# Red Lake River Watershed
# Total Maximum Daily Load Report

This is a report for restoring waters throughout the Red Lake River major watershed that are impaired by total suspended solids, *E. coli*, low dissolved oxygen, or low index of biotic integrity scores.


MINNESOTA POLLUTION CONTROL AGENCY

Red Lake Watershed District • Dedicated to Water Management •

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# Acronyms

| | |
|---|---|
| AUID | Assessment Unit ID |
| BMP | best management practice |
| cfu | colony-forming unit |
| Chl-*a* | Chlorophyll-*a* |
| DNR | Minnesota Department of Natural Resources |
| EPA | U.S. Environmental Protection Agency |
| EQuIS | Environmental Quality Information System |
| HSPF | Hydrologic Simulation Program-FORTRAN |
| LA | Load Allocation |
| Lb | pound |
| LGU | Local Government Unit |
| m | meter |
| mg/L | milligrams per liter |
| mL | milliliter |
| MOS | Margin of Safety |
| MPCA | Minnesota Pollution Control Agency |
| MS4 | Municipal Separate Storm Sewer Systems |
| NPDES | National Pollutant Discharge Elimination System |
| SSTS | Subsurface Sewage Treatment Systems |
| SWPPP | Stormwater Pollution Prevention Plan |
| TMDL | Total Maximum Daily Load |
| TP | Total phosphorus |
| WLA | Wasteload Allocation |
| WRAPS | Watershed Restoration and Protection Strategy |

# Executive Summary

The Federal Clean Water Act (1972) requires each state to develop Total Maximum Daily Load (TMDL) reports for the identification and restoration of waterbodies that are deemed impaired by state regulations. In Minnesota, the Minnesota Pollution Control Agency (MPCA) is tasked with assessing and listing waterbodies that do not meet water quality standards (Minn. R. 7050.022). A TMDL report identifies the pollutant sources causing the impairment and includes a calculation of the maximum amount of pollutant that can enter a waterbody without causing the concentration of the pollutant within the waterbody to exceed water quality standards.

The Red Lake River (Hydrologic Unit Code [HUC] 09020303), in northwest Minnesota, begins at the outlet of Lower Red Lake and flows west to the Red River of the North. The Red Lake River Watershed receives drainage from three other major watersheds: Upper and Lower Red Lakes, Thief River, and Clearwater River. It flows through the cities of Thief River Falls, St. Hilaire, Red Lake Falls, Crookston, Fisher, and East Grand Forks. It is the source of drinking water for the cities of Thief River Falls and East Grand Forks.

The Red Lake River Watershed TMDL Report addresses 31 impairments of aquatic life and/or recreation that have been found within 19 reaches of the Red Lake River and its tributaries. Turbidity and/or total suspended solids (TSS) impairments were found in six reaches of the Red Lake River between the Pennington County Ditch 96 confluence and the Red River of the North. Impairments of *Escherichia coli (E. coli)* bacteria have been found along six reaches of Red Lake River tributaries. Impairments due to low dissolved oxygen (DO) levels have been addressed for two tributaries of the Red Lake River. Low index of biotic integrity (IBI) scores have resulted in macroinvertebrate IBI (M-IBI) impairments for seven reaches and fish IBI (F-IBI) impairments for 10 reaches along tributaries of the Red Lake River.

This report recommends strategies for reducing nonpoint contributions of TSS using various erosion control strategies. Sources of *E. coli* pollution have been identified and described in this report along with strategies for addressing those sources. Recommendations are also given for the improvement of DO levels and the quality of aquatic life. Insufficient base flow is the most common and impactful stressor for aquatic biology and cause of low DO within impaired Red Lake River tributaries. F-IBI scores are also limited by fish passage barriers in some reaches. No pollutant-based causes of low DO or biological impairments have been strongly suggested by the data, so TMDLs have not been calculated for those impairments. This report also includes information about future monitoring plans, cost estimation, and civic engagement strategies.

TMDLs were calculated for reaches that were impaired by quantifiable pollutants. TSS and *E. coli* loading capacities and allocations were calculated using the load duration curve (LDC) method. TSS wasteload allocations (WLAs) were calculated for WWTFs in communities along the main channel of the Red Lake River. Load reduction recommendations were calculated for reaches where concurrent flow and sampling data had been collected. Six turbidity/TSS TMDLs and six. *E. coli* TMDLs were calculated and included in this document.

Efforts were made to inform and involve the public throughout the Red Lake River WRAPS project concurrently with development of this TMDL report. Recent civic engagement efforts and plans are described in this document. There is currently excellent cooperation among agencies underway for project implementation and monitoring.

# 1. Project Overview

## 1.1 Purpose

This report establishes TMDLs for rivers and ditches in the Red Lake River Watershed that are listed on the 303(d) List of Impaired Waters as impaired by high turbidity levels, high total suspended sediment (TSS) concentrations, and high levels of *E. coli*. A TMDL is defined as the maximum quantity of a pollutant that a water body can receive while meeting the water quality standards for the protection of aquatic life and recreation. This report characterizes features of the watershed, identifies sources of pollutants and non-pollutant stressors that are causing the impairments, and suggests future monitoring efforts.

In 2006, Minnesota passed the Clean Water Legacy Act (CWLA) to protect, restore, and preserve the quality of Minnesota's surface waters. As a result, the MPCA established a watershed approach for monitoring, assessment, and the development of TMDLs. One component of that work is to complete TMDLs for the impaired waterbodies within each watershed and develop a watershed-wide TMDL report. This report is intended to fulfill the TMDL requirement. The watershed approach also includes the creation of a Watershed Restoration and Protection Strategy (WRAPS) report that ultimately recommends a list of strategies for restoring impaired waters and protecting waterbodies that are currently meeting water quality standards.

On April 26, 2017, the Red Lake River One Watershed One Plan (1W1P) was approved by the Minnesota Board of Water and Soil Resources (BWSR). Findings of the TMDL and assessment results were incorporated into the 1W1P document. The TMDL and WRAPS documents are also influenced by the recommendations made within 1W1P document. The 1W1P document will be updated, if necessary, when the TMDL and WRAPS documents are finalized.

## 1.2 Identification of Waterbodies

The Red Lake River Watershed TMDL Study discusses 31 impairments of aquatic life and/or recreation found within 19 reaches of the Red Lake River and its tributaries. Turbidity and/or TSS impairments were found within six reaches of the Red Lake River. *E. coli* bacteria impairments have been found in six tributary reaches of the Red Lake River. Impairments due to low DO levels have been identified in three tributaries of the Red Lake River. Two DO impairments are addressed in this document. One DO impairment was recategorized for the 2018 List of Impaired Waters and no longer requires a TMDL. Low IBI scores have resulted in M-IBI impairments for 7 reaches and F-IBI impairments for 10 reaches along tributaries of the Red Lake River.

The cities of Thief River Falls and East Grand Forks draw their drinking water from the Red Lake River. More detailed information regarding impacts to drinking water sources from upstream within the Thief River Watershed, can be found in the Thief River Watershed TMDL and the Thief River WRAPS reports, both dated March 2019. Impaired reaches of the Red Lake River drain to the area where the East Grand Forks raw water intake is located. In addition to excess sediment in the river, both cities have expressed concern over elevated levels of total organic carbon (TOC) in the river. Source water assessments have been completed for each of the cities by the Minnesota Department of Health. The impaired waterbodies within the Red Lake River Watershed are identified in Table 1-1. The locations of those impairments are displayed in Figure 1-1.

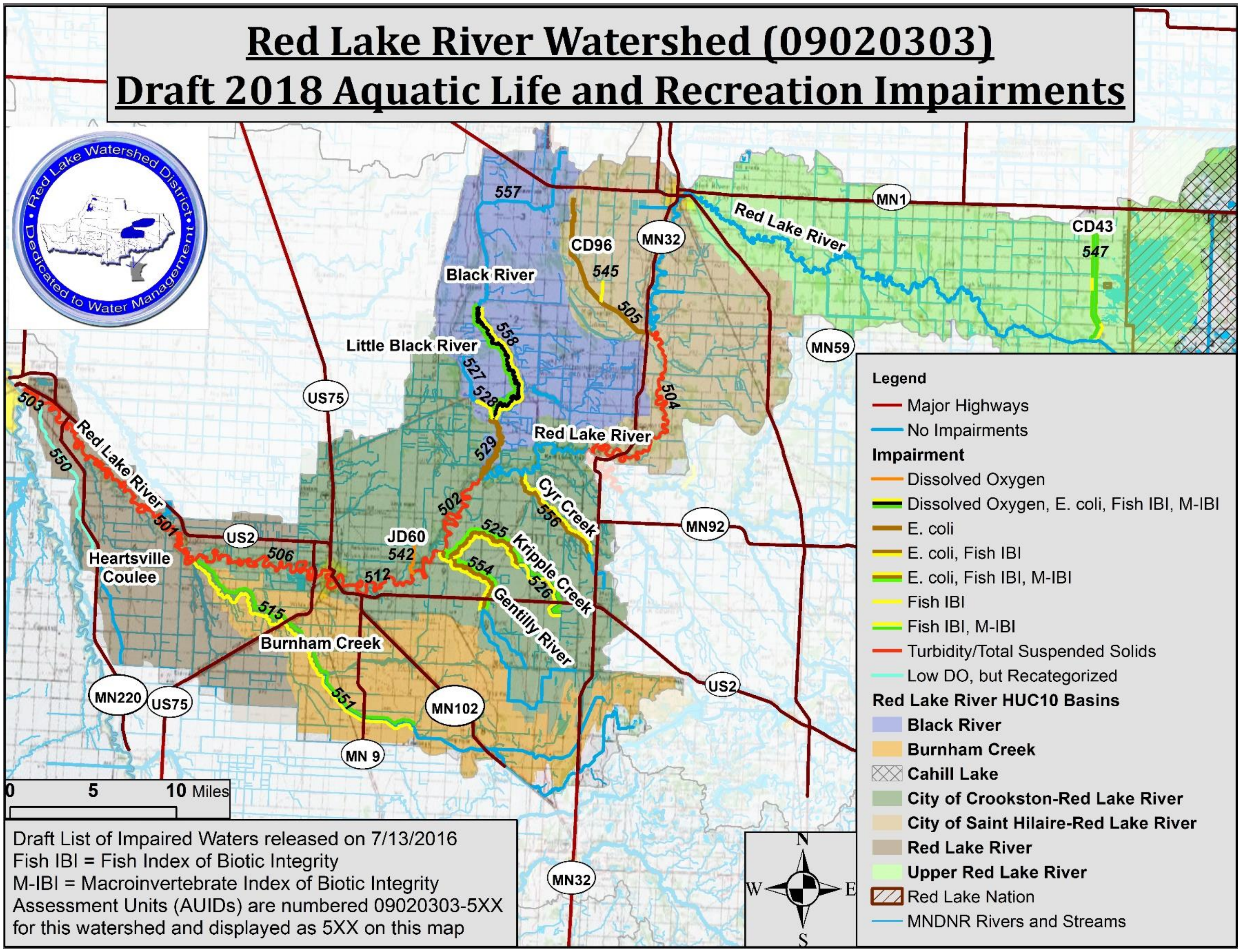


**Figure 1-1. Draft 2016 Red Lake River Impairments**

**Table 1-1. Impaired Waterways of the Red Lake River Watershed on the 2018 List of Impaired Waters.**

| Red Lake River Watershed (09020303) Rivers, Streams, and Ditches on the draft 2018 303 (d) list of Impaired Waters | | | | | | |
|---|---|---|---|---|---|---|
| **HUC 10 Subwatershed** | **Waterbody Name and Reach** | **Use Class** | **Assessment Unit ID** | **Impairment** | **Year Listed** | **TMDL in this Study** |
| **Upper Red Lake River** 0902030302 | **County Ditch 43** Unnamed Ditch to Red Lake River | 2B, 3C | 09020303-547 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | **Red Lake River** Clearwater/Pennington County Line to CD39 | 1C, 2Bd, 3C | 09020303-561 | Aquatic Consumption-Mercury | 1998 | No** |
| | **Red Lake River** CD39 to Thief River | 1C, 2Bd, 3C | 09020303-562 | Aquatic Consumption-Mercury | 1998 | No** |
| **Red lake River** City of St. Hilaire 0902030303 | **Red Lake River** Pennington CD96 to Clearwater River | 1C, 2Bd, 3C | 09020303-504 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity (& TSS)* | 2008 | Yes |
| | **Pennington CD96** Headwaters to Red Lake River | 2B, 3C | 09020303-505 | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| | **Red Lake River** Thief River to Thief River Falls Dam | 1C, 2Bd, 3C | 09020303-509 | Aquatic Consumption-Mercury | 1998 | No** |
| | **Red Lake River** Thief River Falls Dam to Pennington CD96 | 1C, 2Bd, 3C | 09020303-513 | Aquatic Consumption-Mercury | 1998 | No** |
| | **Unnamed Ditch (Branch 5, Pennington CD96)** Unnamed Ditch (Br2 CD96 to Unnamed Creek (CD96 Main Stem) | 2B, 3C | 09020303-545 | Aquatic Life-Fishes Bioassessment | 2016 | No |
| **Black River** 0902030304 | **Little Black River** Unnamed Ditch (Channelized Portion) to Black River | 2B, 3C | 09020303-528 | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | **Black River** Little Black River to Red Lake River | 2B, 3C | 09020303-529 | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| | **Black River** -96.4328 48.0146 to Little Black River | 2Bg, 3C | 09020303-558 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | | | | Aquatic Life-Dissolved Oxygen | 2008 | No |
| | | | | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| **Red Lake River** City of Crookston 0902030305 | **Red Lake River** Black River to Gentilly River | 1C, 2Bd, 3C | 09020303-502 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity (& TSS)* | 2008 | Yes |
| | **Red Lake River** CD99 to Burnham Creek | 1C, 2Bd, 3C | 09020303-506 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity (& TSS)* | 2008 | Yes |
| | **Red Lake River** Clearwater River to Cyr Creek | 1C, 2Bd, 3C | 09020303-510 | Aquatic Consumption-Mercury | 1998 | No** |
| | **Red Lake River** Cyr Creek to Black River | 1C, 2Bd, 3C | 09020303-511 | Aquatic Consumption-Mercury | 1998 | No** |

| Red Lake River Watershed (09020303) Rivers, Streams, and Ditches on the draft 2018 303 (d) list of Impaired Waters | | | | | | |
|---|---|---|---|---|---|---|
| **HUC 10 Subwatershed** | **Waterbody Name and Reach** | **Use Class** | **Assessment Unit ID** | **Impairment** | **Year Listed** | **TMDL in this Study** |
| **Red Lake River** City of Crookston 0902030305 (continued) | **Red Lake River** Gentilly River to CD 99 | 1C, 2Bd, 3C | 09020303-512 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity* | 2009 | Yes |
| | **Kripple Creek** Unnamed Creek to Gentilly River | 2B, 3C | 09020303-525 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | | | | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| | **Kripple Creek (CD66)** Unnamed Ditch to Unnamed Creek | 2B, 3C | 09020303-526 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | **JD 60** Lateral Ditch 4 to Red Lake River | 2B, 3C | 09020303-542 | Aquatic Life-Dissolved Oxygen | 2016 | No |
| | **Gentilly River** CD140 to Red Lake River | 2C | 09020303-554 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | | | | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| | **Cyr Creek** County Road 14 to Red Lake River | 2Bg, 3C | 09020303-556 | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | | | | Aquatic Recreation-*E. Coli* | 2016 | Yes |
| **Burnham Creek** 0902030306 | **Burnham Creek** Polk CD15 to Red Lake River | 2C | 09020303-515 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| | **Burnham Creek** CD106 to Polk CD15 | 2C | 09020303-551 | Aquatic Life-Aquatic Macroinvertebrate Bioassessment | 2016 | No |
| | | | | Aquatic Life-Fishes Bioassessment | 2016 | No |
| **Lower Red Lake River** 0902030307 | **Red Lake River** Burnham Creek to Unnamed Creek (Heartsville Coulee) | 1C, 2Bd, 3C | 09020303-501 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity (& TSS)* | 1998 | Yes |
| | **Red Lake River** Unnamed Creek (Heartsville Coulee) to Red River | 1C, 2Bd, 3C | 09020303-503 | Aquatic Consumption-Mercury | 1998 | No** |
| | | | | Aquatic Life-Turbidity (& TSS)* | 2002 | Yes |
| | **Unnamed Ditch (Heartsville Coulee)** | 2B, 3C | 09020303-550 | Aquatic Life-Dissolved Oxygen | 2016 | No*** |

* The Red Lake River Watershed was assessed using newly adopted TSS standards in 2015. Some turbidity impairments were delisted where TSS standards were met. Turbidity impairments remain listed for those reaches that fail to meet the TSS standards or have insufficient data to prove compliance with the TSS standards.

**Mercury impairments have been addressed by a state-wide Mercury TMDL that was approved by the EPA in 2007: https://www.pca.state.mn.us/sites/default/files/wq-iw4-01b.pdf

***Impairment has been recategorized from a Category 5 to Category 4C.

Use Classes: 1C- Domestic Consumption (requires heavy treatment)
2B-Aquatic Life and Recreation-Warm and Cool Water Habitat (lakes and streams)
2Bd-Aquatic Life and Recreation-Warm and Cool Water Habitats (also protected for drinking water)

| Red Lake River Watershed (09020303) Rivers, Streams, and Ditches on the draft 2018 303 (d) list of Impaired Waters | | | | | | |
|---|---|---|---|---|---|---|
| HUC 10 Subwatershed | Waterbody Name and Reach | Use Class | Assessment Unit ID | Impairment | Year Listed | TMDL in this Study |
| 2Bg-Aquatic Life and Recreation-General Warm Water Habitat (lakes and streams)<br>2C-Aquatic Life and Recreation-Indigenous aquatic live and their habitats (streams)<br>2D-Aquatic Life and Recreation-Wetlands<br>3C-Industrial Consumption (heavy treatment) | | | | | | |

## 1.3 Priority Ranking

The MPCA's projected schedule for TMDL completions, as indicated on the 303(d) Impaired Waters List, implicitly reflects Minnesota's priority ranking of this TMDL. The MPCA has aligned its TMDL priorities with the watershed approach and the WRAPS cycle. The schedule for TMDL completion corresponds to the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan Minnesota's TMDL Priority Framework Report to meet the needs of U.S. Environmental Protection Agency (EPA's) national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the Clean Water Act Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments that will be addressed by TMDLs by 2022. The Red Lake River Watershed waters addressed by this TMDL are part of that MPCA prioritization plan to meet EPA's national measure.

# 2. Applicable Water Quality Standards and Numeric Water Quality Targets

This section describes the applicable water quality standards, as they are described within the MPCA's *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) report and 303(d) List.* Standards are summarized in Tables 2-1 and 2-2. DO and *E. coli* standards are consistent throughout the watershed. The impairment threshold of an individual reach depends on its Tiered Aquatic Life Use (TALU) classification (Table 2-2) and its location within the state. Water chemistry standards for the protection of aquatic life are different for each of the three River Nutrient Regions (Figure 2-1).

**Table 2-1. Applicable water chemistry standards.**

| Parameter | Use Class | Water Quality Standard | Criteria | Standard's Applicable Time Period |
|---|---|---|---|---|
| Total Suspended Solids – Central Nutrient Region | 1C. 2B, 2Bd, 2Bg, 3C | Not to exceed 30 mg/l | Maximum = 10% of Samples | April 1 – September 30 |
| Total Suspended Solids – South Nutrient Region | 1C. 2B, 2Bd, 2Bg, 3C | Not to exceed 65 mg/l | Maximum = 10% of Samples | April 1 – September 30 |
| Dissolved Oxygen | 2B, 2Bd | Daily minimum of 5 mg/l | >90% of daily minimums need to exceed the standard | Open Water Months |
| *Escherichia Coli* | 2A, 2B, 2Bd, 2C, 2D | 126 MPN/100 ml | Maximum Geometric Mean of not less than 5 samples | April 1 – October 31 |
| *Escherichia Coli* | 2A, 2B, 2Bd, 2C, 2D | 1260 MPN/100 ml | Maximum = 10% of Samples within a calendar month | April 1 – October 31 |

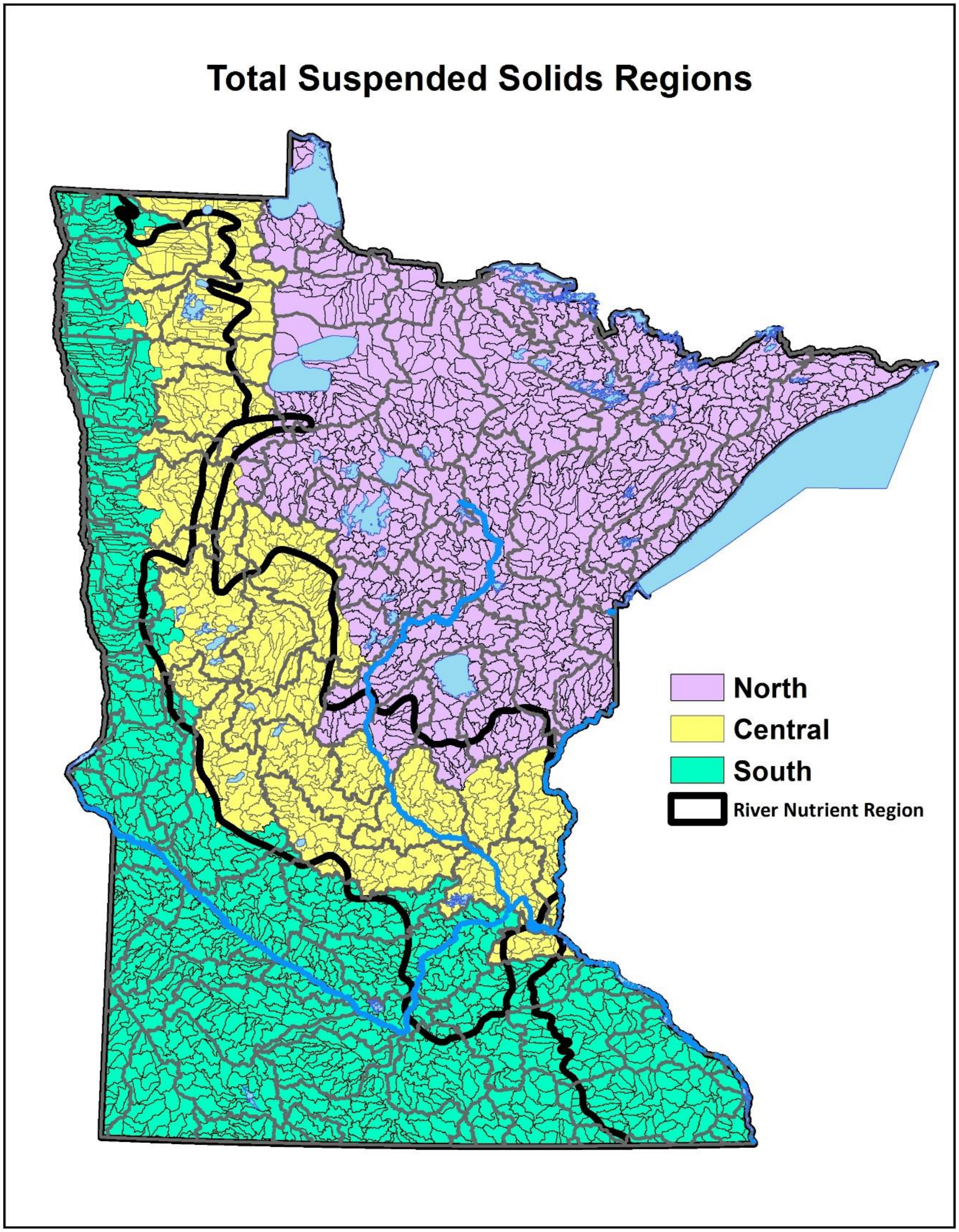


**Figure 2-1. Minnesota Total Suspended Solids Regions for Water Quality Standards.**

## 2.1 Dissolved Oxygen

DO is required for aquatic organisms to live. When DO drops below acceptable levels, desirable aquatic organisms, such as fish, can be killed or harmed. DO standards differ depending on the use class of the water.

**Class 2Bd, 2B, 2C. Not less than 5 mg/L as a daily minimum**

The standard for DO is expressed in terms of daily minimums and concentrations generally follow a diurnal cycle. Consequently, measurements in open-water months (April through November) should be made before 9:00 a.m.

A stream is considered impaired if:

1. More than 10% of the "suitable" (taken before 9:00 a.m.) May through September measurements, or more than 10% of the October through April measurements, violate the standard, and;
2. There are at least three violations.

Because the underlying criterion is that water quality standards can be exceeded no more than 10% of the relevant time, it is usually essential that measurements are a representative sample of overall water quality and are not biased towards certain types of conditions, such as storm events or certain times of the year. The relevant time generally refers not to the entire year, but rather to the usual water quality monitoring portion of the year. The requirement of at least three exceedances helps ensure that the measured data set is sufficiently large to provide an adequate picture of overall conditions.

A designation of "full support" for DO generally requires at least 20 suitable measurements from a set of monitoring data that give a representative, unbiased picture of DO levels over at least two different years. However, if it is determined that the data set adequately targets periods and conditions when DO exceedances are most likely to occur, a smaller number of measurements may suffice for a determination of "full support."

## 2.2 Total Suspended Solids

TSS will be used to address TSS and turbidity impairments. It is a quantifiable standard, which is needed for the calculation of loading capacity, allocations, and reductions. Turbidity is an optical property of water that is useful for on-the-spot assessment of water quality conditions, but needs to be converted to another parameter like TSS in order to be used. With the adoption of the TSS standard, the State no longer applies the turbidity standard during official water quality assessments.

TSS is a measurement of the concentration of soil particles, algae, and other materials that are suspended in water and cause a lack of clarity. Excessive TSS can harm aquatic life, degrade aesthetic and recreational qualities, and make water more expensive to treat for drinking.

A stream is considered to exceed the standard for TSS if:

1. The standard is exceeded more than 10% of the days of the assessment season (April through September), as determined from a data set that gives an unbiased representation of conditions over the assessment season, and;
2. There are at least three such measurements exceeding the standard.

A stream is considered to meet the standard for TSS if the standard is met at least 90% of the days of the asssessment season. A designation of “meeting the standard” for TSS generally requires at least 20 suitable measurements from a data set that gives an unbiased representation of conditions over at least two different years. However, if it is determined that the data set adequately targets periods and conditions when exceedances are most likley to occur, a smaller number of measurements may suffice.

The applicable TSS standard varies by TSS Region, as noted in Table 2-1.

## 2.3 *Escherichia coli*

The numeric standards in Minn. R. ch. 7050 (Waters of the State) that directly protect for primary (swimming and other recreation, where immersion and inadvertently ingesting water is likely) and secondary (boating and wading, where the likelihood of ingesting water is much smaller) body contact are the *E. coli* (Escherichia coli) standards shown in Table 2-1. *E. coli* standards are applicable only during the warm months since there is very little swimming in Minnesota in the non-summer months. Exceedances of the *E. coli* standard mean that the recreational use is not being met.

The MPCA uses an *E. coli* standard based on a geometric mean EPA criterion of 126 *E. coli* colony forming units (CFU) per 100 ml. *E. coli* has been determined by EPA to be the preferred indicator of the potential presence of waterborne pathogens.

There is a considerable amount of *E. coli* data available in Minnesota, and older fecal coliform data. For assessment purposes, only *E. coli* measurements will be used. Exceptions to the exclusive use of *E. coli* data will be made only in special cases, using a ratio of 200 to 126 to convert fecal coliform to *E. coli.*

Data over the full 10-year period are aggregated by individual month (e.g. all April values for all 10 years, all May values, etc.). At least five values for each month is ideal, while a minimum of five values per month for at least three months, preferably between June and September, is necessary to make a determination. Assessment with less than these minimums may be made on a case-by-case basis.

Where multiple bacteria/pathogen samples have been taken on the same day on an assessment unit, then the geometric mean of all the measurements will be used for the assessment analysis.

If the geometric mean of the aggregated monthly values for one or more months exceeds 126 organisms per 100 ml, that reach is considered impaired. In addition, a waterbody is considered impaired if more than 10% of individual values over the 10-year period (independent of month) exceed 1260 organisms per 100 ml. This assessment methodology more closely approximates the five-samples-per-month requirement of the standard while recognizing typical sampling frequencies, which rarely provide five samples in a single month, and usually only one.

Expert review of the data provides a further evaluation. When fewer than five values are available for most or all months, the individual data are reviewed. In some circumstances where four values are available for some or all months, a mathematical analysis is done to determine the potential for a monthly geometric mean to exceed the 126 organisms/100ml standard. All assessments are reviewed by the Watershed Assessment Team (WAT) for each watershed.

Considerations in making the impairment determination include the following:

- Dates of sample collection (years and months)

- Variability of data within a month
- Magnitude of exceedances
- “Remark” codes associated with individual values
- Previous assessments and 303(d) listings

## 2.4 Biological Indicators (Fish and Macroinvertebrate Indices of Biological Integrity)

Biological indicators (fish and macroinvertebrates in streams) are currently evaluated in MPCA assessments. The presence of a healthy, diverse, and reproducing aquatic community is a good indication that the aquatic life beneficial use is being supported by a lake, stream, or wetland. The aquatic community integrates the cumulative impacts of pollutants, habitat alteration, and hydrologic modification on a water body over time. Monitoring the aquatic community, or biological monitoring, is therefore, a direct way to assess aquatic life use support. Interpreting aquatic community data is accomplished using an index of biological integrity or IBI. The IBI incorporates multiple attributes of the aquatic community, called “metrics,” to evaluate a complex biological system. The MPCA has developed fish and invertebrate IBIs to assess the aquatic life use of rivers and streams statewide in Minnesota. The impairment thresholds applied to specific Assessment Unit ID (AUIDs) in the Red Lake River Watershed are shown in Table 2-2.

**Table 2-2. Summary of Fish IBI and Macroinvertebrate IBI standards that were applied to impaired reaches**

| Impaired Reach Name (AUID) | Station # | F-IBI Class | F-IBI Score Threshold | M-IBI Class | M-IBI Threshold |
|---|---|---|---|---|---|
| Burnham Creek (09020303-515) | 10EM112<br>12RD001<br>12RD032<br>12RD115 | 2 (GU) | 50 | 7 (GU) | 41 |
| Kripple Creek (09020303-525) | 05RD077 | 6 (GU) | 42 | 7 (GU) | 41 |
| Kripple Creek (09020303-525) | 12RD022 | 2 (GU) | 50 | 7 (GU) | 41 |
| Kripple Creek / CD 66 (09020303-526) | 07RD006<br>12RD044 | 6 (GU) | 42 | 7 (GU) | 41 |
| Little Black River (09020303-528) | 12RD024 | 6 (GU) | 42 | Unassessed | Unassessed |
| Br 2 CD 96 (09020303-545) | 12RD039 | 6 (MU) | 23 | 7 (MU) | 22 |
| County Ditch 43 (09020303-547) | 12RD045 | 7 (MU) | 15 | 7 (MU) | 22 |
| Burnham Creek (09020303-551) | 12RD030 | 2(MU) | 35 | 7 (MU) | 22 |
| Burnham Creek (09020303-554) | 12RD021 | 2 (GU) | 50 | 7 (GU) | 41 |
| | 12RD043 | 6 (GU) | 42 | 6 (GU) | 42 |
| Cyr Creek (09020303-556) | 12RD023 | 6 (GU) | 42 | Unassessed | Unassessed |
| Black River (09020303-558) | 05RD122 | 5 (GU) | 47 | Unassessed | Unassessed |
| | 12RD012 | 5 (GU) | 47 | 7 (GU) | 41 |
| | 12RD102 | 5 (GU) | 47 | 5 (GU) | 37 |

(GU) =General Use Class; (MU)=Modified Use Class

Further interpretation of aquatic community data is provided by an assessment threshold, or biocriteria standard, against which an IBI score can be compared. In general, an IBI score above this threshold is indicative of aquatic life use support, while a score below the threshold is indicative of non-support. Currently, Minnesota is using a combination of two similar concepts to set biocriteria, the Biological Condition Gradient (BCG) and reference conditions. To develop biocriteria that are protective of the structural and functional health of biological communities, Minnesota used the median of BCG level 4. Communities at the middle of this level can be best characterized as possessing *“overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes”*, which is in line with the language of the CWA interim goal. This BCG-derived criterion was then compared to criteria derived from reference sites to ensure that the two approaches were closely aligned in each IBI class. This same BCG process was used to set the threshold for the lake F-IBI classes.

The state officially adopted the TALU framework for assessing aquatic life in 2015. This framework refines Minnesota’s single goal for aquatic life into three tiers that are based on the aquatic life potential for a water body. These tiered uses are Exceptional, General (GU), and Modified (MU). The process for determining the appropriate tier is called a Use Attainability Analysis and it is carried out before the assessment process. The actual mechanisms for performing an assessment of TALUs are similar to the current process with the only major difference being the biocriteria threshold.

Bracketing each IBI assessment threshold is a 90% confidence interval that is based on the variability of IBI scores obtained at sites sampled multiple times in the same year (i.e., replicates). Confidence intervals account for variability due to natural temporal changes in the community as well as method error. For assessment purposes, sites with IBI scores within the 90% confidence interval are considered “potentially impaired.” Upon further review of available supporting information, an IBI parameter review may change to “indicating support” or “indicating severe impairment,” depending on the extent and nature of this additional information.

# 3. Watershed and Waterbody Characterization

The Red Lake River Watershed is a 909,024-acre HUC8 watershed in northwestern Minnesota. The watershed covers significant portions of the counties of Pennington, Red Lake, and Polk. It flows through (or near) the cities of Thief River Falls, St. Hilaire, Red Lake Falls, Crookston, Fisher, and East Grand Forks. The watershed falls within the jurisdiction of multiple local government units (LGUs), including the Red Lake Watershed District (RLWD), Red Lake Nation Department of Natural Resources, Pennington Soil and Water Conservation District (SWCD), Red Lake County SWCD, and the West Polk SWCD. The characteristics of the watershed change from its eastern origins to its western extent. The Red Lake River begins in the peatlands of the northern Minnesota wetlands ecoregion and flows through the Lake Agassiz plains, beach ridges and sand deltas, and Glacial Lake Agassiz plain portions of the Lake Agassiz plain ecoregion. Prior to settlement, the majority of the land was covered by either prairie or wetland. Today, most of land is being used to produce cultivated crops.

The Red Lake River flows through lake modified glacial till in the eastern, upstream portion of the watershed. Near St. Hilaire, the glacial till deposits change to shoreline and near-shore glacial sediment. The near-shore sediments are moderately to well-sorted silt, clay, and sand that were deposited in shallow water of Glacial Lake Agassiz. The shoreline sediments consist of sand and silt with gravel ridges.

As the river flows south to Red Lake Falls and west to the Black River confluence, fine sand soil types become more prevalent. From the Black River confluence to where the Red Lake River turns direction and flows directly west (near Gentilly), the glacial deposits are from wave-eroded, low-relief glacial sediment. These areas are made up of clay to slightly pebbly soils. Near Crookston, there is a shift to finer soil particles (clay, loam, very fine sandy loam, and silty clay loam). The Red Lake River begins at the outlet of Lower Red Lake, within the Red Lake Nation and is not impaired as it flows through the Upper Red Lake River Subwatershed. It becomes impaired between the cities of St. Hilaire and Red Lake Falls. Tributaries of the Red Lake River are impaired by poor IBI scores, low DO, and *E. coli* bacteria.

## 3.1 Streams

The Red Lake River begins at the United States Army Corps of Engineers' (USACE) dam at the outlet of Lower Red Lake within the Red Lake Nation. The dam is located at the pour point of the 1,263,678-acre Upper and Lower Red Lakes major (HUC8) watershed. The Red Lake River then flows west to the city of Thief River Falls. In the city of Thief River Falls, the Red Lake River is joined by the 624,422-acre Thief River HUC8 major watershed. The Red Lake River then flows south to Red Lake Falls, where it is joined by the 886,600-acre Clearwater River HUC8 major watershed. The Red Lake River then flows south and west through the cities of Crookston and Fisher to the city of East Grand Forks where it flows into the Red River of the North. Other significant streams that flow into the Red Lake River include Cyr Creek, Black River, Gentilly River, and Burnham Creek. Along its path, the river also receives drainage from many county and judicial ditches.

A portion of the Red Lake River between a channel control structure within the Red Lake Nation and Pennington County Ditch 39 was channelized by the USACE to address flooding and water supply issues. Downstream of the channelized reach, the natural channel features a pattern of riffles and pools. As the river nears Thief River Falls, the channel deepens as it enters the area influenced by the Thief River Falls Reservoir. The reservoir was created by a large dam in the city of Thief River Falls (Figure 3-1).

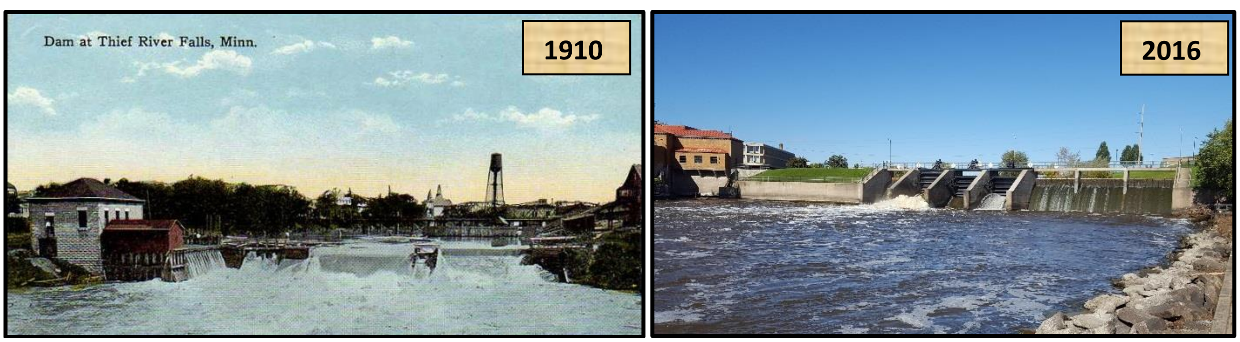


**Figure 3-1. Historical and current images of the Thief River Falls Dam.**

Rapids and pools are found downstream of the Thief River Falls dam. High bluffs are found along the river near Red Lake Falls and its confluence with the Clearwater River. Downstream of the Black River, the water in the Red Lake River becomes cloudier and the gradient decreases as it enters the Lake Agassiz Plain ecoregion. A reservoir remains in the city of Crookston upstream of the retrofitted dam. The river becomes deeper and more sediment laden as it flows west from Crookston to its confluence with the Red River in East Grand Forks.

Glacial Ridge National Wildlife Refuge serves as the headwaters of several tributaries of the Red Lake River, including Burnham Creek, Kripple Creek, and Cyr Creek. Longitudinal monitoring has indicated that the water leaving the refuge is relatively clean, thanks to natural filtration of runoff in the refuge.

The Red Lake River provides opportunities for recreation. Boat and kayak accesses are found throughout the Red Lake River corridor. Local entities have organized to form the Red Lake River Corridor Enhancement Joint Powers Board for the purpose of adding and improving accesses and trails along the river. Upstream of Thief River Falls, there are multiple accesses and a high-quality fishery along the reach, despite the presence of the Thief River Falls Dam (a barrier to fish passage). Anglers can catch walleye, northern pike, black crappie, rock bass, yellow perch, burbot, white sucker, redhorse, and freshwater drum. In addition to the game species of fish found upstream of the Thief River Dam, anglers can also catch channel catfish, bluegill, sauger, smallmouth bass, and sturgeon downstream of the dam. The fishery between Thief River Falls and Crookston improved after the Crookston Dam was replaced with rock rapids in 2005 and sheet piling was removed from the Otter Tail Power Dam upstream of Crookston in 2006. The Red Lake River is utilized for all types of aquatic recreation within the Thief River Falls Reservoir (swimming, tubing, and fishing). Campgrounds are located near the Red Lake River in Thief River Falls, Red Lake Falls, Huot, and Crookston. Ice fishing on the Red Lake River is popular within the cities of Thief River Falls and Crookston.

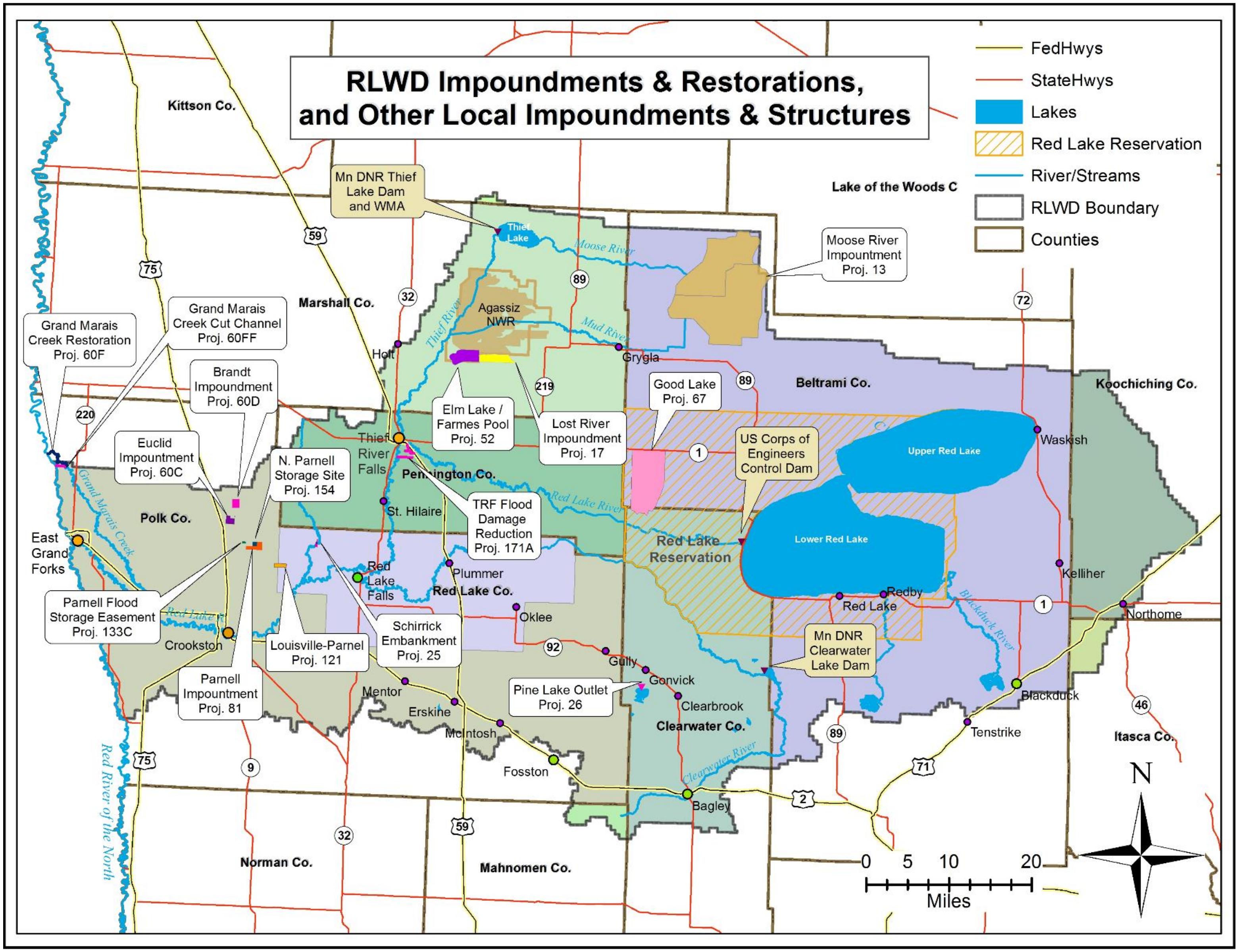


**Figure 3-2. Locations of impoundments within the Red Lake River Watershed and the RLWD.**

Flood control impoundments are significant and influential features of the Red Lake River Watershed. Future construction of new impoundments is likely as LGUs work to meet distributed retention goals, reduce peak flows, and reduce flood damage. Locations of impoundments are shown in Figure 3-2.

#### Good Lake Impoundment

The Good Lake Impoundment is a cooperative effort between the Red Lake Band of Chippewa Indians and the RLWD. The impoundment lies entirely within the Red Lake Reservation, approximately 30 miles east of Thief River Falls. The multi-purpose project provides wetland habitat, floodwater retention, and potential irrigation water supply. Spring storage capacity is 11,300 acre-feet, which is equal to 2.6 inches of runoff from the 73 square-mile drainage area. The project intercepts overland flows to reduce flooding on 4,000 acres of private land immediately west of the project.

#### Goose Lake Swamp

The Goose Lake Swamp is located two miles north of Dorothy. Aerial photos reveal that the pool represents the natural headwaters of the Little Black River. Water is pooled upstream of an outlet structure at the southeastern end of the swamp. Drainage into the Little Black River was re-routed via a ditch that parallels the eastern edge of the swamp. The swamp and surrounding prairie lands make up the Pembina Wildlife Management Area. Wildlife habitat is the primary purpose of this pool.

#### Shirrick Dam

The Shirrick Dam is an on-channel impoundment that was constructed on the Black River in 1985. The project is located in Section 35 of Wylie Township in Red Lake County, approximately six miles northwest of Red Lake Falls. The impoundment provides flood relief to the city of Crookston by reducing flows in the Red Lake River and the Red River of the North by controlling the flow contribution from the Black River. The reservoir has the capacity to detain up to 4,800 acre-feet of water. The outlet structure for this impoundment is a barrier to fish passage and negatively affects upstream fish communities.

#### Thief River Falls Reservoir

The Thief River Falls Dam creates a reservoir within the city of Thief River Falls. The city of Thief River Falls draws its drinking water from the Red Lake River at a location near the dam. More detailed information regarding impacts to drinking water sources from upstream within the Thief River Watershed, can be found in the Thief River Watershed TMDL and the Thief River WRAPS reports, both dated March 2019. The dam is also used to generate hydroelectric power. The quality of fish populations in upstream waters are good, despite the fish passage barrier that is created by the Thief River Falls Dam.

#### U.S. Corps of Engineers Control Dam at the Lower Red Lake Outlet

In 1931, the Indian Service (now Bureau of Indian Affairs) constructed the Red Lake River Dam for the reported “purpose of lake regulation and flood control below the lake.”

#### Louisville/Parnell Impoundment

The Louisville/Parnell Impoundment (and Wetland Bank Project) is located in Section 13 of Parnell Township (Polk County) and Section 18 of Louisville Township (Red Lake County). The project is located in the headwaters of Judicial Ditch 60 (JD60). The project controls break out flows from Lateral 2 of

Judicial Ditch 60. The project provides 400 ac-ft. of floodwater retention and created 37 acres of wetlands.

**Parnell Impoundment**

The Parnell impoundment is located in Sections 3 and 4 of Parnell Township, Polk County. This Impoundment has two discharge locations that allow water to drain into the Red Lake River Watershed, through Judicial Ditch 60, or drain into Polk County Ditch 26, which is located in the Grand Marais Creek Watershed. The project reduces flooding on downstream agricultural lands and urban areas by retaining up to 4,000 ac-ft. of floodwater.

**SCS/NRCS Dams**

The Soil Conservation Service (SCS/NRCS) constructed small dams during the 20$^{th}$ century on tributaries to larger rivers and drainage ways. These multipurpose dams were constructed for the purpose of stabilizing outlets, reducing erosion and siltation, flood retention, and wildlife habitat. They were built with earthen embankments. Permanent pools are created by fixed-crest outlet structures that have no drawdown capabilities. Some of the small NRCS dams are located on ephemeral drainage ways and create no fish passage issues along impaired reaches. The Baird-Beyer Dam on the Little Black River; however, is an on-channel impoundment that is a fish passage barrier for an impaired reach (09020303-528). The dams are accomplishing the goal of stabilizing outlets of drainage ways and reducing erosion at the location of the dam and some distance upstream. The following dams are located on tributaries of the Red Lake River:

- Latundresse Dam
- Odney Flaat Dam (Burnham Creek)
- BR-6 Impoundment (Polk CD 140, Gentilly Creek headwaters)
- Seeger Dam
- Baird-Beyer Dam (Little Black River)
- Thibert Dam

## 3.2 Subwatersheds

The Red Lake River HUC8 major watershed encompasses seven HUC10 subwatersheds, shown in Figure 3-3. The direct and total drainage areas of the impaired AUIDs within the Red Lake River Watershed are listed in Table 3-1. In addition to the drainage area of the Red Lake River major watershed, the Upper/Lower Red Lakes, Thief River, and Clearwater River major watersheds contribute to the total drainage areas for impairments along the Red Lake River. The locations of the direct drainage areas of the impaired AUIDs are shown in Figure 3-4.

**Table 3-1. Total and Direct Drainage Areas of Impaired AUIDs, derived from USGS StreamStats.**

| AUID 09020303-xxx | Waterbody | Description | Total Drainage Area ($mi^2$) | Direct Drainage Area ($mi^2$) | Percent of the 1420.35 $mi^2$ Red Lake River Major Subwatershed | Upstream AUID 09020303-xxx | Monitored Tributary 09020303-xxx | Downstream AUID 0902030x-xxx |
|---|---|---|---|---|---|---|---|---|
| 501 | Red Lake River | Burnham Creek to Heartsville Coulee | 5653.50 | 90.45 | 6.37% | 506 | 515 | 3-503 |
| 502 | Red Lake River | Black River to Gentilly River | 5210.96 | 16.90 | 1.19% | 511 | 529 | 3-512 |
| 503 | Red Lake River | Heartsville Coulee to Red River | 5685.96 | 2.70 | 0.19% | 501 | 550 | 1-504 |
| 504 | Red Lake River | Pennington CD96 to Clearwater River | 3642.52 | 62.10 | 4.37% | 513 | 505 | 3-510 |
| 505 | Pennington CD96 | Headwaters to Red Lake River | 41.55 | 29.16 | 2.05% | -- | 545 | 3-504 |
| 506 | Red Lake River | Polk CD99 to Burnham Creek | 5413.34 | 66.76 | 4.70% | 512 | -- | 3-501 |
| 512 | Red Lake River | Gentilly River to Polk CD99 | 5346.58 | 24.65 | 1.74% | 502 | 542 | 3-506 |
| 515 | Burnham Creek | Polk CD15 to Red Lake River | 149.71 | 76.45 | 5.38% | 551 | -- | 3-501 |
| 525 | Kripple Creek | Unnamed Creek to Gentilly River | 32.91 | 32.45 | 2.28% | 526 | -- | 3-554 |
| 526 | Kripple Creek (CD66) | Unnamed Ditch to Unnamed Creek | 0.46 | 0.46 | 0.03% | -- | -- | 3-525 |
| 528 | Little Black River | Channelized portion to the Black River | 24.66 | 3.99 | 0.28% | 527 | -- | 3-529 |
| 529 | Black River | Little Black River to Red Lake River | 144.87 | 9.37 | 0.66% | 558 | 528 | 3-502 |
| 542 | JD60 | Lateral Ditch 4 to Red Lake River | 43.30 | 43.30 | 3.05% | -- | -- | 3-512 |
| 545 | Branch 5 of Pennington CD96 | Branch 2 of CD96 to CD96 Main Stem | 12.39 | 12.39 | 0.87% | -- | -- | 3-505 |
| 547 | Pennington CD43 | Unnamed Ditch to Red Lake River | 24.36 | 24.36 | 1.72% | -- | -- | 3-561 |
| 550 | Heartsville Coulee | Polk CD115 to Red Lake River | 37.29 | 14.59 | 1.03% | 549 | -- | 3-503 |
| 551 | Burnham Creek | Polk CD106 to Polk CD15 | 73.26 | 15.18 | 1.07% | 552 | 559 | 3-515 |
| 554 | Gentilly River | Polk CD140 to Red Lake River | 67.70 | 41.70 | 2.94% | 553 | 524 | 3-512 |
| 556 | Cyr Creek | County Road 14 to Red Lake River | 24.88 | 19.00 | 1.34% | 555 | -- | 3-511 |
| 558 | Black River | -96.4328 48.0146 (channelized reach) to Little Black River | 110.84 | 29.27 | 2.06% | 557 | 539 | 3-529 |

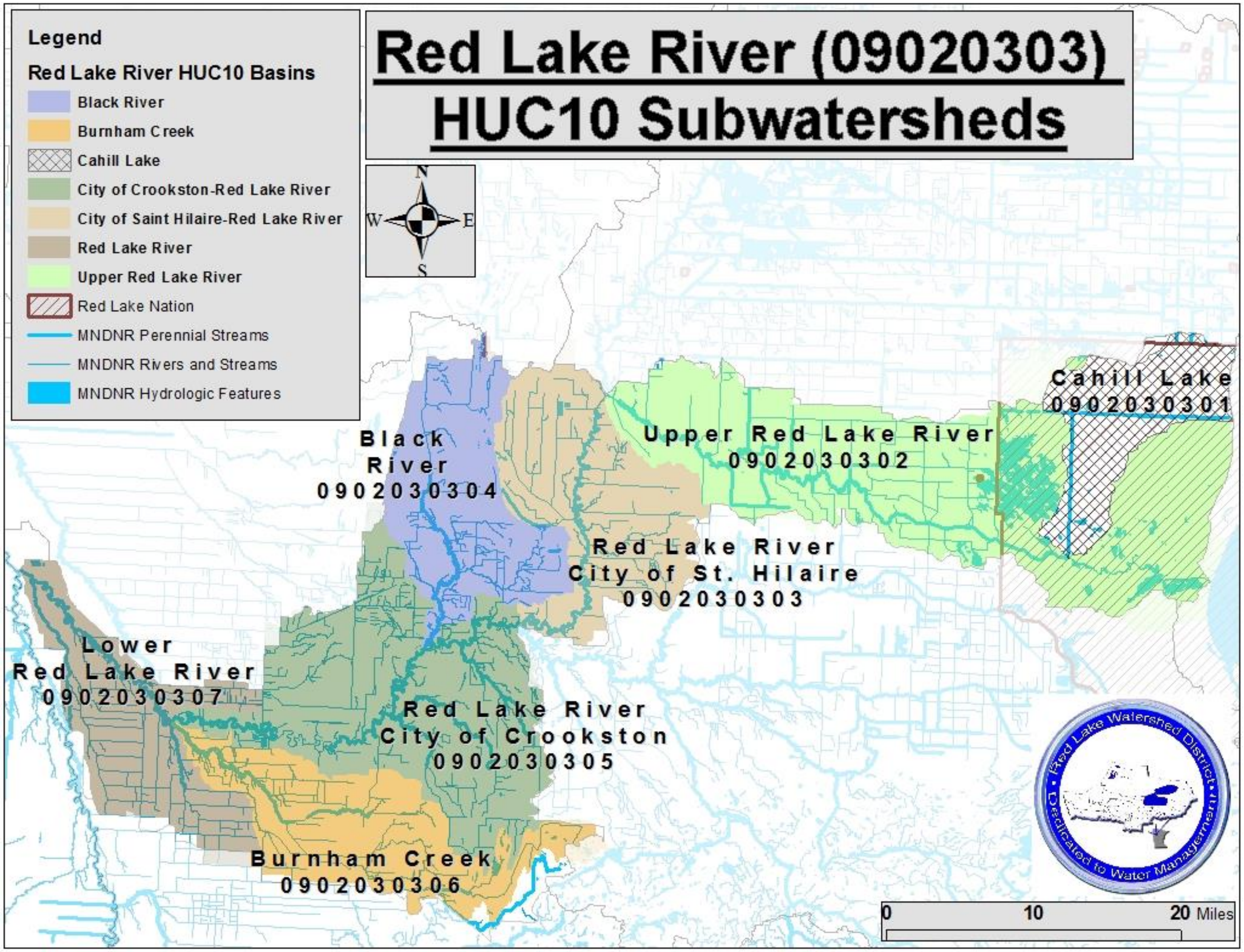


**Figure 3-3. 2016 Red Lake River Watershed Subwatersheds.**

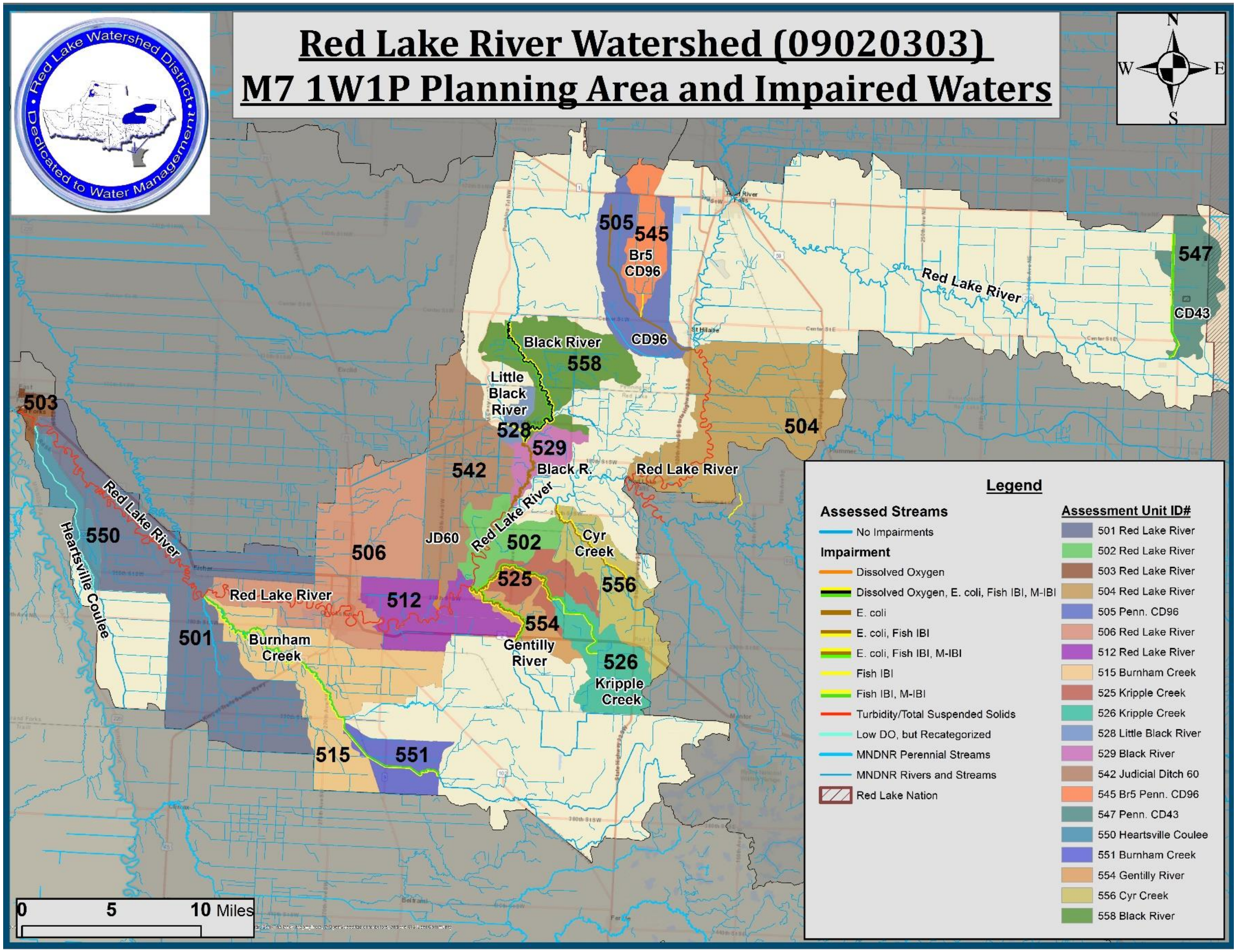


**Figure 3-4. Direct drainage areas of impaired waters in the Red Lake River Watershed.**

## 3.3 Land Use

The predominant land use in the Red Lake River Watershed is agricultural, as shown in Table 3-2 and Figure 3-5. The prevalence of cultivated land is more intense in the western part of the watershed than it is in the eastern part of the watershed. The river receives stormwater runoff from the six towns and cities through which it flows. According to the Red Lake River Watershed Monitoring and Assessment Report, 71.1% of the streams in the Red Lake River Watershed have been modified. This statistic includes artificial watercourses, drainage systems that were constructed where natural channels did not exist. Prior to settlement, the eastern portion of the watershed was dominated by wetlands and the western portion of the watershed was mostly prairie.

Soybeans and grains (barley and wheat) are grown throughout the watershed (Figure 3-6). Sugar beets are grown on many fields throughout the western portion of the watershed for the American Crystal Sugar agricultural cooperative to supply the sugar factories in Crookston and East Grand Forks.

**Table 3-2. Red Lake River Watershed land use and land cover.**

| Red Lake River Land Use Summary | | |
|---|---|---|
| **National Land Cover Database Category** | **Pre-Settlement*** | **Percent of Watershed—2011**** |
| Developed, Open Space | | 4.08% |
| Developed, Low Intensity | | 0.88% |
| Developed, Medium Intensity | | 0.17% |
| Developed, High Intensity | | 0.05% |
| Barren Land | | 0.02% |
| Shrub/Scrub | 14.80% | 0.10% |
| Grassland/Herbaceous | **46.69%** | 0.63% |
| Deciduous Forest | 9.57% | 3.68% |
| Evergreen Forest | | 0.13% |
| Mixed Forest | 0.91% | 0.03% |
| Pasture/Hay | | 5.34% |
| Cultivated Crops | | **60.63%** |
| Woody Wetlands | 4.80% | 9.98% |
| Emergent Herbaceous Wetlands | **23.11%** | **12.96%** |
| Open Water | 0.12% | 1.32% |
| *Land use categories are named different in the MNDNR pre-settlement data and the NLCD data. Pre-settlement data were placed into categories that seemed most appropriate. The *Natural Vegetation of Minnesota* document from the MNDNR was used as guidance. | | |
| **National Land Cover Database. | | |

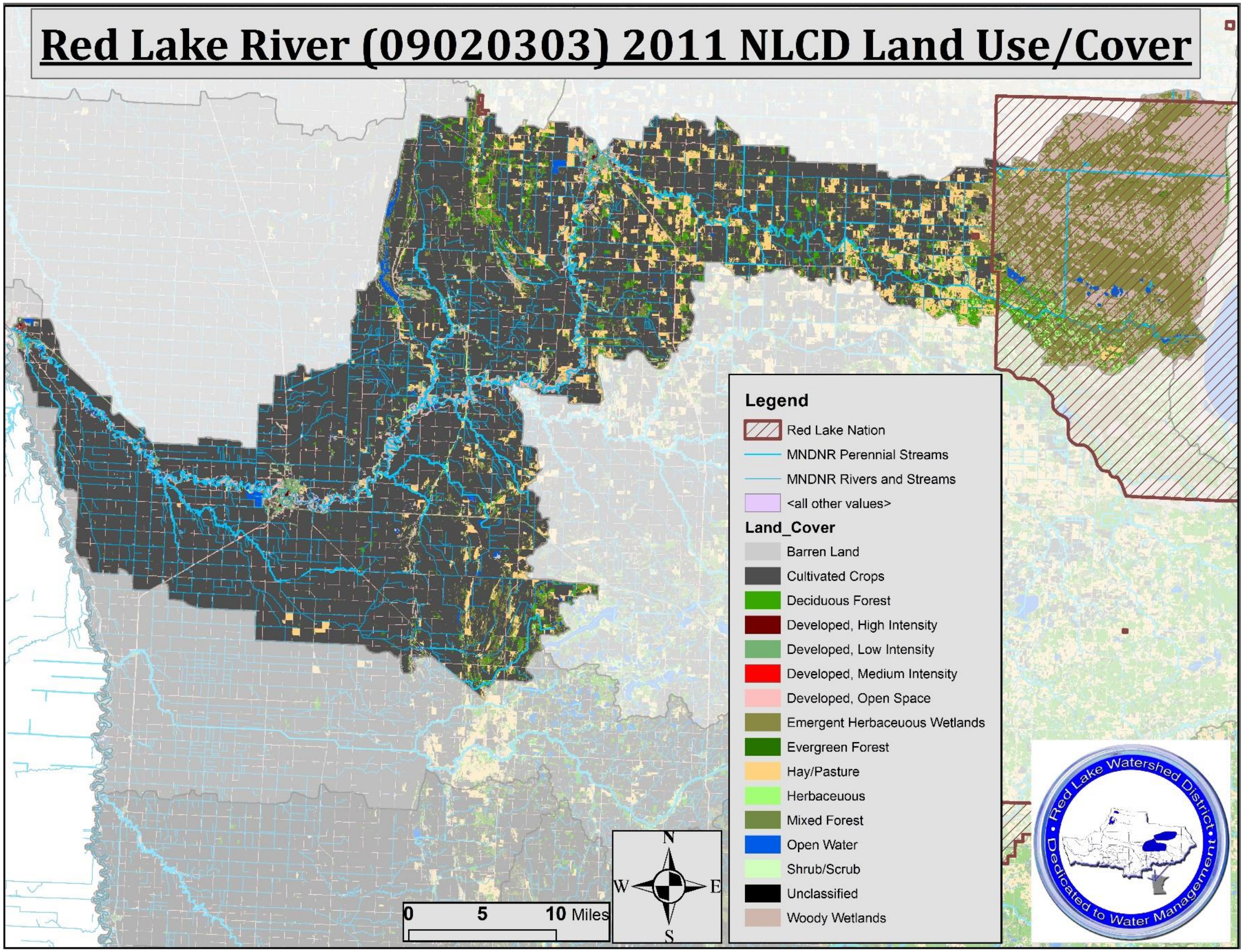


**Figure 3-5. Red Lake River Land Cover (2011 National Land Cover Database).**

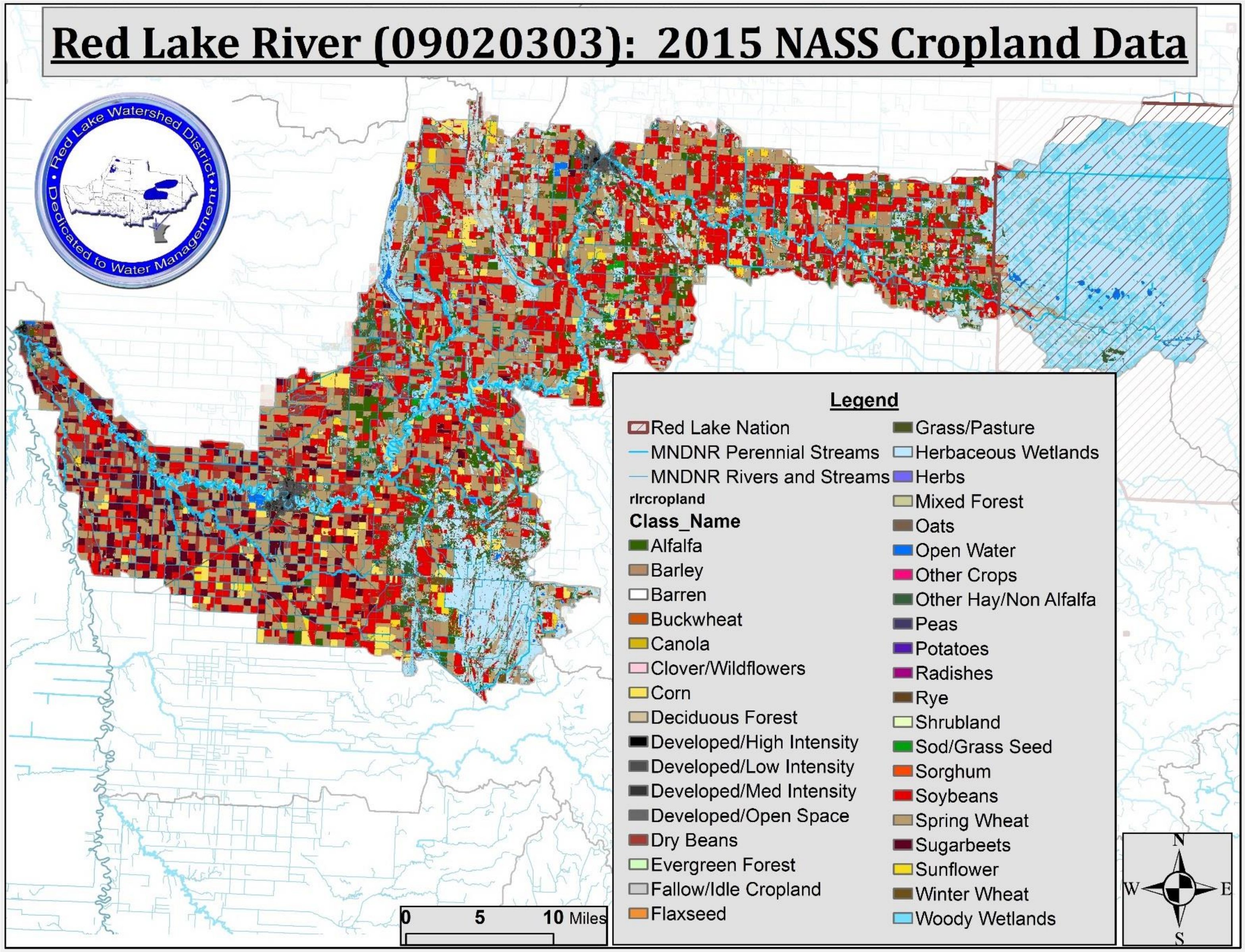


**Figure 3-6. 2015 United States Department of Agriculture, National Agricultural Statistics Service (NASS) Cropland Data.**

## 3.4 Current/Historic Water Quality

The oldest Red Lake River water quality records in the State's Environmental Quality Information System (EQuIS) water quality database were collected in 1953. Data collection efforts were minimal until the late 1990s (Figure 3-7). The intensity of monitoring efforts has increased in the last two decades. Increased awareness of the importance of monitoring data collection, monitoring methods, water quality standards, and assessment results have motivated multiple, productive, local monitoring programs. State agencies have allocated funding for intensive studies, load monitoring, and supplemental condition monitoring. The scope of monitoring efforts has expanded to include continuous water quality monitoring with deployed loggers, increased local stage/flow monitoring, and biological monitoring. Additional information about current monitoring efforts can be found in the monitoring plan in Section 7 of this report.

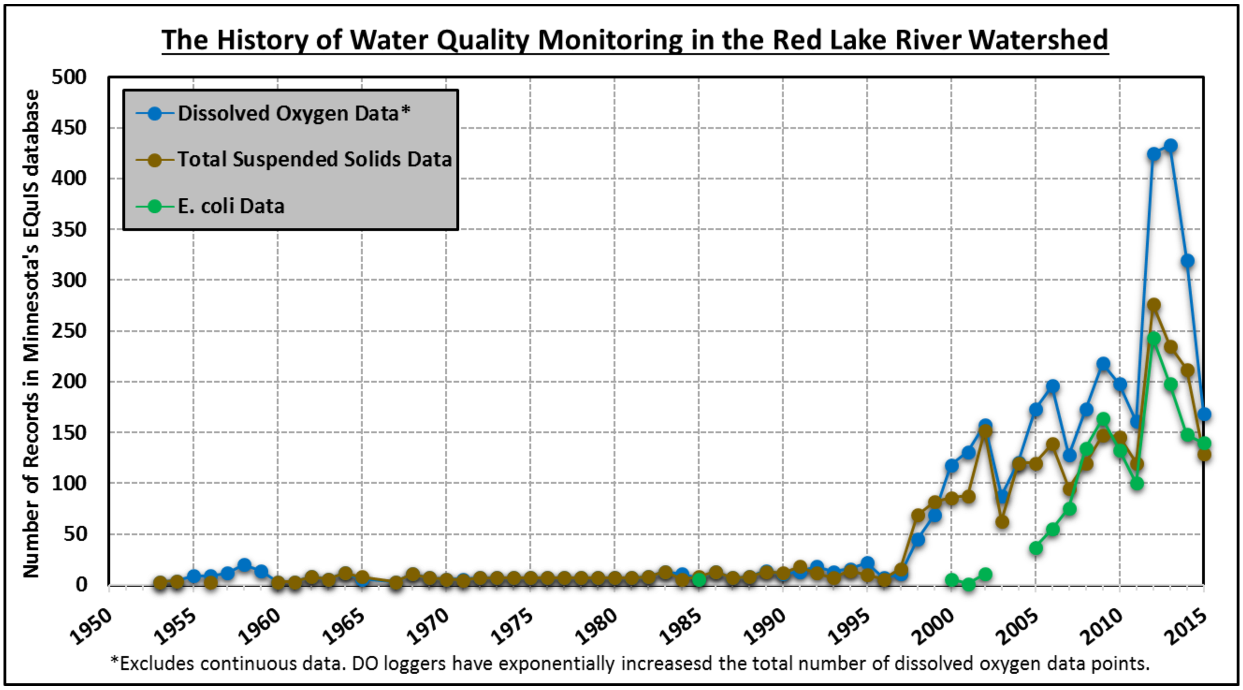


**Figure 3-7. Historical quantification of water quality monitoring data collection.**

The number of known impaired reaches doubled during the 2014 assessment (Figure 3-8). The number of known individual impairments more than doubled. An increase in data, rather than a decrease in water quality, is primarily responsible for the increase in impairments. Some specific changes are:

- The 2014 assessment was the first time that the MPCA used IBI data to assess conditions in the Red Lake River Watershed.
- The 2014 assessment was the first time that many sites had sufficient data for *E. coli* bacteria assessments. The transition from fecal coliform to *E. coli* as the aquatic recreation water quality standard was too recent in 2009 (the last time the Red Lake River Watershed was formally assessed prior to 2014) and many reaches had insufficient data.
- Five reaches were split during the 2014 assessment so that TALU standards could be applied properly. In most cases, a channelized portion of the reach was separated from a natural-channel portion. Local monitoring efforts have increased in order to attain sufficient data from as many of those new assessment units as possible.

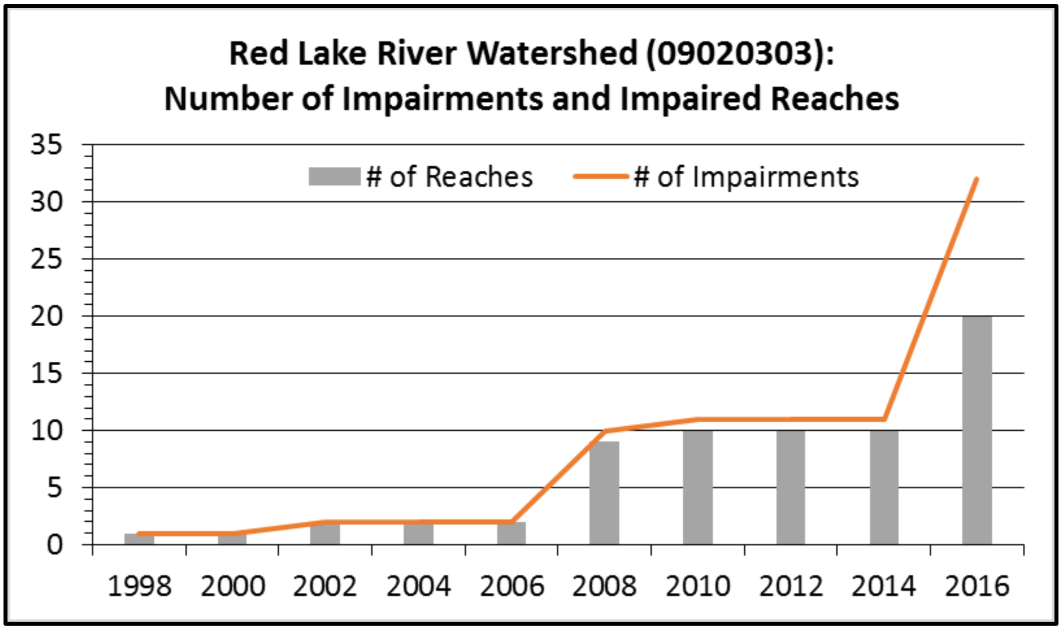


Figure 3-8. Changes in the number of impairments and impaired reaches over time.

**Total Suspended Solids:** The turbidity impairments that existed prior to the Draft 2016 List of Impaired Waters were based upon a 25 NTU standard. Several reaches with existing turbidity impairments are no longer considered to be impaired due to the less-restrictive 65 mg/l TSS standard. The following reaches have been removed from the List of Impaired Waters for Turbidity:

- Burnham Creek AUID 09020303-515
- Black River AUID 09020303-529
- Black River AUID 09020303-530

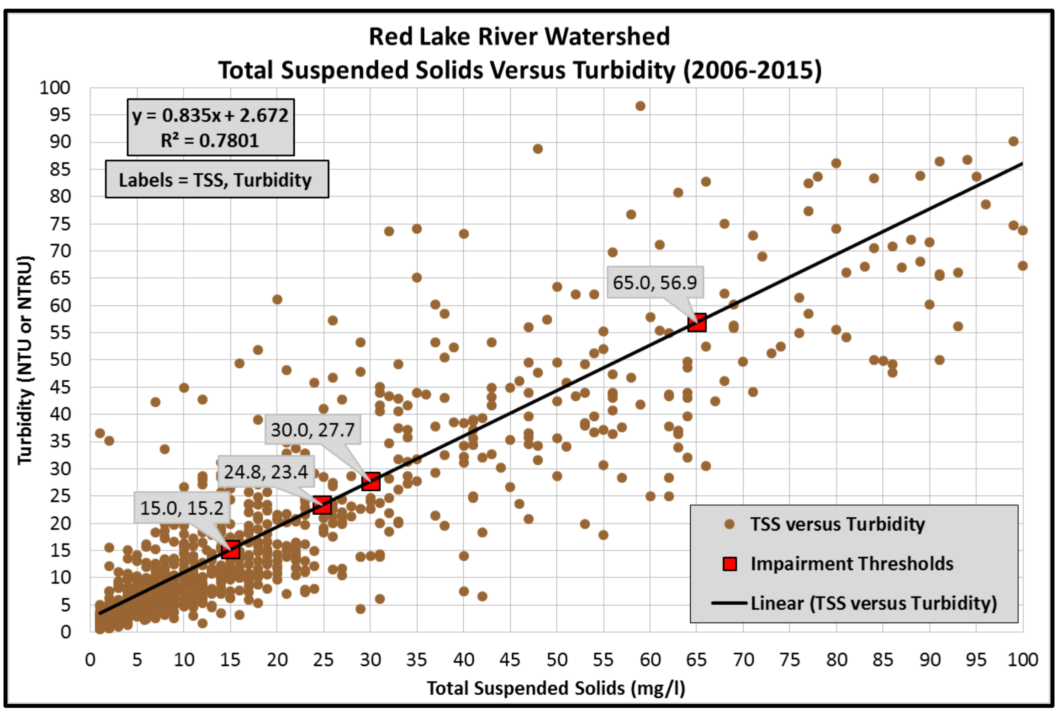


Figure 3-9. A comparison of TSS and turbidity values within the Red River (09020303) Watershed. The data source was all data collected in the years 2006 through 2015 that was stored in the EQuIS database in early 2016.

Prior to the MPCA's adoption of TSS water quality standards to replace the 25 NTU turbidity standard, there was concern about whether or not it is possible for any of the rivers in the lower areas of the Red River Valley ecoregion to meet the 25 NTU standard based on the natural geology and soil types. The new 65 mg/l TSS standard that will be applied to rivers in the Red River Valley allows a level of suspended sediment that is approximately twice as high as the amount allowed by the former turbidity standard. A comparison of TSS and turbidity readings (Figure 3-9) shows that similar numerical values for the two measurements represent similar levels of sediment. Despite the raised impairment threshold; however, restoring the lower reaches to the point at which they are meeting the standard will still be challenging. In 2005 through 2014 data, the exceedance rate of the 65 mg/L TSS standard in the Red Lake River at the Fisher monitoring site (S000-031) was 55.3%. The impairment is less severe within upstream reaches (Figure 3-10). The decreased exceedance rate in 09020303-503 versus the upstream reach of 09020303-501 is a product of sampling schedules rather than improved water quality conditions. A longitudinal "snapshot" of water quality during a runoff event (Figure 4-14) revealed that TSS concentration increased significantly between Fisher and East Grand Forks. Sampling in East Grand Forks (09020303-503) is conducted for long-term condition monitoring programs. Sampling in Fisher (09020303-501) has also included sampling for load monitoring programs that conduct intensified sampling during high flows. The Red Lake River upstream of Crookston (09020303-512) was listed as impaired by high turbidity. It has very little TSS data, but TSS samples are now being regularly collected by local monitoring programs at Station S000-042. It remains on the list of impaired waters because there is insufficient TSS data to prove that it is meeting standards, and both upstream and downstream AUIDs are impaired by high TSS.

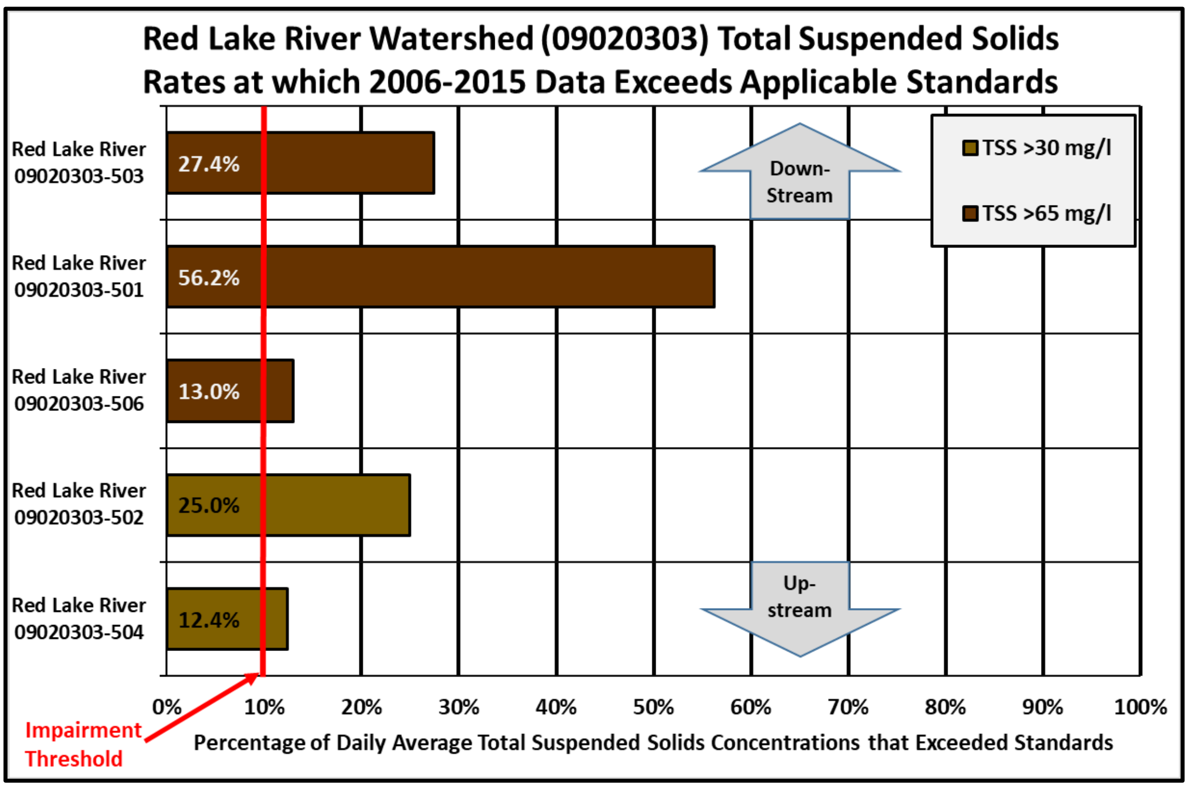


Figure 3-10. Rates at which the TSS standard is exceeded in impaired reaches of the Red Lake River.

**Dissolved Oxygen:** DO impairments have been found in Red Lake River tributaries where stagnant water is a common occurrence (Figure 3-11). Frequent low DO levels have been recorded in other reaches, but they were not listed as impaired because direct connections with zero-flow conditions (e.g. 09020303-541) were identified during the 2014 assessment. Upon further review of the assessment data and the physical setting for Heartsville Coulee (09020303-550) the DO impairment was recategorized as a Category 4C due to low/intermittent flow, stagnant conditions, and significant wetland influence.

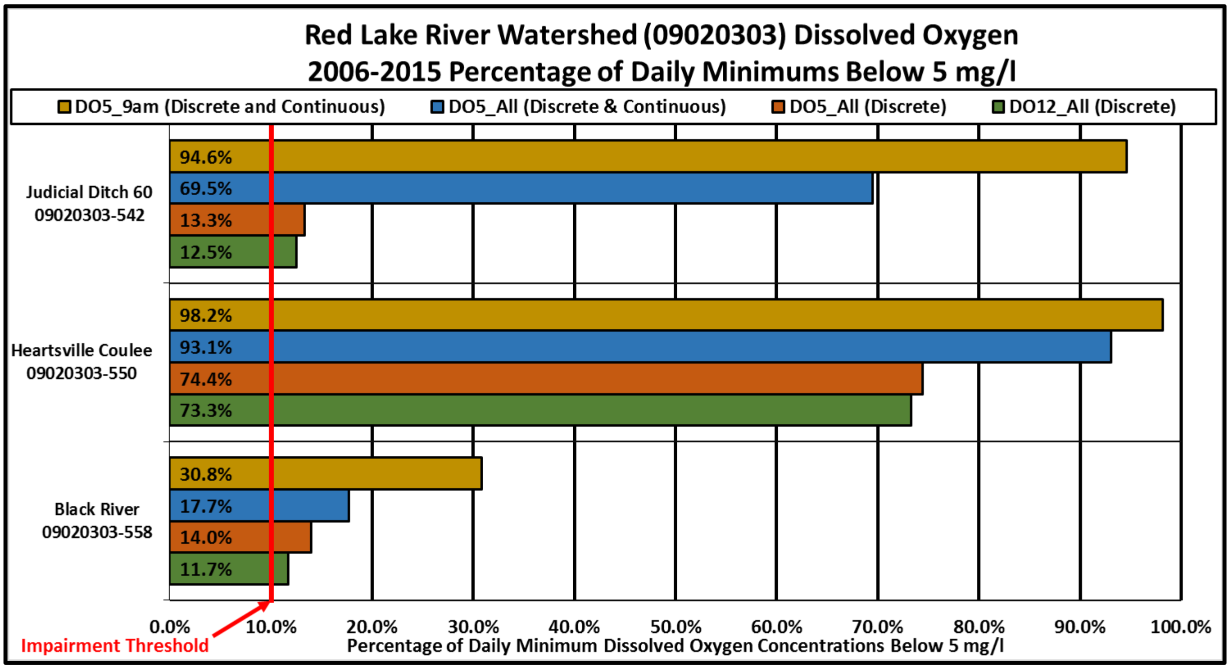


Figure 3-11. Relative severity of dissolved oxygen impairments, based on 2006-2015 data.

***E. coli* Bacteria:** Regular sampling for *E. coli* bacteria did not begin until 2005, when local monitoring program staff became aware of the MPCA's plans to transition away from fecal coliform to *E. coli* as the parameter that is used to assess the safety of aquatic recreation. Due to the requirement of a minimum of five samples per calendar month, most reaches had insufficient data for an assessment when the watershed was assessed in 2009. The watershed was most recently assessed in 2014. Several new *E. coli* impairments were identified during the 2014 assessment (Table 3-3).

Table 3-3. *E. coli*-impaired waters, severity of impairments, and seasonality of impairments

| 2006-2015 Monthly Geometric Mean *E. coli* Concentrations (MNP/100ml) and Exceedances in Impaired Reaches of the Red Lake River Watershed | | | | | | |
|---|---|---|---|---|---|---|
| **Stream Name** | **AUID** | **May** | **June** | **July** | **August** | **September** |
| Pennington CD96 | 09020303-505 | 46.8 | 110.6 | **264.1** | 61.0 | 99.7 |
| Kripple Creek | 09020303-525 | 94.8 | **245.3** | **136.4** | **437.9** | **169.6** |
| Little Black River | 09020303-527 | *12.8** | *31.0** | **194.9** | *62.5** | *161.6** |
| Black River | 09020303-529 | 66.7 | **246.8** | **150.2** | 42.0 | **137.4** |
| Gentilly River | 09020303-554 | 21.5 | **150.2** | **140.7** | **186.0** | 72.0 |
| Cyr Creek | 09020303-556 | 100.5 | **291.3** | **269.0** | 113.3 | **926.9** |
| Black River | 09020303-558 | 11.3 | 89.6 | **141.8** | 110.7 | 24.8 |
| *Italics* and * = Insufficient data for a formal assessment of this month. | | | | | | |
| Water quality standard for monthly geometric mean *E. coli* = 126 MPN/100ml. | | | | | | |

**Index of Biotic Integrity:** The first formal assessment of fish and macroinvertebrate communities in the Red Lake River Watershed by the MPCA was completed in 2014. Prior to the 2014 assessment, two reports with fish sampling results from the Red Lake River Watershed had been published by the DNR

(Red River Basin Stream Survey Report, Red Lake River Watershed, 2004) and the EPA (Development of Index of Biotic Integrity Expectations for the Lake Agassiz Plain Ecoregion, 1998). Sampling was conducted in 2012 by the MPCA in preparation for the assessment. That year was exceptionally dry and IBI scores suffered due to a lack of water and flow. IBI assessment results from sites throughout the watershed are shown in Figures 3-12 and 3-13.

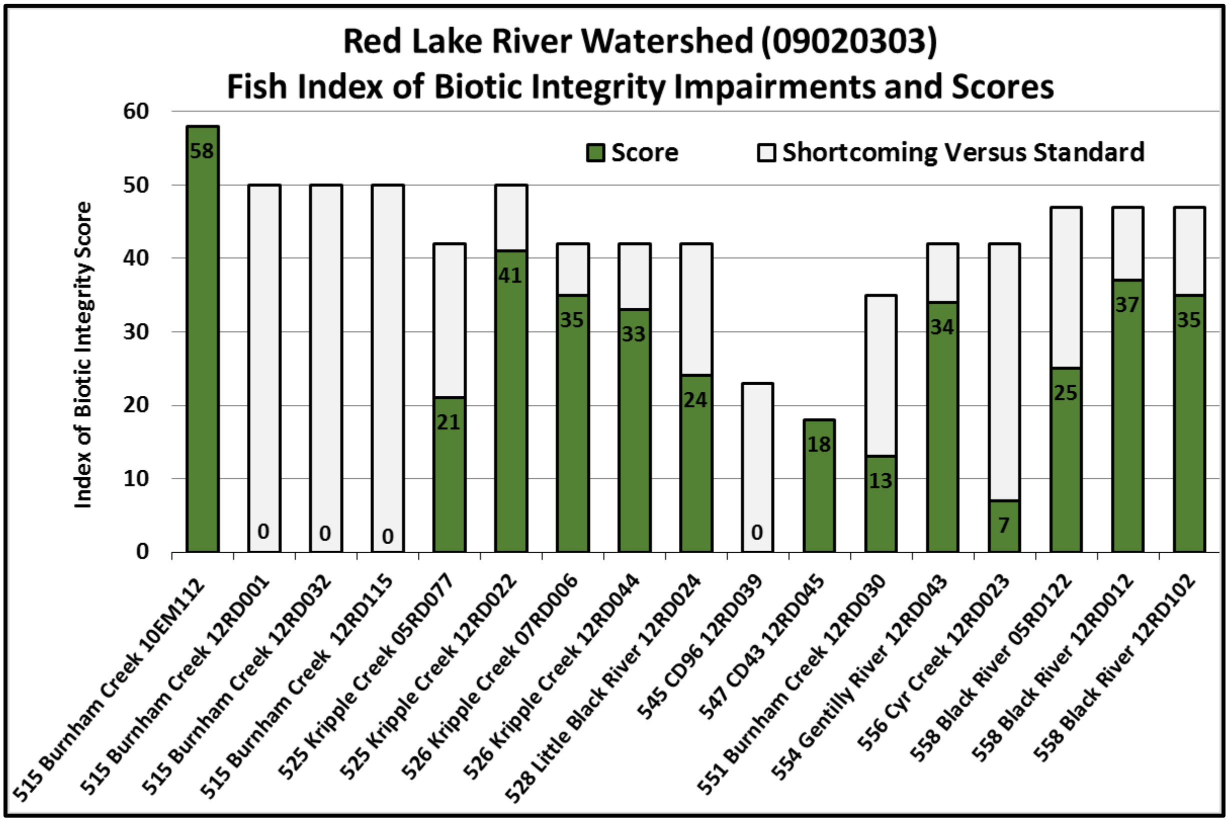


Figure 3-12. Fish IBI scores on impaired reaches and expectations of applied standards.

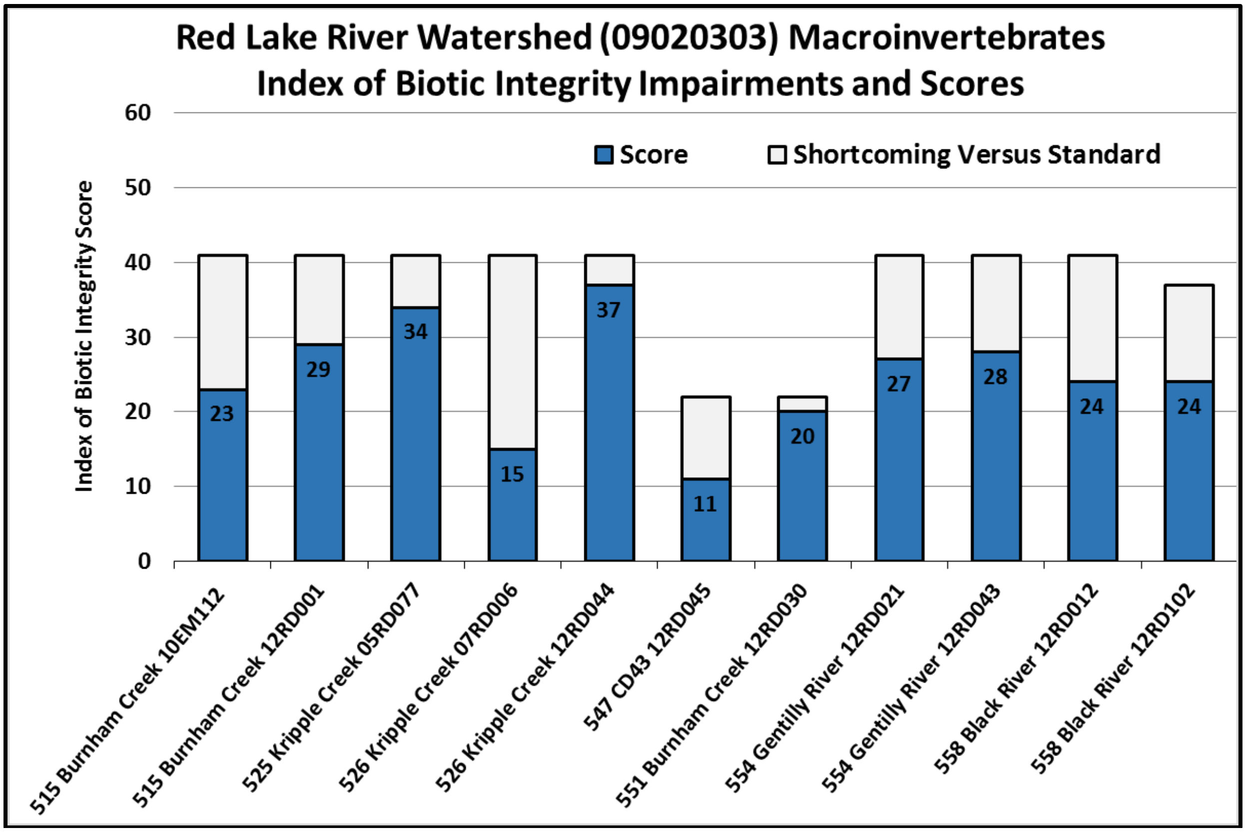


**Figure 3-13. Macroinvertebrate IBI scores on impaired reaches and expectations of applied standards.**

**Trend Analysis:** The Mann-Kendall test was used to identify statistical trends in TSS, DO, total phosphorus (TP), and *E. coli* at long-term monitoring sites along impaired reaches within the Red Lake River Watershed. Monitoring sites with at least 10 years of monitoring data were targeted for the analysis. The Mann-Kendall test is a non-parametric test for identifying trends in time series data. The data values were evaluated as an ordered time series. Each data value was compared to all subsequent data values. An Excel spreadsheet was created to calculate the Mann-Kendall statistic (S), the variance of S (VAR(S)), normalized test statistic (Z), and the probability associated with the normalized test statistic (f(z)) values for each period of time. In Tables 3-4 through 3-11, the trend was shown to be decreasing if the Z value was negative and computed probability was greater than 90%. The trend was considered to be increasing if the Z value was positive and the computed probability was greater than 90%. A series of data points that produced a probability of significance that was greater than 99% was shown as a strong trend (either direction). Analysis of additional sites (unimpaired reaches) can be found in the Red Lake River WRAPS.

**Table 3-4. Historical water quality trends in the Red Lake River in the city of East Grand Forks (09020303-503)**

| Historical Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Red Lake River in East Grand Forks** **S002-963, S000-013** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1953-2015 | 1953-2015 | 1958-2015 | 1985-2015 |
| Annual (All Months) | ↑+ (red) | ↑ | ↓+ | X |
| Summer (May - Sept.) | X | ↑+ | ↓+ | X |
| April | X | ↑+ | ↓ | X |
| May | X | ↑ | ↓+ | X |
| June | X | X | ↓ | X |
| July | X | ↑+ | ↓ | X |
| August | X | ↑+ | ↓+ | X |
| September | X | X | ↓ | X |
| October | X | ↑ | ↓+ | X |

X = No Trend
↑ = Upward Trend (Getting Better)
↓ = Downward Trend (Improvement)
↑+ (red) = Strong Upward Trend (Getting Significantly Worse)
↑+ = Strong Upward Trend (Getting Significantly Better)
↓+ = Strong Downward Trend (Getting Significantly Better)

**Table 3-5. Recent water quality trends in the Red Lake River in the City of East Grand Forks (09020303-503)**

| Recent Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Red Lake River in East Grand Forks** **S002-963, S000-013** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1992-2014 | 1992-2014 | 1992-2014 | 2000-2014 |
| Annual (All Months) | ↑ (red) | ↓ (red) | X | X |
| Summer (May - Sept.) | X | ↑ | X | X |
| April | X | X | X | X |
| May | X | X | X | X |
| June | X | X | X | X |
| July | X | ↑ | X | X |
| August | X | X | ↓ | X |
| September | X | ↑ | ↓ | X |
| October | ↓ | X | ↓ | X |

X = No Trend
↑ = Upward Trend (Getting Better)
↓ = Downward Trend (Improvement)
↑ (red) = Upward Trend (Getting Worse)
↓ (red) = Downward Trend (Getting Worse)
↑+ = Strong Upward Trend (Getting Significantly Better)
↓+ = Strong Downward Trend (Getting Significantly Better)

**Table 3-6. Water quality trends in the Red Lake River at Fisher (09020303-501)**

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Red Lake River at Fisher**<br>**S000-031** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1992-2014 | 1992-2014 | 1992-2014 | 2000-2013 |
| Annual (All Months) | ↑+ (red) | X | ↑ (red) | X |
| Summer (May - Sept.) | ↑ (red) | ↑ (green) | X | X |
| April | X | X | X | X |
| May | ↑ (red) | X | X | X |
| June | X | ↑ (green) | ↓ (green) | ↓ (green) |
| July | X | ↑ (green) | X | X |
| August | X | X | ↓ (green) | X |
| September | X | ↑ (green) | X | X |
| October | X | X | ↓ (green) | X |
| X = No Trend | | | | |
| ↑ (green) = Upward Trend (Getting Better) | | | | |
| ↓ (green) = Downward Trend (Improvement) | | | | |
| ↑ (red) = Upward Trend (Getting Worse) | | | | |
| ↓ (red) = Downward Trend (Getting Worse) | | | | |
| ↑+ (red) = Strong Upward Trend (Getting Significantly Worse) | | | | |

**Table 3-7. Water Quality trends in the Red Lake River at Crookston (09020303-506)**

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Red Lake River**<br>**Crookston**<br>**Site S002-080/05079000** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1994-2014 | 1992-2014 | 1992-2014 | 2005-2014 |
| Annual Average | X | X | X | X |
| April | ↓ (green) | X | ↓ (green) | X |
| May | X | ↑ (green) | X | X |
| June | X | X | X | ↑ (red) |
| July | X | X | X | ↑ (red) |
| August | X | X | X | X |
| September | X | ↑+ (green) | X | X |
| October | X | X | ↓ (green) | X |
| November - March | ↑ (red) | X | X | X |
| X = No Trend | | | | |
| ↑ (green) = Upward Trend (Getting Better) | | | | |
| ↓ (green) = Downward Trend (Improvement) | | | | |
| ↑+ (green) = Strong Upward Trend (Getting Significantly Better) | | | | |
| ↑ (red) = Upward Trend (Getting Worse) | | | | |

Table 3-8. Water quality trends in the Red Lake River at CSAH 3 near Huot (09020303-502)

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Red Lake River at Huot (CSAH 3): Sites S002-976 and S003-173** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1998-2015 | 1998-2015 | 1998-2015 | 2005-2015 |
| All Months | X | ↑ (green) | X | ↑ (red) |
| Summer (May - Sept.) | X | ↑+ (green) | X | ↑ (red) |
| April | X | X | X | X |
| May | ↑ (red) | X | ↑ (red) | ↑ (red) |
| June | X | ↑ (green) | X | X |
| July | ↑ (red) | ↑+ (green) | ↓ (green) | X |
| August | X | ↑ (green) | X | X |
| September | X | ↑ (green) | X | X |
| October | ↓ (green) | ↑ (green) | X | X |
| X = No Trend | | | | |
| ↑ (red) = Upward Trend (Getting Worse) | | | | |
| ↑ (green) = Upward Trend (Getting Better) | | | | |
| ↓ (green) = Downward Trend (Improvement) | | | | |
| ↑+ (green) = Strong Upward Trend (Getting Significantly Worse) | | | | |

Table 3-9. Water quality trends for the downstream end of the Burnham Creek Watershed (09020303-515)

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **(Lower) Burnham Creek At 270th Ave SW, 320th Ave SW, & 270th St. SW Site S002-972, S007-058, S002-081** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1992-2014 | 1992-2014 | 1992-2014 | 2005-2014 |
| Annual (All Months) | X | X | X | X |
| Summer (May - Sept.) | X | X | X | X |
| April | ↓ (green) | X | X | X |
| May | ↑ (red) | X | X | X |
| June | X | X | X | X |
| July | ↓ (green) | X | X | ↑ (red) |
| August | X | X | X | ↓ (green) |
| September | X | X | ↓ (green) | ↓ (green) |
| October | ↓ (green) | X | X | X |
| X = No Trend | | | | |
| ↑ (red) = Upward Trend (Getting Worse) | | | | |
| ↓ (green) = Downward Trend (Improvement) | | | | |

**Table 3-10. Water quality trends in the Gentilly River at CSAH 11 (09020303-554)**

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Gentilly River at CSAH 11**<br>**S004-058** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 2005-2014 | 2005-2014 | 2005-2014 | 2005-2014 |
| Annual (All Months) | X | ↑ (green) | X | X |
| Summer (May - Sept.) | X | X | ↑ (red) | ↑ (red) |
| April | X | X | X | X |
| May | X | X | ↑ (red) | X |
| June | X | X | ↑ (red) | X |
| July | X | X | X | X |
| August | X | X | ↑ (red) | X |
| September | X | ↓ (red) | X | X |
| October | X | X | X | X |

X = No Trend

↑ (green) = Upward Trend (Getting Better)

↓ (green) = Downward Trend (Improvement)

↑ (red) = Upward Trend (Getting Worse)

↓ (red) = Downward Trend (Getting Worse)

**Table 3-11. Water quality trends in the Black River at CSAH 18 (09020303-529)**

| Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis | | | | |
|---|---|---|---|---|
| **Black River**<br>**At CSAH 18**<br>**Site S002-132** | **Total Suspended Solids** | **Dissolved Oxygen** | **Total Phosphorus** | **E. coli** |
| Years | 1992-2014 | 1992-2014 | 1992-2014 | 2005-2014 |
| Open Water (Apr. - Oct.) | X | X | ↑ (red) | ↑+ (red) |
| April | X | X | X | X |
| May | X | X | X | X |
| June | X | ↑ (green) | ↑ (red) | ↑+ (red) |
| July | X | X | X | ↑ (red) |
| August | X | X | X | X |
| September | X | X | X | X |
| October | X | ↑ (green) | X | X |
| November - March | X | X | X | X |

X = No Trend

↑ (green) = Upward Trend (Getting Better)

↑+ (red) = Strong Upward Trend (Getting Significantly Worse)

↑ (red) = Upward Trend (Getting Worse)

# 4. Pollutant Source Summary

The RLWD, MPCA, and project partners were able to collect a large amount of data and other information about the extent of water quality problems, sources of pollutants, and stressors of aquatic life during the Red Lake River WRAPS project. Intensive sampling, longitudinal sampling, deployment of DO loggers, windshield surveys, geomorphic assessment, stressor identification (Stressor ID), water quality models, and stakeholder input have all contributed to the current knowledge of pollutant sources and stressors in the watershed. This section summarizes the large amount of information that has been gathered about sources of sediment, sources of *E. coli* bacteria, and stressors of aquatic life.

## 4.1 Total Suspended Solids

TSS impairments within the Red Lake River Watershed occur within a series of reaches along the Red Lake River that begin at the confluence with Pennington County Ditch 96 and end at the confluence with the Red River of the North. According to the figures generated by the 2017 Red Lake River Hydrologic Simulation Program-FORTRAN (HSPF) model (Figures 4-11 and 4-12); in-stream erosion contributes the majority (54%) of the sediment. The model also estimated that runoff from cultivated land is the second most significant source (25%) of sediment that is entering the Red Lake River.

### 4.1.1 Permitted

Developed land covers a relatively small percentage (5.2%) of the Red Lake River Watershed, but contributes to excess TSS in the Red Lake River. High turbidity, high concentrations of TSS, and high concentrations of other pollutants have been recorded in stormwater runoff and wastewater discharge. Construction stormwater, industrial stormwater, some municipal stormwater, and WWTF are regulated by the MPCA permitting process. Turbidity monitoring was conducted for a stormwater study in the city of Crookston and very high turbidity levels were found in stormwater discharge from Crookston's industrial park. Though some water quality monitoring and sampling has been conducted on stormwater runoff water quality, it has been limited and did not measure the quantity of runoff. Because current loading and permitted loading numbers are not available, the significance of construction and industrial stormwater will need to be estimated based on the amount of activity in the watershed.

**Construction and Industrial Stormwater**

Turbidity and TSS impairments along the Red Lake River have been identified at monitoring sites in Red Lake County and Polk County. According to publicly available information, the annual percentage of land area under construction has been 0.021% in Polk County and .005% in Red Lake County.

According to publicly available facility information, there are somewhere between 375 and 394.34 acres of permitted industrial activity within the 909,024-acre Red Lake River Watershed. That acreage represents 0.04% of the watershed. The facility information for one 19.34-acre parcel is incomplete and does not list the acres of industrial activity, but the percentage of the watershed covered by industrial activity rounds to 0.04% with or without that parcel.

The combined area covered by permitted construction and industrial activity is between 0.045% and 0.061% of the Red Lake River Watershed.

**Municipal Separate Storm Sewer Systems**

A municipal separate storm sewer system (MS4) is a conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, etc.). It is owned or operated by a public entity (which can include cities, townships, counties, military bases, hospitals, prison complexes, highway departments, universities, etc.) that has jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes. It is designed or used for collecting or conveying stormwater and discharges to waters of the United States. It is not a combined sewer (for both stormwater and wastewater). It also is not part of a publicly owned treatment works.

The only current MS4 in the Red Lake River Watershed is located at the downstream end of the watershed along an impaired reach (09020303-503), but a long distance downstream of where the TSS impairments first begin. The City of East Grand Forks (Permit #MS400088) is designated as a small MS4, and is therefore required to obtain coverage under an MS4 permit. A summary of the stormwater management plan for the City of East Grand Forks can be found in Section 8.1.3. Mud from the hauling of sugar beets to the American Crystal Sugar processing plant on the east side of East Grand Forks can increase the amount of sediment that enters the stormwater system. City staff demonstrated the problem to RLWD staff in May of 2009 by running a lift station near the processing plant that discharged dark-colored water with a TSS concentration of 720 mg/l.

The populations of Crookston and Thief River Falls are greater than 5,000 people. When the EPA's 303(d) list of impaired waters is released every two years, MS4s with a population greater than 5,000 based on the latest U.S. Census and that have been assigned a WLA in an approved TMDL are eligible for designation. The list of MS4s that should be given WLAs if found to be causing or contributing to a water quality impairment includes Crookston and Thief River Falls. Stormwater sampling within both cities has shown that turbidity levels and TSS concentrations in runoff are often higher than water quality standards.

The city of Crookston is located along a reach of the river where site-specific TSS concentrations and assessment statistics increase from upstream to downstream. The reach of the river that flows through Crookston is impaired by high TSS. Stormwater contributions have been studied within the city of Crookston. Some of the general findings of the study are applicable to other cities along the Red Lake River. The Crookston Stormwater Management Study identified areas of the city that were contributing to the turbidity impairment in the Red Lake River. Stormwater drainage from the Crookston industrial park had consistently high turbidity levels, up to 447 NTRU. Another discovery that was made by the study was that the city's snow dumping site was located next to the river. In recent years, ice storms have preceded winter snowfall events. The sand and salt that is spread on roads and icy parking lots is plowed into piles along with snow throughout the winter. Multiple situations have been identified in which cities or businesses have piled snow next to a river or ditch. Figure 4-45 shows how a melting mixture of sand and snow along a parking lot in Thief River Falls is directly polluting a ditch that flows into the Red Lake River.

Stormwater from the city of Thief River Falls flows into the Red Lake River. The city has a population greater than 5,000 people and has been identified by the MPCA as a community that could potentially be designated as an MS4. However, Red Lake River is not impaired as it flows through the city of Thief River Falls, and sampling data shows that the city's reservoir has the net effect of removing sediment from the river. The 90$^{th}$ percentile TSS concentration and assessment statistics are better (lower concentration and lower rate of exceedance) within the reservoir and where the river begins to flow out of the city than they are in the Red Lake River or Thief River upstream of the city. Sampling of the Red Lake River near the southern, downstream side of Thief River Falls (S006-225, Greenwood Street Bridge) has yielded no exceedances of the 30 mg/L standard in any of the nine years (2010 through 2018) that location has been sampled. The river becomes impaired further downstream, somewhere between St. Hilaire and Red Lake Falls (along AUID 504). There have been exceedances of the TSS standard upstream of Thief River Falls in the TSS-impaired Thief River and, to a lesser extent, within the Red Lake River upstream of the city. The city's stormwater flows into the Thief River within the influence of the reservoir and downstream of sampling stations that exceeded the TSS standard. Even though there is a net improvement in water quality (regarding TSS concentrations) as water flows through Thief River Falls, there still are notable sources of TSS and other pollutants that have been identified and should be addressed through voluntary practices and cooperation among local entities.

A plume of sediment entering the Red Lake River from Pennington County Ditch 70 was traced upstream to the Digi-Key Electronics parking lot in the spring of 2016 (Figure 4-1). The Pennington County SWCD, with the assistance of a consultant, completed a stormwater study for the City of Thief River Falls. Sampling of accessible stormwater outlets and modeling of stormwater runoff has been completed for the City of Thief River Falls. The Pennington SWCD, with assistance from Houston Engineering, Inc., completed the *Thief River Falls Water Quality Study* in 2017. The study identified optimal locations throughout the city where stormwater BMPs could be targeted to deliver measurable water quality benefits.

**Figure 4-1. Spring parking lot runoff from melting sediment-laden snow piles along Pennington County Ditch 70 in the City of Thief River Falls.**

## Wastewater Treatment Facilities

Six WWTF discharge into the Red Lake River (Table 4-1 and Figure 4-2). Compared to nonpoint sources of sediment like instream erosion and cultivated cropland, WWTF discharge is not a significant contributor from an annual load perspective. Between 2006 and 2015, WWTFs annually contributed an average total of 173.7 tons of sediment to the Red Lake River, combined. That amount is less than one tenth of a percent of the current total estimated annual load in the Red Lake River at Fisher. Discharge records from the St. Hilaire WWTF reveal no occasions in which that facility has exceeded 30 mg/l. Although it is permitted to do so, the Crookston WWTF has not discharged to the Red Lake River since

1997 due to the use of rapid infiltration basins. The permitted TSS concentrations for the facilities along the Red Lake River are less than or equal to the 65 mg/l water quality standard that is applied to the Red Lake River in AUIDs 501, 503, 506, and 512.

**Table 4-1. Red Lake River TMDL establishment sites and respective upstream WWTFs.**

| Red Lake River Wastewater Treatment Facilities and Reaches Impaired | | | Wastewater Treatment Facility Discharge Monitoring Stations | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HUC 10 | Affected Reaches | | Thief River Falls MN0021431 | St. Hilaire MN0024741 | 7 Clans Casino MN0063452 | Red Lake Falls MNG580161 | American Crystal Sugar MN0001929 | Crookston MN0021423 | Fisher MNG580170 |
| 0902030303 | 09020303-504 | CD96 to Clearwater River | X | X | X | | | | |
| 0902030305 | 09020303-502 | Black River to Gentilly River | X | X | X | X | | | |
| 0902030305 | 09020303-512 | Gentilly River to CD99 | X | X | X | X | | | |
| 0902030305 | 09020303-506 | CD99 to Burnham Creek | X | X | X | X | | | |
| 0902030307 | 09020303-501 | Burnham Creek to Heartsville Coulee | X | X | X | X | X | X | X |
| 0902030307 | 09020303-503 | Heartsville Coulee to Red River | X | X | X | X | X | X | X |

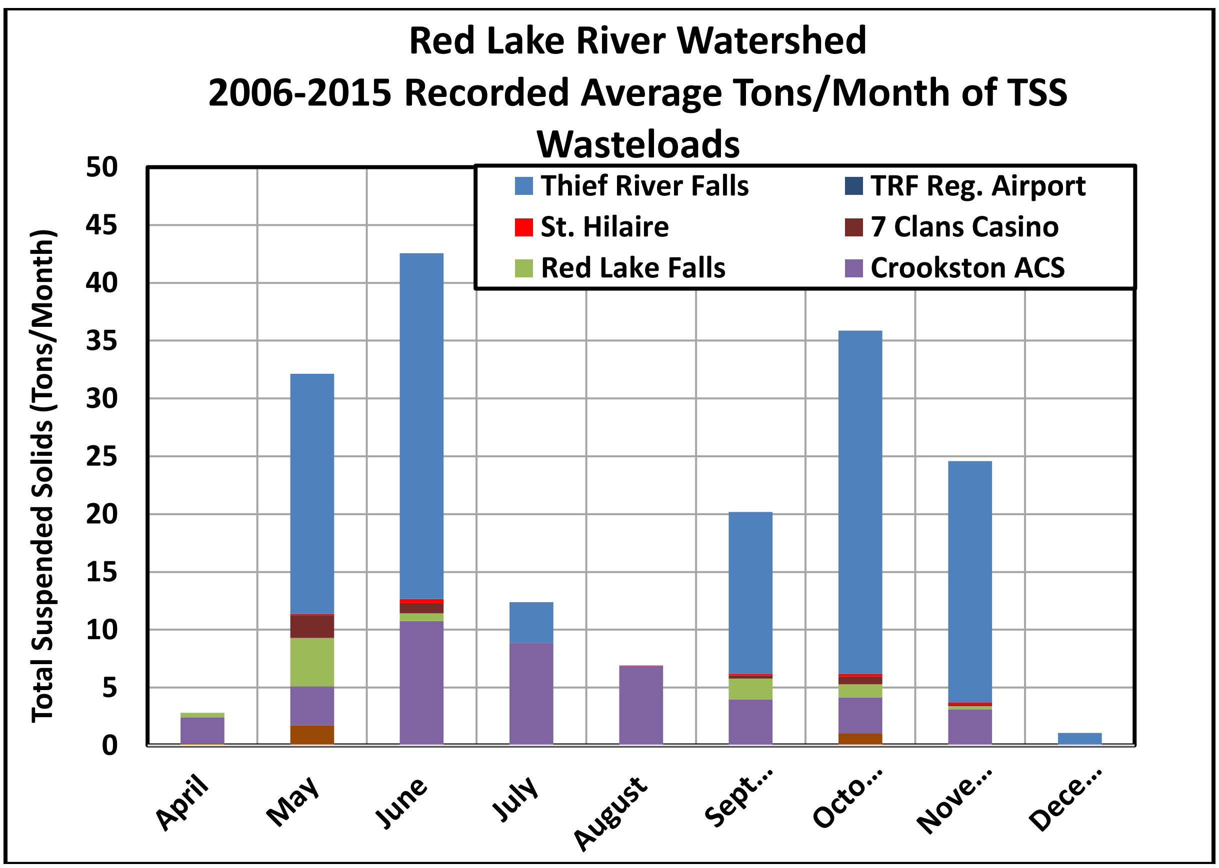


**Figure 4-2. Relative wastewater contributions from cities along the Red Lake River.**

It is still possible for the Red Lake River to be affected by wastewater contributions in some situations. During very low flows, WLAs can account for a large percentage of the total load at the Fisher gage on the Red Lake River. Discharges that occur when flows at the USGS 05080000 gage are lower than 200 cfs could have a significant effect upon water quality in the river. However, the Thief River Falls, St. Hilaire, Red Lake Falls and Fisher WWTFs are all stabilization pond systems and are only permitted to discharge (to non-ice-covered waters) from March 1 to June 30, and September 1 to December 31, when flows are typically higher to allow for dilution. Stabilization pond facilities have secondary treatment limits of a 45 mg/l calendar month average and 65 mg/l calendar week average. Thief River Falls, St. Hilaire, or Red Lake Falls WWTFs discharges with a TSS concentration greater than 30 mg/l could contribute to exceedances of the TSS standard in the portions of the Red Lake River (AUIDs 504 and 502) that are required to meet a 30 mg/l TSS standard.

**Drainage Permitting**

Until recently, no permits were required for private field drainage and subsurface tile drainage projects within the RLWD. The RLWD is now requiring permits for the installation of subsurface tile drainage. This change in management was prompted by multiple concerns about tile drainage management and installation.

- All subsurface tile drainage systems must protect from erosion and include RLWD approved erosion control measures.
- All subsurface tile outlets, including lift station pumps, must be located out of a legal drainage system and governmental roadway right-of-way unless they are approved by RLWD. They must be visibly marked.
- It is recommended that after harvest, tile outlet controls, including lift station pumps, be opened or turned on to remove water from the system unless downstream culverts are freezing.
- Obtaining a permit from the RLWD does not relieve the applicant from the responsibility of obtaining any other additional authorization or permits required by law. (Ex: NRCS, SWCD, Township, County, State, etc.)
- Upon completion of the project, “As Built” plans must be provided to the RLWD.
- Consideration must be made for turning off pumps for short periods of time during the summer so maintenance can be performed on public, legal and private drainage-ways, such as road ditches or private natural field drains.

If erosion at the outlets of subsurface tile drainage systems can be controlled, these drainage systems will not be a significant source of TSS. Data collection within the RLWD has shown that TSS concentrations in tile discharge are minimal. Surface inlets are rarely used in this part of the state. Therefore, the pollutants discharged in significant concentrations from tile drainage in the Red Lake River Watershed will be dissolved (e.g. nitrates and sulfates).

### 4.1.2 Non-permitted

Figure 4-3. Photos of eroding bluffs along the Red Lake River near Red Lake Falls.

Non-permitted sources of pollutants are nonpoint sources of pollution that are not controlled by a permitting authority. LDCs show that most of the exceedances of the TSS water quality standard coincide with high and very high flows. This, along with the HSPF modeling results, indicate that nonpoint sources of sediment are the primary source of excess sediment.

Multiple nonpoint sources are contributing to excess TSS concentrations in the Red Lake River. Overland erosion, streambank erosion (Figure 4-3), wind erosion, and stormwater runoff all contribute to TSS concentrations and loads. Each of these categories of sources have been investigated and documented to some extent. Water quality models have been developed as a means of identifying the areas of the watershed that are contributing the most sediment, particularly from overland erosion. The results of a fluvial geomorphology study can help guide erosion prevention efforts along the river channels. Longitudinal sampling has provided insight into the locations of sediment sources.

**Stream and Ditch Bank Erosion**

Eroding streambanks along the Red Lake River have been documented with georeferenced photos. An erosion site inventory identified and ranked 63 notable erosion problems that were identified during the 2007 Red Lake River Rendezvous canoe tour. Eroding river and stream banks were documented during the fluvial geomorphology study. Inventoried reaches along or near impaired AUIDs include:

- The entirety of the Red Lake River AUIDs 09020303-501 and 09020303-503 between Burnham Creek and the Red River of the North
- A portion of Red Lake River AUID 09020303-506 from a point halfway between Crookston and Fisher (47.784183, -96.726945, in alignment with 310th Ave SW)
- A portion of the Red Lake River AUID 09020303-512 from CSAH 11 to the former location of the Otter Tail Power Dam (47.773091, -96.527230)
- The Red Lake River between Hwy 32 and Old Crossing Treaty Park (AUIDs 09020303-504, 09020303-510, 09020303-511, and 09020303-502)
- 6.3 miles of the Red Lake River downstream of the southern edge of Thief River Falls (48.092769/-96.186071 to 48.040046/-96.210036)

- Red Lake River Forsberg Park (185th Ave NE) to Finsbury Park (in Thief River Falls)
- Red Lake River from approximately 240th Ave to the Smiley (CSAH 7) Bridge
- Red Lake River downstream of Highlanding (CSAH 24 crossing) to approximately 280th Ave NE
- Red Lake River from the River Valley (CSAH 3) access to the Highlanding (CSAH 219) access
- Black River, downstream of CSAH 18.

The importance of deep-rooted vegetation for the prevention of mass wasting and slumping riverbanks becomes evident along the lower reaches of the Red Lake River. The flows of the Red Lake River have great power, so even well vegetated riverbanks are not immune to erosion. However, where there is good root density, the banks are resistant to the scouring power of the river. Where deep-rooted and woody vegetation has been removed (fields, lawns, etc.), the banks are experiencing mass wasting (sloughing).

Channel incision creates situations where floodwaters do not have immediate access to a floodplain. This creates instability because high velocity floodwaters are confined to the stream channel and not allowed to dissipate energy over a larger area. The river will try to create a new equilibrium by possibly downcutting, then eventually widening to create a new floodplain

The outlets of multiple public drainage systems along the Red Lake River are also unstable and contributing to the sediment loads in the Red Lake River. Headcutting, gully formation, instability, and mass wasting are problems along the outlets of drainage systems that discharge to natural channels and coulees along the Red Lake River. Eroding outlets have already been identified in some counties within the Red Lake River Watershed. Funding has been acquired to repair some of them. The Red Lake River TMDL, WRAPS, and 1W1P reports identify these outlets as an issue and recommend prioritization and stabilization of these erosion problems.

One example of an unstable ditch outlet is the outlet of Judicial Ditch 60 (AUID 09020303-542), downstream of CSAH 11. There has been major headcutting and failure of slopes downstream of the CSAH 11 crossing. It is a potential grade stabilization project. The MPCA and RLWD staff visited with the landowner and learned that he would be in favor of a project there. Another notable, rapidly eroding portion of a ditch system is the lower 1.25 miles of Polk County Ditch 1, between Highway 2 and the Red Lake River. Velocities are very high along this reach during runoff events. New, massive slumps have been observed in recent years. A new home has recently been built dangerously close to the unstable ditch bank.

**Upland Sediment Sources**

Overland erosion has been documented in many forms. Gully erosion is occurring within cultivated fields. Gully erosion of private field ditch outlets has been documented in the watershed. Side water inlets and other BMPS need to be implemented to prevent future gully formation. Stream power index layers have been created to identify all flow paths that are highly susceptible to erosion. During windshield surveys, individual erosion sites like the one in Figure 4-4 were documented with georeferenced photographs. Figure 3-5 land use map shows the prevalence of agricultural land in the watershed – land that is susceptible to overland erosion.

Figure 4-4. Large gully in the Burnham Creek Watershed, east of the 340th St. SW crossing.

**Excess Sediment from Tributaries**

Excess TSS in tributary streams and ditches can affect the ability of the Red Lake River to meet TSS standards. There are portions of the Red Lake River that are required to meet the 30 mg/L TSS standard, but receive water from tributaries that exceed the 30 mg/L standard. The Thief and Clearwater Rivers are impaired by excess TSS along AUIDs that flow into the Red Lake River. There are several smaller Red Lake River tributaries that are assigned to the 65 mg/L standard, but exceed the 30 mg/L standard. The Black River (at S002-132) and Cyr Creek (at S004-818) are tributaries that meet the 65 mg/L TSS standard but exceed the 30 mg/L TSS standard at monitoring sites near those streams' pour-points in 2006 through 2015 data. Those two streams enter the Red Lake River upstream of AUID 09020303-502, which needs to meet the 30 mg/L TSS standard. Burnham Creek exceeds the 30 mg/L standard while meeting the 65 mg/L standard at sites near its pour-point. The closest TMDL establishment site downstream of Burnham Creek; however, is the Fisher Bridge (S000-031) where the TMDL is based upon the 65 mg/L standard.

**Wind Erosion**

Wind erosion is a notable source of sediment in the Red Lake River Watershed, particularly in the spring and early summer. Sediment is deposited in ditches throughout the winter as wind erodes soil from plowed fields. Fields with buffers and/or crop stubble appeared to have less wind erosion and less sediment deposited within adjoining ditches. Wind erosion has also been a problem after spring runoff, before crops have begun growing. Tree rows and windbreaks are dying and being removed (Figure 4-5). This has the effect of increasing the amount of fetch on fields and leading to exacerbated wind erosion. According to Marshall County SWCD staff, small root systems, chemicals, fungus issues, and emerald ash borers are contributing to this problem. Some species of trees are reaching the end of their life cycles and are being removed (Chinese elms). Hybrid poplar trees only last about 20 years because they grow too fast and then break. Some re-establishment is occurring, but not much.

Dry weather, rolled fields, and high winds combined to cause some extreme wind erosion in the area. Dust storms occurred in multiple locations. The field in Figure 4-6 had extreme wind erosion and deposition within the road ditch. The field had recently been rolled. Soybean fields are rolled to prevent damage to harvesting equipment. Rolling pushes rocks into the ground and breaks up clumps of dirt that might damage equipment that is set close to the ground. According to an article from the University of Minnesota Extension Service (Dejong-Hughes 2016), this practice poses risks, including potential plant injury, soil sealing, added expense, and erosion.

**Figure 4-5. Photo of a field windbreak that is in the process of being removed.**

**Figure 4-6. April 2015 wind erosion from a field near St. Hilaire.**

## Terrain Analysis and Stream Power Index (SPI)

RLWD staff used SPI analysis of the Red Lake River Watershed to identify points on the landscape where flow accumulation and erosive power create a risk of gully erosion. An intensive culvert inventory was used to hydrocorrect LiDAR data prior to the analysis. The files are available on the RLWD website: http://www.redlakewatershed.org/downloads.html. Figures 4-7, 4-8, and 4-9 show the analysis results from the direct drainage areas of impaired reaches of the Red Lake River. Additional subwatershed maps can be found in the Red Lake River WRAPS document.

Channels and flow paths highlighted in red are more susceptible to erosion than the other 98% of flow paths in the watershed. Some of the highlighted flow paths may already be adequately protected and not actively eroding. It is important to make sure that those areas remain protected in the future. Many of the outlets of drainage systems entering the Red Lake River are highlighted in the SPI maps.

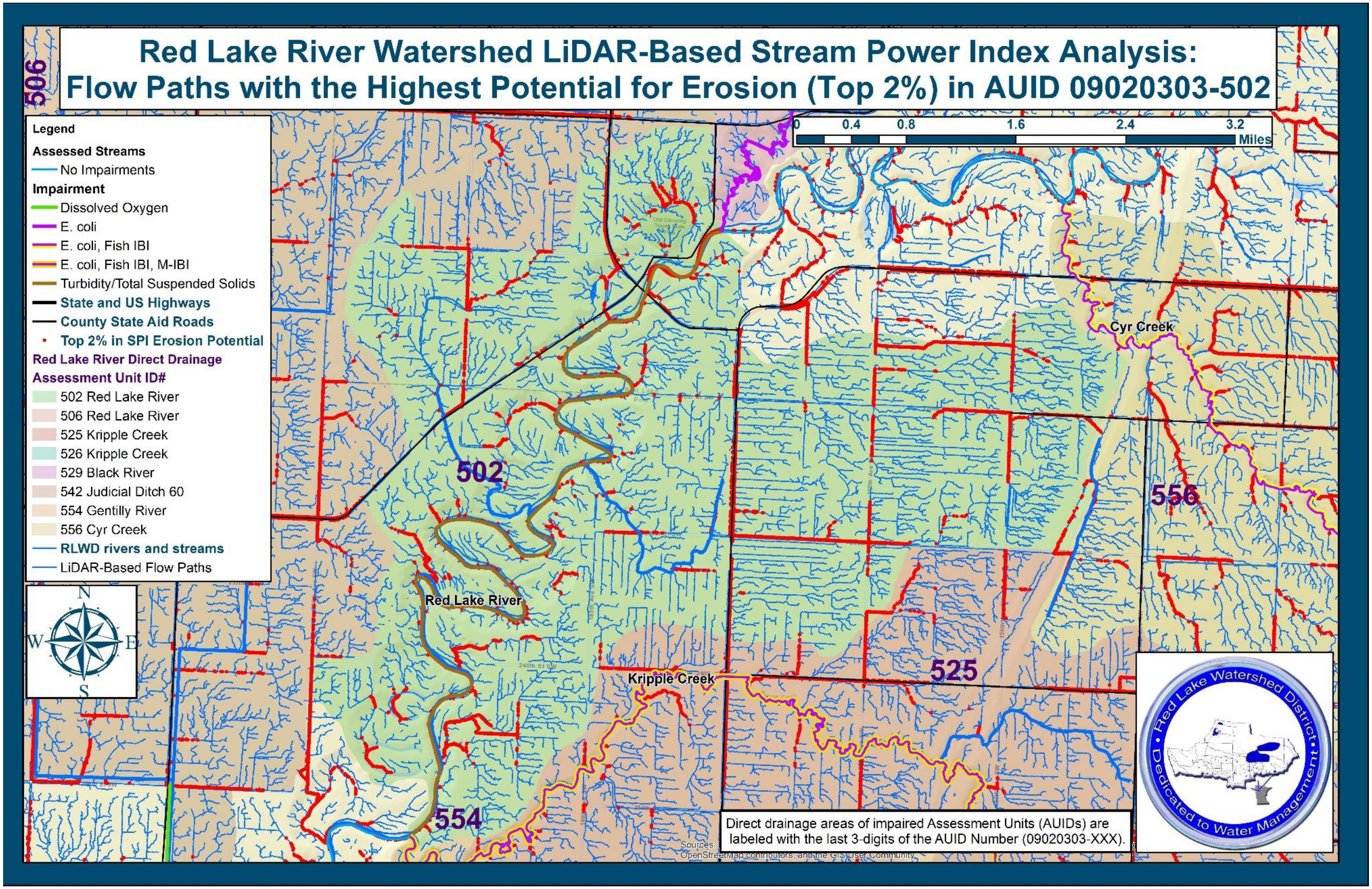


**Figure 4-7. Red Lake River Watershed Stream Power Index Analysis for the direct drainage area of AUID 09020303-502.**

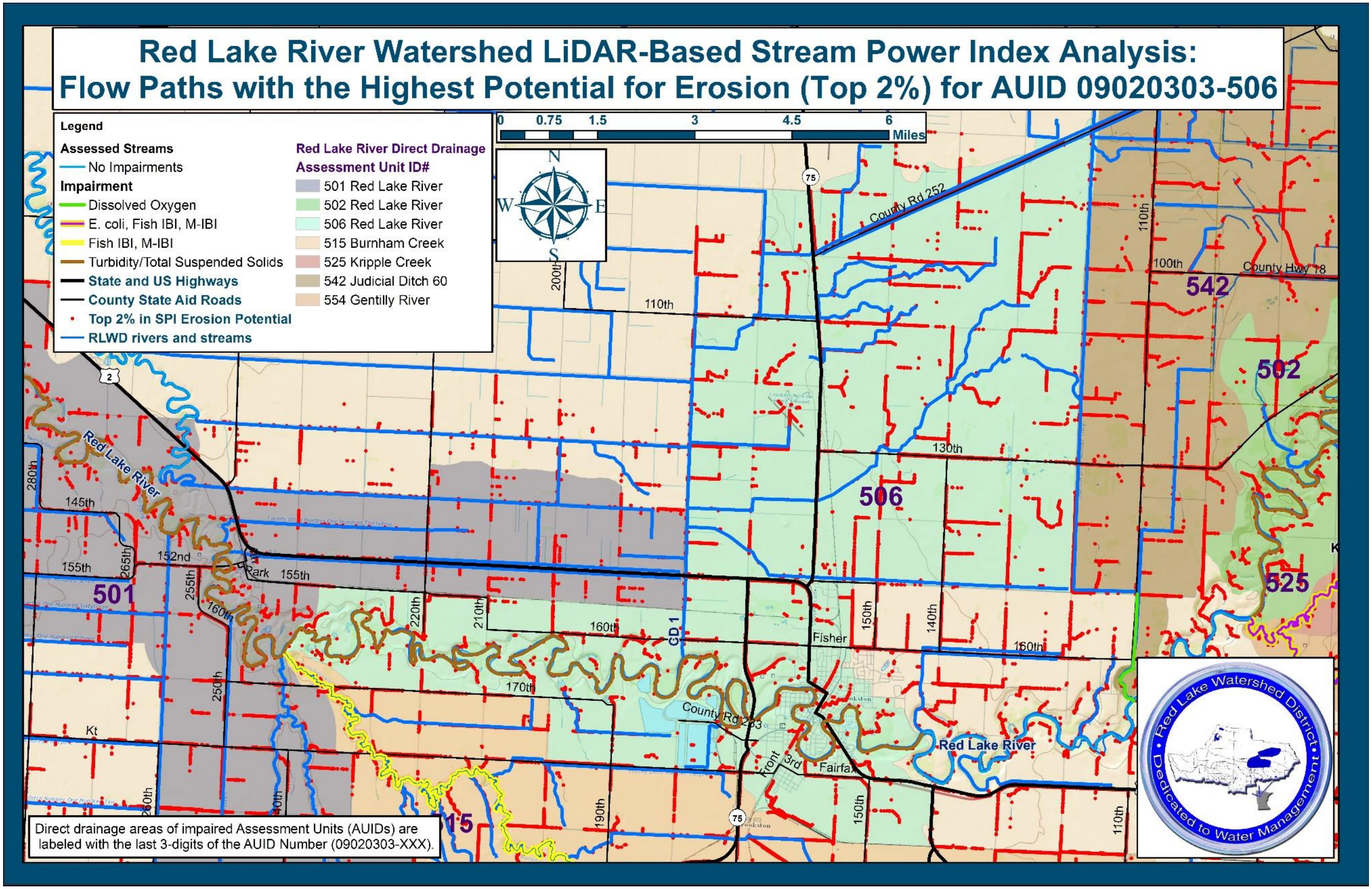


Figure 4-8. Red Lake River Watershed SPI Analysis: direct drainage area of AUID 09020303-506 and eastern 09020303-501.

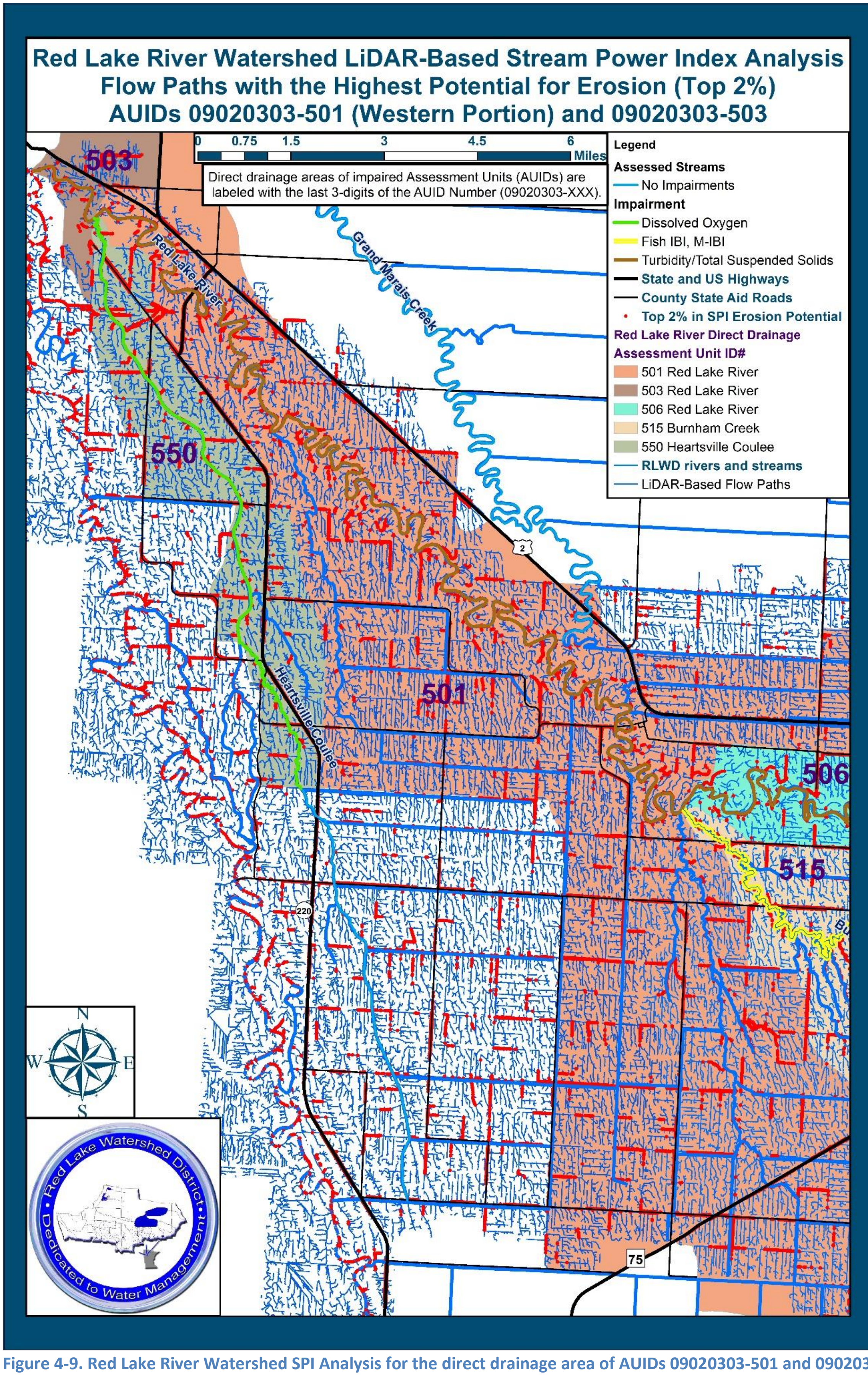


Figure 4-9. Red Lake River Watershed SPI Analysis for the direct drainage area of AUIDs 09020303-501 and 09020303-503.

## Fluvial Geomorphology Assessment

A fluvial geomorphology study was completed for the Red Lake River Watershed. Bank Erosion Hazard Index (BEHI) ratings were conducted along reaches of the Red Lake River and its tributaries in 2012. While traveling down the river in kayaks, DNR, RLWD, and MPCA staff collected notes on study bank height, root depth, root density, bankfull height, bank angle, bank material, substrate material, channel depth, and channel width. Erosion problems along those reaches are well documented with notes and georeferenced photos. Full geomorphic assessments were conducted on representative reaches along the Red Lake River and a tributary in 2012. Follow-up work was completed in 2013. The Pfankuch stability ratings were stable along the Red Lake River. Excess upland and bank erosion problems were still identified. Erosion rates were highest along TSS-impaired reaches (Table 4-2). High, steep banks are very susceptible to gully erosion. Much of the Red Lake River channel between Thief River Falls and the Clearwater River is incised. Development of the land adjacent to the Red Lake River within Thief River Falls is widespread and the buffer condition varies greatly.

**Table 4-2. BANCS Model erosion estimates from the Red Lake River Fluvial Geomorphology Study.**

| Red Lake River Watershed Fluvial Geomorphology Study<br>BANCS Model Erosion Estimates from 2012 Reconnaissance Reaches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **River** | **Reconnaissance Reach** | **AUID(s)** | **Impaired by TSS?** | **Length (miles)** | **Erosion Volume (yds3/yr)** | **Erosion Mass (tons/yr)** | **Erosion Rate (tons/mile/yr)** | **Pfankuch Stability Rating** |
| Red Lake River | CSAH 3 to CSAH 219 | 561 | No | 3.4 | 33.3 | 43.3 | 12.7 | Stable |
| Red Lake River | 110th St. NE to 280th Ave. NE | 561 | No | 4.7 | 45.5 | 59.2 | 12.6 | Stable |
| Red Lake River | East of 230th Ave. NE to CSAH 7 | 562 | No | 7.6 | 177.3 | 230.6 | 30.3 | Stable |
| Red Lake River | Forsberg Park to Finsbury Park | 562 | No | 6.2 | 218.4 | 283.9 | 45.8 | Stable |
| Red Lake River | Mark Blvd. to Hwy 32/CR 7 | 513 | No | 3.8 | 1545.2 | 2008.7 | 528.6 | Stable |
| Red Lake River | Highway 32 to Sportsman's Park near Red Lake Falls | 504 | Yes | 4.9 | 6144.3 | 7987.6 | 1630.1 | Stable |
| Red Lake River | Sportsman's Park to 220th St. SW | 510, 511, 502 | Yes (502), 510 & 511 unknown | 6.2 | 6456.6 | 8393.6 | 1353.8 | Stable |
| Red Lake River | CSAH 11 to 220th Ave. SW (Otter Tail Power Dam) | 512 | Unknown | 4.4 | 30.38.1 | 3949.5 | 897.6 | Stable |
| Black River | CSAH 18 to Red Lake River | 529 | No | 0.95 | 238.4 | 309.9 | 362.2 | Unstable |

## PTMApp

The International Water Institute and Houston Engineering have developed a tool that can be used to prioritize, target, and measure simulated water quality improvements. They have named it "PTMApp," which stands for Prioritizing, Targeting, and Measuring water quality improvement Application. This tool can be used to plan projects and strategies using an online interface or a GIS toolbar. It breaks the drainage areas into relatively small units. The model can estimate sediment and nutrient loss from each of those small units (Figure 4-10). Cost information has been incorporated into the application so that projects can be targeted to achieve the greatest amount of pollutant reduction for each dollar spent. It is best suited to the targeting of practices that reduce pollution from overland runoff because it does not account for in-channel processes. The Red Lake River 1W1P document includes maps that show pollutant reduction estimates and cost effectiveness for each of five categories of BMPs:

- Protection BMPs (stream bed/channel stabilization, critical area planting, streambank and shoreline protection, tree/shrub establishment)
- Source protection (conservation tillage, nutrient management, rotational grazing) – Figure 8-5

- Storage BMPs (drainage water management, stormwater retention, water/sediment control basins, wetland restoration)
- Filtration (conservation cover, cover crop, filter strips, grassed waterway) – Figures 8-3 and 8-4
- Infiltration (two-stage ditch design)

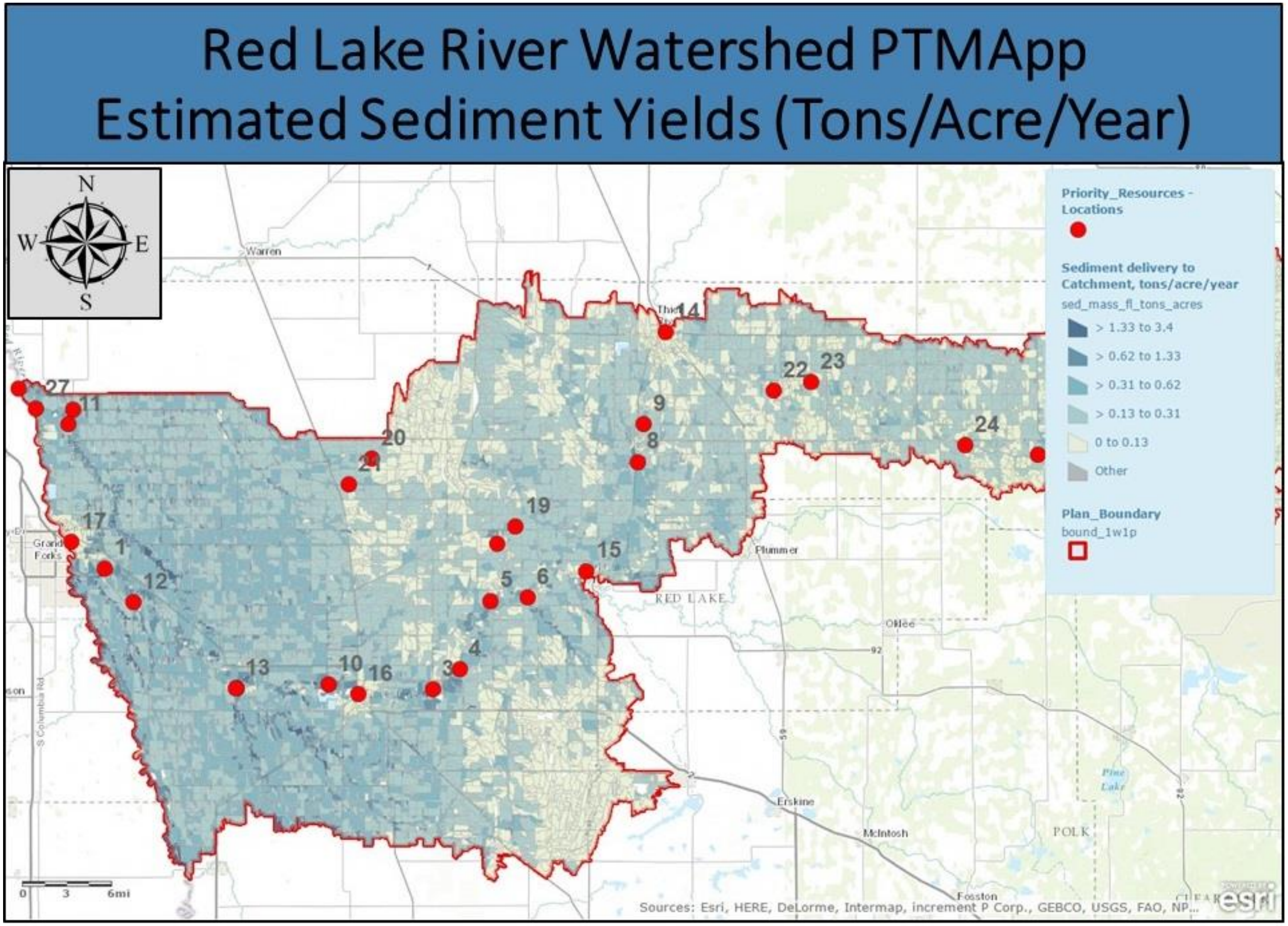


Figure 4-10. Sediment Yields (tons/acre/year) in the Red Lake River Watershed as estimated by the Red Lake River planning area PTMApp.

**SWAT and HSPF Water Quality Modeling Results**

A HSPF model of the Red Lake River was developed by the RESPEC consulting firm. The model was revised during the summer of 2017 to expand the simulated period to 1995 through 2016. Figure 4-11 shows the relative contributions to simulated annual loads from different sources. The majority of overland erosion seems to have come from cultivated fields. Figure 4-13 shows the relative rates of sediment yields throughout the watershed. Those areas in red have the highest rates of erosion. The map highlights the Polk CD 1 and Lower Burnham Creek Subwatersheds as areas that have the highest sediment yields.

Although the total sediment load contributions from developed land are relatively low due to the limited small portion of the watershed that is developed, Figure 4-12 shows how the TSS yields from developed land are relatively high. Stormwater runoff has only recently been examined in the Red Lake River Watershed. The modeling results suggest that more investigation and implementation projects are warranted to address stormwater pollution.

The HSPF Scenario Application Manager (HSPF-SAM) tool is an interface for the extraction of information from an existing HSPF model. The tool can be used to create strategies tables that quantify the BMPs that are needed in order to achieve pollutant reduction goals. The suitability of BMPs can be estimated on the HUC-12 scale. It is most effective when used in tandem with local scale GIS targeting (PTMApp or ACPF) and local resource manager knowledge. Before HSPF-SAM can be used for a watershed, someone familiar with the HSPF model must complete a Processing Application Translator for HSPF (PATH) process for the watershed. A consultant has updated the Red Lake River HSPF model, completed the PATH process, and created an HSPF-SAM for the watershed in 2017. The revised model has an extended, simulated period of 1995 through 2016. The HSPF-SAM application makes the HSPF modeling results accessible to LGUs and provides tools for targeting BMP implementation.

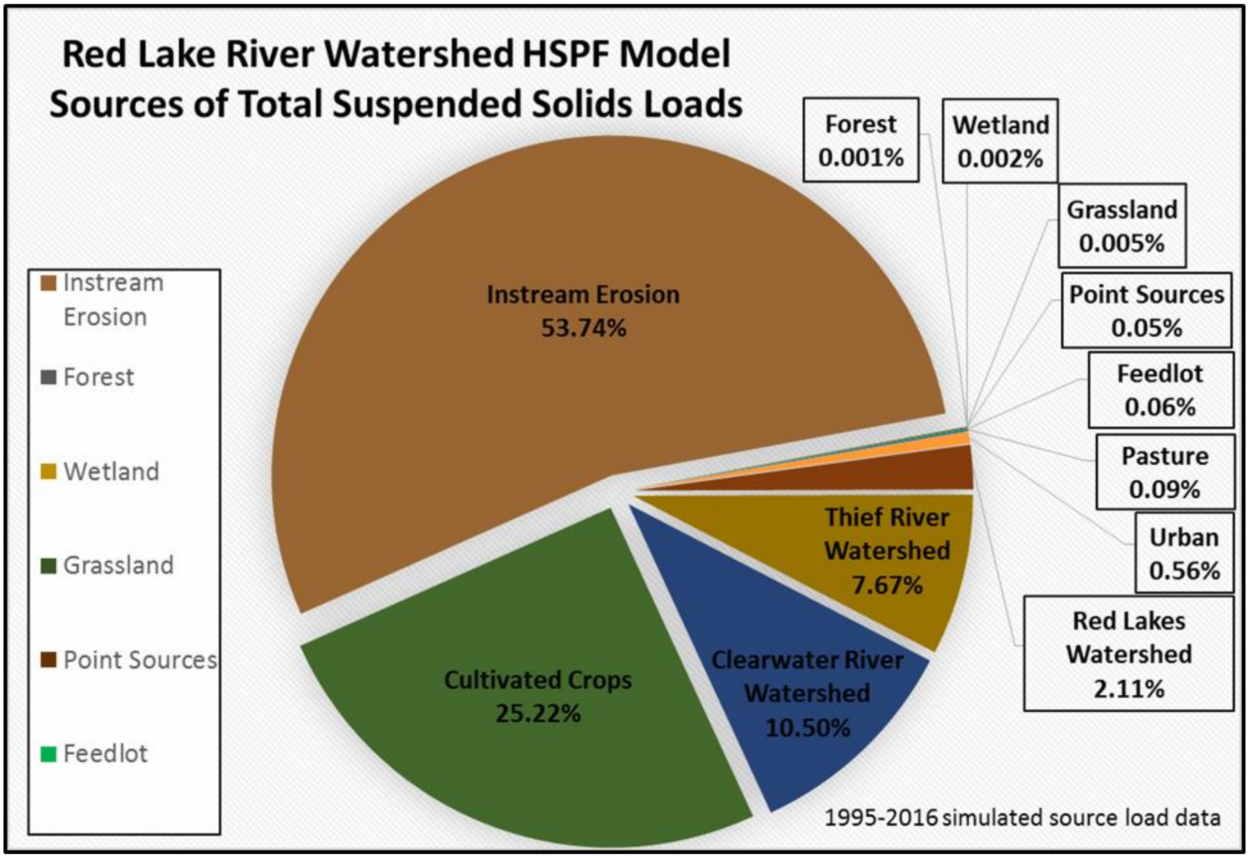


Figure 4-11. Proportions of 1995-2016 HSPF-simulated TSS loads attributed to categories of sources.

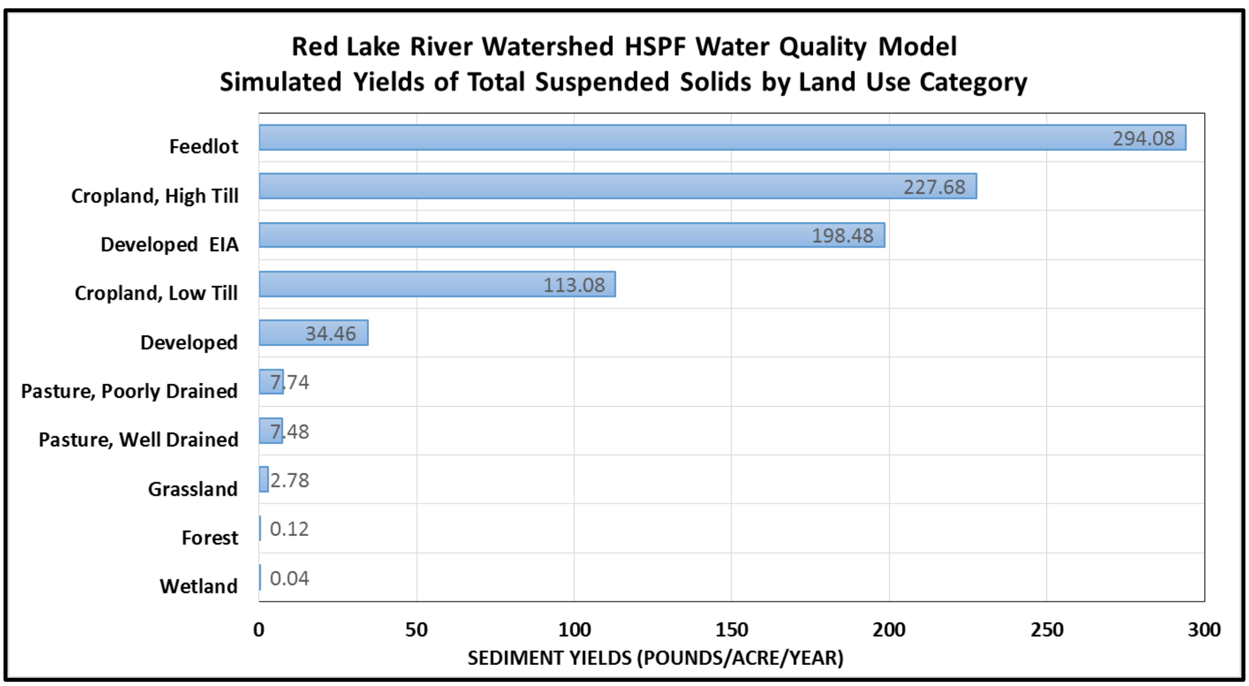


Figure 4-12. TSS yields by land use category, as simulated by the 1996-2009 HSPF Model.

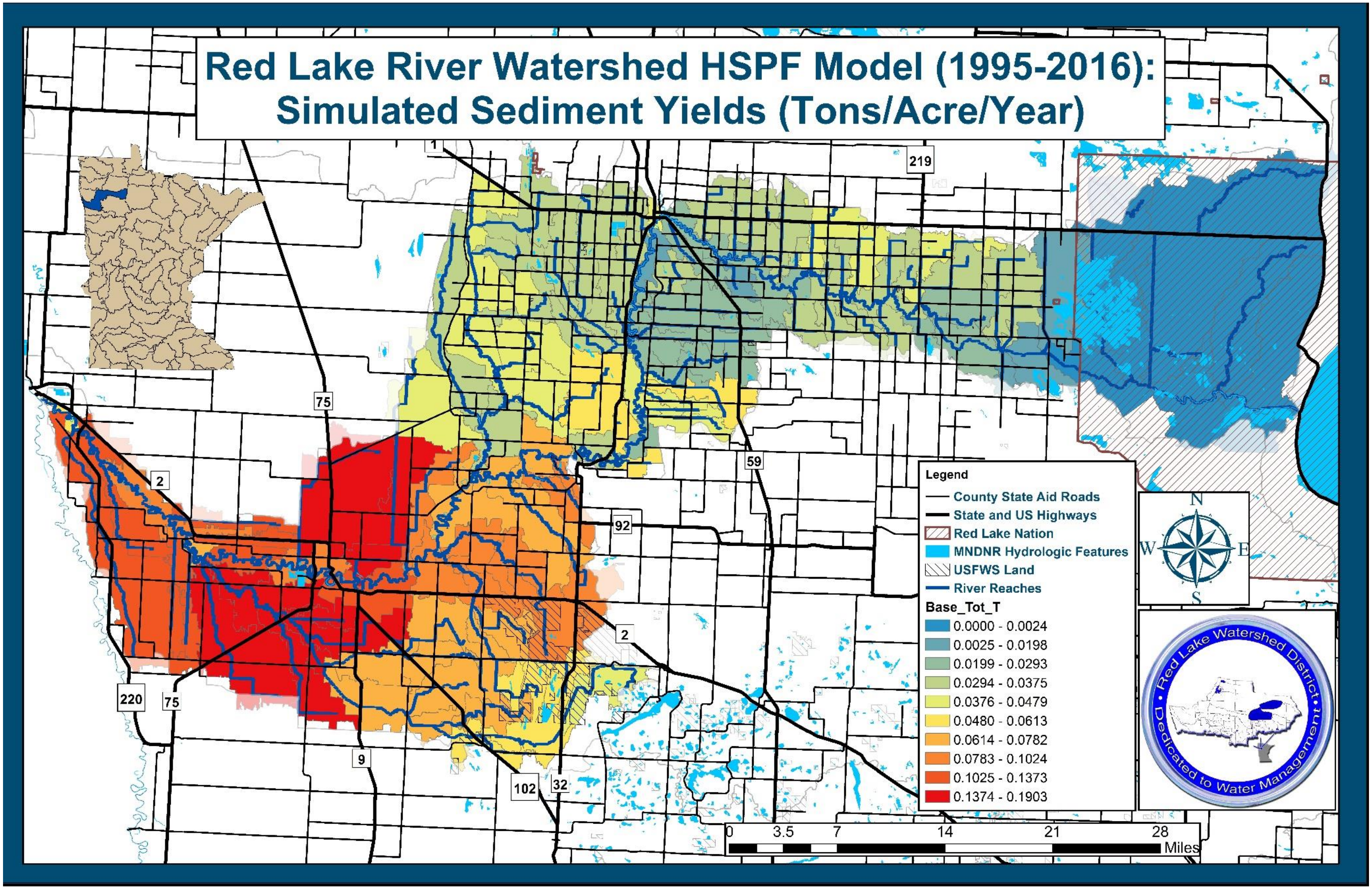


Figure 4-13. HSPF-Modeled 1996-2009 Total Suspended Sediment Yields for the Red Lake River Watershed.

**Longitudinal Sampling Results**

Longitudinal samples were collected along the main channel of the Red Lake River from Murray Bridge in East Grand Forks upstream to the CSAH 3 crossing near Huot on May 23, 2013, during a runoff event that resulted from significant rainfall events on May 19 through May 21, 2013. Figure 4-14 shows how TSS concentrations greatly increased downstream of Crookston.

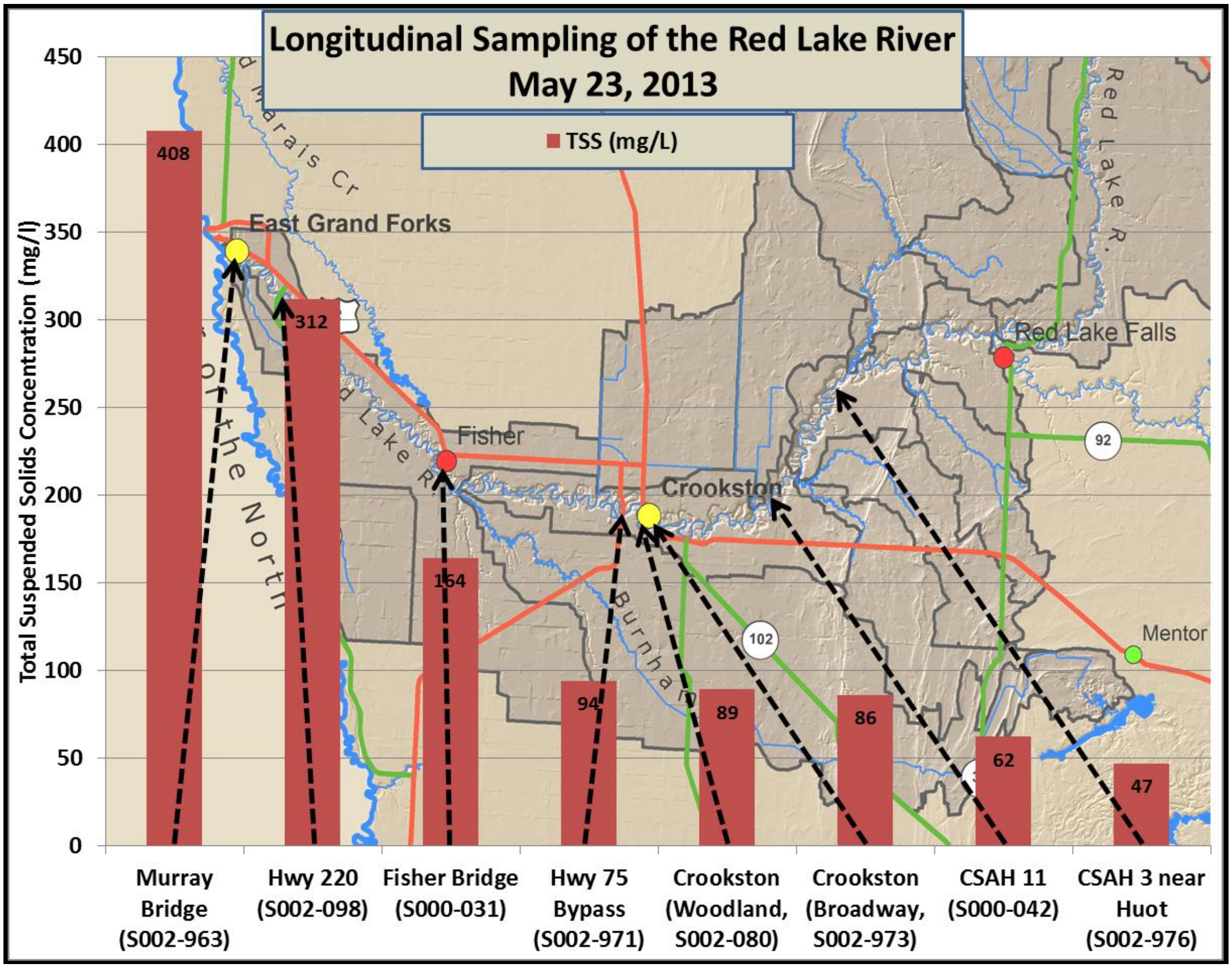


Figure 4-14. May 23, 2013 longitudinal sampling along the Red Lake River.

## 4.2 *E. coli*

Six tributary reaches within the Red Lake River Watershed are impaired by *E. coli* bacteria. The process of identifying *E. coli* sources (Table 4-3) in the Red Lake River involved identification of anthropogenic sources, and other locations and means in which animals are concentrated in or near the water. Sources of *E. coli* bacteria have been identified within the drainage areas of the impaired reaches, including livestock, waterfowl, birds (cliff swallows), and failing septic systems. Through the intensive monitoring that was conducted during the study, sources were also identified along other reaches that could lead to future impairments. Sources along reaches that are not currently impaired are described in the Red Lake River WRAPS for protection purposes.

Table 4-3. Summary of sources that have been identified along each reach that is impaired by *E. coli.*

| Stream Name | AUID | Sampling Sites Where High *E. coli* Levels Have Been Found | Natural Background | Livestock | Birds (Cliff Swallows at Bridges and Culverts | Waterfowl | Humans (Failing Septic Systems) |
|---|---|---|---|---|---|---|---|
| Pennington CD 96 | 09020303-505 | S005-683 | | | | | |
| Kripple Creek | 09020303-525 | S004-835, S008-105, S008-101, S008-106 | | | | | |
| Black River | 09020303-529 | S002-132, S008-098 | | | | | |
| Gentilly River | 09020303-554 | S004-058, S007-060, S008-109 | | | | | |
| Cyr Creek | 09020303-556 | S004-818 | | | | | |
| Black River | 09020303-558 | S003-943, S008-107, S008-112 | | | | | |

### 4.2.1 Permitted

There are no WWTFs or MS4s within the drainage area of any reach in the Red Lake River Watershed that is impaired by high concentrations of *E. coli* bacteria. Permitted feedlots, however, are a source of *E. coli* in most of the impaired reaches in the Red Lake River Watershed. There is a high density of feedlots along AUIDs 558 and 529 of the Black River (Figure 4-15). At least one operation is located within the watersheds of the other streams that are impaired by *E. coli* bacteria. Longitudinal sampling has shown that a single livestock operation can greatly increase *E. coli* concentrations in these small rivers.

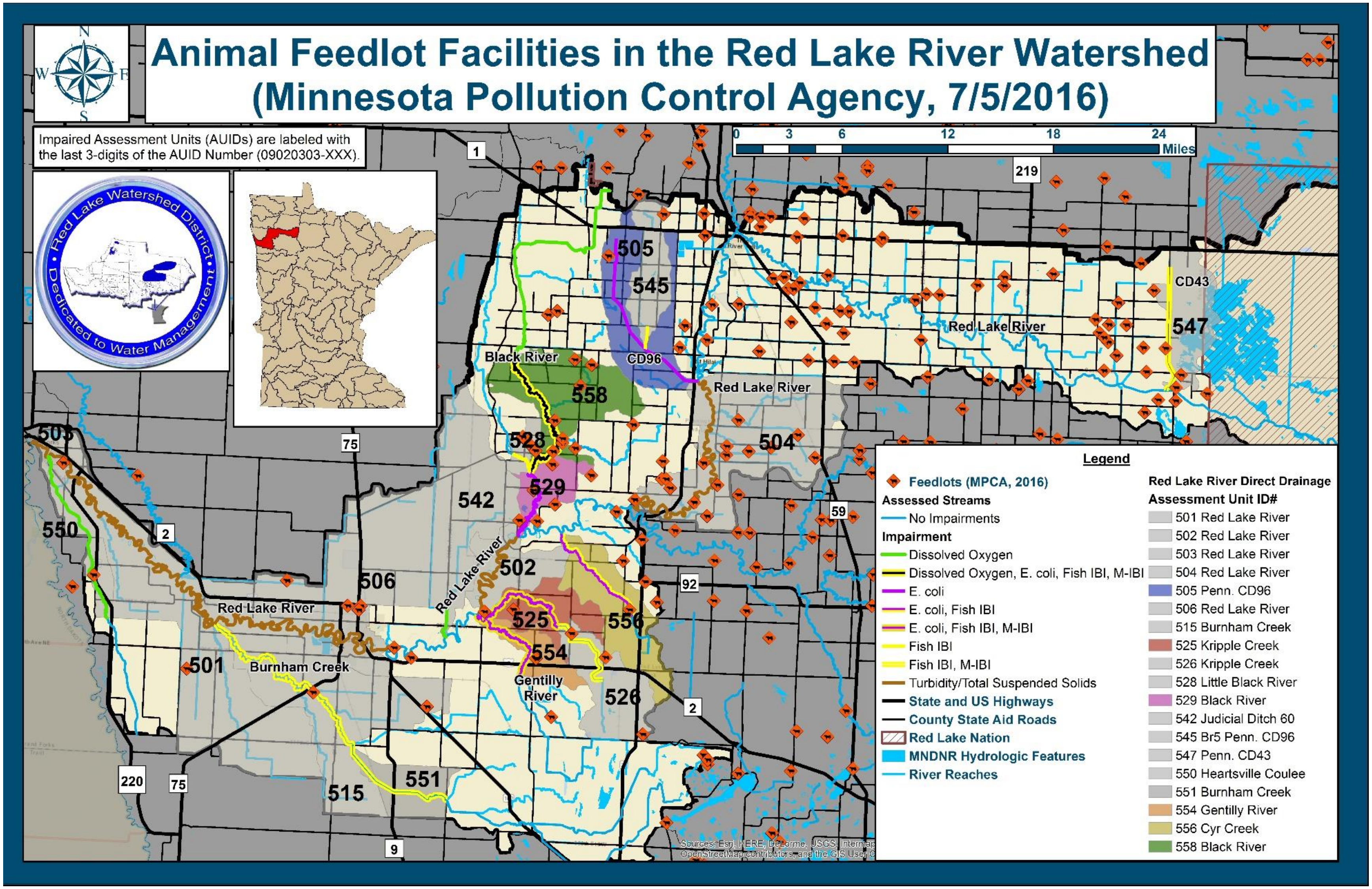


**Figure 4-15. Map of feedlot locations throughout the Red Lake River Watershed based on GIS data published by the MPCA on 7/5/2016.**

### 4.2.2 Non-permitted

**Wildlife**

There are sources of natural background bacteria in the tributaries of the Red Lake River that are not going to be eliminated by BMPs, but only minimally contribute to *E. coli* levels in rivers. Warm-blooded wild animals in the watershed contribute to *E. coli* concentrations in watercourses. In natural settings, wildlife is scattered, and such a small fraction of wild animal waste is “deposited” in waterways that natural background sources are not enough to cause an impairment. The average minimum monthly (May through September) geometric mean *E. coli* concentration in unimpaired streams in data collected from 2004 through 2014 was just 24.2 MPN/100ml.

There are; however, situations in which natural sources of bacteria can become a source of excess bacteria. Concentrated populations of animals near a waterway can contribute enough *E. coli* bacteria to create an impaired condition. Birds and waterfowl congregate at locations that provide favorable habitat and food. Birds have been proven to be a source of *E. coli* in some of the impaired streams in the Red Lake River through Microbial source tracking analysis and observations made during sampling. Microbial source tracking is a method for identifying the type of animal that is the source of fecal coliform and *E. coli* pollution. Cliff swallow communities under bridges and inside box culverts are a significant source of fecal bacteria from birds. The nests are built above the water and are heavily concentrated. Swallows can be numerous in flocks that reside under a bridge (Figure 4-16) and they swarm over the water when disturbed (e.g., when someone is sampling at the site). During sampling visits, the birds swarm around the bridge and over the water. Their droppings fall with regularity into the water that is being sampled. Flocks of waterfowl congregating in wetlands or in stream/ditch channels can cause high *E. coli* concentrations in downstream waters in some circumstances. High *E. coli* concentrations in the Gentilly River were tracked upstream to the BR-6 impoundment. However, it is important to note that not all wetlands are sources of excess *E. coli* bacteria. Water flowing out of a restored wetland in the headwaters of Kripple Creek during a runoff event had an *E. coli* concentration that was safely below the 126 MPN/100ml standard.

**Figure 4-16. Cliff swallow nests under a bridge.**

**Livestock**

Livestock access to rivers and streams (Figure 4-17) is a common source of excess *E. coli* in rivers and streams. A visual assessment of the watershed through windshield surveys and examination of aerial photos identified numerous areas where livestock have been concentrated along or near rivers and streams. Significant increases in *E. coli* bacteria concentrations were found downstream of livestock operations during longitudinal sampling efforts along Kripple Creek. Sources of the Kripple Creek *E. coli* impairment were narrowed down to a section of land in the southwest corner of Red Lake County that contains several livestock operations. The concentration was well below the standard upstream of that area and far above the standard downstream of that area.

Cattle have access to Cyr Creek at a livestock operation. More longitudinal sampling is recommended along Cyr Creek to determine the relative impact of potential sources.

There are multiple livestock operations along the Black River and its tributaries that are contributing to that river's *E. coli* impairment.

Figure 4-17. Cattle along the Red Lake River.

**Microbial Source Tracking and Failing Septic Systems**

Microbial source tracking samples were collected from the Black River, Gentilly River, and Kripple Creek on July 15, 2014. The samples were analyzed by a lab in Florida (Source Molecular) that specializes in this testing. *E. coli* samples were also collected and sent to RMB Environmental Laboratories in Detroit Lakes to obtain the total concentration of *E. coli* bacteria at the time of sampling. Past data was used as a guide for the timing of sample collection. The tests revealed that human waste is getting into the Black River and Kripple Creek. The results of the tests (Table 4-4) have been passed along to local governmental units that are in charge of regulating septic systems.

An inspection of the Chief's Coulee drainage area within the city of Thief River Falls has identified several problems with septic systems that need to be replaced. Therefore, the existence of failing septic systems in a rural setting is not surprising.

**Table 4-4. Results of Microbial Source Tracking analysis within the Red Lake River Watershed.**

| Date | Site Name | Sampling Location S-Code | *E. coli* (CFU/100 ml) | Analysis Requested | Quantification | DNA Analytical Results | Contributing to Fecal Pollution? |
|---|---|---|---|---|---|---|---|
| 7/15/14 | Black River at CSAH 18 | S002-132 | 69.1 | Bird Fecal ID | Not detected | Absent | No |
| | | | | Cow Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | <LOQ | Trace | Potential Contributor |
| | | | | Human Bacteroidetes ID 2 | <LOD | Absent | |
| 8/26/14 | | | 73.8 | Bird Fecal ID | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 2 | Not detected | Absent | No |
| | | | | Ruminant Fecal ID | Not detected | Absent | No |
| 6/18/14 | Red Lake River at Sportsman's Bridge (CSAH 13) | S003-172 | 157.6 | Bird Fecal ID | <LOQ | Trace | Potential Contributor |
| | | | | Cow Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 2 | Not detected | Absent | No |
| 6/24/14 | | | 27.2 | Bird Fecal ID | <LOQ | Trace | Potential Contributor |
| | | | | Cow Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 2 | Not detected | Absent | No |
| 7/15/14 | Gentilly River at CSAH 11 | S004-058 | 67.7 | Bird Fecal ID | Not detected | Absent | No |
| | | | | Cow Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | <LOD | Absent | No |
| | | | | Human Bacteroidetes ID 2 | <LOD | Absent | No |
| 8/26/14 | | | 77.1 | Bird Fecal ID | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 2 | Not detected | Absent | No |
| | | | | Ruminant Fecal ID | Not detected | Absent | No |
| 7/15/14 | Kripple Creek at 180th Ave. SW | S004-835 | 86.0 | Bird Fecal ID | Not detected | Absent | No |
| | | | | Cow Bacteroidetes ID 1 | Not detected | Absent | No |
| | | | | Human Bacteroidetes ID 1 | 7.59E+02 | Present | Potential Contributor |
| | | | | Human Bacteroidetes ID 2 | <LOD | Absent | |
| 8/26/14 | | | 292.0 | Bird Fecal ID | <LOQ | Trace | Potential Contributor |
| | | | | Human Bacteroidetes ID 1 | <LOQ | Trace | Potential Contributor |
| | | | | Human Bacteroidetes ID 2 | Not detected | Absent | |
| | | | | Ruminant Fecal ID | Not detected | Absent | No |
| <LOD = Below the Limit of Detection (<10 copy numbers per reaction). | | | | | | | |
| <LOQ = Below the Limit of Quantification | | | | | | | |

**Longitudinal Sampling Results**

Kripple Creek begins in Glacial Ridge National Wildlife Refuge and flows northwest (generally) to the Gentilly River. High turbidity and *E. coli* levels have been observed at the lower end of the watershed during routine monitoring. Longitudinal samples were collected along Kripple Creek on June 2, 2014 (Figure 4-18), during a rainfall event. The sampling revealed sources of sediment and *E. coli.* The longitudinal TSS results can be found in the Red Lake River WRAPS report. The longitudinal sampling results for *E. coli,* germane to the impairment, are shown in Figure 4-18. Water flowing from Glacial Ridge NWR at the upstream end of Kripple Creek was very clean. *E. coli* concentrations greatly increased downstream of a farm with livestock near the intersection of 260th Street Southwest and 140th Avenue Southwest in Section 30 of Pleasant Township in Red Lake County. *E. coli* concentrations actually decreased at each of the next three crossings that were sampled and then increased again downstream of CSAH 11 (where there are some horses along the stream).

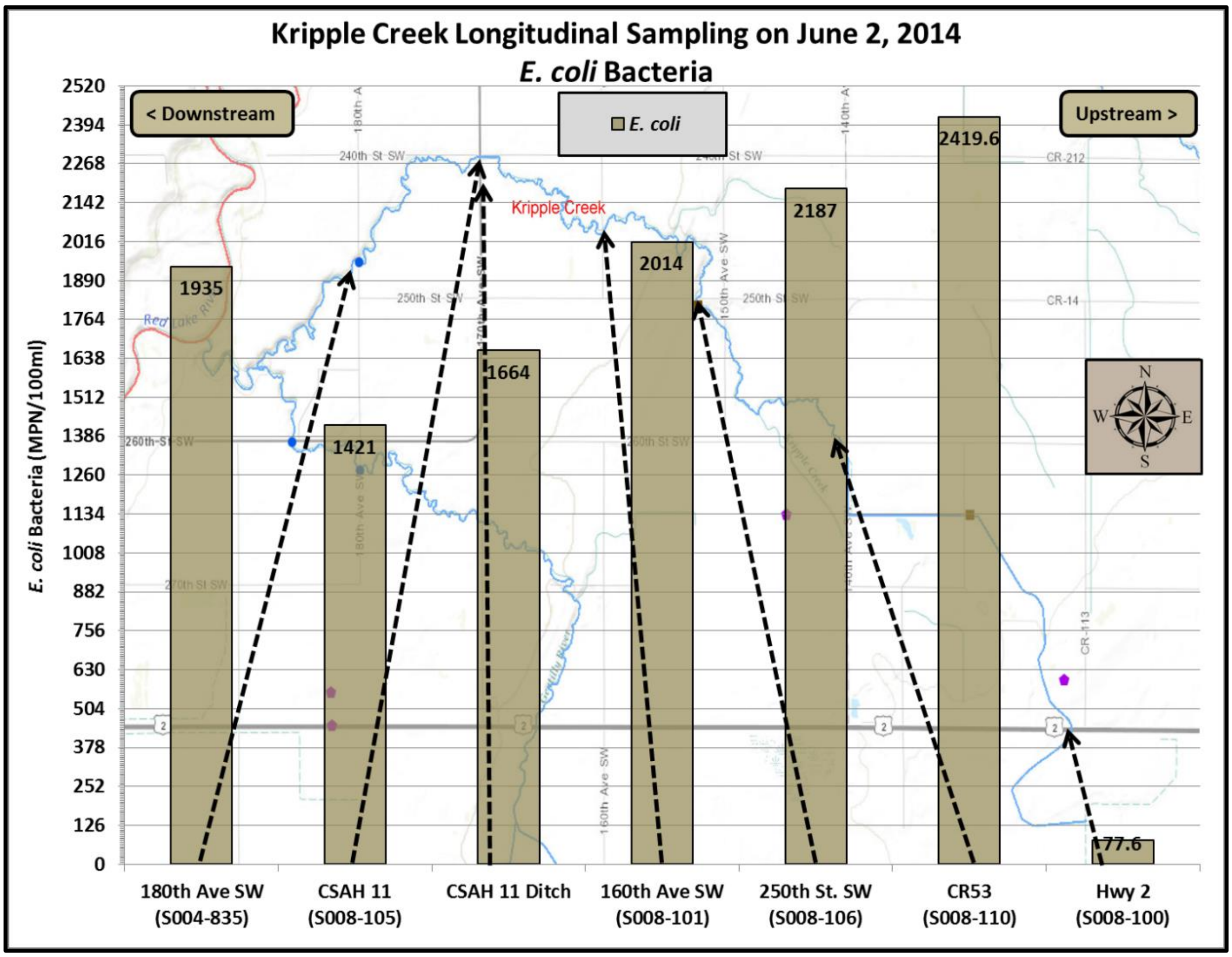


Figure 4-18. Longitudinal profile of *E. coli* concentrations in Kripple Creek during a June 2, 2014 runoff event.

Longitudinal samples were collected along Gentilly River on June 5, 2014 (Figure 4-19). The samples were collected after several days of rainfall in the area, including rain on the day of sample collection. *E. coli* concentrations and turbidity levels spike where the Polk County Ditch 140 portion of the Gentilly River crosses CR 44 and 300th Street Southwest. A livestock operation, located east of CR 44 along 310th Street Southwest in Sections 13 and 24 of Kertsonville Township, drains to both branches of CD 140 and could be contributing to high *E. coli* levels. The livestock operation is not the only source, however. There was a significant increase in *E. coli* concentrations between CR 44 and 300th Street, even though there does not seem to be any obvious sources of *E. coli* (based on aerial photos) in Section 15 of Kertsonville Township. The *E. coli* concentration was high at the furthest upstream sampling site at CSAH 45. Most of the land along CD 140 upstream of CSAH 45 is not farmed, so the sources of *E. coli* in this area may be "natural." A big potential source of excessive "natural" *E. coli* bacteria could be the BR-6 impoundment that would attract great numbers of waterfowl.

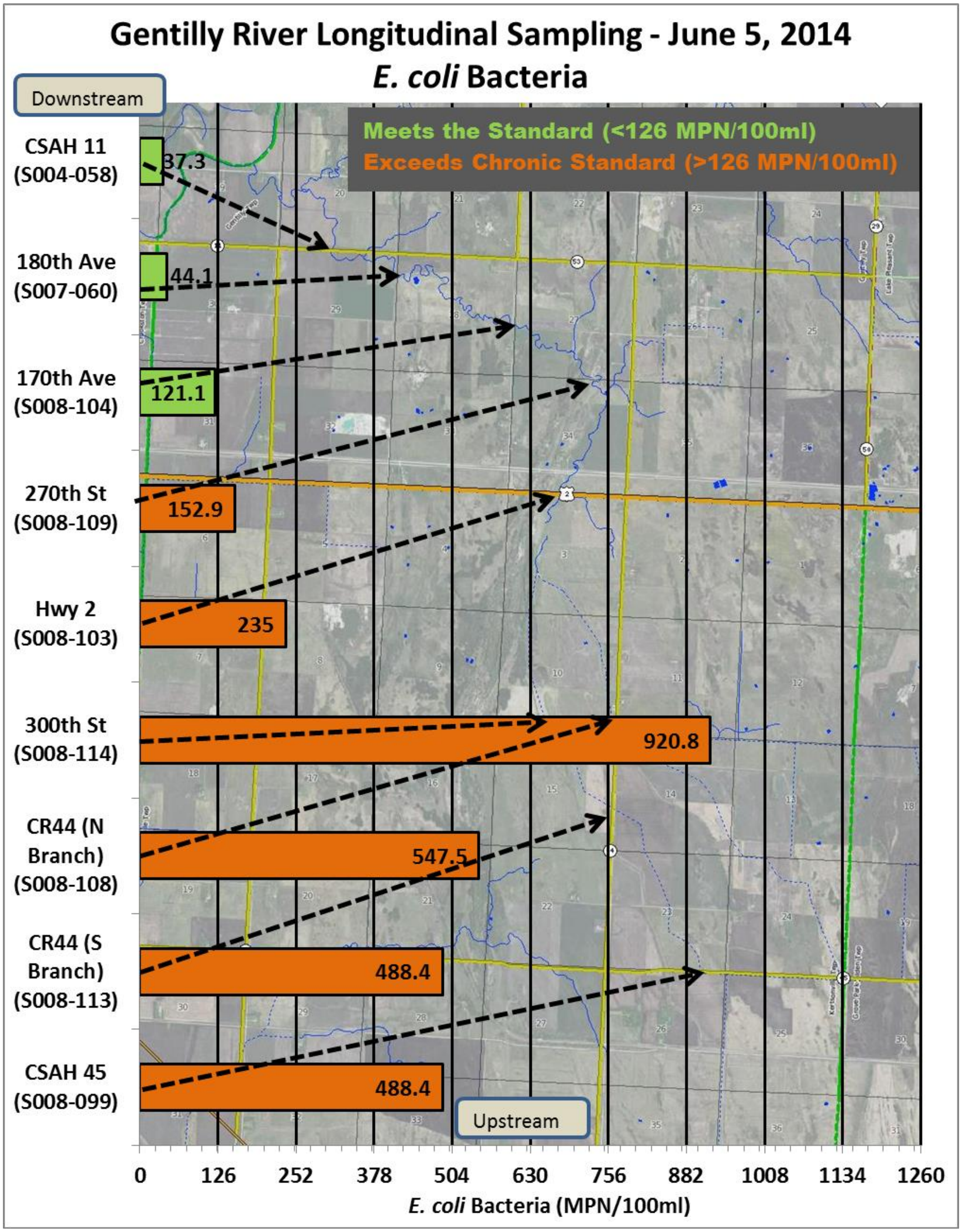


**Figure 4-19. Longitudinal profile of *E. coli* concentrations along the Gentilly River on June 5, 2014.**

On June 16, 2014, longitudinal samples were collected at sites along the Black River and at the pour points of two of its main tributaries (Little Black River and Browns Creek). The samples were taken after a rain event to help identify specific areas in the watershed in which runoff is significantly increasing pollutant concentrations in the river. These areas can be targeted for project implementation. Figure 4-20 shows that the most significant increase in *E. coli* concentrations was found at the CR 103 crossing.

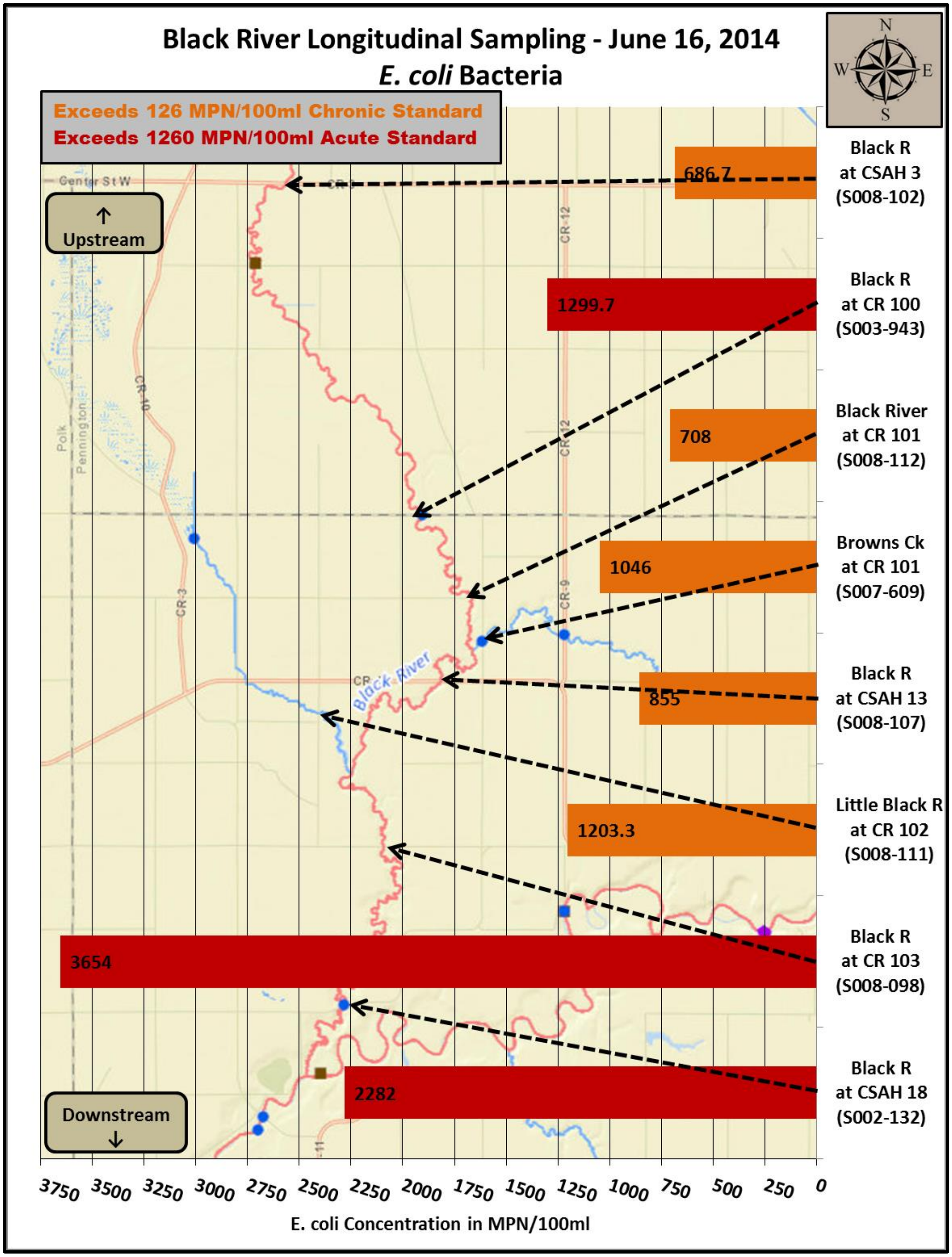


**Figure 4-20. Longitudinal profile of *E. coli* concentrations along the Black River on June 16, 2014.**

## 4.3 Stressors

A lack of base flow was determined to be the foundational stressor that caused the 20 individual IBI and low DO impairments. Low flows allow minor channel obstructions to act as fish passage barriers. DO levels are depressed within stagnant water. The vast majority of biological data that was used for this assessment was collected in 2012, when flows were exceptionally low. Other than uncontrollable climatic factors, the primary cause of low base flows is suspected to be the extensive hydrologic modification that has occurred in the watershed. The Red Lake River Watershed Monitoring and Assessment Report expounds on this observation. The watershed generally has a low gradient. Extensive ditching and straightening of channels have occurred since the area was settled in order to improve the suitability of the land for agriculture. Because drainage projects are effective at quickly draining water from the land, many of the streams in the watershed have become hydrologically unstable and prone to bank failure from increased peak flows. The drainage reduces retention and residence time, which results in a reduction of base flow levels.

In addition to a lack of flow, fish passage barriers, and low DO, in-stream habitat needs improvement along many reaches. Multiple years of data are available for some reaches within the Red Lake River Watershed. Some temporal variation in IBI scores was noted and was most likely due to differences in hydrologic conditions.

### 4.3.1 Burnham Creek, 09020303-515, Fish Biotic Integrity

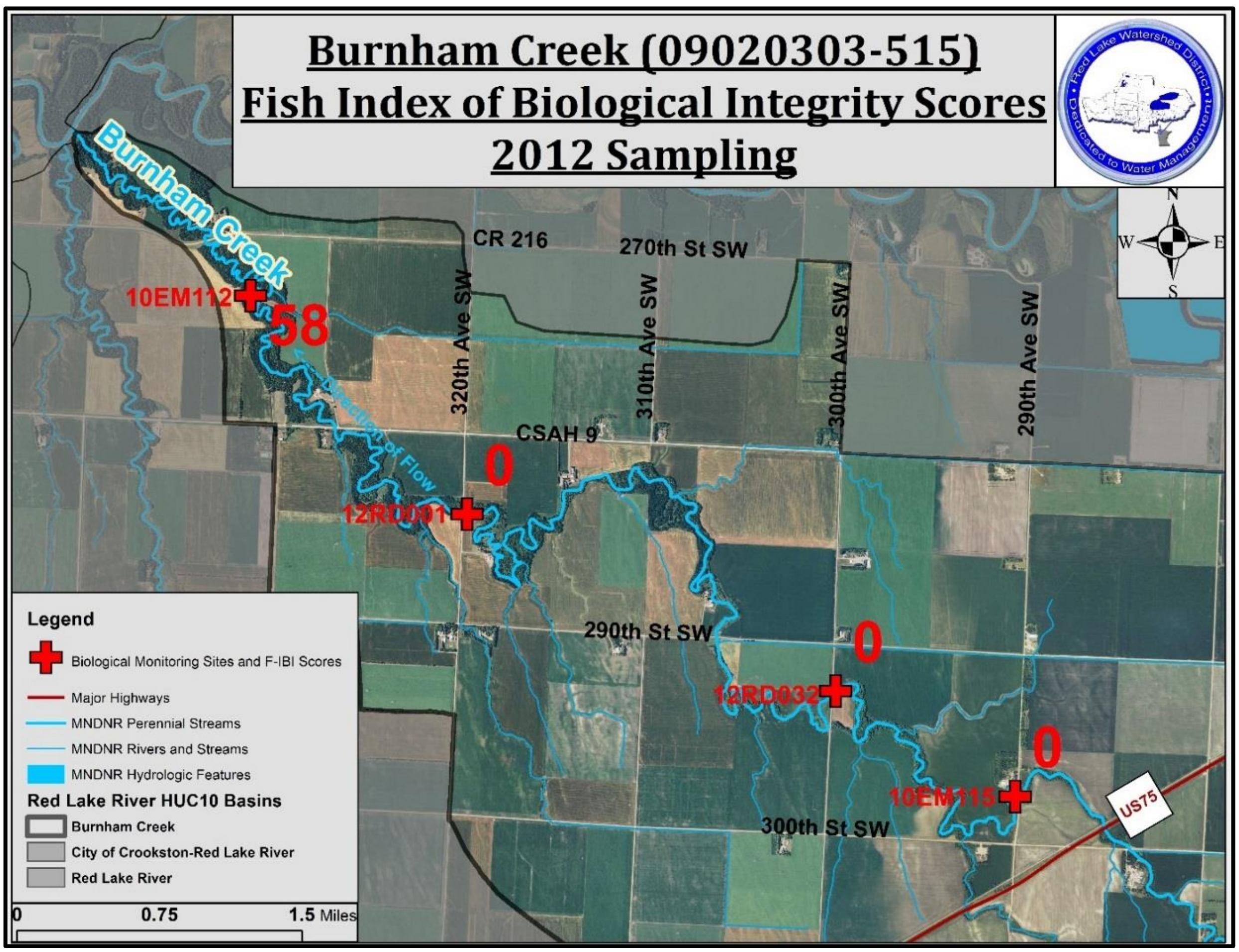


Figure 4-21. Burnham Creek (09020303-515) Fish IBI Scores.

The fish community of AUID 515 was monitored at Station 10EM112 on July 13, 2010, Station 12RD001 on June 11, 2012, Station 12RD032 on June 12, 2012, and Station 12RD115 on June 13, 2012. The stations were designated as General Use within the Southern Streams F-IBI Class. The applicable impairment threshold for these stations is an F-IBI score of 50. Station 10EM112, which represents the farthest downstream station along the reach, scored slightly above the impairment threshold, with an F-IBI score of 58. Monitoring at the upstream stations (i.e., 12RD001, 12RD032, and 12RD115) each yielded an F-IBI score of zero (Figure 4-21). The evidence gathered for the Red Lake River Watershed Stressor ID Report suggested "that the F-IBI impairment is likely attributed to the following stressors:

- Lack of base flow
- Lack of instream habitat
- Low DO levels

Further examination of the data has revealed that minor fish passage barriers may also be negatively affecting fish communities during low flows. Examination of data found that low DO levels mainly occur during times of low flow and stagnant water. Work can be done to reduce the severity of other stressors, but insufficient base flow is the primary stressor to aquatic life in Burnham Creek because it intensifies the influence of other stressors.

Flow within Burnham Creek can be flashy, due to extensive agricultural drainage in the watershed. Spikes in hydrographs can be separated by periods of low flow or even dry conditions (Figure 4-23). Low flows exacerbate the effect of minor obstructions to fish passage and create stagnant conditions in which DO levels become depleted. Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are early maturing and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). Evidence of a causal relationship between a lack of base flow and the F-IBI impairment of AUID 515 is provided by the following individual F-IBI metric responses (Appendix C) for Stations 10EM112, 12RD001, 12RD032, and/or 12RD115:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

The Stressor ID Report was inconclusive about the effect of fish passage barriers upon the quality of fish communities in Burnham Creek. Evidence was examined further during the writing of this TMDL document. The logical conclusion of that effort was that, although some fish passage may be possible during high flows, fish passage during low and moderate flows should be investigated and addressed. Low flow is still the primary stressor for fish along this reach because it worsens the impact of the types of barriers that have been found along Burnham Creek. Fish were plentiful and diverse near the lower end of the watershed, yet scarce throughout the majority of this reach. There are no significant changes in M-IBI, MPCA Stream Habitat Assessment (MSHA), and water quality sampling data that could explain the differences in fish populations.

There is evidence that suggests that fish are able to migrate upstream in Burnham Creek. In the Stressor ID Report, the presence of highly tolerant white suckers in an upstream reach (AUID 09020303-551) was used as evidence that fish are able to migrate upstream in Burnham Creek.

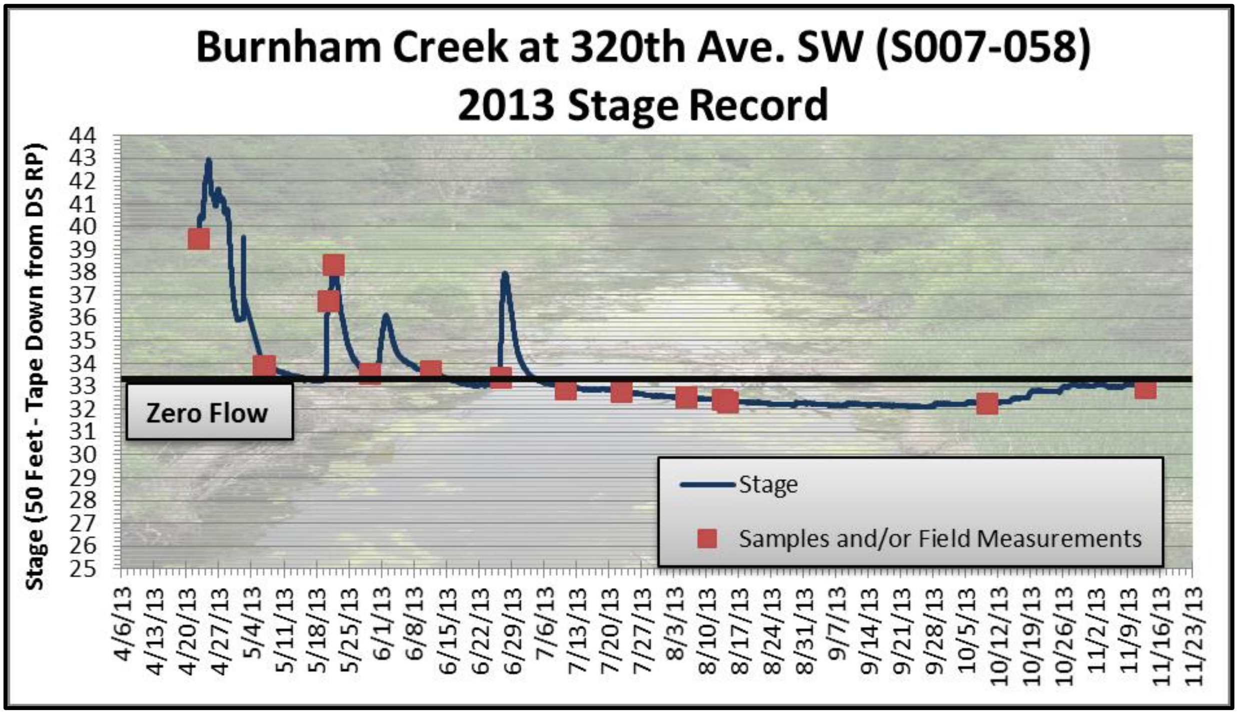


Figure 4-22. Flashy flow during runoff and a lack of base flow in Burnham Creek are demonstrated by the 2013 stage record.

Conversely, there is evidence to suggest that migration of fish within Burnham Creek is being severely limited during low flows despite being passable during high flows. Thirty-nine white suckers were counted at 10EM112 (furthest downstream site), but only three (total) individuals were found at the other three sites along this reach. Yellow perch were found at 10EM112, but nowhere else within the watershed. There was a complete disappearance of all fish species at site 12RD115 (Table 4-5), and a dramatic difference between 10EM112 and the rest of the sites along the reach. The difference could also have been temporal in nature as 10EM112 was sampled in 2010 and the rest of the sites were sampled in 2012. There was more flow in the channel in July 2010 than there was during the 2012 sampling. There were significant runoff events that caused flows to increase in late May and late June of 2010. Flows were exceptionally low in 2012 (and often zero in tributaries). As shown in Figure 4-21, F-IBI scores drop from a score that is above the impairment threshold at the downstream end of the reach (10EM112) to a score of zero at the next upstream monitoring site (12RD001). Only 4.7 miles of stream channel separate sites 10EM112 and 12RD001, but there was a 58-point difference in F-IBI scores.

**Table 4-5. Fish sampling results along Burnham Creek.**

| Site ID | Nearest Road Crossing | Fish Sampling Date | AUID 09020303-xxx | Fish IBI Score | Black Bullhead | Blackside Darter | Burbot | Central Mudminnow | Common Carp | Common Shiner | Creek Chub | Fathead Minnow | Gen: Catostomus | Johnny Darter | Northern Pike | Rock Bass | Sand Shiner | Shorthead Redhorse | Spotfin Shiner | White Sucker | Yellow Perch | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10EM112 | 270th St. SW | 7/13/10 | 515 | 58 | 1 | 18 | | 1 | 5 | | 11 | | | 15 | 6 | 3 | 5 | 1 | 19 | 39 | 2 | 126 |
| 12RD001 | 320th Ave. SW | 6/11/12 | 515 | 0 | 1 | | 1 | 3 | | | | | | 1 | | | | | | 2 | | 8 |
| 12RD115 | 300th Ave. SW | 6/13/12 | 515 | 0 | | | | | | | | | | | | | | | | | | |
| 12RD032 | 290th Ave SW | 6/12/12 | 515 | 0 | | 1 | | 2 | | | | | 51 | | 17 | 1 | | | 10 | 1 | | 83 |
| 12RD030 | CSAH 45 | 6/11/12 | 551 | 13 | | 1 | | | | 8 | 9 | 2 | | | | | | | | 143 | | 163 |

There are noticeable barriers to fish passage throughout the Burnham Creek Watershed, particularly in aerial photos. Beaver dams and logjams have been noted during water chemistry sampling and biological sampling efforts. Some projects have been implemented to mitigate significant barriers (perched culverts and large weirs) in upper reaches of the watershed. However, more work can be done downstream of Polk County Ditch 15. Beaver dams and their remnants are suspected of inhibiting fish passage during low flow. Rock dams and old crossings can create barriers to fish passage and stagnant upstream conditions during low flows. The water pooled upstream of the 300th Street rock dam may provide a winter refuge and an explanation for the higher population of white suckers that was found within AUID 09020303-551 near CSAH 45 (12RD030). The barriers identified in this reach; however, can be overtopped by high flows. Fish passage may be impeded during periods of low flow (much of the sampling season), but fish would be able to migrate upstream during high flows. This would explain the presence of white suckers throughout this AUID and the next AUID upstream.

Stage, flow, and photographic records reveal that flows in Burnham Creek were very low during the 2012 fish sample collection and fish passage barriers would have been influencing fish migration. Figure 4-23 shows how remnants of a beaver dam, located downstream of 320th Avenue Southwest, can create a pool of stagnant water and impede fish passage during low flows (left photo). In the right photo of Figure 4-23, high flows are overtopping the minor obstruction and fish passage would be more possible. There was no flow monitoring within Burnham Creek in 2011. However, the 05080000 USGS gauge on the Red Lake River at Fisher is located nearby and downstream of the Burnham Creek confluence. The debris in Figure 4-23 appeared to be blocking flow and fish passage in the photo from October 20, 2011. The flow in the Red Lake River on October 20, 2011, was greater than the flow during 2012 fish sample collection. Flow in the Red Lake River at Fisher during the June 11, 2012, fish sampling was 845 cfs. The 2012 stage record at 320th Avenue Southwest (S007-058) shows that flow was either zero or very low during the fish sampling effort. Even minor obstructions to flow would have been limiting fish passage during the 2012 sampling effort.



**Figure 4-23. Beaver dam remnants downstream of 320th Ave SW during low flow on October 20, 2011 (left) and high flow on June 29, 2011 (right).**

Differences in F-IBI scores are not explained by habitat degradation or pollution. Two sites in the lower portion of Burnham Creek are separated by less than four miles of channel but have drastically different IBI scores. Of those two sites, Station 10EM112 is the downstream site (58-point F-IBI score) and Station 12RD001 is the upstream site (0-point F-IBI score). Habitat and M-IBI scores suggest that habitat and water quality conditions are better where poor F-IBI scores were found at upstream sites. M-IBI scores indicate that long-term, in-stream habitat and water quality conditions need improvement but are actually better upstream at 12RD001 than they are at 10EM112. The MSHA habitat score at 12RD001 is sufficiently superior to the habitat score at 10EM112 for it to fall into a higher rating category (Table 4-6). The TSS concentrations recorded during 2013 longitudinal sampling near 10EM112 and 12RD001 were similar (Figure 4-25, CR 216 vs 320th Avenue) and suggest that water quality does not change significantly enough to explain the change in F-IBI scores.

**Table 4-6. Fish and Habitat Community attributes in Burnham Creek.**

| Site ID | Nearest Road Crossing | Fish Sampling Date | AUID 09020303-xxx | Fish IBI Score | DELTA (Abnormalities) | Darter Species | Exotic Species | Fish per 100 m | Game Fish Species | Gravel Spawning Species | Piscivore Species | Pollution Intolerant Species | Special Concern Species | Total Species | MSHA Score | MSHA Rating | M-IBI Scorer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10EM112 | 270th St. SW | 7/13/10 | 515 | 58 | 1 | 2 | 1 | 33 | 3 | 3 | 2 | | | 13 | 44 | Poor | 23 |
| 12RD001 | 320th Ave. SW | 6/11/12 | 515 | 0 | | 1 | | 2.7 | | 2 | 1 | 1 | | 5 | 53 | Fair | 29 |
| 12RD115 | 300th Ave. SW | 6/13/12 | 515 | 0 | | | | | 1 | | | | | | 56 | Fair | |
| 12RD032 | 290th Ave SW | 6/12/12 | 515 | 0 | | 1 | | 12 | | 2 | 1 | | | 4 | 58 | Fair | |
| 12RD030 | CSAH 45 | 6/11/12 | 551 | 13 | | 1 | | 109 | | 3 | | | | 5 | 33 | Poor | 20 |

The location of this reach (more than 45 minutes of travel time away from the RLWD office) has prevented the collection of sufficient pre-9 a.m. discrete DO measurements, but multiple deployments of DO loggers have provided a record of daily minimum DO levels in this reach of Burnham Creek. Table 4-7 shows that the rate of low DO levels exceeds the 10% impairment threshold at nearly every site along this reach. The only site with continuous DO data and an acceptable rate of low DO levels is S002-972 at the CR 216 crossing (near the 10EM112 site that had a good F-IBI score). This could be considered evidence that DO is a limiting factor upstream. If DO levels were the primary cause of the dramatic decrease in F-IBI scores between 10EM112 and 12RD001, M-IBI scores would also theoretically decrease. However, the macroinvertebrate score was higher at the upstream site (12RD001) than at the downstream site (10EM112). DO records were collected in different years. The S007-058 continuous DO data was collected in 2012, a year in which flows were exceptionally low and DO was also (Figure 4-24). Although higher DO levels should be a goal addressed in the WRAPS report, DO does not appear to be the primary obstacle to attaining quality fish communities within Burnham Creek.

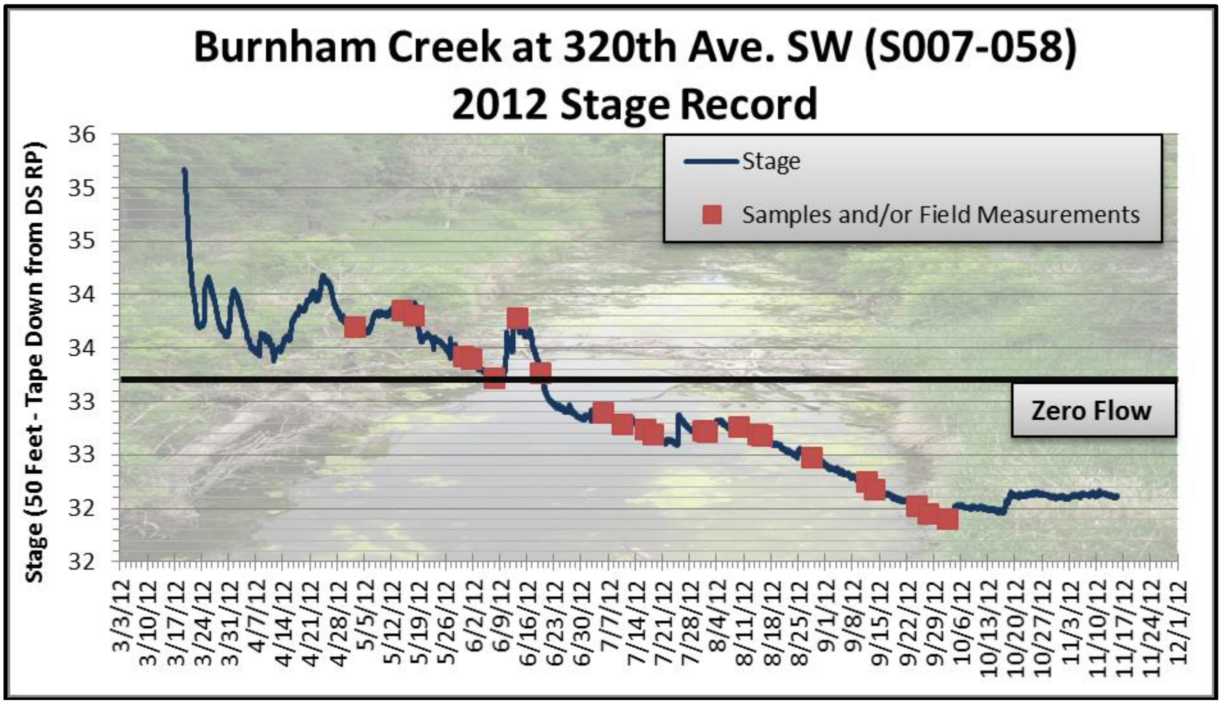


**Figure 4-24. 2012 stage record at S007-058 showing low-flow conditions during biological sampling efforts.**

Throughout the reach, even at the one site that had a good F-IBI score, in-stream habitat is in need of improvement. Benthic insectivores and simple lithophilic spawners require quality benthic habitat (e.g., clean, coarse substrate) for feeding and/or reproduction purposes, while detritivores utilize decomposing organic matter (i.e., detritus) as a food resource and, therefore, are less dependent upon the quality of instream habitat (Aadland et al. 2006). MSHA scores were either "fair" or "poor." Sampling stations scored poorly in the categories of land use, substrate, and morphology. The Stressor ID report found that poor results for five individual M-IBI metric responses might have been caused by a lack of in-stream habitat.

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- High relative abundance of taxa that are detritivorous
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species
- Low taxa richness of simple lithophilic spawning species

## 4.3.2 Burnham Creek, 09020303-515, Macroinvertebrate Biotic Integrity

The Red Lake River Watershed Stressor ID Report identified the four most significant stressors to macroinvertebrates to be:

- Excessive sediment
- Lack of in-stream habitat
- Lack of base flow
- Low DO levels

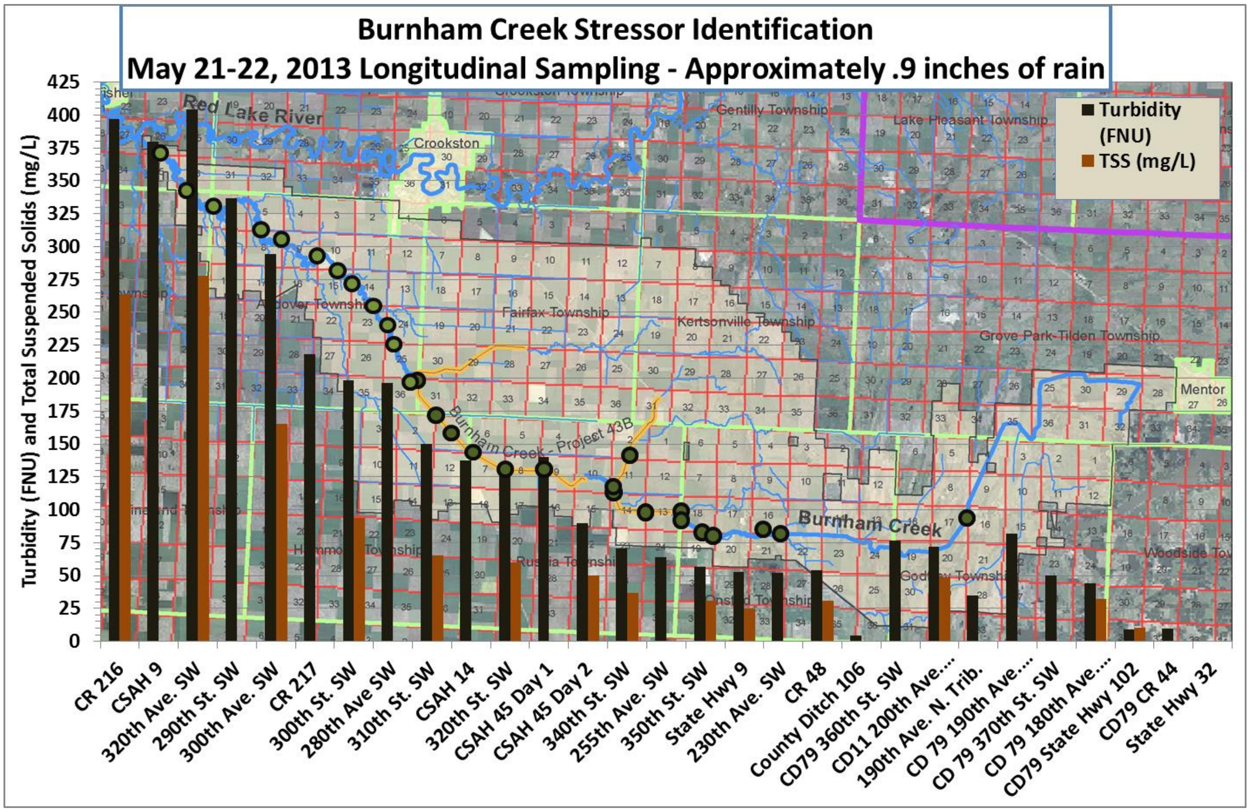


Figure 4-25. Longitudinal TSS and turbidity levels along Burnham Creek during a runoff event.

The Stressor ID process found that this reach is failing to meet the biological standards due to excess sediment. The reach is meeting the applied 65 mg/L TSS standard (4% exceedance rate in 2006 through 2015 data), but would exceed the 30 mg/L TSS standard (12% exceedance rate in 2006 through 2015 data). The Stressor ID report found that the stream is not adequately supporting collector-filterers, including members of the order Trichoptera. Five poorly scoring M-IBI metric responses indicated that excess sediment was a stressor for macroinvertebrates in this reach of Burnham Creek:

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

The Red Lake River 1W1P identifies this reach as a priority un-impaired reach that is in danger of becoming impaired. The M-IBI score decreased from the upstream site near 320th Avenue South (29) to the downstream sampling site near CR 216 (23). Longitudinal sampling has shown that TSS levels generally increase from upstream to downstream along Burnham Creek (Figure 4-25). During a May 2013 rain event, TSS concentrations were below the 65 mg/l standard upstream of 310th Avenue Southwest but exceeded the standard downstream of that point.

Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects to attach themselves to, while burrowing and legless macroinvertebrates are tolerant of degraded benthic habitat. The MSHA scores indicated a need for improvement, particularly in the categories of land use, substrate, and morphology. In the Stressor ID Report, four M-IBI metric responses were provided as evidence of the effect of poor habitat upon macroinvertebrates:

- High relative abundance of burrower individuals
- Low taxa richness of clinger taxa
- Low relative abundance of collector-filterer individuals in a subsample
- High relative abundance of legless individuals

As with the F-IBI impairment, a lack of base flow is also significantly affecting macroinvertebrates. The stressor ID report found eight M-IBI metric responses that could have been caused by a lack of flow:

- Low relative abundance of collector-filterer individuals
- High relative abundance of the dominant five taxa in a subsample
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

The photo in Figure 4-26 was taken on October 2, 2012 at the downstream end of the Red Lake River, near its confluence with the Red River of the North. The trickle of flow shown in the photo is all that was being yielded from the entire Red Lake River Watershed at that time. The photo aptly illustrates the low-flow conditions that occurred in 2012 that negatively affected IBI scores and DO concentrations.

Figure 4-26. Red Lake River in East Grand Forks, near the confluence with the Red River of the North on October 2, 2012.

The DO record within this reach of Burnham Creek indicates that the daily minimum concentrations are often low (Table 4-7). The Stressor ID report found six M-IBI metric responses that provide evidence that macroinvertebrates are being affected by low DO:

- High Hilsenhoff's Biotic Index value
- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

Table 4-7. Site-specific assessment of DO and TSS along the 09020303-515 reach of Burnham Creek.

| Burnham Creek (09020303-515) 2006 – 2012 Site-Specific Exceedances | | | | | |
|---|---|---|---|---|---|
| **Sites located between Polk CD 15 and the Red Lake River** | DO5_All (5 mg/l) Discrete and Continuous | DO5_All (5 mg/l) Discrete Only | Continuous Data Available? | Total Suspended Solids (65 mg/l) | Turbidity (25 NTU) |
| S002-972 (CR 216) | 3.6% | 0.0% | X | 14.3% | 35.3% |
| S007-058 (320th Ave. SW) | 35.0% | 0.0% | X | 7.4% | 15.4% |
| S002-081 (280th Ave. SW) | 10.5% | 10.5% | | 0.0% | 25.4% |
| S007-638 (CSAH 45) | 33.3% | 7.7% | X | IF | 100% |
| 09020303-515 | 28.8% | 7.6% | X | 4.3% | 26.1% |
| 09020303-515 (w/o S007-638) | 27.1% | 7.8% | | 4.7% | 23.3% |

IF = Insufficient Data

Continuous DO monitoring data has shown that low DO levels occur regularly within Burnham Creek, particularly in late July through August. Low DO levels coincide with low flow. Drainage and a lack of storage throughout the watershed have a combined result of flashy flows during runoff events.

Hydrographs quickly regress to a baseline of zero flow after runoff events. In mid-summer, flow typically ceases for the remainder of the year.

DO data was cross-referenced with stage data. Flow measurements and "Z" Stream Condition notes (no flow, ponded) can be used to estimate the stage below which there is no flow within Burnham Creek at 320th Avenue Southwest (S007-058).

- The highest stage at which no measurable flow has been observed is 33.4' (RP elevation on the upstream bridge curb= 50', tape down = 16.6').
- The highest stage at which a "Z" (ponded and not flowing) stream condition value has been recorded is 33.7' (tape down = 16.3').
- The highest stage at which a low DO reading was recorded was 33.6 feet (4.83 mg/l).
- The second highest stage with a low DO value is just 33.09 feet, which is well below the zero-flow threshold.
- Low DO readings are common at stages lower than 33.1 (DO5_All = 55.1%).

The data analysis found that the majority of all DO measurements have been recorded on days in which there was no flow. Just 26.1% of the 157 DO5_All (May through September, any time of day) measurements were taken at a stage greater than 33.4 feet. Only 17 measurements within the DO5_All subset were recorded while stage was greater than 33.7 feet (10.8% of all DO5_All measurements). Table 4-8 shows how the DO assessment metrics of DO5_All and DO5_9AM (May through September and earlier than 9:00 a.m.) met the DO standard as long as there was flow within the channel.

**Table 4-8. Dissolved oxygen vs. stage within the 09020303-515 reach of Burnham Creek.**

| Burnham Creek at 320th Ave. SW (S007-058) 20060 – 2012Dissolved Oxygen versus Stage Flow | | | |
|---|---|---|---|
| DO Assessment Metric | All Stages | Stage > 33.4 ft.<br>Tape Down < 16.6 ft. | Stage > 33.7 ft.<br>Tape Down < 16.3 ft. |
| DO5_All Discrete | 0.0% | 0.0% | 0.0% |
| DO5_All Discrete and Continuous | 35.0% | 2.4% | 0.0% |
| DO5_9AM Discrete | IF | IF | IF |
| DO5_9AM Discrete and Continuous | 41.5% | 3.4% | 0.0% |
| Data indicates that a zero threshold at this site exists at the stage between 33.4 feet and 33.7 feet.<br>The RP is a chiseled square on the downstream wooden bridge curb, over the thalweg.<br>The RP elevation is 50 feet.<br>IF=Insufficient Data.<br>The threshold frequency of low DO impairment is 10%. | | | |

In summation, a lack of consistent flow leads to prolonged periods of stagnant water within Burnham Creek. DO becomes depleted within the stagnant pools that form upstream of minor barriers to flow and fish passage and aquatic life is negatively impacted.

### 4.3.3 Kripple Creek, 09020303-525, Fish Biotic Integrity

The lower portion of Kripple Creek (natural channel, AUID 09020303-525) failed to meet the expectations set for "Northern Headwaters – General Use" on the upper end of the reach and Southern Streams – General Use at the lower end of the reach (Figure 4-27). The F-IBI score at site 12RD022 near 180th Avenue Southwest indicates that this reach of Kripple Creek is the most "restorable" biology-impaired waterway in the Red Lake River Watershed. At that location, near the lower end of the reach, the F-IBI score is relatively close to the impairment threshold (41-point F-IBI, 50-point impairment threshold). The 12RD022 sampling site also received a good score for habitat. These scores indicate that the impaired portion of the stream has potential to support a quality fishery and should be a high priority for targeted implementation of projects and BMPs.

The upstream end of this reach is in worse condition than the downstream end, however. The two biological sampling stations were classified differently. The upstream site (05RD077) was held to a lower standard (42-point F-IBI score impairment threshold for Class 6 Northern Headwaters stream) than the downstream site (50-point F-IBI score impairment threshold for Class 2 Southern Streams) and still fell 21 points short of meeting expectations.

In the Red Lake River Watershed Stressor ID Report, the strength of evidence suggested that the F-IBI impairment of this reach of Kripple Creek was likely caused by lack of base flow and low DO.

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are trophic generalists, early maturing, pioneering, short-lived, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). The Stressor ID Report identified nine F-IBI metric responses that provide evidence that a lack of base flow is responsible for causing the F-IBI impairment:

- High relative abundance of taxa that are generalists
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High taxa richness of short-lived species
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

The quantity of water during base flows in Kripple Creek appears to be inadequate. Logically, the DO concentration in water can only affect fish population if there is some water present in the channel. Therefore, a lack of base flow is likely the main cause of the impairment.

Water levels in 2012, during the MPCA’s sampling effort, were exceptionally low (Figure 4-28). The low water levels, alone, could have discouraged fish passage if portions of the channel (riffles) were left dry or nearly dry. The Stressor ID Report calculated an average flow of just 1 cfs for the entire 2012 monitoring season (March 12, 2012 to November 15, 2012). The Stressor ID Report also lists multiple F-IBI metrics that provide evidence of a causal relationship between a lack of base flow and the F-IBI impairment.

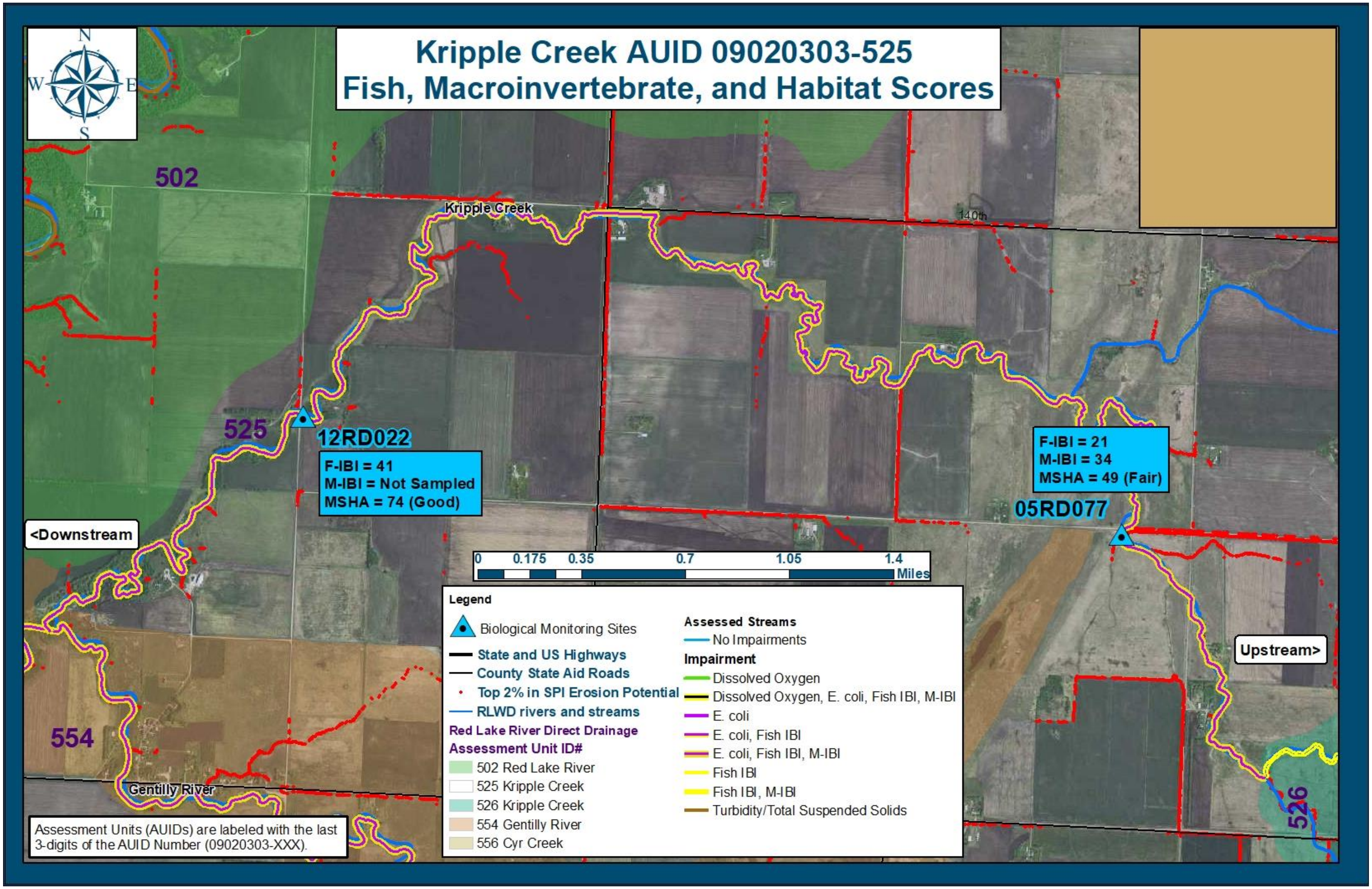


**Figure 4-27. Spatial relationship of 09020303-525 biological sampling sites, F-IBI scores, M-IBI scores, and MSHA scores.**

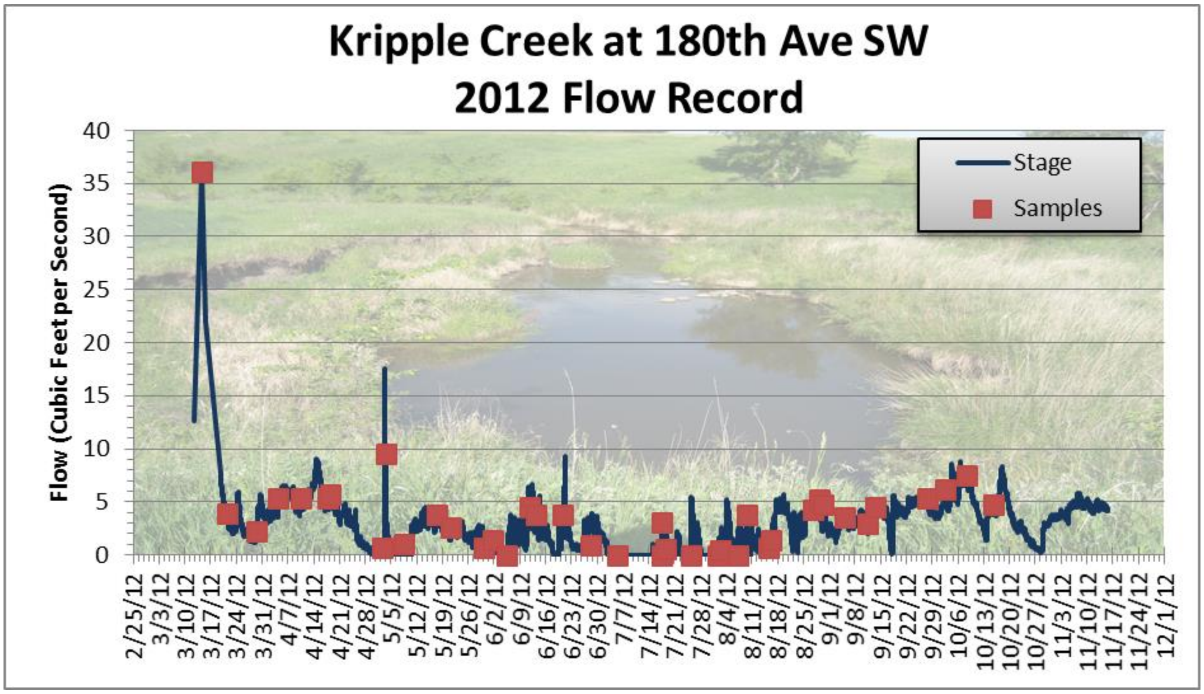

Figure 4-28. 2012 Kripple Creek flow record - showing long periods of low flow.

The Stressor ID Report identified F-IBI metrics that indicate a possibility that low DO is a stressor of aquatic life, but available DO data does not support that assertion. Monitoring data (including data from deployed DO loggers) indicates that DO levels are adequate in Kripple Creek. Including an entire monitoring season of continuous data, DO was measured in 207 days from 2006 through 2015. Only eight (3.9%) of those days had DO levels that dropped below 5 mg/l. Zero days would be ideal, so there is room for improvement. However, 3.9% falls below the 10% impairment threshold.

The Stressor ID Report identified five F-IBI metric responses that may have been caused by a lack of habitat. MSHA scores identified room for improvement in the categories of land use, cover, and morphology. The quality of habitat near the upstream end of this reach (05RD077, upstream of 250th Street Southwest) is worse than the habitat quality found near the downstream end of this reach. The F-IBI score was better at the sampling station where the MSHA score was also better. Although that downstream sampling station received a “good” MSHA habitat rating, it failed to meet F-IBI expectations. This indicates that another stressor is currently affecting fish more significantly than habitat.

Beaver dams have been occasionally observed in Kripple Creek between 180th Avenue Southwest and CSAH 11, and could be a factor that temporarily negatively affects fish passage. Beaver dams have also been found in upstream reaches. However, no dams or other fish passage barriers have been noted downstream of the 12RD022 site (180th Avenue Southwest), and that site still fails to meet the F-IBI standard. Because fish should have unimpeded access to the site, the low F-IBI scores are more likely to be the result of other needs not being met (sufficient water and DO).

Although TSS concentrations can occasionally exceed the 65 mg/l standard, a TSS TMDL will not be written to address this IBI impairment. The Stressor ID Report found no evidence of a causal relationship between TSS and F-IBI scores. The individual F-IBI metrics with low scores along this reach are not known to directly respond to high TSS.

### 4.3.4 Kripple Creek, 09020303-525, Macroinvertebrate Biotic Integrity

Macroinvertebrates were sampled in Kripple Creek at site 05RD077 in 2012. The site received a score of 34 points and failed to exceed the 41-point impairment threshold. In the Stressor ID Report, the strength of evidence suggested that the M-IBI impairment of this reach of Kripple Creek was likely caused by lack of base flow, excess suspended sediment, and low DO.

Frequent and/or prolonged periods of very low or no-flow tend to limit Trichoptera taxa, many of which are collector-filterers, and favor taxa that are tolerant of environmental disturbances (EPA 2012; Klemm et al. 2002, Poff and Zimmerman 2010). According to the Stressor ID Report, low scores from five of the M-IBI metrics relating to Trichoptera, collector/filterers, and intolerant species provide evidence of a causal relationship between a lack of base flow and the M-IBI impairment:

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

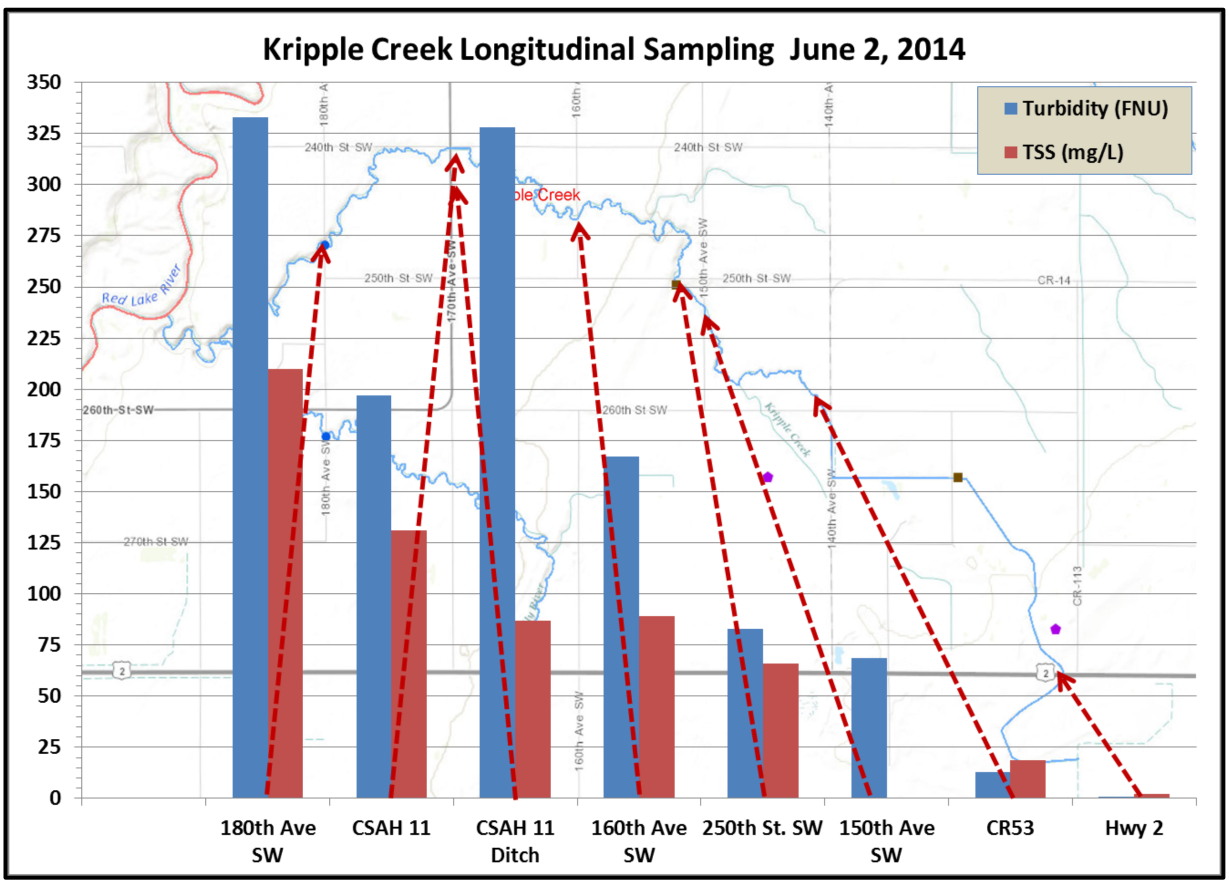


Figure 4-29. Kripple Creek longitudinal turbidity and TSS sampling results.

The Stressor ID Report found five M-IBI metric responses that provide evidence that excess sediment is a stressor that is negatively affecting aquatic macroinvertebrates. Because the reach meets the applied 65 mg/l water quality standard; however, a TSS TMDL is not necessary to meet current TSS standards for this reach and a TMDL will not be written at this time. The stream exceeded 30 mg/L TSS in 14.8% of 2006 through 2015 samples, but it is not currently required to meet that more protective TSS standard. Agricultural and stream channel erosion reduction should be suggested as protection strategies in the Red Lake River WRAPS document. Although Kripple Creek meets the 65 mg/l TSS standard, excess suspended sediment and turbidity have been documented in Kripple Creek during runoff events. Ditches carry runoff from poorly buffered fields. The turbidity measured in a ditch entering Kripple Creek at CSAH 11 was 328 NTRU during a June 2, 2014 rain event. The TSS concentration near the 05RD077 biological sampling site exceeded the 65 mg/l standard during the June 2, 2014 runoff event (Figure 4-29).

The Stressor ID Report provided evidence that DO is a stressor of aquatic life in this reach of Kripple Creek in the form of five M-IBI metric responses. Low DO readings are infrequent, however, and DO is not likely to be the primary cause of the low IBI scores. The stream is meeting the 5 mg/l DO standard, but low DO concentrations occur occasionally. Data analysis revealed that low flows in the stream have limited DO concentrations. DO data was cross-referenced with flow data to determine the extent to which low DO levels are connected to stagnant water conditions. In the 207-day history of monitoring in the watershed have been eight days in which DO levels lower than 5 mg/l have been recorded. The average flow in seven of those eight days was less than 1 cfs. Half of the low DO readings have been recorded during times of zero flow. Filtering days with zero cfs from the DO record resulted in improved assessment results for two DO assessment metrics.

- 3.9% = Rate of low DO, May through September, any time of day (8/207)
- 2.1% = Rate of low DO, May through September, any time of day, Flow >0 cfs (4/190)
- 5.8% = Rate of low DO, May through September, earlier than 9:00 a.m. (8/139)
- 3.2% = Rate of low DO, May through September, earlier 9:00 a.m., Flow >0 cfs (4/125)

Fish scores within the Kripple Creek Watershed also appear to be closely correlated to habitat quality scores (Figure 4-30). Projects and BMPs should be implemented to improve aquatic habitat quality within Kripple Creek. The MPCA's assessment gave portions of Kripple Creek low MSHA scores for land use (07RD006) and substrate (12RD044).

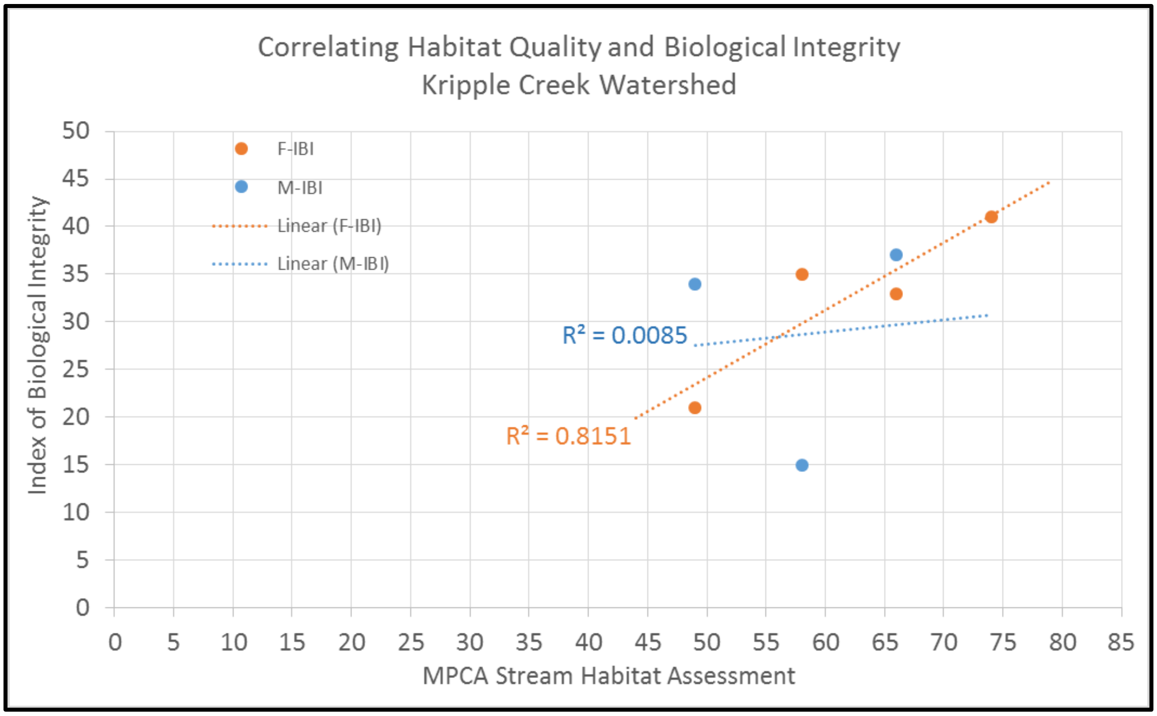


Figure 4-30. Correlation between MPCA Stream Habitat Assessment (MSHA) cores and index of biological integrity scores.

Overall, the macroinvertebrate assemblage of the station was dominated by taxa that are adapted to lentic conditions (i.e., Hyalella and Physa). Compared to the relatively low frequencies of high TSS (6.7%) and low DO (3.9%) in 2006 through 2015 data, the prevalence of low flows that are less than 1 cfs (69% in 2012) is the stressor that is most chronically limiting the quality of aquatic life communities within Kripple Creek. Based on the scores of individual M-IBI metrics, Trichoptera is an order of insects that is notably lacking within Kripple Creek. Elevated TSS concentrations, low quality buffers, and insufficient base flow may contribute to the inadequate Trichoptera populations. The scores related to Trichoptera were not zero, so there is potential in this stream. If projects and practices are implemented successfully, there is reason to suspect that Kripple Creek sampling could yield better M-IBI scores when it is sampled again in 2022.

### 4.3.5 Kripple Creek, 09020303-526, Fish Biotic Integrity

The fish community of AUID 526 was monitored at Station 07RD006 in 2007 and Station 12RD044 in 2012. The stations were designated as General Use within the Northern Headwaters (Class 6) F-IBI Class. Accordingly, the applicable impairment threshold for these stations is an F-IBI score of 42. Both stations had an F-IBI score below this threshold, as shown in Figure 4-31. The Red Lake River Watershed Stressor ID Report found that evidence suggested that the F-IBI impairment is likely attributed to the following stressors:

1. Lack of base flow
2. Lack of instream habitat
3. Low DO levels

A lack of base flow is a limiting factor for biological integrity in the downstream reach of Kripple Creek (525). Logically, flows would be even lower in the upstream AUID 526. When site 12RD044 was sampled on July 12, 2012, flow had been at 0 cfs for a full week and less than 1 cfs for 10 days prior to the biological sampling date at the 180th Avenue Southwest crossing of Kripple Creek. Evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 526 is provided by many individual F-IBI metric responses for Stations 07RD006 and/or 12RD044:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of taxa that are generalists
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are serial spawners
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

The MSHA habitat scores for this reach's two sampling stations resulted in "fair" ratings for both sites. There is room for improvement, particularly in the land use and substrate aspects. Approximately 77% of the watercourses in the Kripple Creek Subwatershed have been hydrologically altered (i.e. channelized, ditched, or impounded), including 83% of AUID 526. The Stressor ID Report found four F-IBI metric responses that indicated that in-stream habitat is a stressor of aquatic macroinvertebrates:

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- Low taxa richness of darter and sculpin species
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species

Low DO is listed as candidate cause of the low F-IBI scores. The Stressor ID Report listed six F-IBI metrics as evidence that the low F-IBI scores were caused by low DO.

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

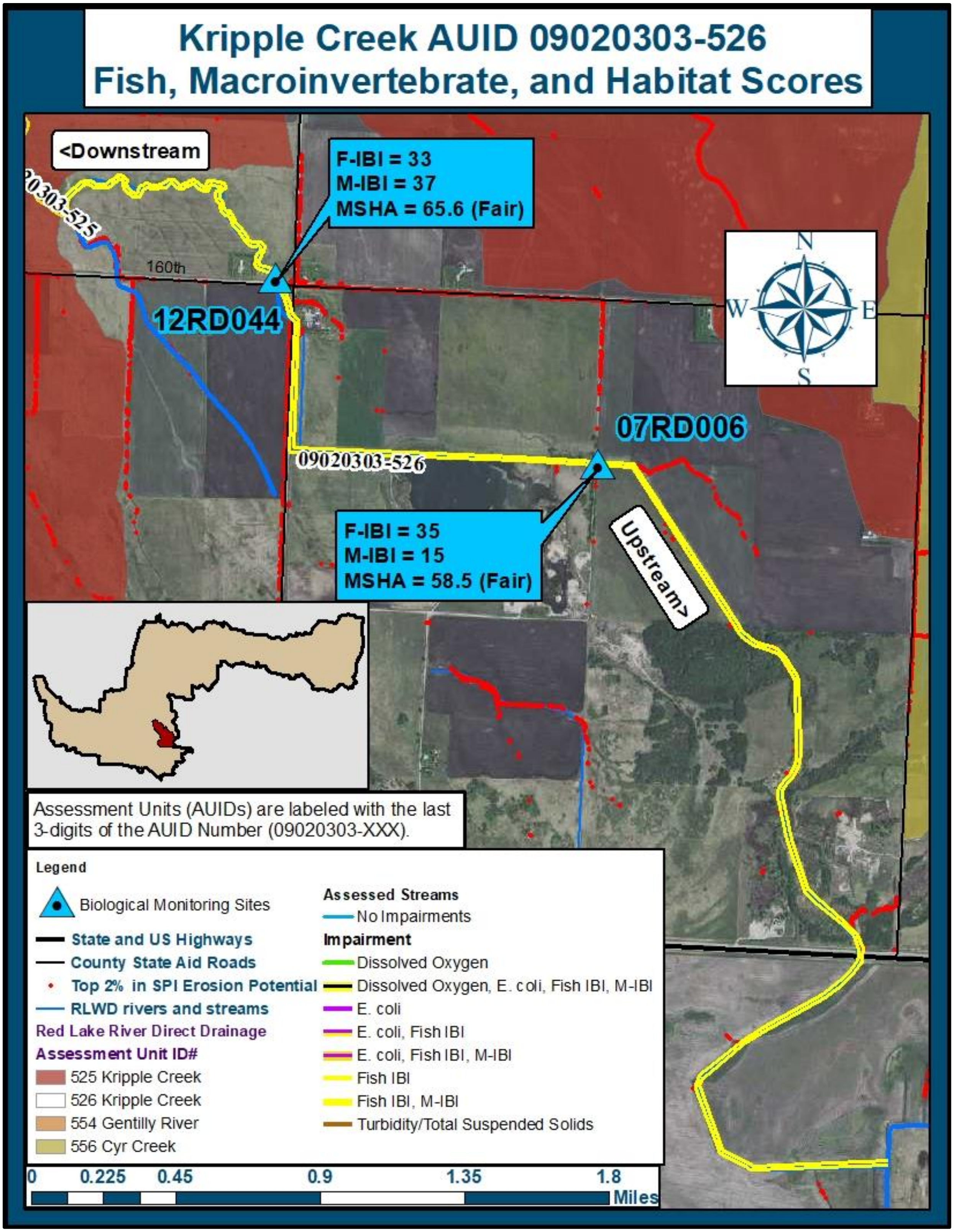


**Figure 4-31. Habitat and IBI scores along the 09020303-526 reach of Kripple Creek.**

The DO monitoring data from this reach, albeit limited, contradicts findings of the Stressor ID Report. The amount of monitoring data is very limited, but there have been no low DO readings recorded in this reach of Kripple Creek. An August 2014, deployment of a DO logger recorded zero DO concentrations lower than the 5 mg/l standard. Daily average flows during that August 14, 2014 to August 27, 2014, deployment ranged from 1.2 cfs to 4.3 cfs at the (downstream) 180$^{th}$ Avenue Southwest crossing. The limited data set does not include any DO measurements that were recorded during periods of zero flow. If flow drops to zero cfs, there would be stagnant pools in which DO levels could logically drop below the standard. Even if low DO conditions would be present in stagnant pools, a lack of base flow would still be the root cause in those cases.

### 4.3.6 Kripple Creek, 09020303-526, Macroinvertebrate Biotic Integrity

The macroinvertebrate community of AUID 526 was monitored at Station 07RD006 in 2007 and Station 12RD044 in 2012. The stations were designated as General Use within the Prairie Streams-Glide/Pool Habitats M-IBI Class. Accordingly, the applicable impairment threshold for these stations is an M-IBI score of 41. Both stations had an F-IBI score below this threshold, as shown in Figure 4-31.

The Red Lake River Watershed Stressor ID Report found that evidence indicates that the M-IBI impairment is likely the result of the following stressors:

- Lack of base flow
- Lack of instream habitat
- Low DO levels
- High suspended sediment

The Stressor ID Report identified nine M-IBI metric responses (low scores) that likely resulted from a lack of base flow.

- Low relative abundance of collector-filterer individuals
- High relative abundance of the dominant five taxa in a subsample
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

The MSHA habitat scores for the two sampling stations on this reach resulted in “fair” ratings for both sites. There is room for improvement, particularly in the land use and substrate aspects. Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects to attach themselves to, while burrowing and legless macroinvertebrates are tolerant of degraded benthic habitat. The

Stressor ID Report found four M-IBI metric responses that provide evidence that in-stream habitat is a limiting factor for aquatic macroinvertebrates:

- High relative abundance of burrower individuals
- Low taxa richness of clinger taxa
- Low relative abundance of collector-filterer individuals in a subsample
- High relative abundance of legless individuals

The Stressor ID Report found eight M-IBI metric responses that suggest that low DO is a limiting factor for aquatic macroinvertebrates in this reach of Kripple Creek. As described in Section 4.3.5; however, monitoring data indicates that DO levels are sufficient while there is flow in the stream.

- High Hilsenhoff's Biotic Index value
- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

The Stressor ID Report listed five M-IBI metric responses as evidence that TSS is a stressor of aquatic macroinvertebrates within this reach. Longitudinal sampling during a significant rainfall event in June of 2014 revealed that high TSS is not a problem in this reach (Figure 4-29). Near the headwaters of the reach, during a rainstorm, turbidity was only 0.4 NTRU at the Highway 32 crossing (S008-100). Large wetland and prairie restorations within the Glacial Ridge National Wildlife Refuge filter runoff in the headwaters of this reach. Because there is insufficient data for a formal assessment of TSS on this reach, additional sampling is recommended.

The rationale expressed in the previous section about the F-IBI impairment along this reach of Kripple Creek would also apply to the M-IBI impairment. A lack of base flow and inadequate habitat quality would be the primary stressors for this impairment. Low DO would most likely be a result of low flow and does not seem to be an independent stressor. Additional monitoring is advised for this reach.

### 4.3.7 Little Black River, 09020303-528, Fish Biotic Integrity

The Red Lake River Watershed Stressor ID Report found that the evidence suggests that the F-IBI impairment is likely attributed to the following stressors:

- Loss of physical connectivity
- Lack of base flow, lack of instream habitat
- Low DO levels

The most obvious stressor to fish in this reach is the Baird-Beyer on-channel conservation dam. The Stressor ID Report examined evidence and found that fish sampling data and IBI metrics show that "the Baird-Beyer Dam is undoubtedly limiting the species diversity of the reach." Beaver dams have also been observed along this reach.

The quality of fish communities sampled downstream of the Baird-Beyer Dam (Figure 4-32) have been significantly greater than those collected upstream of the dam. The fish assemblage sampled upstream of the dam at Station 12RD024 (near water quality site S008-111 and the County Road 102 crossing) was comprised of 178 individuals and only 4 species: brook stickleback, central mudminnow, fathead minnow, and northern redbelly dace. These species are early maturing and non-migratory. In 2003, the DNR conducted fish sampling at a station located immediately downstream of this reach along the lower extent of the Black River (Groshens 2005). The sampling yielded 382 individuals and 22 species, including 10 sensitive species. Evidence of a causal relationship between a loss of physical connectivity and the F-IBI impairment associated with AUID 528 is also provided by two individual F-IBI metric responses for Station 12RD024.

- Low relative abundance of individuals with a female mature age of equal to or greater than three years, excluding tolerant taxa
- Low relative abundance of individuals that are migratory

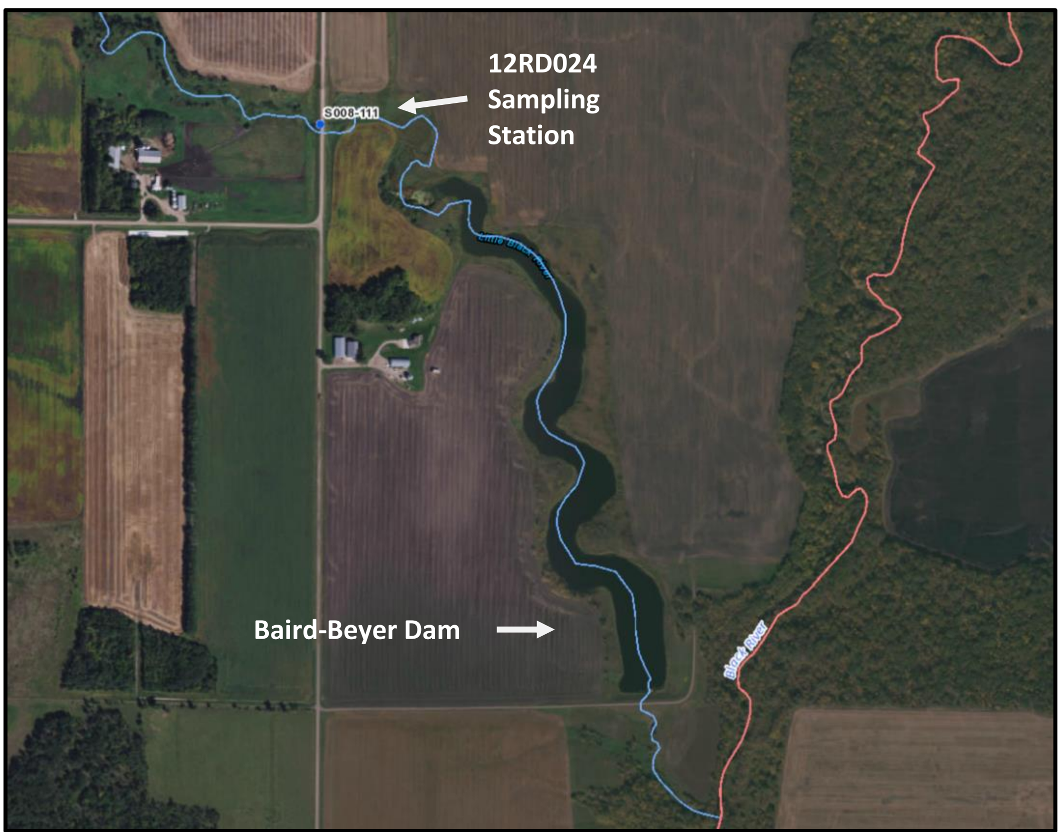


**Figure 4-32. Aerial view of the Baird-Beyer Dam on the Little Black River.**

There is evidence that a lack of flow may also be a limiting factor for fish populations in this lower reach of the Little Black River. Flow was insufficient for MPCA macroinvertebrate sampling in 2012. Evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 528 is provided by nine individual F-IBI metric responses for Station 12RD024.

- High combined relative abundance of the two most abundant taxa
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are serial spawners
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Despite abundant riffle habitat and coarse substrate, the Stressor ID Report also identified poor instream habitat as a stressor. Evidence of a causal relationship between a lack of instream habitat and the F-IBI impairment associated with AUID 528 is provided by six individual F-IBI metric responses (Appendix C) for Station 12RD024.

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- Low taxa richness of darter and sculpin species
- High relative abundance of taxa that are detritivorous
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species
- Low taxa richness of simple lithophilic spawning species

Data strongly indicates that low DO can be a limiting factor for aquatic life in this reach. Continuous data collected in 2014 resulted in daily minimums that consistently fell below the 5 mg/l standard. No flow monitoring has been conducted and no flow rating curves have been developed, but stream condition metadata indicated that flows were normal during site visits throughout July and August of 2014 - a period of time when DO concentrations were regularly low in continuous and discrete data. Evidence of a causal relationship between low DO and the F-IBI impairment associated with AUID 528 is provided by five individual F-IBI metric responses for Station 12RD024.

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Because it is not realistic to expect to find particular indicator species for the low flow or instream habitat stressors if the fish are unable to migrate to the site, there is less certainty about the direct effects of low flow and, particularly, in-stream habitat upon F-IBI scores. The conclusion of this report is that the Baird-Beyer Dam is the primary reason for poor F-IBI scores along this reach. Until fish migration from the Black River to the Little Black River is made possible, expectations for fish populations in this reach are going to remain low. The potential of this reach to support aquatic life is further limited by low DO levels. Another conclusion is that macroinvertebrate populations should be sampled prior to the next assessment in order to better assess the ability of this stream to support aquatic life. Future monitoring efforts should determine the relationship between DO and flow. Continuous stage/flow and continuous DO data should be collected simultaneously throughout a monitoring season and a full range of flow conditions. This data should then be analyzed to determine whether or not low DO levels mostly occur during zero/low flow conditions or if they occur consistently throughout a broad range of flows.

### 4.3.8 Judicial Ditch 60, 09020303-542, Dissolved Oxygen

Discrete and continuous DO data collection has shown that Judicial Ditch 60 (JD60, Figure 4-33) is not meeting the 5 mg/l DO standard. Water quality in JD60 was tested for the first time in 2012 at the start of the Red Lake River WRAPS and Surface Water Assessment Grant (SWAG) projects. The following assessment statistics are the result of an assessment of data collected during a 2006 through 2015 assessment period (only data from 2012 through 2015 exists for this reach).

- DO12_All (discrete data) = 12.5% violation rate of the DO standard
- DO5_All (discrete data) = 13.3% violation rate of the DO standard
- DO5_All (discrete and continuous data) = 69.5% violation rate of the DO standard
- DO5_9am (discrete and continuous data) = 94.6% violation rate of the DO standard

This portion of JD 60 is not an altered natural watercourse, but rather, an artificial watercourse that was constructed to intercept overland runoff and reduce flooding of fields. The channel did not exist prior to its construction. The MPCA have not sampled fish or macroinvertebrates in this reach of JD60. The channel was constructed to provide drainage, not habitat. Flow is intermittent within the JD60 channel, but water does remain in deeper pools throughout the year. It is important, nonetheless, to have some knowledge of water quality within the reach so that its impact upon receiving waters is known. The reach (upstream of the monitoring site) does not appear to be contributing to the TSS problem in the Red Lake River. Zero exceedances of the 65 mg/l TSS standard have been recorded. However, there appears to be dramatic stream channel instability, erosion, slope failures, and mass wasting downstream of CSAH 11. *E. coli* concentrations have met Minnesota's water quality standards. TP is exceeding the standard, but the dataset is insufficient. Only two samples were collected on days in which there was measurable flow.

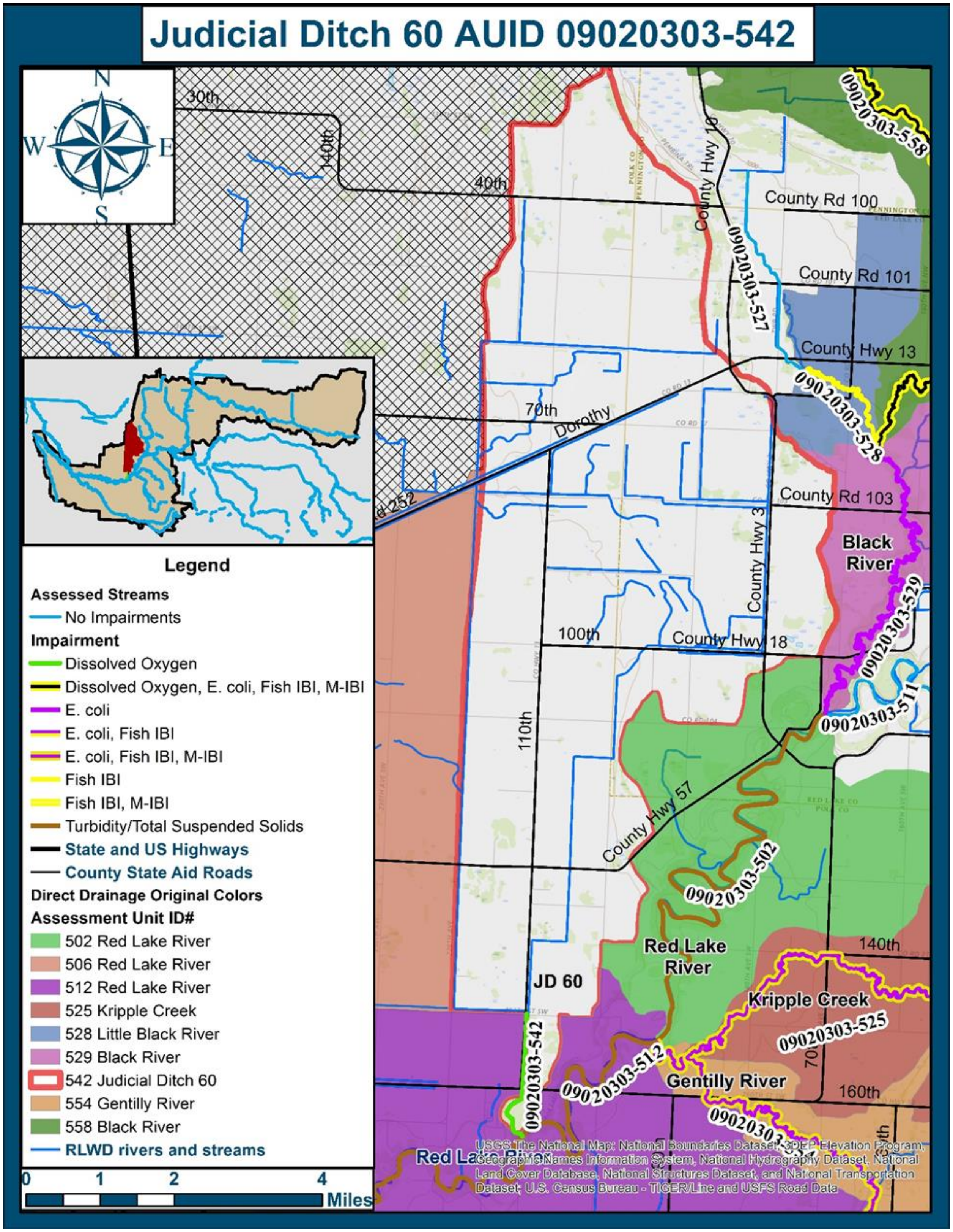


**Figure 4-33. Judicial Ditch 60 Subwatershed and AUID Location.**

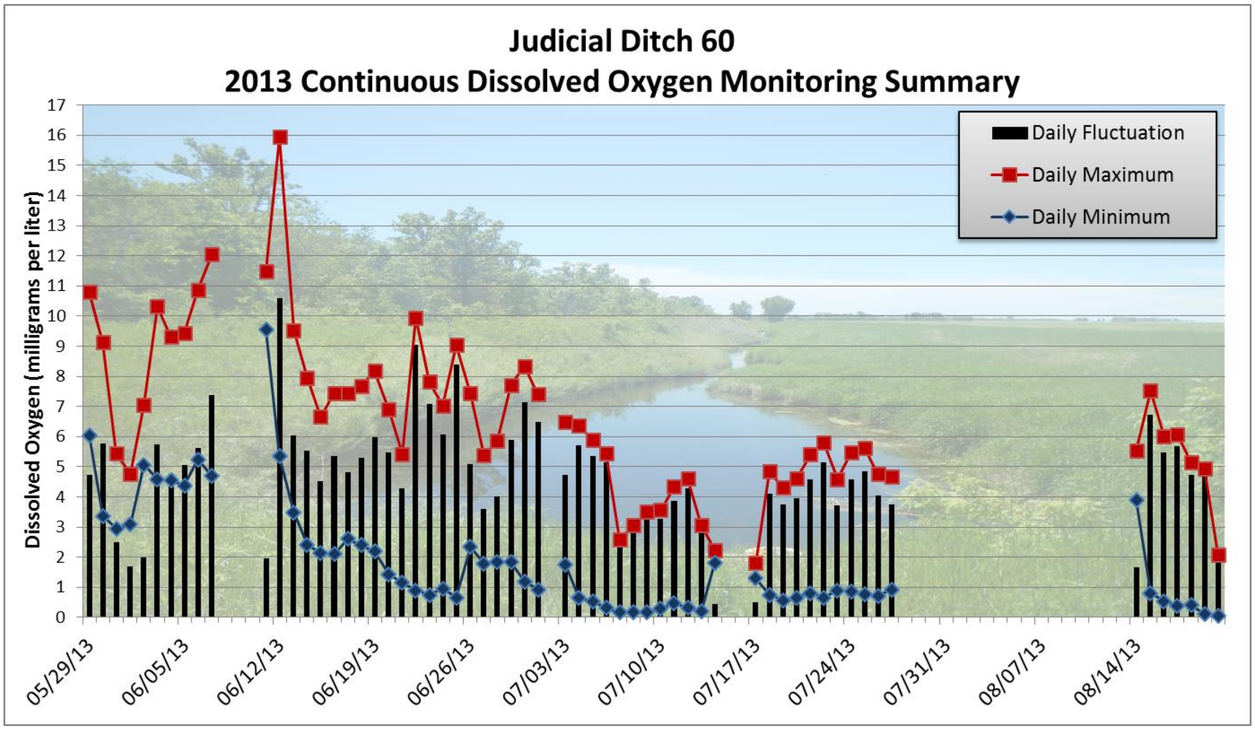


Figure 4-34. JD60 2013 continuous DO monitoring summary.

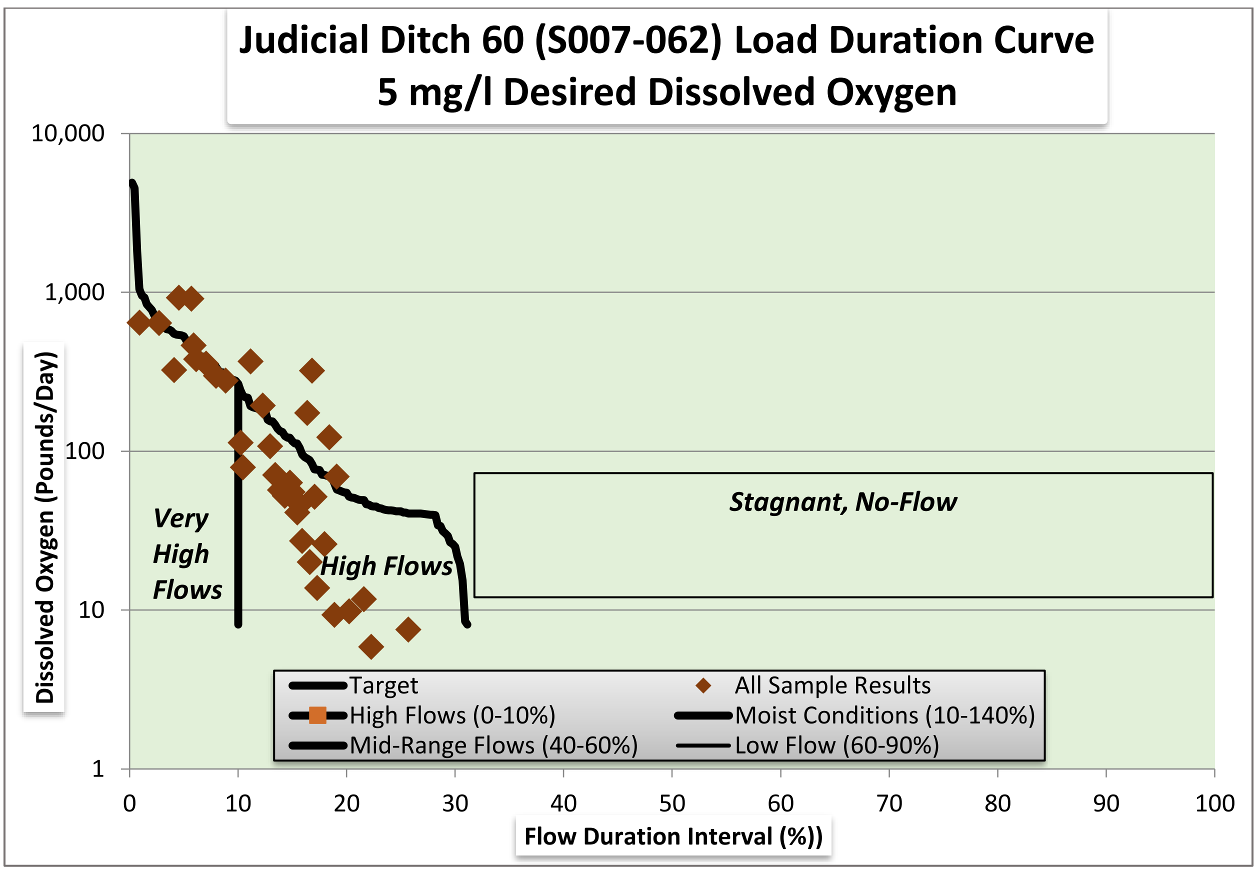


Figure 4-35. Load duration curve: desirable DO loads in JD60 compared to measured concentrations.

Stagnant water conditions exist for extended periods of time during the summer in JD60, downstream of 250th Street Southwest at site S007-062. Figure 4-34 shows how low DO readings became more common in the latter part of the summer when water becomes stagnant. Some of the daily maximums failed to reach 5 mg/l during the warm summer months. Aerial photos indicate that stagnant water is also a problem along upstream reaches of JD60 (intermittent pools of pooled water that are covered with algae and pondweed). Even if there is some flow in the channel, pools such as the one downstream of 250th Street Southwest can still be somewhat stagnant. Flow within JD60 is intermittent. Little more than 30% of the flows measured within JD60 have been greater than zero cfs. Low DO concentrations have occurred throughout the entire range of flows during which DO has been measured at the site (0-38.79 cfs). The LDC in Figure 4-35 shows how DO levels have been insufficient during measurable flows and worse at lower flows.

Data were analyzed to determine whether nutrient loads were influencing DO concentrations. Data analysis found that TP was the only pollutant that could potentially be considered a pollutant of concern in JD60. The small TP dataset shows a negative, but weak, correlation between TP and DO. Only 12 samples have been collected, but nine of those samples have exceeded the 150 µg/l TP standard. No low DO readings have been recorded while TP is meeting the 0.15 mg/l standard, but there are only two such measurements. The June through September summer average during the 2012 through 2013 duration of sample collection was 269 µg/l.

High TP concentrations in this ditch would not translate into high loads because the high concentrations have occurred during times of very low or zero flow. Because high TP concentrations occur during periods of low flow and stagnant water, TP loads would be minimal.

Further analysis discovered that high TP concentrations in JD60 are caused by high orthophosphorus (OP) concentrations. High OP concentrations are a product of anaerobic conditions in stagnant water, rather than a cause of the low DO levels (Gunnison 1985). The average OP concentration was 448 µg/l. The majority of the phosphorus present was in the dissolved inorganic form. High TP and OP concentrations have been occurring during periods of low flow and stagnant water. TP concentrations have ranged from .05 to .52 mg/l for sampling events during which flow was zero cfs. At lower flows, OP concentrations represent a greater portion of the TP in samples. The two highest concentrations of OP occurred on days in which the average flow was zero cfs.


**Figure 4-36. JD60 at S007-062 on August 14, 2013; DO was low, flow was 0 cfs, and filamentous algae growth was extensive.**

There is some evidence that indicates that temperatures may be elevated within JD60 relative to other streams during the warmer summer months. The absence of riparian cover and a lack of water movement (Figure 4-36) are two suspected reasons for the increased temperatures. JD60 data was compared to that of a nearby stream with a similarly sized drainage area that is meeting the DO standard. The continuous DO monitoring sites on JD60 (S007-062) and Kripple Creek (S004-835) are located only three miles apart. However, DO levels were dramatically different. In 2013, DO and temperature loggers were deployed in both JD60 and Kripple Creek. The Kripple Creek continuous DO data met the DO standard, but daily minimum DO concentrations in JD60 consistently fell below 5 mg/l. DO levels in JD60 were okay through mid-June of 2013, but then consistently fell below 5 mg/l from late June through August.

Temperature and flow data from JD60 and Kripple Creek are compared in Figure 4-37. Throughout the entire monitoring season, the average difference in temperature between JD60 and Kripple Creek was minimal. For the month of July however, daily average JD60 water temperatures were an average of 1.45˚C higher than daily average water temperatures in Kripple Creek. The difference in flow was more dramatic than the difference in temperatures. The July 2013 flows in JD60 and nearby Kripple Creek are compared in Figure 4-38. Kripple Creek continues to flow throughout the month. Flows in JD60 ceased early in the month and remained at zero cfs throughout the month of July. The lower temperatures and the relatively more consistent flow in Kripple Creek (Kripple Creek also needs improvement to base flows) helped maintain sufficient DO concentrations throughout July 2013. In JD60, a lack of riparian cover led to increased temperatures and a lack of base flow led to stagnant conditions. The increased temperatures and lack of flow resulted in low DO concentrations in JD60. In addition, JD60 has a very low gradient upstream of the primary monitoring site compared to the gradient upstream of the primary Kripple Creek monitoring site.

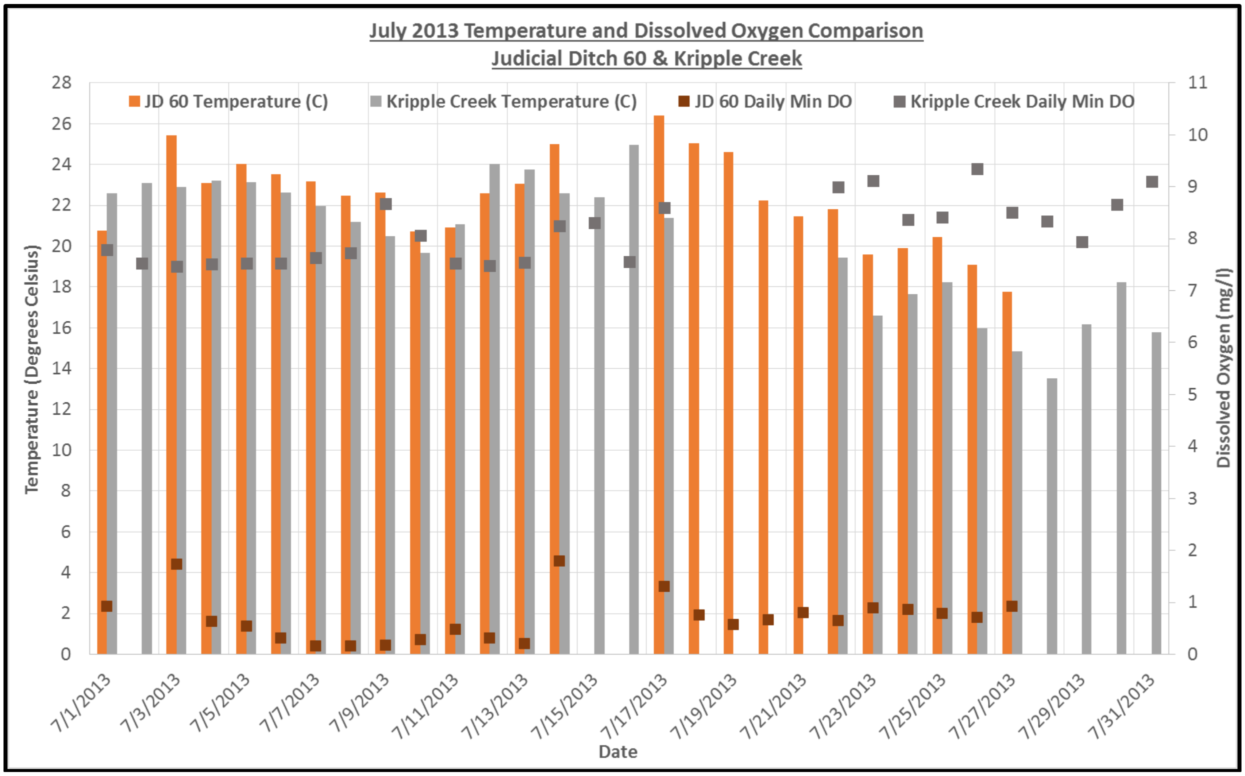


Figure 4-37. JD60 and Kripple Creek July 2013 Temperature and Dissolved Oxygen Comparison.

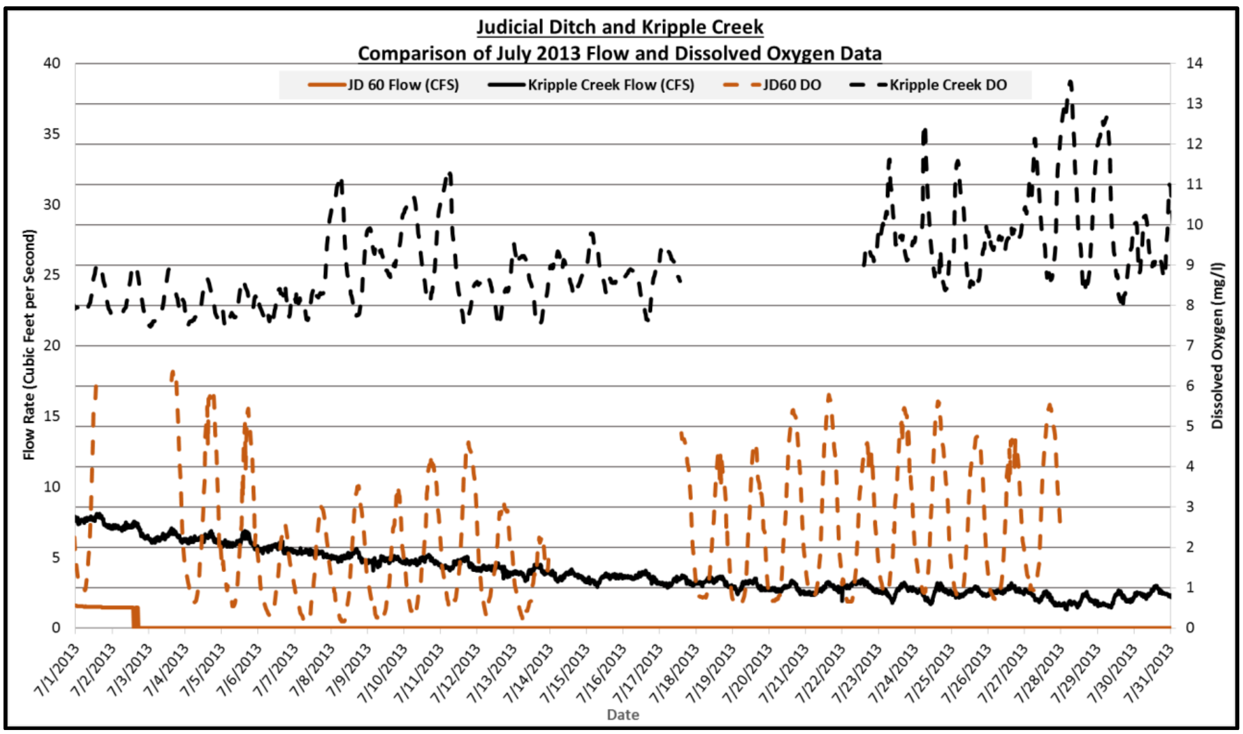


Figure 4-38. Comparison of July 2013 flow and DO data collected in JD60 and Kripple Creek.

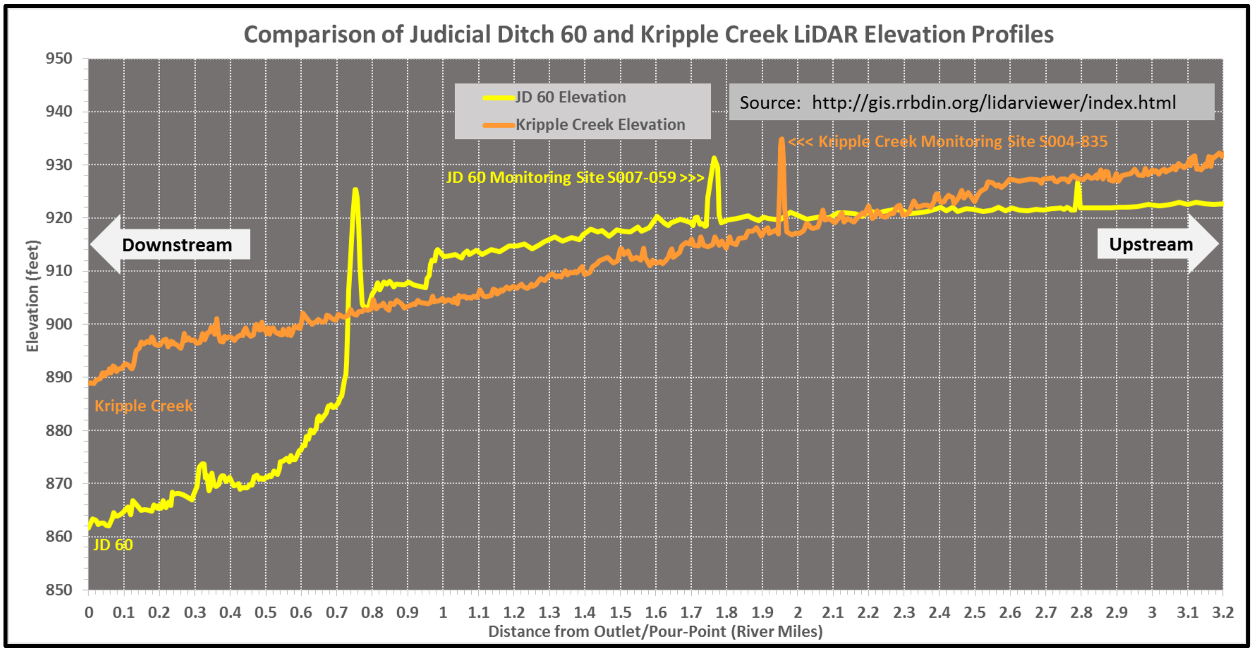


Figure 4-39. Judicial Ditch 60 (09020303-542) LiDAR Elevation Profile.

Low DO is not the only factor that is limiting aquatic life in JD60. There is an impassable fish barrier at CSAH 11 in the form of a very significantly perched culvert (Figure 4-39). There is a rock structure upstream of CSAH 11 that is another barrier to fish passage. Of the nine miles of JD60 upstream of 250th Street Southwest, at least 3.5 miles of ditch are lacking an adequate buffer.

The low DO problem in JD60 appears to be mainly caused by morphology and a lack of base flow. No pollutant impairments have been identified on the reach. No pollutants could be proven to be pollutants of concern. Therefore, a pollutant-based TMDL will not be written for this reach. Improvements in buffers and base flow are recommended. Prescribing protection strategies in the WRAPS for sediment and nutrient reduction would still be appropriate. Unless the outlet of the ditch and the perched culvert at CSAH 11 are addressed, expectations for the support of fish populations within JD60 are going to remain very low. The collection of a greater amount of sampling data during positive flow conditions would be a goal to consider adding to local monitoring plans.

### 4.3.9 Branch 5 of Pennington County Ditch 96, 09020303-545, Fish Biotic Integrity

This short (one mile) segment of the Pennington County Ditch (CD96) drainage system flows between Branch 5 and Branch 3 of the system through the centers of Sections 26 and 35 of Sanders Township in Pennington County, Minnesota (Figure 4-40). The fish community of AUID 545 was monitored at Station 12RD039 (0.1 mi downstream of the CR 57 crossing) on June 18, 2012. The station was designated as Modified Use within the Northern Headwaters F-IBI Class. The applicable impairment threshold for the station was an F-IBI score of 23. The station had an F-IBI score of zero. The only taxa sampled at the station were brook stickleback and central mudminnow.

The Red Lake River Watershed Stressor ID Report found that the evidence suggests that the F-IBI impairment is likely attributed to lack of base flow and low DO.

The Stressor ID Report identified six F-IBI metric responses that provide evidence that a lack of base flow is limiting fish populations in this ditch.

- High combined relative abundance of the two most abundant taxa
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are tolerant

Fish sampling along this reach occurred on June 18, 2012. Flow at the Highway 32 crossing of CD96 was zero cfs on that day. Flow records have shown zero-flow conditions are common in the mid-to-late summer in the CD96 Watershed. If there was no flow at the Highway 32 crossing, then flow was likely to be similarly low at the 12RD039 sampling site, 4.7 miles upstream.

The Stressor ID Report concluded that poor habitat was not a significant cause of the very low poor fish scores. The MSHA habitat assessment scores were adequate (better than a “fair” rating) for the categories of land use, riparian quality, substrate, and cover. The reach did score poorly in the morphology category, which is not surprising for a ditch. The scores and ratings nonetheless indicate that there is room for habitat improvement along this channel. Portions of the ditch do not have an adequate buffer, as shown in Figure 4-41. Upstream ditches that flow into this reach are also insufficiently buffered. In addition to the lack of the buffer width that is required by law, the quality of the riparian buffer along this ditch provides limited, if any shading.

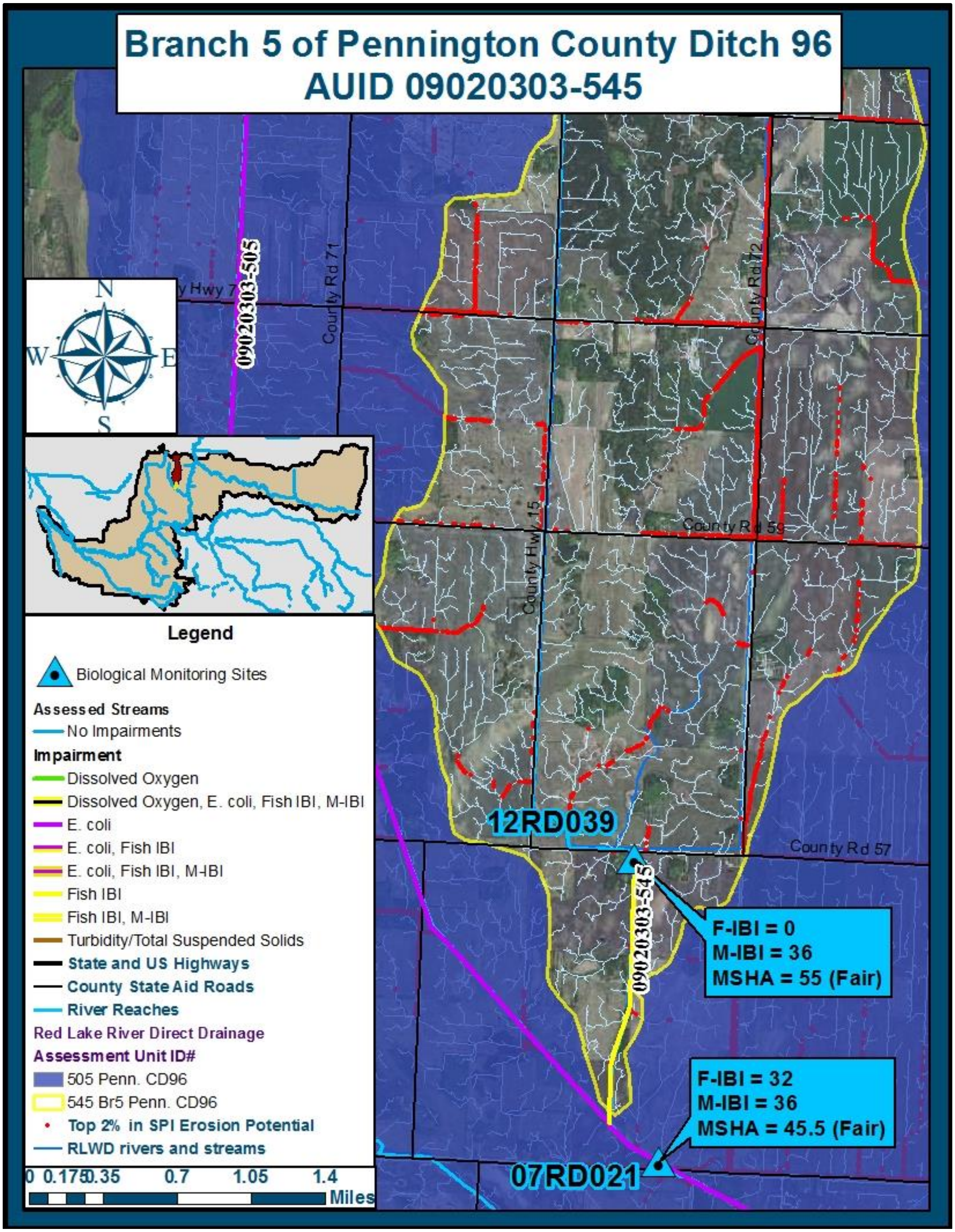


Figure 4-40. IBI and MSHA scores for Branch 5 of CD96 and a downstream portion of CD96.


Figure 4-41. Photo of the 09020303-545 reach of Pennington County Ditch 96.

Six F-IBI metric responses provide evidence that low DO levels could be a liming factor for fish populations within this ditch.

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Poor DO levels have been documented in the CD96 Watershed. Continuous DO monitoring was conducted throughout the summer of 2013 along a downstream reach at the S005-683 monitoring site at Highway 32. Nearly 65% of the days in which DO was measured prior to 9:00 a.m. by a DO logger or a discrete measurement had minimum DO concentrations that were less than 5 mg/l. The DO problem occurs when there is flow in the ditch. The DO data from the S005-683 monitoring site still violates the standard on 37.7% of days in which flows are greater than 5 cfs. Two discrete measurements of DO have been below 5 mg/l. However, there are additional reasons why the 09020303-505 reach is excluded from the 2016 Draft List of Impaired Waters. Biological data from that reach indicated that it is supporting aquatic life. Additional monitoring was recommended.

The MPCA staff deployed a DO logger along reach 545 in late July and early August of 2014. DO dropped below 5 mg/l (as low as 0.04 mg/l) on every single day of that deployment. Flow (from the watershed) seems to have a positive effect upon DO in reach 545. Despite the sub-5 mg/l readings, daily minimum DO levels were higher when there was a higher rate of flow at S005-683. Flows ranged from 0 cfs to 182 cfs during that deployment. Daily DO fluctuation also decreased during higher rates of flow. The good M-IBI score contradicts the assertion that water quality (DO) conditions in the reach were inadequate for aquatic life. There is no pollutant data available from this reach, so the identification and/or rejection of potential pollutants of concern are not currently possible on AUID 09020303-545.

There was insufficient evidence to conclude that connectivity was a primary stressor in the Stressor ID Report. The Monitoring and Assessment Report stated that there was sufficient flow during the 2012 sampling event; however, 2012 was a particularly dry year. The low flow conditions would have ensured that minor or temporary barriers like beaver dams would have been limiting fish passage. There are fish passage barriers that would reduce physical connectivity during low and moderate flows. A rock check dam was identified during fish sampling that was a potential barrier during low flows. The CD96 culvert at the State Highway 32 crossing is significantly perched. Beaver dams are visible in aerial photos. Further evidence that fish passage is a primary stressor is that the macroinvertebrate score for this reach was 63.6% better than the impairment threshold. The good M-IBI score indicates that water quality conditions and habitat are adequate for aquatic life, but lack of flow and physical connectivity could be preventing the migration of fish to this reach. A site along the main channel of CD96 (07RD021 on Reach 09020303-505) yielded an acceptable F-IBI score of 32 during a 2007 sampling effort. Flow and fish passage conditions, however, could have been different between that sampling event and the 2012 sampling event on 09020303-545. The sampling events were separated by nearly five years. Some of the headcutting that has occurred along CD96 downstream of Highway 32 could have happened during those five years. M-IBI scores, however, were identical at the two sites. This provides further evidence that something other than in-stream water quality or habitat is limiting the quality of fish populations.

In conclusion, data indicates that a lack of flow is limiting DO concentrations and is exacerbating fish passage barriers in the watershed. The main channel of CD96 is in need of a grade stabilization project that alleviates the problem of the perched culvert at the Highway 32 crossing. There is insufficient evidence to suggest that a TMDL for TSS or nutrients would improve F-IBI scores.

### 4.3.10 Pennington County Ditch 43, 09020303-547, Fish Biotic Integrity

Pennington County Ditch 43 (CD43) is a drainage ditch along CSAH 27 in the eastern part of the county. It drains in a southerly direction and empties into the Red Lake River approximately 700 meters downstream of the CSAH 27 crossing of the Red Lake River. The fish community of AUID 547 was monitored at Station 12RD045 (0.1 mi upstream of the CSAH 3 crossing) on June 18, 2012. The station was designated as Modified Use within the Low Gradient F-IBI Class. Despite having the limited habitat of a ditch channel, the F-IBI score in CD 43 had a score of 18, which was above the 15-point impairment threshold for that classification. However, the station had five individual metrics that scored below the threshold score. While the F-IBI score slightly exceeded the impairment threshold, the reach was determined to be impaired based upon the station’s limited sample population (less than 25 individuals) that was dominated by tolerant species (i.e., brook stickleback, central mudminnow, and fathead minnow). According to the MPCA’s assessment:

> "Four tolerant fish species were caught, resulting in a score that was slightly above the modified use threshold, but within the confidence interval. Extremely low numbers of fish and species suggest severe impairment and a fish-IBI score may not be adequately reflecting (the) biological condition. For this reason, an impairment based on fish was assigned. Consistent with the 2016 Guidance Manual, scores within the confident interval are considered potentially impaired and supporting information is utilized to help complete the assessment. In this case, the poor number of species and overall fish indicated that the reach was not meeting aquatic life use."

The water level conditions in 2012, when fish were sampled, represent a worst-case scenario of climatic conditions due to the dry conditions and watershed-wide low flows.

The conclusion of the Stressor ID Report was that the F-IBI impairment in AUID 547 is likely attributed to lack of base flow, lack of in-stream habitat, and low DO.

The CD43 channel is a ditch that was constructed along the eastern side of CSAH 27. The channel empties into an oxbow from the original (pre-channelization) course of the Red Lake River (Figure 4-42). Because it is a ditch, constructed for drainage purposes, the in-stream habitat is limited. The anthropogenic morphology of this channel was taken into account when impairment thresholds were established with relatively low expectations.

No obstructions to flow have been identified. The amount of water quality sampling data from this reach is minimal. TSS data from the Red Lake River upstream and downstream of the confluence with CD43 meets the 30 mg/l water quality standard. The riparian buffer along portions of CD43 is inadequate, and some private field drainage ditches have not yet been retrofit with side water inlets. There was no visual evidence of significant gully erosion within the CD43 drainage area that would result in excess TSS concentrations.

Because it is a drainage ditch with a limited drainage area, fish populations will be limited by a lack of perennial base flow. The Stressor ID Report found evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 547 in the low scores recorded for eight individual F-IBI metric responses for Station 12RD045:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are serial spawners
- High relative abundance of taxa that are tolerant

The Stressor ID Report also states that "frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are early maturing, pioneering, serial spawners, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010)."

Figure 4-42. Photo of the Pennington County Ditch 43 Channel (09020303-547). The trapezoidal channel geometry and the results of weed spraying activity can be seen in this photo.

The instream habitat of AUID 547 was evaluated at Station 12RD045 using the MSHA; the entire length of the reach has been altered (MPCA 2013). The station yielded a total MSHA score of 40 (“poor”). The MSHA score for the station was limited by the land use, substrate, and channel morphology subcategories. The land use adjacent to the station was dominated by agriculture (i.e., hay fields and row crops). In addition, the station lacked riffle habitat, had limited coarse substrate, lacked sinuosity, and had “poor” channel development. Other than the oxbow into which the ditch discharges near the Red Lake River, the ditch is an artificial channel. There are no grade stabilization (rock riffle) structures along this ditch. There is ample vegetation within the channel. However, a portion of that vegetation is periodically killed by the application of pesticides (see the brown vegetation in Figure 4-42). Ditches are sprayed with pesticides to control the growth of cattail, brush, and weeds. Benthic insectivores (e.g., darters and sculpins) and simple lithophilic spawners require quality benthic habitat (e.g., clean, coarse substrate) for feeding and/or reproduction purposes, while detritivores utilize decomposing organic matter (i.e., detritus) as a food resource and, therefore, are less dependent upon the quality of instream habitat (Aadland et al. 2006). The Stressor ID Report found evidence of a causal relationship between a lack of instream habitat and the F-IBI impairment associated with AUID 547 through six individual F-IBI metric responses for Station 12RD045:

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- Low taxa richness of darter and sculpin species
- High relative abundance of taxa that are detritivorous
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species
- Low taxa richness of simple lithophilic spawning species

The MPCA staff deployed a DO logger within the ditch at the CSAH 3 crossing of CD43 (S008-177) in August of 2014. DO levels dropped below the 5 mg/l standard on every day of the deployment, as shown in Figure 4-43. The mean daily fluctuation in DO was 5.8 mg/l. DO concentrations "bottomed out" with less than 0.05 mg/l for a period of 26.5 hours on August 21 and 22 of 2014. Low DO often results in a limited fish community that is dominated by tolerant taxa (EPA 2012). The Stressor ID Report identified five F-IBI metric responses that provide evidence of a causal relationship between low DO and the F-IBI impairment in AUID 547:

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are tolerant

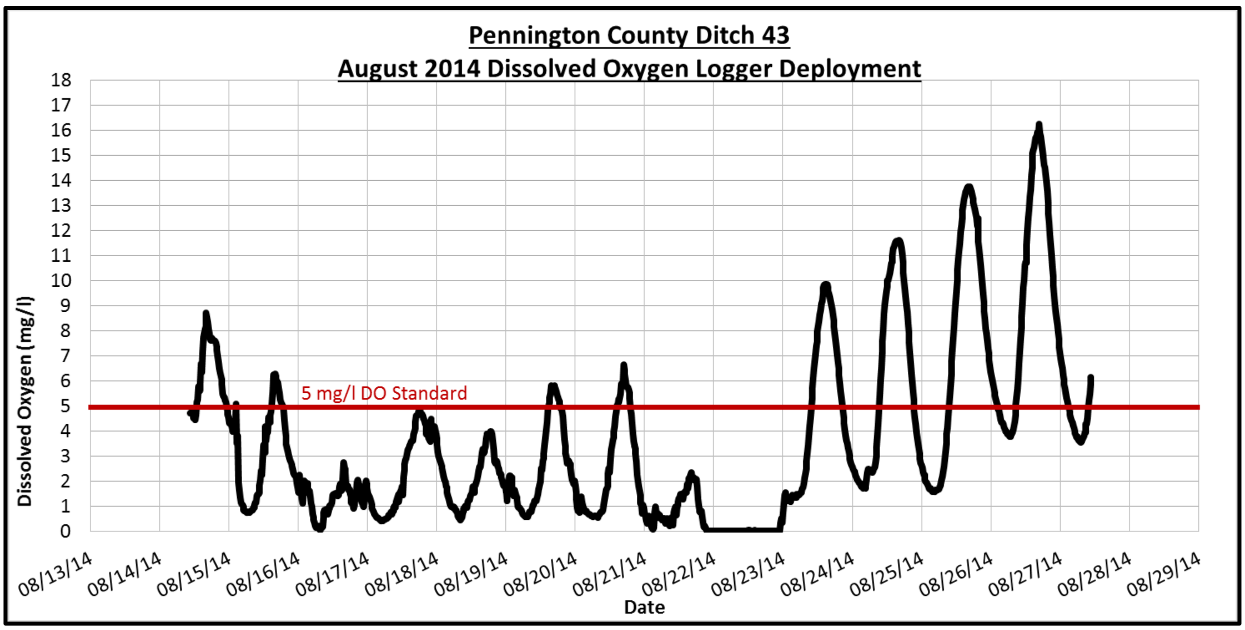


**Figure 4-43. August 2014 dissolved oxygen logger deployment in Pennington County Ditch 43.**

Existing data and information support the conclusions of the Stressor ID Report. There is no evidence to suggest that low DO is caused by anything other than stagnant water and low flow. Therefore, no pollutant TMDL is being established for this reach. The sampling results also yielded an M-IBI score of 11, which failed to meet or exceed the 22-point impairment threshold.

### 4.3.11 Pennington County Ditch 43, 09020303-547, Macroinvertebrate Biotic Integrity

The macroinvertebrate community of AUID 547 was monitored at Station 12RD045 on August 7, 2012. The station was designated as Modified Use within the Prairie Streams-Glide/Pool Habitats M-IBI Class. The monitoring results for the station yielded an 11-point M-IBI score below the 22-point impairment threshold that was applied to this reach (Figure 4-44). Overall, the macroinvertebrate assemblage of the station was dominated by tolerant taxa, specifically Valvata (snails). The stressors of macroinvertebrates that have been identified for the CD43 channel are identical to the stressors that were explained in the previous section for the F-IBI impairment.

- Lack of base flow
- Lack of in-stream habitat
- Low DO levels

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity, specifically taxa belonging to the orders of Plecoptera, Ephemeroptera, and Trichoptera (many of which are collectors and filterers), and favor taxa that are tolerant of environmental disturbances (EPA 2012; Klemm et al. 2002, Poff and Zimmerman 2010). The Stressor ID Report lists eight metric responses that could have been caused by a lack of base flow:

- Low relative abundance of collector-filterer individuals
- High relative abundance of the dominant five taxa in a subsample
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

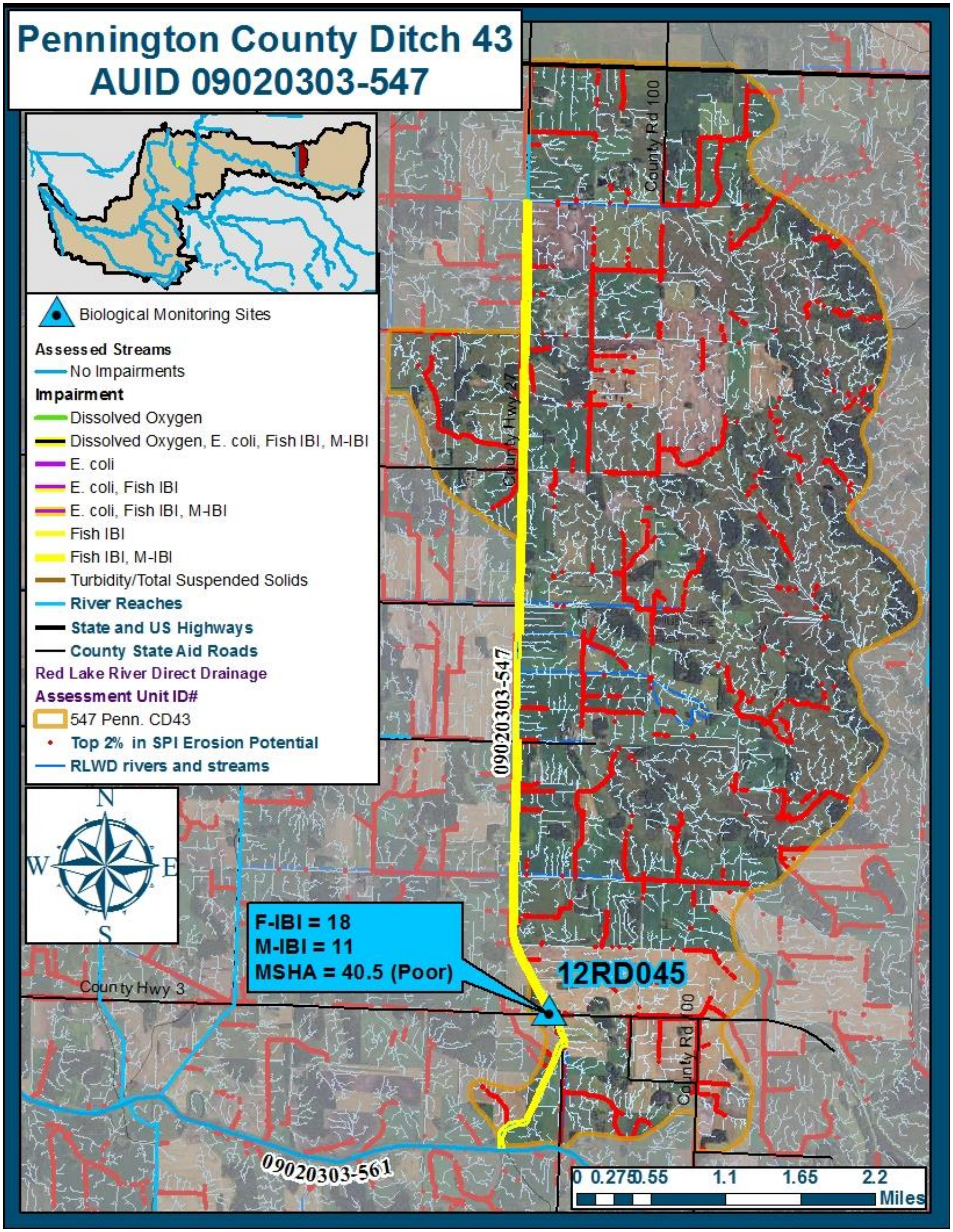


Figure 4-44. IBI and MSHA scores from Pennington CD43 AUID 09020303-547.

Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects to attach themselves to, while legless macroinvertebrates are tolerant of degraded benthic habitat. The Stressor ID Report found evidence of a causal relationship between a lack of instream habitat and the M-IBI impairment associated with AUID 547 through the following individual M-IBI metric responses at Station 12RD045:

- Low taxa richness of clinger taxa
- Low relative abundance of collector-filterer individuals in a subsample
- High relative abundance of legless individuals

Low DO often limits the taxa richness of macroinvertebrates, particularly members of the orders Plecoptera, Odonata, Ephemeroptera, and Trichoptera, and favors taxa that are tolerant (EPA 2012; Weber 1973). No sampling or stage/flow monitoring data is available to correlate poor DO levels with pollutants. Stagnant water (periods of no flow) has been observed in the ditch. Low and stagnant flow likely negatively affect DO levels more significantly than pollutants. Reduction of sediment and nutrient runoff in the CD43 drainage area should still be a goal in the implementation plan of the TMDL and the Red Lake River WRAPS. The Stressor ID Report found six M-IBI metric responses from Station 12RD045 that provide evidence of a causal relationship between low DO and the M-IBI impairment associated with AUID 547:

- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

Existing data and information support the conclusions of the Stressor ID Report. There is no evidence to suggest that low DO is caused by anything other than stagnant water and low flow. Therefore, no pollutant TMDL is being established for this reach.

### 4.3.12 Burnham Creek, 09020303-551, Fish Biotic Integrity

This reach represents a seven-mile segment of what is historically referred to as Burnham Creek (Figure 4-45). Much of the reach is legally recognized as a legal drainage system that is referred to as RLWD Project 43B. This project extends from the confluence of what used to be referred as Polk County Ditch 106 to its confluence with Polk County Ditch 15. The fish community of AUID 551 was monitored at Station 12RD030 (0.1 mi upstream of the 340$^{th}$ Street Southwest crossing) on June 11, 2012. The AUID 09020303-551 reach of Burnham Creek yielded an F-IBI score of 13 points, which failed to exceed the impairment threshold of 35 points that was assigned to the reach. According to the Stressor ID Report, the only F-IBI metric with a positive score was the relative abundance (percentage) of individuals with a female mature age less than or equal to two years. The sample was dominated by young of the year sucker. Three sites along the downstream reach (AUID 515) received F-IBI scores of zero. AUID 551 is likely affected by the same stressors that are severely limiting F-IBI scores in AUID 515. The Stressor ID Report compiled evidence that suggests that the F-IBI impairment is likely attributed to lack of base flow, lack of in-stream habitat, and low DO.

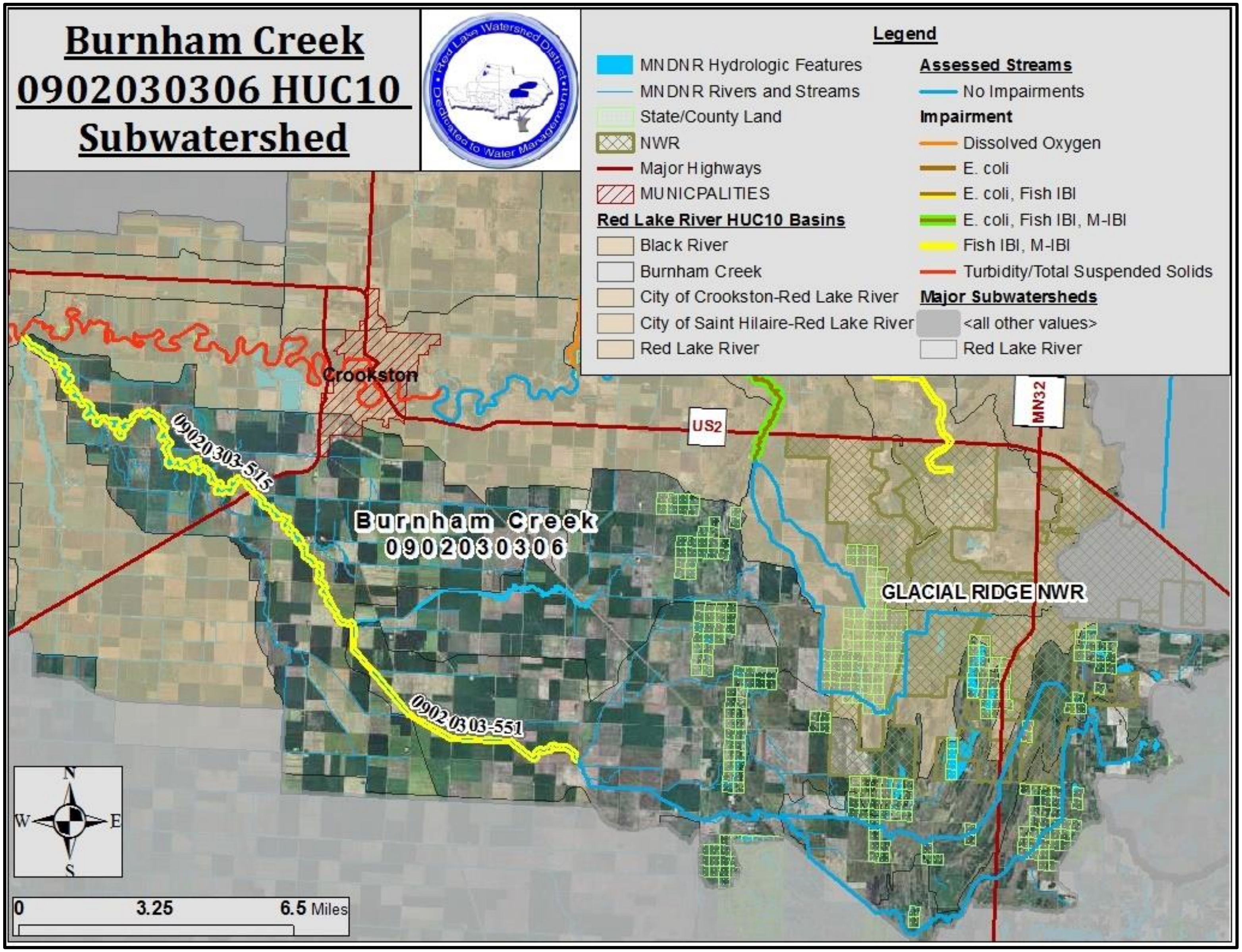


Figure 4-45. Location of the Burnham Creek HUC10 Subwatershed and Assessment Units.

A lack of base flow intensifies the influence of other stressors to aquatic life. Without base flow, minor channel obstructions (e.g. beaver dam remnants) become fish passage barriers. Without adequate base flow, water becomes stagnant and DO levels are depleted. Flow has not been measured within this reach, but long periods of low flow have been documented near the downstream end of the Burnham Creek Subwatershed. Continuous stage and flow monitoring have revealed that Burnham Creek is prone to periods of low-to-no flow in the summer months. This is explained in detail in Section 4.2.1 and exhibited by the 2013 flow record shown in Figure 4-22. Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are trophic generalists, pioneering, short-lived, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). The Stressor ID Report identified eight individual F-IBI metric responses for Station 12RD030 that provide evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 551:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of taxa that are generalists
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low relative abundance of taxa that are sensitive
- High taxa richness of short-lived species
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

The in-stream habitat of AUID 551 was evaluated at Station 12RD030 using the MSHA; the entire length of the reach has been altered (MPCA 2013). The station yielded a total MSHA score of 34 (“poor”). The MSHA score for the station was limited by the land use, substrate, cover, and channel morphology subcategories. The land use adjacent to the station was dominated by row crop agriculture (i.e., corn and sugar beets). In addition, the station lacked riffle habitat, had no coarse substrate, lacked sinuosity, and had “poor” channel development. Insectivores require quality benthic habitat (e.g., clean, coarse substrate) for feeding and/or reproduction purposes, while detritivores utilize decomposing organic matter (i.e., detritus) as a food resource and, therefore, are less dependent upon the quality of instream habitat (Aadland et al. 2006). The Stressor ID Report identified three individual F-IBI metric responses from the June 11, 2012, sampling of Station 12RD030 that provide evidence of a causal relationship between a lack of instream habitat and the F-IBI impairment of AUID 551:

- High relative abundance of taxa that are detritivorous
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species

Much of this reach is required to have a 16.5-foot buffer strip under Minn. Stat. 103E. During a past routine inspection by RLWD Ditch Inspector, it was determined that this reach of the legal drainage system is in violation of the buffer strip law (Figure 4-46). To date, Polk County does not have 100% compliance with the buffer law, however right-of-way markers have been placed along this reach. The

1.2-mile-long meandering segment at the upstream end of AUID has been classified as a public water and is not part of the legal drainage system. Therefore, under the recently passed Buffer Law, that portion of Burnham Creek will be required to have a buffer strip with an average width of 50 feet. The buffer width on the south side of the segment is currently inadequate. Although the channelized portion of AUID 551 is designated as a Public Watercourse, it does not have a shoreland classification and is a public ditch. As stated in the Buffer Law, "*Public Water Watercourses that are also a Public Ditch and do not have DNR assigned shoreland classification, will be mapped as requiring a 16.5 foot buffer*." If a watercourse has a shoreland classification, an average 50 foot of buffer is required under the Buffer Law, even if it is a public ditch.

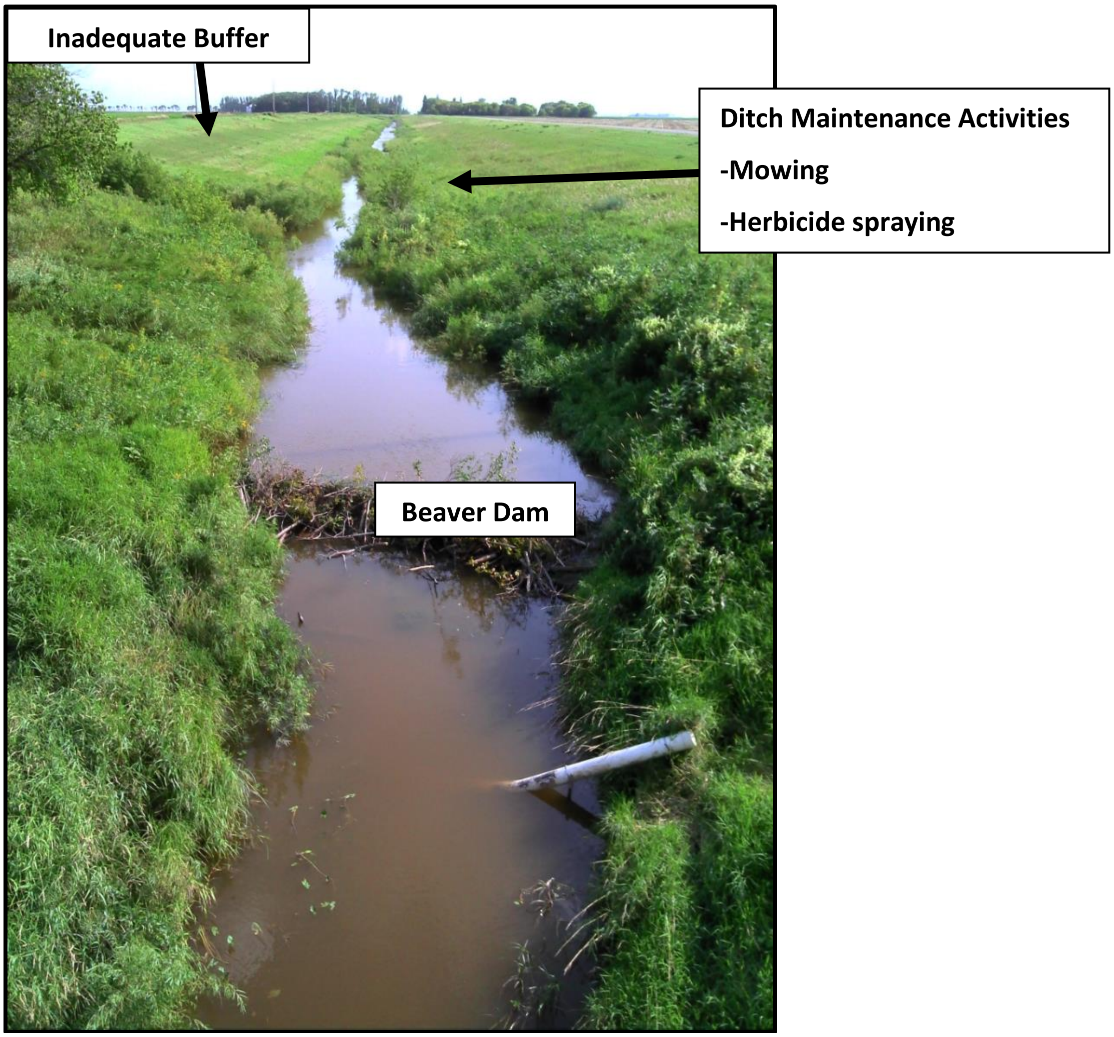


Figure 4-46. View of the 09020303-551, upstream of CSAH 45 (S007-638).

The quality of the riparian and in-stream vegetation along this reach is also problematic for fish and macroinvertebrate habitat. The reach is heavily managed as a ditch. Vegetation is controlled as a stipulation of a 1988 operation and maintenance agreement between the RLWD and the USDA SCS (now NRCS). The RLWD is responsible for maintenance activities that "include: channel excavation or silt removal, repairing eroded channel banks, channel bottoms and spoil banks, critical area seeding and fertilization, surface water inlet (corrugated metal pipe) repair or replacement, concrete structure repair and riprap repair. Mowing will be done to control weeds or brush within the project right-of-way. Areas requiring tillage to control weeds will be re-established to vegetative cover within one year."

Accordingly, the ditch is mowed on a regular basis, eliminating the possibility of woody vegetation and eliminating the possibility of shading from riparian vegetation. Ditch maintenance also includes spraying to kill broadleaf vegetation and cattails. For example, aerial application of herbicides was administered to 4.3 miles of this reach and over 11 miles of channel throughout the Burnham Creek Watershed in 2016 (Figure 4-47). Willow spraying was also conducted along this reach in 2016 between the 230th Avenue Southwest and CSAH 45 crossings.

The lack of consideration given to aquatic ecology along this reach in favor of ditch maintenance activities and maximization of drainage capacity is detrimental to any future support of aquatic life along this reach or upstream reaches. The management of this reach limits the potential of stream restoration efforts that have been completed along upstream reaches. As long as the ditch maintenance agreement requires the destruction of any leafy vegetation that tries to grow along the channel, there will be little hope of restoring aquatic life to desirable levels.


**Figure 4-47. Extent of 2016 aerial herbicide application along Burnham Creek.**

Low DO often results in a limited fish community that is dominated by tolerant taxa (EPA 2012). The Stressor ID Report identified six individual F-IBI metrics with poor responses from sampling at Station 12RD030 on AUID 551 that could have been limited by low DO:

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant species
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

DO logger (Eureka Manta equipped with an optical DO probe) data was collected at the CSAH 45 crossing of Burnham Creek (S007-638) in July through September of 2015. Based on the description of AUID 551, Station S007-638 is located at the downstream end of AUID and a short distance upstream of the Polk County Ditch 15 confluence. Due to an erroneous GIS layer that includes a misplaced flow path for the outlet of CD15, S007-638 was associated with AUID 09020303-515 during the most recent water quality assessment. The information from that site is, nonetheless, applicable to AUID 551. More than 34% of the daily minimum DO concentrations were lower than 5 mg/l. One of the 13 discrete DO measurements also fell below 5 mg/l. Available information indicates that low DO levels are related to low flow conditions, rather than a particular pollutant. Because no pollutants of concern have been identified, no pollutant-based TMDLs will be written to address low DO levels in the AUID 551 reach of Burnham Creek.

Another factor that limits the quality of fish populations in the AUID 551 reach of Burnham Creek is poor physical connectivity. There are obvious barriers to fish passage upstream and downstream of this reach. Fish passage problems are very evident in the downstream reach (AUID 515). At the time of sampling, a large weir was acting as a fish passage barrier two miles upstream of AUID 551 within AUID 552. That weir was retrofitted with rock riffles in 2014. There is a "Texas crossing" within AUID 551 that is in line with 220$^{th}$ Avenue Southwest. Even though the MPCA staff did not spot any beaver dams (as stated in the Stressor ID Report), they can be found along this reach. Figure 4-20 shows a beaver dam that was found in 2015. There was another dam downstream of the bridge when the photo was taken. When beaver dams are found along this reach, they can be removed for the purpose of ditch maintenance. F-IBI metrics faired far worse in this reach and several downstream sites than macroinvertebrate metrics. If fish were able to access the site, the results may still fall below the impairment threshold, but F-IBI metrics would at least score measurable results.

A limited number of TSS concentrations have been recorded within this reach. Zero of the TSS samples have exceeded the applied 65 mg/l standard, including samples collected during a significant runoff event in May 2013. The reach has exceeded 30 mg/L in 25% of 2006 through 2015 samples but is not required to meet that more protective standard. A TSS TMDL will not be necessary for this reach to meet the 65 mg/L standard that has been assigned to this reach.

### 4.3.13 Burnham Creek, 09020303-551, Macroinvertebrate Biotic Integrity

The macroinvertebrate community of AUID 551 was sampled at Station 12RD030 on August 8, 2012. The station was designated as Modified Use within the Prairie Streams-Glide/Pool Habitats M-IBI Class. Accordingly, the applicable impairment threshold for the station is an M-IBI score of 22. The monitoring results for the station yielded an M-IBI score of 20 points, which was slightly below the impairment threshold. The station had seven individual metrics that scored below the threshold score. Overall, the macroinvertebrate assemblage of the station was dominated by tolerant taxa, specifically Coenagrionidae (damselflies).

The Stressor ID Report compiled evidence that indicates that the M-IBI impairment on the AUID 551 reach of Burnham Creek is likely the result of the following stressors:

- Lack of base flow
- Lack of instream habitat
- High suspended sediment
- Low DO levels

As noted in the previous section, a lack of base flow in Burnham Creek results in stagnant water and depressed DO levels. There was no flow at the downstream end of the Burnham Creek Watershed (S007-058) on the August 8, 2012, sampling date. Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity, specifically taxa belonging to the orders of Plecoptera, Ephemeroptera, and Trichoptera (many of which are collectors and filterers), and favor taxa that are tolerant of environmental disturbances (EPA 2012; Klemm et al. 2002, Poff and Zimmerman 2010). Overall, the macroinvertebrate assemblage of the station was dominated by taxa that are adapted to lentic conditions (i.e., Coenagrionidae). The Stressor ID Report identified nine individual M-IBI metric responses for Station 12RD030 the provide evidence that a lack of base flow may be causing the M-IBI impairment associated with AUID 551:

- Low relative abundance of collector-filterer individuals
- High relative abundance of the dominant five taxa in a subsample
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

The habitat deficiencies along this reach are described in the previous section. Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects upon which to attach themselves. The station had a "low" score for each of these metrics, thereby negatively affecting the overall M-IBI score and directly contributing to the biological impairment of the reach. The Stressor ID Report identified two individual M-IBI metric responses for Station 12RD030 that provide evidence that a lack of instream habitat may be causing the M-IBI impairment associated with AUID 551:

- Low taxa richness of clinger taxa
- Low relative abundance of collector-filterer individuals in a subsample

Collector-filterers, including several members of the order Trichoptera, utilize specialized mechanisms (e.g., silk nets) to strain organic material from the water column. High TSS can interfere with these mechanisms (Arruda et al. 1983; Barbour et al. 1999; Lemley 1982; Strand and Merritt 1997). The Stressor ID Report found five poorly scoring individual IBI metrics that indicated a causal relationship between high TSS and the M-IBI impairment of AUID 551:

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

Although all of Burnham Creek meets the 65 mg/l TSS standard that has been assigned to the stream, TSS concentrations significantly increase (nearly double) from the upstream end of AUID 551 through the downstream end of AUID 515. However, M-IBI scores were slightly better within portions of the downstream AUID 515 at stations 10EM112 (23) and 12RD001 (29) than the score at Station 12RD030 on AUID 551. The average TSS concentration for AUID 551 from data collected from 2006 through 2015 during the months of April through September was 16.4 mg/l. The average concentration for the downstream AUID 515 was 32.7 mg/l. A TMDL will not be written for TSS along this reach. The available data shows that areas with higher concentrations of TSS unexpectedly had higher M-IBI scores instead of lower scores. Although the TSS concentrations are not high enough to warrant a TMDL, erosion and sedimentation should still be addressed in the WRAPS. Erosion problems have been documented within the watershed. The buffer along the main channel of this reach is marked with right-of-way stakes and appears to be meeting the requirements of the Buffer Law. However, some tributary ditches have inadequate buffers and field that are plowed to the crown of the ditch bank. Eight of the nine stream physical appearance remarks that have been recorded along this reach describe the waters as either muddy or cloudy. For the combined reaches of AUID 515 and 551 along Burnham Creek, 65 of 78 observations of the stream’s physical appearance describe it as being cloudy or worse (cloudy, muddy and green).

Low DO often limits the taxa richness of macroinvertebrates, particularly members of the orders Plecoptera, Odonata, Ephemeroptera, and Trichoptera, and favors taxa that are tolerant (EPA 2012; Weber 1973). The station had a high percentage of low DO tolerant taxa and a low number of low DO intolerant taxa. The previous section describes how DO is clearly a problem within this reach. DO is depleted when flow ceases and water becomes stagnant where it is pooled. The Stressor ID Report found that eight of the poorly scoring individual metric responses could provide evidence that low DO levels are to blame for the M-IBI impairment.

- High Hilsenhoff’s Biotic Index value
- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

### 4.3.14 Gentilly River, 09020303-554, Fish Biotic Integrity

The fish community of AUID 554 was sampled at Station 12RD021 (0.1 mi upstream of the 180th Avenue Southwest crossing) and Station 12RD043 (0.1 mi upstream of the U.S. Highway 2 crossing) on June 12, 2012. Station 12RD021 was designated as a "General Use" stream within the Southern Streams F-IBI Class and barely met the F-IBI impairment threshold of 50 points with an F-IBI score of 50 points. Station 12RD043 was classified as General Use within the Northern Headwaters F-IBI Class. Station 12RD043 failed to meet the impairment threshold of 42 with an F-IBI score of only 34 points. The Stressor ID Report provided evidence that several stressors may be causing the F-IBI impairment.

- Lack of base flow
- Lack of in-stream habitat
- High suspended sediment
- Low DO levels

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are early maturing, pioneering, serial spawners, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). Stage and flow monitoring near site 12RD021 found that there was no flow at the site for much of the summer of 2012. Water was pooled behind a series of beaver dams and became stagnant. The Stressor ID Report found eight individual F-IBI metric responses from sampling at Stations 12RD021 and/or 12RD043 that provide evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 554:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low relative abundance of taxa that are sensitive
- High relative abundance of taxa that are serial spawners
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Stage measurements have been recorded during site visits since sampling began in Gentilly Creek in 2005. Continuous stage measurement began in 2012 and has become part of the RLWD stream gauging program so that monitoring can continue into the future. A flow rating curve has been created from flow measurements made at flows ranging from 0 cfs to 389.5 cfs. The flow rating curve has been used to estimate flow rates for each stage measurement. Of the 743 days with stage measurements and flow estimates, 471 (63.4%) had a daily average flow of 0 cfs. Much has been done within the Glacial Ridge National Wildlife Refuge to increase water storage in the watershed. The possibility of augmenting base flows with water stored within impoundments could be explored. Increased storage outside of the refuge could be used to reduce flashiness of flows and augment base flows. In addition to water quality benefits, increased storage within this drainage area will help accomplish the goals of the Red Lake Watershed Expanded Distributed Detention Strategy by reducing peak flows downstream. Off-channel storage opportunities should be pursued in this subwatershed. On-channel storage; however, could be counterproductive to the goals of establishing a quality fish population.

The Stressor ID Report found that the in-stream habitat of the Gentilly River is in need of improvement. The instream habitat of AUID 554 was evaluated at Stations 12RD021 and 12RD043 using the MSHA. Station 12RD021, which is located along a natural segment of the reach (MPCA 2013), had a MSHA score of 55 ("fair"). According to Figure 4-55, the MSHA score for the station was limited by the land use subcategory. The land use adjacent to the station was dominated by row crop agriculture (e.g., corn and soybeans). Station 12RD043, which is situated along an altered segment of the reach (MPCA 2013), had a total MSHA score of 57 ("fair"). The station scored above the "fair" rating threshold for all subcategories (land use, riparian, substrate, cover, and morphology). Additionally, both stations lacked riffle habitat, but offered coarse substrate; however, the substrate had a "moderate" level of embeddedness. Benthic insectivores (e.g., darters and sculpins) and simple lithophilic spawners require quality benthic habitat (e.g., clean, coarse substrate) for feeding and/or reproduction purposes, while detritivores utilize decomposing organic matter (i.e., detritus) as a food resource and, therefore, are less dependent upon the quality of instream habitat (Aadland et al. 2006). The Stressor ID Report found that poor results for six of the individual F-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by a lack of in-stream habitat.

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- Low taxa richness of darter and sculpin species
- High relative abundance of taxa that are detritivorous
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant species
- Low taxa richness of simple lithophilic spawning species

There are portions of the Gentilly River along which the width of the riparian buffer had been inadequate and did not comply with the requirements of Minnesota's Buffer Law. To date, Polk County does not have 100% compliance with the buffer law. Currently, 50-foot buffer of permanent vegetation or alternative practice is required along this channel downstream of Highway 2 and a 16.5-foot buffer is required upstream of Highway 2. The quality of riparian vegetation should also be improved wherever landowner cooperation can be found. Deep-rooted woody and native vegetation will stabilize stream banks and provide shading for the stream. The gradient should be sufficient along Gentilly River to provide quality riffle and pool habitat.

There also are obstructions to fish passage and flow within the reach (Figure 4-48). There is a small dam downstream of CSAH 11 that was likely installed to create a water source for a historic swimming pool in the town of Gentilly. There is a rudimentary rock dam upstream of 180$^{th}$ Avenue Southwest that may have been created to provide a stream crossing for agricultural purposes, but also created a fish passage barrier. LiDAR data indicates that the drop from upstream to downstream of that rock dam could be five feet. Beaver dams are a common occurrence, particularly during low flows. Beaver dams are typically washed away by high flows annually. Those higher flows overtop the known fish passage barriers. Fish sampling data also suggests that fish are able to migrate upstream, even if it is only occasionally. Fish passage barriers are most impactful during low flows.


Figure 4-48. Fish passage barriers near the Town of Gentilly along the Gentilly River.

The combination of low flows and fish barriers creates pools of stagnant water in which DO is depleted. Low DO often results in a limited fish community that is dominated by tolerant taxa (EPA 2012). The Stressor ID Report found that six individual F-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 provide evidence of a causal relationship between low DO and the AUID 554 F-IBI impairment:

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Continuous DO data collected by both the RLWD (Figure 4-49) and the MPCA support the theory that DO is a significant stressor of aquatic life in the Gentilly River. In 2012, 58.5% (72 of 123 days) of the daily minimum DO concentrations fell below 5 mg/l. Once flows became low and water became stagnant behind beaver dams, DO levels became regularly low. When water was stagnant, some of the daily maximum concentrations also failed to exceed the 5 mg/l standard. The MPCA staff deployed a DO logger further upstream at the Highway 2 crossing (S008-103) for 11 days in August 2014 (August 16, 2014 through August 26, 2014) and found similar results. More than 71% of the daily minimum DO concentrations during that deployment fell below 5 mg/l. For the same range of dates in 2012, 100% of the August 16, 2012 through August 26, 2012 daily minimum DO concentrations were less than 5 mg/l at

S007-060. An overall assessment of DO data from AUID 554 reveals that 44.9% of the daily minimums, from a combination of discrete and continuous data collected at any time of day in the months of April through September (DO5_ALL) in the years 2006 through 2015, fell below 5 mg/l. When that data set is limited to measurement made at a time earlier than 9 am (DO5_9AM), the rate of low DO readings rises to 61.5%. Therefore, there is a large amount of data showing that low DO concentrations are a problem in this reach, the DO problem exists at multiple locations in the watershed, and that low DO is a recurring problem. The next step in the analysis was to determine if low DO is caused by a pollutant or caused by low flow.

There is strong evidence that low DO in the Gentilly River is caused by low flow and stagnant water. The DO record (May through September, 2006 through 2015) was cross-referenced with the flow record at CSAH 11. Eliminating days in which there was no flow also eliminated all the violations of the DO standard. Of the 185 days in which DO has been measured in the Gentilly River (2006 through 2015), the estimated flow was 0 cfs on 158 days. There was no flow throughout much of 2012, when a DO logger was deployed throughout the monitoring season. Of the 27 days with measurable flow (all May through September data from 2006 through 2015), zero days had DO levels below 5 mg/l.

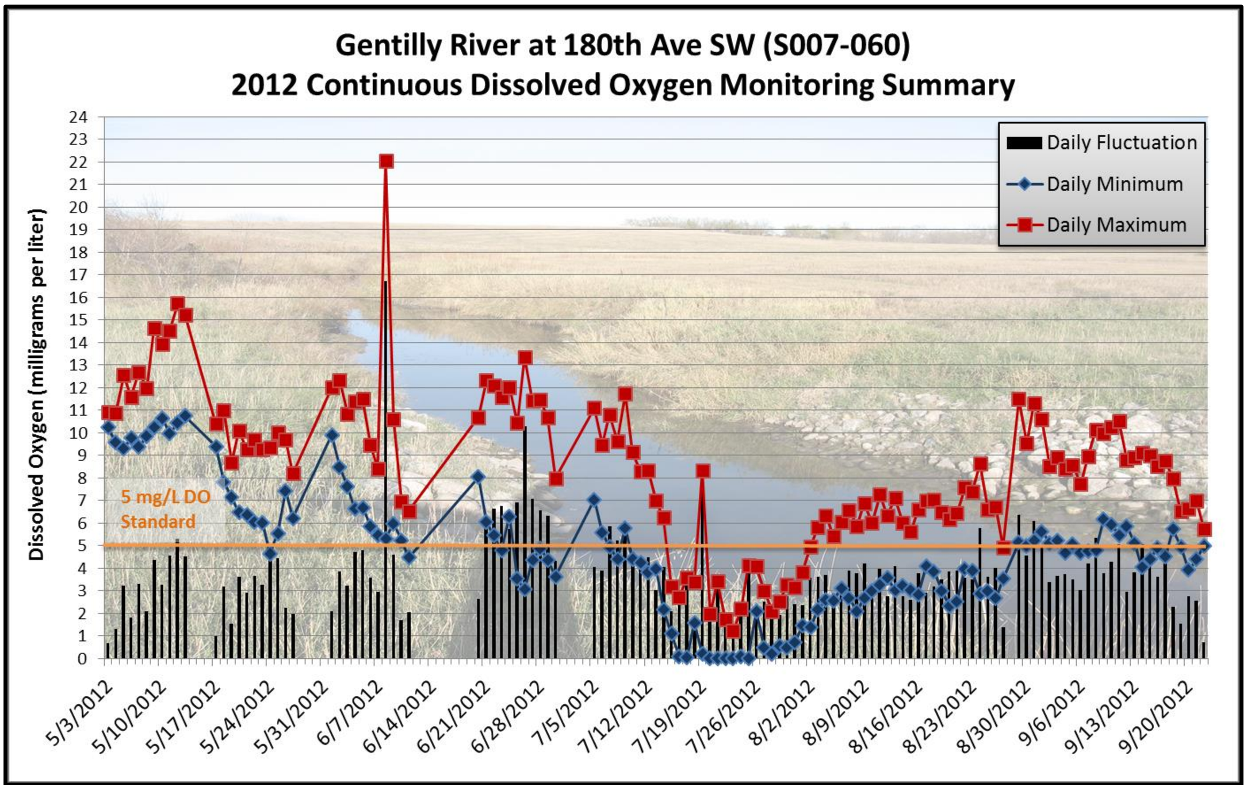


**Figure 4-49. Daily minimum, maximum, and fluctuation record from the 2012 dissolved oxygen logger deployment at S007-060 in the Gentilly River.**

If low DO levels were caused by pollutant loading, low DO concentrations would occur during runoff events. No DO violations occurred while there was measurable flow in the Gentilly River. In addition to meeting the 65 mg/l TSS standard, the Gentilly River also meets the 150 µg/l river eutrophication standard for TP with a summer average of 73 µg/l.

### 4.3.15 Gentilly River, 09020303-554, Macroinvertebrate Biotic Integrity

The macroinvertebrate community of AUID 554 was monitored at Station 12RD021 on July 31, 2012, and Station 12RD043 on July 31, 2012. The stations were designated as General Use within the Prairie Streams-Glide/Pool Habitats M-IBI Class. Accordingly, the applicable impairment threshold for these stations is an M-IBI score of 41. Monitoring at Station 12RD021 yielded M-IBI score of 27, while Station 12RD043 had an M-IBI score of 28; both scores indicated impairment.

The stressors affecting aquatic macroinvertebrates were similar to those that were described in detail in the previous section (4.2.15), with the addition of excess suspended sediment as a potential stressor.

- Lack of base flow
- Lack of in-stream habitat
- Excess suspended sediment
- Low DO

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity, specifically taxa belonging to the orders of Plecoptera, Ephemeroptera, and Trichoptera (many of which are collectors and filterers), and favor taxa that are tolerant of environmental disturbances (EPA 2012; Klemm et al. 2002, Poff and Zimmerma 2010). The Stressor ID Report found that poor results for seven of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by a lack of base flow.

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects to attach themselves to, while burrowing and legless macroinvertebrates are tolerant of degraded benthic habitat. The Stressor ID Report found that poor results for four of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by a lack of in-stream habitat.

- High relative abundance of burrower individuals
- Low taxa richness of clinger taxa
- Low relative abundance of collector-filterer individuals in a subsample
- High relative abundance of legless individuals

The Stressor ID Report also found that poor results for six of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by low DO.

- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

The extent of the low DO problem and the way that DO is affected by low flows is documented in the previous section (4.2.15).

Collector-filterers, including several members of the order Trichoptera, utilize specialized mechanisms (e.g., silk nets) to strain organic material from the water column. Excess suspended sediment can interfere with these mechanisms (Arruda et al. 1983; Barbour et al. 1999; Lemley 1982; Strand and Merritt 1997). The Stressor ID Report found that poor results for five of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by high levels of suspended sediment.

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

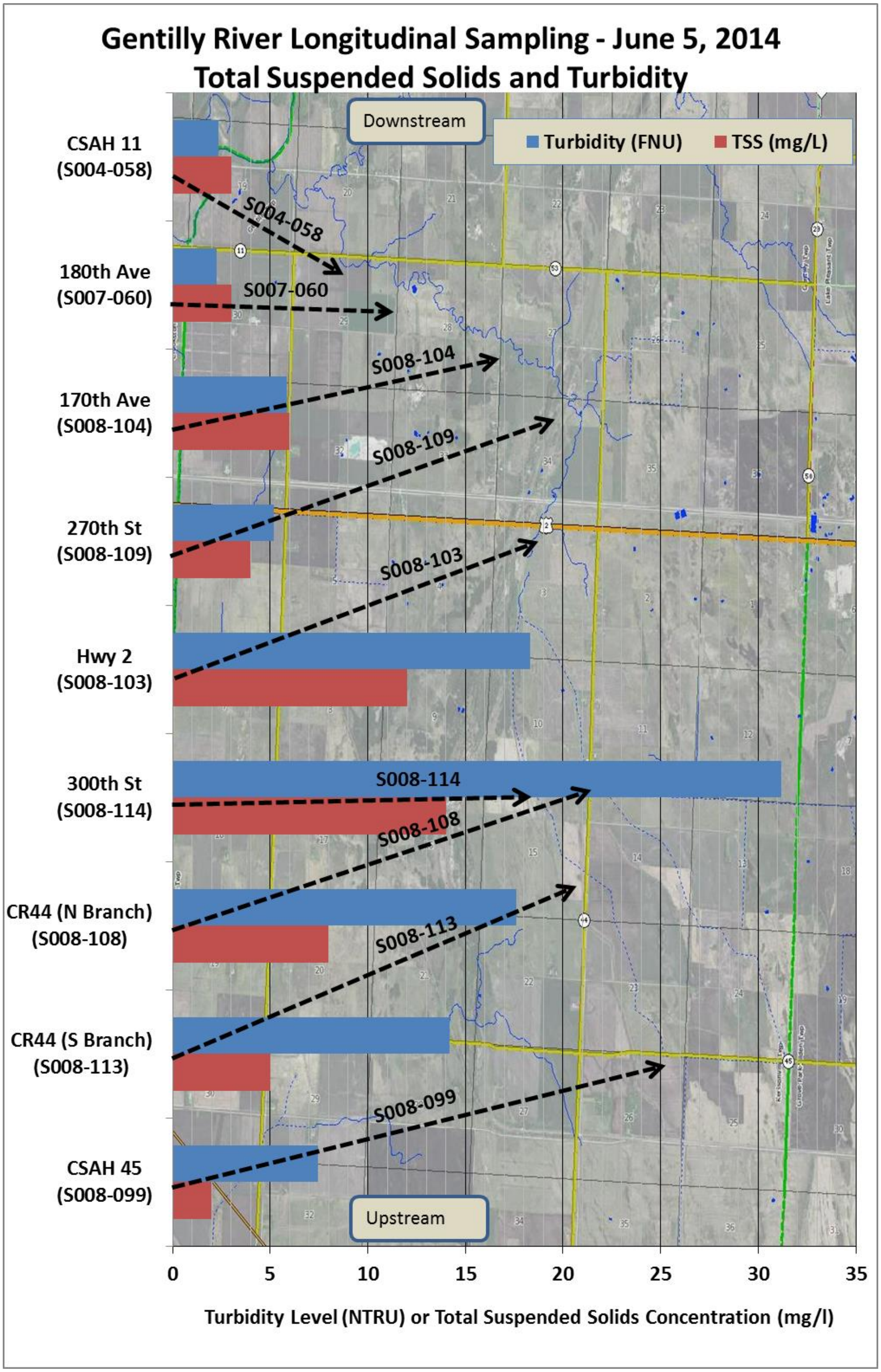


**Figure 4-50. Longitudinal TSS and turbidity measurements along the Gentilly River.**

The Gentilly River comfortably meets the 65 mg/l TSS standard. Only one exceedance of the 65 mg/l TSS standard has been recorded in the 42 samples that have been collected from Gentilly River from 2006 through 2015. That was also the only sample that was higher than the 30 mg/L Central River Nutrient Region Standard. In fact, the TSS concentrations in the Gentilly River have been low enough to meet the Central North River Nutrient Region TSS standard of 15 mg/l with a 7.1% exceedance rate. Figure 4-50 shows that even samples collected during a runoff event along the Gentilly River did not even exceed the 15 mg/l standard. There is always room for improvement in TSS concentrations within rivers and ditches in agricultural landscapes, but a TSS TMDL is clearly not warranted for this reach because of the relatively low concentrations that have been recorded. Deposition of suspended sediment has resulted in the embeddedness of coarse substrate and the associated biotic response at both biological sampling stations. The decrease in TSS concentrations between Highway 2 and CSAH 11 during the June 5, 2014 runoff event indicates that sedimentation may have been occurring along the reach. Erosion control and BMPs are in the Red Lake River WRAPS as protection strategies. Channel features that cause sedimentation like the dam by CSAH 11, beaver dams, and Texas crossings (low water crossings) may also be addressed.

### 4.3.16 Cyr Creek, 09020303-556, Fish Biotic Integrity

The fish community of AUID 09020303-556 (Figure 4-51) was monitored at Station 12RD023 (0.1 mi upstream of the CR 110 crossing, near the S004-818 water quality monitoring station) on June 12, 2012. The station was designated as General Use within the Northern Headwaters F-IBI Class. The station had an F-IBI score of 7 points, which was well beneath the threshold of 42 points that was assigned to this reach. The fish community that was sampled at the station consisted of few taxa (4) and was dominated by brook stickleback. Eight of the ten total metrics scored zero points. The station had nine individual metrics that scored below the threshold score:

- Darter and sculpin taxa
- Headwater taxa, excluding tolerant taxa
- Percent insectivorous cyprinid individuals
- Percent insectivorous taxa, excluding tolerant species
- High relative abundance of individuals that are tolerant
- Low number of individuals per meter of stream sampled, excluding tolerant species
- Low taxa richness of sensitive species
- Simple lithophilic taxa
- High relative abundance of taxa that are tolerant

The evidence presented in the Stressor ID Report suggests that the F-IBI impairment is likely attributed to the following stressors:

- Lack of base flow
- Low DO

Fish passage should be examined whenever there is a F-IBI impairment. Although the Stressor ID Report did not find that a lack of physical connectivity was a significant stressor, beaver dams are common near the 12RD023 station. They are not permanent and are more common during periods of low flow. There are private stream crossings that could be impeding fish passage. Because the barriers are temporary or limited to low flow, fish passage was not considered to be significantly stressing of aquatic life.

Instream habitat appears to be sufficient within Cyr Creek. The Stressor ID Report noted that the instream habitat of AUID 556 was evaluated at Station 12RD023 using the MSHA. The entire length of the reach is natural (MPCA 2013). The station yielded a total MSHA score of 74 (good). The station scored above the "fair" rating threshold for all MSHA subcategories. The station had abundant riffle habitat, offered coarse substrate, with only light embeddedness, and had a moderate amount of cover.

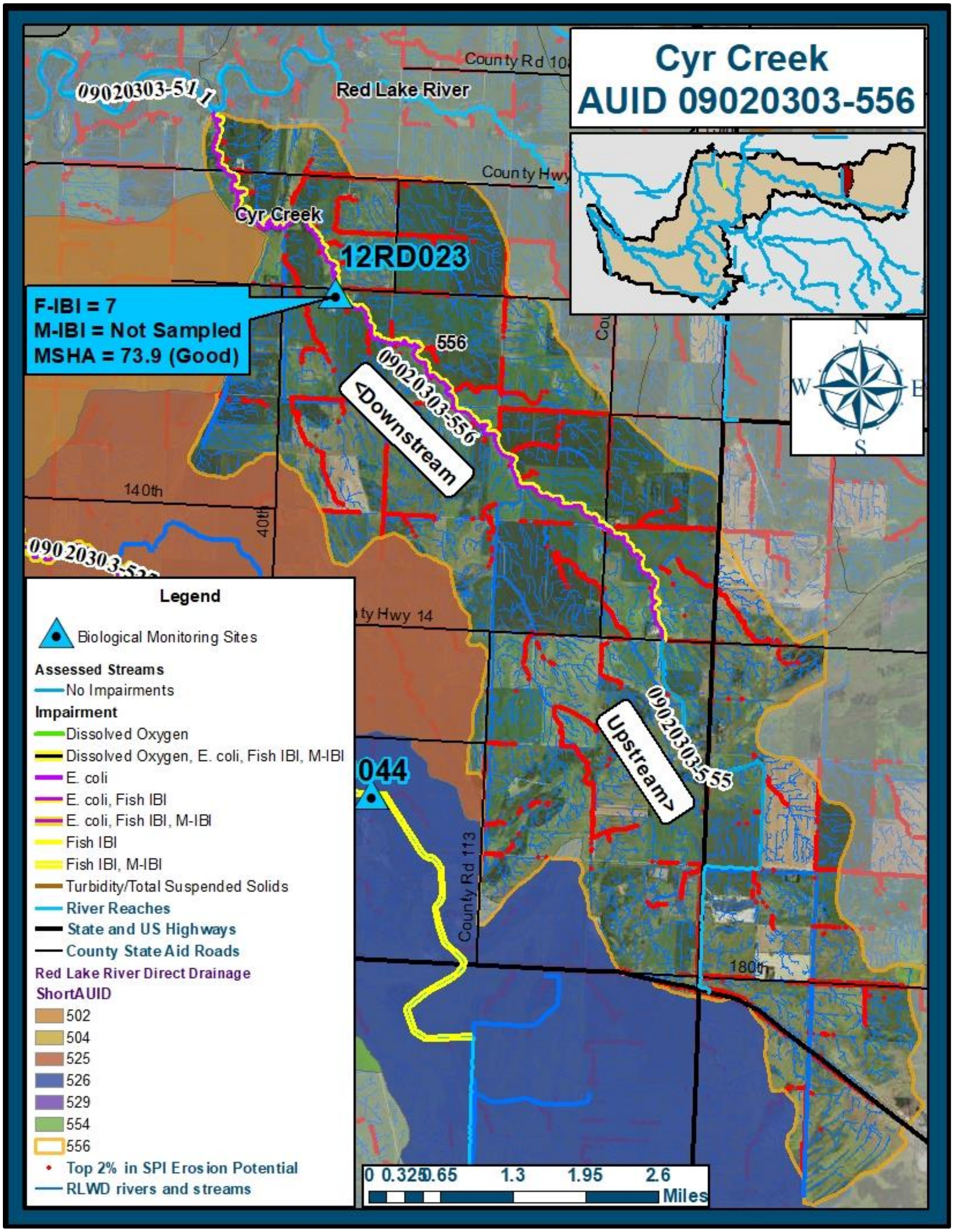


Figure 4-51. Cyr Creek Subwatershed location, IBI scores, and MSHA scores.

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are trophic generalists, early maturing, pioneering, short-lived, serial spawners, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). There is a significant amount of evidence that demonstrates that the prevalence of low-to-no-flow conditions in Cyr Creek is limiting the quality of the fish community within Cyr Creek. As shown in Cyr Creek LDC in Figure 4-60, flow has exceeded 0 cfs in just slightly more than 50% of days in which stage or flow has been measured. There was no flow on the July 12, 2012, biological sampling date. The absence of flow in 2012 prevented the MPCA biological monitoring staff from performing macroinvertebrate sampling at Station 12RD023 along AUID 556. The year 2012, was an exceptionally dry year. More than 80% of days during the open water monitoring season (March 12, 2012 through March 24, 2012, had zero flow (Figure 4-52). Eleven individual F-IBI metric responses for Station 12RD023 were identified by the Stressor ID Report as evidence of a causal relationship between a lack of base flow and the F-IBI impairment associated with AUID 556:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of taxa that are generalists
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant species
- High relative abundance of taxa that are pioneers
- Low taxa richness of sensitive species
- Low relative abundance of taxa that are sensitive
- High taxa richness of short-lived species
- High relative abundance of taxa that are serial spawners
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

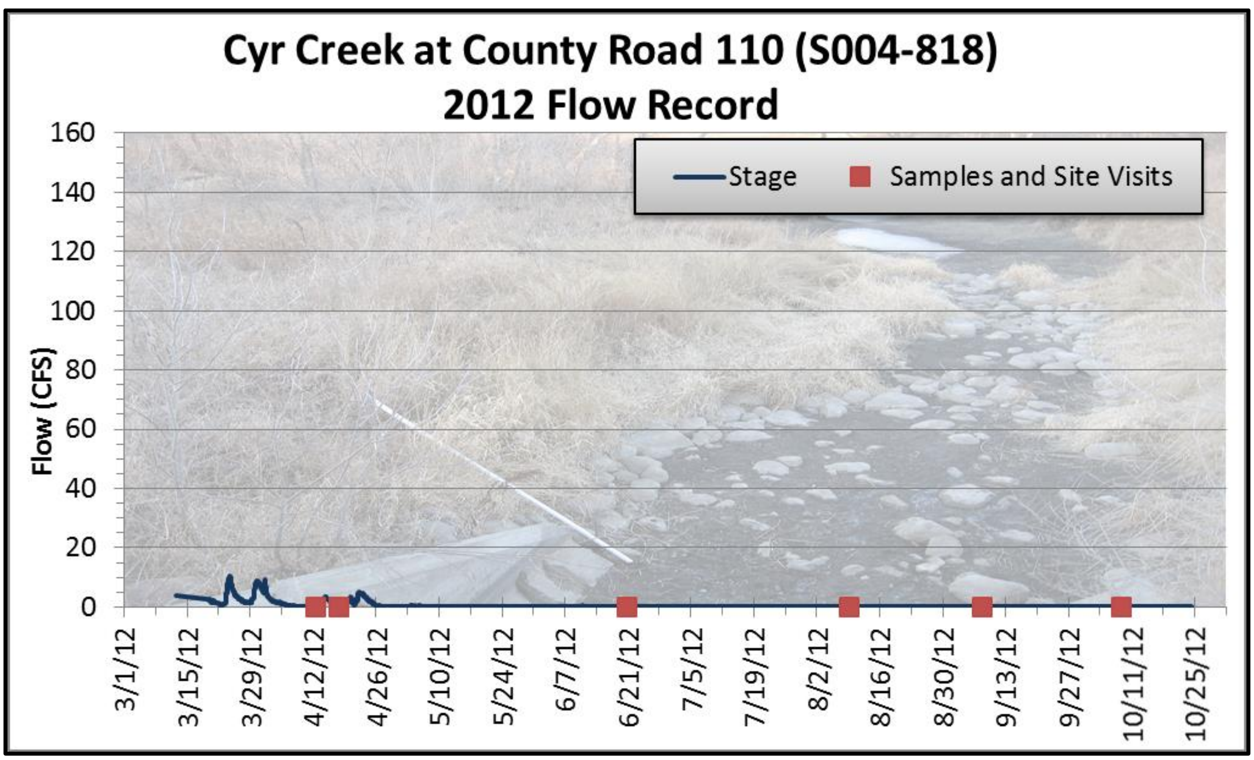


Figure 4-52. 2012 Flow Record for Cyr Creek at County Road 110 (S004-818).

Low DO often results in a limited fish community that is dominated by tolerant taxa (EPA 2012). The Stressor ID Report found that poor results for six of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD021 and/or 12RD043 might have been caused by low DO.

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- Low taxa richness of sensitive species (Sensitive)
- Low relative abundance of taxa that are sensitive
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

Daily minimum DO concentrations (discrete and continuous DO readings, May through September of 2006 through 2015) and daily average flow rates were cross-referenced to determine the extent to which low DO concentrations are connected to low flow conditions. This analysis discovered that low DO concentrations have been recorded throughout the range of flows that have been recorded at the site. Summer, discrete DO concentrations (DO5_All) have been recorded on 56 days during the most recent 10 years (2006 through 2015). DO loggers have been deployed during the 2013 monitoring season by the RLWD and in August of 2014, by the MPCA. Figures 4-53 and 4-54 show how sub-5 mg/l DO readings became a daily occurrence for some time after flow decreased to zero in July 2013. Continuous DO logger data increases the total number of days in the May through September, 2006 through 2015 assessment period to 128 days. Of those 128 days, 32.8% of the daily minimums were lower than 5 mg/l. Analysis found that removal of DO values from days with 0 cfs increased the frequency of low DO readings to 38.7%. Filtering-out days with flows lower than 1 cfs further increased the frequency of low DO levels to 41.5%. The frequency of low DO levels is reduced at flows greater than 5 cfs (14.8% were <5 mg/l), but the data still fails to meet the standard.

Longitudinal DO measurements were collected on June 10, 2014 and July 1, 2016. Throughout AUID 556, DO ranged from 7.37 mg/l to 8.96 mg/l on June 10, 2014 and ranged from 9.64 mg/L to 13.25 mg/L on July 1, 2016. The longitudinal measurements were collected during workday hours and did not represent pre-9 a.m. or daily minimum values. A low DO concentration was found upstream of AUID 556, at the Highway 32 crossing (S008-165), on June 10, 2014 (2.81 mg/L). The daily average flow on June 10, 2014, was slightly greater than 12 cfs. Stage was not properly measured at S004-818 on July 1, 2016, but sample metadata indicates that flow was low.

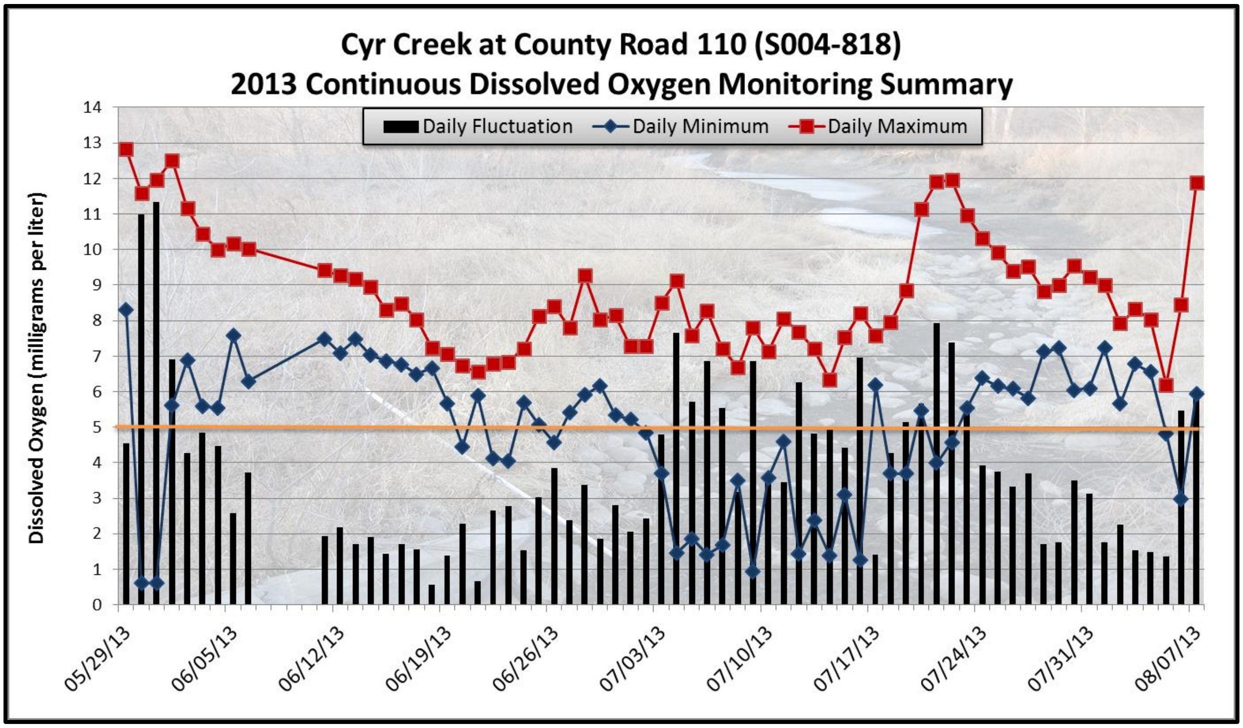


Figure 4-53. 2013 continuous DO monitoring record from Cyr Creek at CR 110 (S004-818).

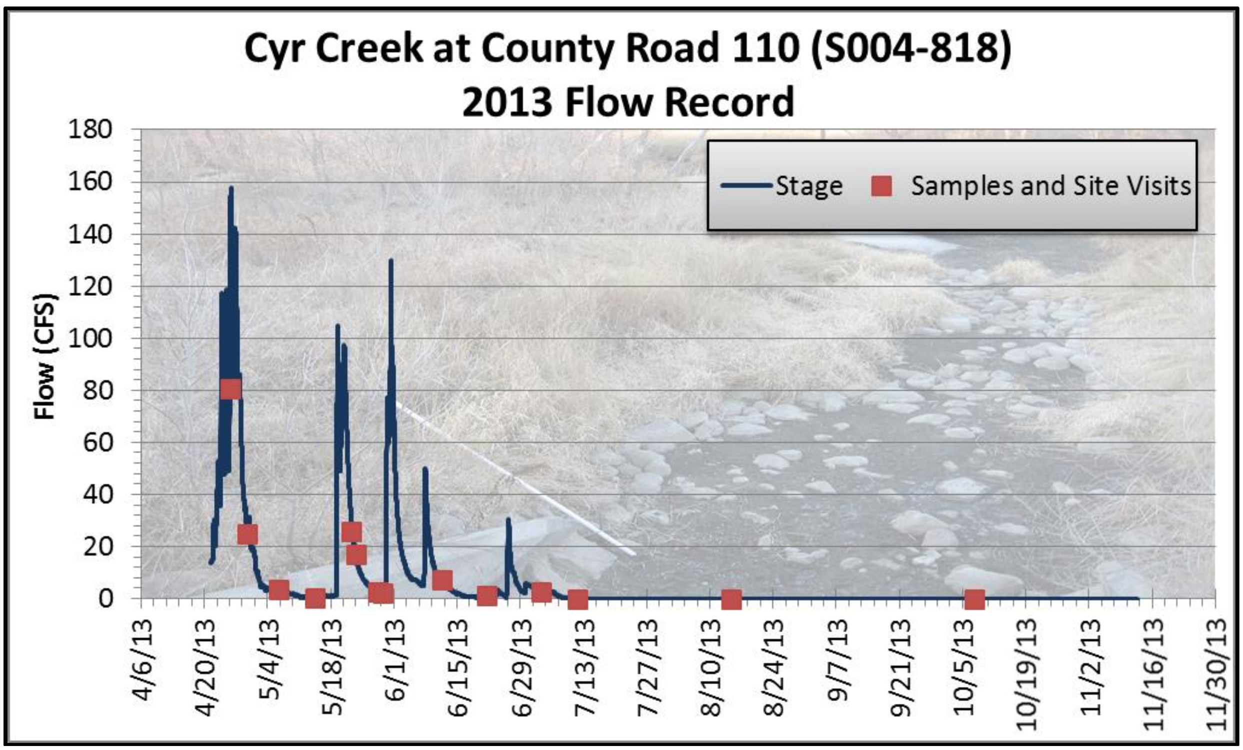


Figure 4-54. 2013 Flow Record for Cyr Creek at County Road 110 (S004-818).

The stressor ID process found no evidence of a causal relationship between excess suspended sediment and the F-IBI impairment associated with AUID 556. None of the individual F-IBI metrics for Station 12RD023 exhibited a correlation to this candidate cause. TSS samples have never exceeded the 65 mg/l impairment threshold that has been applied to this stream. Notable streambank and upland erosion problems do exist within this watershed, however. These erosion problems are addressed in the protection strategies of the WRAPS. Significant gullies have been spotted in fields adjacent to the stream. There are obvious channel and streambank instability problems downstream of CR 110. The Red Lake County SWCD has recently been awarded funding for a project that addresses gully erosion. Minnesota's recently adopted Buffer Law will require a 50-foot buffer along this reach. The riparian buffer width had been insufficient to meet that requirement along many segments of this reach, however some progress has been made with some recently planted, spotty buffers. Although there are still portions of the channel and tributary ditches that are not in compliance.

All attempts to correlate DO with a pollutant resulted in weak or non-existent correlations. The one parameter that showed any hint of a negative correlation with DO was TP. When the entire data set was examined, however, the overall correlation was insignificant. There appeared to be three outlier TP values that were very high (Figure 4-55). Other than those three, the rest of the paired TP and DO measurements appeared to be clustered in a pattern in which DO decreased as TP increased. When those three "outliers" were eliminated, there still appeared to be a downward trend in DO with increasing TP, but the pattern was scattered and the $R^2$ value was low (Figure 4-56). The correlation between DO and TP becomes worse when the months are limited to June through September. Theoretically, the effect of TP upon eutrophication and DO consumption would be greater during the warmer summer months and the negative correlation should have become stronger.

TP does exceed the current water quality standard in AUID 09020303-556. The summer (June through September) average concentration was 173 µg/l in the most recent 10 years of data (2006 through 2015), which exceeded the 150 µg/l standard for the South River Nutrient Region. Data was examined to see if violations of the DO standard coincided with violations of the TP standard. Discrete DO readings comprise the majority of the DO readings that were collected on the same day as TP samples. Only three of those readings were less than 5 mg/l. Those violations of the DO standard all occurred while TP concentrations were less than the 150 µg/l standard.

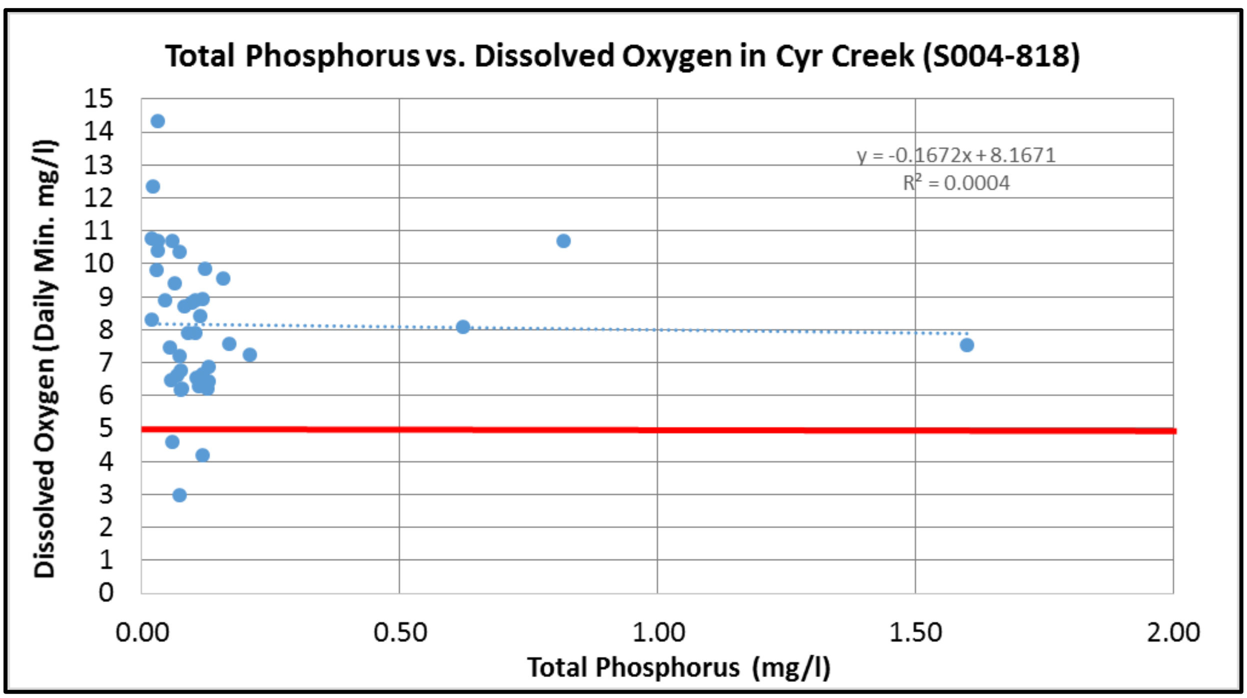


Figure 4-55. Poor correlation between TP and DO in Cyr Creek.

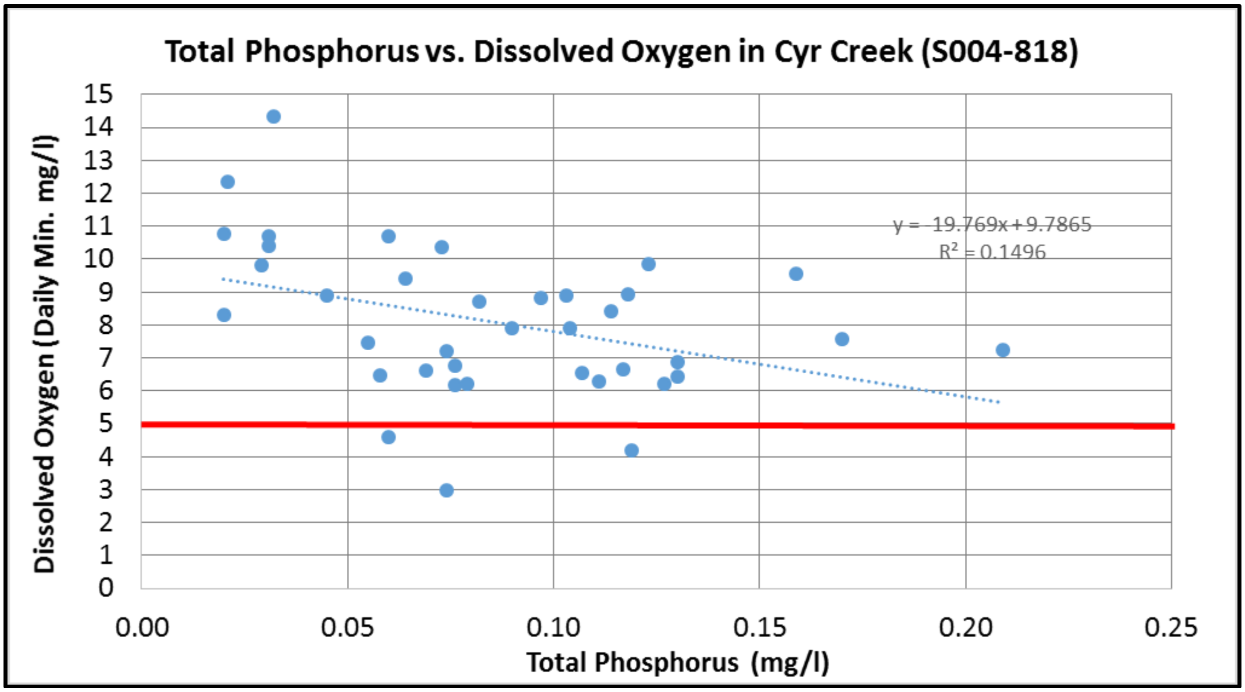


Figure 4-56. Correlation between DO and TP concentrations, without the three highest TP concentrations.

An experimental TP load allocation (LA) (Figure 4-57) and TMDL calculations were created to learn more about the timing of high TP and whether or not load reduction recommendations are necessary. High TP concentrations occurred throughout the range of flows at which samples have been collected during the summer months of June through September. Through the calculation of LAs, it became evident that most of the exceedances of the TP standard occurred while flows were at zero cfs.

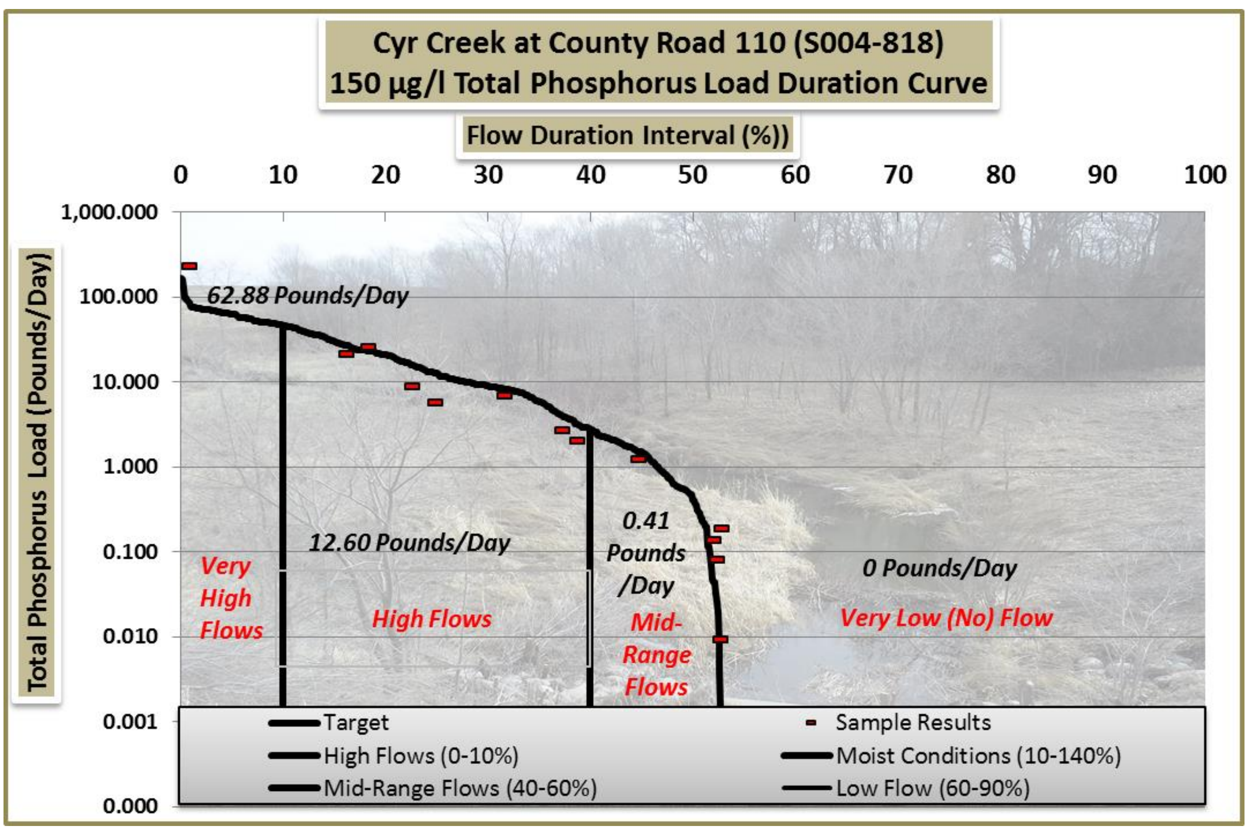


Figure 4-57. Cyr Creek total phosphorus (150 µg/l) load duration curve.

The data was filtered to remove TP samples that were collected on days with zero flow. The summer average TP during times of measurable flow was 147 µg/l, which meets the 150 µg/l standard. Data was then filtered so that only TP samples collected during zero flow were assessed. During times of zero flow, the summer average TP concentration was 198 µg/l. TP concentrations are nearly 35% higher in stagnant water than they are in flowing water within Cyr Creek. Because a large percentage of the TP concentration in stagnant, anaerobic conditions is likely to belong to OP, the TP/OP relationship in Cyr Creek was examined.

TP and OP have a strong, positive correlation at the site. On average, OP represents approximately 74% of the TP concentration on any given sample. On the day of the highest TP concentration of 1.60 mg/l, the OP concentration was 1.51 mg/l (94%). There was one day in the OP concentration (0.63 mg/l) was higher than the TP concentration (0.11 mg/L). The high levels of OP indicate that TP concentrations are influenced by dissolved inorganic phosphorus that is released from sediment in stagnant, anaerobic conditions.

The conclusion of this analysis is that low flows are creating stagnant water, which results in anaerobic conditions and the release of OP from sediment.

Additional monitoring is recommended. Future collection of sufficient data for a complete assessment for eutrophication is recommended. Additional sampling for fish and macroinvertebrates during measurable flow is recommended. Longitudinal DO measurements should be made in the late summer while flows are less than 1 cfs.

### 4.3.17 Black River, 09020303-558, Fish Biotic Integrity

The fish community of AUID 558 was sampled at Station 05RD122 (near 110th Street Southwest) on June 21, 2006, Station 12RD012 (140$^{th}$ Street Southwest) on July 17, 2012, and Station 12RD102 (0.4 mi downstream of the CR 13 crossing) on June 12, 2012. Stations 12RD012 and 05RD122 are located upstream of Shirrick Dam and 12RD102 is located a short distance downstream of that impoundment. All the stations were designated as General Use within the Northern Streams F-IBI Class. All sites failed to meet expectations and scored below the 47-point F-IBI impairment threshold (Figure 4-58). The Stressor ID Report compiled evidence that indicates that the F-IBI impairment on the AUID 558 reach of the Black River is likely the result of the following stressors:

- Loss of physical connectivity
- Lack of base flow
- Lack of in-stream habitat
- Low DO levels

The F-IBI score near the upstream end of AUID 558 (25 points) was nearly equal to the F-IBI score near the downstream end of the next upstream AUID, 09020303-557 (27 points). The habitat scores within this reach are better than the scores along the upstream, channelized reach. The F-IBI and M-IBI scores at the downstream sites along this reach (12RD012 and 12RD102) were better than the score that was found near the upstream end of this reach at Station 05RD122. Despite some apparent upstream-to-downstream improvement, all the F-IBI scores along this reach failed to reach the impairment threshold. In order to meet aquatic life standards, the IBI scores from this essentially need to be twice as high as the thresholds that are applied to the upstream, channelized reach. The channelized reach of the Black River (JD 25, AUID #09020303-557) is expected to meet the standards associated with the “modified use” designation (23-point F-IBI score, 22-point M-IBI score). This impaired reach of the Black River (09020303-558) is required to meet standards that are applied to streams with a “general use” designation (47-point F-IBI score, 37/41-point M-IBI score).

The ability of fish to survive in riverine systems often requires the ability to move from one location to another to avoid unfavorable conditions. Late maturing and migratory fish species require well-connected environments in order to access the habitats and resources necessary to complete their life history. The Black River channel, downstream of the channelized portion of the river, has a number of crossings and dams that appear to be obstructing flow and fish passage. Shirrick Dam is an on-channel impoundment on the Black River that is an insurmountable fish passage barrier. No migratory species were found upstream of the dam and scores were lower upstream of the dam. The Stressor ID Report found that poor results for two of the individual M-IBI metric responses from the 2012 sampling at Stations 05RD122, 12RD012, and 12RD102 might have been caused by a lack of physical connectivity:

- Low relative abundance of individuals with a female mature age of equal to or greater than three years, excluding tolerant taxa
- Low relative abundance of individuals that are migratory

However, poor F-IBI scores were also recorded downstream of the dam. The sampling site that is nearest to the pour point of the watershed (12RD002) had a F-IBI score of 50 and indicates that there should be potential for a quality fish population downstream of the dam. However, at least two potential fish passage barriers exist between the 50-point score downstream of CSAH 18 (12RD002) and the 35-point score that was found downstream of the Shirrick Dam, near CSAH 13 (12RD102). There appears to be a Texas crossing of the Black River channel one half mile upstream of the Little Black River confluence in Section 3 of Louisville Township. During low flow conditions, the culverts at the CSAH 18 crossing are perched and act as barriers to fish passage. Flows were very low during the 2012 biological sampling effort. Upstream of Shirrick Dam, there are at least four additional points along the channel where crossings appear to be potential passage and/or flow barriers.

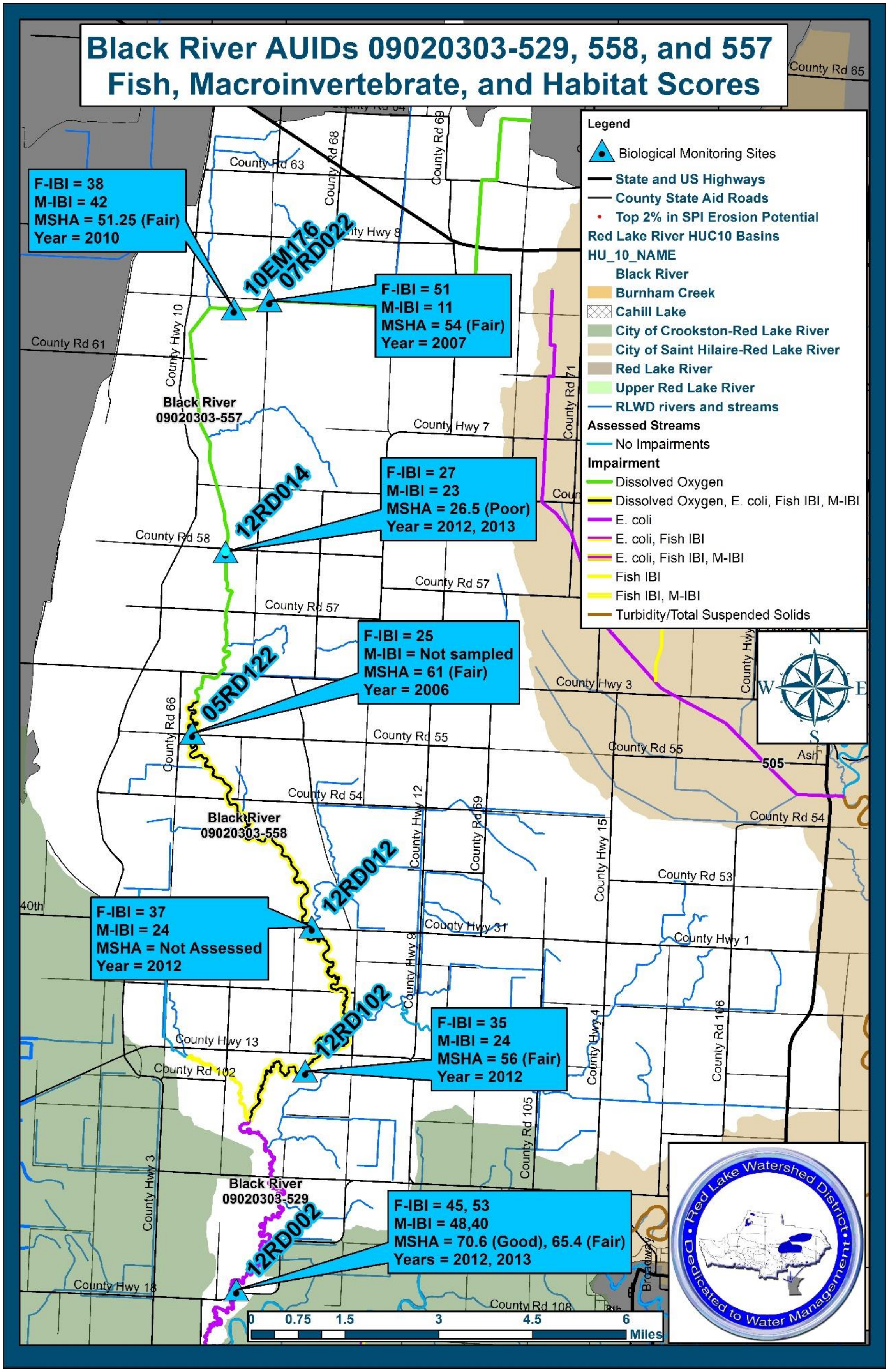


**Figure -4-58. Fish IBI, Macroinvertebrate IBI and habitat scores along the Black River.**

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity and favor taxa that are trophic generalists, early maturing, pioneering, short-lived, serial spawners, and/or tolerant of environmental disturbances (Aadland et al. 2005; Poff and Zimmerman 2010). The Stressor ID Report found that poor results for nine individual M-IBI metric responses from the 2012 sampling at Stations 05RD122, 12RD012, and 12RD102 might have been caused by a lack of base flow:

- High combined relative abundance of the two most abundant taxa
- High relative abundance of taxa that are generalists
- High relative abundance of early-maturing individuals with a female mature age equal to or less than two years
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- High relative abundance of taxa that are pioneers
- High taxa richness of short-lived species
- High relative abundance of taxa that are serial spawners
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

During the summer of 2012 (Figure 4-59), when the fish samples were collected, periods of no flow were recorded near the pour point of the Black River Watershed. There was too little flow at the upstream end of the reach to allow for the sampling macroinvertebrates. A lack of base flow acts as a stressor upon fish populations and exacerbates the impact of other stressors. A lack of flow leads to stagnant conditions that negatively affect DO concentrations. Minor fish passage barriers (e.g. beaver dams and beaver dam remnants) that may be passable during high flows become barriers to fish passage during low flows and dry conditions. Beaver dam construction in Red Lake River tributaries seems to increase and have a more significant impact upon streams during extended periods of low or no flow.

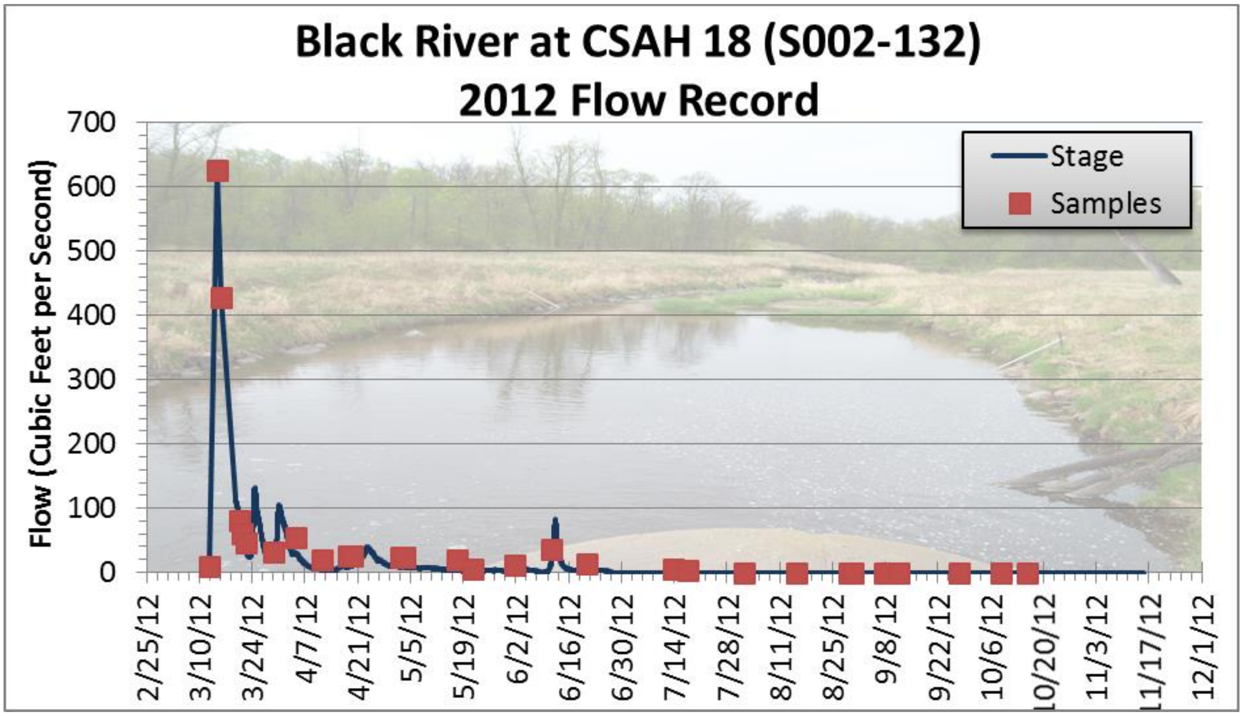


Figure 4-59. 2012 flow record for the Black River.

Benthic insectivores (e.g., darters and sculpins) and simple lithophilic spawners require quality benthic habitat (e.g., clean, coarse substrate) for feeding and/or reproduction purposes (Aadland et al. 2006). The Stressor ID Report identified five poor M-IBI metric responses from the 2012 sampling at Stations 05RD122, 12RD012, and 12RD102 that may have been caused by a lack of in-stream habitat:

- Low relative abundance of taxa that are benthic insectivores, excluding tolerant species
- Low relative abundance of taxa that are darters, sculpins, and round-bodied suckers
- Low relative abundance of individuals that are insectivorous Cyprinids
- Low relative abundance of taxa that are insectivorous, excluding tolerant taxa
- Low relative abundance of individuals that are simple lithophilic spawners

The instream habitat of AUID 558 was evaluated at Stations 05RD122, 12RD012, and 12RD102 using the MSHA. This reach of the Black River has not been channelized. Each of the stations had a total MSHA score in the “fair” range (Figure 4-63). The MSHA score for Station 12RD012 was limited by the substrate and channel morphology subcategories, while Station 12RD102 scored poorly in the land use and riparian subcategories. The stations had very limited to no riffle habitat. Two stations (05RD112 and 12RD102) offered coarse substrate. However, the substrate had a moderate level of embeddedness. Station 12RD012 entirely lacked coarse substrate.

Figure 4-60. Photos showing different characteristics of separate reaches of the Black River. Right: Rock-lined ditch channel in the headwaters of the Black River that had a good F-IBI score of 51. Left: Straightened channel at the 140th St. SW (S003-943) crossing of the Black River.

A longitudinal, visual assessment of the watershed was conducted along AUIDs 09020303-557 and 09020303-558 in 2016 to gain a better understanding of changes along the river that may be affecting IBI scores. A F-IBI score of 51 in the headwaters of the Black River Watershed indicates that there may be potential for a quality fish community upstream of the Shirrick Dam. That high-scoring reach was different from the rest of the watershed. The sampling occurred in a portion of the JD25 portion of the Black River (AUID 09020303-557) that begins at the 150th Avenue Northeast and ends upstream of the 150th Street Northwest crossing. Compared to the rest of the Black River channel, the gradient within that portion is relatively steep (left photo in Figure 4-65). It flows west, down the slope of a Glacial Lake Agassiz beach ridge. Much work has been done to install BMPs and stabilize the stream channel. New buffer has been planted along JD 25 upstream of 110th Avenue, but buffers near 120th Avenue have not been improved. The east-west flowing portion of JD 25 is still planted to the edge of the ditch bank. The water in this ditch was clear and had a swift current. To stabilize the channel, the bottom of the ditch was lined with rock. Side water inlets and other grade stabilization BMPs are installed along the channel. The low-flow channel is relatively narrow, which improves fish habitat by improving depths and preventing stagnant water. This type of ditch construction, however, is limited to the high gradient portion of the stream. A more conventional, streamlined channel was used in the downstream, low-gradient portion (right photo in Figure 4-60).

After the channelized (JD25) portion of the Black River channel begins flowing south, the gradient significantly decreases (Figure 4-61), the channel widens, water becomes cloudier, there is more evidence of sedimentation within the channel, and water can become more stagnant. A portion of the channel parallels the Goose Lake swamp and exhibits some swamp-like characteristics such as cattails and stagnant water. The riparian buffer along the much of the channelized reach has been poor and lacks shading from trees. Trees have recently been removed from some areas along the channel. These conditions lead to lower DO levels and poor fish habitat. These poor stream conditions are likely negatively affecting aquatic life downstream.

Insufficient riparian buffers along the Black River likely contribute to sedimentation. Sedimentation seems to increase from upstream to downstream along the Black River. The MSHA score for substrate was low at 12RD012. This indicates that there is room for improvement and implementation of practices that reduce runoff and erosion. However, data indicates that turbidity and TSS are not strongly connected to low F-IBI scores.

Although MPCA and RLWD staff noticed evidence of sediment deposition along the reach, the Stressor ID process did not find a correlation between F-IBI metrics and suspended sediment. The reach meets the 65 mg/l water quality standard that is applied to this reach.

Low DO often results in a limited fish community that is dominated by tolerant taxa (EPA 2012). The Stressor ID Report found that poor results for five individual M-IBI metric responses from the 2012 sampling at Stations 05RD122, 12RD012, and 12RD102 might have been caused by low DO:

- Low relative abundance of individuals that are intolerant
- Low number of individuals per meter of stream sampled, excluding tolerant taxa
- High relative abundance of individuals that are tolerant
- High relative abundance of taxa that are tolerant

DO monitoring data, mainly from the S003-943 monitoring site at 140th Street Southwest, also confirmed that low DO has been a problem along this reach. The reach is impaired by low DO. The rate of low DO levels in discrete data collected from 2006 to 2015 during the months of May through September (DO5_All) is 14%. The MPCA Stressor ID staff deployed a DO logger for 14 days in August of 2014. DO dropped below 5 mg/l during four of those days (28.6%). A stream is considered impaired if that low DO rate is greater than 10%. Low DO concentrations become more frequent during low flow, when water can become warm and stagnant. The exceptionally dry conditions in 2012, when the biological sampling was conducted, resulted in frequent low DO levels in rivers throughout the Red Lake River Watershed and neighboring watersheds. This DO impairment is addressed further within in Section 4.2.20 of this report.

Based upon the evidence that was collected for this reach, no pollutant-based TMDLs are warranted. The IBI scores seem to be most affected by low flows and fish passage barriers. Low flows exacerbate the effects of minor fish passage barriers and cause stagnant conditions in which DO levels fail to meet standards.

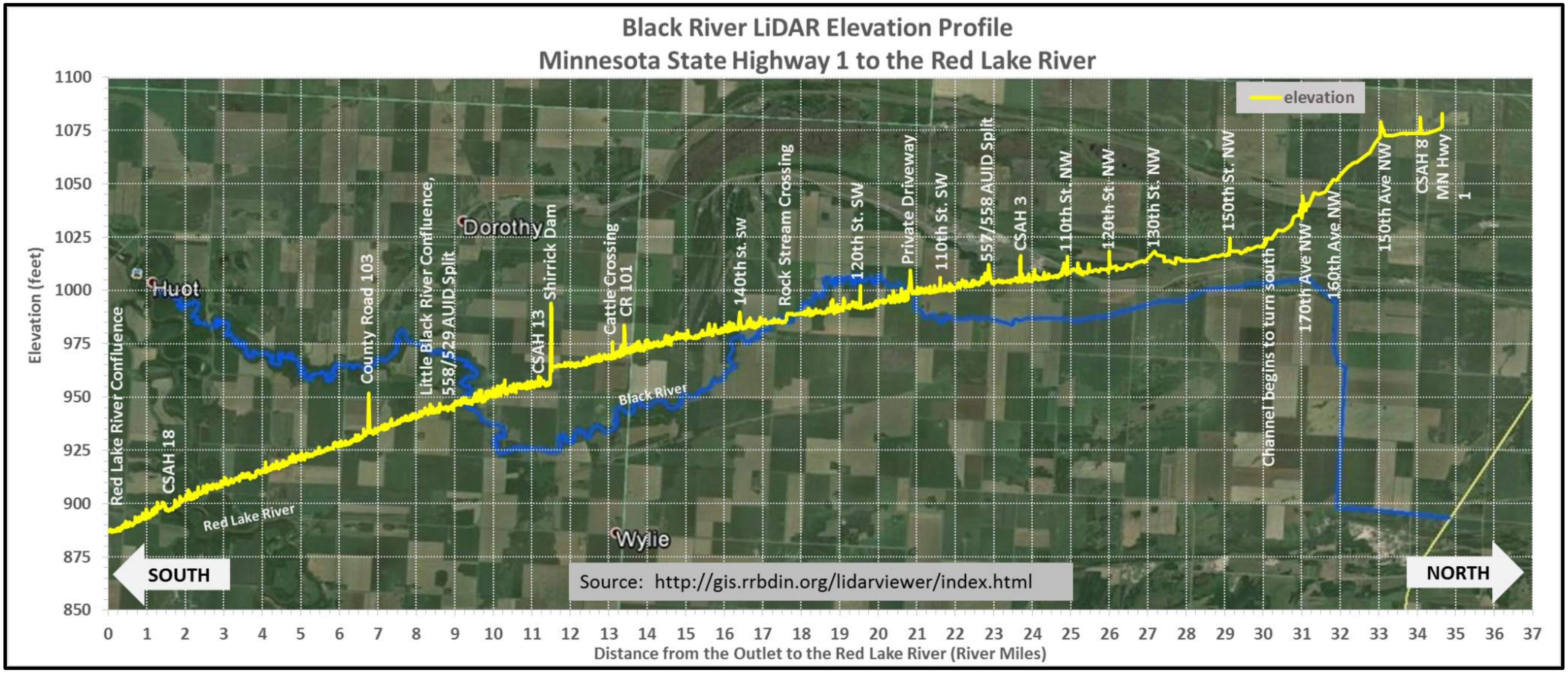


**Figure 4-61. Black River Watershed LiDAR-Based Elevation Profile.**

### 4.3.18 Black River, 09020303-558, Macroinvertebrate Biotic Integrity

The macroinvertebrate community of AUID 558 was monitored at Station 12RD012 (140th Street Southwest) on July 31, 2012, and Station 12RD102 (CSAH 13) on July 31, 2012. Station 12RD012 is located upstream of the Shirrick Dam impoundment and 12RD102 is located a short distance downstream of that impoundment. Station 12RD102 was designated as General Use within the Southern Streams-Riffle/Run Habitats M-IBI Class, while Station 12RD012 was classified as General Use within the Prairie Streams-Glide/Pool Habitats M-IBI Class. Accordingly, the M-IBI impairment threshold is score of 37 for Station 12RD102 and a score of 41 for Station 12RD012. Monitoring at both stations yielded an M-IBI score of 24. While the overall IBI scores were the same at each site, different suites of metrics were used to assess each of the two sites. Scores for individual metrics that were common to both sites were lower at the downstream site than the upstream site. The Stressor ID Report found evidence of potential stressors that could be negatively affecting the quality of macroinvertebrate communities within this reach of the Black River.

- Lack of base flow
- Poor in-stream habitat
- Elevated levels of suspended sediment
- Low DO levels

Frequent and/or prolonged periods of minimal to no flow tend to limit species diversity, specifically taxa belonging to the orders of Plecoptera, Ephemeroptera, and Trichoptera (many of which are collectors and filterers), and favor taxa that are tolerant of environmental disturbances (EPA 2012; Klemm et al. 2002, Poff and Zimmerman 2010). Dry portions of the streambed and stagnant water were observed in the Black River in 2012, the year in which biological monitoring was conducted. The reach was lacking taxa (e.g. Trichoptera) that prefer coarse substrate and swiftly flowing water. The Stressor ID Report identified 10 individual metric responses that provide evidence that the M-IBI impairment is being caused by a lack of base flow:

- Low relative abundance of collector-filterer individuals
- High relative abundance of the dominant five taxa in a subsample
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Plecoptera
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

Clinger taxa, including many collector-filterers, require clean, coarse substrate or other objects to attach themselves to, while burrowing and legless macroinvertebrates are tolerant of degraded benthic habitat. Deficiencies in the aquatic habitat along this reach are described in the previous section of this report, Section 4.2.18. The Stressor ID Report identified five individual M-IBI metric responses for Stations 12RD012 and/or 12RD102 that point to a lack of instream habitat as a potential cause of the M-IBI impairment associated with AUID 558:

- High relative abundance of burrower individuals
- Low taxa richness of clinger taxa
- Low relative percentage of taxa adapted to cling to substrate in swift flowing water
- Low relative abundance of collector-filterer individuals in a subsample
- High relative abundance of legless individuals

Collector-filterers, including several members of the order Trichoptera, utilize specialized mechanisms (e.g., silk nets) to strain organic material from the water column. High suspended sediment can interfere with these mechanisms (Arruda et al. 1983; Barbour et al. 1999; Lemley 1982; Strand and Merritt 1997). The Stressor ID Report found five poorly scoring individual IBI metrics that indicated a causal relationship between high TSS and the M-IBI impairment of AUID 558:

- Low relative abundance of collector-filterer individuals
- Low taxa richness of macroinvertebrates with tolerance values less than two
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative percentage of non-hydropsychid Trichoptera individuals

This reach meets the 65 mg/L standard for TSS that was applied to the reach by the MPCA. It also meets or nearly meets more protective standards that are applied to other areas of the state in daily average, April through September data from the years 2006 through 2015.

- 0.0% > 65 mg/L (meets the South River Nutrient Region TSS standard)
- 5.8% > 30 mg/L TSS (meets the Central River Nutrient Region TSS standard)
- 11.5% > 15 mg/L TSS (nearly meets the North River Nutrient Region TSS standard)

A TSS TMDL is not warranted for this reach because it meets the applied standard. Occasional TSS concentrations greater than 65 mg/l have been recorded within the upstream, channelized portion of the Black River. Sampling results and a visual exploration of the watershed indicate that sediment from upstream sources is being deposited in this reach. A quantitative longitudinal assessment of sediment deposition along the reach is recommended as a part of future monitoring activities. Protection strategies to minimize erosion and sedimentation are described in the Red Lake River WRAPS and the Red Lake River 1W1P. The findings of the Stressor ID Report indicate that a more protective TSS standard may be appropriate for this reach and the upstream reach.

As with fish, macroinvertebrates in the Black River are also being limited by low DO. Low DO often limits the taxa richness of macroinvertebrates, particularly members of the orders Plecoptera, Odonata, Ephemeroptera, and Trichoptera, and favors taxa that are tolerant (EPA 2012; Weber 1973). The Stressor ID Report found that poor results for nine of the individual M-IBI metric responses from the 2012 sampling at Stations 12RD012 and/or 12RD102 might have been caused by low DO:

- High Hilsenhoff's Biotic Index value
- Low taxa richness of macroinvertebrates with tolerance values less than or equal to two
- Low taxa richness of Plecoptera
- Low taxa richness of Plecoptera, Odonata, Ephemeroptera, and Trichoptera
- Low total taxa richness of macroinvertebrates
- High relative percentage of taxa with tolerance values equal to or greater than six
- Low taxa richness of Trichoptera
- Low relative percentage of taxa belonging to Trichoptera
- Low relative abundance of non-hydropsychid Trichoptera individuals in a subsample

Water quality monitoring data definitively shows that low DO is a problem in the Black River. AUID 558 is impaired by low DO. The low DO impairment is addressed in the following section of this report, Section 4.2.20. The low DO readings have been caused by low flow conditions.

The reach meets current water quality standards for pollutants that may affect IBIs. Therefore, the aquatic macroinvertebrates in this reach are primarily being impacted by a lack of base flow. A pollutant-based TMDL is not warranted at this time.

### 4.3.19 Black River, 09020303-558, Dissolved Oxygen

The Black River is impaired by low DO between the downstream end of the channelized reach (-96.4328, 48.0146) and the confluence with the Little Black River (AUID 528). Within this reach, the vast majority of water quality monitoring data has been collected at the 140$^{th}$ Street Southwest (S003-943) crossing. The frequency of low DO levels in discrete data collected from 2006 to 2015 during the months of May through September (DO5_All) was 14%. The MPCA Stressor ID staff deployed a DO logger for 14 days in August of 2014. DO concentrations dropped below 5 mg/l on 4 of those days (28.6%). That rate exceeded the low DO impairment threshold of 10%. Low DO concentrations become more frequent during low flow, when water can become warm and stagnant. While biological sampling was being conducted in 2012, exceptionally dry conditions caused frequent low DO levels in streams throughout the Red Lake River Watershed and neighboring watersheds.

Longitudinal DO measurements were recorded along this reach and AUID 09020303-557 on August 25, 2016 (Figure 4-62). The primary monitoring site on this reach, S003-943, had the lowest DO concentration (4.98 mg/l). The highest DO concentration along this reach was a concentration of 7.31 mg/l at the upstream end (S009-412 at CR 55). The furthest downstream site along AUID 557, S008-102 at CSAH 3, had a DO concentration of 11.54 mg/l. Those results indicate a gradual decrease in DO levels from AUID 557 through AUID 558.

A lack of base flow has also been identified as a stressor along this reach. Low flows and stagnant water have been recorded near the pour point of the Black River Watershed, along AUID 529, at the CSAH 18 crossing (S002-132). No flow measurements or flow rating curves were available for sites along AUID 558, but stage measurements were collected. The most frequently sampled site along AUID 558 was the CR 100 crossing (S003-943). Theoretically, flow in AUID 558 would be zero during times in which flow in the downstream reach (529) is zero. DO data from AUID 558 was cross-referenced with the flow record from S002-132. Of the 11 days with both flow >0 cfs at S002-132 and DO data at S003-943, 2 days had DO levels below 5 mg/l. Those two low DO readings occurred on consecutive days during a period of significant runoff on July 23, 2014 and July 24, 2014.

Many DO readings at S003-943 were collected prior to the 2012 initiation of continuous flow monitoring in the Black River Watershed. It was initially unclear which measurements may have been affected by a lack of flow. Stage measurements were collected during site visits, though, so days with no flow could be filtered from the DO data set if the stage at which flow ceases could be identified. Stage and flow data from AUIDs 529 and 558 were compared in order to identify an approximate stage at site S003-943 (within AUID 09020303-558) at which flow ceased. Knowledge of that stage allowed for a more complete analysis of DO data in AUID 558. Continuous stage and flow monitoring at S002-132 (CSAH 18, within AUID 529) began in 2012. A comparison of stage measurements at S003-943 and flow measurements at S002-132 revealed a very good correlation. The correlation between the two sites suggested that there was measurable flow at S003-943 when the tape-down stage measurements were less than 12.83 feet.

An assessment was conducted on a data set that included AUID 558 DO measurements that were collected when the tape-down measurement was 12.83 feet or less at S003-943, and DO measurements that were collected on days in which flow at S002-132 was greater than zero. The total number of days known to have measurable flow at S003-943 was 24 days. The two days from July 2014 remained the only low DO readings that were recorded while there was flow within AUID 558. With the addition of more data, the rate of DO violations dropped below the 10% impairment threshold to 8.3%. In turn, days with zero flow could be assessed to see if stagnant water increased the frequency of low DO levels. The rate of low DO readings while flow was known to be stagnant was relatively high, at 22.6% (7 out of 31). It would be preferable to have a greater amount of data, but the available data does indicate that, outside of one extreme summer runoff event, low DO readings are being caused by periods of low-to-no flow and stagnant water.

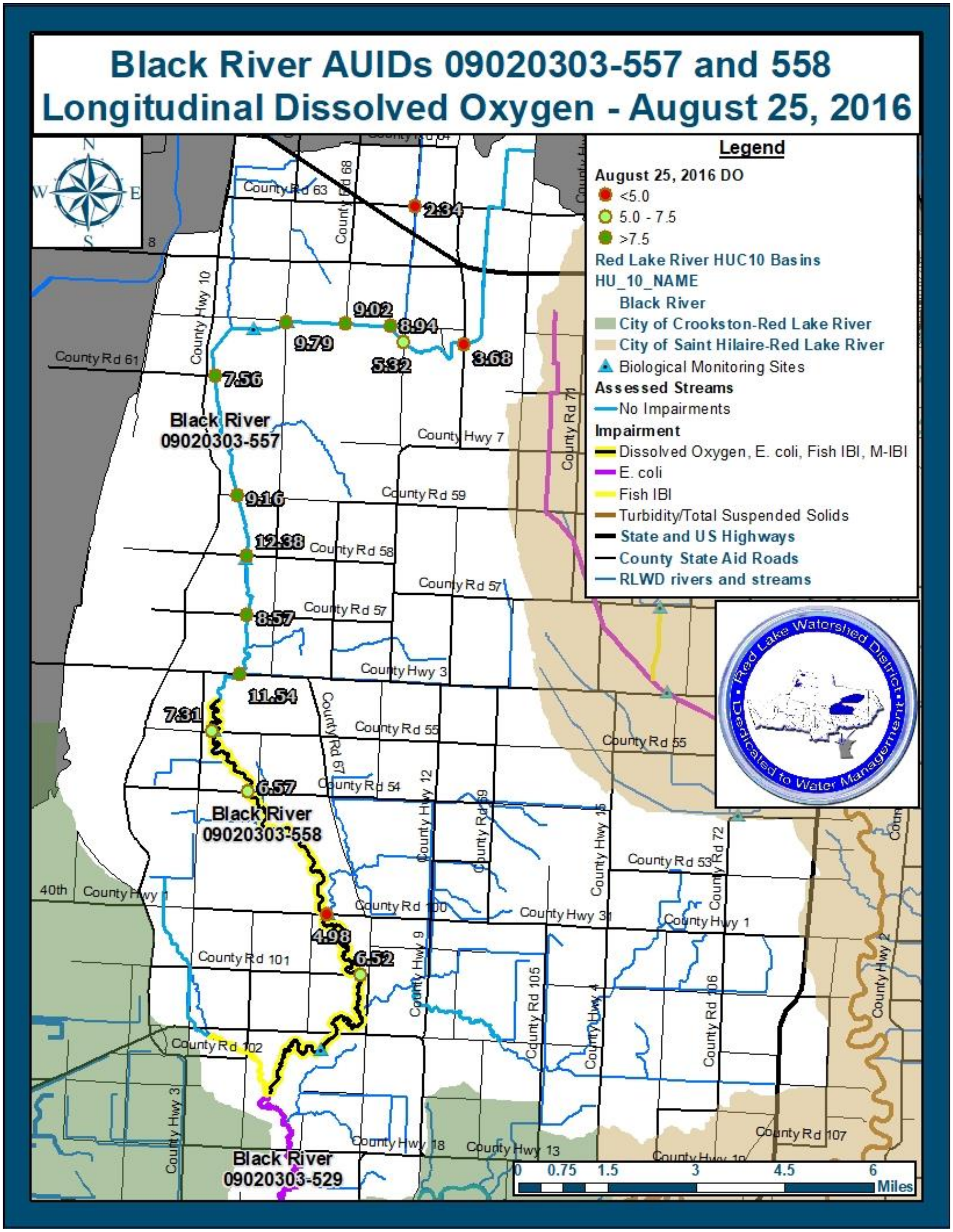

Figure 4-62. Longitudinal DO in the Black River on August 25, 2016.

This reach may also be influenced by low DO concentrations in the upstream reach (AUID 557). A series (July 16, 2015 to September 25, 2015) of DO logger deployments at CR 58 (“Black River North,” S003-948) resulted in an 88.7% rate of low daily minimum DO concentrations. Flow was very low or non-existent during a large portion of that period (Figure 4-63).

Figure 4-63. No-flow conditions in the Black River at 120th St. NW (S003-948).

The relationship between DO and flow exists throughout the Black River Watershed. Low DO readings have also been recorded frequently at the pour point of the watershed (S002-132). The unfiltered data set from that site indicates that it is impaired by low DO. Removal of days with zero flow from the analysis, however, results in a frequency of low DO readings that met the standard. The rate of low DO readings recorded during the months of May through September in the years 2006 through 2015 at S002-132 drops from 23.4% to 2.8% when days with 0 cfs are removed from the record.

TP and TSS data were assessed for AUID 558 for the purpose of being thorough. The summer average TP concentration from 2006 through 2015 was 141 µg/l, which met the 150 µg/l eutrophication standard for the South River Nutrient Region. As stated in Section 4.3.19, zero TSS samples collected along this reach have exceeded the 65 mg/l TSS standard for the South River Nutrient Region that has been assigned to this reach.

# 5. TMDL Development

TMDL establishment sites were chosen for each impaired AUID at frequently-monitored sites that are nearest to the pour point of the reach. Due to the limited number of Red Lake River crossings, some of the TSS TMDL establishment sites are located in mid-reach locations. Most of the tributaries are monitored regularly at crossings that are near the pour points of those subwatersheds.

## 5.1 Total Suspended Solids

### 5.1.1 Loading Capacity

The EPA defines pollutant loading capacity as “the greatest amount of loading that a water can receive without violating water quality standards.” The loading capacity provides a reference, which helps guide pollutant reduction efforts needed to bring a water into compliance with the standards. The LDC method is based on an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes, virtually the full spectrum of allowable loading capacities is represented by the resulting curve. In the TMDL summary tables of this report (Tables 5-19 to 5-22) only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, the entire curve represents the TMDL and is what is ultimately approved by the EPA.

LDC and TMDL calculations were completed for monitoring stations (Figure 5-1) where long term water quality sampling data was available or where future data could be feasibly collected. Due to deep water and high flows, road crossings are necessary for regular sample collection along the Red Lake River. One site was chosen for each reach of the Red Lake River that was impaired by TSS. The following sites were used to calculate TMDLs for each of the TSS-impaired reaches.

1. AUID 09020303-501: S000-031 – CSAH 15 in the city of Fisher (Figure 5-3)
2. AUID 09020303-502: S002-976 – CSAH 3 near the community of Huot (Figure 5-8)
3. AUID 09020303-503: S002-963/S000-013 – Louis Murray Bridge in the city of East Grand Forks (Figure 5-2)
4. AUID 09020303-504: S003-172 – CSAH 13 near Red Lake Falls (Figure 5-7)
5. AUID 09020303-506: S002-080 – Woodland Ave in the city of Crookston (Figure 5-4)
6. AUID 09020303-512: S000-042 – CSAH 11 near Gentilly (Figure 5-5)

Average daily flow records were compiled for those sites. The flow records consisted of long-term USGS data at some of the sites. Simulated flow records from the HSPF model were used for sites without automated gauges. Flows were ranked from highest to lowest. Then, that ranking was used to assign a sequential value to each average daily flow data point. The probability of exceedance of each average daily flow value was calculated as a percentage. This created the information needed to create a flow duration curve by plotting probability of exceedance (X-axis) against the flow level (logarithmic Y-axis). Using the allowable concentration of 30 mg/l or 65 mg/l and conversion factors, the LDCs in Figures 5-2 through 5-7 (daily loads on the Y-axis) were developed to show the allowable tons per day of sediment for each level of flow along the curve. The LDC data was used to determine the median loading capacity for each flow regime.

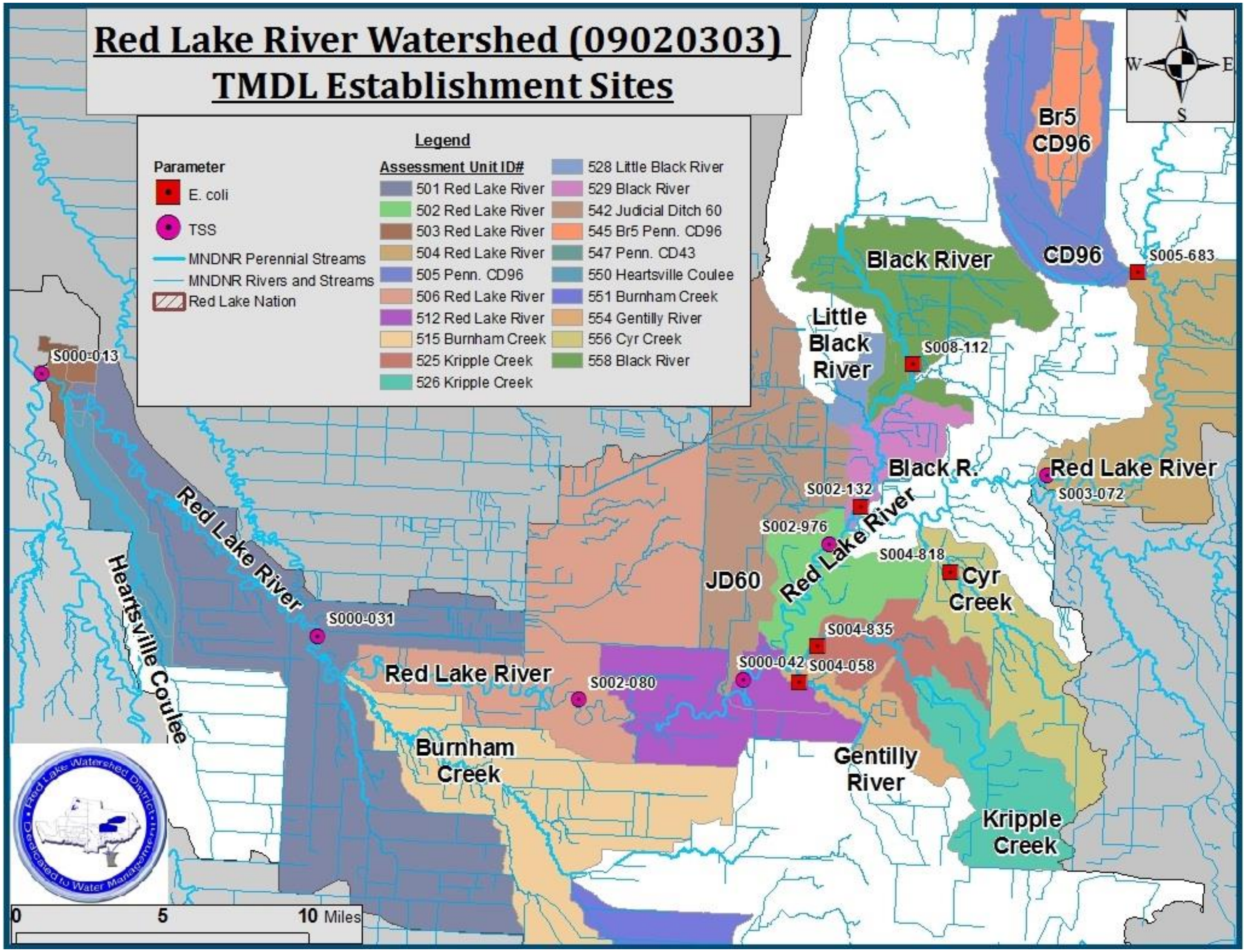

**Figure 5-1. Locations where TSS and *E. coli* TMDLs were established.**

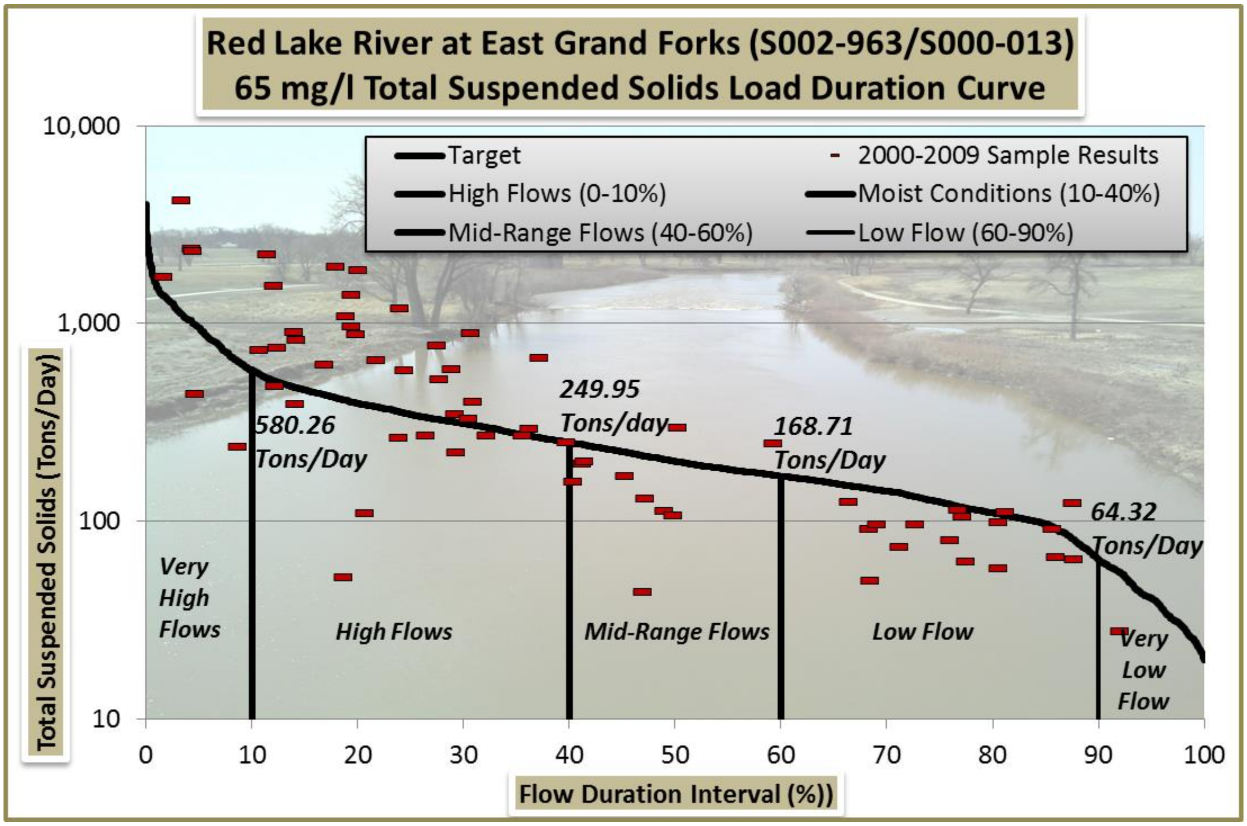


Figure 5-2. Load Duration Curve and median flows for the Red Lake River in East Grand Forks (AUID 09020303-503).

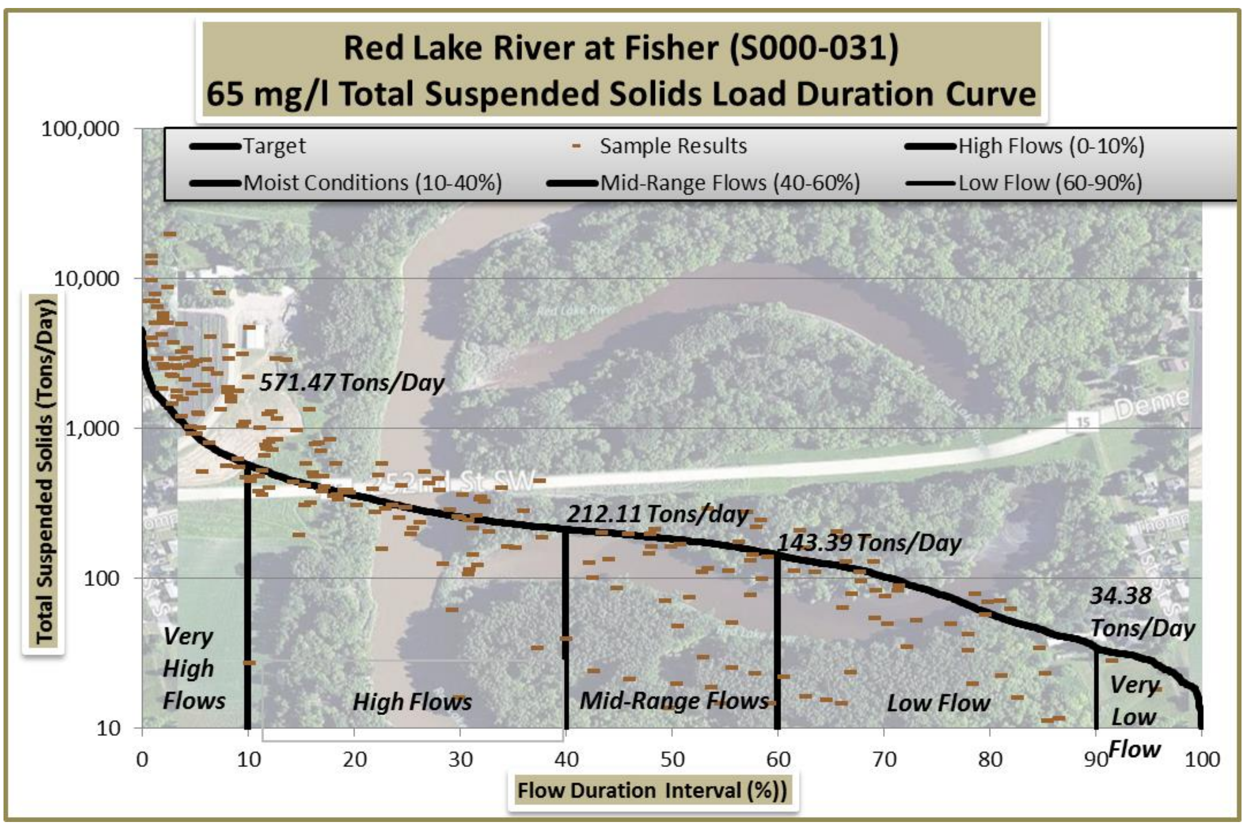


Figure 5-3. Load duration curve and median flows for the Red Lake River at Fisher (AUID 09020303-501).

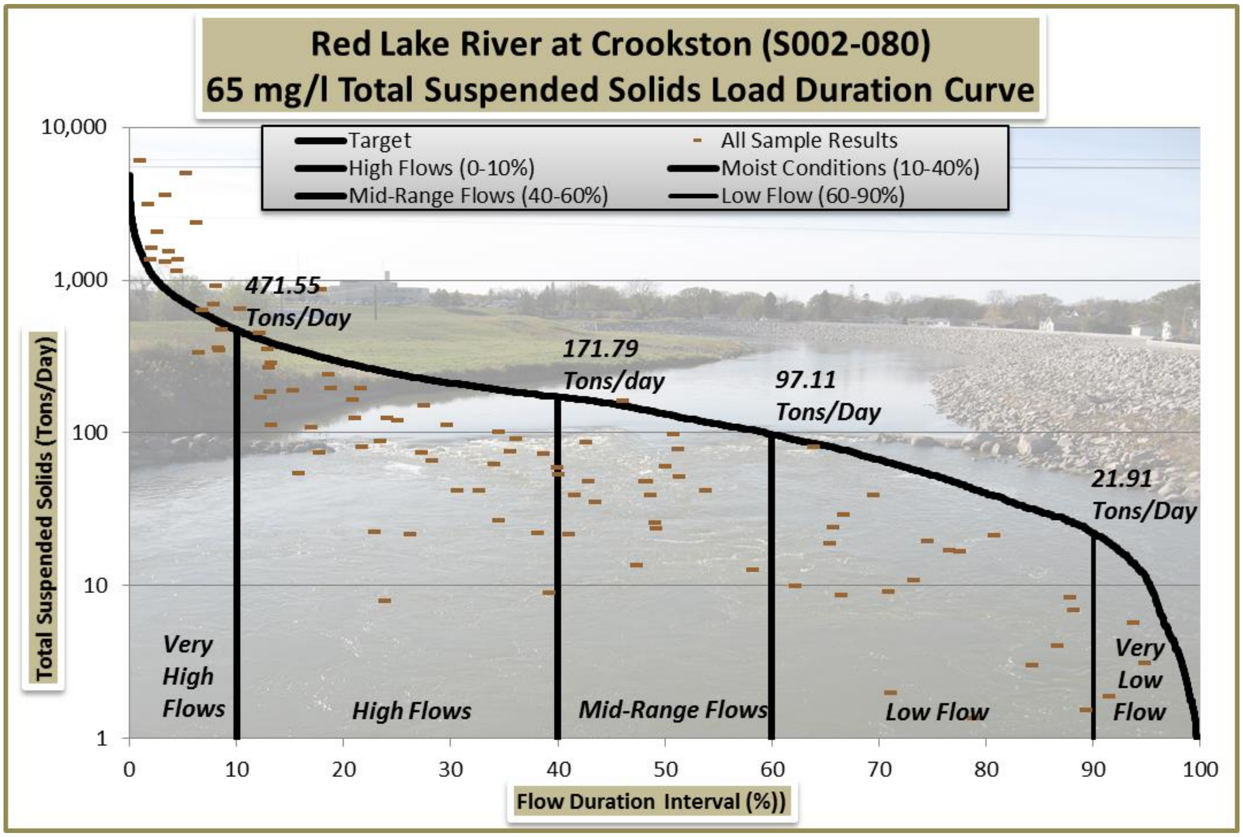


Figure 5-4. Load duration curve and median flows for the Red Lake River in Crookston (AUID 09020303-506).

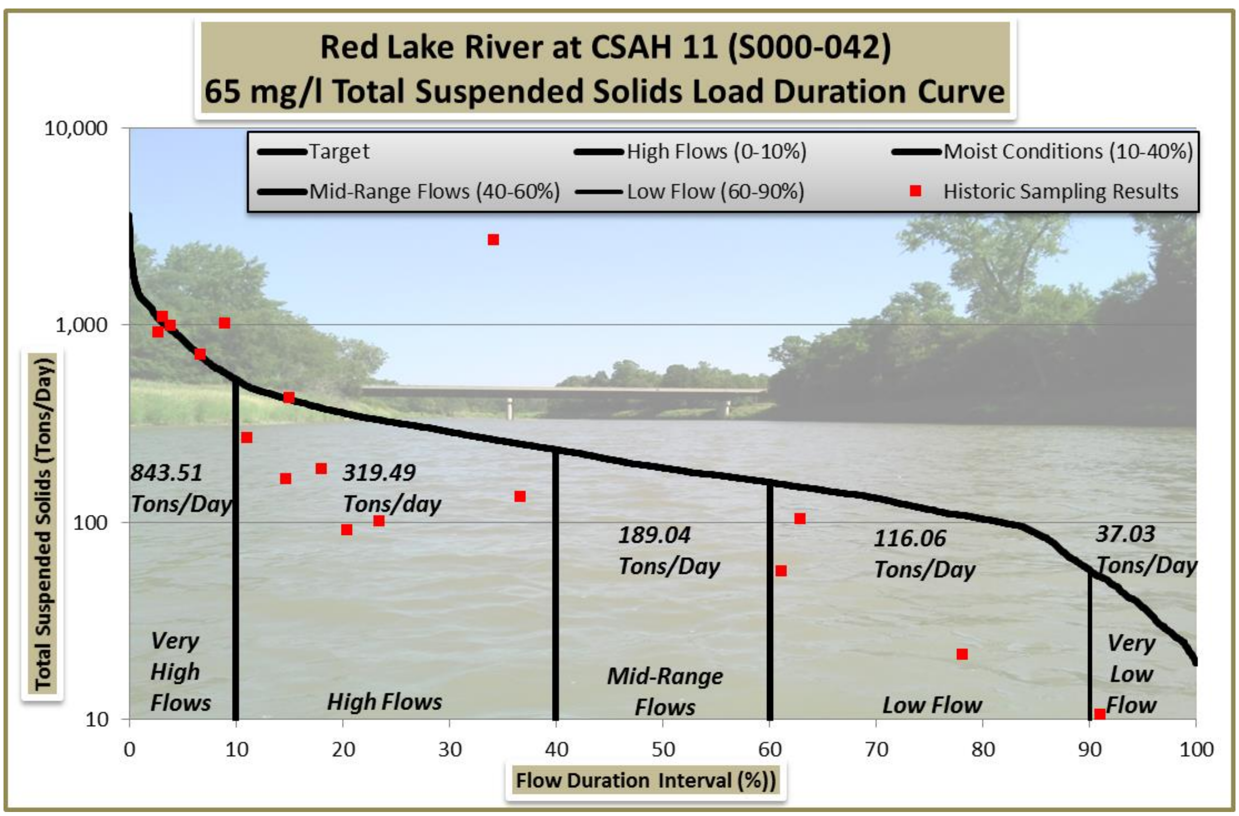


Figure 5-5. Load duration curve and median flows for the Red Lake River at CSAH 11 near Gentilly (AUID 09020303-512).

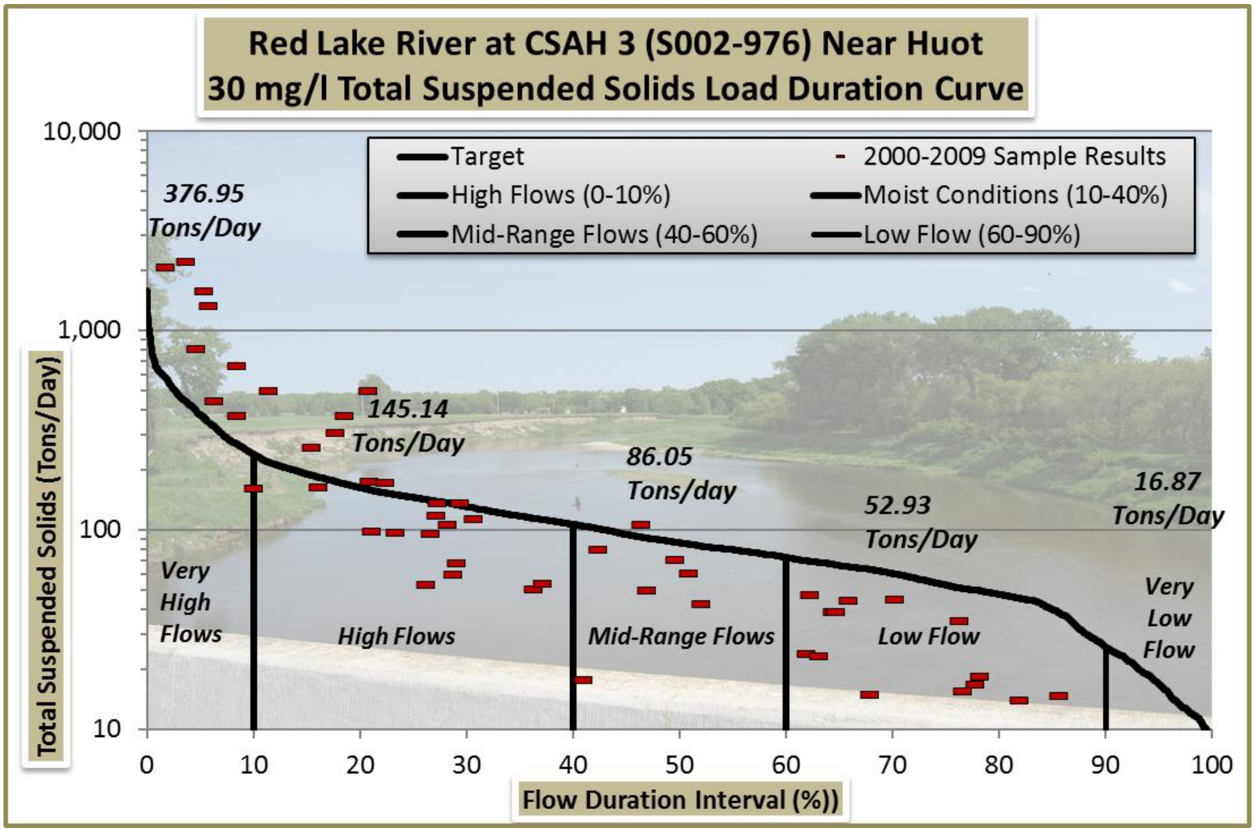


Figure 5-6. Load duration curve and median flows for the Red Lake River at CSAH 3 near Huot (AUID 09020303-502).

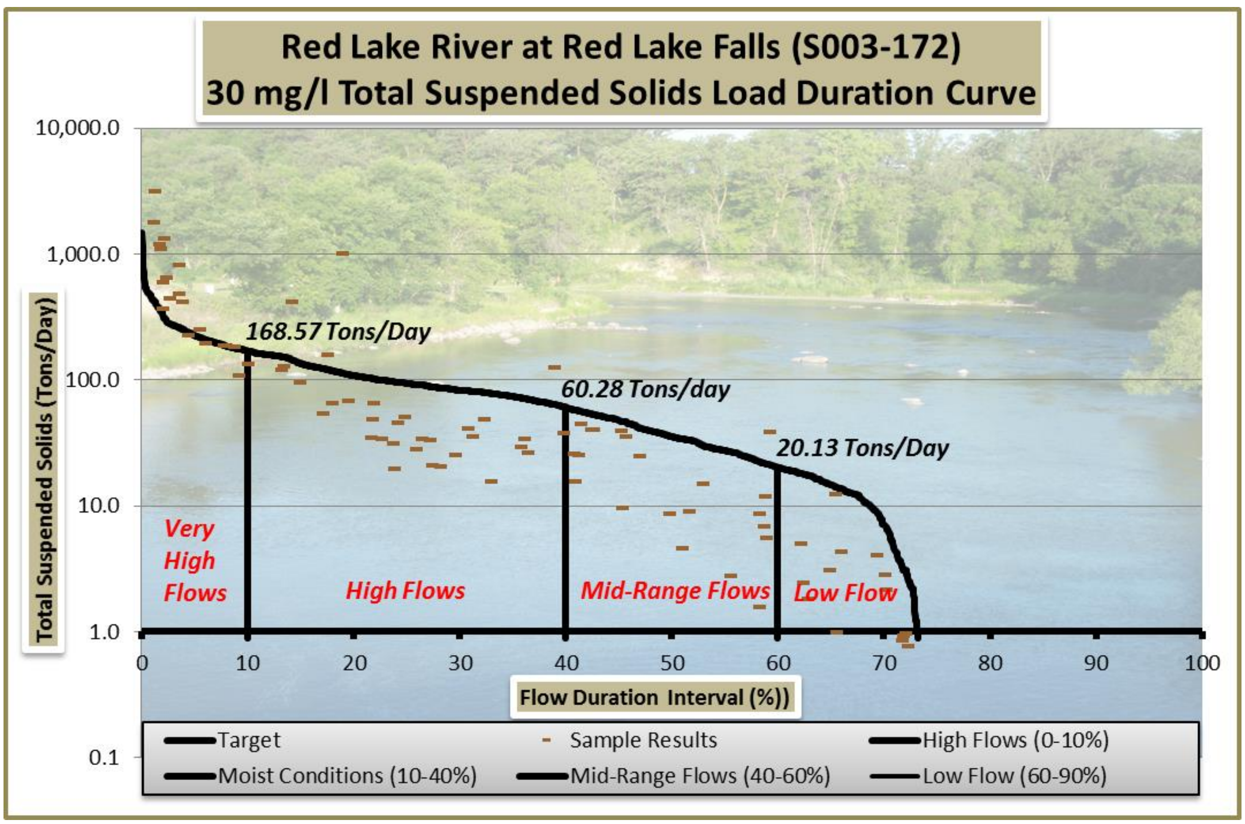


Figure 5-7. Load duration curve and median flows for the Red Lake River at Red Lake Falls (AUID 09020303-504).

### 5.1.2 Load Allocation Methodology

Portions of the total loading capacity were reserved for WLAs, construction and industrial stormwater, reserve capacity, and a margin of safety (MOS). The remaining loading capacity for each flow regime is considered the LA. The current loading estimates were calculated by finding the average TSS concentration for each flow regime. TSS data collected during the years of 2005 through 2014 (most recent 10 years) were used to assess and represent current conditions within the watershed. Flow rates and flow regime values were assigned to each average daily TSS data point. Average TSS concentrations were calculated for each flow regime. Load reduction recommendations were calculated by subtracting the LA from the current load.

### 5.1.3 Wasteload Allocation Methodology

**Wastewater Treatment Facilities**

Seven WWTF are permitted to discharge into the Red Lake River. Nearly all the cities along the Red Lake River have WWTF permits. There are two significant permits in the City of Crookston: American Crystal Sugar and the City of Crookston WWTF. The WWTF for the Seven Clans Casino discharges to the Pennington CD16 drainage system that flows into the Red Lake River southeast of St. Hilaire. The Red Lake River also flows through the city of East Grand Forks, but that city discharges wastewater to the Red River of the North instead of the Red Lake River. For that reason, wastewater discharge from that city is not factored into any Red Lake River TMDLs. All of the facilities have secondary treatment ponds. The Crookston WWTF has a tertiary treatment pond. The most typical windows for release are the early summer months of May and June, as well as the late fall months of September, October, and November. The WWTF WLAs in each TMDL are calculated as the sum of the upstream, applicable (Table 4-1) WLA values in the 'TSS WLA" column of Table 5-1.

Table 5-1. Daily and annual TSS WLAs for WWTFs that discharge to the Red Lake River.

| Facility | Secondary Cell Size (acres) | Permitted Max Daily Discharge (gpd) | Liters per Gallon | Permitted Max Daily Discharge (L/day) | Average # of Days per Year of Discharge | Permitted TSS Concentration mg/l) | TSS WLA (kg/day) | Kg/ton | TSS WLA (tons/day) | TSS WLA (tons/year) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thief River Falls WWTF MN0021431** | 219.00 | 35,680,000 | 3.79 | 135,048,800 | 44.50 | 45 | 6077.20 | 907.20 | 6.70 | 298.10 |
| **St. Hilaire WWTF MNG580139** | 2.29 | 373,270 | 3.79 | 1,412,827 | 24.00 | 45 | 63.58 | 907.20 | 0.07 | 1.68 |
| **7 Clans Casino WWTF MN0063452** | 3.47 | 535,610 | 3.79 | 2,029,962 | 40.00 | 45 | 96.35 | 907.20 | 0.10 | 4.03 |
| **Red Lake Falls WWTF MNG580161** | 15.40 | 2,510,000 | 3.79 | 9,500,350 | 18.00 | 45 | 427.52 | 907.20 | 0.47 | 8.48 |
| **Crookston WWTF MN0021423** | 74.90 | 12,208,700 | 3.79 | 46,209,930 | 33.80 | 45 | 2079.45 | 907.20 | 2.29 | 77.47 |
| **American Crystal Sugar WWTF MN0001929** | -- | 10,000,000 | 3.79 | 37,850,000 | 33.80 | 30 | 1135.50 | 907.20 | 1.26 | 42.31 |
| **Fisher WWTF MNG580170** | 5.04 | 820,070 | 3.79 | 3,103,965 | 19.70 | 45 | 139.68 | 907.20 | 0.15 | 3.03 |

For each TMDL establishment site, the maximum daily permitted WLA was calculated for each WWTF discharging upstream of that location. The WLA was computed using the maximum permitted daily flow rate and calendar month average (CalMoAvg) TSS concentration. The maximum daily permitted TSS WLA was converted to maximum annual loads by reviewing discharge monitoring reports and calculating the average number of days that each WWTF discharged in a year during the most recent 10 years of data (typically 2006 through 2015) and multiplying that value by the permitted daily discharge. The St. Hilaire WWTF only had six years of available data. The maximum permitted daily and annual TSS WLA for each WWTF are shown in Table 5-1. Table 4-1 shows which WWTF WLAs apply to each impaired reach and TMDL establishment location.

**Regulated Construction and Industrial Stormwater**

National Pollutant Discharge Elimination System (NPDES) permitted construction stormwater must be given a WLA for TMDLs that are established for TSS and other pollutants. The Industrial Stormwater Multi-Sector General Permit is also utilized by the MPCA to manage compliance with a TMDL. Industrial stormwater must also receive a WLA if facilities are present in the drainage area of an impaired AUID. The MPCA has issued construction and industrial NPDES permits within each of the counties through which the Red Lake River flows. Construction and industrial activity comprise a small percentage of the land area in the watershed, so the allocations for these two activities were combined in the WLA calculations for this TMDL. According to MPCA data, the annual percentage of land area under construction has been 0.012% in Polk County and .006% in Red Lake County. Identical land area percentages for each county were used to calculate LAs for industrial stormwater activity. The average annual acreage was calculated by dividing the total acreage under construction by the number of unique start date years. That average annual acreage within each county was divided by the total acreage of the county to calculate the density of construction stormwater activity as a percentage of land area (Table 5-2) that was applied to the loading capacity (LC) using the following equation:

Construction and Industrial Stormwater WLA = (% of Land Area) x (LC – MOS)

Table 5-2. Calculation of construction and industrial stormwater land use percentages.

| Site | S002-963 | S000-131 | S002-080 | S000-042 | S002-976 | S003-072 |
|---|---|---|---|---|---|---|
| AUID 09020303-XXX | 503 | 501 | 506 | 512 | 502 | 504 |
| Nearest Community | East Grand Forks | Fisher | Crookston | Gentilly | Huot | Red Lake Falls |
| Penn. Co. Const. Stormwater - Average Annual Land Area (ac) | 39.02 | 39.02 | 39.02 | 39.02 | 39.02 | 39.02 |
| Red Lake Co. Const. Stormwater - Average Annual Land Area (ac) | 15.43 | 15.43 | 15.43 | 15.43 | 15.43 | 15.43 |
| Polk Co. Const. Stormwater - Average Annual Land Area (ac) | 148.31 | 148.31 | 148.31 | 148.31 | | |
| Total Applicable County Land Area (acres)* | 1,951,360 | 1,951,360 | 1,951,360 | 1,951,360 | 672,640 | 672,640 |
| Construction Stormwater as a % of Land Area | 0.010% | 0.010% | 0.010% | 0.010% | 0.008% | 0.008% |
| Industrial Stormwater % | 0.021% | 0.021% | 0.021% | 0.021% | 0.016% | 0.016% |

| Site | S002-963 | S000-131 | S002-080 | S000-042 | S002-976 | S003-072 |
|---|---|---|---|---|---|---|
| AUID 09020303-XXX | 503 | 501 | 506 | 512 | 502 | 504 |
| Nearest Community | East Grand Forks | Fisher | Crookston | Gentilly | Huot | Red Lake Falls |
| Total % Industrial and Construction Stormwater Allocation | 0.031% | 0.031% | 0.031% | 0.031% | 0.024% | 0.024% |
| *1,277,820 acres in Polk County; 277,120 acres in Red Lake County; 395,520 aces in Pennington County | | | | | | |

**Regulated Municipal Separate Storm Sewer Systems and MnDOT Right of Way**

The MS4 systems are designed to convey stormwater into a receiving waterbody and are permitted under the NPDES Permit. All current MS4 communities and future designated MS4 communities are included in the WLA (Table 5-3). The cities of East Grand Forks, Crookston, and Thief River Falls have populations greater than 5,000 and have stormwater systems that drain to the Red Lake River. The city of East Grand Forks is already designated as a small MS4 and is therefore required to obtain coverage under an MS4 permit (MS400088, East Grand Forks City MS4). Crookston will be designated as an MS4 because its population is greater than 5,000 people and its stormwater discharges to an impaired reach of the Red Lake River. The Red Lake River is not impaired as it flows through the city of Thief River Falls and the city's reservoir has the net effect of removing sediment from the river. For those reasons, the city of Thief River Falls will not be recommended for MS4 designation and will not receive an MS4 allocation at this time. Stormwater in Thief River Falls will be addressed through continued monitoring and voluntary practices.

Table 5-3. Calculation of acreage and percentages applied to MS4 and MnDOT Stormwater WLAs

| Water Quality Station: | S002-963 | S000-131 | S002-080 | S000-042 | S002-976 | S003-072 |
|---|---|---|---|---|---|---|
| AUID 09020303-XXX: | 503 | 501 | 506 | 512 | 502 | 504 |
| Nearest Community: | East Grand Forks | Fisher | Crookston | Gentilly | Huot | Red Lake Falls |
| Acres of East Grand Forks Jurisdiction within AUID Drainage Area: | 1566.74 | -- | -- | -- | -- | -- |
| Acres of MnDOT ROW within Urbanized East Grand Forks: | 865.96 | -- | -- | -- | -- | -- |
| Acres of Crookston Jurisdiction within AUID Drainage Area: | 2719.70 | 2719.70 | 2719.70 | -- | -- | -- |
| Total acres in MS4 Jurisdiction: | 3420.48 | 2719.70 | 2719.70 | -- | -- | -- |
| Total Drainage Area of AUID: | 3,683,724 | 3,618,240 | 3,464,538 | 3,421,811 | 3,335,014 | 2,331,213 |
| Acres in the Upper/Lower Red Lakes HUC8 Watershed: | 1,263,678 | 1,263,678 | 1,263,678 | 1,263,678 | 1,263,678 | 1,263,678 |
| Acres in the Thief River HUC8 Watershed: | 624,422 | 624,422 | 624,422 | 624,422 | 624,422 | 624,422 |
| Acres in the Clearwater River HUC8 Watershed: | 886,600 | 886,600 | 886,600 | 886,600 | 886,600 | -- |
| Applicable acres for calculating MS4 WLAs: | 909,024 | 843,540 | 689,838 | 647,111 | 560,314 | 443,113 |
| Percentage of Land - MS4: | **0.376%** | **0.322%** | **0.394%** | -- | -- | -- |
| Percentage of Land Area - MnDOT: | **0.095%** | -- | -- | -- | -- | -- |

MS4 allocations were calculated using the following equation:

MS4 Allocation = %MS4 Area ∗ (LC – MOS – WWTF WLA)

Where:

%MS4 Area = the ratio of the total MS4 area to the total drainage area for the given AUID (within the Red Lake River HUC8). Areas were obtained using ArcMap.

LC = Total Loading Capacity

WWTF WLA = Wasteload allocation from upstream communities

The WLAs for each individual community and flow regime are shown in the TMDL tables in Section 5.1.7.

The acreage under the Minnesota Department of Transportation (MnDOT) right of way (ROW) that lies within the urbanized portion of an impaired AUID was subtracted from the acreage of the city's jurisdiction and divided by the drainage area of AUID 503 (the entire Red Lake River HUC8) to calculate separate WLA. East Grand Forks was the only urbanized area within the watershed, so the TMDL at Station S000-013 in East Grand Forks was the only station that required a separate WLA for MnDOT ROW. The AUID drainage areas for MS4 calculations include the drainage area of the pour points of impaired AUIDs, not just the drainage area for the TMDL establishment locations. This provides a better representation of the relative effect that stormwater from each community has upon water quality in the Red Lake River. The AUID drainage areas for MS4 calculations only included the area within the Red Lake River HUC8. The most up-to-date, publicly available GIS data was used to calculate the areas for the MS4s and MnDOT WLAs. City boundary GIS data from MnDOT was dated July 6, 2018. The 2010 urbanized area GIS data was used along with MnDOT ROW footprint GIS data (downloaded from the Minnesota Geospatial Commons on November 26, 2018) to calculate the MnDOT ROW acreage.

### 5.1.4 Margin of Safety

The statute and regulations require that a TMDL include a MOS to account for any lack of knowledge concerning the relationship between load and WLAs and water quality (CWA §303(d)(1)(c), 40 C.F.R. §130.7(c)(1)). The EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified. An explicit MOS equal to 10% of the loading capacity was applied to each flow regime. The explicit 10% MOS accounts for:

- Uncertainty in the observed daily flow record
- Uncertainty in the observed water quality data.
- Allocations and loading capacities are based on flow, which varies from high to low. This variability is accounted for using the five flow regimes and the LDCs.
- The variability in pollutant concentrations at any given flow.
- Imperfect homogeneity of pollutants throughout the water column.

### 5.1.5 Seasonal Variation

The LDC figures in Section 5.1.2 show that exceedances of the TSS standard occur most frequently during the highest of flows. The TMDL summary tables in Section 5.1.7 show that all the reaches need load reductions in the very high flow regimes. This suggests that TSS exceedances are primarily driven by runoff events at most locations along the river. At the Fisher Bridge (S000-031), sediment load reductions are necessary across nearly all flow regimes in order for the river to meet the TSS standard. In the downstream reaches, TSS can remain high throughout the monitoring season. In the upstream reaches, TSS levels were high during spring runoff and summer runoff events but could be acceptably low during moderate and low flows (Figure 5-8).

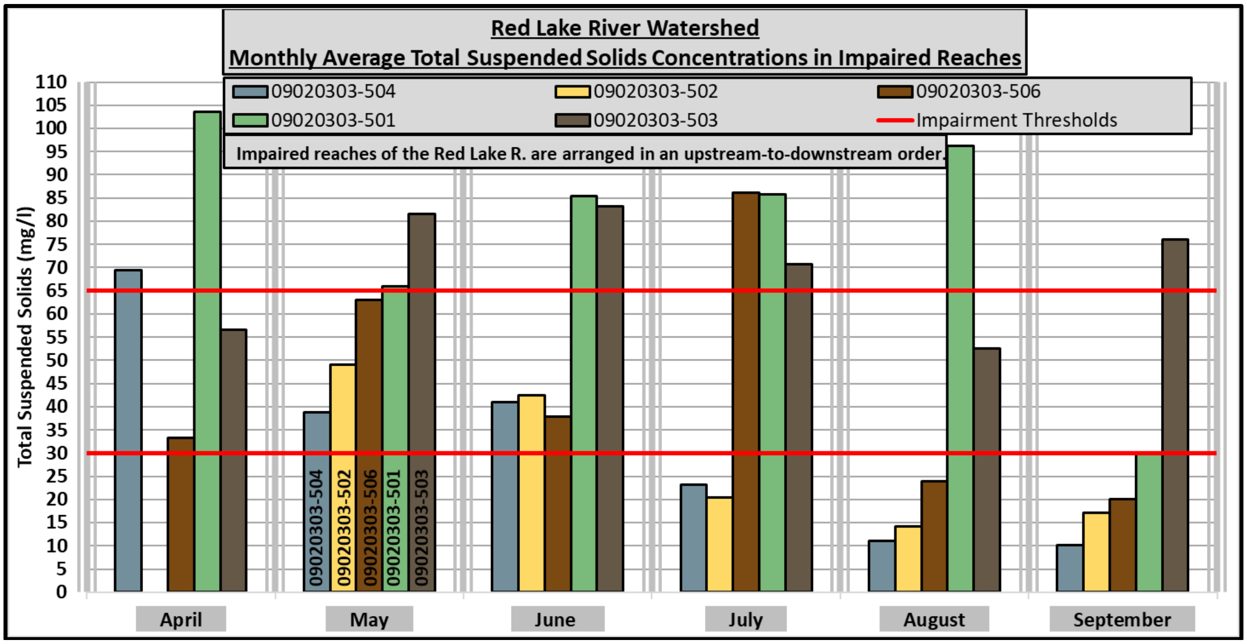

Figure 5-8. Monthly average TSS concentrations in impaired AUIDs of the Red Lake River (2006-15)

### 5.1.6 Reserve Capacity

A minimal amount of reserve capacity (5%) within LA tables (Table 5-10) was reserved for future development. Modest amounts of future urban development are planned within this agricultural watershed, however. Implementation goals will focus on lessening the impact of agricultural practices. There is a precedent for setting the reserve capacity to zero in other watershed TMDLs within the Red River Basin. No reserve capacity is necessary for the Crookston, Fisher, and East Grand Forks WWTFs because their permitted effluent concentrations are lower than the TSS standard for the reaches of the Red Lake River that receive discharge from those facilities. Also, no reserve capacity was applied for stormwater in accordance with MPCA guidance.

### 5.1.7 TMDL Summary

Tables 5-2, 5-4, 5-6, 5-8, 5-9, and 5-11 summarize the calculation of TMDLs for TSS-impaired reaches of the Red Lake River. Necessary load reductions were calculated (annual and flow-regime) where there was sufficient TSS and flow data. Annual load reduction summaries are shown in Tables 5-5, 5-7, 5-9, 5-12, and 5-14. In order to calculate load reductions, a pivot table was used to summarize existing TSS data by flow regime. Filters were applied to limit data to the years of 2005 through 2014 and the months of April through September.

The Murray Bridge (S000-013/S002-963) monitoring site in East Grand Forks is the only road crossing of the TSS-impaired 09020303-503 AUID. According to the state's EQuIS database, monitoring data collection dates back to 1953. There is no flow monitoring at the site, so TMDL calculations relied upon flows that were simulated by the Red Lake River HSPF model. Upstream WWTFs include Fisher, both Crookston facilities, Red Lake Falls, St. Hilaire, and Thief River Falls. Overall, very large non-point load reductions will be necessary to allow this reach to meet the 65 mg/l TSS standard.

**Table 5-4. TSS Load Allocation Summary for the Red Lake River at East Grand Forks on AUID 503.**

| Site ID: S002-963/S000-013 (Murray Bridge)<br>Total Suspended Solids Standard: 65 mg/l<br>Drainage Area (square miles): 5,756<br>% MS4: 0.376%<br>Total WWTF Design Flow (mgd): 39.92 | **Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River in East Grand Forks AUID: 09020303-503** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low** |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **946.62** | **346.01** | **200.90** | **125.39** | **40.97** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 11.03 | 11.03 | 11.03 | 11.03 | 11.03 |
| East Grand Forks NPDES Permitted MS4 Community | 0.65 | 0.23 | 0.13 | 0.08 | 0.02 |
| Crookston NPDES Permitted MS4 Community | 2.53 | 0.91 | 0.52 | 0.32 | 0.09 |
| East Grand Forks MnDOT Urbanized ROW WLA | 0.80 | 0.29 | 0.17 | 0.10 | 0.03 |
| Construction and Industrial Stormwater | 0.18 | 0.07 | 0.04 | 0.02 | 0.01 |
| **Reserve Capacity** | 47.33 | 17.30 | 10.05 | 6.27 | 2.05 |
| **Daily Load Allocation** | 789.44 | 281.58 | 158.87 | 95.03 | 23.64 |
| **Daily Margin of Safety** | 94.66 | 34.60 | 20.09 | 12.54 | 4.10 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 946.62 | 346.01 | 200.90 | 125.39 | 40.97 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 1.165% | 3.188% | 5.490% | 8.797% | 26.922% |
| East Grand Forks NPDES Permitted MS4 Community | 0.077% | 0.077% | 0.077% | 0.077% | 0.077% |
| Crookston NPDES Permitted MS4 Community | 0.299% | 0.299% | 0.299% | 0.299% | 0.299% |
| East Grand Forks MnDOT Urbanized ROW WLA | 0.095% | 0.095% | 0.095% | 0.095% | 0.095% |
| Construction and Industrial Stormwater | 0.021% | 0.021% | 0.021% | 0.021% | 0.021% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 83.395% | 81.379% | 79.079% | 75.788% | 57.701% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 5400.09 | 1973.84 | 1146.05 | 715.28 | 233.70 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| *the 1996-2009 flow record was simulated by the Red Lake River HSPF Model.<br>** Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton) | | | | | |

**Table 5-5. Annual load Reduction needed for the Red Lake River at East Grand Forks.**

| **Red Lake River at East Grand Forks (09020303-503, S002-963, S00-013) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **Very Low Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| Current Daily Load (tons/day) | 1020.83 | 726.02 | 161.26 | 91.34 | 27.74 | |
| Load Allocation (tons/day) | 789.44 | 281.58 | 158.87 | 95.03 | 23.64 | -- |
| Load Reduction (tons/day) | 231.39 | 444.44 | 2.39 | 0.00 | 0.00 | -- |
| % of Flows Represented | 10% | 30% | 20% | 30% | 10% | 100% |
| Number of Days Represented | 36.50 | 109.50 | 73.00 | 109.50 | 36.50 | 365.00 |
| Annual Load Reduction (tons/year) | 8,445.74 | 48,666.18 | 174.47 | 0.00 | 0.00 | **57,286.39** |
| Total Current Load | 37,260.36 | 79,498.88 | 11,771.98 | 10,002.22 | 1,012.39 | 139,545.83 |
| % Reduction | **22.67%** | **61.22%** | **1.48%** | 0.0% | 0.0% | **41.05%** |

The "Fisher Bridge" (S000-031) monitoring site near Fisher is the only site with a USGS flow gauge along the impaired 09020303-501 AUID and is regularly sampled by multiple monitoring programs. This site has been a part of load monitoring programs, so an extensive amount of data was available for the calculation of current loads and necessary load reductions.

Table 5-6. TSS Load Allocation Summary for the Red Lake River at Fisher on AUID #09020303-501.

| Site ID: S000-031 (EQuIS), 05080000 (USGS)<br>Total Suspended Solids Standard: 65 mg/l<br>Drainage Area (square miles): 5,680<br>% MS4: 0.322% | Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River at 252nd Street NW at Fisher AUID: 09020303-501 | | | | |
|---|---|---|---|---|---|
| | Duration Curve Zone | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low** |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **916.63** | **298.01** | **182.31** | **79.23** | **28.57** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 11.03 | 11.03 | 11.03 | 11.03 | 11.03 |
| Crookston NPDES Permitted MS4 Community | 2.63 | 0.84 | 0.51 | 0.21 | 0.06 |
| MnDOT Urbanized ROW WLA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Construction and Industrial Stormwater | 0.17 | 0.06 | 0.03 | 0.01 | 0.01 |
| **Reserve Capacity** | 45.83 | 14.90 | 9.12 | 3.96 | 1.43 |
| **Daily Load Allocation** | 765.31 | 241.38 | 143.39 | 56.10 | 13.18 |
| **Daily Margin of Safety** | 91.66 | 29.80 | 18.23 | 7.92 | 2.86 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 916.63 | 298.01 | 182.31 | 79.23 | 28.57 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 1.203% | 3.701% | 6.050% | 13.921% | 38.607% |
| NPDES Permitted MS4 Communities | 0.322% | 0.322% | 0.322% | 0.322% | 0.322% |
| MnDOT Urbanized ROW WLA | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Construction and Industrial Stormwater | 0.021% | 0.021% | 0.021% | 0.021% | 0.021% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 83.492% | 80.997% | 78.652% | 70.807% | 46.132% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 5,229 | 1,700 | 1,040 | 452 | 163 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| *The flow record from USGS Gauge 05080000 was used to develop flow zones and loading capacities.<br>** Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton) | | | | | |

Table 5-7. Annual load reduction needed for the Red Lake River at Fisher.

| **Red Lake River at Fisher (09020303-501, S000-031) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **Very Low Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| Current Daily Load (tons/day) | 3,340.14 | 544.68 | 168.29 | 82.23 | 15.02 | |
| Load Allocation (tons/day) | 765.31 | 241.38 | 143.39 | 56.10 | 13.18 | -- |
| Load Reduction (tons/day) | 2,574.83 | 303.30 | 24.90 | 25.13 | 1.84 | -- |
| % of Flows Represented | 10% | 30% | 20% | 30% | 10% | 100% |
| Number of Days Represented | 36.50 | 109.50 | 73.00 | 109.50 | 36.50 | 365.00 |
| Annual Load Reduction (tons/year) | 93,981.30 | 33,211.35 | 1,817.70 | 2,751.74 | 67.16 | **131,829.25** |
| Total Current Load | 121,915.02 | 59,642.94 | 12,284.88 | 9,004.18 | 548.34 | 203,395.36 |
| % Reduction | **77.09%** | **55.68%** | **14.80%** | **30.56%** | **12.25%** | **64.81%** |

The “790” (S000-080) monitoring site within the city of Crookston is the most frequently sampled site and is the only site with a USGS flow gauge along the impaired 09020303-506 AUID. Volunteer and longitudinal sampling has been conducted at other crossings in or near Crookston, but this site has been co-located with the USGS Gauge Number 05079000, has been part of a long-term condition-monitoring program, and has been sampled for a load-monitoring program.

Table 5-8. TSS load allocations for the Red Lake River in Crookston on AUID # 09020303-506.

| Site ID: S002-080 (EQuIS), 05079000 (USGS)<br>Total Suspended Solids Standard: 65 mg/l<br>Drainage Area (square miles): 5,270<br>% MS4: 0.394%<br>Total WWTF Design Flow (mgd): 16.89 | Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River in Crookston AUID: 09020303-506 | | | | |
|---|---|---|---|---|---|
| | Duration Curve Zone | | | | |
| | Very High | High | Mid | Low | Very Low |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **722.23** | **241.92** | **132.35** | **52.59** | **11.04** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 7.34 | 7.34 | 7.34 | 7.34 | 7.34 |
| Crookston NPDES Permitted MS4 Community | 2.55 | 0.85 | 0.46 | 0.17 | 0.03 |
| MnDOT Urbanized ROW WLA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Construction and Industrial Stormwater | 0.14 | 0.05 | 0.03 | 0.01 | 0.00 |
| **Reserve Capacity** | 36.11 | 12.10 | 6.62 | 2.63 | 0.55 |
| **Daily Load Allocation** | 603.87 | 197.39 | 104.66 | 37.18 | 2.02 |
| **Daily Margin of Safety** | 72.22 | 24.19 | 13.24 | 5.26 | 1.10 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 722.23 | 241.92 | 132.35 | 52.59 | 11.04 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 1.016% | 3.034% | 5.546% | 13.957% | 66.486% |
| Crookston NPDES Permitted MS4 Community | 0.394% | 0.394% | 0.394% | 0.394% | 0.394% |
| MnDOT Urbanized ROW WLA | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Construction and Industrial Stormwater | 0.021% | 0.021% | 0.021% | 0.021% | 0.021% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 83.612% | 81.593% | 79.078% | 70.698% | 18.297% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 4120.00 | 1380.00 | 755.00 | 300.00 | 63.00 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| *The flow record from USGS Gauge 05079000 was used to develop flow zones and loading capacities.<br>**Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton) | | | | | |

Table 5-9. Annual load reduction needed for the Red Lake River at Crookston.

| **Red Lake River at Crookston (09020303-506, S002-080) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **Very Low Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| Current Daily Load (tons/day) | 1,453.91 | 170.55 | 53.45 | 24.05 | 4.40 | |
| Load Allocation (tons/day) | 603.87 | 197.39 | 104.66 | 37.18 | 2.02 | -- |
| Load Reduction (tons/day) | 850.04 | 0.00 | 0.00 | 0.00 | 2.38 | -- |
| % of Flows Represented | 10% | 30% | 20% | 30% | 10% | 100% |
| Number of Days Represented | 36.50 | 109.50 | 73.00 | 109.50 | 36.50 | 365.00 |
| Annual Load Reduction (tons/year) | 31,026.46 | 0.00 | 0.00 | 0.00 | 86.87 | **31,113.33** |
| Total Current Load | 53,067.69 | 18,675.28 | 3,901.52 | 2,633.98 | 160.65 | 78,439.12 |
| % Reduction | **58.47%** | 0.00% | 0.00% | 0.00% | **54.07%** | **39.67%** |

The “Gentilly Bridge” monitoring site at the CSAH 11 crossing (S000-042) of the Red Lake River is the only road crossing along the AUID 09020303-512 portion of the Red Lake River. This location is primarily influenced by upstream and tributary AUIDs because the site only represents 8% of the direct drainage area to AUID 09020303-512. Reducing sediment loads in upstream reaches of the Red Lake River (09020303-502, 510, 511, and 504) will be very important for the restoration of this reach. Erosion reduction in Red Lake River tributaries like the Black River, Cyr Creek, Gentilly River, and Kripple Creek will also be beneficial for this reach. Reduction of erosion along this AUID will benefit downstream, impaired reaches of the Red Lake River (09020303-506, 501, and 503). Despite its position near the upstream end of AUID 512, the S000-042 monitoring station is still significant. The CSAH 11 crossing represents an additional 132 square miles of drainage area when compared to the nearest monitoring station along the upstream AUID of the Red Lake River (09020303-502, CSAH 3, S002-976). That area includes direct drainage to the Red Lake River and the entire drainage area of the Gentilly River.

The impairment of this reach was mostly identified by turbidity and transparency measurements collected by volunteers (Crookston High School River Watch). There was very little TSS data available. Therefore, the following flow regimes and LAs were calculated using HSPF-simulated flow data for the period of 1996 through 2009. The CSAH 11 crossing lies along reach number 450 of the HSPF model, which extends from the Gentilly River confluence to the JD60 confluence. Approximately 26% of the drainage area within that sub-basin flows past the CSAH 11 crossing. The total drainage area (including upstream portions of the Red Lake River Watershed and the Upper/Lower Red Lakes Watershed) of the Red Lake River at CSAH 11 is equal to 99.86% of the total drainage area of HSPF Sub-basin 450 according to HSPF delineations and 99.84% according to USGS StreamStats drainage area delineations. The HSPF delineations are based upon LiDAR data and should be more precise. Therefore, the 99.86% figure was used to adjust the simulated flow record for sub-basin 450 downward to estimate flows at CSAH 11. There was too little TSS data available to reliably calculate current loads or prescribe load reductions at this time.

**Table 5-10. TSS Load Allocation Summary for the Red Lake River at CSAH 11 on AUID #09020303-512.**

| Site ID: S000-042<br>Total Suspended Solids Standard: 65 mg/l<br>Drainage Area (square miles): 5,281<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 16.89 | **Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River at CSAH 11, near Gentilly AUID: 09020303-512** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low** |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **843.51** | **319.49** | **189.04** | **116.06** | **37.03** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 7.34 | 7.34 | 7.34 | 7.34 | 7.34 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MnDOT Urbanized ROW WLA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Construction and Industrial Stormwater | 0.16 | 0.06 | 0.04 | 0.02 | 0.01 |
| **Reserve Capacity** | 42.18 | 15.97 | 9.45 | 5.80 | 1.85 |
| **Daily Load Allocation** | 709.48 | 264.17 | 153.31 | 91.29 | 24.13 |
| **Daily Margin of Safety** | 84.35 | 31.95 | 18.90 | 11.61 | 3.70 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 843.51 | 319.49 | 189.04 | 116.06 | 37.03 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0.870% | 2.326% | 3.883% | 6.324% | 19.822% |
| NPDES Permitted MS4 Communities | 0.000% | 0.00% | 0.000% | 0.000% | 0.000% |
| MnDOT Urbanized ROW WLA | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Construction and Industrial Stormwater | 0.021% | 0.021% | 0.021% | 0.021% | 0.021% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 84.110% | 82.685% | 81.099% | 78.658% | 65.163% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 4811.90 | 1822.58 | 1078.42 | 662.07 | 211.26 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| *An area-weighted flow record was calculated by using outputs from the Red Lake River HSPF Sub-Basin 450) and used to develop flow zones and loading capacities.<br>**Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton) | | | | | |

The “Huot” (S002-976) monitoring site at CSAH 3 near the village of Huot is the only road crossing along the TSS-impaired 09020303-502 AUID. There was no long-term flow monitoring station at the site, so modeled flows were used for the calculation of TMDLs and current loads.

**Table 5-11. TSS Load Allocation Summary for the Red Lake River at CSAH 3 near Huot on AUID 502.**

| Site ID: S002-976<br>Total Suspended Solids Standard: 30 mg/l<br>Drainage Area (square miles): 5,148<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 16.89 | Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River at CSAH 3, near Huot AUID: 09020303-502 | | | | |
|---|---|---|---|---|---|
| | Duration Curve Zone | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low** |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **376.95** | **145.14** | **86.05** | **52.93** | **16.87** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 7.34 | 7.34 | 7.34 | 7.34 | 7.34 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MnDOT Urbanized ROW WLA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Construction and Industrial Stormwater | 0.05 | 0.02 | 0.01 | 0.01 | 0.00 |
| **Reserve Capacity** | 18.85 | 7.26 | 4.30 | 2.65 | 0.84 |
| **Daily Load Allocation** | 313.01 | 116.01 | 65.79 | 37.64 | 7.00 |
| **Daily Margin of Safety** | 37.70 | 14.51 | 8.61 | 5.29 | 1.69 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 376.95 | 145.14 | 86.05 | 52.93 | 16.87 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 1.947% | 5.057% | 8.530% | 13.867% | 43.509% |
| NPDES Permitted MS4 Communities | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| MnDOT Urbanized ROW WLA | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Construction and Industrial Stormwater | 0.016% | 0.016% | 0.016% | 0.016% | 0.016% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 83.304% | 79.930% | 76.456% | 71.113% | 41.494% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 4,6590.4 | 1,794.93 | 1,063.56 | 654.16 | 208.48 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| *The 1996-2009 flow record was simulated by the Red Lake River HSPF Model.<br>**Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton) | | | | | |

**Table 5-12. Annual load reduction needed for the Red Lake River at CSAH 3 near Huot (S002-976).**

| **Red Lake River at CSAH 3, near Huot (09020303-502, S002-976) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **Very Low Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| Current Daily Load (tons/day) | 1,395.93 | 137.42 | 36.31 | 23.21 | 3.88 | |
| Load Allocation (tons/day) | 313.01 | 116.01 | 65.79 | 37.64 | 7.00 | -- |
| Load Reduction (tons/day) | 1,082.92 | 21.41 | 0.00 | 0.00 | 0.00 | -- |
| % of Flows Represented | 10% | 30% | 20% | 30% | 10% | 100% |
| Number of Days Represented | 36.50 | 109.50 | 73.00 | 109.50 | 36.50 | 365 |
| Annual Load Reduction (tons/year) | 39,526.58 | 2,344.40 | 0.00 | 0.00 | 0.00 | **41,870.98** |
| Total Current Load | 50,951.45 | 15,047.49 | 2,650.63 | 2,541.50 | 141.62 | 71,332.69 |
| % Reduction | **77.58%** | **15.58%** | 0.00% | 0.00% | 0.00% | **58.70%** |

The “Sportsman’s Bridge” (S003-072) monitoring site on the outskirts of the city of Red Lake Falls was the most frequently sampled site and the only site with flow measurement instrumentation along the impaired 09020303-504 AUID. Flow data from the Minnesota DNR/MPCA cooperative stream gauge number 63025001 (USGS Site #05076650) was used to calculate TMDLs and current loads.

Table 5-13. TSS Load Allocations for the Red Lake River at Red Lake Falls on AUID # 09020303-504.

| Site ID: S003-072<br>Total Suspended Solids Standard: 30 mg/l<br>Drainage Area (square miles): 3,635<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 14.38 | **Loading Capacity and Load Allocations for Total Suspended Solids in the Red Lake River at CSAH 13, in Red Lake Falls AUID: 09020303-504** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low*** ** | **No Flow** |
| TMDL Component | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **225.00** | **93.85** | **35.49** | **12.77** | **0.00** |
| **Wasteload Allocation**** | | | | | |
| NPDES Permitted WWTF | 6.87 | 6.87 | 6.87 | 6.87 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MnDOT Urbanized ROW WLA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Construction and Industrial Stormwater | 0.03 | 0.01 | 0.01 | 0.00 | 0.00 |
| **Reserve Capacity** | 11.25 | 4.69 | 1.77 | 0.64 | 0.00 |
| **Daily Load Allocation** | 184.35 | 72.89 | 23.29 | 3.98 | 0.00 |
| **Daily Margin of Safety** | 22.50 | 9.39 | 3.55 | 1.28 | 0.00 |
| | Values Expressed as Tons per Day of Sediment | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 225.00 | 93.85 | 35.49 | 12.77 | 0.00 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 3.053% | 7.320% | 19.358% | 53.800% | 0.000% |
| NPDES Permitted MS4 Communities | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| MnDOT Urbanized ROW WLA | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |
| Construction and Industrial Stormwater | 0.016% | 0.016% | 0.016% | 0.016% | 0.016% |
| **Reserve Capacity** | 5% | 5% | 5% | 5% | 5% |
| **Load Allocation** | 81.193% | 77.666% | 65.624% | 31.167% | 0.000% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 2781.00 | 1160.00 | 438.68 | 157.88 | 0.00 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 67% | 95% |

*The flow record from site S003-172 was used to develop flow zones and loading capacities.
**Wasteload Allocations are rounded to the nearest 2 digits (1/100th of a ton)
***Flow only persists to an exceedance probability of 73.26%

Table 5-14. Annual load reduction needed for the Red Lake River at Red Lake Falls.

| **Red Lake River at CSAH 13, in Red Lake Falls (09020303-504, S003-172) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **No Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| Current Daily Load (tons/day) | 714.94 | 105.60 | 21.19 | 3.41 | 0.00 | |
| Load Allocation (tons/day) | 184.35 | 72.89 | 23.29 | 3.98 | 0.00 | -- |
| Load Reduction (tons/day) | 530.59 | 32.71 | 0.00 | 0.00 | 0.00 | -- |
| % of Flows Represented | 10% | 30% | 20% | 13.26% | 26.74% | 100% |
| Number of Days Represented | 36.50 | 109.50 | 73.00 | 48.40 | 97.60 | 365.00 |
| Annual Load Reduction (tons/year) | 19,366.54 | 3,581.75 | 0.00 | 0.00 | 0.00 | **22,948.29** |
| Total Current Load | 26,095.39 | 11,563.23 | 1,547.07 | 165.23 | 0.00 | 39,370.92 |
| % Reduction | **74.21%** | **30.98%** | 0.00% | 0.00% | 0.00% | **58.29%** |

## 5.2 *E. coli* Bacteria

### 5.2.1 Loading Capacity Methodology

The EPA defines pollutant loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards." The loading capacity provides a reference, which helps guide pollutant reduction efforts needed to bring a water into compliance with the standards. The LDC method is based upon an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes, virtually the full spectrum of allowable loading capacities is represented by the resulting curve. In the *E. coli* TMDL summary tables of this report (Tables 5-14, 5-16, 5-17, 5-19, 5-20, 5-22) only five (or fewer) points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, the entire curve represents the TMDL and is what is ultimately approved by the EPA.

Monitoring sites were chosen for TMDL establishment based upon the monitoring (stage/flow and water quality sampling) history at the sites and their location within the watershed. Sites nearest the pour point of a subwatershed or AUID with a significant amount of historical, current, and future monitoring activity are ideal. The following sites were chosen for *E. coli* TMDL establishment:

1. Pennington County Ditch 96 (AUID 09020303-505) at Highway 32 (S005-683) – Figure 5-9
2. Kripple Creek (09020303-525) at 180th Ave SW (S004-835) – Figure 5-10
3. Black River (09020303-529) at CSAH 18 (S002-132) – Figure 5-11
4. Black River (09020303-558) at County Road 101 (S008-112) – Figure 5-12
5. Gentilly River (09020303-554) at CSAH 11 (S004-058) – Figure 5-13
6. Cyr Creek (09020303-556) at County Road 110 (S004-818) – Figure 5-14

Average daily flow records were compiled for the sites that were chosen for TMDL establishment. Flows were ranked from highest to lowest. Average daily flow values were assigned a flow rank value. The probability of exceedance of each average daily flow value was calculated as a percentage. This created the information needed to create a flow duration curve by plotting probability of exceedance (X-axis) against the flow level (logarithmic Y-axis). Using the allowable concentration of 126 MPN per 100 ml and conversion factors, a LDC was developed to show the allowable billions of organisms per day of *E. coli* bacteria for each level of flow along the curve. The LDC data was used to determine the median loading capacity for each flow regime. Some flow regimes were incomplete due to a lack of flow and zero-flow conditions that made up more than 10% of the LDC. Median values for flows and loads were calculated from the remaining records in those flow regimes after zero-flow records were excluded.

For the one ungauged reach (09020303-558), flow records from the Red Lake River HSPF model were used to create LDCs. Where HSPF sub-basin pour points did not match with monitoring site locations, drainage area weighting was used to adjust discharge records. On the ungauged reaches, current loads could not be representatively calculated due to the lack of flow data from 2010 through the present. When TMDLs were calculated, there were no recent (2010 to present) flow records to be matched with the recent (2010 to present) *E. coli* sampling data that led to the designation of an impairment. This problem occurred for the *E. coli* impairment of the Black River upstream of the Little Black River (09020303-558). Pollutant reduction goals for that reach will simply have the aim of reducing monthly geometric means. Updated HSPF data could be used to estimate *E. coli* load reductions as a part of future planning efforts.

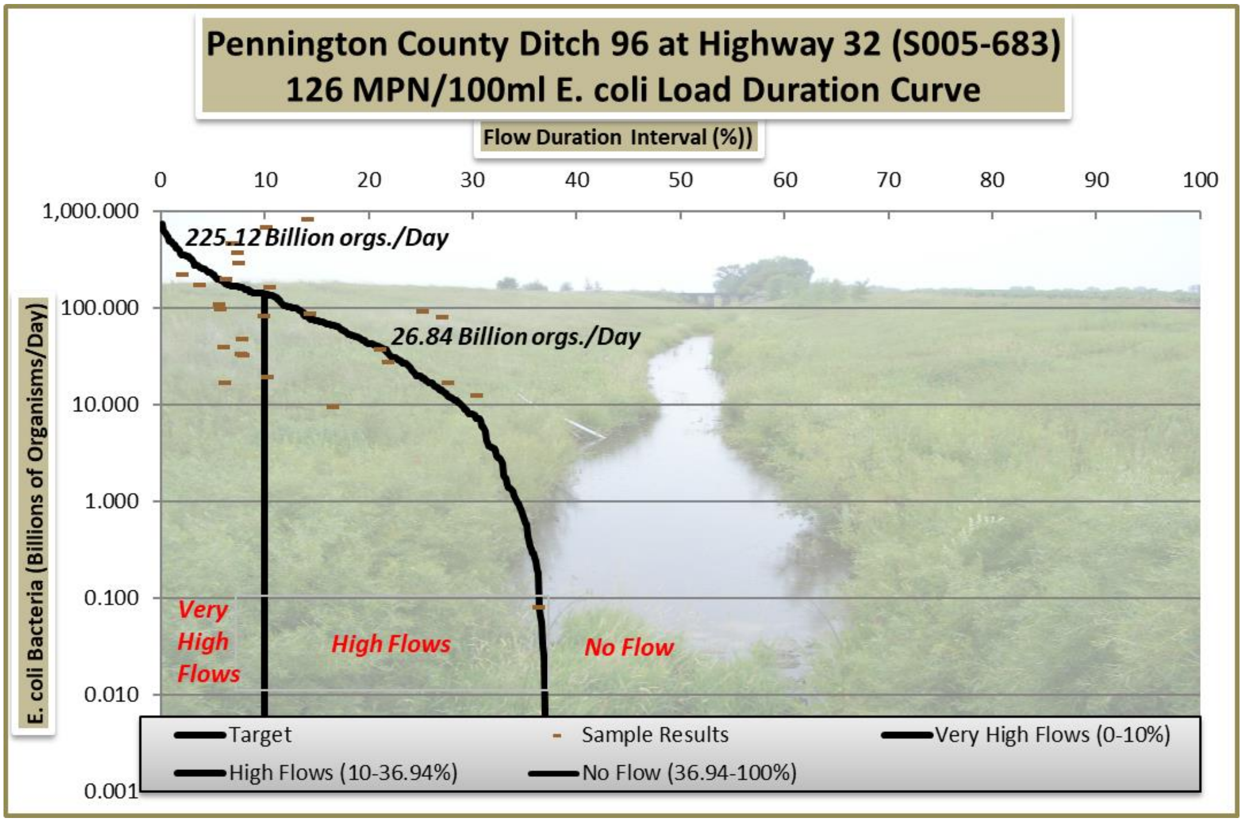

Figure 5-9. *E. coli* load duration curve for Pennington County Ditch 96 at Highway 32 (S005-683), representing AUID 09020303-505.

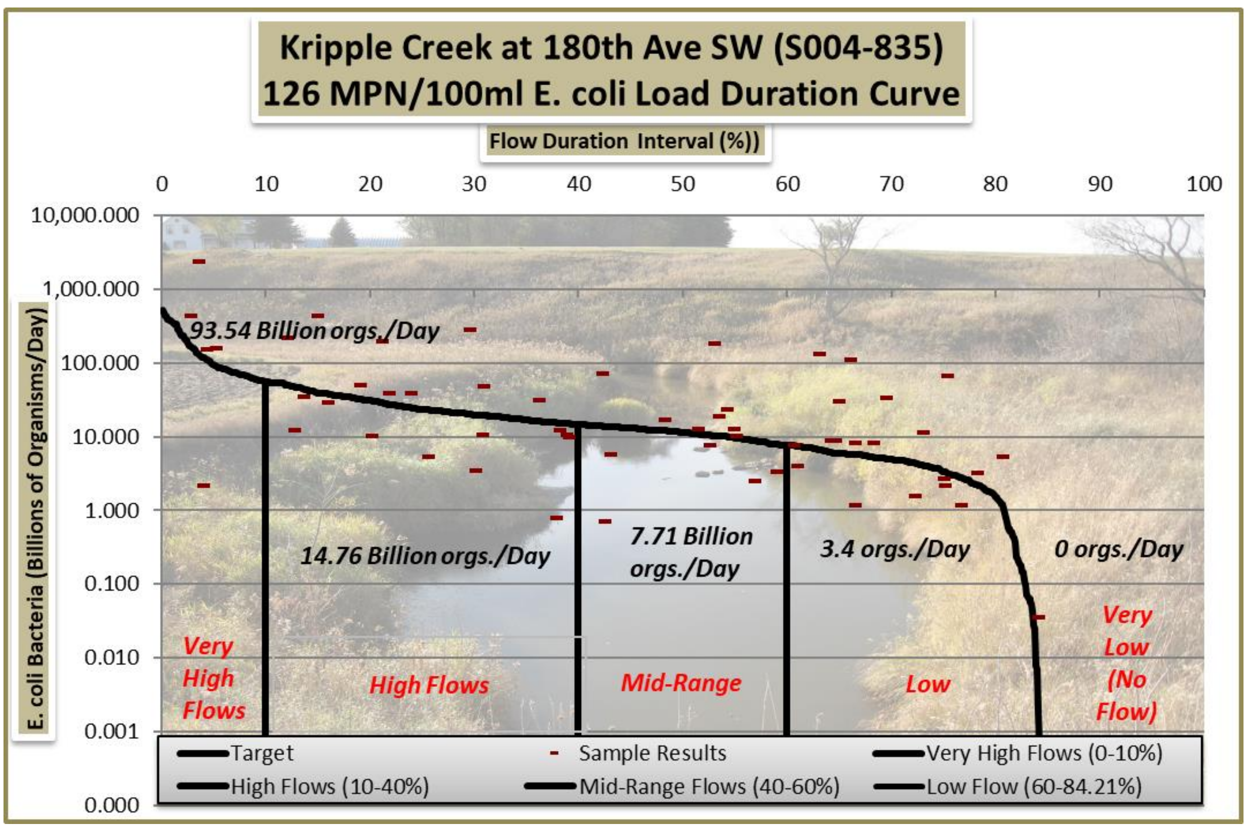

Figure 5-10. *E. coli* load duration curve for Kripple Creek at 180th Ave SW (S004-835), representing AUID 09020303-525.

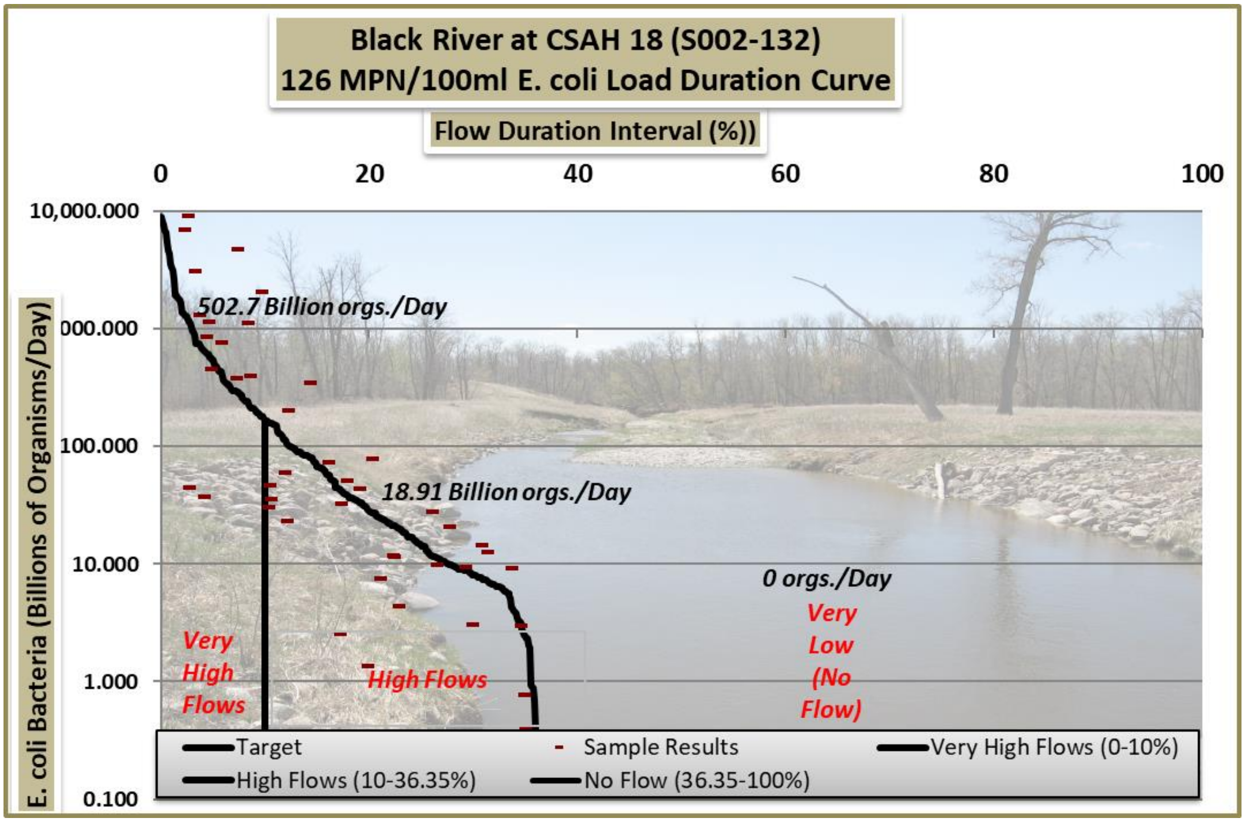


Figure 5-11. *E. coli* load duration curve for the Black River at CSAH 18 (S002-132), representing AUID 09020303-529.

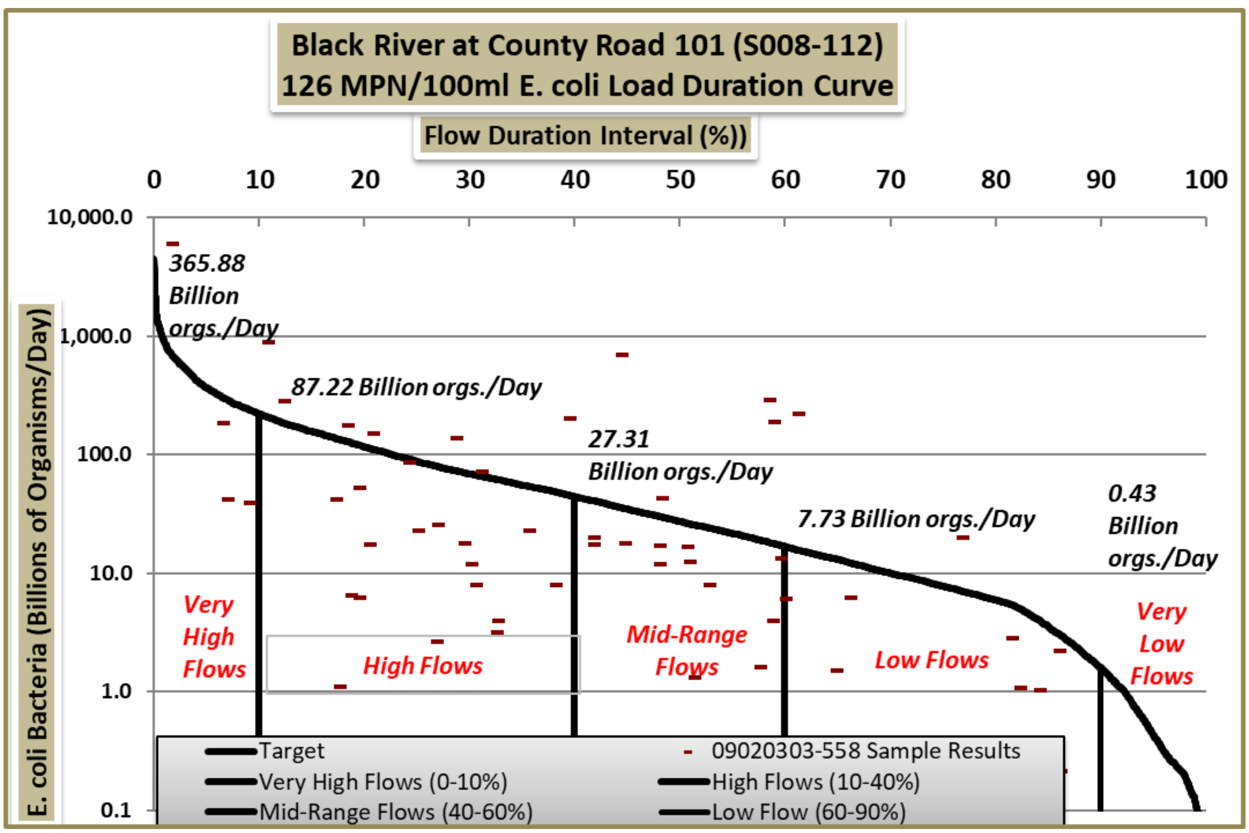


Figure 5-12. *E. coli* load duration curve for the Black River at Red Lake County Road 101 (S008-112), representing AUID 09020303-558.

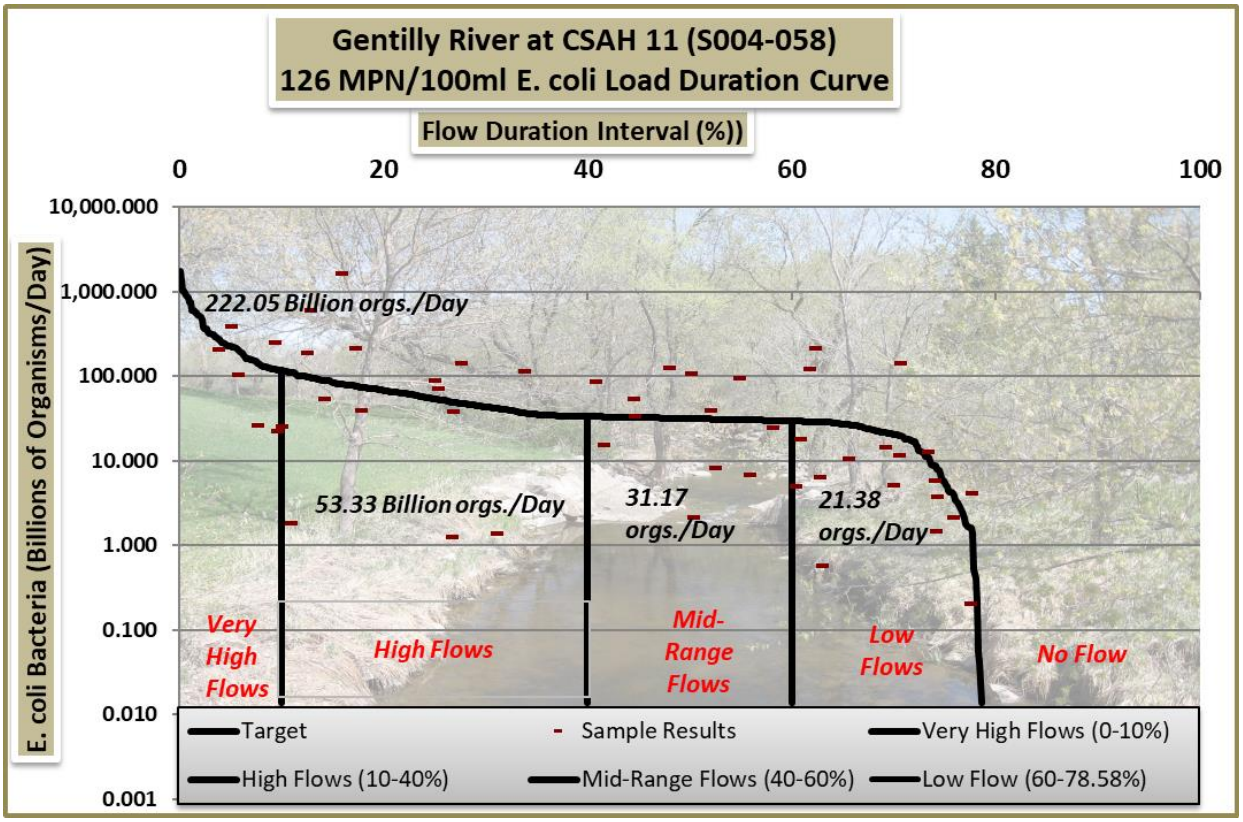


**Figure 5-13.** *E. coli* **load duration curve for the Gentilly River at CSAH 11 (S004-058), representing AUID 09020303-554.**

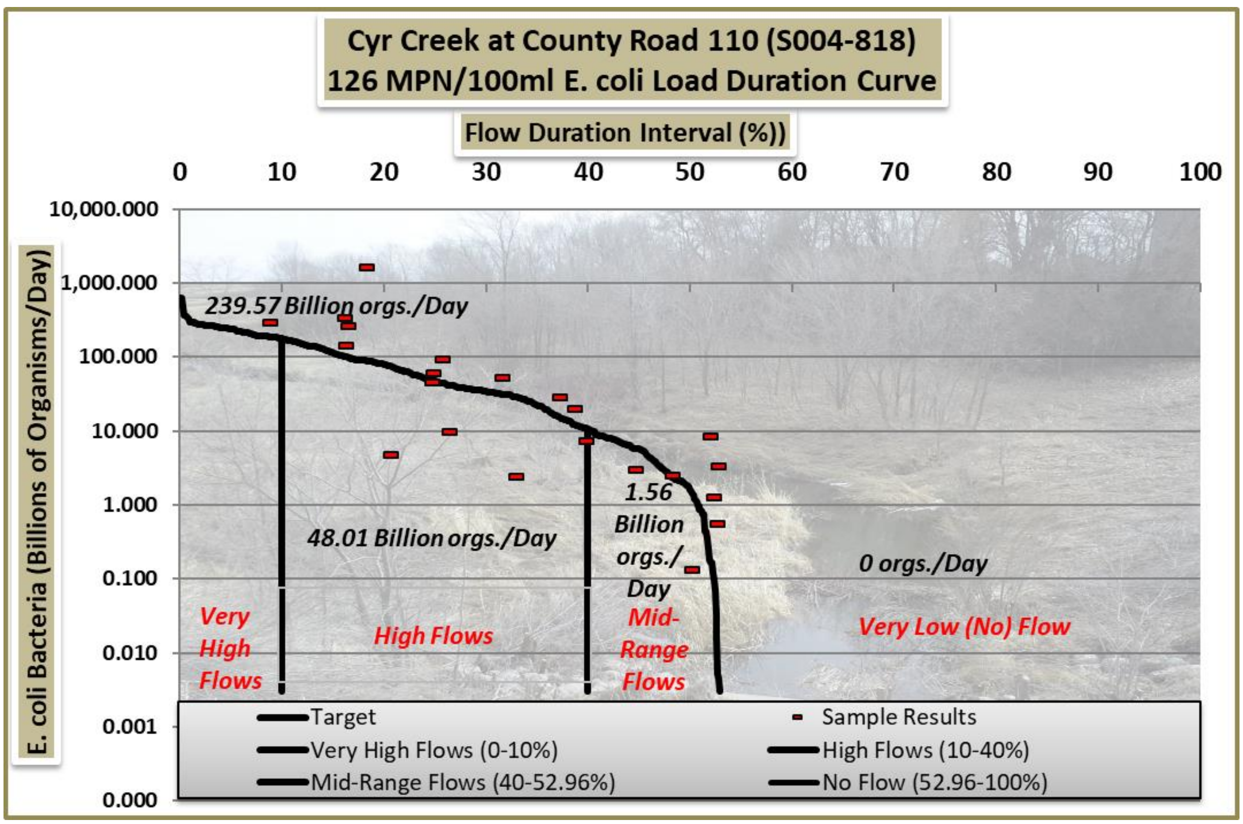


**Figure 5-14.** *E. coli* **load duration curve for Cyr Creek at County Road 110 (S004-818), representing AUID 09020303-556.**

### 5.2.2 Load Allocation Methodology

Portions of the total loading capacity were reserved for a MOS. No WWTFs discharge to waters impaired by *E. coli* within the Red Lake River Watershed. No reserve capacity was warranted for the rural, agricultural subwatersheds where *E. coli* impairments have been identified. No current or future MS4s drain to the *E. coli*-impaired streams. There is no evidence to suggest that construction or industrial stormwater are sources of *E. coli* bacteria in any of the impaired streams, so no *E. coli* LAs were established for permitted stormwater sources. The remaining loading capacity for each flow regime is considered to be the LA, which could include non-compliance Subsurface Sewage Treatment Systems (SSTS), livestock pasture, registered feedlots, and agricultural runoff. Where possible, load reduction recommendations were calculated. The current loading estimates were calculated by finding the geometric mean *E. coli* concentration for each flow regime. *E. coli* data collected during the years of 2005 through 2014 (most recent 10 years) was used to assess and represent current conditions within the watershed. Flow rates and flow regime values were assigned to each daily geometric mean *E.coli* data point. Daily mean *E. coli* concentrations were calculated for each flow regime. Load reduction recommendations were calculated by subtracting the LA from the current load.

### 5.2.3 Wasteload Allocation Methodology

None of the WWTFs in the Red Lake River Watershed contribute to reaches that are impaired by high *E. coli* concentrations. All the WWTFs discharge to the Red Lake River. There are no *E. coli* impairments on the Red Lake River. All the *E. coli* impairments in the Red Lake River Watershed have been found on tributaries of the Red Lake River.

### 5.2.4 Margin of Safety

The statute and regulations require that a TMDL include a MOS to account for any lack of knowledge concerning the relationship between load and WLAs and water quality (CWA §303(d)(1)(c), 40 C.F.R. §130.7(c)(1)). The EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified. An explicit MOS equal to 10% of the loading capacity was applied to each flow regime. The explicit 10% MOS accounts for:

- Uncertainty in the observed daily flow record
- Uncertainty in the observed water quality data.
- Allocations and loading capacities are based on flow, which varies from high to low. This variability is accounted for using the five flow regimes and the LDCs.
- The variability in pollutant concentrations at any given flow.
- Imperfect homogeneity of pollutants throughout the water column.

### 5.2.5 Seasonal Variation

*E. coli* concentrations are generally highest during the warm summer months. That general concept holds true within the Red Lake River Watershed. The violations of the 126 MPN/100ml *E. coli* standard have occurred in the months of June through September (Figure 5-15). The LDCs show that violations of the *E. coli* standard can occur at any level of flow. Where current loads are known, load reductions are essentially needed at nearly all levels of measurable flow. Livestock operations have been identified along all of the reaches that are impaired by *E. coli*. Runoff from those areas during high flows would create high *E. coli* concentrations. During low flows, sources of *E. coli* bacteria can be more influential upon concentrations within streams because there is less dilution and flushing. That is particularly evident within Cyr Creek where September flows are typically low, and the September geometric mean *E. coli* concentration was very high. Some of the impaired reaches did not have flow throughout the entire record of flows. Therefore, a significant percentage of the flows were zero and the number of applicable flow regimes was limited.

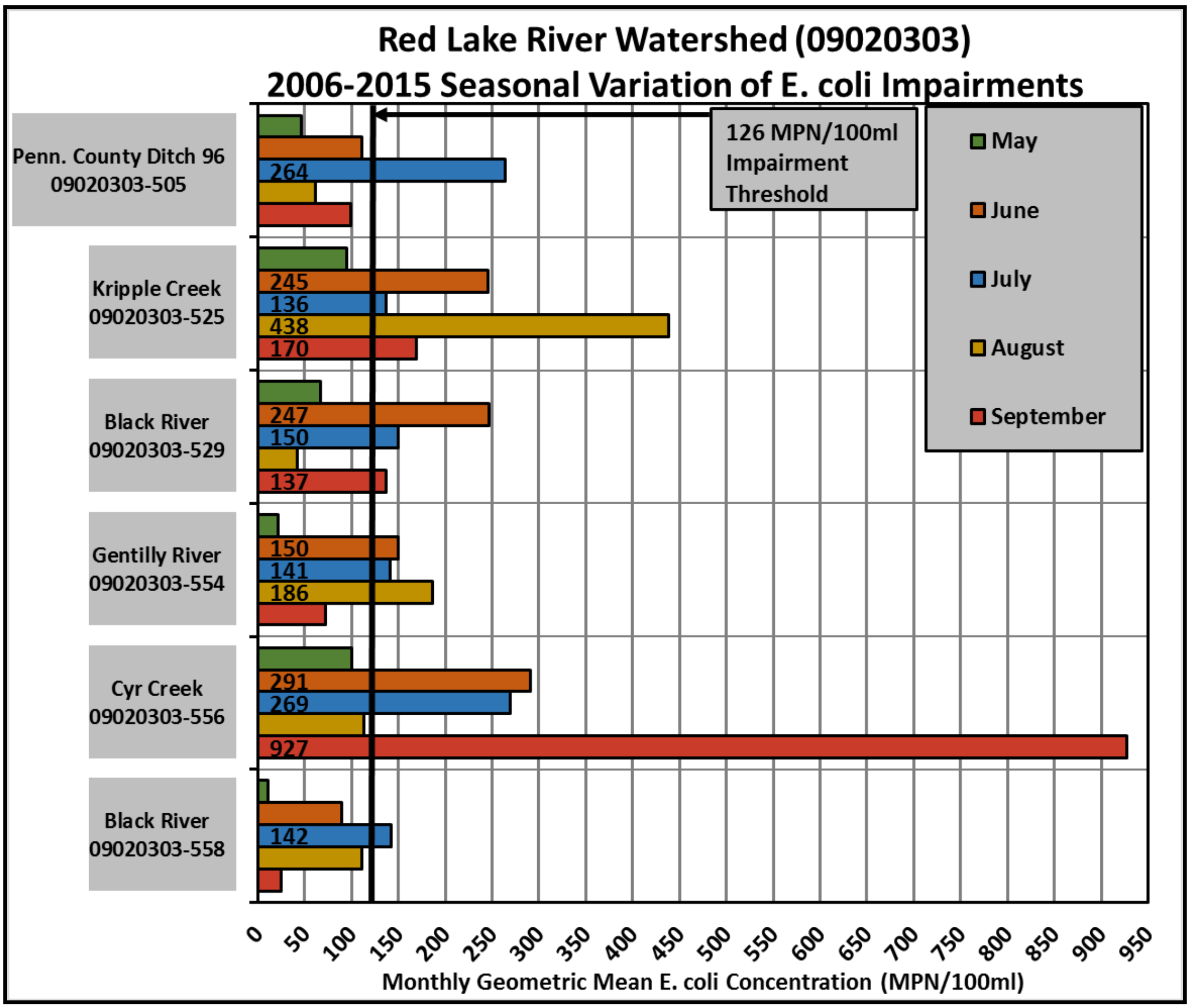


**Figure 5-15. Seasonal variation of *E. coli* data from impaired reaches.**

### 5.2.6 Reserve Capacity

The *E. coli*-impaired reaches within the Red Lake River Watershed receive water from rural, agricultural watersheds. Therefore, reserve capacities for *E. coli* TMDLs in the Red Lake River Watershed have been set to zero.

### 5.2.7 TMDL Summary

Tables 5-15, 5-17, 5-19, 5-21, and 5-22 summarize the *E. coli* loading capacities, LAs, WLAs, and MOS for a site on an impaired reach. Calculations were made for each flow regime. Load reduction estimates were calculated where concurrent *E. coli* and flow data were available. Tables 5-14, 5-16, 5-18, 5-21, and 5-23, show the annual load reductions that are needed for each flow regime and total annual reductions.

The CD96 (S005-683) monitoring site at the Highway 32 crossing of CD96, south of St. Hilaire, is the most frequently sampled site and the only site with stage/flow instrumentation along the *E. coli*-impaired 09020303-505 AUID of CD96. Only 36.94% of daily average flows were greater than 0 cfs.

**Table 5-15. *E. coli* loading capacity and allocations for Pennington County Ditch 96 at Highway 32.**

| Site ID: S005-683<br>*E. coli* Standard: 126 MPN/100ml<br>Drainage Area (square miles): 41.51<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in Pennington CD96 at MN Highway 32 AUID: 09020303-505** | | |
|---|---|---|---|
| | **Duration Curve Zone** | | |
| | **Very High** | **High** | **No Flow** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | |
| **TOTAL DAILY LOADING CAPACITY*** | **225.12** | **26.84** | **0.00** |
| **Wasteload Allocation** | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **202.61** | **24.16** | **0.00** |
| **Daily Margin of Safety** | 22.51 | 2.68 | 0.00 |
| | Values Expressed as Billions of Organisms/Day | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 225.12 | 26.84 | 0.00 |
| **Wasteload Allocation** | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% |
| MEDIAN FLOW* | 73.0 | 8.7 | 0.0 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 23.5% | 68.5% |
| *The flow record from site S005-683 was used to develop flow zones and loading capacities. | | | |

Table 5-16. Annual *E. coli* load reductions needed for CD 96 (09020303-505) at Hwy 32 (S005-683).

| **Pennington CD96, (09020303-505, S005-683) *E. coli* Load Reductions** | **Very High Flow** | **High Flow** | **No Flow** | **Annual Total** |
|---|---|---|---|---|
| **Current Geometric Mean Daily Load (billions of orgs/day) for Flow Regime** | 136.98 | 26.82 | 0.00 | -- |
| **Load Allocation (billions of orgs/day)** | 202.61 | 24.16 | 0.00 | -- |
| **Load reduction (billions of orgs/day)** | 0.00 | 2.66 | 0.00 | -- |
| **% of Flows Represented** | 10.00% | 26.94% | 63.06% | 100.00% |
| **# of Days Represented** | 36.50 | 98.33 | 230.17 | 365.00 |
| **Annual Load Reduction (billions of orgs/yr)** | 0.00 | 261.11 | 0.00 | **261.11** |
| **Total Current Load** | 4,999.76 | 2,636.79 | 0.00 | 7,636.55 |
| **Percent Reduction** | **0.0%** | **9.9%** | 0.0% | **3.4%** |

The Kripple Creek (S004-835) monitoring site at the 180th Avenue Southwest crossing of Kripple Creek, north of Gentilly, is the most frequently sampled site and the only site with stage/flow instrumentation along the *E. coli*-impaired, 09020303-525 AUID of Kripple Creek. Kripple Creek was flowing on less than less than 90% (84.21%) of days with stage or flow measurements.

Table 5-17. *E. coli* loading capacity and allocations for Kripple Creek at 180th Ave SW.

| Site ID: S004-835<br>*E. coli* Standard: 126 MPN/100ml<br>Drainage Area (square miles): 32.28<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in Kripple Creek at 180th Avenue SW AUID: 09020303-525** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **No Flow** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **93.54** | **23.59** | **11.47** | **4.46** | **0.00** |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| "Straight Pipe" Septic Systems | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **84.19** | **21.23** | **10.32** | **4.01** | **0.00** |
| **Daily Margin of Safety** | 9.35 | 2.36 | 1.15 | 0.45 | 0.00 |
| | Values Expressed as Billions of Organisms/Day | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 93.54 | 23.59 | 11.47 | 4.46 | 0.00 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% | 0% | 0% |
| "Straight Pipe" Septic Systems | 0% | 0% | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 30.34 | 7.65 | 3.72 | 1.45 | 0.00 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5.0% | 25.0% | 50.0% | 72.1% | 92.1% |
| *The flow record from site S004-835 was used to develop flow zones and loading capacities. | | | | | |

Table 5-18. Annual *E. coli* load reductions for Kripple Creek (AUID 525) at 180th Ave SW (S002-132).

| Kripple Creek at 180th Avenue SW (09020303-525, S004-835) *E. coli* Load Reductions | Very High Flow | High Flow | Mid-Range Flow | Low Flow | Very Low Flow | Annual Total |
|---|---|---|---|---|---|---|
| **Current Geometric Mean Daily Load (billions of orgs/day) for Flow Regime** | 141.65 | 25.69 | 11.18 | 6.43 | 0.00 | -- |
| **Load Allocation (billions of orgs/day)** | 84.19 | 21.23 | 10.32 | 4.01 | 0.00 | -- |
| **Load reduction (billions of orgs/day)** | 57.47 | 4.47 | 0.86 | 2.42 | 0.00 | -- |
| **% of Flows Represented** | 10.00% | 30.00% | 20.00% | 24.21% | 15.79% | 100.00% |
| **# of Days Represented** | 36.50 | 109.50 | 73.00 | 88.40 | 57.60 | 365.00 |
| **Annual Load Reduction (billions of orgs/yr)** | 2,097.58 | 489.06 | 63.14 | 214.01 | 0.00 | **2,863.80** |
| **Total Current Load** | 5,170.35 | 2,813.25 | 816.31 | 568.28 | 0.00 | 9,368.19 |
| **Percent Reduction** | **40.6%** | **17.4%** | **7.7%** | **37.7%** | 0.0% | **30.6%** |

The BL18 (S002-132) monitoring site at the CSAH 18 crossing of the Black River, north of Huot, is the most frequently sampled site and the only site with stage/flow instrumentation along the *E. coli*-impaired, 09020303-529 AUID of the Black River. This is a long-term monitoring site for the RLWD and the Red Lake SWCD. Stage and flow data will continue to be collected by the RLWD into the future.

Table 5-19. *E. coli* loading capacity and allocations for the Black River at CSAH 18 (S002-132).

| Site ID: S002-132<br>*E. coli* Standard: 126 MPN/100ml<br>Drainage Area (square miles): 144.35<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in Black River at CSAH 18 AUID: 09020303-529** | | |
|---|---|---|---|
| | **Duration Curve Zone** | | |
| | **Very High** | **High** | **No Flow** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | |
| **TOTAL DAILY LOADING CAPACITY*** | **502.70** | **18.91** | **0.00** |
| **Wasteload Allocation** | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 |
| "Straight Pipe" Septic Systems | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **452.43** | **17.02** | **0.00** |
| **Daily Margin of Safety** | 50.27 | 1.89 | 0.00 |
| | Values Expressed as Billions of Organisms/Day | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 502.70 | 18.91 | 0.00 |
| **Wasteload Allocation** | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% |
| "Straight Pipe" Septic Systems | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% |
| MEDIAN FLOW* | 163.07 | 6.13 | 0.00 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 23.22% | 68.18% |
| *The flow record from site S002-132 was used to develop flow zones and loading capacities. | | | |

**Table 5-20. Annual *E. coli* load reductions for the Black River (09020303-529) at CSAH 18 (S002-132).**

| Black River at CSAH 18 (09020303-529, S002-132) *E. coli* Load Reductions | Very High Flow | High Flow | No Flow | Annual Total |
|---|---|---|---|---|
| **Current Geometric Mean Daily Load (billions of orgs/day) for Flow Regime** | 19,686.94 | 38.00 | 0.00 | -- |
| **Load Allocation (billions of orgs/day)** | 452.43 | 17.02 | 0.00 | -- |
| **Load reduction (billions of orgs/day)** | 19,234.51 | 20.98 | 0.00 | -- |
| **% of Flows Represented** | 10.00% | 26.35% | 63.65% | 100.00% |
| **# of Days Represented** | 36.50 | 96.18 | 232.32 | 365.00 |
| **Annual Load Reduction (billions of orgs/yr)** | 702,059.51 | 2,018.26 | 0.00 | **704,077.77** |
| **Total Current Load** | 718,573.24 | 3,654.74 | 0.00 | 722,227.98 |
| **Percent Reduction** | **97.7%** | **55.2%** | 0.0% | **97.5%** |

The Red Lake County Road 101 (S008-112) crossing of the Black River is located upstream of the Browns Creek confluence and the Shirrick Dam along 09020303-558. This is the furthest downstream crossing along this reach that can be feasibly and safely sampled on a regular basis. The crossing nearest the pour point, at CSAH 13 (S008-107) is a narrow bridge within a steep river valley. The road dips down, relatively abruptly to the bridge, and the visibility of sampling staff working on the bridge is limited to a relatively short distance. The landowner upstream of that site has threatened state monitoring staff, so monitoring in this area is not advised. The CR 101 crossing is much safer, as it is a side-road and is located near different landowners. No stage/flow records have been collected from this reach. Simulated flows from the Red Lake River HSPF model were used to calculate TMDLs. There was insufficient concurrent flow and *E. coli* data to calculate load reductions with the version of the HSPF model that simulated flows for the years 1996 through 2009. The HSPF model has been more recently updated to simulate flows from a larger and more up-to-date range of years (1995 through 2016). The updated HSPF-simulated flows were used to revise the TMDL and load reduction estimates for AUID 558. Updated assessment statistics from this reach show that it is nearly restored and temporarily met the standard 2007 through 2016 data. The August geometric mean *E. coli* concentration rose above the 126 MPN/100ml standard in 2008 through 2017 data, however, so the reach cannot yet be recommended for delisting. The reach is so close to being restored that the geometric mean daily *E. coli* loads for every flow regime were lower than the LA values when 2007 through 2014 data or 2007 through 2016 data were used (sampling began in 2007). The 2007 through 2015 data range produced a geometric mean *E. coli* load for mid-range flows that required a 17.8% decrease in *E. coli* loads during mid-range flows, which amounts to 387.71 billion org/year (2.2%) reduction in *E. coli* loads in this reach.

Table 5-21. *E. coli* loading capacity and allocations for the Black River AUID 558 at CR 101 (S008-112).

| Site ID: S008-112<br>*E. coli* Standard: 126 MPN/100 ml<br>Drainage Area (square miles): 78<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in the Black River at Red Lake CR 101 AUID: 09020303-558** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low (No)** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **365.88** | **87.22** | **27.31** | **7.73** | **0.43** |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| "Straight Pipe" Septic Systems | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **329.29** | **78.50** | **24.58** | **6.96** | **0.39** |
| **Daily Margin of Safety** | 36.59 | 8.72 | 2.73 | 0.77 | 0.04 |
| | Values Expressed as Billion Organisms/Day | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 365.88 | 87.22 | 27.31 | 7.73 | 0.43 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% | 0% | 0% |
| "Straight Pipe" Septic Systems | 0% | 0% | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 118.7 | 28.3 | 8.9 | 2.5 | 0.1 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 75% | 95% |
| FLOW REGIME OF MEDIAN FLOW | Very High | High | Mid | Low | Very Low |
| *The 1995-2016 flow record was simulated by the Red Lake River HSPF Model. Station S008-112 captures 99.08% of the drainage area of the HSPF model's reach number 409. That percentage was used to adjust the simulated Reach 409 discharge records slightly downward and create an area-weighted flow record. | | | | | |

The CSAH 11 (S004-058) crossing of the Gentilly River, in Gentilly, is the most frequently sampled site and the only site with stage/flow instrumentation along the *E. coli*-impaired, 09020303-554 AUID of the Gentilly River. This is a long-term monitoring site for the RLWD. Stage and flow data will continue to be collected by the RLWD into the future.

**Table 5-22. *E. coli* loading capacity and allocations for the Gentilly River at CSAH 11 (S004-058).**

| Site ID: S002-132<br>*E. coli* Standard: 126 MPN/100 ml<br>Drainage Area (square miles): 34.18<br>% MS4: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in the Gentilly River at CSAH 11 AUID: 09020303-554** | | | | |
|---|---|---|---|---|---|
| | **Duration Curve Zone** | | | | |
| | **Very High** | **High** | **Mid** | **Low** | **Very Low (No)** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **222.05** | **53.33** | **31.17** | **21.38** | **0.00** |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| "Straight Pipe" Septic Systems | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **199.85** | **48.00** | **28.05** | **19.24** | **0.00** |
| **Daily Margin of Safety** | 22.20 | 5.33 | 3.12 | 2.14 | 0.00 |
| | Values Expressed as Billions of Organisms/Day | | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 222.05 | 53.33 | 31.17 | 21.38 | 0.00 |
| **Wasteload Allocation** | | | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% | 0% | 0% |
| "Straight Pipe" Septic Systems | 0% | 0% | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 72.03 | 17.30 | 10.11 | 6.94 | 0.00 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 50% | 69.33% | 89.29% |
| *The flow record from site S002-132 was used to develop flow zones and loading capacities. | | | | | |

**Table 5-23. Annual *E. coli* load reductions for the Gentilly River (AUID 554) at CSAH 11 (S004-058).**

| **Gentilly River at CSAH 11 (09020303-554, S002-132) *E. coli* Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **No Flow** | **Annual Total** |
|---|---|---|---|---|---|---|
| **Current Geometric Mean Daily Load (billions of orgs/day) for Flow Regime** | 83.68 | 51.74 | 25.13 | 7.76 | 0.00 | -- |
| **Load Allocation (billions of orgs/day)** | 199.85 | 48.00 | 28.05 | 19.24 | 0.00 | -- |
| **Load reduction (billions of orgs/day)** | 0.00 | 3.73 | 0.00 | 0.00 | 0.00 | -- |
| **% of Flows Represented** | 10.00% | 30.00% | 20.00% | 19.00% | 21.00% | 100.00% |
| **# of Days Represented** | 36.50 | 109.50 | 73.00 | 68.33 | 0.21 | 287.54 |
| **Annual Load Reduction (billions of orgs/yr)** | 0.00 | 408.98 | 0.00 | 0.00 | 0.00 | **408.98** |
| **Total Current Load** | 3,054.43 | 5,665.19 | 1,834.72 | 530.54 | 0.00 | 11,084.88 |
| **Percent Reduction** | 0.0% | **7.2%** | **0.0%** | **0.0%** | 0.0% | **3.7%** |

The CR 110 (S004-818) crossing of Cyr Creek is the most frequently sampled site and the only site with stage/flow instrumentation along the *E. coli*-impaired, 09020303-556 AUID of Cyr Creek. This is a long-term monitoring site for the RLWD and the Red Lake SWCD. Stage and flow data will continue to be collected by the RLWD into the future.

Table 5-24. *E. coli* loading capacity and allocations for Cyr Creek at County Road 110 (S004-818).

| Site ID: S004-818<br>*E. coli* Standard: 126 MPN/100 ml<br>Drainage Area (square miles): 18.98<br>% MS4 Urban: 0.00<br>Total WWTF Design Flow (mgd): 0.00 | **Loading Capacity and Load Allocations for *E. coli* in Cyr Creek at CR 110<br>AUID: 09020303-556** | | | |
|---|---|---|---|---|
| | **Duration Curve Zone** | | | |
| | **Very High** | **High** | **Mid** | **Very Low (No)** |
| TMDL Component | Values Expressed as Billions of Organisms/Day | | | |
| **TOTAL DAILY LOADING CAPACITY*** | **239.57** | **48.01** | **3.87** | **0.00** |
| **Wasteload Allocation** | | | | |
| NPDES Permitted WWTF | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted MS4 Communities | 0.00 | 0.00 | 0.00 | 0.00 |
| NPDES Permitted Livestock Facilities | 0.00 | 0.00 | 0.00 | 0.00 |
| "Straight Pipe" Septic Systems | 0.00 | 0.00 | 0.00 | 0.00 |
| **Reserve Capacity** | 0.00 | 0.00 | 0.00 | 0.00 |
| **Daily Load Allocation** | **215.61** | **43.21** | **3.48** | **0.00** |
| **Daily Margin of Safety** | 23.96 | 4.80 | 0.39 | 0.00 |
| | Values Expressed as Billions of Organisms/Day | | | |
| **TOTAL MONTHLY LOADING CAPACITY** | 239.57 | 48.01 | 3.87 | 0.00 |
| **Wasteload Allocation** | | | | |
| NPDES Permitted WWTF | 0% | 0% | 0% | 0% |
| NPDES Permitted MS4 Communities | 0% | 0% | 0% | 0% |
| NPDES Permitted Livestock Facilities | 0% | 0% | 0% | 0% |
| "Straight Pipe" Septic Systems | 0% | 0% | 0% | 0% |
| **Reserve Capacity** | 0% | 0% | 0% | 0% |
| **Load Allocation** | 90% | 90% | 90% | 90% |
| **Margin of Safety** | 10% | 10% | 10% | 10% |
| MEDIAN FLOW* | 78 | 16 | 1 | 0 |
| FLOW DURATION INTERVAL OF MEDIAN FLOW | 5% | 25% | 46.51% | 76.48% |
| FLOW REGIME OF MEDIAN FLOW | Very High | High | Mid-Range | No Flow |
| *The flow record from site S004-818 was used to develop flow zones and loading capacities. | | | | |

Table 5-25. Annual *E. coli* load reductions needed for Cyr Creek (09020303-556) at CR 110 (S004-818).

| **Red Lake River at CSAH 13, in Red Lake Falls (09020303-504, S003-172) Total Suspended Solids Load Reductions** | **Very High Flow** | **High Flow** | **Mid-Range Flow** | **Low Flow** | **Very Low Flow (No)** | **Annual Total** |
|---|---|---|---|---|---|---|
| **Current Geometric Mean Daily Load (billions of orgs/day) for Flow Regime** | 283.20 | 43.79 | 1.49 | 0.00 | 0.00 | 283.20 |
| **Load Allocation (billions of orgs/day)** | 215.61 | 43.21 | 3.48 | 0.00 | 0.00 | 215.61 |
| **Load reduction (billions of orgs/day)** | 67.59 | 0.58 | 0.00 | 0.00 | 0.00 | 67.59 |
| **% of Flows Represented** | 10.00% | 30.00% | 12.96% | 47.04% | 100.00% | 10.00% |
| **# of Days Represented** | 36.50 | 109.50 | 47.30 | 171.70 | 365.00 | 36.50 |
| **Annual Load Reduction (billions of orgs/yr)** | 2,467.00 | 63.99 | 0.00 | 0.00 | **2,530.99** | 2,467.00 |
| **Total Current Load** | 10,336.77 | 4,795.23 | 70.56 | 0.00 | 15,202.55 | 10,336.77 |
| **Percent Reduction** | **23.9%** | **1.3%** | 0.0% | 0.0% | **16.6%** | **23.9%** |

## 5.3 Future Growth Considerations

No reserve capacity was needed for the agricultural watersheds in which *E. coli* impairments were found. No IBI impairments were connected to pollutants that needed TMDLs. The HSPF model indicates that urban stormwater runoff can contribute to TSS loads. However, populations have generally remained steady throughout the watershed (Figure 5-16). Populations of East Grand Forks and Polk County experienced a dip in the late 1990s. East Grand Forks lost 17% of its residents after the 1997 Red

River Flood. Although populations have remained steady, a 5% reserve capacity was calculated for the TSS TMDLs.

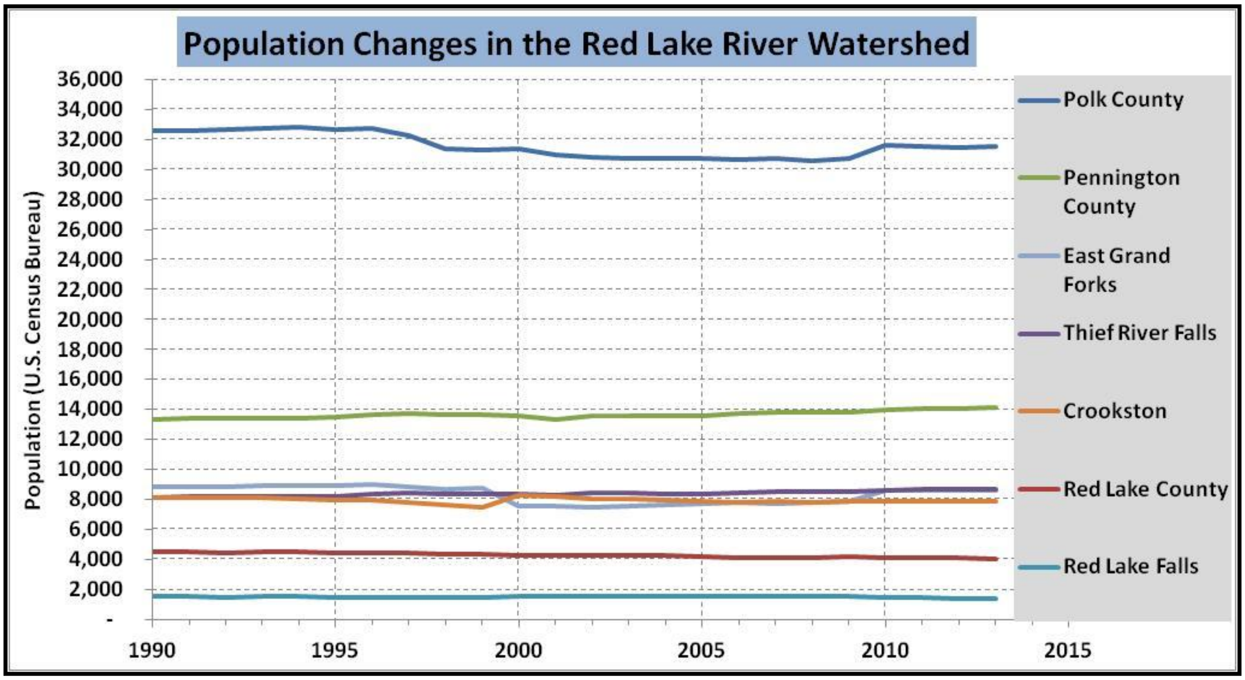


**Figure 5-16. Population changes in cities and counties within the Red Lake River Watershed.**

## 5.4 New or Expanding Permitted MS4 WLA Transfer Process (TSS TMDLs Only)

Future transfer of watershed runoff loads in this TMDL may be necessary if any of the following scenarios occur within the project watershed boundaries:

1. New development occurs within a regulated MS4. Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.
2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.
3. One or more non-regulated MS4s become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.
4. Expansion of a U.S. Census Bureau Urban Area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an Urban Area at the time the TMDL was completed but are now inside a newly expanded Urban Area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related point source is identified and is covered under a NPDES permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

An MS4 owned or operated by a municipality with a population of at least 5,000 and discharges or has potential to discharge stormwater to a water listed as impaired under section 303(d) of the Clean Water Act, 33 U.S.C. § 1313 is subject to stormwater regulation under the Clean Water Act. Non-regulated MS4s along the Red Lake River that may be subject to future regulation under this rule include Crookston (2013 population = 7,904) and Thief River Falls (2013 population = 8,716).

## 5.5 New or Expanding Wastewater (TSS and *E. coli* TMDLs only)

The MPCA, in coordination with the U.S. EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to waterbodies with an EPA approved TMDL (MPCA 2012). This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target, and will ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and U.S. EPA to comment on the permit changes based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that the new or expanded wastewater discharge is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

For more information on the overall process, visit the MPCA's TMDL Policy and Guidance webpage.

# 6. Reasonable Assurance

Pollution reductions needed in the watershed are primarily from nonpoint sources. Watershed assessment and planning activities undertaken in recent years will be used to guide implementation to assure impairments will be addressed. The implementation strategies from this Red Lake River Watershed TMDL report and the accompanying WRAPS report have been incorporated into the Red Lake River 1W1P local water management plan. The listing of implementation activities within a local water management plan like the 1W1P improves the chance of those projects being funded by the state's grant funds. The cooperation among local agencies is excellent within the Red Lake River Watershed. The processes of writing the Red Lake River 1W1P and the TMDL/WRAPS documents were concurrent and shared similar details and goals. The RLWD staff that wrote the TMDL and WRAPS documents also contributed to portions of the 1W1P. Members of the 1W1P planning group were also members of the WRAPS Technical Advisory Committee (TAC)/Core Team. Pollutant (sediment and *E. coli*) reduction goals in the 1W1P were based on the goals calculated for the TMDLs. Progress toward meeting pollutant reduction goals will be tracked and regularly reported by 1W1P partners. The RLWD provides cost-share funding to SWCDs for erosion projects. Leftover funding from the Pennington County SWCD's ditch inventory was shared with the West Polk SWCD so that ditches throughout the entirety of the Red Lake River Watershed Planning Area could be inventoried for erosion problems and buffer compliance (Red Lake County has already been completed).

In addition to commitment from local agencies, the State of Minnesota has also made a commitment to protect and restore the quality of its waters. In 2008, Minnesota voters approved the Clean Water, Land, and Legacy Amendment to increase the state sales tax to fund water quality, habitat, and cultural improvements. The interagency Minnesota Water Quality Framework (Figure 6-1) illustrates the cycle of assessment, watershed planning, and implementation to which the state is committed. Funding to support implementation activities under this framework is made available through Minnesota's BWSR, an agency that has awarded grant funding to the RLWD in the past. With completion of the RLW 1W1P, $677,000 in initial funding has been awarded for plan implementation.


**Figure 6-1. Minnesota Water Quality Framework.**

Local, State, Tribal, and Federal agencies that have cooperated on projects in the past and plan to work together in the future to improve water quality and habitat in the Red Lake River Watershed include:

- RLWD
- Red Lake Department of Natural Resources
- Pennington SWCD
- Red Lake SWCD
- West Polk SWCD
- Natural Resources Conservation Service (NRCS)
- United States Fish and Wildlife Service (USFWS)
- Minnesota Department of Natural Resources (DNR)
- MPCA
- Minnesota BWSR

The RLWD, Pennington County SWCD, Red Lake County SWCD, West Polk SWCD, and NRCS have all been active in promoting BMPs and completing projects for the purpose of improving and protecting water quality along the Red Lake River and its tributaries, including the Thief River, Clearwater River, and Upper/Lower Red Lakes watersheds. Below, is a list of projects that have been completed and/or recently funded in recent years within the Red Lake River HUC10 watershed:

- Burnham Creek Watershed Restoration Project
    - AUID 09020303-552
    - West Polk SWCD and RLWD, with funding from BWSR, DNR, and USFWS
    - Grade stabilization structures
    - Fish passage structures to address three perched culverts and a weir
    - Stream bank stabilization
- The Pennington County SWCD constructed two rain gardens to capture runoff from the Ralph Engelstad Arena in Thief River Falls.
    - AUID 09020303-509
    - $110,851.00
- The Red Lake County SWCD installed 66 side water inlets in 2013.
- Pennington County ditch inventory
- 2009 Red Lake County Erosion Site Inventory
- Red Lake County culvert inventory
- Development of a Red Lake River 1W1P document
- A large amount of money has been spent to stabilize riverbanks within the city of Crookston
- Chief's Coulee Septic System Inventory
    - AUID 09020303-509
- City of Thief River Falls Stormwater Assessment
    - AUIDs 09020303-509, 09020303-902, and 09020303-513
    - Pennington County SWCD
- Pennington County Ditch 96 – added payments for buffer installation
    - AUIDs 09020303-505 and 09020303-545
- Jerome Street Project
    - AUID 0920303-513
- Stream bank stabilization of the Red Lake River near the Huot Bridge
    - AUID 09020303-502

- Sportsman's Park bank stabilization
    - AUID 09020303-504
- Development of tools that can be used to target BMP implementation (All AUIDs)
    - PTMApp
    - HSPF Model
    - SWAT Model
    - Stream Power Index
- 2011 RLWD Ditch 3 & Ditch 7 Clean Water Fund Project
    - AUID 09020303-504
    - Red Lake SWCD, RLWD, and landowners
    - Side water inlet installation
    - $34,500.00
- 2011 Erosion Control Projects in the Red Lake River Watershed Clean Water Fund Project
    - AUIDs 09020303-504 and 09020303-558
    - Red Lake SWCD
    - Stabilization of gully erosion problems along two private drainage ditches.
    - $128,645.00
- SSTS Imminent Health Threat Clean Water Fund Grant
    - Pennington SWCD
    - $15,789.00 in 2011
    - $36,226.00 in 2012
    - $27,673.00 in 2013
    - Low-income households were provided with an opportunity to upgrade their systems because of surface discharge or direct connection to surface waters.
- 2012 Reducing Sedimentation in RLWD Ditch #3 Clean Water Fund Project
    - AUID 09020303-504
    - Red Lake SWCD
    - $45,000.00
- Accelerated Erosion Control Projects in the Red Lake River Watershed
    - Red Lake SWCD Clean Water Fund Project
    - Addresses priority areas identified in the 2009 Red Lake County Erosion Site Inventory

    - Addresses gully erosion problems
    - Sediment reduction = 2,200 tons/year
    - $150,000.00
- RLWD Project 134 (Polk County Ditch 63) grade stabilization and erosion control project
    - AUID 09020303-515
    - RLWD and West Polk SWCD Clean Water Fund Project
    - Grade stabilization structure, side water inlets, and buffers.
    - Sediment reduction = 31 tons/year
- 2017 Red Lake County JCD 66 Water Quality Improvement Projects
    - AUID 09020303-555
    - Red Lake SWCD Clean Water Fund Project
    - 22 sites will be treated with grade stabilization structures, grassed waterways, and water and sediment basins.
    - Sediment reduction = 640 tons/year
    - Phosphorus reduction = 588 pounds/year
- 2017 Pennington County Ditch 21 Soil Health Inventory
    - AUID 09020303-541
    - Pennington SWCD
    - $260,482.00
    - Target the CD 21 watershed for documentation of tillage practices and the amount of cover to determine which landowners could use additional soil health practices. Small unmanned aerial systems (UAS) will be utilized for data collection.
- 2017 Pennington County Drainage System Outlet Analysis
    - Pennington SWCD
    - $332,749.00
    - Numerous ditch systems in Pennington County end at a natural drainage prior to entering the Red Lake River or other watercourse and those outlets can be very unstable and actively eroding. LiDAR technology on small UASs will be used to assess the conditions of those systems.

The Glacial Ridge National Wildlife Refuge was established in 2004. The land encompassed by the refuge serves as the headwaters of the Burnham Creek, Kripple Creek, and Gentilly River Subwatersheds. Prior to the establishment of the refuge, the land was used for agricultural production. Many wetlands and many acres of native prairie have been restored. Longitudinal sampling has revealed that the water leaving the refuge is pristine, even during runoff events. The USGS, The Nature Conservancy, USFWS, DNR and the RLWD have collaborated to support restoration projects and studies within the refuge. The USFWS has expressed interest in working with LGUs to implement habitat restoration projects beyond the borders of the refuge. The USGS has conducted intensive surface and groundwater monitoring within the refuge. The RLWD has assisted the USGS with the administration of grant funds.

Minnesota's Buffer Law that was signed into law by Governor Dayton in June 2015 was amended by the Legislature and signed into law by Governor Dayton on April 25, 2016. Minnesota's buffer law establishes new perennial vegetation buffers of 50 feet along public waters and 16.5 feet along ditches. The law provides flexibility and financial support for landowners to install and maintain buffers. Many segments of streams and ditches have been poorly buffered due to landowner choice, "grandfathering" status of old ditches that are not subject to current rules, and incomplete enforcement. This law will provide the means and support needed to fix those problems in order to significantly improve and protect water quality.

Some stormwater retention ponds have been constructed within the cities along the Red Lake River. New ponds were constructed to capture runoff from the parking lots of large shopping centers constructed in the cities of Thief River Falls and Crookston. A pond was recently constructed along Greenwood Street in Thief River Falls during the construction of a new bridge over the Red Lake River. Large rain gardens were constructed to capture runoff from the Ralph Engelstad Arena in Thief River Falls and smaller rain gardens have been constructed in other locations.

Extensive lists of projects and goals for the watershed can be found in the Red Lake River WRAPS and Red Lake River Watershed 1W1P documents.

- Red Lake River Watershed 1W1P: http://westpolkswcd.org/1w1p.html
- Red Lake River WRAPS: http://www.rlwdwatersheds.org/1449384-wrap-info

Progress toward restoration will be tracked by local water quality monitoring programs. The majority of the water quality data from this watershed has been collected by local organizations including the RLWD, International Water Institute, Pennington County SWCD, Red Lake County SWCD, and the River Watch program. Monitoring plans for the next 10 years are described in Section 7 of this report.

# 7. Monitoring Plan

Local, state, and federal agencies combine efforts to collect a large amount of environmental data within the Red Lake River Watershed. Water quality in rivers and streams is monitored using specialized equipment and laboratory analysis. Stage and flow levels are monitored along the Red Lake River and its tributaries. SWCDs monitor groundwater levels. The state conducts biological (aquatic and terrestrial) monitoring. Compliance monitoring is also important for the protection of natural resources.

Water quality monitoring can be conducted for multiple purposes. Much of the data is collected for the purpose of monitoring the condition of waterways over time, assessing current water quality conditions, or calculating pollutant loads. Official water quality assessments require a minimum number of water quality measurements in order to determine whether a waterway is meeting or violating water quality standards. The number of parameters and the frequency at which they are measured depends upon the project goals, the budget of the monitoring project, available equipment, and available staff time. Monitoring programs may be short-term or long-term. Short-term monitoring efforts may aim to achieve a minimal snapshot of water quality conditions (SWAG Grants), diagnose the source of a water quality problem, or measure the effectiveness of a project. Long-term monitoring should be sufficient to measure trends over time and to compile sufficient data for the assessment of whether or not waterways support aquatic life and recreation. All data that is collected following proper procedures needs to be submitted to the MPCA for entry and storage in the state's EQuIS water quality database. The state uses data stored in EQuIS during the official water quality assessments. Data compiled in EQuIS is also used for many other purposes, like writing TMDLs.

The parameters that are measured for long-term monitoring projects may vary slightly among organizations and monitoring sites. Basic parameters that can be measured on-site while monitoring (field parameters) include water temperature, DO, pH, specific conductivity, stage, transparency, turbidity, and observations/comments. Water samples are shipped overnight or delivered on the same day to a lab that is certified by the Minnesota Department of Health for analysis. Typically, samples are analyzed for a basic set of parameters that includes TP, OP, TSS, ammonia nitrogen, total Kjeldahl nitrogen, nitrates and nitrites, and *E. coli*. Additional parameters like chemical oxygen demand, biochemical oxygen demand (BOD), sulfates, TOC, and/or chlorophyll-a (Chl-*a )* may be collected, dependent upon project needs. TOC from the main stem of the Red Lake River and its major tributaries is useful to public water suppliers along the river in Thief River Falls and East Grand Forks. Oxygen demand data is collected at sites on reaches that are impaired by low DO levels (either officially or suspected). Chl-*a* has been collected for the MPCA from the lower end of major subwatersheds to measure eutrophication levels.

The RLWD began monitoring water quality in the Red Lake River Watershed in 1980 and now monitors 25 sites in the watershed (Figure 7-1). Newer sites that were monitored for the Red Lake River Watershed Restoration and Protection Project were added to the RLWD long-term monitoring program. The monitoring program collects data from the significant waterways within the watershed, including multiple reaches of the Red Lake River and its significant tributaries. Field measurements of DO, temperature, turbidity, specific conductivity, pH, and stage are collected during each site visit (if there is water). Four rounds of samples are also collected and analyzed for TP, OP, TSS, total dissolved solids, TKN, ammonia nitrogen, nitrates + nitrites, and *E. coli* at most of the sites. For the past few years, BOD analysis has been added for the sites that are located on reaches that have had low DO levels. BOD was replaced with chemical oxygen demand analysis in 2014 because too many BOD levels were too low to be measured. Sampling months are alternated each year with the goal of collecting at least five samples per calendar month within a 10-year period. Within the Red Lake River Watershed planning area, the RLWD monitors:

1. Red Lake River at the Louis Murray Bridge in East Grand Forks (Murray Bridge, S002-963)
2. Red Lake River at the Fisher Bridge (S000-031)
3. Red Lake River at Woodland Avenue in Crookston (790, S002-080)
4. Red Lake River at CSAH 13 near Red Lake Falls (Sportsman's Bridge, S003-172)
5. Red Lake River at Greenwood Street in Thief River Falls (RLR Greenwood, S006-225)
6. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls (Smiley, S007-063)
7. Red Lake River at Highlanding (75, S002-077)

8. Heartsville Coulee at 210th Street Southwest (HC210, S007-061). This site may be moved downstream, closer to the pour point, where there is flowing water.
9. Burnham Creek at 320th Avenue SW (BC320, S007-058)
10. Burnham Creek at Polk County Road 48 (BC48, S007-644)
11. Polk County Ditch 1 at County Road 61 (CD1, S007-059)
12. Gentilly River at CSAH 11 (86, S004-058)
13. Kripple Creek at 180th Avenue Southwest (S004-835)
14. Black River at CSAH 18 (BL-18, S002-132)
15. Little Black River at Red Lake County Road 102 (LBR102, S008-111)
16. Browns Creek at Red Lake County Road 101 (Browns101, S007-609)
17. Cyr Creek at Red Lake County Road 110 (S004-818)
18. Pennington County Ditch 96 at Highway 32 (CD96, S005-683)
19. Pennington County Ditch 21 at 135th Avenue Northeast (CD21-135, S008-889)
20. Chief's Coulee at Dewey Avenue within the city of Thief River Falls (S008-496)

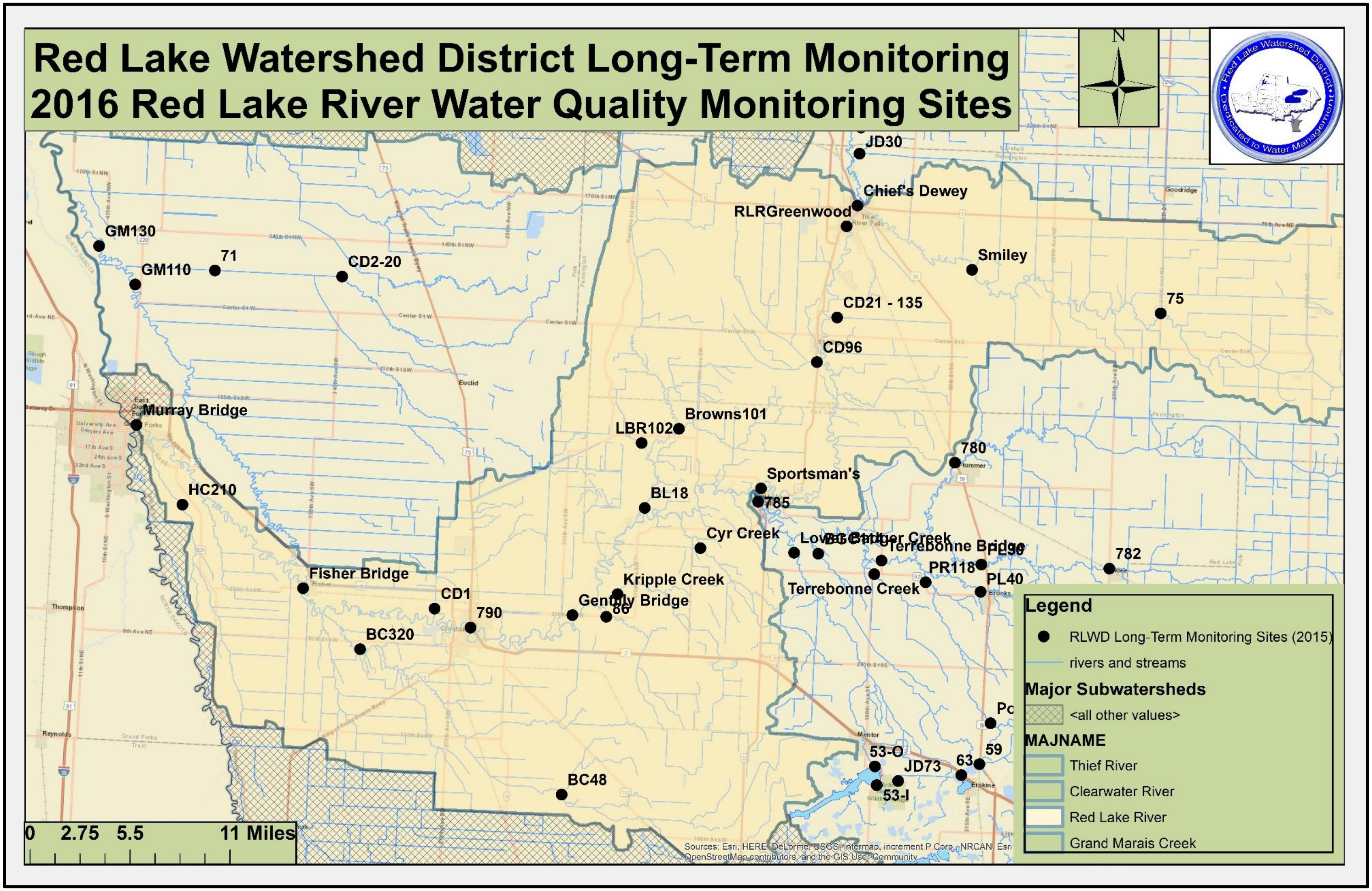


Figure 7-1. Red Lake River and Grand Marais Creek Long-Term Water Quality Monitoring Sites.

The Red Lake County and Pennington County SWCDs have long-term monitoring programs in which monthly samples and field measurements are collected at strategic sites. The Red Lake County SWCD monitors six sites in Red Lake County, once a month, during the months of May through September. The Pennington SWCD monitors nine sites in Pennington County, May through October. The Water Quality parameters that are tested include: turbidity, ammonia, total Kjeldahl nitrogen, nitrate + nitrite, TP, OP, TSS, *E.coli* bacteria, specific conductivity, total dissolved solids, DO, pH, and temperature. The SWCD long-term monitoring program sites within the Red Lake River Subwatershed include:

1. Red Lake River at Red Lake County Road 3 near Huot (S002-976)
2. Red Lake River at Pennington County Road 3 near Street Hilaire (S003-942)
3. Red Lake River at 1st Street in Thief River Falls (S002-076)
4. County Ditch 70 near the Greenwood Street Bridge (S004-964)
5. Red Lake River at 250th Avenue Northeast (Kratka Bridge, S003-947)
6. Red Lake River at 420th Avenue Southeast (East Line, S003-944)
7. Black River at CSAH 18 (S002-132)
8. Black River at 140th Street Southwest (Black River South, S003-943)
9. Black River at 120th Street Northwest (Black River North, S003-948)

River Watch is a volunteer monitoring program that gives high school students the opportunity to collect water quality data. This data is collected using the same methods that are used by professionals and is stored in the EQuIS database along with all other data that is collected within the watershed. Students in East Grand Forks (Sacred Heart High School), Fisher, Crookston, Red Lake Falls, and Thief River Falls have participated in the program. The Thief River Falls River Watch program is active periodically but is currently inactive. Reviving this program and keeping it active is a locally recommended goal. Some River Watch groups have sampled macroinvertebrates for educational purposes. The calculation of M-IBI scores using MPCA methods could be an advanced goal of this sampling. Intermediate goals of sampling efforts could focus on specific metrics or species where numbers were found to be deficient during the 2012 MPCA sampling. For example, the Red Lake Falls River Watch group could compare trichoptera numbers at multiple sites along the Black River.

The Red Lake River Monitoring sites that are co-located with USGS and DNR/MPCA Cooperative gauging stations have been intensively monitored for other projects, including the Major Watershed Pollutant Load Monitoring Network (WPLMN). Frequent sampling may continue for the MPCA's WPLMN. The International Water Institute has worked with the MPCA to conduct that sampling.

Robust collection of water chemistry data at long-term stream gaging sites improves the quality of water quality models (SWAT, HSPF) by providing a record of measured water quality that can be compared to the simulated conditions during the model calibration process. Key monitoring sites where more frequent data collection would aid future model calibration efforts include:

1. Red Lake River at 252nd Street SW in Fisher (S000-031)
2. Red Lake River at Woodland Avenue in Crookston (S002-080)
3. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls (S007-063)

4. Burnham Creek at 320th Avenue Southwest (S007-058)
5. Gentilly River at CSAH 11 (S004-058)
6. Kripple Creek at 180th Avenue Southwest (S004-835)
7. Black River at CSAH 18 (S002-132)
8. Cyr Creek at Red Lake County Road 110 (S004-818)

Additional data collection efforts and adjustments could be considered for future monitoring efforts. LGUs could stablish Regional Assessment Location monitoring sites on the Red Lake River and its most significant tributaries. Additional intensive sampling during runoff events will help shed light upon the causes of water quality problems in the watershed.

The collection of continuous DO data is essential, at most sites, for the collection of DO measurements prior to 9:00 a.m. The MPCA requires a record of pre-9 a.m. DO readings in order to declare that the waterway contains enough DO to fully support aquatic life. DO logging equipment can collect regular DO measurements (e.g. every 15 or 30 minutes) while deployed in a waterway. Equipment is deployed for a maximum of two weeks at a time before it is retrieved for data retrieval, cleaning, and re-calibration. Prior to the next state water quality assessment of the Red Lake River, continuous DO monitoring should be conducted to fully assess the capacity of key reaches in the watershed to support aquatic life. Data collected during the monitoring seasons of 2014 through 2023 can be used for the 2024 State water quality assessment. Priority should be given to reaches and sites that are too remotely located from LGU offices for pre-9 a.m. measurements. Data from DO loggers can also be used to calculate daily or diurnal fluctuation (DO flux). Summer average DO flux is used as a response variable for river eutrophication assessments.

Bolstered data collection efforts at key sites would aid with pre/post project evaluation:

1. RLWD Ditch 15 (Brandt Channel) at Highway 75 (S004-132) for evaluation of the effects of the Brandt Impoundment and outlet restoration project.
2. Polk County Ditch 2 at Polk County Road 62 (S004-131) to evaluate the effects of the Brandt Impoundment, Euclid Impoundment, Brandt Outlet Channel Restoration Project, and the Ditch 15 project.
3. Grand Marais Creek at Polk County Road 35 (130th Street Northwest, S008-903) to evaluate the effects of the Grand Marais Creek Outlet Restoration Project.
4. Burnham Creek at Polk County Road 48 (210th Avenue Southwest, S007-644) to evaluate the effects of erosion control and channel restoration efforts along the upper reaches of the Burnham Creek Watershed.

Long-term monitoring programs can evolve to include different or additional sites that have a strategic value that is equal to or greater than existing long-term monitoring sites.

1. The Red Lake River at 252nd Street Southwest in Fisher (S000-031) is a strategic location in the watershed because it is the furthest downstream USGS gaging stations. Samples are currently being collected frequently at the site for the WPLMN. If that program ever ends, local monitoring efforts should ensure that data collection at the site continues. If there is a need for additional parameters

(like TOC) beyond those that are being collected for the WPLMN, the site could be added to a local water monitoring program immediately.

2. The Little Black River, upstream of the dam, is strategic because it is the furthest downstream monitoring site prior to the dam. High *E. coli* concentrations were found at the site during investigative sampling conducted throughout the Black River Watershed for the Red Lake River WRAPS. It would also be a good site for monitoring water quality in a reach that is disconnected from the rest of the Black River by an impoundment. Data from the Little Black River would aid water quality model calibration.
3. The Red Lake River at CSAH 11 (S000-042) has been monitored by the Crookston River Watch program, but lab samples have only rarely been collected at the site. Because of the way that the Red Lake River is sectioned into assessment units, it is the only monitoring site on an 11.77-mile reach of the Red Lake River (09020303-506). Additional, perhaps intensive, monitoring is recommended to collect a robust collection of TSS data. LGU staff should periodically calculate assessment statistics and current load estimates to measure progress toward restoration. Flow and stage monitoring should be considered for this reach.
4. Pennington County Ditch 96 has been monitored by several short-term monitoring efforts. Being a ditch system without perennial flow, it has not been included in a long-term monitoring program. Now that water quality issues have been identified in the ditch, long-term monitoring is recommended.
5. Judicial Ditch 60 is another ditch system without perennial flow. Long-term stage/flow and water quality monitoring are recommended until the reach is removed from the 303(d) List of Impaired Waters.
6. Polk County Ditch 1 is a ditch with intermittent flow, but serious erosion problems. This channel should be a high priority for a stabilization project. Gathering pre-project and post-project data from the Polk County Road 61 (S007-059) would inform the condition of the waterbody.
7. Because of the erosion control, channel stabilization, and channel restoration work being conducted in the upper reaches of the Burnham Creek Watershed, additional monitoring should take place there. Historically, monitoring activity has been focused on the lower end of the watershed.
8. The RLWD shall work with city staff to collect stormwater samples in cities along the Red Lake River during runoff events. Samples have been collected at Thief River Falls stormwater outlets.

The MPCA plans to assess the Red Lake River Watershed once every 10 years. The RLWD water quality staff will use the latest MPCA assessment methods to assess conditions once every two years, at a minimum. Tracking water quality conditions is important for finding reaches that can be recommended for delisting (post-restoration removal from the 303(d) List of Impaired Waters), tracking progress toward delisting, identifying new problems so they can be addressed sooner, and identifying areas that need additional data (Figure 7-2).

Real-time stage and discharge monitoring stations have been installed in several locations along the Red Lake River (Figure 7-3). The DNR/MPCA Cooperative Gauging Program also monitors several sites without the use of telemetry. These Other significant reaches of the watershed are monitored with HOBO water level loggers by the RLWD.

1. USGS Gauge on the Red Lake River at Fisher
    - USGS gaging station
    - USGS# 05080000
    - EQuIS ID# S000-031
    - http://waterdata.usgs.gov/mn/nwis/uv?05080000
2. Red Lake River at Crookston
    - USGS gaging station
    - USGS# 05079000
    - EQuIS ID# S002-080
    - http://waterdata.usgs.gov/mn/nwis/uv?05079000
3. Red Lake River at CSAH 13 near Red Lake Falls
    - DNR/MPCA Cooperative Stream Gaging station
    - USGS ID# 05076650
    - EQuIS ID# S003-172
    - http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=getsitereport&site=63025001
4. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls
    - DNR/MPCA Cooperative Stream Gaging station
    - EQuIS ID# S007-063
5. Red Lake River at Highlanding
    - USGS gaging station
    - USGS ID# 05075000
    - EQuIS ID# S002-077
    - http://waterdata.usgs.gov/mn/nwis/uv?05075000
6. Red Lake River at CSAH 27
    - RLWD HOBO Water Level Logger station
    - EQuIS ID# S007-234

7. Red Lake River at the outlet of Lower Red Lake
    - USGS gaging station operated in cooperation with the U.S. Army Corps of Engineers
    - EQuIS ID# S000-064
    - http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=62021001

Stage logging stations and water level loggers are installed without telemetry or real-time data at the following locations on tributaries of the Red Lake River and in the Grand Marais Creek Watershed:

1. Heartsville Coulee at 210th Street Southwest (S007-061)
    - RLWD HOBO Water Level Logger station
2. Burnham Creek at 320th Avenue Southwest (S007-058)
    - DNR/MPCA Cooperative Stream Gaging station
3. Polk County Ditch 1 at Polk County Road 61 (S007-059)
    - RLWD HOBO Water Level Logger station
4. Gentilly River at CSAH 11 (S004-058)
    - RLWD HOBO Water Level Logger station
5. Kripple Creek at 180th Avenue Southwest (S004-835)
    - RLWD HOBO Water Level Logger station
6. Black River at CSAH 18 (S002-132)
    - RLWD HOBO Water Level Logger station
7. Cyr Creek at Red Lake County Road 110 (S004-818)
    - RLWD HOBO Water Level Logger station
8. Pennington County Ditch 96 at Minnesota Highway 32 (S005-683)
    - RLWD HOBO Water Level Logger station

The process of gathering data for water quality model calibration revealed a need for flow data from significant reaches that are separated from downstream reaches by an impoundment. The Little Black River and the Black River upstream of the Shirrick Dam are two reaches on which additional stage monitoring stations could be established. Stage and flow near the outlets of the Thief River and Clearwater River major subwatersheds that flow into the Red Lake River are also monitored by USGS gaging stations.

1. Thief River near Thief River Falls
    - USGS gaging station
    - USGS ID# 05076000
    - EQuIS ID# S002-079

- http://waterdata.usgs.gov/mn/nwis/uv?05076000

2. Clearwater River in Red Lake Falls
    - USGS gaging station
    - USGS ID# 05078500
    - EQuIS ID# S002-118

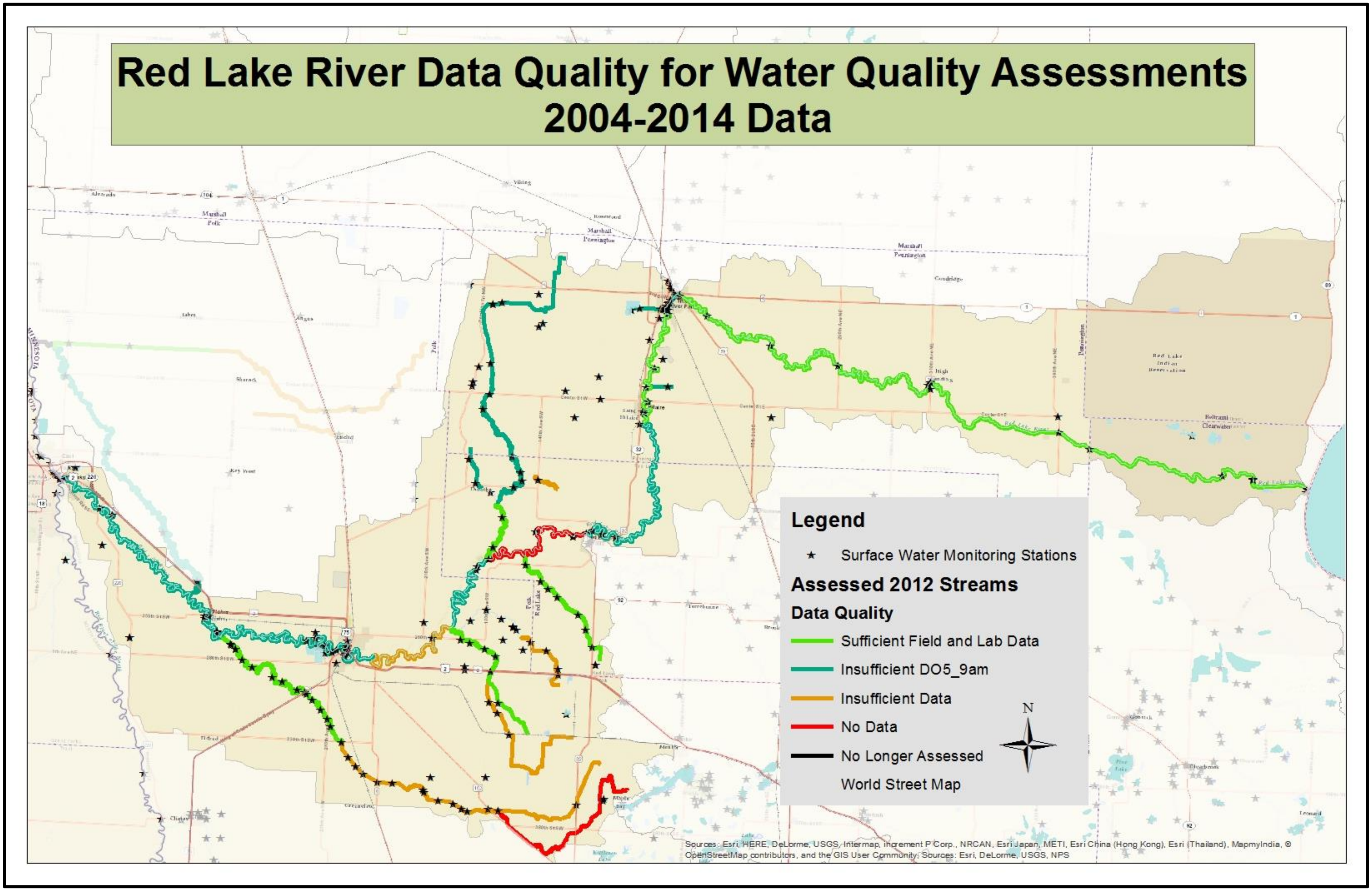


**Figure 7-2. Map showing the quality of data that was available for the 2015 assessment.**

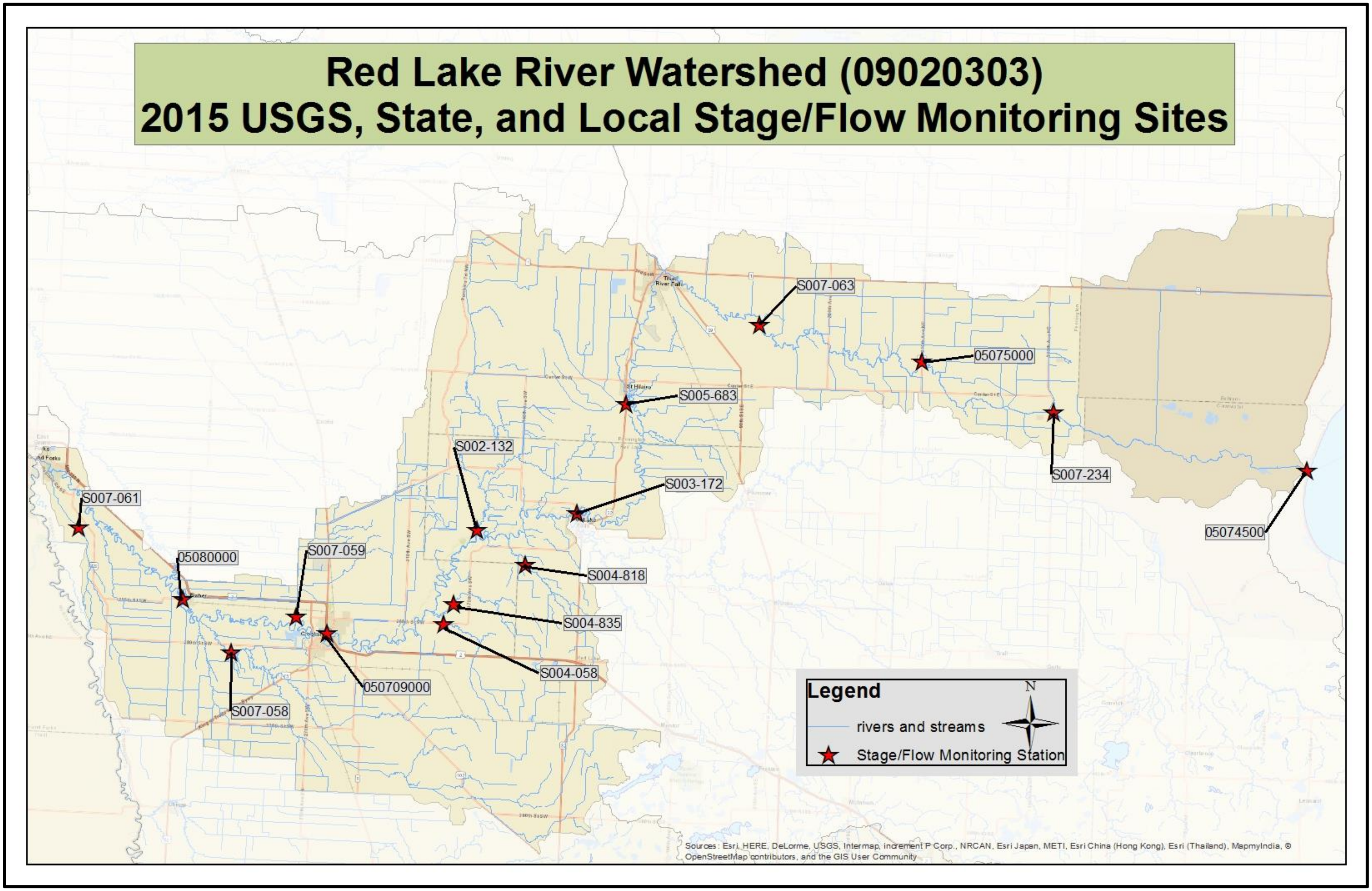


**Figure 7-3. Stage and flow monitoring sites in the Red Lake River Watershed.**

The 2012 MPCA biological sampling effort was incomplete and not representative of typical conditions in the watershed due to exceptionally low flows and dry conditions that occurred in 2012. Follow-up fish sampling is typically beyond the scope of local agencies due to the requirements of specialized, expensive equipment and permitting requirements. The sampling of macroinvertebrates, however, could be conducted. River Watch volunteers have been sampling macroinvertebrates for educational purposes. The RLWD is equipped for macroinvertebrate sampling. If proper methods are used, targeted volunteer sampling and/or LGU sampling could provide useful data. That data could be used to, at least, calculate some of the key metrics (e.g. those related to Trichoptera) and provide an indication as to whether or not conditions have changed in a particular reach. Reaches that are in need of follow-up sampling by the MPCA, LGUs, and/or volunteers include:

- Little Black River (09020305-528) at or near site 12RD024, downstream of the County Road 102 crossing.
- Kripple Creek (09020305-525)
- Burnham Creek (09020305-515) at multiple locations. Macroinvertebrates were not sampled at sites upstream of 12RD001 (320$^{th}$ Avenue Southwest) along this reach in 2012.
- Burnham Creek at the Spring Gravel stream restoration site. Monitor the project's effectiveness at improving aquatic habitat.
- Branch 5 of CD 96 (09020303-545). Fish should be sampled along this reach when there is flow.
- Cyr Creek (09020303-556). Fish should be sampled while there is measurable flow. Macroinvertebrates were not sampled at all in 2012, so macroinvertebrate sampling would help improve knowledge about water quality conditions in Cyr Creek. It would allow for a comparison of F-IBI and M-IBI scores that could improve the understanding about factors limiting IBI scores in the reach.
- A quantitative longitudinal assessment of sediment deposition along the 09020303-557 and 09020303-558 reaches of the Black River is recommended as a part of future monitoring activities. This effort could be coupled with macroinvertebrate sampling to determine the effect of sediment deposition upon aquatic macroinvertebrates.

Other forms of monitoring are also important for the protection of natural resources in the Red Lake River Watershed.

- An intensive geomorphological study of the watershed was completed in conjunction with the Red Lake River WRAPS. The process can be repeated at least once every 10 years to measure erosion rates and assess the accuracy of BEHI ratings.
- The findings of drainage ditch inventories can be used to identify areas that need to be addressed with BMPs to reduce erosion and sedimentation within ditches.
- Traveling along navigable streams in a kayak or canoe and documenting conditions is one of the best ways to find erosion problems, finding other sources of water quality problems, and assessing the quality of habitat along a waterway.

- The Northland Community and Technical College Aerospace Program can help LGUs inspect ditch systems and identify the sources of water quality problems. Drones are now capable of collecting high resolution three-dimensional images that can be used to find and measure erosion problems along rivers and streams.

# 8. Implementation Strategy Summary

Implementation strategies for the Red Lake River Watershed have been developed through extensive field reconnaissance, collaboration with local and state agencies, stakeholder involvement, multiple water quality studies, and the use of watershed modeling tools. The strategies in this TMDL focus on water quality improvement along impaired reaches. Additional strategies are discussed in the Red Lake River WRAPS Report. The strategies described in this section are also described in further detail for each subwatershed within the Restoration and Protection Strategies Section of the Red Lake River WRAPS. The following list is a summary of the suggested strategies needed to achieve restoration goals in the watershed:

- Improve and maintain buffers along the Red Lake River and its tributaries. Establish riparian brush, trees, and other deep-rooted vegetation.
- Improve base flows in Red Lake River tributaries (upstream storage sites).
- Implement agricultural BMPs to reduce soil erosion and sedimentation.
- Continue long-term monitoring efforts.
- Utilize the recommendations of the Red Lake River Watershed Geomorphology Report as guidance for future implementation projects and ditch maintenance.
- Restore meandering channels with floodplain access to reduce sedimentation and improve habitat.
- Utilize models, tools, site visits, and inventories to implement targeted best management practices (BMPs) to control upland erosion. Those practices include, but are not limited to side water inlets, alternative side water inlets, cover crops, and crop residue management.
- Install and renovate field windbreaks to reduce wind erosion.
- Continue and further develop education and outreach activities.
- Install BMPs and storage to moderate runoff rates to reduce in-channel erosion.

## 8.1 Permitted Sources

### 8.1.1 Construction Stormwater

The WLA for stormwater discharges from sites where there is construction activity reflects the number of construction sites greater than one acre (or five acres, for drainage systems) expected to be active in the watershed at any one time, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at construction sites are defined in the state's NPDES/SDS General Stormwater Permit for Construction Activity (MNR100001). If a construction site owner/operator obtains coverage under the NPDES/SDS General Stormwater Permit and properly selects, installs and maintains all BMPs required under the permit, including those related to impaired waters discharges and any applicable additional requirements found in Appendix A of the Construction General Permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Construction activities must also meet local construction stormwater requirements if they are more restrictive than the State General Permit.

### 8.1.2 Industrial Stormwater

The WLA for stormwater discharges from sites where there is industrial activity reflects the number of sites in the watershed for which NPDES Industrial Stormwater Permit coverage is required, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at the industrial sites are defined in the state's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or NPDES/SDS General Permit for Construction Sand & Gravel, Rock Quarrying and Hot Mix Asphalt Production facilities (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS Permit and properly selects, installs and maintains all BMPs required under the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. All local stormwater management requirements must also be met.

### 8.1.3 MS4

The MPCA oversees all regulated MS4 entities. The MS4 NPDES/SDS Permits require regulated municipalities to implement BMPs to reduce pollutants in stormwater runoff to the maximum extent practicable. All owners or operators of regulated MS4s (also referred to as “permittees”) are required to satisfy the requirements of the MS4 General Permit. The MS4 General Permit requires the permittee to develop a Stormwater Pollution Prevention Program (SWPPP) that addresses all permit requirements. The city of East Grand Forks discharges to impaired portions of the Red Lake River, is already designated as an MS4, and has developed a SWPPP that is described below. The city of Crookston will likely be designated as an MS4 because it has a population greater than 5,000 people and discharges to an impaired river. Crookston will need to develop a SWPPP when it is designated as an MS4. MnDOT will also be required to incorporate BMPs into a SWPPP for the urbanized portion of the MnDOT ROW in the city of East Grand Forks.

A SWPPP is a management plan that describes the MS4 permittee’s activities for managing stormwater within their jurisdiction or regulated area. In the event a TMDL study has been completed, approved by the EPA prior to the effective date of the general permit, and assigns a WLA to an MS4 permittee, that permittee must document the WLA in their application and provide an outline of the BMPs to be implemented in the current permit term to address any needed reduction in loading from the MS4.

The MPCA requires applicants submit their application materials and SWPPP document to the MPCA for review. Prior to extension of coverage under the general permit, all application materials are placed on 30-day public notice by the MPCA, to ensure adequate opportunity for the public to comment on each permittee’s stormwater management program. Upon extension of coverage by the MPCA, the permittees are to implement the activities described within their SWPPP and submit annual reports to the MPCA by June 30 of each year. These reports document the implementation activities that have been completed within the previous year, analyze implementation activities already installed, and outline any changes within the SWPPP from the previous year.

**East Grand Forks**

The city of East Grand Forks is designated as a small MS4 and is therefore required to obtain coverage under an MS4 permit (MS400088, East Grand Forks City MS4). East Grand Forks is located near the pour point of the watershed. The only TMDL establishment location that is affected by the MS4's catchment is the Murray Bridge (S002-963/S000-013) monitoring site. According to State MS4 boundary GIS data, approximately 2.8 $mi^2$ of the East Grand Forks MS4 catchment contributes to the Murray Bridge monitoring site. That area comprises just 0.05% of the total drainage area for the Red Lake River at the Murray Bridge. The city's stormwater pollution prevention plan (SWPP) and educational materials can be found on the city's website: http://www.egf.mn/index.aspx?NID=240. The following tasks are described in further detail within the East Grand Forks SWPPP. These SWPP practices can also be included in the Crookston SWPP and be applied voluntarily to non-MS4 communities (Thief River Falls, Red Lake Falls, St. Hilaire, and Fisher).

Public Outreach and education activities in the SWPPP include:

1. Distribute educational materials to city employees and to the public through employee newsletters, city newspapers, and the city website (http://www.egf.mn/).
2. Annual presentations to public city council meetings.
3. Educating the public about stormwater issues in the community and the impact that it has on water quality.
4. Education program: public participation
    a. Increase public awareness and understanding of stormwater issues within the community.
    b. Inform and educate the public about the impacts of stormwater runoff upon water quality and what an individual can do to help minimize those impacts.
    c. Inform and educate the public about how the city manages stormwater runoff through its SWPP.
5. Education program: Illicit discharge detection and elimination
    a. Increase public awareness about what an illicit discharge is.
    b. Teach the public proper steps in stopping someone who is discharging and whom they should contact.
    c. Talk about the benefits of eliminating illicit discharge on water quality and the community.
    d. Reduce and eliminate the frequency of illicit discharges into the storm sewer system.
6. Education program: Developing, implementing, and enforcing a program that will reduce the impacts of storm water runoff from construction activities.
7. Education program: Post-construction stormwater management in new development and redevelopment

8. Education program: Pollution prevention/good housekeeping for municipal operations
    a. Increase the public awareness about good housekeeping practices for pollution prevention.
    b. The city will start a program that will reduce or eliminate the impacts of stormwater pollution from open space maintenance, snow disposal, vehicle and building maintenance, land disturbances, and storm sewer system maintenance.
9. The city will develop an education program directed toward business activities with the potential to cause stormwater pollution. Activities with known stormwater pollution potential will be targeted. Literature specific to targeted activities will be developed along with a general version applicable to any commercial business whose premise is impacted by stormwater.
10. The city will hold an annual public meeting to discuss the SWPPP.

Illicit discharge detection and elimination in East Grand Forks will be accomplished through:

- Creation and updates of a storm sewer map
- Ordinances that prohibit non-stormwater discharge into the storm sewer system
- Education of the general public, businesses, and staff
- Facilitation of illicit discharge reporting using a community hotline and the city website
- Household Hazardous Waste program that is available to the city's residents
- Evaluation of non-stormwater discharges and flows such as water line flushing and lawn watering which are significant contributors of pollutants
- Development of action plans to evaluate and address the impact that non-stormwater discharge is having on stormwater quality

The City of East Grand Forks enforces construction site ordinances that meet the minimum requirements set forth by the MPCA. Construction site plans will be reviewed for the implementation of sedimentation and erosion controls before ground is broken. Erosion and sediment control BMPs will be implemented to minimize stormwater runoff pollution and flooding. The city's program to control construction site waste will address construction entrances, concrete truck cleanout, and equipment washing areas. The city shall also address contractor and inspector training and certification. A Stormwater System Inspection Program will be implemented to identify maintenance needs.

The City of East Grand Forks will operate and maintain the storm sewer system using procedures that minimize discharged pollutants. The city implements a street sweeping program. The city intends to sweep all city streets and parking lots at least once each year. Spring street sweeping will begin as early in the spring as weather allows with a goal of sweeping all streets and parking lots within a one-week timeframe. The city also plans to inspect a minimum of 20% of the MS4 outfalls, sediment basins, and ponds each year on a rotating basis. As a result of inspections, the city will maintain, repair, or replace the required components of the storm sewer system to insure proper operation. Exposed stockpile, storage, and material handling areas will be inspected annually. The city also follows a number of record-keeping procedures regarding stormwater pollution reduction programs.

**Crookston**

Michael Knudson, a University of North Dakota graduate student, University of Minnesota GreenCorps employee, and Crookston resident, conducted a stormwater study for the City of Crookston. His work also included a stormwater survey of municipality leaders, mayors, city council members, city administrators, department heads, and others in East Grand Forks, Thief River Falls, and Crookston. Seventeen of the surveys were completed and returned (50%). Here are few observations from the survey results:

- Almost one third of respondents manage stormwater on their property.
- Most respondents viewed agricultural runoff as being more influential than other sources of water pollution.
- Most respondents felt that water quality in their river is good and that water quality is very important to their livelihood and quality of life.
- Most communities have stormwater utility fees and there are some ordinances in place to limit pollution in urban runoff. There is room for improvement in the enforcement of those ordinances and in community education.
- Of six BMP options (stormwater retention ponds, permeable surfaces, vegetative buffers, rain gardens, rain barrels, and green roofs), respondents ranked stormwater retention ponds as the BMPs for their communities.

The Crookston Stormwater Study provided insight into the parts of the city in which stormwater BMPs are most needed.

- The turbidity levels from Crookston industrial park stormwater runoff were extremely high in 2011.
- The stormwater outlet near the Highland Park and softball complex in Crookston was relatively less impactful than the other outlets. Moreover, there is some filtration of the water by wetlands before it gets to the river. The turbidity levels at the stormwater outlet that drains runoff from the University of Minnesota, Crookston were not much worse, and sometimes better, than ambient turbidity levels in the Red Lake River.
- Two stormwater outlets (47.780002, -96.610710 and 47.779972, -96.609794) that drain the northern end of town and many parking lots (grocery store, bar, hardware store, car dealer, school, church) also had relatively high turbidity levels in stormwater runoff. They enter directly into the river and there is not much space between the outlets and Hwy 2. There might not be much room for a stormwater retention pond near the lower end of this drainage area. Therefore, low impact development (LID) BMPs like rain gardens and smaller retention basins nearer the source of the runoff may be the most appropriate strategy for reducing pollution from these two stormwater outlets.
- Alternative sites for the disposal of snow should be located. Snow should be piled in areas that do not drain directly to waterways.

### 8.1.4 Wastewater

WWTFs in Thief River Falls, St. Hilaire, Red Lake Falls, Crookston (City of Crookston and American Crystal Sugar), and Fisher shall continue to meet the requirements of their respective wastewater permits. The WWTFs that discharge to reaches that are subject to a 65 mg/l standard are not contributing to the impairment. They are discharging at a concentration of 45 mg/l or less, which is lower than the standard. For river reaches that are subject to the 30 mg/l TSS standard, discharges greater than 30 mg/l could contribute to an impaired condition. State and local monitoring staff will be alert for potential wastewater discharge violations during regular monitoring activities and assist the MPCA enforcement staff with investigative sampling. No reductions in wastewater loads have been prescribed by this TMDL.

## 8.2 Non-Permitted Sources

### 8.2.1 Stream and Ditch Bank Erosion

There are multiple outlets of ditches and other small tributaries of the Red Lake River that are unstable and have been rapidly eroding. The final road crossings of these waterways usually act as a grade control, but severe channel degradation has occurred along the relatively steep slopes between road crossings and the Red Lake River. In many cases, the legal ditch system ends upstream of natural watercourses before entering the Red Lake River. Those natural waterways have steep slopes and are unable to accommodate flow from artificial drainage systems without actively eroding.

LGUs will inventory and stabilize actively eroding outlets of ditches and other Red Lake River tributaries. Some SWCDs have already been awarded funding for these projects. Some projects have already been completed (Figure 8-1) and can be used as examples for future projects. Eroding ditch outlets in Polk County were identified in 2012. The West Polk SWCD will use this information to plan grade stabilization projects that can be funded by the Clean Water Fund. The Pennington SWCD was awarded 2017 fiscal year funding from the Clean Water Fund to utilize drone technology to identify ditch system outlets that are most in need of stabilization. Drone, or UAS, technology can be utilized to monitor erosion rates along rivers, streams, and ditches to prioritize areas that are most actively eroding and are most in need of stabilization projects. Drones can be equipped with a wide variety of sensors, including LiDAR. Utilizing LiDAR and photography, the drones can produce georeferenced three-dimensional photography.

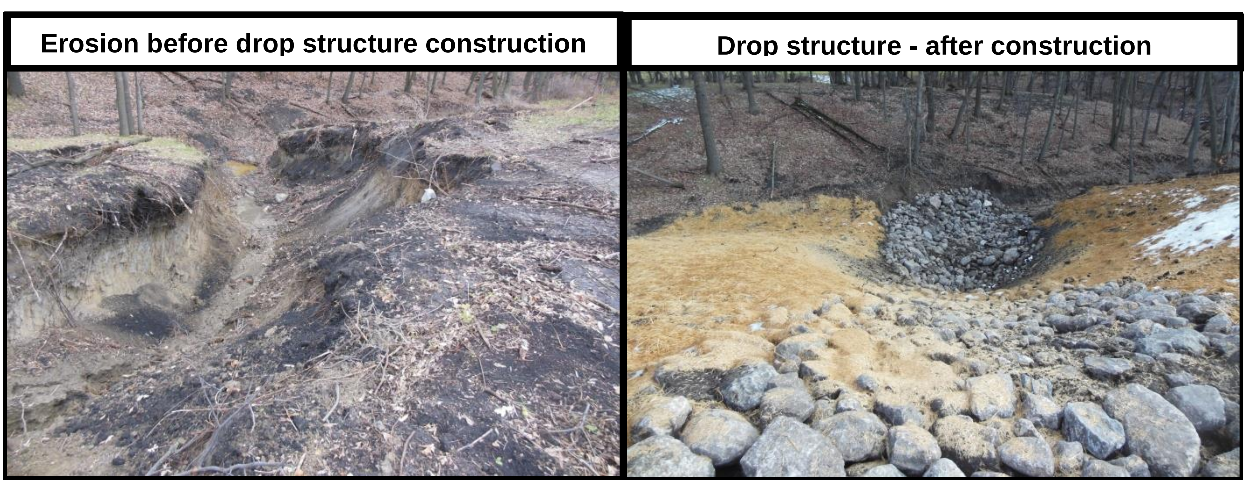


Figure 8-1. Example of a grade stabilization structure along an eroding drainage outlet along the Red Lake River.

Erosion from a drainage system that flows into the 09020303-512 reach of the Red Lake River has been depositing a significant amount of sediment into the river, as shown in Figure 8-2. Some grade stabilization work has been done along that system (which has a relatively high gradient), but more protection is needed downstream of existing grade control structures. Similar gully erosion problems still exist along the outlet channels of some of the SCS dams on tributaries of the Red Lake River. Further grade stabilization efforts should be constructed to prevent further streambank erosion and headcutting that could endanger the stability of the dams' earthen embankments (Thibert Dam and Latundresse Dam).

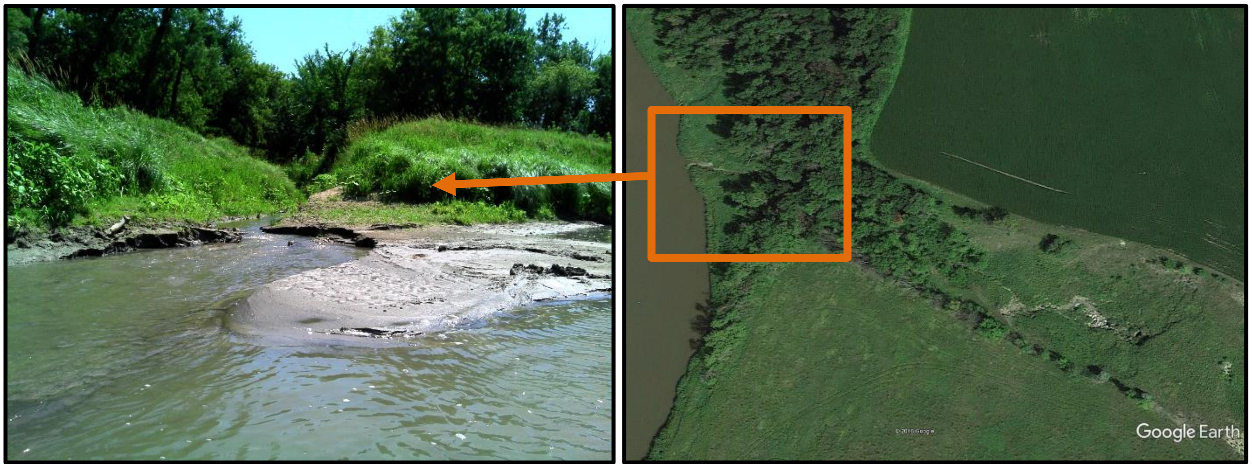


Figure 8-2. Eroding ditch outlet along the Red Lake River, south of CSAH 11.

### 8.2.2 Reduce Agricultural and Overland Erosion

Overland and gully erosion contribute to TSS impairments in the Red Lake River. Much has already been done already to reduce sediment loading from these sources, but much additional work is needed. The results of completed erosion site inventories will be used to prioritize and plan projects. Additional inventories will be conducted where necessary. Recommendations of stream channel stability assessments shall provide guidance for the proper course of action (stabilization of individual erosion sites or reach-wide grade stabilization). Recently developed desktop tools have the ability to provide a detailed prioritization of areas where BMPs will be most necessary and effective.

Implementation of the requirements of Minnesota's Buffer Initiative Law, enacted in 2015, will provide much-needed protection of riparian corridors that will help stabilize streambanks and reduce sediment delivery from overland runoff. The Buffer Initiative will protect Minnesota's water resources from erosion and runoff pollution by establishing perennial vegetative cover adjacent to Minnesota's waters. The buffer width will be an average of 50 feet on public waters. The buffer width will be a minimum of 16.5 feet on public ditches. Buffer widths on other waters will be determined by SWCDs. Water quality monitoring and aerial/windshield surveys identified buffer improvement as a need for most of the impaired AUIDs.

Promote on-field BMPs. The BMPs that have been implemented within the watershed include:

- Cover crops ("popular" with farmers in Polk County)
- Seasonal residue use ("popular" with farmers in Polk County)
- Structures for water control ("popular" with farmers in Polk County)

- Grade stabilization structures (“popular” with farmers in Polk County)
- No-till
- Strip-till
- Filter strips
- Field borders
- Field and farmstead windbreaks
- Ring dikes
- Nutrient management
- Pest management
- Pasture management systems
- CRP grass seeding
- Wetland restorations

LGUs will work to reduce upland agricultural erosion in the Burnham Creek Watershed that affects water quality in AUIDs 09020303-515 and 09020303-551. The portion of the watershed downstream of Highway 75 should be targeted as the highest priority area (09020303-515). Streambank erosion along the lower portion of Burnham Creek should be addressed.

LGUs will utilize desktop tools (HSPF, SPI, PTMApp) to identify critical areas that are contributing a disproportionate amount of eroded soil to the river. PTMApp’s online interface can be used to generate maps that show the results of a variety of forms of analysis of sediment runoff, nutrient runoff, and hydrology. Examples of PTMApp outputs are shown in Figures 8-3 and 8-4.

LGUs shall work to protect, replace, and establish new windbreaks to minimize wind erosion from the large expanses of cropland that are found in the Red Lake River Watershed. According to local SWCD staff, black hill spruce trees work well in sandy soil. Although conifers take a while to grow, they are very effective. Ash used to be a go-to tree, but not anymore. Instead, cottonwood and boxelder trees are becoming more popular.

Water retention through the construction of impoundments and wetland restorations will improve water quality conditions by limiting peak flows in streams and attenuating base flows.

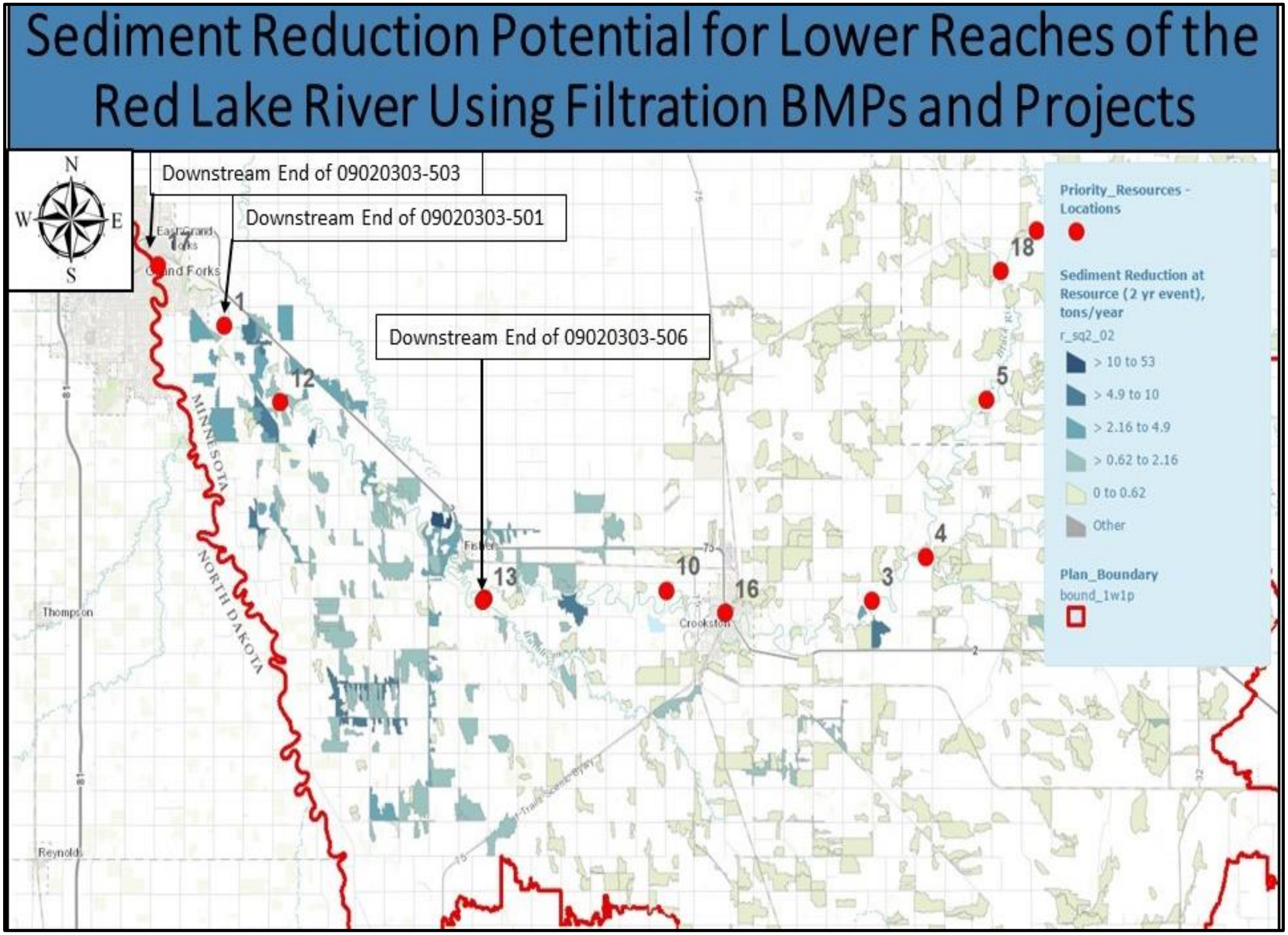


**Figure 8-3. PTMApp-generated sediment reduction potential for lower reaches of the Red Lake River using filtration BMPs.**

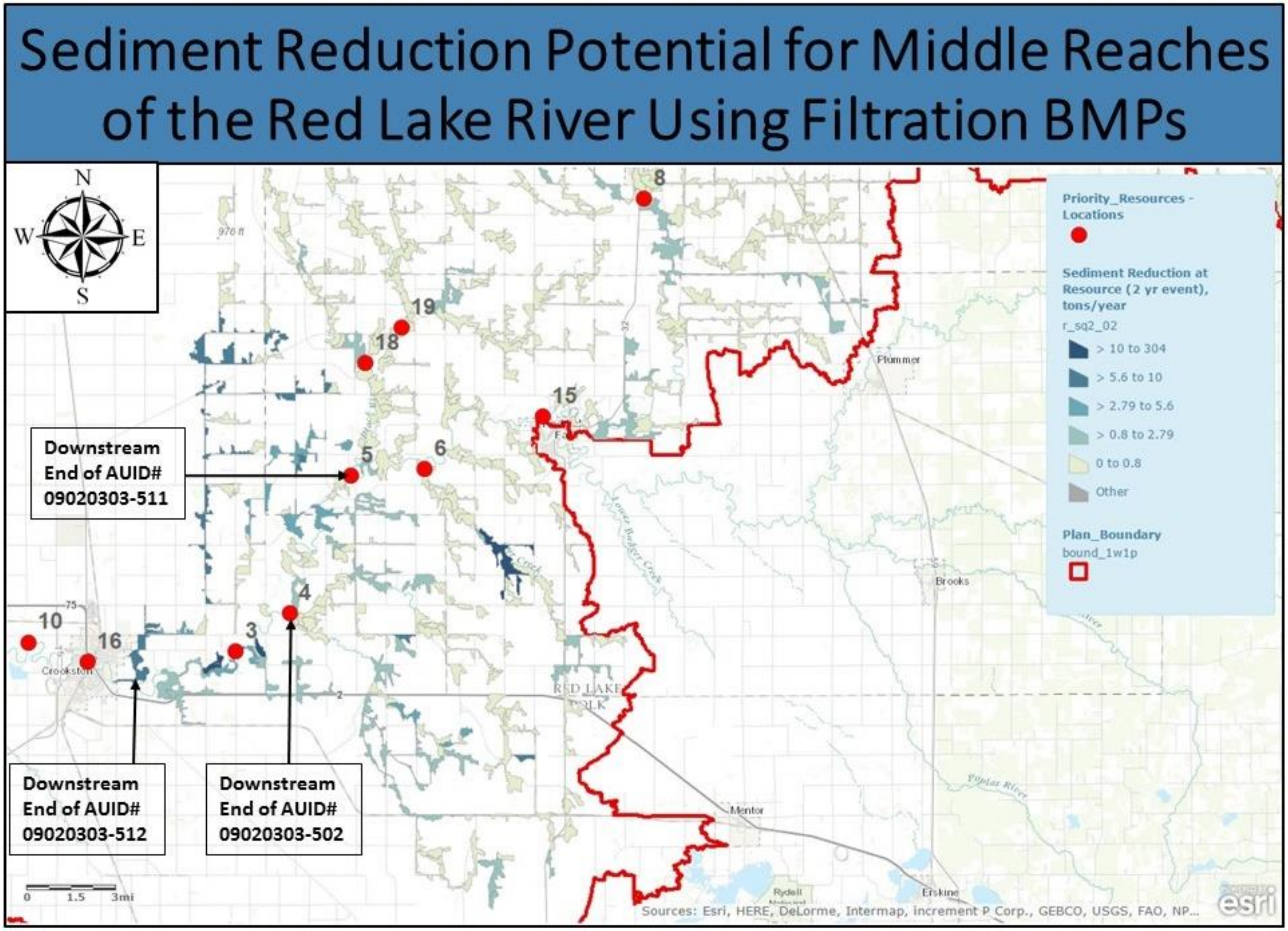


**Figure 8-4. PTMApp-generated sediment reduction potential for the middle reaches of the Red Lake River using filtration BMPs.**

### 8.2.3 Streambank Stabilization

In-channel erosive processes were identified by the HSPF model as the largest source of sediment in the Red Lake River at East Grand Forks. The following actions have been identified for the purpose of reduction streambank erosion and channel degradation within the watershed.

- Use recommendations of stream channel stability assessments to determine the proper course of action (stabilization of individual erosion sites or reach-wide grade stabilization).
- Target areas with greater slopes and drainage areas that are probable sources of sediment and other nonpoint pollution. Targeting those features with BMPs can maximize benefits for water quality and maximize the efficiency of funding used for conservation. Tools like the HSPF model, stream power index, and PTMApp can be used to help target those practices.
- To reduce streambank erosion and create healthy riverine habitat, channels should have access to a floodplain (one to two year recurrence interval).
- Take steps to slow the erosional processes by maintaining and improving riparian buffers and mitigating for changes in hydrology.
- In developed areas, landowners should be encouraged to manage their riverfront property in ways that add to the stability of banks.
- Creating setbacks within the riparian zone will minimize future problems with the Red Lake River encroaching upon development.
- Soils on top of bluff banks along the Red Lake River are prone to gully erosion and mass wasting, so maintain adequate buffers in these areas is essential. It is also important to maintain buffers where banks are composed of more erodible soils. Existing buffers should be maintained and buffers should be improved where they are lacking, especially on outside bends.
- Install grade stabilization structures in unstable ditch outlets and along the Black River (between CSAH 18 and the Red Lake River). Structures should be designed with guidance from the Minnesota DNR in order to ensure that fish passage is not negatively affected.
- If the factors pushing watercourses toward instability cannot be alleviated, at a minimum, the conditions near the watercourses must be improved. The rate at which instability worsens can be slowed by ensuring the following:
    - Perennial vegetation with robust and dense root mass is present adjacent to the watercourses.
    - The vegetative planting is of an appropriate width to function as a buffer.
    - Watercourses must have access to a floodplain at the bankfull elevation (1.5 to 2 year flood recurrence interval).
    - Artificial and altered natural watercourses should be designed and maintained with an appropriate base flow channel with floodplain access.
- Reduce the flashiness of stream flows. Implement suitable strategies of the distributed retention plan.

- PTMApp can be used to simulate reductions in sediment loads or sediment yields that can result from the implementation of protection BMPs that provide treatment by physically armoring the landscape in areas with high potential for erosion. This category would include stream bank and shoreline stabilization projects (Figure 8-5).

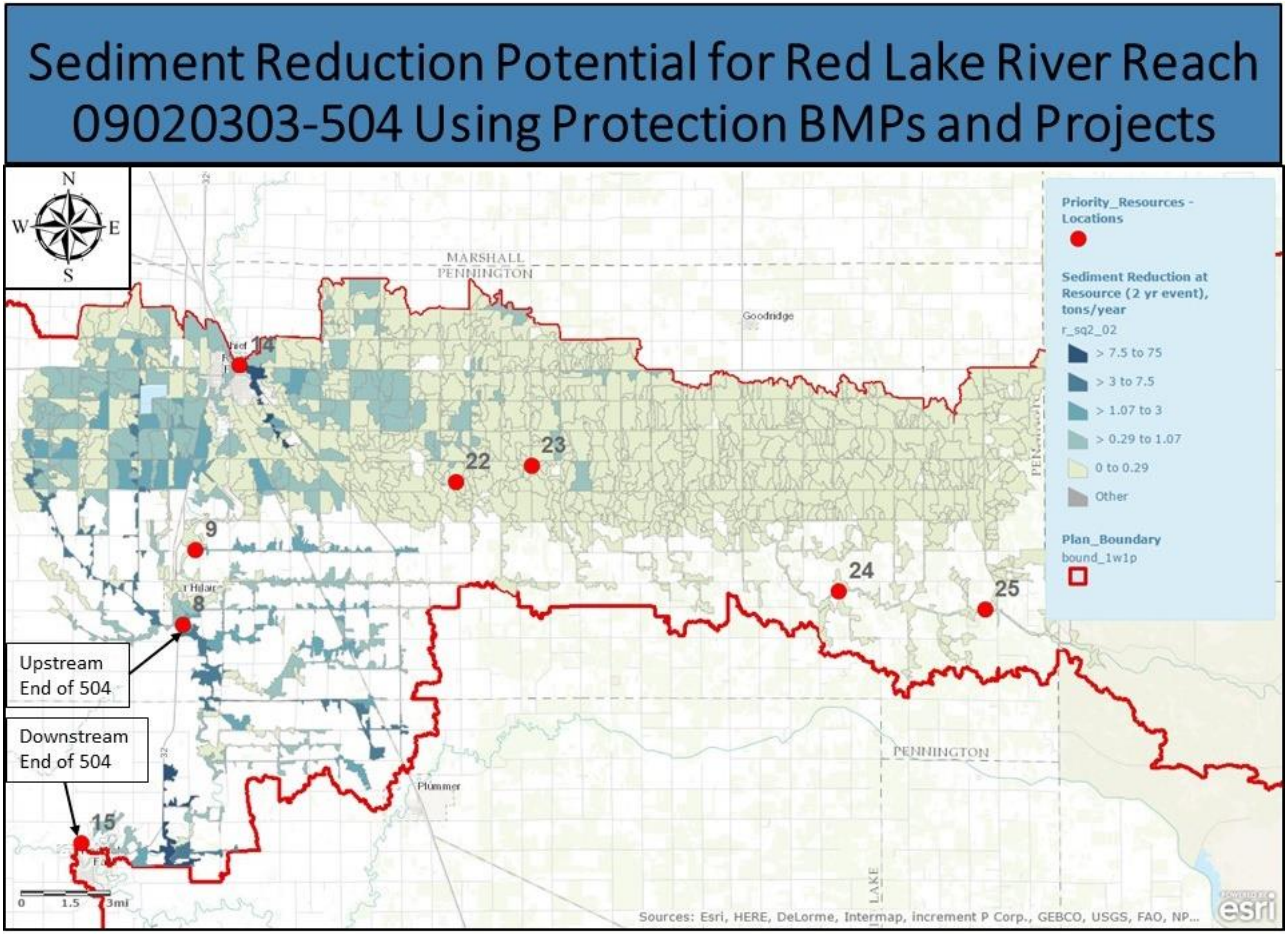

**Figure 8-5. Sediment reduction potential for AUID 504 using protection BMPs, as simulated by PTMApp.**

### 8.2.4 Unregulated Stormwater

Activities similar to those listed in Section 8.1.3 should be implemented in other cities along the Red Lake River. The list of activities in that section can be used to generate ideas for projects within cities that have infrastructure for stormwater drainage but are not required to have a SWPPP. Stormwater runoff often contains high concentrations of sediment and other pollutants. Sampling outlets can help identify and prioritize problem areas that need stormwater BMPs. The Minnesota Stormwater Manual can guide the selection and installation of stormwater BMPs: https://stormwater.pca.state.mn.us/index.php?title=Main_Page.

### 8.2.5 Habitat improvement

**Watershed-wide**

In-stream and riparian habitat improvements are needed throughout the Red Lake River Watershed to help improve fish and M-IBI scores. Riparian buffer widths have and will be improved along many reaches of rivers, streams, and ditches in the Red Lake River through the enforcement of the requirements of Minnesota's 2015 Buffer Law. The quality of riparian buffer vegetation can be improved to include more perennial deep-rooted vegetation, preferably shrubs, native plants, and trees. Currently, managers of ditch systems are reluctant to allow the presence of trees along waterways that are managed as public drainage ditches (e.g. AUID 0920303-551). Reasons for this reluctance include potential for flow obstruction, restricted access for inspections, increased nuisance beaver activity, and increased maintenance costs. LGUs may research options and establish vegetation that is beneficial to habitat and streambank stabilization without significantly impeding flow during runoff events. The Stressor ID process identified a need for habitat improvement along the following reaches that have F-IBI or M-IBI impairments:

- Burnham Creek (09020303-515)
- Kripple Creek (09020303-525)
- Kripple Creek (09020303-526)
- Little Black River (09020303-528)
- Pennington County Ditch 43 (09020303-547)
- Burnham Creek (09020303-551)
- Gentilly River (09020303-554)
- Black River (09020303-558)

Projects and BMPs that can help reduce stream temperatures, reduce sediment concentrations, and improve base flows are recommended to support higher quality populations of trichoptera (caddisfly larvae) within tributaries of the Red Lake River. LGUs should work with state biological staff to plan projects that will effectively improve habitat conditions for sensitive and desirable species.

Projects should be completed to increase the amount of off-channel storage within the watersheds of streams in which aquatic life is being limited by a lack of base flow. All of the IBI and DO impairments in the watershed appeared to be influenced by low flows. Low flows also exacerbated the impacts of other stressors. Multiple streams could benefit from storage within the “middle” Red River Basin runoff timing zone. This is a case where projects can be beneficial to flood damage reduction goals and water quality goals. “Everything else being equal, the middle areas contribute the most to downstream main stem flood peaks” on the Red River of the North. “The relationship between tributary and main stem flooding is also easiest to understand in the middle areas. Activities that decrease peak flow from these areas will decrease peak flows on the main stem. Conversely, activities that increase the peak flow from these areas will increase peak flows on the main stem.” The timing zones are shown in Figure 8-6. On-channel impoundments should be avoided along significant waterways. On-channel impoundments would conflict with the goals of improving aquatic habitat in streams and improving/maintaining fish passage. Reaches that can specifically benefit from additional storage and increased base flows include:

- Kripple Creek (09020303-525)
- Kripple Creek (09020303-526)
- Burnham Creek (09020303-515)
- Judicial Ditch 60 (09020303-542)
- Branch 5 of Pennington County Ditch 96 (09020303-545)
- Heartsville Coulee (09020303-550)
- Burnham Creek (09020303-551)
- Gentilly River (09020303-554)
- Cyr Creek (09020303-556)
- Black River (09020303-558)

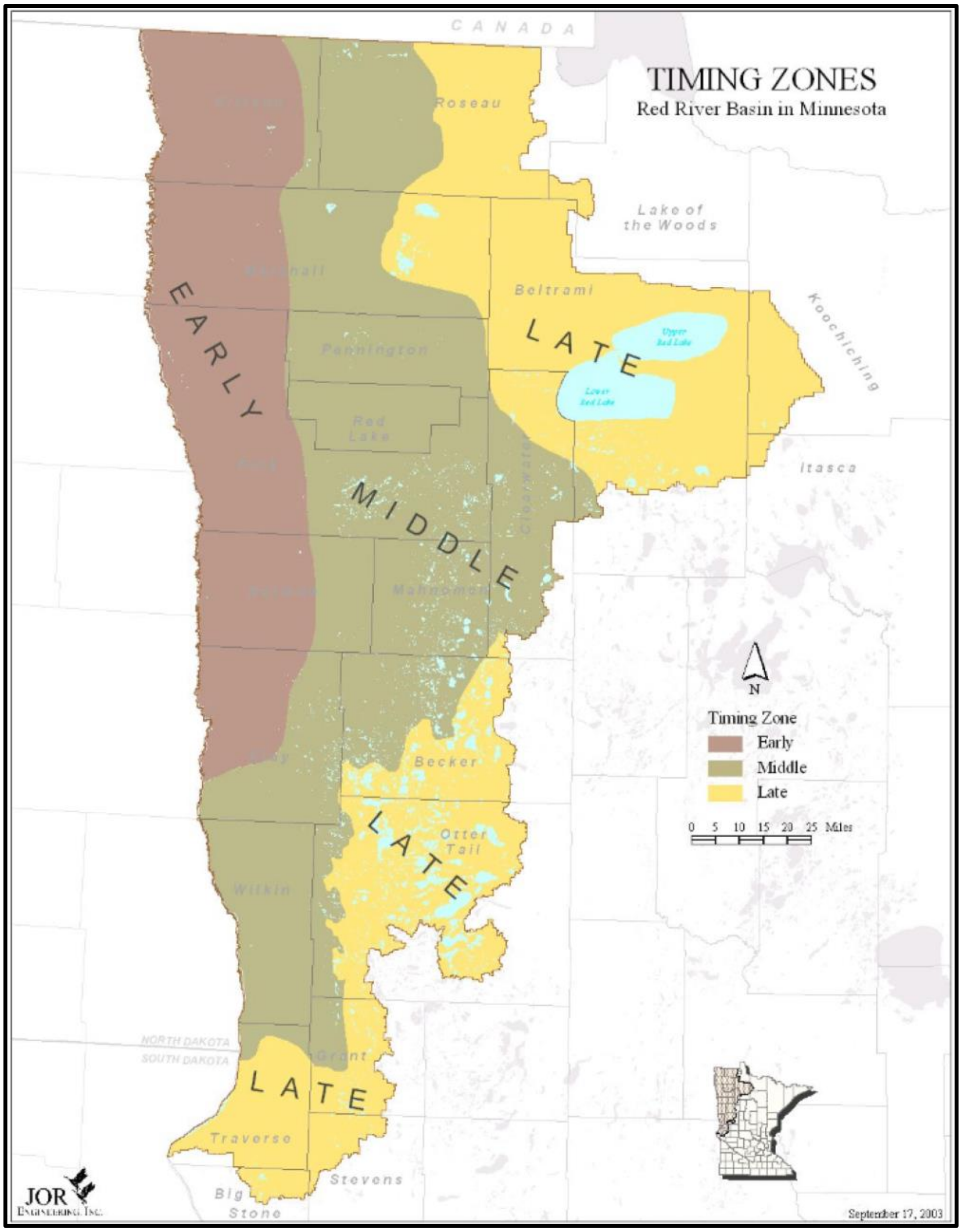


Figure 8-6. Early, middle, and late runoff timing zones in the Red River Basin.

### Burnham Creek (09020303-515 and 09020303-551)

The path to restoration for the 09020303-551 reach of Burnham Creek can be described in a systematic process.

1. Complete a detailed geomorphic assessment, including BEHI ratings.
2. Improve base flows in the Burnham Creek Watershed. More storage is needed to reduce peak flows and maintain sufficient base flow to support aquatic life. Improved base flows should reduce the prevalence of stagnant water within the channel. Less stagnant water and more water movement will improve DO levels. Improved base flows will also lessen the impact of minor fish passage barriers like beaver dam remnants.
3. Improve physical connectivity by removing and retrofitting barriers to fish passage. F-IBI scores likely cannot be significantly improved without first improving connectivity and enabling fish passage.

4. Once there is enough water to support fish and fish have a clear path for migration to this reach, then measures will be needed to improve the quality of in-stream and riparian habitat along this reach. A compromise between the need for vegetative cover (shading, stream channel stability) and the need for drainage efficiency should be negotiated. Rock riffles, if deemed appropriate, could be mutual beneficial for grade stabilization along the ditch and aquatic habitat within the ditch. A two-stage ditch channel would be ideal for a channel like AUID 551, but that solution may not be practical. Improvements in the vegetation along the channel, or at least along the low-flow portion of the channel, should improve DO levels. Multiple rock riffle structures have been installed upstream of this reach. Improvements in base flows will increase the amount of water that is aerated as it flows over and through those riffles. Upstream reaches should be examined to locate opportunities for stream channel restoration and two-stage ditch projects. Although the reach is not impaired by TSS, reducing TSS concentrations will help maximize DO concentrations and reduce sedimentation. Gully and stream bank erosion has been documented in the watershed. Those erosion problems should be addressed.

There should be discussion about adjustments to the operation and maintenance plan of the Project 43B portion of Burnham Creek (09020303-551) that could improve in-channel habitat while meeting the hydrologic needs of the system. Research should be conducted for the identification of plant species that can improve aquatic habitat without significantly reducing conveyance capacity. The effect of willows upon flow rates should be researched. Scientifically determine whether improved vegetative cover within the channel will reduce the flood protection benefits of the channelized section of Burnham Creek.

**Kripple Creek (09020303-525 and 09020303-526)**

Improve the quality of habitat within Kripple Creek. Focus on areas upstream of the natural channel. Seek funding and landowner support for channel restoration projects on channelized portions. Because low-flow directly affects biological communities, can exacerbate fish passage problems, and can negatively affect DO concentrations, efforts to increase storage to improve base flows should be a priority in the Kripple Creek Subwatershed. Fifty-two percent of the watercourses in the Kripple Creek Subwatershed have been hydrologically altered (channelized, ditched, or impounded). Channel restoration projects can be implemented to improve the quality of aquatic habitat. There is a large wetland restoration at the headwaters of reach 526. Water levels could possibly be manipulated within that pool to provide storage and a minimal amount of base flow. There may be other opportunities for large wetland restoration and off-channel flood storage projects in the Kripple Creek Subwatershed. Explore the possibility of gravel mine reclamation for flood storage and wildlife habitat. Work closely with the Glacial Ridge National Wildlife Refuge to plan and facilitate these projects.

**Little Black River (09020303-528)**

Macroinvertebrate sampling is needed in order to assess the quality of water quality and habitat conditions in this reach. Fish populations are limited by the Baird-Beyer Dam, but aquatic macroinvertebrates would be influenced more by water quality conditions than fish passage. An M-IBI score would provide an indication of whether water quality and habitat are adequate for aquatic life, and if fish passage is the primary stressor that is keeping F-IBI scores low. Woody and deep-rooted vegetation could improve habitat quality along this reach. Restoration of the meandering channel of the upstream, AUID 09020303-527 reach of the Little Black River between CSAH 13 and Township Road 3 would be beneficial.

**Branch 5 of Pennington County Ditch 96 (AUID 09020303-545)**

The main channel of CD96 is in need of a grade stabilization project that alleviates the problem of the perched culvert at the Highway 32 crossing. In-channel habitat improvements could be evaluated and installed if they are compatible with drainage needs.

**Pennington County Ditch 43 (AUID 09020303-547)**

Improve in-stream habitat conditions within Pennington County Ditch 43. Implement storage projects to reduce peak flows during runoff events and to augment base flows later in the summer. Improve buffer widths and install side water inlets in the Pennington County Ditch 43 drainage area. As of the summer of 2019, the ditch downstream of CSAH 27 has no buffer, but the upstream portion has a recently established buffer. The ditch channel was well vegetated, but for the majority of the channel, there was no buffer beyond the top of the ditch bank. The Minnesota Buffer Law requires a 16.5-foot buffer beyond the top of the ditch bank. Reduce sediment and nutrient runoff, in general, throughout the CD43 Subwatershed.

**Heartsville Coulee (09020303-550)**

General sediment and nutrient reduction practices throughout the drainage area can help protect the ecology of the wetland environments along Heartsville Coulee. Only a large-scale channel restoration project would alleviate the low DO problems in the low-gradient portion of Heartsville Coulee. The costs of such a project should be weighed against the benefits of any work done to transform this intermittently flowing channel. In 2017, long-term monitoring was shifted to the reach between the diversion structure and the Red Lake River that was more of a free-flowing stream. High pollutant concentrations have been recorded at that new site (S014-946) and it seems to be affected by stormwater runoff from developments on the south side of East Grand Forks. The portion of Heartsville Coulee downstream of Bygland Road SE flows through the jurisdiction of the city of East Grand Forks that is subject to the requirements of the city's SWPP.

**Gentilly River (09020303-554)**

Improve buffer widths along the Gentilly River to comply with the Buffer Law. Improve the quality of vegetation along the channel where possible. Repair damage done to the channel by rudimentary agricultural stream crossings. Remove or retrofit obstructions to flow and fish passage along the Gentilly River.

**Cyr Creek (09020303-556)**

Notable streambank and upland erosion problems have been identified within this watershed. These erosion problems should be addressed in the protection strategies of the WRAPS. Significant gullies have been spotted in fields adjacent to the stream. There are obvious channel and streambank instability problems downstream of CR 110. Minnesota's recently adopted Buffer Law requires a 50-foot buffer along this reach. There are many segments of this reach along which the riparian buffer width was insufficient to meet that requirement at the time of the assessment. It is not known if buffers that meet the requirement of the buffer law exist along Cyr Creek currently.

**Black River (09020303-558)**

In addition to previously mentioned goals, reduce sediment and nutrient runoff from upland sources. Implement grazing management to improve vegetative cover along the banks of the river. Assess sedimentation with this reach and the next reach upstream. Improve base flows and moderate peak flows through storage projects and wetland restorations.

### 8.2.6 Grazing Management

SWCDs and Counties, with assistance from state agencies, will work to implement projects that limit or exclude the access of livestock to waterways. They will strive to ensure that all feedlots are up to date and comply with regulations. For feedlots that do not meet the regulations, they will work with the landowner to get into compliance.

This strategy will be implemented watershed-wide, but extra attention is required for the impaired and potentially impaired reaches of Pennington CD96 (505), Kripple Creek (525), Little Black River, Black River (529 and 558), Gentilly River (554), and Cyr Creek (556). This effort is needed to delist existing impairments and to ensure that unimpaired waters continue to meet standards.

### 8.2.7 Septic System Compliance

SWCDs will conduct septic system inventories to identify non-compliant septic systems. Out-of-compliance systems shall be brought into compliance in a timely manner. County ordinances should be updated to include point-of-sale septic inspections. Local agencies will also help homeowners get low interest loans or Clean Waer Partnership 0% interest loans for septic system updates. Failing systems have been identified in rural portions of the watershed. The Pennington County SWCD's inspection of the Chief's Coulee drainage area can be used as a model for future efforts that target an area where failing septic systems are suspected (Black River and Kripple Creek).

## 8.3 Cost

Restoration options for rivers are numerous with varying rates of success. Consequently, each strategy must be evaluated in light of our current understanding of physical and biological processes in the river or stream. It is difficult to precisely predict costs during the planning of a specific project. There is even more guesswork involved in creating an estimate for a large group of yet-to-be-funded projects.

The required cost estimate for the implementation of this TMDL is based upon a period of 10 years of work, estimated pollutant reductions achieved by previous projects, and the rate at which projects can realistically be completed by local staff. Cost estimates for applicable, pertinent practices in the Red Lake River 1W1P were tallied for each pertinent planning area (those that encompassed impaired waters). Total costs for each practice are listed in Table 8-1. This estimate will be refined as implementation plans and projects are developed. The actual number of years needed to accomplish the goal of restoring these waterways will vary based upon the amount of funding that is successfully acquired for projects, the amount of available staff time, and the amount of cooperation among agencies and stakeholders.

Table 8-1. Cost estimation table.

| Summary of Cost Estimates from the Red Lake River One Watershed One Plan that are Relevant to Impaired Reaches in the Red Lake River Watershed | | |
|---|---|---|
| **Strategy** | **Practice** | **Total Cost Estimate** |
| Protection | Channel Bed and Stream Channel Stabilization | $ 1,275,630 |
| | Critical Area Planting | $ 240,412 |
| | Grade Stabilization Structure | $ 2,886,742 |
| | Streambank, Shoreland, and Roadside Protection | $ 7,469,917 |
| | Tree/Shrub Establishment | $ 52,053 |
| | Septic System Upgrades | $ 240,000 |
| | Restoration & Management of Rare/Declining Habitat | $ 1,037,260 |
| | Gravel Pit Reclamation | $ 28,680 |
| Source Reduction | Residue and Tillage Management | $ 331,160 |
| | Nutrient Management | $ 10,452 |
| | Rotational and Prescribed Grazing | $ 2,259,767 |
| | Conservation Cover | $ 5,511,369 |
| | Cover Crop | $ 102,846 |
| | Filter Strips | $ 108,640 |
| | Precision Ag Practices | $ 12,000 |
| Storage | Drainage Water Management (Tile) | $ 839,870 |
| | Stormwater Management | $ 1,500,000 |
| | Raingardens | $ 105,000 |
| | Wetland restoration | $ 3,404,325 |
| | Wastewater and Feedlot Runoff Control | $ 8,000 |
| | Water Control Structures | $ 108,000 |
| | Water and Sediment Control Basins | $ 91,250 |
| | Ag Waste Storage | $ 3,000 |
| | Diversion | $ 110,200 |
| | Milkhouse Waste Storage Treatment | $ 1,000 |
| | FDR Impoundment | $ 5,000,000 |
| Filtration | Conservation Cover | $ 6,042,663 |
| | Cover Crop | $ 728,492 |
| | Filter Strips | $ 440,352 |
| | Grassed Waterway | $ 1,179,192 |
| | Riparian Buffers | $ 252,498 |
| | Field Borders | $ 31,490 |
| **Infiltration** | Multi-Stage Ditch | $ 1,868,310 |
| Non-Structural | Wind Erosion Prediction System (WEPS) Plan | $ 60,000 |
| | Reach Assessment Classification | $ 60,000 |
| | Delineate 10-Yr Non-Contributing Areas Develp a Runoff Detention Plan | $ 210,010 |
| | Urban BMP Retrofit Assessment and Plan | $ 90,000 |
| | Conduct a County Drainage Ditch Inventory | $ 130,000 |
| | Revised AIS Plan | $ 40,000 |
| | Fish Passage Field Assessment and Implemtation | $ 60,000 |
| | Update Education and Outreach Program | $ 15,000 |
| | Public Waters Buffers under MN Buffer Law | $ 200,000 |
| | Public Drainage Ditch Buffers under MN Buffer Law | $ 200,000 |
| | Long-Term Water Quality Monitoring Program | $ 250,000 |
| | RLWD Support for the River Watch Program | $ 460,000 |
| | Stage and Flow Monitoring | $ 63,000 |
| | Continuous Dissolved Oxygen Monitoring | $ 128,000 |
| | Erosion Site Inventories, Updates, and Sharing of Information | $ 32,000 |
| | Assist the MNDNR with Geomorphological Assessments | $ 19,000 |
| | Aerial Data Collection (UAS) to Measure Channel Stability and Erosion Rates along River Channels and Ditch Systems | $ 1,000,000 |
| | ID New Feedlots and Ag Waste Systems | $ 20,000 |
| | Conduct a Culvert Inventory (Size and Fish Passage) | $ 180,000 |
| | Inventory of Legal Ditch Outlets for Stabilization Projects | $ 150,000 |
| | Update Existing Inventories with New Information | $ 30,000 |
| | **Grand Total** | **$ 46,677,580** |
| Red Lake River 1W1P cost estimates for management areas with impaired waters and management areas that contribute directly to impaired waters were used to generate the total costs for each practice. Only practices that may contribute to restoration of downstream impairments were used. Mangement areas that were a part of this summary include: L3, L4, L5, L6, L7, M3, M4, M5, M7, M8, M9, M10/M11, and U4. | | |

## 8.4 Adaptive Management

The implementation goals for restoration efforts that have been proposed in Section 8 of this report are also detailed in the Red Lake River WRAPS report, along with strategies for protecting unimpaired waters. Although a tremendous amount of effort was invested in the development of the strategies of the TMDL and WRAPS, additional project ideas and opportunities may arise as knowledge continues to be gained about the watershed. Continued monitoring and "course corrections" (Figure 8-7) responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired water bodies.

The watershed will be formally assessed again in 2024. Interim assessment calculations can be performed by LGU staff to track progress toward restoration goals. Impaired reaches that attain compliance with water quality standards can be recommended for delisting. New impairments discovered by expanded monitoring efforts may be added to the 2026 List of Impaired Waters and will need to be addressed by a TMDL. Interim assessment calculation by LGUs can identify these impairments early and, ideally, projects can be implemented to restore waters before TMDLs are necessary.

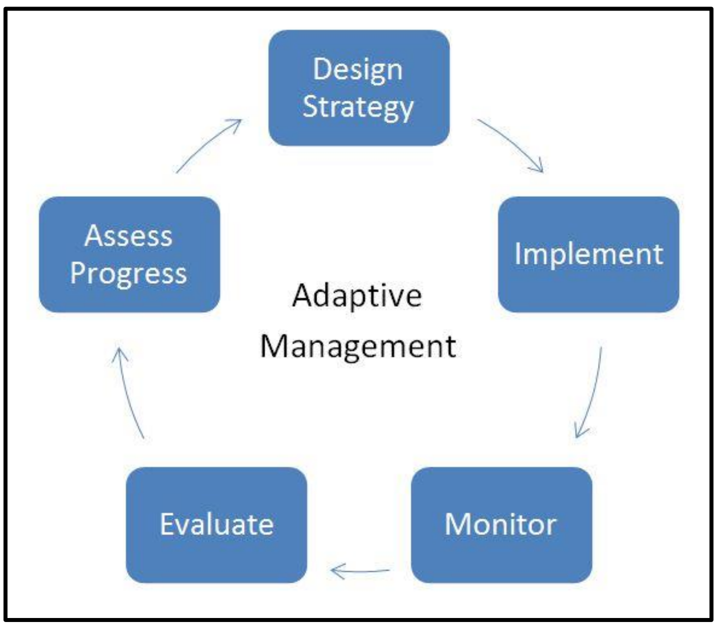


Figure 8-7. Adaptive Management diagram.

# 9. Public Participation


**Figure 9-1. Photos from civic engagement events.**

RMB Environmental Laboratories, Inc. was hired to help with the civic engagement aspect of the Red Lake River WRAPS. At the onset of the Red Lake River WRAPS project in 2011, a list of potential stakeholders was compiled. RMB staff researched potential collaborations in order to assess the community's capacity for watershed planning and mapped social networks. RMB and RLWD staff created a tabletop display with laminated posters that were used during public events for the Red Lake River WRAPS.

Multiple forms of digital communication were explored as ways to expand the audience and interest in water quality issues in the Red Lake River. A blog was established for the Red Lake River Watershed: https://redlakeriver.wordpress.com/. A Facebook page was created for the RLWD.

The RLWD, with help from Emmons and Olivier Resources, Inc., has launched a new set of web pages to make it easier for anyone to learn more about a watershed. Each of the five major watersheds within the RLWD District will have has its own set of pages with general information, links to reports, a photo gallery, Watershed Restoration and Protection project information, maps, and contacts. Organizing information by watershed should make it easier for people to find information that is pertinent to the area in which they live/farm/hunt/fish. Follow this link to begin exploring your watershed: http://www.rlwdwatersheds.org/.

RLWD staff created a Flickr account for sharing georeferenced photos of erosion problems and georeferenced scenic photos. Other local government staff can use this as a tool for finding areas where erosion control projects can be implemented. A map-based search for photos can be conducted at this site: https://www.flickr.com/map. The RLWD photos can be found at this site: https://www.flickr.com/photos/131072259@N04/.

A "Come grill us about your watershed" event (Figure 9-1) was held at the Downtown Central Square in Crookston on September 24, 2012. Flyers and postcards were created to promote the event. Fact sheets about the Red Lake River were created for display at the Crookston event and future events. Articles were written in the Crookston Times and the Grand Forks Herald about the event. The event was advertised in local newspapers. Free will donations were accepted for the Crookston Natural Play Space. Two people involved with that project helped serve food. RLWD and DNR staff were interviewed on the Crookston radio station KROX 1260 AM about the Red Lake River and the upcoming event. Attendees filled out surveys. Brats and hot dogs from B&E Meats, pickles, chips, and cupcakes from Simplee Cupcakes were served. The DNR and MPCA staff also helped with the event – particularly with the surveys. Stephanie Klamm of the DNR also brought an informational display. The weather (very windy) and attendance were not ideal, but those that did attend enjoyed the event. Staff were able to have conversations with most of the attendees.

Two public stakeholders' update meetings were held in April 2013. A meeting was held in Grand Forks for people that live and/or work in the lower part of the Red Lake River Watershed. People who live and/or work in the upper part of the watershed were able to go to a meeting in Thief River Falls. Presentations from the meetings are available on the Red Lake River blog at http://redlakeriver.wordpress.com/.

Brochures were printed and mailed to approximately 10,000 residents of townships along the Red Lake River to provide information about the WRAPS study and promote the April 2013 public meetings. Brochures began arriving at people's homes in late March.

The RLWD set up a booth at the Thief River Falls Community Expo at the Ralph Engelstad Arena on April 25, 2013, in Thief River Falls (Figure 9-1). Display boards were set up with information about the WRAP projects and other RLWD projects.

A draft Red Lake River Watershed Public Participation Strategy document was completed by RMB Environmental Laboratories for the RLWD.

RMB Environmental Laboratories, RLWD, and the MPCA staff created short videos to help local citizens understand DO, turbidity, and *E. coli* bacteria. Combined, the videos have accumulated over 8,200 views on YouTube as of June 4, 2018.

- DO: http://youtu.be/qUq7jFdVo3g
- Turbidity: http://youtu.be/EkH3jZvADTk
- *E. coli* bacteria: http://youtu.be/vkYUiJXyqLI

TAC meetings were held to seek input on the direction of the project.

- December 15, 2011
- August 27, 2014

A newsletter was composed and distributed near the end of the WRAPS project. It contained information about the locations of impairments, sources of pollution, and stressors of aquatic biology.

The RLWD and other LGUs need to continue conducting the public outreach efforts that were initiated during the WRAPS process. Monthly water quality reports will be made available to the public on the RLWD website and their availability will be announced through Facebook posts, blog posts, and direct email. LGUs may continue to host open house style events that will facilitate one-on-one discussions with residents and other stakeholders. Booths at county fairs and community events (Thief River Falls Expo) are another way to connect with the public.

Measurable goals for future civic engagement efforts in the Red Lake River Watershed include:

1. Increase volunteer participation in natural resource monitoring.

2. Increase the number of watershed residents participating in water quality discussions.
3. Find effective ways to engage citizens in a meaningful way.
4. Increase the resources utilized to communicate water quality activities within the watershed.
5. Create a document with contact information for local resources, specific to certain water quality concerns or funding sources.

The RLWD Water Quality Coordinator writes monthly water quality reports that originated as reports to the RLWD Board of Managers and represent a means of documenting project progress throughout the year (making annual report writing easier). The reports are available on the RLWD website (www.redlakewatershed.org), shared on social media, and shared with a large list of email contacts.

The public can be kept informed of water related news, water quality problems, solutions to water issues, and opportunities for involvement in water-related programs through several different means.

- Websites of LGUs
    - RLWD
        - www.redlakewatershed.org
        - www.rlwdwatersheds.org
    - Pennington County SWCD
        - http://www.penningtonswcd.org/
    - Red Lake County SWCD
        - http://redlakecountyswcd.org/index.html
    - West Polk County SWCD
        - http://westpolkswcd.org/index.html
    - MPCA
        - http://www.pca.state.mn.us/
        - https://www.pca.state.mn.us/water/watersheds/red-lake-river
- Mailings to individual landowners
- Radio interviews
- Informational brochures and displays
- Press releases and advertisements with local media contacts
- SWCD newsletters
- Organization of events to bring attention to the resource
- Presentations for local civic groups

Local government can gain insight on water issues by consulting the public. The public can provide useful feedback on analysis, alternatives, and/or decisions. Working directly with the public throughout the process helps ensure that public concerns and aspirations are consistently understood and considered.

- Public meetings
- Red Lake River blog: https://redlakeriver.wordpress.com/
- Social Media
  - RLWD Facebook page
  - West Polk SWCD Facebook page
- Public Comment period on final draft reports
- Open houses
- World Café discussions

Public participation efforts are based on the principle that if the solutions in the WRAPS report are developed with input from local land managers, the likelihood of implementation will increase. In addition, implementation activities will be streamlined due to the collaboration between landowners, local agencies, and funding sources.

### Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from July 14, 2019, through August 14, 2019. There were two comment letters received and responded to as a result of the public comment period.

# 10. Literature Cited


Aadland, L.P., T.M. Koel, W.G. Franzin, K.W. Stewart, and P. Nelson. 2005. Changes in fish assemblage structure of the Red River of the North. American Fisheries Society Symposium 45:293-321. City of East Grand Forks. Storm Water Pollution Prevention Plan (SWPP). January 2007.

Anderson, Charles, Al Kean. Red River Basin Flood Damage Reduction Framework, Red River Basin Flood Damage Reduction Work Group Technical and Scientific Advisory Committee Technical Paper No. 11. May 2004. Retrieved from http://docplayer.net/1243911-Red-river-basin-flood-damage-reduction-framework.html.

Coon Creek Watershed District. Coon Creek Watershed District Total Maximum Daily Load (TMDL), Mississippi River – Twin Cities Major Watershed. April 2016. Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-iw8-44e.pdf.

DeJong-Hughes, Jodi, Phil Glogoza. Rolling Soybeans: The Good, the Bad, and the Injured. May 2, 2016. Retrieved from: http://blog-crop-news.extension.umn.edu/2016/05/rolling-soybeans-good-bad-and-injured.html.

Groshens, Tom. Red River Basin Stream Survey Report, Red Lake River Watershed 2004. 2005. Retrieved from http://www.redlakewatershed.org/waterquality/Red%20Lake%20River%20Watershed%202004%20Stream%20Survey%20Report.pdf.

Gunnison, Douglas. Microbial Processes in Reservoirs. Dordrecht, Boston, Lancaster. 1985. DR W. Junk Publishers. Retrieved from https://books.google.com.

HDR Engineering. Red Lake Watershed Distributed Detention Strategy. November 21, 2013.

HDR Engineering. Red Lake River One Watershed One Plan (Draft). August 16, 2016. Retrieved from http://westpolkswcd.com/uploads/3/4/8/5/34855804/red_lake_river_1w1p_draft_aug_2016.pdf.

Houston Engineering, Inc. Thief River Falls Water Quality Study. December 18, 2017.

Klemm, D.J., K.A. Blocksom, J.J. Hutchens, F.A. Fulk, W.T. Thoeny, and E.S. Grimmett. 2002. Comparison of Benthic Macroinvertebrate Assemblages from Intermittent and Perennial Streams in the Mid-Atlantic Region. Presented at North American Benthological Society, Pittsburgh, PA, May 28-June 1, 2002.

MacGregor, Molly. Red River Basin Turbidity Impairment Project. January 2006.

Minnesota Department of Natural Resources. Natural Vegetation of Minnesota at the Time of Public Survey, 1847-1907. December 1988. Retrieved from http://files.dnr.state.mn.us/eco/mcbs/natural_vegetation_of_mn.pdf.

Minnesota Pollution Control Agency. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, wq-iw1-04i. July 2016. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04i.pdf.

Minnesota Pollution Control Agency. Municipal Stormwater (MS4) website. https://www.pca.state.mn.us/water/municipal-stormwater-ms4.

Minnesota Pollution Control Agency. Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria. December 2013 (Revised March 2016). https://www.pca.state.mn.us/sites/default/files/wq-s6-18.pdf.

Minnesota Pollution Control Agency. Zumbro River Watershed Total Maximum Daily Load Report. November 2017. https://www.pca.state.mn.us/sites/default/files/wq-iw7-45e.pdf

Paakh, Bruce, Wayne Goeken, Danni Halvorson. State of the Red River of the North, Assessment of the 2003 and 2004 Water Quality Data for the Red River and its Major Minnesota Tributaries. April 2006. Retrieved from https://www.pca.state.mn.us/sites/default/files/redriverreport2006.pdf.

Poff, N.L., and J.K. Zimmerman. 2010. Ecological responses to altered flow regimes: a literature review to inform the science and management of environmental flows. Freshwater Biology 55:194-205.

Red Lake Watershed District. 2015 Annual Report. 2015. Retrieved from http://www.redlakewatershed.org/Annual%20Reports/2015%20Annual%20Report.pdf.

Sanderson, Loren. Dam Maintenance – History and Priority, Presentation to the RLWD Board of Managers. 12/31/2015.

Sharp, Michael, Minnesota Pollution Control Agency. Red Lake River Watershed Stressor Identification Report. September 2015. https://www.pca.state.mn.us/sites/default/files/wq-ws5-09020303a.pdf.

United States Department of Agriculture – Soil Conservation Service. Operation and Maintenance Agreement for Burnham Creek Watershed, Main-1 and CD 15. 1988.

United States Environmental Protection Agency. *Development of Index of Biotic Integrity Expectations for the Lake Agassiz Plain Ecoregion*. September 1998.

Unknown. A Red Lake Project History (1909-2002). Retrieved from http://www.redlakewatershed.org/planupdate/HistoryRedLakeProject.pdf.