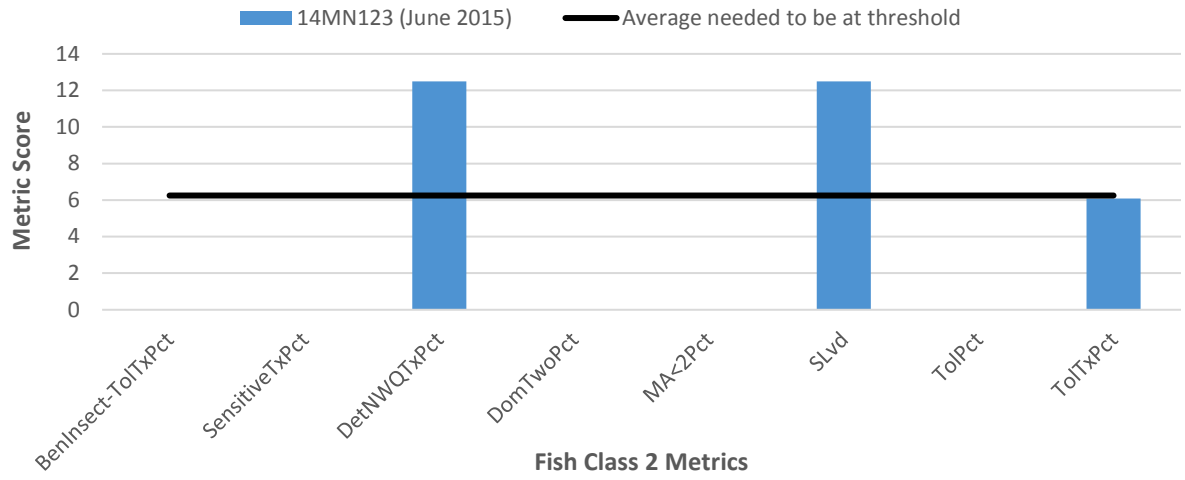
Located in the city of Shakopee, Unnamed Creek/Prior Lake Outlet Channel 9 (-728) is a 1.88 mile long constructed stream reach that extends from Dean Lake to Blue Lake. This reach is impaired for biology due to both its fish and macroinvertebrate assemblages. There is one biological monitoring station along this reach, 14MN123, located just north of Highway 101.

Biology

Fish

Unnamed Creek (Prior Lake Outlet Channel) (-728) was sampled for fish at its biological monitoring station, 14MN123, in June of 2015. The FIBI score for this visit was 31.1, which is below the Fish Class 2 Southern Streams General Use Threshold of 50. Only two of the 8 metrics comprising the FIBI scored above the average needed to reach the FIBI threshold (DetNWQTxPct, SLvd), while the remaining six metrics scored either just below the average needed (TolTxPct) or zero. (Figure 298)

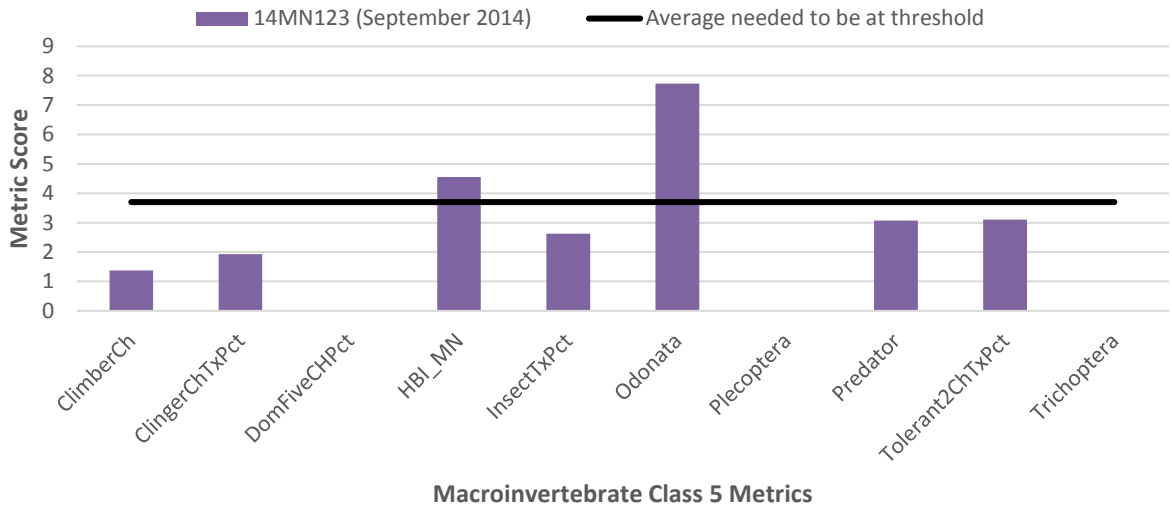
Figure 298. Fish metric scores



Macroinvertebrates

A macroinvertebrate sample was also taken from 14MN123 during September of 2014. The MIBI score from this visit was 24.4 which is below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. Only two of the 10 metrics comprising the MIBI for this class reached the averaged needed to achieve the MIBI threshold. (HBI_MN, Odonata). The remaining metrics scored below average to very poorly (Figure 299).

Figure 299. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a large DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 4.96 mg/L to 11.14 mg/L with one value under the DO standard of 5 mg/L. The lowest value was sampled in June. No continuous data was available.

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.1-14.2 mg/L with 8% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach did not have any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawning individuals was low at 4.55%. The fish community was comprised of zero individuals that are intolerant to low DO conditions, while DO tolerant fish comprised 86% of the population.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; three low DO tolerant taxa was present and 23.91% of DO tolerant individuals were present. There was only one low DO value collected, but the biological response was mixed. Low DO as a stressor was inconclusive.

Table 591. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN123	0	4.55	7	23.91	6.79	3	6.94
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

This Unnamed Creek is an outlet channel from Prior Lake. Upper Prior Lake is impaired for nutrients. There is a large number of phosphorus values available on this stream, ranging from 0.02 to 0.154 mg/L. The highest value was collected in July. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.4 mg/L with a mean of 0.1 mg/L.

Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. BOD, chlorophyll-a, and DO flux data were not available. pH values ranged from 7.2 to 8.51. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. Thick algal growth was observed at station 14MN123 in May of 2015 at the culvert (Figure 300).

Figure 300. Thick algal growth at site 14MN123 (May 21, 2015)

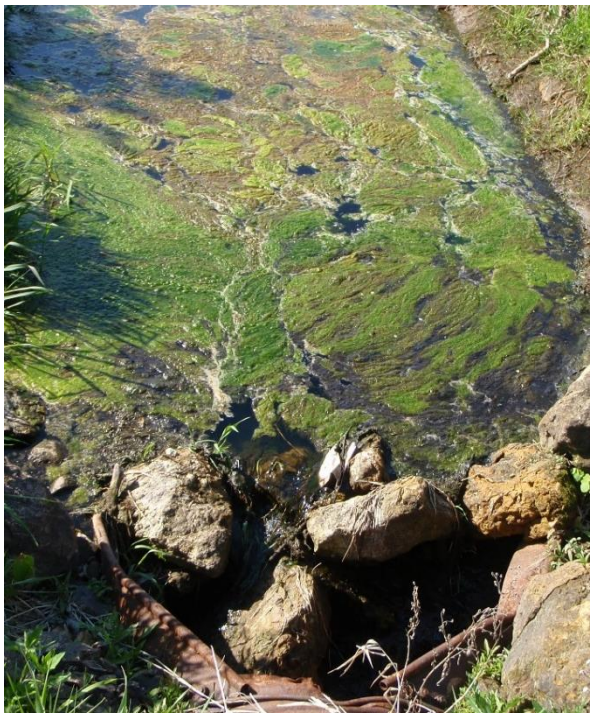


Table 592. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN123	0	0	81.82	4.55	24	7.19	77.5
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter species were not present at station 14MN123. Tolerant individuals comprised 81.82% of the fish community. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was much lower than the class average of sites meeting the general threshold. More than three quarters of the macroinvertebrate sample was dominated by two species. The EPT percentage was very low. Based on phosphorus values, the biological response, and the algal growth, eutrophication is a stressor.

Candidate Cause: Nitrate

One nitrate sample was taken from Unnamed Creek (-728). The sample was taken on 06/16/2015 and had a nitrate concentration of 1.6 mg/L. These results are pretty comparable to nearby Credit River (-811), which has similar landuse and has had extensive nitrate sampling take place.

Table 593. Nitrate related metrics

Station	TrichopteraChTxPct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN123	8.33	12.42	0.00	2.39
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Unnamed Creek (-728) at site 14MN123 scored below average in two of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 593). The site had low numbers of Trichoptera taxa and lacked any nitrate intolerant species. However, the site also had a low amount of nitrate tolerant taxa and a very good nitrogen TIV score. Those results indicate that this stream reach is not being negatively impacted by nitrates.

Based on the low amounts of nitrate tolerant species, the good Nitrogen TIV score, the low observed nitrate concentrations, and the low presence of nitrates in nearby streams indicate that nitrates are not a stressor in Unnamed Creek (-728).

Candidate Cause: Sediment

From 2014-2015, a total of 26 TSS samples were taken from Unnamed Creek (-728). These sample values ranged from 1-50 mg/L, with an average value of 5.7 mg/L. Additionally, from 2014-2015, 30 secchi tube measurements were taken from this reach. These readings ranged from 90 to >100 cm. The TSS concentrations and secchi tube measurements both do not indicate potential stress.

Table 594. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
14MN123	**0.00**	**9.09**	**0.00**	**9.09**	**0.00**	**0.00**	**9.09**	**0.00**	**4.55**	**12.83**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in the Prior Lake Outlet (-728) at site 14MN123 scored below average in eight of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 594). This reach had a good TSS Index Score and an above average amount of Centrarchid individuals. These results can indicate that the stream is not being negatively impacted by high concentrations of suspended sediment. However, the reach did score poorly in the remaining metrics.

Table 595. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN123	13.24	0	8	4.35	60.31	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 14MN123 score below average in two of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet

the MIBI General Use Threshold (Table 595). This stream reach lacked TSS intolerant and Plecoptera taxa. This reach did have a good TSS index score, a high amount of collector filterer individuals, as well as a low amount of TSS tolerant taxa and TSS tolerant individuals. These results reflect a community likely unaffected by high suspended sediment concentrations.

The observed chemical data does not indicate an issue with suspended sediment. The macroinvertebrate community strongly suggests that suspended sediment is not having a negative impact, while the fish assemblage had an above average TSS Index Score, which can be a good indicator. Therefore, suspended sediment is not a stressor to aquatic life in this reach. Other stressors appear to be having a negative impact, especially on the fish community, resulting in lower metric scores.

Candidate Cause: Habitat

Unnamed Creek/Prior Lake Outlet Channel (-728) had a qualitative habitat assessment take place at the biological monitoring site, 14MN123, during the fish sampling event in 2015 and the macroinvertebrate sampling event in 2014. The average MSHA score from these visits was 69.13 (Good). Limiting the MSHA at this site was the urban/industrial land use, sand and silt substrates, and moderate embeddedness. A breakdown of the MSHA category scores for this site can be seen in Figure 301.

Figure 301. Habitat metric scores

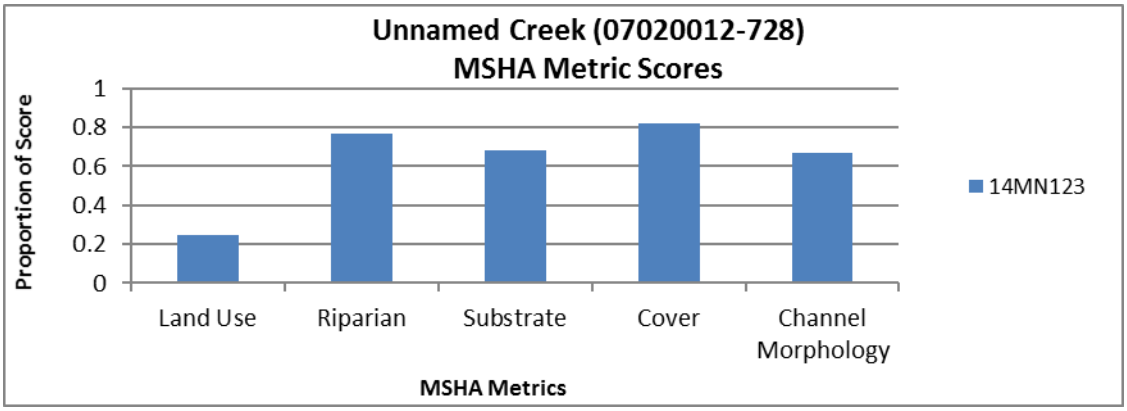


Table 596. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN123	**0.00**	**9.09**	**0.00**	**0.00**	**4.55**	**13.64**	**81.82**	**4.55**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Unnamed Creek (-728) scored below average in seven of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use

Threshold (Table 596). While the site had a high percentage of tolerant and few habitat specializing species, the site also had a small sample size that could potentially skew the metric results.

Table 597. Sediment related macroinverebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN123	0.31	3.13	63.44	7.19	6.25	28.13
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in two of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 597). The site had low numbers of both burrower and legless individuals, which can signal that the fine substrates present are not causing stress to aquatic life. Many clinger and sprawler species were present, which can also signal that the habitat issues are not causing stress.

Based on the good MSHA scores, as well as the majority of the macroinvertebrate habitat related metrics scoring above average, habitat is not a stressor to aquatic life in this stream reach. The low sample size in the fish sample appears to be skewing the metric data. It is likely that another stressor is negatively impacting that assemblage.

Candidate Cause Chloride/Ionic Strength

Chloride values were available on this reach ranged from 20.8 to 102.1 mg/L, without any values above the water quality standard of 128 mg/L. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 217 to 800 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values of the values in the small dataset were over 1,000 uS/cm.

Table 598. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN123	24	3	6.25	7.19	9.09
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					4.89
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	41.93	6.04	22.91	43.90	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were far below class averages, while the taxa counts were also below average. The macroinvertebrate community was comprised of 7.14% conductivity tolerant individuals. One conductivity intolerant individuals was collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were present at 9.09%. Species that are tolerant to conditions with high ionic strength were not present. The chloride and specific conductance datasets did not include elevated values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be predominantly modified, as it is a constructed channel. Altered hydrology and increases in precipitation in the watershed cause issues with “increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime” (DNR, 2017a). Channelization alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 12% of the time during the spring-fall months.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A weir is present at the outlet of Dean Lake and a rock buildup at the culvert near station 14MN123 is a possible fish barrier. The biological crew noted that the culvert was blown out in 2014, which would result from high flows.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 18.18% of

the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised 13.64% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 1.88% of the population. The channelization is likely contributing to the frequent low flow periods, and the culvert being blown out. The biological indicators were mixed, however only 22 fish were collected which led to depressed generalist and nest guarder percentages. Altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Unnamed Creek (Prior Lake Outlet Channel) (-728) are being stressed by Flow Alteration/Connectivity (Table 599). Dissolved Oxygen, Eutrophication, and Chloride were inconclusive as stressors at this point, while Nitrates, Suspended Sediment, and habitat were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 599. Stressors on Unnamed Creek (Prior Lake Outlet Channel)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Unnamed creek (Prior Lake Outlet Channel)	07020012-728	o	●	---	---	---	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.8 Chaska Creek (-803)

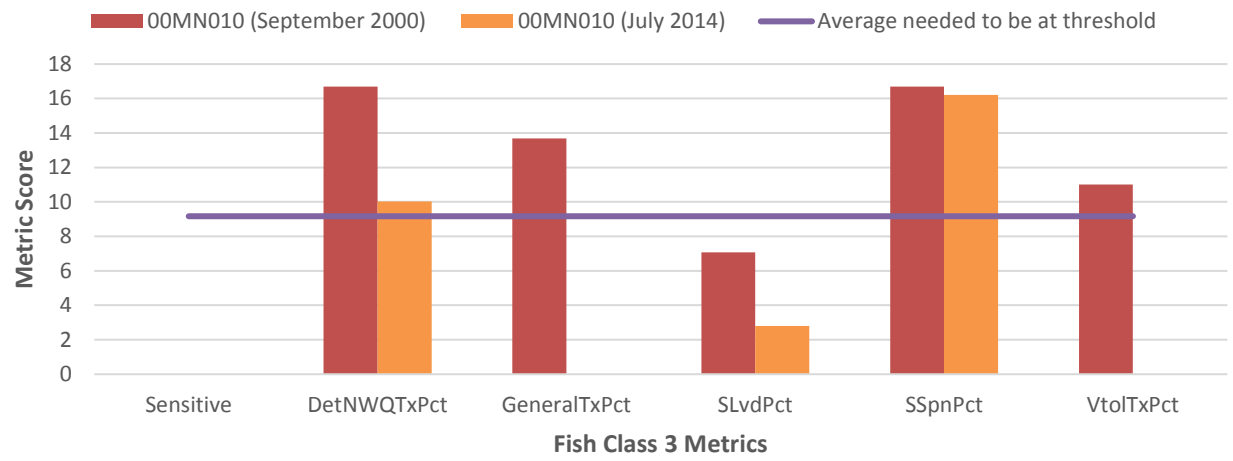
Located in the city of Chaska, Chaska Creek (-803) is a 1.73 mile long reach extending from Highway 212 Creek Road near the Minnesota River. This reach is impaired for biology due to its fish and macroinvertebrate assemblages. There is one biological monitoring station along this reach, 00MN010.

Biology

Fish

Chaska Creek (-803) was sampled for fish at its biological monitoring station, 00MN010, twice. One visit was in September of 2000 and the other in July of 2014. The FIBI scores during these visits were 65.2 (2000) and 29.0 (2014). The 2014 visit is well below the Fish Class 3 Southern Headwaters General Use Threshold of 55. Both visits lacked sensitive fish species, while the 2014 visit also had higher numbers of Generalist feeding species and very tolerant taxa resulting in poor metric scores (Figure 302).

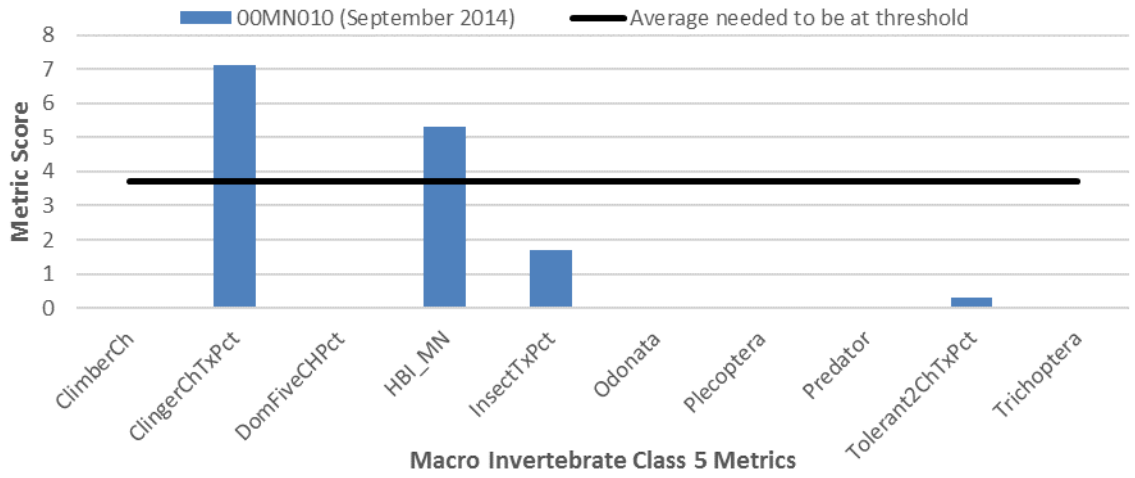
Figure 302. Metric fish scores



Macroinvertebrates

A macroinvertebrate sample was also taken at site 00MN010 in September of 2014. This visit had an MIBI score of 14.4, which is far below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This visit scored well in two of the MIBI metrics (ClingerChTxPct, HBI_MN), while scoring below average or poorly in the eight remaining metrics comprising the Class 5 MIBI (Figure 303).

Figure 303. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a very small DO dataset on this reach in recent years (2014-2016). Concentrations ranged from 7.31 mg/L to 8.81 mg/L with none of the limited values under the DO standard of 5 mg/L. The lowest value was sampled in July. No continuous data was available. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 1.5-13.8 mg/L with less than 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach did not have any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The number of serial spawning individuals was low at 2.22%. The fish community was comprised of less than 1% of individuals that are very tolerant to low DO conditions.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; four low DO tolerant taxa was present and less than 1% of DO tolerant individuals were present. No low DO values were collected, and the preponderance of evidence indicates DO is not a stressor.

Table 600. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
00MN010	0	2.22	5	0.32	6.54	4	7.84
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause Eutrophication

There is a small number of phosphorus values available on this stream, ranging from 0.117 to 0.139 mg/L. The highest value was collected in June. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-0.9 mg/L with a mean of 0.2 mg/L.

Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. However, BOD, chlorophyll-a, and DO flux data were not available. As a result of eutrophication, pH values also increase. pH values ranged from 8.23 to 8.32.

Table 601. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
00MN010	0	0	99.74	0	13	20.65	86.13
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Sensitive and darter species were not present on Chaska Creek. Tolerant individuals comprised almost all of the fish community. A positive relationship also exists between eutrophication and omnivorous fish. Omnivorous fish were not present. More than three quarters of the macroinvertebrate sample was dominated by two species. The EPT percentage was lower than the class average of sites meeting the

general threshold. While there were some phosphorus values, the biological response was mixed, making eutrophication inconclusive as a stressor.

Candidate Cause: Nitrate

There were two nitrate samples taken from Chaska Creek (-803) from 2014-2016. These samples were 1.5 mg/L on July 31, 20014 and 2.0 mg/L on June 1, 2016. Both of these concentrations are fairly low especially given the much higher values seen in this watershed.

Table 602. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
00MN010	**15.38**	**32.48**	**0.00**	**2.97**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 00MN010 in Chaska Creek (-803) scored below average in one of the four evaluated nitrate related metric categories when compared to all other Class 5 Southern Stream Stations RR that meet the MIBI General Use Threshold (Table 602). The sampling station had zero nitrate intolerant individuals, while scoring very well in the other categories.

Despite the small sample size, the nitrate concentrations in Chaska Creek were found to be low and the majority of the nitrate related biological metrics were in agreement that nitrates are not a stressor to the impaired biological communities at this time.

Candidate Cause: Sediment

Two TSS samples were taken from Chaska Creek (-803) from 2014-2016. These values were 10 mg/L on July 31, 2014 and 6.4 mg/L on June 1, 2016. Additionally, two secchi tube readings were taken in 2014 with these readings being 51 and 58 cm. The TSS samples were both well below the 65 mg/L standard and the secchi tube measurements did not fall below the 10 cm standard.

Table 603. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
00MN010	**0.13**	**0.00**	**0.00**	**0.13**	**0.00**	**0.00**	**67.43**	**0.00**	**0.00**	**12.56**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Chaska Creek scored below average in eight of the 10 suspended sediment related metrics at site 00MN010 when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 603). This reach had a good TSS Index Score and also had an above average amount of simple lithophilic individuals. These metrics scoring well can indicate a stream not being negatively impacted by high suspended sediment levels. However, the site did score poorly in the eight remaining metrics.

Table 604. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
00MN010	**13.91**	**0**	**7**	**6.37**	**67.42**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Chaska Creek (-803) at site 00MN010 scored below average in two of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 604). This reach had no TSS intolerant or Plecoptera taxa, but did score well in the remaining metrics which can indicate that this stream is not being negatively impacted by high suspended sediment concentrations.

The limited data set indicates that suspended sediment is not an issue, the macroinvertebrate community scored very well, and the fish community had a good index score. Other stressors may be limiting some of the fish metric scores as suspended sediment is not a stressor to Chaska Creek (-803) at this time.

Candidate Cause: Habitat

Chaska Creek (-803) had qualitative habitat assessments take place at its biological monitoring site, 00MN010, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 58.85 (Fair). Limiting the habitat at these sites was the moderate to heavy bank

erosion, sand and silt substrates, light embeddedness, fair sinuosity, presence of mid-channel bars, and moderate channel stability. A breakdown of the MSHA category scores for these sites can be seen in Figure 304.

Figure 304. Habitat metric scores

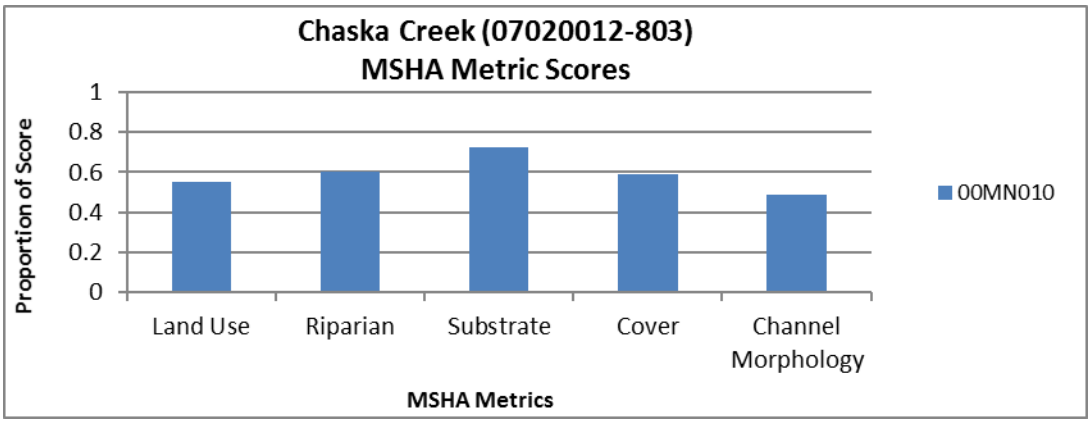


Table 605. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
00MN010	**0.13**	**67.43**	**0.13**	**0.00**	**0.00**	**94.70**	**99.87**	**29.62**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Chaska Creek (-803) scored below average in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 605). The sample consisted primarily of species that are tolerant to degraded habitat conditions including blacknose dace, creek chubs, green sunfish, fathead minnows, and central mudminnows.

Table 606. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
00MN010	**0.65**	**4.19**	**87.42**	**20.65**	**5.81**	**7.74**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 00MN010 scored below average in three of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 606). The site did have lower amounts of burrower and legless individuals, which are typically higher in a stream system affected by excess sediment. However, the stream also had few climber, sprawler, and EPT individuals which can signal degraded habitat conditions.

Based on the majority of the fish and half of the macroinvertebrate habitat related metrics scoring below average as well as the fair MSHA score, habitat is a stressor to the impaired biological communities in Chaska Creek (-803) at this time.

Candidate Cause Chloride/Ionic Strength

No chloride values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 630 to 676 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). None of the values of the values in the small dataset were over 1,000 uS/cm.

Table 607. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
00MN010	13	1	19.68	20.65	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	**41.93**	**6.04**	**22.91**	**43.90**	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Increased ionic strength can cause an increase in ion tolerant taxa and an increase in ion tolerant life stages, causing fish and invert impairments, but it is difficult to separate this effect from other stressors. As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The mayfly (Ephemeroptera) and EPT percentages were below class averages, while the taxa count was also below average. Taxa counts were below average for their respective classes but taxa count also is related to other stressors, so ionic strength could be contributing to this decline along with other stressors. The macroinvertebrate community was comprised of 6.05% conductivity tolerant individuals. No conductivity intolerant individuals were collected.

Elevated chloride can also lead to increases in sunfish based assemblages. Centrarchidaes (sunfish) were not present. Species that are tolerant to conditions with high ionic strength comprised less than 0.5% of the fish community. The specific conductance values in the small dataset did not include elevated values, and the biological indicators were mixed. Ionic strength is inconclusive as a stressor.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be 100% natural, however the upstream watershed is predominantly modified. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Channelization and tile drainage in the upstream watershed alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities. The biological crew noted that the culvert was blown out in 2014, which would result from high flows.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 10% of the time during the spring-fall months.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. An artificial channel was created Chaska on Chaska Creek for flood overflow from the Minnesota River (Figure 305). The channel is preventing fish migration from the Minnesota River into Chaska Creek.

Figure 305. Artificial channel constructed on Chaska Creek downstream of site 00MN010 (September 30, 2013)

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 97.78% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised 4.44% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 0.32% of the population. The biological indicators were mixed, however the artificial concrete channel and the loss of fish migration, make altered hydrology a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Chaska Creek (-803) are being stressed by the Habitat conditions (Table 608). Eutrophication, Flow Alteration/Connectivity, and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen, Nitrates, and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 608. Stressors on Chaska Creek (-803)

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Chaska Creek	07020012-803	---	o	---	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.9 Ninemile Creek (-807)

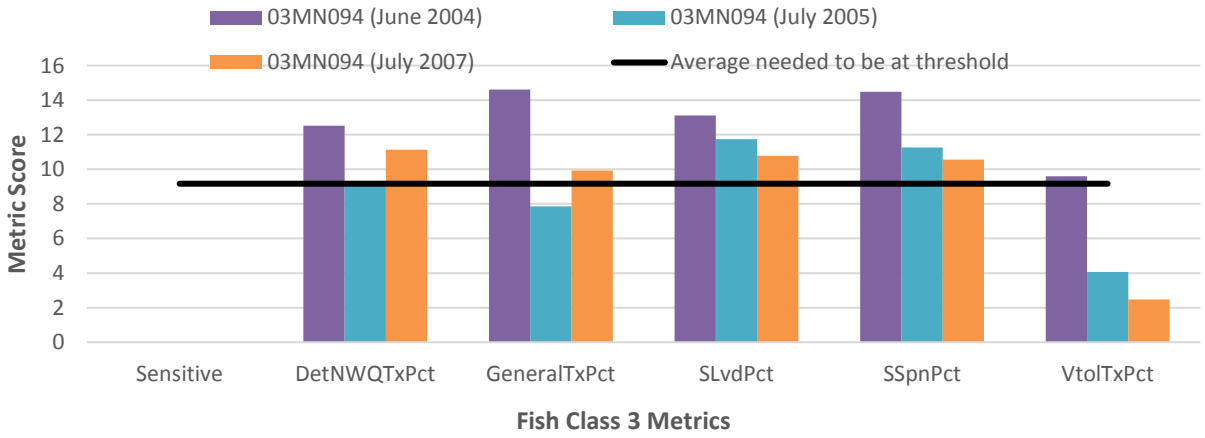
Ninemile Creek (-807) is a 6.17 mile long stream reach that includes the headwaters of the creek and extends to Metro Boulevard. The stream reach is located in located in the city of Edina. This reach was impaired for biology due to the fish assemblage in 2004. Two biological monitoring sites are located along this reach, 00MN011 and 03MN094. A Stressor ID Report was completed in 2010 by Barr Engineering which identified dissolved oxygen and sediment as stressors (Barr, 2010b).

Biology

Fish

Ninemile Creek (-807) was sampled for fish three times at biological monitoring site 03MN094 from 2004-2007. The FIBI scores from these visits were 64.3 (2004), 44.2 (2005), and 44.9 (2007). All three of these visits lacked sensitive fish taxa, while the 2005 and 2007 visits to this site also had a higher amount of very tolerant taxa resulting in a lower FIBI metric score (Figure 306).

Figure 306. Fish metric scores



Candidate Cause Dissolved Oxygen

The only current data was collected by the Nine Mile Creek Watershed District (NMCWD), where continuous data collected in 2009 ranged from 0.039 to 10.47 mg/L (Barr, 2010b). An early morning longitudinal survey at 7 locations in July of 2009 found three of the locations with DO concentrations below 5 mg/L (Barr, 2010b), while two additional sites were below 6 mg/L. The two highest values were both located upstream of US 169. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.7-13.9 mg/L with 7% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. This reach did not have any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The one visit had a percentage lower than the class average. The fish community was comprised of 11% of individuals that are very tolerant to low DO conditions. Recent macroinvertebrate data was not available. Low DO values were collected, but no current biological data is available. Collecting current fish and macroinvertebrate data would be helpful. DO as a stressor is currently inconclusive.

Table 609. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
00MN011 (2000)	0	10.95	10	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Candidate Cause Eutrophication

No recent phosphorus, BOD, chlorophyll-a, or DO flux data was available to analyze eutrophication. The only data available was a pH value of 8.04 from 2000. As a result of eutrophication, pH values also increase. The HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.4 mg/L with a mean of 0.2 mg/L.

Sensitive species were not present and darters were present at less than 1%. Tolerant individuals comprised almost the entire fish community. A positive relationship also exists between eutrophication and omnivorous fish. The omnivorous fish percentage was slightly lower than the class average. Macroinvertebrates were not sampled. Without chemistry data and recent biological data, eutrophication as a stressor cannot be evaluated.

Table 610. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
00MN011	0	0.73	98.05	13.63	NA	NA	NA
Statewide average for Class 3 Southern Headwate stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Candidate Cause: Nitrate

Only one nitrate sample was taken from Ninemile Creek (-807). This sample was taken on 07/02/2017 and had a nitrate concentration for 0.18 mg/L. This value is consistent with the concentrations observed in the two impaired reaches downstream Ninemile Creek (-808) and the significant data set at Ninemile Creek (-809).

Based on the very low observed nitrate concentration in this reach, as well as the reaches downstream and in the immediate neighboring subwatersheds, nitrates are not a stressor to aquatic life in Ninemile Creek (-807).

Candidate Cause: Sediment

One TSS sample was taken from Ninemile Creek (-807). This value was 66 mg/L and was taken on July 2, 2007. This is above the 65 mg/L standard for TSS. Additionally, on this day a secchi tube measurement was taken and the reading was 100 cm.

The HSPF model also calculated daily TSS values for this subwatershed from 1996-2012. These values ranged from 2.8-348.6 mg/L with an average TSS concentration of 23.8 mg/L. Of these calculations, 199 (3.2%) were above the 65 mg/L standard for TSS. This value is rather low when compared throughout the watershed.

Table 611. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
00MN011	**11.68**	**0.97**	**0.00**	**1.70**	**10.95**	**0.00**	**14.60**	**0.00**	**0.00**	**15.90**
03MN094	**18.82**	**0.21**	**0.00**	**14.35**	**4.69**	**0.00**	**9.82**	**0.00**	**0.00**	**15.38**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community scored below average in nine (03MN0945) and ten (00MN011) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 611). Site 03MN094 did have an above average amount of Perciformid (perch-like) individuals, but scored poorly in the remaining metrics.

No macroinvertebrate sample took place along this reach.

The observed data in this stream reach is very limited. However, the HSPF model calculated a very low rate of standard exceedance. This value is consistent to other nearby subwatersheds. Therefore, suspended sediment is not a stressor to aquatic life. It is likely that other stressors are causing the fish metrics to be lower.

Candidate Cause: Habitat

Ninemile Creek (-807) had a qualitative habitat assessment take place at the biological monitoring site, 03MN094, during the fish sampling event in 2007. The MSHA score from this visit was 47.4 (Fair). Limiting the MSHA at this site was the residential land use, moderate bank erosion, sand and silt substrates, moderate embeddedness, sparse fish cover, moderate channel stability, and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 307. Site 00MN011 did not have a qualitative habitat assessment.

Figure 307. Habitat metric scores

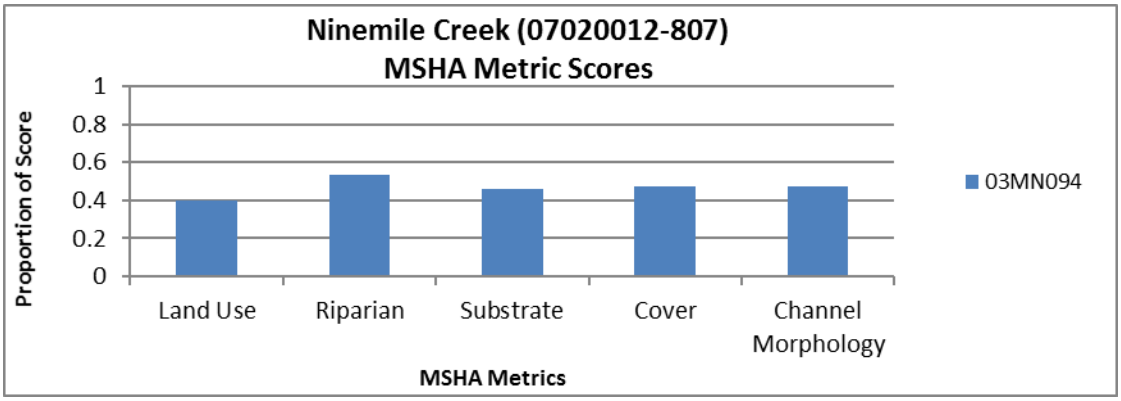


Table 612. Habitat related metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
00MN011	**0.73**	**14.60**	**0.73**	**10.95**	**0.00**	**80.05**	**98.05**	**68.86**
03MN094	**14.14**	**9.82**	**14.14**	**4.69**	**0.05**	**50.61**	**85.65**	**60.59**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Ninemile Creek (-807) scored below average in seven of the eight habitat metrics at both sites, 00MN011 and 03MN094, when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 612). These sites were dominated by species that are very tolerant of poor habitat conditions including creek chubs, blacknose dace, white suckers, central mudminnows, and bigmouth shiners.

Macroinvertebrate sampling did not take place along this reach.

Based on the fair MSHA score as well as the majority of the habitat related metrics in the fish assemblage scoring below average, habitat is a stressor to the impaired fish community in Ninemile Creek (-807).

Candidate Cause Chloride/Ionic strength

No recent chloride specific conductance values were available on this reach. Specific conductance is a measure of ions including chloride. Measurements on this stream reach include one values of 605 µS/cm, collected in 2000. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). The one available value was below 1,000 uS/cm.

Elevated chloride can also lead to increases in sunfish based assemblages. The percentage of Centrarchidae (sunfish) at station 00MN011 was 0.97%. Conductivity tolerant individuals comprised less than 1% of the fish community. The lack of data indicates chloride and ionic strength are inconclusive stressors. Collecting current chloride and specific conductance data would be helpful.

Table 613. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
00MN011	NA	NA	NA	NA	0.97
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
Expected response to increased TP stress	↓	↓	↓	↓	↑

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be almost entirely modified except where biological station 00MN011 was located. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 19% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 82.97% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised 4.62% of the fish community. The biological indicators were mixed, making altered hydrology inconclusive as a stressor. Collecting current fish and macroinvertebrate data would be helpful.

Conclusions and recommendations

The impaired fish community in Ninemile Creek (-807) is being stressed by the habitat conditions (Table 614). Dissolved Oxygen, Eutrophication, Flow Alteration/Connectivity and Chloride were inconclusive as stressors at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 614. Stressors on Ninemile Creek (-807)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Ninemile Creek	07020012-807	o	o	---	---	●	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.10 Ninemile Creek (-808)

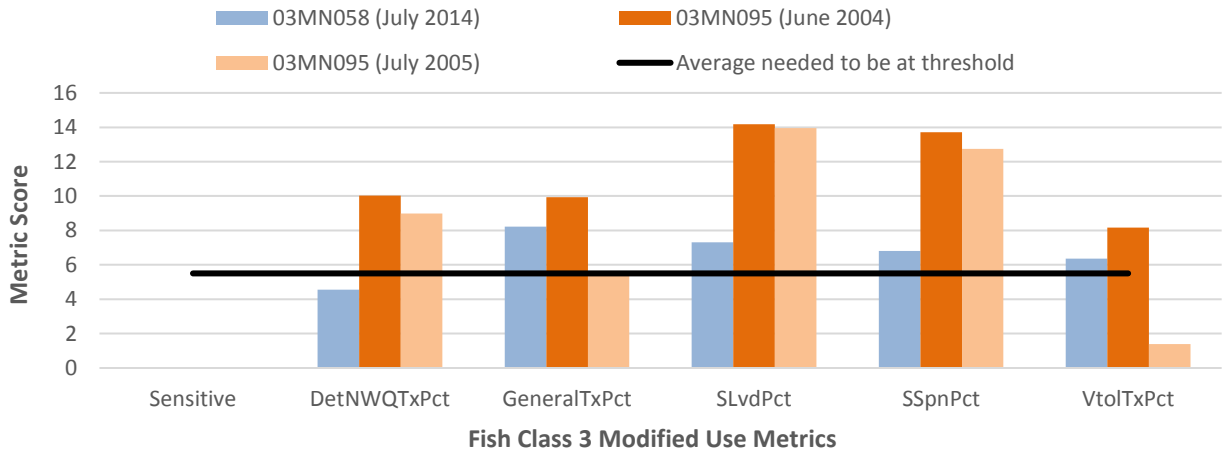
Ninemile Creek (-808) is a 4.94 mile long stream reach that extends from Metro Boulevard in Edina to the Nine Mile Creek dam in Bloomington near Russell Ave S. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. Two biological monitoring sites are located along this reach, 03MN058 and 03MN095. There are two dams on this reach. A Stressor ID Report was completed in 2010 by Barr Engineering which identified dissolved oxygen and sediment as stressors (Barr, 2010b).

Biology

Fish

Ninemile Creek (-808) had three fish samples taken between its two biological monitoring stations, 03MN058 and 03MN095. Site 03MN058 was sampled in July of 2014 and had a FIBI score of 30.6, which is below the Fish Class 3 Southern Headwaters Modified Use Threshold of 33. Site 03MN095 had FIBI scores of 56 (2004) and 42.7 (2005). Both of these scores were above the FIBI threshold. All three visits did lack sensitive fish taxa, which limited the FIBI score (Figure 308).

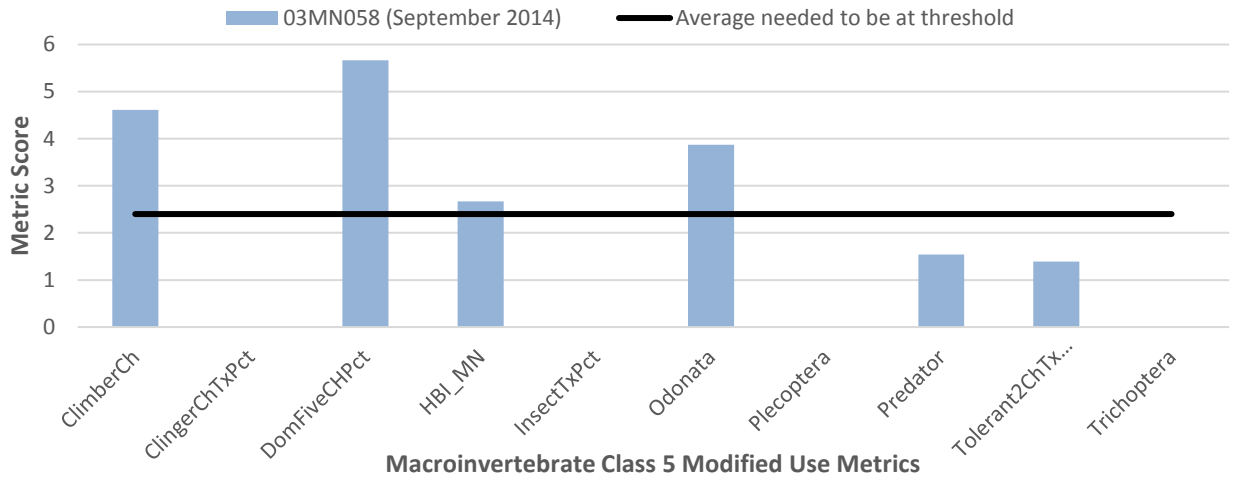
Figure 308. Fish metric scores



Macroinvertebrates

Site 03MN058 was also sampled for macroinvertebrates in September of 2014. This visit had an MIBI score of 19.7, which is below the Macroinvertebrate Class 5 Southern Streams RR modified use threshold of 24. This visit had four metrics score above the average needed to be at the threshold (ClimberCh, DomFiveCHPct, HBI_MN, Odonata), however, the remaining metrics scored below average with four scoring zero (Figure 309).

Figure 309. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

While many samples were taken on this reach in the 1960s, recent samples are limited. Recent concentrations ranged from 6.01 mg/L to 9.61 mg/L without any values in the limited dataset below the DO standard of 5 mg/L. An early morning longitudinal survey of 2 locations in July of 2009 with values of 5.15 and 4.99 mg/L (Barr, 2010b). Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.7-14.0 mg/L with 5% of values below the water quality standard of 5 mg/L.

Table 615. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN058	0	45.56	11	17.15	7.44	2	5.79
03MN095 (2004)	0	13.75	10	NA	NA	NA	NA
03MN095 (2005)	0	18.18	13	NA	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	**1.43**	**10.56**	**10.03**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)				**18.23**	**7.57**	**4.51**	**6.75**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. None of the visits on this reach had any fish that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. The three visits all had percentages higher than the class average with station 03MN058 the highest at 45.46%. 58%-80% of the fish communities was comprised of fish species that are very tolerant to low DO conditions at the three fish visits.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed; two low DO tolerant taxa was present and 17.15% of DO tolerant individuals were present. No low DO values were collected, but the biological evidence indicates DO is a stressor at station 03MN058.

Candidate Cause Eutrophication

A very small dataset of phosphorus values ranged from 0.03 to 0.058 mg/L without any values in the limited dataset over the water quality standard of 0.150 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus, however none of this data was available on this reach. As a result of eutrophication, pH values also increase. pH values ranged from 7.63 to 8.15. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.6 mg/L with a mean of 0.2 mg/L.

Table 616. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN058	0	3.33	96.67	46.67	39	0.97	29.22
03MN095 (2005)	0	7.27	90.91	23.64	NA	NA	NA
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	5.54	10.36	76.45	19.58			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)					33.60	36.82	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The two stations lacked any sensitive species. The darter species ranged from 3.33 to 7.27%, both below the class average. The tolerant percentages were both higher than the class average. A positive relationship exists between eutrophication and omnivorous fish; the omnivorous fish percentages were both higher than the class average. Less than half of the macroinvertebrate sample was dominated by two species at station 03MN058. The number of taxa were higher than the class average while the EPT percentages were lower. The limited dataset does not have phosphorus or eutrophication data indicating eutrophication, and the biological data was mixed making eutrophication as a stressor inconclusive.

Candidate Cause: Nitrate

Two nitrate samples were taken from Ninemile Creek (-808) from 2003-2014. The sample from 2003 was taken on August 13, 2003 and had a nitrate concentration of 0.16 mg/L. The other sample was

taken on July 7, 2014 and had a nitrate concentration of 0.66 mg/L. Both of these nitrate concentrations are low and are consistent with the extensive data set that is available on the next downstream reach, Ninemile Creek (-809).

Table 617. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN058	**5.88**	**50.90**	**0.00**	**3.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*10.99*	*57.02*	*0.30*	*3.22*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Ninemile Creek (-808) at site 03MN058 scored below average in two of the four nitrate related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 617). The stream reach had few Trichoptera taxa and no nitrate intolerant species. However, this reach did have a lower amount of nitrate tolerant taxa, while also having a good Nitrogen TIV score. These results suggest a stream not being negatively impacted by excessive nitrates.

Based on the low observed values that are consistent with the minimal nitrate values found in the next downstream reach, as well as the low amount of Nitrate tolerant taxa and good scoring nitrogen TIV score, nitrates are not a stressor at Ninemile Creek (-808) at this time.

Candidate Cause: Sediment

From 2003-2014, two TSS samples were taken from Ninemile Creek (-808). These samples were 12 mg/L on 08/12/2003 and 6.8 mg/L on 07/07/2014. Additionally, three secchi tube measurements were taken during this time frame. These readings ranged from 60-95 cm. Both TSS and transparency measurements in this reach had zero exceedances of their respective standards.

Table 618. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN058	**10.22**	**0.37**	**0.00**	**8.25**	**2.33**	**0.00**	**7.30**	**0.00**	**1.29**	**19.91**
03MN095	**8.12**	**1.25**	**0.00**	**6.26**	**3.11**	**0.00**	**6.11**	**0.00**	**2.46**	**20.22**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*31.38*	*1.01*	*10.83*	*12.43*	*22.62*	*6.02*	*30.09*	*0.52*	*4.91*	*15.49*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Ninemile Creek (-808) scored below average in nine (03MN095) and ten (03MN058) of the ten suspended sediment related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 618). These results indicate potential stress from the suspended sediment conditions.

Table 619. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN058	**13.69**	**0.00**	**10.00**	**23.82**	**15.62**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*16.10*	*1.16*	*10.53*	*36.67*	*22.05*	*0.10*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community scored below average in three of the six suspended sediment related metrics at site 03MN058 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 619). This site had a low amount of collector filterer individuals, while also lacking Plecoptera and TSS intolerant taxa. However, this reach did have a good TSS Index Score, while having a low percentage of TSS tolerant species and taxa.

Based on the very low observed TSS and transparency values and similar values to nearby stream reaches with large data sets, and many of the macroinvertebrate metrics related to suspended sediment scoring above average, suspended sediment is not a stressor to aquatic life in this reach. The majority of the low scoring fish metrics are likely attributed to other stressors.

Candidate Cause: Habitat

Ninemile Creek (-808) had a qualitative habitat assessment take place at the biological monitoring site, 03MN058, during the fish and macroinvertebrate sampling events in 2003 and 2014. The average MSHA score from these visits was 42.68 (Poor). Limiting the MSHA at this site was the urban/industrial land use, a narrow riparian buffer, sand substrate, light embeddedness, sparse fish cover, moderate channel stability, poor sinuosity and fair channel development. A breakdown of the MSHA category scores for this site can be seen in Figure 310. Site 03MN095 did not have a qualitative habitat assessment.

Figure 310. Habitat metric scores

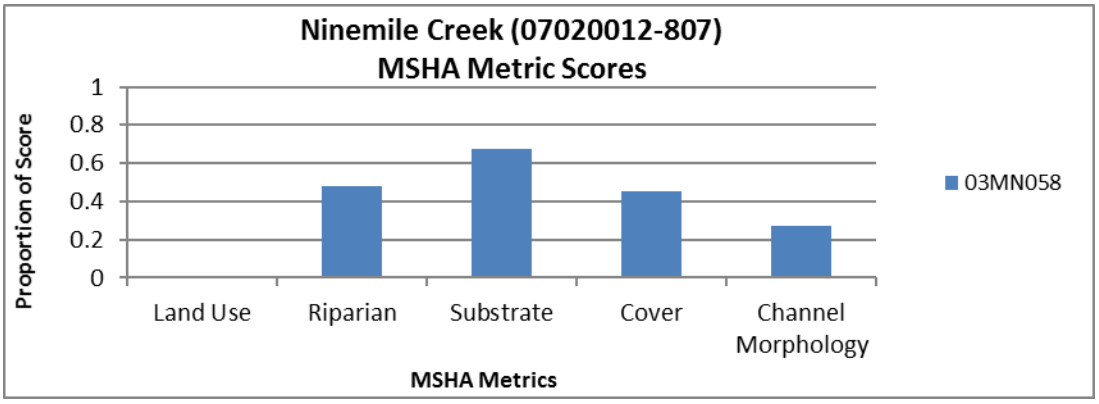


Table 620. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSuc Pct	RiffePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN058	**7.89**	**7.30**	**7.89**	**2.33**	**0.00**	**19.66**	**91.75**	**66.15**
03MN095	**5.01**	**6.11**	**5.01**	**3.11**	**0.42**	**19.05**	**93.13**	**42.04**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)	*10.91*	*30.09*	*10.59*	*22.62*	*1.97*	*57.98*	*46.70*	*32.54*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Ninemile Creek (-808) scored below average in all eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that meet the FIBI Modified Use Threshold (Table 620). The fish assemblage consisted primarily of tolerant fish species, while mostly lacking species that require specialized habitat conditions. These results suggest that the habitat conditions are stressing the fish community.

Table 621. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN058	**15.83**	**20.02**	**38.26**	**7.99**	**73.07**	**18.61**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	*6.43*	*19.88*	*38.44*	*27.84*	*44.43*	*18.90*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate assemblage scored below average in five of the six habitat related metrics at site 03MN058 when compared to all other Class 5 Southern Streams RR stations that meet the MIBI Modified Use Threshold (Table 621). The community had high amounts of both burrower and legless individuals, while lacking EPT individuals, which is a strong indicator of habitat stress.

Based on the poor MSHA score as well as the results of both of the fish and macroinvertebrate habitat related metrics, habitat is a stressor to aquatic life in Ninemile Creek (-808).

Candidate Cause Chloride/Ionic strength

One recent value of chloride was available at 5.8 mg/L. Specific conductance is a measure of ions that includes chloride. Measurements on this stream reach ranged from 1086 to 1338 uS/cm. A study of Minnesota biological data and stressor linkages found that sites with conductivities higher than 1,000 µS/cm rarely meet the biological thresholds for general use streams (MBI, 2012). All three of the values in the small dataset were over 1,000 uS/cm.

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentage were far below class average, and EPT% decreased from 15.01% in 2003 to 0.97% in 2014. The taxa count was just above average. The macroinvertebrate community is comprised of conductivity tolerant individuals comprised 43.04% of the community.

Table 622. Metrics related to ionic strength

	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
03MN058	39	1	0.97	0.97	0
03MN095 (2004)	NA	NA	NA	NA	3.75
03MN095 (2005)	NA	NA	NA	NA	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI Modified Use Threshold (33.0)					1
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI Modified Use Threshold (24.0)	**36.82**	***4.43***	***17.02***	***33.60***	
Expected response to increased TP stress	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. The percentage of

Centrarchidae (sunfish) ranged from zero at station 03MN058 to 3.75% at station 03MN095. Conductivity tolerant individuals comprised 50% of the fish community, up from 16% in 2003 at station 03MN058 and ranged from 20 to 48% at station 03MN095.

Each of the specific conductance values in the small dataset were over 1000 uS/cm. The elevated concentrations might be influencing the decrease in EPT and mayfly percentages. There is currently not enough evidence to indicate ionic strength as a stressor. Additional sampling throughout the reach and throughout the year of chloride would be beneficial.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be almost entirely modified. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 9% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised a range of 40 to 84.44% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised a range of 6.25 to 76.67% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to

stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 0.65% of the population. The channelization is likely contributing to the lack of habitat and seems to be influencing the low flow periods. The biological results indicate altered hydrology is a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Ninemile Creek (-808) are being stressed by Dissolved Oxygen, Habitat, and Flow Alteration/Connectivity (Table 623). Eutrophication and Chloride were inconclusive as stressors at this point, while Nitrates and Suspended Sediment were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 623. Stressors on Ninemile Creek (-808)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Ninemile Creek	07020012-808	●	o	---	---	●	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.11 Ninemile Creek (-809)

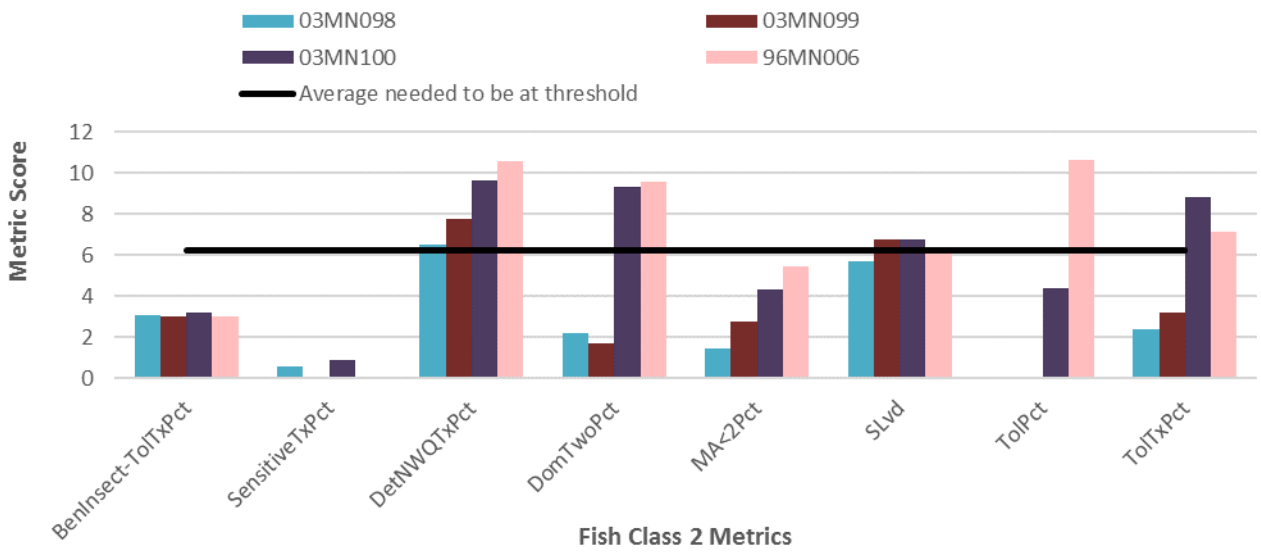
Ninemile Creek (-809) is a 5.32 mile long stream reach that extends from Nine Mile Creek dam to the Minnesota River in Bloomington. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. Six biological monitoring sites are located along this reach, 03MN098, 03MN099, 03MN100, 96MN004, 96MN005, and 96MN006. This reach is also impaired for Chloride. A Stressor ID Report was completed in 2010 by Barr Engineering which identified dissolved oxygen and sediment as stressors (Barr, 2010b).

Biology

Fish

Ninemile Creek (-809) was extensively sampled for fish between four different sites. The average FIBI scores from these sites are 21.9 (03MN098), 25.1 (03MN099), 44.8 (03MN100), 52.6 (96MN006). Site 96MN006 is the only site to have an average FIBI score above the Fish Class 2 Southern Streams General Use Threshold of 50. See Figure 311 for a breakdown of the average metric scores at each of the sites along this stream reach.

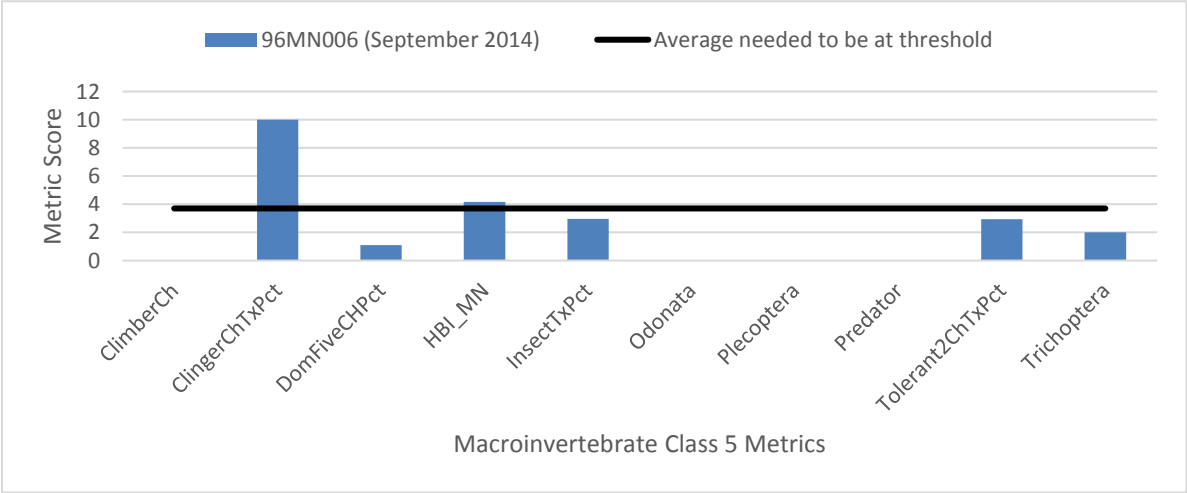
Figure 311. Fish metric scores



Macroinvertebrates

The macroinvertebrate community in Ninemile Creek (-809) was sampled at 96MN006 in September of 2014. The MIBI score for this reach was 23.2, which is well below the Macroinvertebrate Class 5 Southern Streams RR General Use Threshold of 37. This site scored above the average needed to reach the threshold for this class in just two of the ten metrics comprising the MIBI (ClingerChTxPct, HBI_MN). Four of the metrics had a score of zero severely limiting the MIBI for this site (Figure 312).

Figure 312. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

While were a number of samples taken on this reach in recent years (2014-2016), concentrations ranged from 4.1 mg/L to 10.11 mg/L without any values in the limited dataset below the DO standard of 5 mg/L. One recorded value was below the water quality standard of 5 mg/L at station 03MN098, the most upstream station in the reach. The NMCWS collected continuous DO data both in 2008 and 2009 at 98th St., where values ranged from 2.1 to 8.6 mg/L in 2008 and 0.40 to 10.6 mg/L in 2009 (Barr, 2010b). Of eight locations sampled in a longitudinal survey, four were below 5 mg/L (Barr, 2010b).

Table 624. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN098 (2005)	0	54.93	12	NA	NA	NA	NA
03MN098 (2007)	0	31.17	8	NA	NA	NA	NA
03MN099 (2005)	0	20.09	12	NA	NA	NA	NA
03MN099 (2007)	0	7.57	10	NA	NA	NA	NA
03MN100 (2005)	1.28	40.38	20	NA	NA	NA	NA
03MN100 (2007)	0	11.28	19	NA	NA	NA	NA
96MN006	2.33	30.23	21	0	6.93	4	7.68
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	12.16				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↓

Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 2.7-14.1 mg/L with 1% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Each of the visits on this reach had less than 2.5% of fish individuals that reproduce at a mature age. Low DO values also correspond with increased serial spawning fish percentage. All visits except one had serial spawning percentages higher than the class average with station 03MN098 the highest at 54.93%. The fish communities were comprised of 0 to 39% of fish species that are very tolerant to low DO conditions at the three fish visits.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were only analyzed at station 96MN006, the only station with a macroinvertebrate sample. Four low DO tolerant taxa were present and zero DO tolerant individuals were present. Low DO values were collected both individually and in continuous data. DO was not a stressor to the macroinvertebrate community, but the biological evidence indicates DO is a stressor to fish at the upper section of the reach. There is an upstream wetland complex which is likely influencing the low DO values.

Candidate Cause Eutrophication

A small dataset of phosphorus values ranged from 0.05 to 0.131 mg/L without any values over the water quality standard of 0.150 mg/L. Chlorophyll-a, BOD, and DO fluctuation values are a proximate

measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a samples had a range of values from 1 to 100, with five values over the southern standard of 40. BOD values ranged from 1 to 15 with 16% of values over the standard of 3.5 mg/L. As a result of eutrophication, pH values also increase. pH values ranged from 7.87 to 8.41.

Table 625. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN098 (2005)	0.33	6.91	89.14	40.79	NA	NA	NA
03MN098 (2007)	0	6.48	92.42	4.40	NA	NA	NA
03MN099 (2005)	0	5.02	86.76	15.07	NA	NA	NA
03MN099 (2007)	0	0.88	98.42	27.46	NA	NA	NA
03MN100 (2005)	0	4.17	65.38	19.87	NA	NA	NA
03MN100 (2007)	0.13	5.84	90.92	6.61	NA	NA	NA
96MN006	0	6.40	34.88	7.56	29	20.87	47.66
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.6 mg/L with a mean of 0.2 mg/L .

Sensitive individuals ranged from 0 to 0.33% and darter species ranged from 0.88 to 6.91%. The tolerant percentages were all higher than the class average except at station 96MN006. A positive relationship exists between eutrophication and omnivorous fish; the omnivorous fish percentages ranged from 4.40 to 40.79%.

Close to half of the macroinvertebrate sample was dominated by two species at station 96MN006. The number of taxa and the EPT percentages were lower than the class average. The EPT that were present were Hydropsyche, which are tolerant to eutrophication conditions. The limited dataset does not have phosphorus indicating eutrophication, however elevated BOD and chlorophyll-a values were collected and the biological data indicates eutrophication stress.

Candidate Cause: Nitrate

From 2004-2015, a total of 188 Nitrate samples were taken from this section of Ninemile Creek (-809). These values ranged from 0.05-1.74 mg/L with an average reading of 0.4 mg/L. This value is very low compared to many other parts of the watershed.

Table 626. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
96MN006	**20.00**	**37.04**	**0.00**	**2.99**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage at site 96MN006 scored below average in only one of the four nitrate related metrics that were evaluated when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 626). This site lacked nitrate intolerant individuals, but scored very well in the other metrics.

Given the very low nitrate concentrations found with a large sample size as well as the majority of the nitrate related macroinvertebrate metrics scoring above average, nitrates are not a stressor in Ninemile Creek at this time.

Candidate Cause: Sediment

From 2007-2014, a total of 13 TSS samples were taken from Ninemile Creek (-809). These values ranged from 1-32 mg/L with an average TSS concentration of 7.91 mg/L. All samples were well under the 65 mg/L standard for TSS. Additionally, 39 secchi tube measurements were taken from 2007-2015. These readings ranged from 25-100 cm, with an average value of 96.08 cm. This value is very high.

Table 627. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN098	**8.90**	**0.00**	**0.08**	**4.42**	**4.40**	**0.08**	**7.96**	**0.00**	**0.21**	**18.62**
03MN099	**15.52**	**2.32**	**0.13**	**3.98**	**13.86**	**0.00**	**28.31**	**0.00**	**2.58**	**15.80**
03MN100	**14.28**	**18.87**	**3.18**	**24.95**	**8.24**	**0.51**	**14.30**	**0.00**	**27.78**	**21.78**
96MN004	**8.73**	**12.25**	**0.09**	**20.75**	**6.89**	**0.00**	**16.84**	**0.00**	**20.96**	**21.08**
96MN005	**16.26**	**12.38**	**1.46**	**16.26**	**12.62**	**0.00**	**34.47**	**0.00**	**15.29**	**16.08**
96MN006	**12.69**	**32.02**	**0.74**	**37.19**	**8.55**	**0.00**	**21.21**	**0.00**	**34.48**	**16.56**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Ninemile Creek (-809) scored below average in six (96MN006), seven (96MN005, 96MN004, 03MN100), nine (03MN099), and ten (03MN098) of the ten suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold. All six of the sites showed below average numbers of benthic feeding, herbivorous, riffle dwelling, sensitive, simple lithophilic, and intolerant individuals.

Table 628. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
96MN006	**15.25**	**0**	**5**	**30.86**	**66.04**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community in Ninemile Creek (-809) scored below average in two of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 628). The site, 96MN006, lacked TSS intolerant and Plecoptera species, but did have a good TSS Index score, a high amount of collector filterer individuals, as well as a low amount of TSS tolerant Taxa and TSS tolerant individuals.

Based on the very low observed TSS and transparency values from a large dataset, and the majority of the macroinvertebrate metrics related to suspended sediment scoring above average, suspended sediment is not a stressor to aquatic life in this reach. The majority of the low scoring fish metrics are likely attributed to other stressors.

Candidate Cause: Habitat

Ninemile Creek (-809) had a qualitative habitat assessment take place at its biological monitoring sites, 03MN098, 03MN099, 03MN100, and 96MN006, during the fish and macroinvertebrate sampling events in 2007 and 2014. The average MSHA scores from these visits were 50 (Fair) at 03MN098, 64.1 (Fair) at 03MN099, 69.2 (Good) at 03MN100, and 76.23 (Good) at 96MN006. Limiting the MSHA at these sites was the residential land use at 03MN098, a very narrow riparian buffer at 03MN098, moderate to heavy bank erosion, sand substrate, severe embeddedness, and low to moderate channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 313. Site 03MN095 did not have a qualitative habitat assessment.

Figure 313. Habitat metric scores

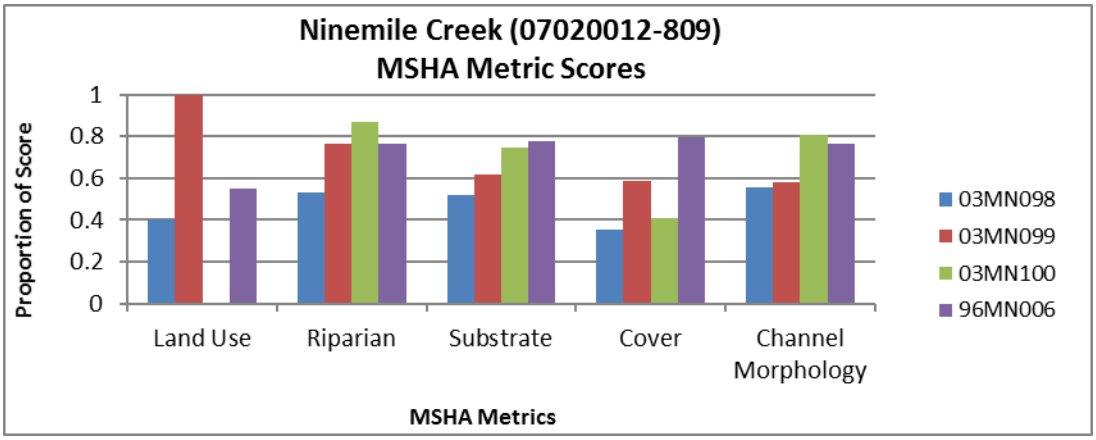


Table 629. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSuc Pct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN098	**4.50**	**7.96**	**4.42**	**4.40**	**0.00**	**43.22**	**93.25**	**67.88**
03MN099	**1.85**	**28.31**	**1.85**	**13.86**	**0.16**	**81.99**	**94.79**	**61.65**
03MN100	**7.55**	**14.30**	**6.90**	**8.24**	**5.55**	**31.42**	**62.53**	**35.06**
96MN004	**3.59**	**16.84**	**3.30**	**6.89**	**8.10**	**33.82**	**67.71**	**48.72**
96MN005	**3.64**	**34.47**	**3.40**	**12.62**	**12.86**	**61.65**	**79.85**	**41.50**
96MN006	**4.79**	**21.21**	**4.50**	**8.55**	**20.57**	**29.20**	**56.04**	**27.44**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish assemblage in Ninemile Creek (-809) scored below average in six (96MN005), seven (03MN099, 03MN100, 96MN004, and 96MN006), and eight (03MN098) of the eight habitat related metrics evaluated when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 630). In general, the numerous sampling along this reach consistently showed a high amount of habitat tolerant species, while lower numbers of species requiring specialized habitat conditions.

Table 630. habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
96MN006	**0.93**	**6.54**	**81.31**	**51.71**	**11.53**	**2.49**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Ninemile Creek (-809) at site 96MN006 scored below average in two of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 630). The generally good metric scores corresponds to the good MSHA score this site has over multiple visits and does not show much stress, if any, on the macroinvertebrate community.

The habitat conditions at site 96MN006 are good as evidenced by the higher MSHA score as well as the majority of the habitat related macroinvertebrate metrics, however, the remaining sites have MSHA scores ranging from Fair to Good, with the vast majority of the habitat related fish metrics scoring below average and consisting of a high amount of tolerant fish species as well as having few habitat specialist species. Based on this information, the habitat conditions are likely causing some stress to aquatic life in this reach, but may not be the driver of the aquatic life impairment. Therefore, habitat should be considered a secondary stressor.

Candidate Cause Chloride/Ionic Strength

Ninemile Creek has been impaired for chloride since 2004. A large dataset of chloride values ranged from 8.5 to 1302 mg/L with 22% of values over the standard of 230 mg/L. The highest values were collected from December to March, which is when road salt is most commonly used.

Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 302 to 914 uS/cm. The ecoregion norm for the North Central Hardwood Forests (based on the 75th percentile of annual specific conductance values) is 330 (McCollor et. al, 1993). All values were collected downstream of the city of Bloomington.

Table 631. Metrics related to ionic strength

Station	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
96MN006	20	1	20.87	51.71	16.94
Statewide average for Class 5 Southern Streams RR stations meeting the MIBI General Use Threshold (37.0)	*41.92*	*6.04*	*22.91*	*10.87*	
Statewide average for Class 2 Southern Streams meeting the FIBI General Use Threshold (50.0)					*4.89*
Expected response to stress	↓	↓	↓	↓	↓

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. Station 96MN006 was the only station sampled for macroinvertebrates. The EPT percentage was 51.71%. and the mayfly (Ephemeroptera) percentage was 20.87% with one species present. The taxa count was below the class average with reductions in mayfly taxa and EPT richness. The macroinvertebrate community was comprised of 12.96% of conductivity tolerant individuals and had one intolerant individual.

Elevated chloride can also lead to increases in sunfish based assemblages. While station 96MN006 had a Centrarchidae (sunfish) percentage above the class average (16.94%), the number of individuals decreased from 1996 when the percentage was 47.09%. Species that are tolerant (orangespotted sunfish, gizzard shad) to conditions with high ionic strength comprised 1.4% of the fish community. Chloride and the surrogate measure of specific conductance are high at times in Ninemile Creek.

While macroinvertebrate taxa and the number of mayflies was below class average but sunfish and EPT individuals were higher than average. Taxa count also is related to other stressors, so ionic strength could be contributing to this decline along with other stressors. While the periodic elevated values might be contributing as a stressor, it is not a clear stressor at this time.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be almost entirely natural, while the upstream watershed is predominantly channelized. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels. There were no known connectivity issues.

Channelization and tile drainage in the upstream watershed alter the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease

living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 1% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprising 32.56% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising 74.42% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 0.62% of the population. The upstream channelization is likely contributing to the lack of habitat, however low flows were not present and the biological information was mixed. The biological results indicate altered hydrology is not a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Ninemile Creek (-809) are being stressed by Dissolved Oxygen, Eutrophication, and Habitat. (Table 633) Nitrates, Suspended Sediment, Flow Alteration/Connectivity, and Chloride were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 632. Stressors on Ninemile Creek (-809)

Stream Name	AUID	Stressors: Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Ninemile Creek	07020012-809	●	●	---	---	●	o	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.12 Credit River (-811)

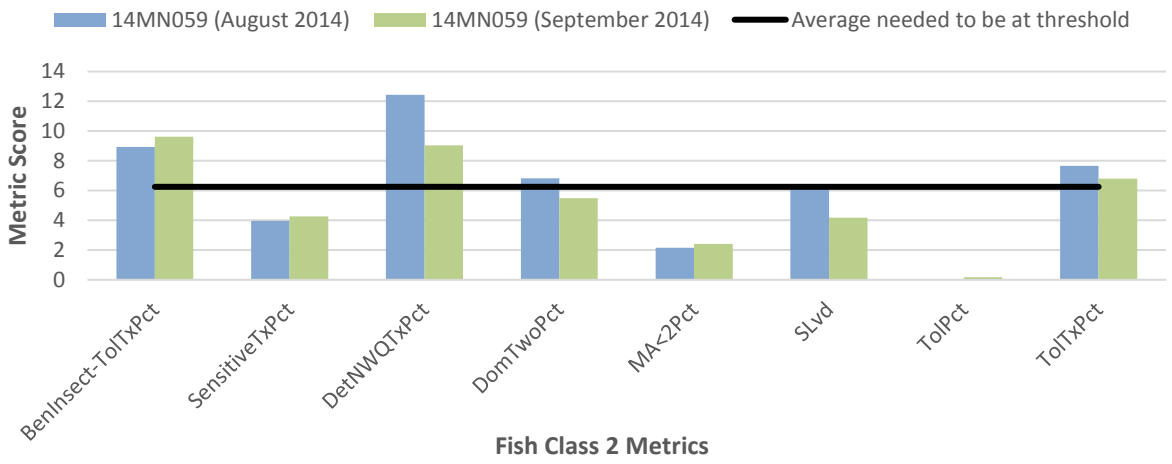
Credit River (-811) is a 12.11 mile long stream reach that flows from just upstream of County Road 75 to the confluence with the Minnesota River. This reach is located in northeastern Scott county. This reach is impaired for biology due to both the fish and macroinvertebrate assemblages. Two biological monitoring sites are located along this reach, 14MN059 and 90MN117. This reach is also impaired for Chloride.

Biology

Fish

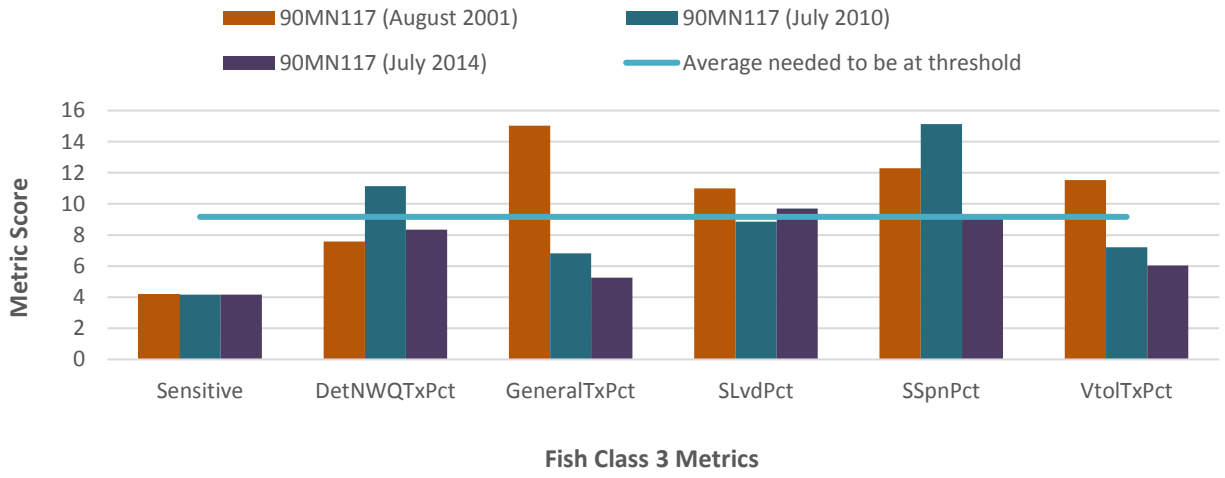
The Credit River (-811) was sampled for fish twice at biological monitoring site 14MN059 in 2014. The FIBI scores from these visits were 48.2 (August 2014) and 42.0 (September 2014). Both of these scores were below the Fish Class 2 Southern Streams General Use Threshold of 50. Both visits at this site had a lack of sensitive taxa, and a higher number of early maturing and tolerant individuals resulting in a lower FIBI score (Figure 314).

Figure 314. Fish Class 2 metric scores



Site 90MN117 was sampled three times from 2001-2014. The FIBI scores from these visits were 61.6 (2001), 53.3 (2010), and 42.6 (2014). The 2010 and 2014 visits have an FIBI score that is below the Fish Class 3 Southern Headwaters general use threshold of 55. All three visits to this site had a low amount of sensitive fish taxa which limited the FIBI score. (Figure 315)

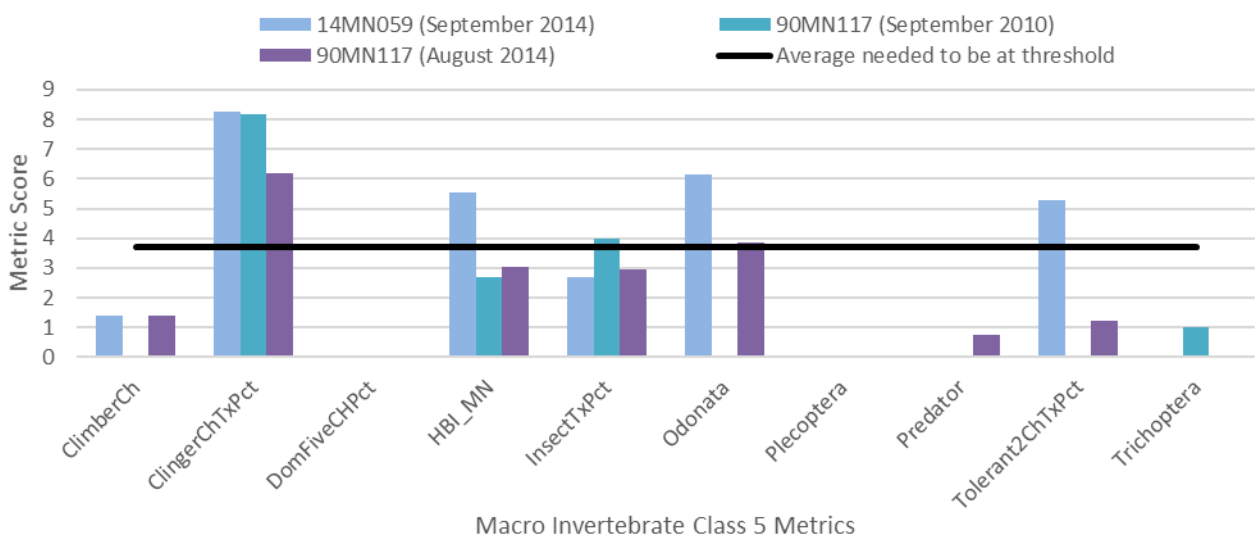
Figure 315. Fish Class 3 metric scores



Macroinvertebrates

The two biological sampling stations (14MN059, 90MN117) along the Credit River (-811) are classified as Class 5 Southern Streams RR stations. Site 14MN059 was sampled in 2014 and had an MIBI score of 30.0, which is below the 37.0 MIBI threshold for Class 5 general use sites. Also on this stream reach, site 90MN117 was sampled twice, once in September of 2010 and again in August of 2014. For a further breakdown of the MIBI metric scores for these sites, refer to (Figue 316).

Figure 316. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years. Concentrations ranged from 0.87 mg/L to 11.24 mg/L. 12% of values were below the water quality standard of 5 mg/L. Low values were located throughout the stream reach. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 3.1-14.0 mg/L with 1% of values below the water quality standard of 5 mg/L.

Table 633. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
90MN117 (2010)	0	7.20	12	5.47	7.43	2	7.28
90MN117 (2014)	0	35.02	8	4.40	7.31	2	7.33
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
14MN059 (8/28/14)	1.06	27.81	14	0.62	6.46	9	7.79
14MN059 (9/10/14)	1.99	35.04	13	NA	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. There was a range of 0 to 1.99% at four visits, all much lower than class averages. Low DO values also correspond with increased serial spawning fish percentage. All 2014 visits were close to or higher than class averages, while the percentage at station 90MN117 in 2010 was lower. Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at each station. Station 14MN059 had a high number of intolerant species, while both visits at station 90MN117 was 2 intolerant species. The number of individuals tolerant to low DO ranged from 0.62 to 5.47, all very low. There were some low DO values collected in 2008 and 2009, but not in more recent years. Low DO is not a stressor to the macroinvertebrate communities. There is not a consistent biological fish response. The evidence is stronger at station 90MN117 which indicates DO is a limited stressor in the lower portion of the creek. A wetland complex is upstream of station 90MN117 which is likely affecting the low DO values. DO is a secondary stressor, which is likely being impacted by eutrophication.

Candidate Cause Eutrophication

A large dataset of phosphorus values ranged from 0.05 to 1.32 mg/L with 56% over 0.150 mg/L. Orthophosphorus is a measurement of phosphorus available for plant uptake. Orthophosphorus comprised the majority of phosphorus concentrations, with a range of 20% in April to 100% in August and an average of 71%.

Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Chlorophyll-a values ranged from less than 1 to 69 ug/L with five values over the southern standard of 40 mg/L over a number of years. BOD values ranged from 0.9 to 9 mg/L, with 13 values over the southern standard of 3.5 mg/L. Values over 8.5 and

large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 6.85 to 9.24. DO flux data were not available.

Table 634. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
90MN117 (2010)	7.78	9.51	89.05	7.78	17	80.71	38.91
90MN117 (2014)	0.67	0.67	99.33	55.56	25	37.97	44.94
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
14MN059 (8/28/14)	11.46	14.44	83.44	22.93	29	36.11	61.42
14MN059 (9/10/14)	21.37	23.36	74.36	20.80	NA	NA	NA
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0.1-1.1 mg/L with a mean of 0.2 mg/L .

Sensitive individuals ranged from 0.67 to 21.37% and darter species ranged from 0.67 to 23.36%. Values were much lower at the upstream station 90MN117 than at station 14MN059. The tolerant percentages were all higher than the class average. A positive relationship exists between eutrophication and omnivorous fish; the omnivorous fish percentages ranged from 7.78 to 55.56%.

The macroinvertebrate sample was dominated by two species at station 14MN059, but not at station 90MN117. The number of taxa and the EPT percentages were low except at station 90MN117. The EPT that were present were Cheumatopsyche and Hydropsyche which are tolerant to eutrophication conditions.

There were indicators of eutrophication on the Credit River with some elevated BOD, phosphorus, and chlorophyll-a values. The biological communities are showing some effects of the eutrophication particularly at station 90MN117. Eutrophication as a stressor in the upstream section of the river is reinforced by the sensitive and darter individuals decreasing and the tolerant and omnivore individuals increasing from 2010 to 2014.

Candidate Cause Nitrate

From 2001-2015, a total of 203 nitrate samples were taken from this portion of the Credit River (-811). These sample values ranged from 0.05-4.4 mg/L with an average value of 0.88 mg/L. These nitrate values are relatively low when compared to other parts of the watershed.

Table 635. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN059	**6.90**	**47.84**	**0.00**	**2.97**
90MN117	**8.00**	**61.01**	**0.00**	**2.65**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community along the Credit River scored below average in two (14MN059) and three (90MN117) of the nitrate related biological metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 635).

Given that both sites had good TIV scores and the low nitrate concentrations in this reach with a large sample size, it is likely that other stressors are having a negative impact on this reach leading to some of the lower metric scores observed. Nitrate is not a stressor in the Credit River (-811) at this time.

Candidate Cause Sediment

From 2008-2016, a total of 59 TSS samples were taken from Credit River (-811). These sample values ranged from 1-59 mg/L, with an average TSS concentrations of 7.76 mg/L. This value is very low. Additionally, 103 transparency measurements were taken within this reach. These values ranged from 14-100cm with no values falling below the 10cm standard.

Table 636. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
90MN117	**30.69**	**0.00**	**17.49**	**7.74**	**28.71**	**5.76**	**29.52**	**0.00**	**0.00**	**16.69**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
14MN059	**31.93**	**0.46**	**4.37**	**20.64**	**29.44**	**16.42**	**44.74**	**0.00**	**2.20**	**14.77**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Credit River (-811) scored below average in eight (90MN117) and seven (14MN059) of the 10 suspended sediment related metrics when compared to Class 3 Southern Headwaters and Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 636). Both sites had low amounts of Centrarchids, benthic feeding species, sensitive species, intolerant taxa, and long lived species individuals.

Table 637. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN059	**13.85**	**0.00**	**6.00**	**6.48**	**38.58**	**0.00**
90MN117	**15.83**	**0.33**	**6.67**	**45.00**	**52.70**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Credit River (-811) scored below average in two (14MN059) and three (90MN117) of the suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 637). Both sites, 14MN059 and 90MN117, had low levels of TSS Intolerant Taxa and had zero Plecoptera individuals. Those results can be common in streams negatively affected by high suspended sediment levels. However, the reach did have above average TSS Index Scores, high amounts of collector filterer individuals, as well as low amounts of TSS tolerant taxa, which signal that the stream is not being negatively impacted by suspended sediment.

Based on the very low observed TSS and transparency values from a large dataset, and the majority of the macroinvertebrate metrics related to suspended sediment scoring above average, suspended sediment is not a stressor to aquatic life in this reach. The majority of the low scoring fish metrics are likely attributed to other stressors.

Candidate Cause Habitat

Credit River (-811) had qualitative habitat assessments take place at its biological monitoring sites, 14MN059 and 90MN117, during the fish and macroinvertebrate sampling events in 2001, 2010, and 2014. The average MSHA score from these visits was 72.13 (Good) at 14MN059 and 72.88 (Good) at 90MN117. Limiting the habitat at these sites was the presence sand substrates, light embeddedness, and some areas with erosion. A breakdown of the MSHA category scores for these sites can be seen in Figure 317.

Figure 317. Habitat metric scores

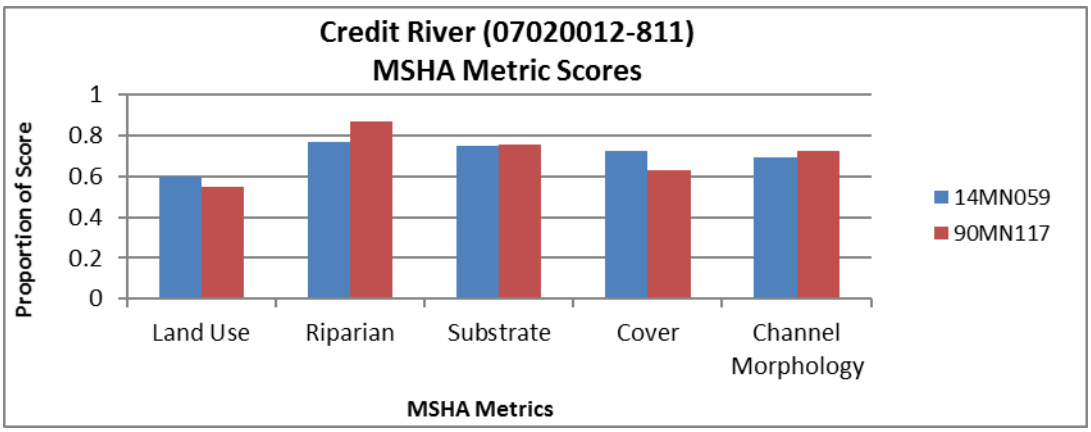


Table 638. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RiffPct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
90MN117	**4.65**	**28.36**	**4.65**	**31.54**	**0.00**	**64.06**	**94.87**	**42.34**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
14MN059	**19.15**	**44.74**	**19.15**	**29.44**	**1.63**	**64.39**	**78.90**	**31.93**
Statewide average for Class 2 Southern Headwaters stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community scored below average in seven of the eight (90MN117) and five of the eight (14MN059) habitat related fish metrics in the respective fish class when compared to all other sites in that class that meet the FIBI threshold (Table 638). The high amount of tolerant and pioneering species individuals while the low to below average amounts of habitat specialists species all signal habitat stress especially at site 90MN117.

Table 639. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
90MN117	**13.41**	**11.98**	**59.14**	**50.22**	**33.30**	**8.22**
14MN059	**1.85**	**2.78**	**77.16**	**36.11**	**8.64**	**16.98**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in the Credit River (-811) scored below average in three of the six habitat related metrics at site 90MN117 and two of six metrics at site 14MN059 when compared to other Class 5 Southern Streams RR stations that did meet the MIBI General Use Threshold (Table 639). These sites did score relatively better than the fish metrics and had more habitat specialist species such as clingers. The below average amount of legless and burrower (at 14MN059), was also a good sign that the site does not have an overabundance of fine sediment.

While the fish community scored relatively low in the majority of the habitat related metrics at both sites, the macroinvertebrate community fared much better. The MSHA scores were also good at both sites and were consistently good over a long time period. It is likely that the fish community is being

negatively impacted by another stressor causing lower scores in the evaluated metrics. Therefore, habitat is not considered a stressor to the biological communities at this time.

Candidate Cause Chloride/Ionic strength

A small dataset of chloride values from 2014 ranged from 38.6 to 82.3 mg/L without any values in the limited dataset over the standard of 230 mg/L. Specific conductance is a measure of ions that includes chloride. Measurements on this stream reach ranged from 231 to 1055 uS/cm. The ecoregion norm for the North Central Hardwood Forests (based on the 75th percentile of annual specific conductance values) is 330 (McCollor et. al, 1993).

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT and mayfly (Ephemeroptera) percentage range was 22.15 to 33.02%, all above class average. Taxa counts were below average for their respective classes but taxa count also is related to other stressors, so ionic strength could be contributing to this decline along with other stressors. The macroinvertebrate community is comprised of conductivity tolerant individuals ranging from 29 to 40%.

Elevated chloride can also lead to increases in sunfish based assemblages. The percentage of Centrarchidae (sunfish) at station 90MN117 was 0 at both stations, while the visits at station 14MN059 were both below 1%. Conductivity tolerant individuals comprised 16-19% of the fish community.

There are instances of elevated specific conductance concentrations that might be influencing the biological community but there is still healthy EPT and mayfly percentages. The preponderance of evidence indicates chloride and ionic strength are not currently stressors. Additional sampling throughout the reach and throughout the year of chloride would be beneficial.

Table 640. Metrics related io ionic strength

Stations	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
90MN117 (2010)	17	2	23.47	23.47	0
90MN117 (2014)	25	5	22.15	22.15	0
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)					**0.89**
14MN059 (8/28/14)	29	2	33.02	33.02	0.64
14MN059 (9/10/14)	NA	NA	NA	NA	0.28
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)					***4.89***
Statewide average for Class 5 Southern Streams RR stations meeting the MIBI General Use Threshold (37.0)	**41.92**	**6.04**	**22.91**	**10.87**	
Expected response to increased DO stress	↓	↓	↓	↓	↓

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be almost entirely natural, while the upstream watershed is predominantly channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 2% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised a range of 52.74 to 83.50% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised a range of 12.39 to 35.35% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised a range of 0.32 to 6.17% of the population, down from 4.97% in 2002. Based on the lack of low flows and the biological information being mixed, altered hydrology is not a stressor.

Conclusions and recommendations

The impaired fish and macroinvertebrate communities in Credit River (-811) are being stressed by Dissolved Oxygen and Eutrophication (Table 641). Nitrates, Suspended Sediment, Habitat, Flow Alteration/Connectivity and Chloride were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page 653.

Table 641. Stressors on Credit River (-811)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Credit River	07020012-811	●	●	---	---	---	---	---

● = stressor; o = inconclusive stressor; --- = not an identified stressor

14.13 Purgatory Creek (-828)

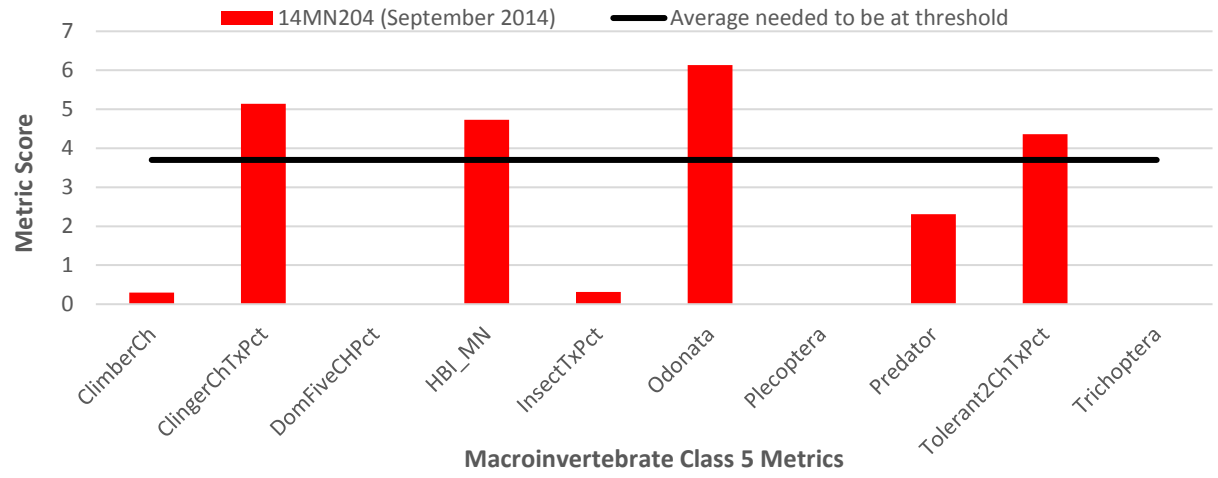
Purgatory Creek (-828) is a 6.1 mile long reach that is located in southern Hennepin county. This reach extends from Staring Lake to the confluence with the Minnesota River. This reach is impaired for biology due to the macroinvertebrate assemblage. There is one biological monitoring station, 14MN204, located along this stream section.

Biology

Macroinvertebrates

The impaired macroinvertebrate community in Purgatory Creek was sampled in 2014 at site 14MN204. This station is a Macroinvertebrate Class 5 Southern Streams RR station that had a MIBI score of 23.3, which is well below the 37.0 class 5 threshold. The macroinvertebrate assemblage in this reach scored below the average metric score needed to reach the MIBI threshold in six of the ten MIBI metrics. These metrics were: ClimberCH, DomFiveCHPct, InsectTxPct, Plecoptera, Predator, and Trichoptera. (Figure 318).

Figure 318. Macroinvertebrate metric scores



Candidate Cause Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years. Concentrations ranged from 4.86 mg/L to 18.35 mg/L with 1 value below the standard of 5 mg/L at station S009-316 located in the city of Eden Prairie. Two elevated values over 15 mg/L were collected on one day at two separate locations in May of 2014. Other elevated values over 11 mg/L indicate possible daily DO fluctuations. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.3-14.5 mg/L with 4% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. The one station had a value much higher than the class average, indicating that conditions are favorable to fish surviving to mature age. Low DO values also correspond with increased serial spawning fish percentage. Station 14MN204 had a higher than average percentage. Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at each station. There was one macroinvertebrate taxa collected that was intolerant to low DO condition and individuals tolerant to low DO were much lower than the class average. There are some low DO values in the upper part of the reach, but there is not a consistent biological fish response. Low DO is not a stressor to the biological communities.

Table 642. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
14MN204	15.63	37.50	13	6.41	6.73	1	7.21
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**2.06**	**17.09**	**12.16**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause Eutrophication

This section of Purgatory Creek flows out of Staring Lake which is impaired for nutrients. A large dataset of phosphorus values ranged from 0.033 to 0.181 mg/L with 8% over the southern standard of 0.150 mg/L. Values were taken throughout the reach with the highest value taken just downstream of the lake. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Recent chlorophyll-a values ranged from 1 to 48 mg/L with one value over the southern standard of 40 mg/L. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to measure algal productivity in surface water. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.5 to 8.97. BOD and DO flux data were not available. Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-1.4 mg/L with a mean of 0.1 mg/L .

Station 14MN204 had 3.13% sensitive individuals and zero darter species, which were both below class average. The tolerant percentage was also much lower than the class average. A positive relationship exists between eutrophication and omnivorous fish; the omnivorous fish percentage was elevated.

Table 643. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
14MN204	3.13	0	40.63	25	15	13.14	79.17
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	**8.9**	**12.11**	**70.79**	**14.71**			
Statewide average for Class 5 Southern Streams RR stations tha are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

The macroinvertebrate sample was dominated by two species (79.17% of the sample was comprised of just two species). The number of taxa and the EPT percentages were low and far below class average. The EPT that were present were Cheumatopsyche which are tolerant to eutrophication conditions.

There were some indicators of eutrophication at station 14MN204 with some elevated DO, pH, and chlorophyll-a values and filamentous algae. The biological communities are showing some effects of the eutrophication but eutrophication is inconclusive as a stressor on Purgatory Creek.

Candidate Cause Nitrate

From 2014-2015, a total of 16 nitrate samples were taken from this section of Purgatory Creek. These sample values ranged from 0.05-0.61 mg/L with an average value of 0.22 mg/L. These nitrate sample values are very low.

Table 644. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
14MN204	**13.33**	**16.99**	**0.00**	**2.63**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at site 14MN204 along Purgatory Creek (-828) scored below average in one of the four evaluated metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 644). The site lacked nitrate intolerant species, but scored well in the other metrics.

Given the majority of the nitrate related macroinvertebrate metrics scored well and the very low nitrate concentrations detected with ample water chemistry sampling, elevated nitrates are not a stressor to the impaired macroinvertebrate community in Purgatory Creek (-828) at this time.

Candidate Cause Sediment

From 2013-2016, a total of 63 TSS samples were taken from Purgatory Creek (-828). These samples ranged in value from 2-73 mg/L with an average TSS concentration of 18.34 mg/L. Only one sample was above the 65 mg/L standard. Additionally, 20 secchi tube readings were taken from 2014-2015. These measurements ranged from 28-100 cm, with no values below the 10 cm standard.

Table 645. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
97MN001	**5.52**	**13.79**	**0.00**	**63.45**	**2.76**	**0.00**	**3.45**	**0.00**	**77.93**	**18.52**
14MN204	**0.00**	**15.63**	**0.00**	**31.25**	**3.13**	**3.13**	**0.00**	**0.00**	**28.13**	**22.80**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*37.83*	*0.90*	*13.33*	*13.93*	*28.33*	*8.55*	*33.71*	*1.95*	*3.56*	*15.27*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Purgatory Creek (828) at sites 97MN001 and 14MN204 scored below average in seven of the ten metrics related to suspended sediment when compared to all other Class 3 Southern Headwaters stations that meet the FIBI General Use Threshold (Table 645). The sites did have higher numbers of long lived, Centrarchid-Tolerant, and Perciformid (perch-like) individuals. Those types of fish are typically not found in streams negatively impacted by high suspended sediment levels.

Table 646. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
14MN204	**13.75**	**0**	**6**	**17.31**	**79.17**	**0.00**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Purgatory Creek (-828) at site 14MN204 scored below average in two of the six metrics related to suspended sediment. This reach lacked TSS intolerant taxa and also had zero Plecoptera species. However, the site did have a good TSS index score, few TSS tolerant species, and a very large number of Collector Filterer taxa, which are much less abundant in streams negatively impacted by suspended sediment levels.

Based on the observed chemical data that showed only one TSS exceedance from a large data set, no transparency standard exceedances, the majority of the macroinvertebrate metrics related to suspended sediment, as well as the presence of long lived, Centrarchid, and perciformid species in higher numbers, suspended sediment is not a stressor in Purgatory Creek (-828). Other stressors are likely causing low scores on some of the fish metrics related to suspended sediment.

Candidate Cause Habitat

Purgatory Creek (-828) had a qualitative habitat assessment take place at one of its biological monitoring sites, 14MN204, during the fish and macroinvertebrate sampling events in 2014. The average MSHA score from these visits was 70.65 (Good). Limiting the MSHA score at this site was the presence of sand and silt substrates, light embeddedness, and moderate high channel stability. A breakdown of the MSHA category scores for this site can be seen in Figure 319. In addition, Barr Engineering found six sites with significant bank failures and mass wasting (RPBCWD, 2015).

Figure 319. Habitat metric scores

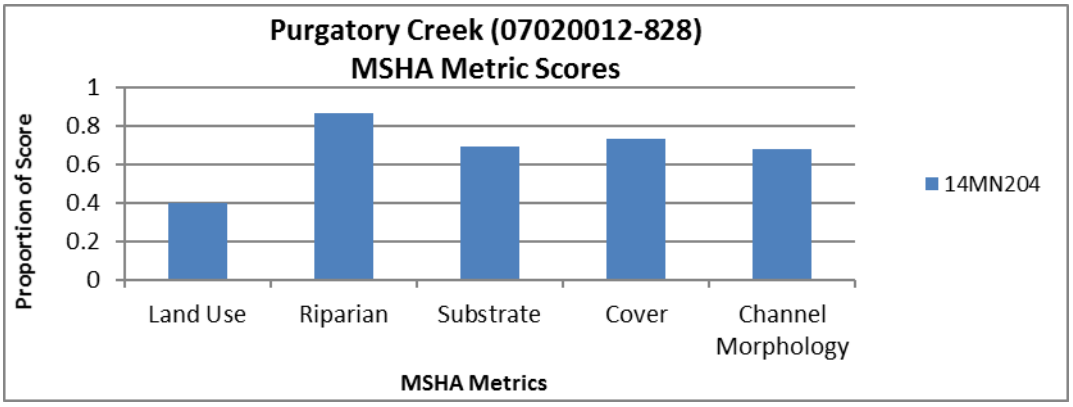


Table 647. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
14MN204	**0.00**	**0.00**	**0.00**	**3.13**	**9.38**	**3.13**	**40.63**	**21.88**
97MN001	**2.76**	**3.45**	**2.76**	**2.76**	**4.83**	**7.59**	**35.17**	**9.66**
Statewide average for Class 3 Southern Headwaters stations that are meeting the FIBI General Use Threshold (55.0)	*14.22*	*33.71*	*12.55*	*28.33*	*1.62*	*69.21*	*70.64*	*37.79*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community along Purgatory Creek (-828) scored below average at both sites in five of the eight habitat related metrics when compared to all other Class 3 Southern Headwaters stations that did meet the FIBI General Use Threshold (Table 647). These sites were fairly diverse given the stream size as they averaged 14.5 species per site. The fish assemblage had many fewer tolerant and pioneer species than average. Those two metrics are usually good indicators of degraded habitat conditions.

Table 648. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
14MN204	**0.32**	**4.81**	**83.33**	**13.14**	**8.97**	**7.05**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate community at 14MN204 scored below average in half of the habitat related biological metrics when compared to other Class 5 Southern Streams RR stations that did meet the MIBI General Use Threshold. The lower numbers of both burrowers and legless suggests that the amount of fine substrates that lightly embedded some of the gravels in the stream is having a minimal impact on the macroinvertebrate community. It was noted that a mudslide occurred prior to the macroinvertebrate sample, filling the stream with sediment. Another sample would be beneficial.

Based on the Good MSHA score, as well as some of the habitat related metric scores that would normally be below average in degraded habitat conditions for both the fish and macroinvertebrate communities, habitat is not a stressor at this time. Other stressors are likely impacting these assemblages resulting in some lower metric scores.

Candidate Cause Chloride/Ionic strength

A small dataset of chloride values from 2014 ranged from 60.6 to 115 mg/L without any values in the limited dataset over the standard of 230 mg/L. Specific conductance is a measure of ions that includes chloride. Measurements on this stream reach ranged from 445 to 1151 uS/cm. The ecoregion norm for the North Central Hardwood Forests (based on the 75th percentile of annual specific conductance values) is 330 (McCollor et. al, 1993).

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was 13.14% and the mayfly (Ephemeroptera) percentage was 2.24%. The taxa count and mayfly numbers were far below the class average, but the EPT percentages was slightly above class average. The macroinvertebrate community was comprised of 17.31% conductivity tolerant individuals.

Table 649. Metrics related to ionic strength

Stations	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct
14MN204	15	1	2.24	13.14	15.63
Statewide average for Class 3 Southern Streams meeting the FIBI General Use Threshold (55.0)					**0.89**
Statewide average for Class 5 Southern Streams RR stations meeting the MIBI General Use Threshold (37.0)	**41.92**	**6.04**	**22.91**	**10.87**	
Expected response to increased DO stress	↓	↓	↓	↓	↓

Elevated chloride can also lead to increases in sunfish based assemblages. The percentage of Centrarchidae (sunfish) was far above the class average. Species that are tolerant to conditions with high ionic strength comprised 31.3% of the fish community. There are instances of elevated specific conductance concentrations that might be influencing the biological community with low taxa count and mayflies. Taxa count also is related to other stressors, so ionic strength could be contributing to this decline along with other stressors. While the periodic elevated values might be contributing as a stressor, chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. Chloride is inconclusive as a stressor on Purgatory Creek (-828) at this time.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer showed this creek to be almost entirely natural. Changes in landscape vegetation, pavement, and drainage can increase how fast rainfall runoff reaches stream channels. This creates a stronger pulse of flow, followed later by decreased baseflow levels.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs 8% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised 46.88% of the population. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprised 37.5% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 2.56% of the population.

Connectivity is another important aspect of hydrology. Fish migration is dependent on stream connectivity. A rock dam is located on the stream creating a fish barrier (Figure 320). While the fish community wasn't impaired, the FIBI Score was only one point over the threshold. The rock dam should be addressed to reconnect connectivity of the creek. Altered hydrology is likely affecting the fish community but is inconclusive as a stressor to the impaired macroinvertebrate community.

Figure 320. Rock dam downstream of dam

Conclusions and recommendations

The impaired macroinvertebrate community in Purgatory Creek (-828) is being stressed by Flow Alteration/Connectivity. (Table 650) Eutrophication and Chloride were inconclusive as stressors at this point, while Dissolved Oxygen, Nitrates, Suspended Sediment, and Habitat were ruled out as stressors. For further information on the stressors and recommendations to fixing the stressors in the Minnesota River HUC 10 watershed, please see page below.

Table 650. Stressors on Purgatoory Creek (-828)

		Stressors:						
Stream Name	**AUID**	**Dissolved Oyxgen**	**Eutrophication**	**Nitrate**	**Suspended Sediment**	**Habitat**	**Flow Alteration/Connectivity**	**Chloride**
Purgatory Creek	07020012-828	---	o	---	---	---	o	o

● = stressor; o = inconclusive stressor; --- = not an identified stressor

Minnesota River HUC 10 Conclusions and Recommendations

The Minnesota River subwatershed contains thirteen biologically impaired stream reaches. Stressors found in at least five of the thirteen impaired reaches were Dissolved Oxygen (5), Eutrophication (3), Habitat (8) and Altered Hydrology/Connectivity (8). Suspended Sediment was found to be a contributing stressor in three of the stream reaches while Nitrates and Chlorides were either completely eliminated as stressors or need more information to determine their stressor status in this watershed (Table 651).

The majority of this subwatershed is within the Twin Cities metro region, therefore, the vast majority of the land use is developed. There are small areas of row crop agriculture and hay/pasture in the far southern and western reaches of this subwatershed.

Significant issues in this watershed are related to the amount the channelizing of stream systems or any alterations of natural stream flow. These practices lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

Also, limiting the use of fertilizers and runoff will also help decrease the amount of phosphorus entering the stream system, which may lead to eutrophication and dissolved oxygen issues.

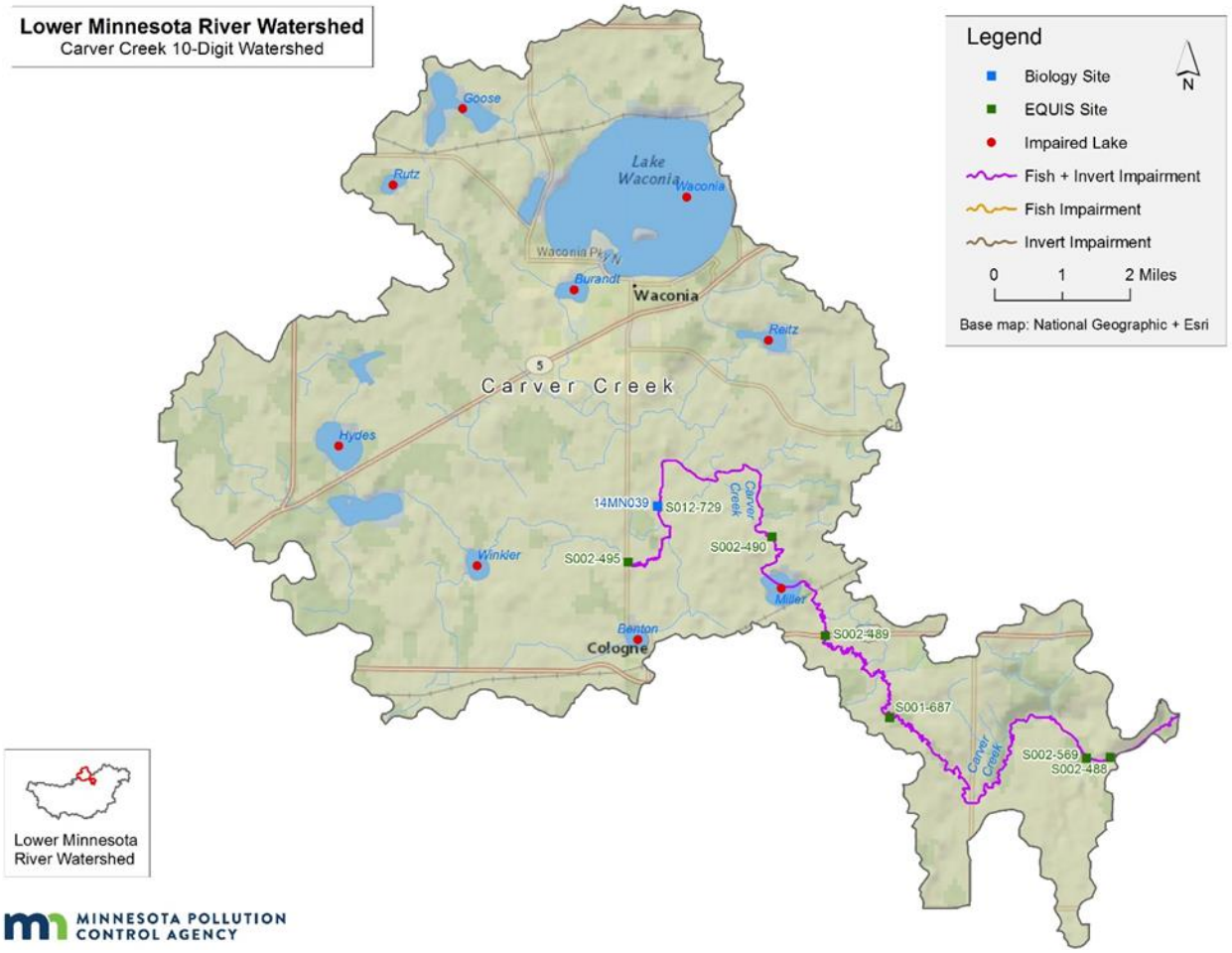
Addressing flow alteration is a priority in this watershed. The loss of wetlands in this subwatershed has limited the amount of water storage capacity on the landscape. Finding ways to increase the storage and infiltration of water throughout the watershed will help mitigate this issue. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions.

Table 651. Stressors on streams in the Minnesota River HUC 10

Stream Name	AUID	Stressors:						
		Dissolved Oxygen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Flow Alteration/Connectivity	Chloride
Riley Creek	07020012-511	o	o	---	●	---	●	o
East Creek	07020012-581	---	●	---	●	●	●	o
Assumption Creek	07020012-582	o	o	---	---	---	o	o
County Ditch 13	07020012-604	●	●	o	---	●	●	o
Bluff Creek	07020012-710	---	●	---	●	●	●	o
South Fork Ninemile Creek	07020012-723	●	o	---	---	●	●	o
Unnamed creek (Prior Lake Outlet Channel)	07020012-728	o	o	---	---	---	●	o
Chaska Creek	07020012-803	---	o	---	---	●	●	o
Ninemile Creek	07020012-807	o	o	---	---	●	o	o
Ninemile Creek	07020012-808	●	o	---	---	●	●	o
Ninemile Creek	07020012-809	●	●	---	---	●	o	---
Credit River	07020012-811	●	●	---	---	---	---	---
Purgatory Creek	07020012-828	---	o	---	---	---	o	o

15. Carver Creek HUC 10 (0702001210)

Figure 321. Smapling sites in the Carver Creek HUC 10



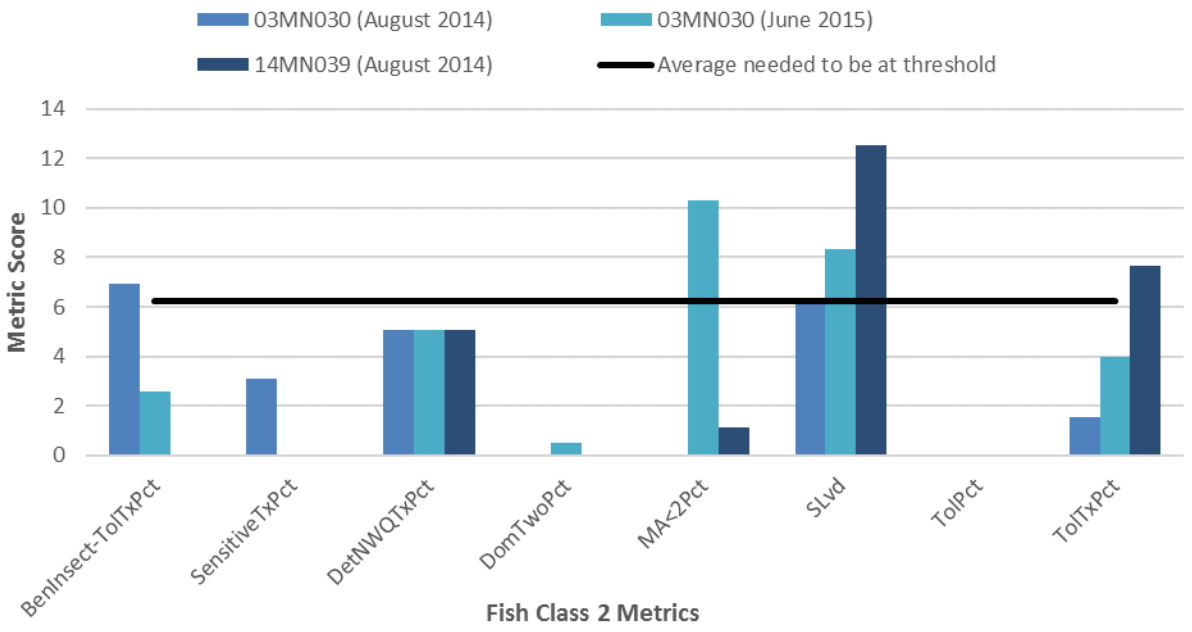
15.1 Carver Creek (-806)

Biology

Fish

Carver Creek (-806) had two biological monitoring stations that were sampled for fish, 03MN030 and 14MN039. Both of these stations were classified as Class 2 Southern Streams stations. Site 03MN030 was sampled twice from 2014-2015. The fish IBI scores from these visits were 22.9 (2014) and 30.9 (2015), while site 14MN039 was sampled once in 2014 and had a fish IBI score of 26.3. All of these scores are well below the Fish Class 2 IBI threshold of 50. The fish community in this reach scored especially poor in four metrics (SensitiveTxPct, DetNWQTXPct, DomTwoPct, TolPct) as all sampling visits scored well below the average needed to achieve the Class 2 IBI Threshold (Figure 322).

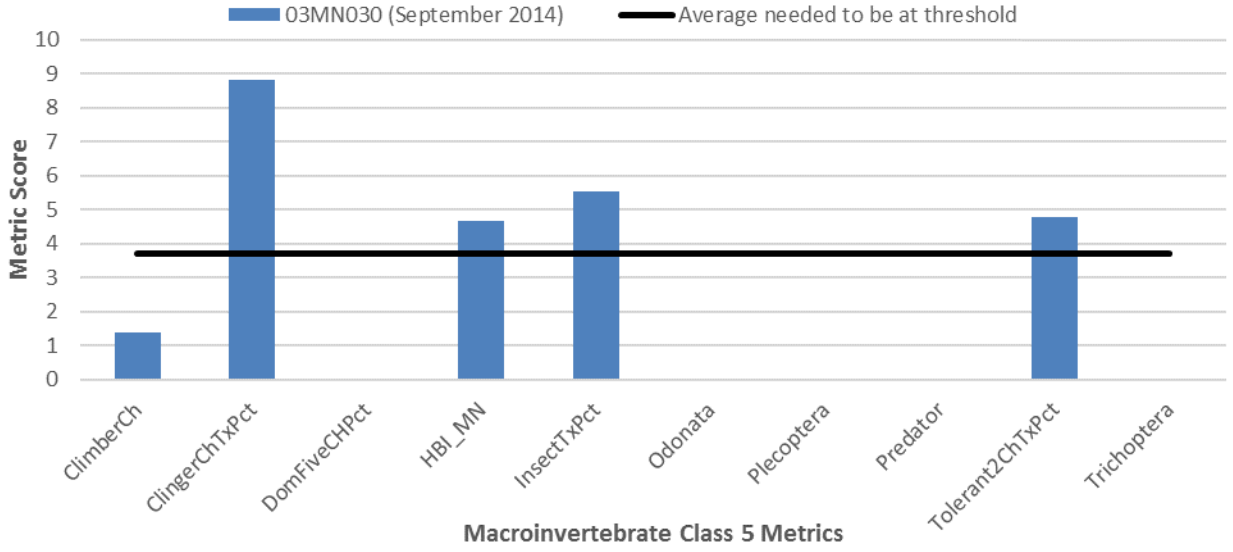
Figure 322. Fish metric scores



Macroinvertebrates

Carver Creek (-806) had one macroinvertebrate sample taken at 03MN030 in 2014. This site is a macroinvertebrate Class 5 Southern Streams RR station. Site 03MN030 had an MIBI of 25.1 which is well below the class 5 MIBI threshold of 37. The macroinvertebrate community scored well below the average needed to meet the MIBI threshold in six metrics comprising the MIBI (ClimberCH, DomFiveCHPct, Odonata, Plecoptera, Predator, and Trichoptera) (Figure 323).

Figure 323. Macroinvertebrate metric scores



Candidate Cause: Dissolved Oxygen

There is a sizeable DO dataset on this reach in recent years (2004-2016). Concentrations ranged from 3.70 mg/L to 17.26 mg/L with 10% of values below the standard of 5 mg/L. The lowest value was

collected in July at station S002-490. Five elevated values over 15 mg/L were collected indicating possible daily DO fluctuations. Additionally, the HSPF model calculated daily minimum DO values in May-September from 1996-2012. These values ranged from 0.5-16.3 mg/L with less than 2% of values below the water quality standard of 5 mg/L.

The abundance of fish individuals where females mature at greater than three years in age decreases with low DO conditions. Visits at station 03MN030 had no fish that reproduce at a mature age, while station 14MN039 was higher (8%), it was still lower than the class average of sites meeting the standard. Low DO values also correspond with increased serial spawning fish percentage. The serial spawning percentage was also higher at station 14MN039, which was three times the class average while the two visits at station 03MN030 were both much lower than the class average of stations that met the general threshold.

Macroinvertebrate species that are specifically tolerant and intolerant to DO were analyzed at each station. The number of intolerant taxa ranged from 2-4, and the low DO tolerant fish individuals ranged from 0 to 10.94%. Low DO values were present in the upper part of this reach, which is also where the biological response was more pronounced. Low DO is a limited stressor to the biological communities in the upper section of the river near station 14MN039.

Table 652. DO related metrics

	MA>3 years Percentage	Serial Spawning Fish Pct	Fish Taxa Count	Percentage DO Tolerant Macroinvertebrates	HBI_MN	Intolerant DO Macroinvertebrate Taxa	DO Tolerant Index Score
03MN030 (2014)	0	4.19	9	0	6.76	4	7.65
03MN030 (2015)	0	8.73	12	NA	NA	NA	NA
14MN039	8.0	87.11	6	10.94	7.80	2	7.13
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**12.36**	**28.72**	**20.38**				
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)				**8.62**	**7.04**	**8.97**	**7.10**
Expected response to increased DO stress	↓	↑	↓	↑	↑	↓	↑

Candidate Cause: Eutrophication

A large dataset of phosphorus values ranged from 0.01 to 2.04 mg/L from 2004-2016 with 60% over the southern standard of 0.150 mg/L. Values were taken throughout the reach with the highest value at station S002-490. Chlorophyll-a, BOD, and DO fluctuation values are a proximate measurement of eutrophication and have more direct impacts on biology than phosphorus. Recent chlorophyll-a values ranged from 9.5 to 490 mg/L with over 50% of values over the southern standard of 40 mg/L. BOD values ranged from 1 to 20 with 34% of values over the southern standard of 3.5 mg/L. Increases in chlorophyll-a are directly related to elevated phosphorus concentrations and are commonly used to

measure algal productivity in surface water. Values over 8.5 and large daily pH fluctuations can be tied to nutrient enrichment. pH values ranged from 7.61 to 9.33. DO flux data were not available.

Additionally, the HSPF model calculated daily TP concentrations from 1996-2012. These values ranged from 0-0.8 mg/L with a mean of 0.1 mg/L .

Table 653. Metrics related to eutrophication

	Sensitive Pct	Darter Pct	Tolerant Fish Pct	Omnivorous Fish Pct	Invert Taxa	EPT Pct	Dominant 2 Invert Taxa Pct
03MN030 (2014)	1.05	1.57	98.43	94.76	14	19.56	83.59
03MN030 (2015)	0	0.87	96.51	65.07	NA	NA	NA
14MN039	0	0	90.67	89.33	30	71.16	53.92
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	**18.65**	**11.68**	**44.85**	**16.53**			
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)					**41.92**	**43.90**	
Expected response to increased TP stress	↓	↓	↑	↑	↓	↓	↑

Each visit on this reach had less than 2% sensitive individuals and darter species, all below class averages. Darter percentage at station 03MN030 was 7.11% in 2003 and decreased to less than 2% in 2014 and 2015. Also at station 03MN030, the omnivore percentage increased from 2003 (2.89%) to 94.76% in 2014. The tolerant and omnivore percentages were both much higher the class averages. A positive relationship exists between eutrophication and omnivorous fish. The macroinvertebrate sample was dominated by two species at both stations (53.92 and 83.59% of the samples were comprised of just two species). The number of taxa were both below class average. While the EPT percentage was low at station 03MN030, the number was much higher at station 14MN039.

The biological communities are showing the effects of the elevated phosphorus and chlorophyll-a values, particularly in the fish community. Eutrophication is a stressor to Carver Creek.

Candidate Cause: Nitrates

From 2002-2015 a total of 323 nitrate samples were taken along Carver Creek (-806). These values ranged from 0.05-10.8 mg/L, with an average value of 1.49 mg/L. This average is relatively low given the high number of samples taken and compared to the western parts of the watershed.

Table 654. Nitrate related metrics

Station	TrichopteraChTx Pct	% N Tolerant Taxa	% N Intolerant Taxa	Nitrogen TIV
03MN030	**13.72**	**33.41**	**0.29**	**2.69**
14MN039	**3.33**	**35.31**	**0.00**	**3.15**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*13.16*	*48.68*	*0.96*	*3.00*
Expected response to Nitrate stress	↓	↑	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage scored below average in one (03MN030) and three (14MN039) of the four evaluated metric related to nitrate when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 654). Site 14MN039 is located further upstream and the surrounding land use in this area consists of more agriculture. This site lacked Trichoptera taxa and had a Nitrogen TIV score that was below average.

Based on the extensive chemical data set that shows that the vast majority of nitrate concentrations in this reach are relatively low as well as the majority of the nitrate related metrics at site 03MN030, overall, nitrates are not a stressor in this reach. Excessive nitrates may be having more of an impact in the upper portions of this reach, but in the entirety of the reach, it does not appear to be negatively impacting aquatic life.

Candidate Cause: Sediment

From 2004-2015, a total of 300 TSS samples were taken from Carver Creek (-806). These samples ranged in value from 1-1950 with a median value of 96.22 mg/L. Of these samples, 64 (21.33%) were at or above the 65 mg/L standard for TSS. Additionally, from 2004-2015, a total of 216 secchi tube measurements were taken along this reach. These readings ranged from 9-100 cm, with an average measurement of 38.30 cm. This reach was assessed and determined to be impaired for turbidity in 2002.

Table 655. Sediment related fish metrics

Station	BenFdFrimPct	Centr-TolPct	HerbvPct	Percfm-TolPct	RiffePct	SensitivePct	SLithopPct	IntolerantPct	Longlived Pct	TSS Index Score (RA)
03MN030	**29.92**	**0.58**	**6.96**	**3.77**	**28.05**	**1.31**	**38.99**	**0.00**	**30.86**	**22.15**
14MN039	**0.00**	**0.44**	**0.00**	**8.44**	**0.00**	**0.00**	**0.00**	**0.00**	**11.11**	**23.03**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*37.38*	*4.89*	*9.61*	*18.66*	*32.49*	*18.65*	*39.38*	*4.97*	*11.68*	*17.59*
Expected response to TSS stress	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The fish community in Carver Creek scored below average in nine (03MN030) and ten (14MN039) of the suspended sediment related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 655). Site 03MN030 did have a higher number of long-lived individuals, but scored poorly in the remaining metrics. Both sites had very poor TSS Index scores.

Table 656. Sediment related macroinvertebrate metrics

Station	TSS Index Score	TSS Intolerant Taxa	TSS Tolerant Taxa	TSS Tolerant Pct	Collector Filterer Pct	Plecoptera Pct
03MN030	13.87	1.00	11	25.24	53.49	0.00
14MN039	21.50	0	11	70.94	17.87	0.00
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*15.87*	*3.02*	*11.59*	*35.23*	*26.89*	*0.54*
Expected response to TSS stress	↑	↓	↑	↑	↓	↓

Highlighted equals the metric score is higher or lower than average, depending on expected response with increased stress.

The macroinvertebrate assemblage in Carver Creek (-806) scored below average in two (03MN030) and five (14MN039) of the six suspended sediment related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 656). Site 023MN030 had a good TSS index score, a high amount of Collector Filterer individuals, and a low amount of both TSS tolerant taxa and individuals. Site 14MN039 did have a lower amount of TSS tolerant taxa, but scored below average in the remaining metrics.

Based on the high exceedances of the TSS standard, the many below average suspended sediment related fish and macroinvertebrate metrics (especially fish), as well as the current turbidity impairment conclude that suspended sediment is a stressor to aquatic life in Carver Creek (-806).

Candidate Cause: Habitat

Carver Creek (-806) had a qualitative habitat assessment take place at its biological monitoring sites, 03MN030 and 14MN039, during the fish and macroinvertebrate sampling events in 2003, 2014, and 2015. The average MSHA score from these visits was 76.14 (Good) at 03MN030 and 50.55 (Fair) at 14MN039. Limiting the MSHA score at these sites was the presence row crop in the land use at 14MN039, a moderate riparian buffer, the presence of sand, clay, and silt substrates, light to moderate embeddedness, and fair channel development at 14MN039. A breakdown of the MSHA category scores for this site can be seen in Figure 324

Figure 324. Habitat metric scores

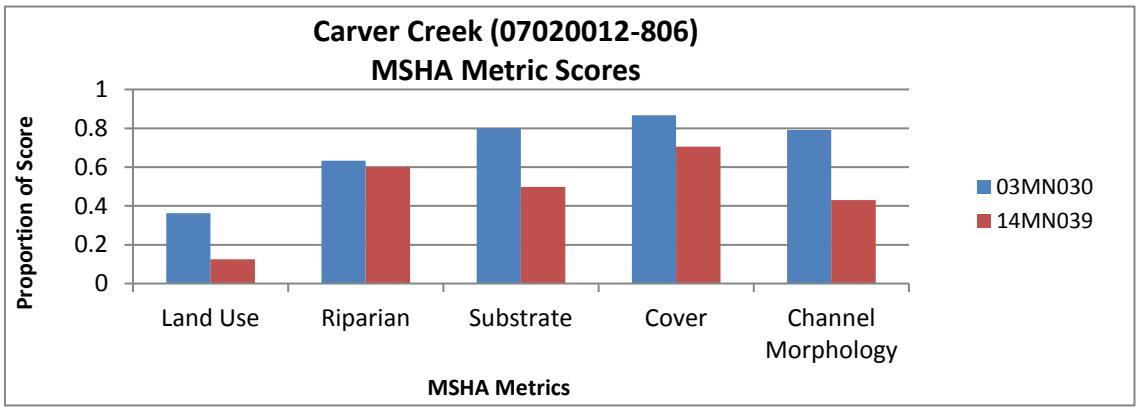


Table 657. Habitat related fish metrics

Station	BenInsect-TolPct	SLithopPct	DarterSculpSucPct	RifflePct	PiscivorePct	LithFrimPct	TolPct	PioneerPct
03MN030	**3.19**	**38.99**	**3.19**	**28.05**	**0.58**	**57.36**	**95.94**	**16.84**
14MN039	**0.00**	**0.00**	**0.00**	**0.00**	**0.44**	**0.00**	**90.67**	**86.22**
Statewide average for Class 2 Southern Streams stations that are meeting the FIBI General Use Threshold (50.0)	*20.4*	*39.38*	*18.18*	*32.49*	*5.24*	*58.26*	*44.85*	*19.02*
Expected response to Habitat stress	↓	↓	↓	↓	↓	↓	↑	↑

The fish community in Carver Creek scored below average in seven (03MN030) and eight (14MN039) of the eight habitat related metrics when compared to all other Class 2 Southern Streams stations that meet the FIBI General Use Threshold (Table 657). These sites had many tolerant species present as the fish sample at 14MN039 was comprised mainly of the habitat tolerant fathead minnow (86.22%). Many other habitat tolerant species were present in large numbers at these sites, while species requiring specialized habitat conditions were rarely present.

Table 658. Habitat related macroinvertebrate metrics

Station	BurrowerPct	ClimberPct	ClingerPct	EPTPct	LeglessPct	SprawlerPct
03MN030	**12.28**	**7.90**	**64.37**	**34.18**	**23.37**	**2.11**
14MN039	**2.19**	**6.27**	**74.29**	**71.16**	**18.18**	**12.23**
Statewide average for Class 5 Southern Streams RR stations that are meeting the MIBI General Use Threshold (37.0)	*5.66*	*12.52*	*49.77*	*42.46*	*34.53*	*13.99*
Expected response to Habitat stress	↑	↓	↓	↓	↑	↓

The macroinvertebrate community scored below average in four (03MN030) and two (14MN039) of the six habitat related metrics when compared to all other Class 5 Southern Streams RR stations that meet the MIBI General Use Threshold (Table 658). Both of these sites had low numbers of both climber and sprawler individuals which can signal potential habitat stress. However, both sites had a high number of clinger individuals, and a below average amount of legless individuals, which suggests that the habitat conditions are not degraded. Based on the fair to good MSHA scores, as well as the mixed biological metric results, habitat is inconclusive as a stressor to aquatic life in Carver Creek (-806) at this time.

Candidate Cause Chloride

A small dataset of chloride values ranged from 17 to 40 mg/L without any values in the limited dataset of values over the standard of 230 mg/L. The values were all collected during the spring and summer months of 2014. Specific conductance is a measure of ions including chloride. Measurements on this stream reach ranged from 239 to 914 uS/cm. The ecoregion norm for the North Central Hardwood Forests (based on the 75th percentile of annual specific conductance values) is 330 (McCollor et. al, 1993).

As salinity increases, macroinvertebrate taxa richness and Ephemeroptera richness have been found to decrease (Piscart et al., 2005). Echols et. al (2009) also found a reduction in EPT abundance as ionic strength values increased. The EPT percentage was 48.80% in 2003 and 19.56% in 2014. 51.71% and the mayfly (Ephemeroptera) percentage was 31.14% in 2003 and 8.83% in 2014. The taxa count was far below the class average at both stations, but the EPT percentages were both above class average, and the mayfly numbers were low at station 03MN030 but not 14MN039. The macroinvertebrate community composition ranged from 18.3% to 29.4% of conductivity tolerant individuals.

Table 659. Metrics related to ionic strength

Stations	TaxaCountAllChir	EphemeropteraCh	EphemeropteraPct	EPTPct	Cent-TolPct	Tolerant Fish Pct
03MN030 (2014)	14	3	8.83	19.56	0	95.3
03MN030 (2015)	NA	NA	NA	NA	1.75	12.2
14MN039	30	6	62.38	71.16	0.44	0
Statewide average for Class 2 Southern Streams meeting the FIBI General Use Threshold (50.0)					**4.89**	
Statewide average for Class 5 Southern Streams RR stations meeting the MIBI General Use Threshold (37.0)	**41.92**	**6.04**	**22.91**	**10.87**		
Expected response to increased DO stress	↓	↓	↓	↓	↓	↑

Elevated chloride can also lead to increases in sunfish based assemblages. Each of the visits had Centrarchidae (sunfish) percentages below the class average. Species that are tolerant to conditions with high ionic strength comprised none of the fish community at station 14MN039, but 12.2% and 95.3% at station 03MN030 during 2014 and 2015 respectively. Specific conductance values are high at times in Carver Creek, and station 03MN030 had low taxa count, mayfly individuals, sunfish, and increased conductivity tolerant fish. While the periodic elevated values might be contributing as a

stressor, chloride values taken throughout the year would help confirm chloride and specific conductance as a stressor. It is inconclusive at this time.

Candidate Cause: Altered Hydrology/Connectivity

An analysis of the MPCA altered watercourse layer measured Carver Creek to be about evenly split between natural and modified. The upstream watershed is channelized. There were no known connectivity issues. Altered hydrology, drainage, and increases in precipitation in the watershed have caused issues in the watershed with "increased bank erosion, excess sediment, habitat degradation, and disturbance of natural flow regime" (DNR, 2017a). Channelization and tile drainage alters the natural flow regime by moving water through the system at a higher frequency, increasing the impact of high flow events and increasing the intensity of low flow periods, both of which affect biological communities.

Increased flow events can cause increased bank erosion and bedload sedimentation, affecting fish species that rely on clean substrate for habitat. Habitat availability can be scarce when flows are interrupted, or low for a prolonged duration. Flows that are reduced beyond normal baseflow decrease living space for aquatic organisms and increase competition for resources. HSPF models show this section is experiencing low flow at less than 1 cfs less than 2% of the time during the spring-fall months.

Generalist fish species, which are adaptable to different habitats through generalized food preferences, are correlated with channelization. The reach had a population of generalist fish comprised a range of 90.22 to 96.34% of the population, up from 66% in 2003. The numbers of nest guarder species are also positively correlated with increased low flows. The nest guarder species had a population comprising a range of 3.66 to 86.67% of the fish community. Long-lived macroinvertebrates decrease with flow changes as they are not able to stay in one place as conditions change. The percentage of long-lived macroinvertebrates comprised 0.32% of the population, down from 4.49% in 2003. The upstream channelization and reach channelization is likely contributing to the biological impairment. The preponderance of biological data indicate altered hydrology is a stressor.

Carver Creek HUC 10 Conclusions and Recommendations

The Le Sueur Creek subwatershed contains just one biologically impaired stream reach. The impaired fish and macroinvertebrate communities in Carver Creek (-806) are being stressed by Dissolved Oxygen, Eutrophication, Suspended Sedimentsediment, and Flow Alteration/Connectivityconnectivity (Table 660). Habitat and Chloride were inconclusive as stressors at this time while Nitrates were ruled out as a stressor.

Hay/pasture, row crop agriculture, and development are the most prevalent land uses in this watershed.

Significant issues in this watershed are related to the amount of phosphorus entering the stream system. There are many lakes that constitute the headwaters of many of the streams in this subwatershed. These lakes could potentially be a large source of the phosphorus present in this watershed. These lakes, the surrounding development, as well as agricultural practices in this watershed are likely the largest contributors. The presence of phosphorus can lead to eutrophication in the lakes and streams as well as cause the DO to have high daily fluctuations making it difficult for more sensitive fish and macroinvertebrate species to survive.

Channelizing streams can also lead to very high flow rates resulting in bank erosion. Bank erosion leads to higher amounts of both bedded and suspended sediment in the stream resulting in poor habitat and

visibility conditions impacting the breeding and feeding environments for more sensitive fish and macroinvertebrate species.

Improvements in the Carver Creek Watershed are possible to improve the biological conditions in the impaired reaches. A primary focus to remedy these issues would be to better manage the amount of phosphorus being applied to the landscape and removing easy pathways for phosphorus to enter the stream system. Also, there is a need to address flow alteration in the headwaters of the watershed. This can be achieved by increasing the storage and infiltration of water in locations with flow alteration stressors. This will also help reduce sediment inputs from stream banks, improve habitat by protecting streambanks, reduce erosion and overall stream sedimentation. Re-establishing a quality riparian corridor to increase stream stabilization, shading, and habitat features is also needed to improve conditions. These improvements can both be applied to the agricultural and developed areas to this watershed.

Table 660. Stressor on Carver Creek (-806)

Stream Name	AUID	Stressors:						
		Dissolved Oyxgen	Eutrophication	Nitrate	Suspended Sediment	Habitat	Chloride	Flow Alteration/Connectivity
Carver Creek	**07020012-806**	●	●	---	●	o	o	●

● = stressor; o = inconclusive stressor; --- = not an identified stressor

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Key: ●=suspected source, ○=potential so | Stressor | Inconclusive | Not a Stressor

AUID	Lower Minnesota River	Biological Stations	Probable Sources/ Pathways	Temperature				Dissolved Oxygen					Eutrophication					Nitrate					Suspended Solids						Habitat					Connectivity						Altered Hydrology				Chloride			
				Riparian/Hydrology	Urban runoff	Point Sources	Add'l/recent Monitoring?	Plant Respiration	Lack of flow	Wetland influence	Unidentified	Add'l/recent Monitoring?	Wetland influence	Lake influence	Stream Phosphorus	Algal/Plant Shift	Unidentified	Add'l/recent Monitoring?	Rip Drainage/Land Use	Wetland/Lake influence	Lack of Tile/Hydrology/Spring	Point Sources	Add'l/recent Monitoring?	Suspended Algae	Flow Alteration/Velocity	Streambank erosion	Bed Channelization	Urbanization	Pasture	Add'l/recent Monitoring?	Riparian/Lack of Riparian	Channel Morphology	Reduced habitat	Erosion	Add'l/recent Monitoring?	Flow Alteration/Connectivity	Dams/Impoundments	Road Crossings/Perched Culverts	Wetland Alt./Ineffective Ditches	Beaver Dams	Add'l/recent Monitoring?	Altered Riparian/Channelization	Reduced Baseflow	Rip Drainage/Land Use	Add'l/recent Monitoring?	Unidentified	Add'l/recent Monitoring?
	HIGH ISLAND CREEK																																													
-653	High Island Creek	07MN083, 14MN067	F-IBI, M-IBI					●				-			●	●			●					●	●	●	●				●	●	●	●	●							●	●	●				
-834	High Island Creek	01MN062, 14MN049, 14MN116, 15MN301, 15MN302, 97MN007	F-IBI, M-IBI					●							●	●			●					●	●	●	●					●	●	●													
-838	High Island Creek	14MN122	F-IBI, M-IBI					●							●	●			●						●	●	●					●	●	●	●							●	●	○				
-590	Judicial Ditch 11	14MN072	F-IBI					●	○						●	●			●					○	●		●				●	●	●		●							●	●	●				
-593	Judicial Ditch 11	14MN071	F-IBI, M-IBI					○	○						●				●						●	●	●				●	●	●	●	●							●	●	●				
-682	Judicial Ditch 15	14MN070	F-IBI, M-IBI					●	○						●	●			●						●	○	●				●	●	●	○	●	●						●	●	●				
-683	County Ditch 39	14MN068	M-IBI					○	●						○	○			●						●	○	●				●	●	●		●							●	●	●				
-794	Judicial Ditch 12	14MN048	F-IBI					○	●						●				○						●	●	●				●	●	●	●	●							●	●	●				
-832	Buffalo Creek	90MN111	F-IBI, M-IBI												●				○							●	●					●	●	●	●	○							○	●	○				
	NORTH BRANCH RUSH RIVER																																													
-555	North Branch Rush River (JD 18)	14MN055, 14MN084	F-IBI, M-IBI					●							●	●			●					●	●	●	●				●	●	●	●	●							○	●	●				
-556	County Ditch 55	14MN052	F-IBI, M-IBI					○	○						●	●			○					●	●	●	●				●	●	●	●	●							●	●	●				
-788	Unnamed ditch	14MN102	M-IBI					○	○						○	○			●						●	●	●				●	●	●	●	●							●	●	●				
-790	County Ditch 56	14MN083	M-IBI					○			●				●	○			●						○	○	○				●	●	●	●	●							●	●	●				
-791	County Ditch 18	14MN060	F-IBI					○	○						●				●						●	●	●				●	●	●	●	●	●						●	●	●				
	MIDDLE BRANCH RUSH RIVER																																													
-521	Rush River	03MN028, 90MN110	F-IBI, M-IBI												●	●									○	●	○				●	●	●	●	○													
-548	Rush River	14MN061, 14MN082, 97MN010	F-IBI, M-IBI								●				●	○			○						○	●	○				○	●	●	●	○							○	●	●				
-586	Middle Branch, Rush River (CD23	14MN085	F-IBI, M-IBI												●	●			●						●	●	●				●	●	●	●	●							●	●	●				
-551	County Ditch 42	14MN220	M-IBI					●							●	●			●						●	●	●				●	●	●	●	●							●	●	●				
-677	County Ditch 49	14MN074	F-IBI, M-IBI					●	○						●	●			●						●	●	●				●	●	●	●	●							●	●	●				
-786	County Ditch 44	14MN076	F-IBI, M-IBI					○							●	○			●						●		●				●	●	●		●	●						●	●	●				
-796	County Ditch 50	14MN062	F-IBI, M-IBI												●	○			○						○	●	○				○		●	●	○	○						○	●	○				
	SOUTH BRANCH RUSH RIVER																																													
-825	South Branch Rush River	14MN077, 14MN105, 14MN230, 03MN025	F-IBI, M-IBI					○			●	●			●	○			●						●	●	●				●	●	●	●	●							●	○	●				
-826	South Branch Rush River	97MN012	F-IBI, M-IBI												●	○			○						○	●	○				○		○	●								○						
-636	County Ditch 13	14MN088	M-IBI					●	●						●	●			●						●	●	●				●	●	●	●	●							●	●	●				
-783	County Ditch 32A	14MN053	F-IBI, M-IBI					○	○						○	○			●						●	●	●				●	●	●	●	●							●	●	●				
-784	County Ditch 9	14MN058	F-IBI					○							○	○			●						●	○	●				●	●	●	●	●							●	●	●				
-785	Judicial Ditch 1	14MN089	M-IBI												●	○			●						●	○	●				●	●	●	○	●							●	●	●				
-801	County Ditch 30 Branch A	14MN054	F-IBI, M-IBI					●	●						●	●			●					●	●	○	●				●	●	●	○	●							●	●	●				
	BEVENS CREEK																																													
-514	Bevens Creek	00MN012, 90MN114	F-IBI, M-IBI												●	●			○						○	●	○						●	●	○													
-843	Bevens Creek	14MN042	M-IBI					●	●						●	●									●	●	●				●	●	●	○	●							●	●	●				
-845	Bevens Creek	14MN038	F-IBI												●	●			●						●	●	●				●	●	●	●	●							●		●				
-848	Bevens Creek	15EM014	F-IBI, M-IBI					○							●	○									○	●	○																			
-813	Silver Creek	14MN095, 14MN203, 90MN113	F-IBI, M-IBI												●	○			●						●	○					○	●	●	●	●													
	CITY OF LE SUEUR-MINNESOTA RIVER																																													
-602	Barney Fry Creek	03MN076	F-IBI, M-IBI												●	○																		●									○	○	○				
-792	County Ditch 47A	14MN081	F-IBI					●	○						●	●			●					○	●	●	●				●	●	●	●	●							●	○	●				
-793	County Ditch 75	14MN080	F-IBI					●	○						●	●			●					○	●	○	●				●	●	●	●	●	●						●	●	○				
	CITY OF BELLE PLAIN-MINNESOTA RIVER																																													
-575	Robert Creek	00MN013, 91MN112	F-IBI, M-IBI												●	●			○						○	●	○						●	●	●													
-798	Unnamed Creek	14MN047	F-IBI, M-IBI												●	○			○							●	●					●	●	●	●	○							○	●	○				
-830	Brewery Creek	00MN007	F-IBI, M-IBI					○							●	○									●	●	●				●	●	●	●	○							○						
	SAND CREEK																																													
-513	Sand Creek	00MN006, 07MN033, 07MN034, 01MN044	F-IBI					●							●	●			●						●	●	○				●	●	●	●	○							●						
-538	Sand Creek	07MN055, 90MN116	F-IBI												●	○			●						○	○					○				○													
-839	Sand Creek	14MN119	F-IBI					●							●	●			●						●	●	●				●	●	●	●	●							●		●				
-840	Sand Creek	07MN056, 14MN129	F-IBI, M-IBI					●							●	●			○						●	○	●				●	●	●	●	●							○						
-579	Unnamed Creek (Picha Creek)	01MN058, 14MN200	F-IBI, M-IBI					●							●	●									●	○	●				●	●	●	○	●							○	○					
-580	Unnamed Creek (Picha Creek)	14MN096, 15EM078	F-IBI					○							●	○										○	●				○	●	●	○	●							○	○					
-628	County Ditch 10	14MN134	M-IBI												●	○			●						●	●	●				●	●	●	○	●							●		○				
-716	Raven Stream	14MN090	F-IBI, M-IBI												●	●			●						○	○	●				●	●	●	●	○									○				
-732	Unnamed Creek	10EM103	F-IBI, M-IBI					○							●	●			○							●	○				●	●	●	○	●									○				
-817	Porter Creek	99MN004	F-IBI, M-IBI												●	○									●		●				○			●	○									○				
-822	Unnamed Creek	03MN029	F-IBI, M-IBI					○							●	○			○						○	○	●				●	●	●	●	●							●		●				
-842	West Branch Raven Stream	14MN132, 14MN133	F-IBI, M-IBI					●					○		●	●			●						○	●	●				●	●	●	●	●							●	○	●				
-849	Unnamed Creek	14MN078	F-IBI					○	●						●	○			○						○	●	●				○	●	●	●	○							●	●	○				
	LE SUEUR CREEK																																													
-823	Le Sueur Creek	07MN063	F-IBI												●	●			○						●	●	●				●	●	●	○	●							●		●				
-824	Le Sueur Creek	03MN074, 14MN092, 14MN093, 14MN106	F-IBI, M-IBI												●	○			●							●	●				○	●	●	●	●							●	●	●				
-725	Forest Prairie Creek	03MN075, 14MN033, 14MN034, 14MN120	F-IBI, M-IBI												●	○			○													●	●									●	●	●				
-763	Unnamed ditch to Forest Prairie C	14MN031	F-IBI, M-IBI					○	○						●	○			●						○	○	○				●	●	●	●	●							○	●	○				
-764	County Ditch 34	14MN032	F-IBI, M-IBI					○	○						○	○																										○	●	●				
-767	Judicial Ditch 4	14MN035	F-IBI					○	○						○	○			●						●	○	●				●	●	●	○	●							●		●				
-768	Tributary to Le Sueur Creek	14MN036	F-IBI, M-IBI												○	○			○							○						●		●									●		○				
-772	County Ditch 42	14MN030	F-IBI, M-IBI					○	●						○	○									●	●	●				●	●	●	●	●							●	●	●				
	MINNESOTA RIVER																																													
-511	Riley Creek	14MN124	F-IBI, M-IBI					○	○				○		○	○									○	●	○																○	●					
-581	East Creek	01MN008, 14MN125, 14MN201	F-IBI, M-IBI												●	○			○						●	●	●				●	●	●	●	●							●	●					
-582	Assumption Creek	99MN007	F-IBI					○							○	○																										●					
-604	County Ditch 13	14MN099	F-IBI					●	○						●	●			○						●	●	●				●	●	●	●	●							●	●	●				
-710	Bluff Creek	00MN008, 00MN009	F-IBI												●	●									●	●	●				●	●	●	○	●							●	●					
-723	South Fork Ninemile Creek	03MN059, 03MN097	F-IBI, M-IBI					●					●		●	●									●	●	●																●	●					
-728	Unnamed creek (Prior Lake Outlet	14MN123	F-IBI, M-IBI					●					●		●	●																											●	●					
-803	Chaska Creek	00MN010	F-IBI, M-IBI												○																●	●	●	●	○								●	●					
-807	Ninemile Creek	00MN011, 03MN094	F-IBI					○							○	○															●	●	●	●	●								○	○					
-808	Ninemile Creek	03MN058, 03MN095	F-IBI, M-IBI					●	○						●	○															●	●	●		●								●	●	●				
-809	Ninemile Creek	03MN098, 03MN099, 03MN100, 96MN004, 96MN005, 96MN006	F-IBI, M-IBI					●							●	●									●	○	●				●	●	●														
-811	Credit River	14MN059, 90MN117	F-IBI, M-IBI					●							●	●																																
-828	Purgatory Creek	14MN204	M-IBI												○																						○	○									
	CARVER CREEK																																													
-806	Carver Creek	14MN039, 03MN030	F-IBI, M-IBI					●							●	●									●						○		○									●		○				