Little Fork River Watershed Sediment Reduction Project (Total Maximum Daily Load)

The amount of sediment reduction from the land and stream beds that is needed to reduce the concentrations of sediment in area streams.

MINNESOTA POLLUTION CONTROL AGENCY

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Authors and contributors:

Emmons & Olivier Resources, Inc.

Meghan Funke, PhD

Paula Kalinosky

Jason Naber

Jason Ulrich

Minnesota Pollution Control Agency

Mike Kennedy

Nolan Baratono

Jesse Anderson

Greg Johnson

Itasca County Soil and Water Conservation District

Kim Slanga

Koochiching County Soil and Water Conservation District

Eric Olson

Jolén Simon

North St. Louis County Soil and Water Conservation District

Sam Soderberg (under contract from Koochiching County SWCD)

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Acronyms

AUID	Assessment Unit ID
BMP	best management practice
DNR	Minnesota Department of Natural Resources
EPA	United States Environmental Protection Agency
HUC	Hydrologic Unit Code
HSPF	Hydrologic Simulation Program-Fortran
Kg	kilogram
Kg/yr	kilogram per year
LA	Load Allocation
LDC	Load Duration Curve
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
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total Suspended Solids
USGS	United States Geologic Survey
WLA	Wasteload Allocation
WWTF	Wastewater Treatment Facilities
WRAPS	Watershed Restoration and Protection Strategies

Executive Summary

This report addresses four stream segments in the Little Fork River Watershed that are impaired due to excess sedimentation (turbidity). Excess sedimentation affects waterbodies' ability to sustain a healthy aquatic eco-system.

The federal Clean Water Act (CWA) requires a process to identify, analyze, and correct water problems. This is called a Total Maximum Daily Load (TMDL) study. The TMDL identifies the pollutant that is causing the problem and establishes the maximum amount of the pollutant an impaired waterbody can receive on a daily basis and still meet water quality standards. The TMDL also identifies the sources of the pollutant and methods and practices that can be undertaken to alleviate the problem.

A holistic approach was taken to monitor and assess the surface water bodies (i.e., streams, lakes) in the Little Fork River Watershed to determine if they meet water quality standards for aquatic life use, recreation use, and consumption use.

Fifty-four locations were sampled for biology at the outlets of subwatersheds of varying sizes in the Little Fork River Watershed. Forty-three stream segments in the watershed (Assessment Unit Identifier (AUIDs)) were assessed for aquatic life use. Thirty-seven of the forty-three stream segments fully support aquatic life use. The remaining six segments did not support aquatic life use and were determined to be impaired. In five of these impaired segments, the cause was determined to be excess turbidity (or sediment) in the water. In the sixth segment, the impairment was determined due to a poor fish community. Of the six impaired segments, two are being deferred at this time and will be addressed during Cycle 2 of the Watershed Restoration and Protection Strategies (WRAPS) process in the Little Fork River Watershed, starting in 2018. One of the deferred segments (AUID 09030005-502, the Little Fork River from Lost Lake to Rice River) is impaired for aquatic life use by turbidity (or sediment). There was conflicting data from the four biological monitoring stations along this stretch of river and it was determined, by the local partners, that this segment should be studied further. The other deferred segment (AUID 09030005-517, the Rice River from Johnson Creek to the Little Fork River) is impaired for aquatic life use due to a poor fish community. Of the three biological stations in this segment, one of the stations (station number 05RN010) had conflicting information. Local partners decided to develop a comprehensive monitoring plan for further investigation.

In this report, the following sediment sources are evaluated for each impaired stream: watershed runoff, loading from upstream waterbodies and tributaries, channel erosion, near bank erosion, streambed erosion, and point sources. An inventory of pollutant sources was used to develop a load duration curve (LDC) model for each impaired stream. This model was then used to determine the sediment reductions needed for the impaired streams to meet water quality standards.

Sediment reduction best management practices (BMPs) can be deployed in many places throughout the watershed to begin to make reductions in the overall numbers. These reduction projects must achieve large percentages of reductions in order to meet the total suspended solids (TSS) standard for rivers in the Northern Lakes and Forest eco-region, 15 mg/L. Due to the geology and soils of the watershed, it is understood that these reductions will be very difficult.

The findings from this TMDL study were used to aid the selection of implementation activities as part of the Little Fork River WRAPS process. The purpose of the WRAPS report is to support local working groups and jointly develop scientifically supported restoration and protection strategies to be used for subsequent local implementation planning. The WRAPS report is publically available on the MPCA Little Fork River Watershed website: https://www.pca.state.mn.us/water/watersheds/little-fork-river.

1. Project Overview

1.1 Purpose

This TMDL study addresses aquatic life use impairments due to turbidity (TSS) in four reaches of the Little Fork River in northern Minnesota (Table 1). The goal of this TMDL is to provide wasteload allocations (WLAs) and load allocations (LAs) and to quantify the pollutant reductions needed to meet the state water quality standards. These TMDLs are being established in accordance with section 303(d) of the Clean Water Act, because the State of Minnesota has determined that these streams exceed the state established standards.

1.2 Identification of Waterbodies

Six stream reaches within the Little Fork River Watershed (HUC 09030005) are on the 2016, 303(d) list of impaired waters for aquatic life use impairment due to turbidity/TSS or due to below-threshold fish bioassessment (Table 1, Figure 1).

Bracketed by impaired waters, 10.2 river miles of the Little Fork River main stem (48.00455N, -93.24391W to 48.06964N, -93.34333W, Prairie Creek to Nett Lake River), are waters of the Bois Forte Band of Chippewa and, therefore, are not assessed in this report.

In five of these impaired segments, the cause was determined to be excess turbidity (or sediment) in the water. In the sixth segment, the impairment was due to a poor fish community. Of the six impaired segments, two are being deferred at this time due to the need for more data to better determine their condition, and will be addressed during Cycle 2 of the WRAPS process in the Little Fork River Watershed, starting in 2018. One of the deferred segments (AUID 09030005-502, the Little Fork River from Lost Lake to Rice River) is impaired for aquatic life use by turbidity (or sediment). There was conflicting data from the four biological monitoring stations along this stretch of river, and it was determined, by the local partners that this segment should be studied further. The other deferred segment (AUID 09030005-517, the Rice River from Johnson Creek to the Little Fork River) is impaired for aquatic life use due to a poor fish community. Of the three biological stations in this segment, one of the stations (station number 05RN010) had conflicting information. Local partners decided to develop a comprehensive monitoring plan for further investigation.

Table 1. Little Fork River Watershed impaired streams

AUID	Name	Location/Reach Description	Designated Use Class	Listing Year	Target Start/ Completion	Affected Use: Pollutant/Stressor
09030005-502	Little Fork River	Headwaters to Rice River	2B	2010	No action at this time[§]	*Aquatic Life*: Turbidity (TSS)
09030005-506	Little Fork River	Willow River to Valley River	2B	2010	2012/2015	
09030005-508	Little Fork River	Prairie Creek to Nett Lake River	2B	2010	2012/2015	
09030005-510	Little Fork River	Cross River to Beaver Brook	2B	2008	2012/2015	
09030005-501	Little Fork River	Beaver Brook to Rainy River	2B	2006	2012/2015	
09030005-517	Rice River	Johnson Creek to Little Fork River	2B	2011	No action at this time[§]	*Aquatic Life*: Fish bioassessment

[§] Additional study recommended for this reach

Table 2. Little Fork River Watershed impaired streams addressed in the Minnesota Statewide Mercury TMDL

AUID 09030005-XXX	Name/Description	AUID 09030005-XXX	Name/Description
501	Little Fork River, Beaver Creek to Rainy River	**508**	Little Fork River, Prairie Creek to Nett River
502	Little Fork River, Headwaters to Rice River	**509**	Little Fork River, Nett Lake River to Cross River
503	Little Fork River, Rice River to Beaver Creek	**510**	Little Fork River, Cross River to Beaver Brook
504	Little Fork River, Beaver Creek to Sturgeon River	**514**	Sturgeon River, Bear River to Little Fork River
505	Little Fork River, Sturgeon River to Willow River	**523**	Sturgeon River, East Branch Sturgeon River to Dark River
506	Little Fork River, Willow River to Valley River	**524**	Sturgeon River, Dark River to Bear River
507	Little Fork River, Valley River to Prairie Creek	**527**	Sturgeon River, Headwaters to East Branch Sturgeon River

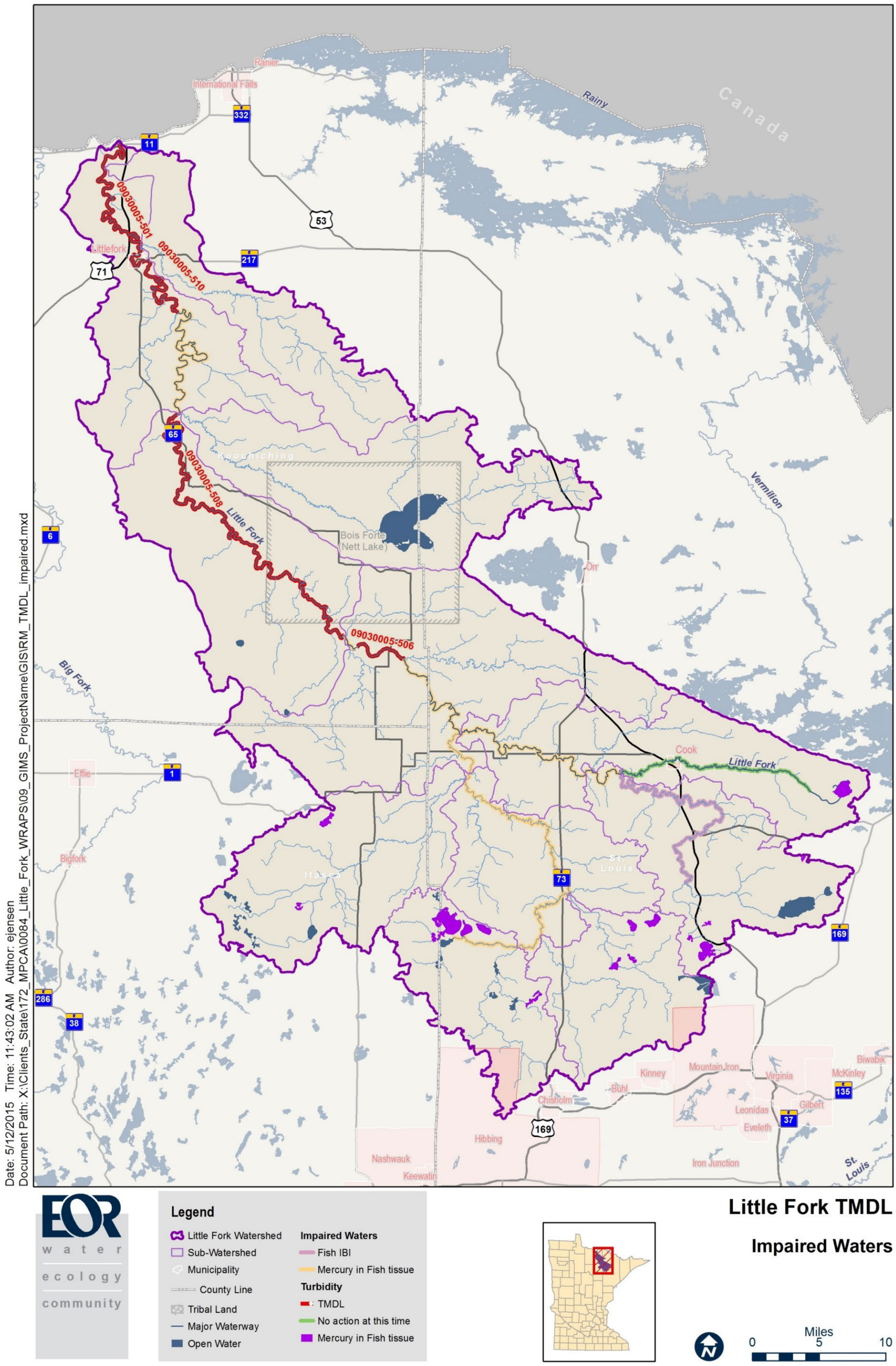

Figure 1. Little Fork River Watershed impaired streams

1.3 Priority Ranking

The MPCA's schedule for TMDL completions, as indicated on the 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL. The MPCA has aligned our TMDL priorities with the watershed approach and our 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 the 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 four impaired river segments in this TMDL are part of the MPCA prioritization plan to meet the EPA's national measure.

2. Applicable Water Quality Standards and Numeric Water Quality Targets

2.1 Designated Use

Each stream reach has a Designated Use Classification defined by the MPCA, which defines the optimal purpose for that waterbody (see Table 1). The streams addressed by this TMDL fall into one of the following three designated use classifications:

1B, 2A, 3B – drinking water use after approved disinfectant; a healthy coldwater aquatic community; non-food industrial use with moderate treatment

2B, 3C – a healthy warm water aquatic community; industrial cooling and materials transport without a high level of treatment

2C – a healthy indigenous fish community

Class 1 waters are protected for aquatic consumption, Class 2 waters are protected for aquatic life and aquatic recreation, and Class 3 waters are protected for industrial consumption as defined by Minn. R. ch. 7050.0140. The most protective of these classes is 1B, however water bodies are not currently being assessed by the MPCA for the beneficial use of domestic consumption; therefore water quality standards for the Class 1B waters are not presented here. The next most protective of these classes is 2A and 2B, for which water quality standards are provided below.

2.2 Stream Turbidity/Total Suspended Solids (TSS)

Turbidity is a measure of reduced transparency due to suspended particles in the water such as sediment, algae, and organic matter. The former Minnesota turbidity standard was 25 Nephelometric Turbidity Unit (NTU) for class 2B waters (see the Section 2 introduction for a definition of the designated use classes). Streams in the Little Fork River Watershed were assessed against the Class 2B turbidity standard first established in 1967 (25 NTU). A minimum of 20 independent observations were required for the turbidity assessment, and a stream was listed as impaired for turbidity if 10% or more of the observations were in violation of the turbidity standard. Previous studies of turbidity in the Little Fork River have determined that high turbidity is due predominantly to suspended sediment (Anderson et al. 2006, Gran et al. 2007, Ellison et al. 2013).

The state of Minnesota, in 2014, amended state water quality standards and replaced stream water quality standards for turbidity with standards for TSS. One component of the rationale for this change is that the turbidity unit (NTUs) previously used is not concentration-based and therefore not well-suited to load-based studies (Markus 2011; http://www.pca.state.mn.us/index.php/view-document.html?gid=14922). The new TSS criteria are stratified by geographic region and stream class due to differences in natural background conditions resulting from the varied geology of the state and biological sensitivity. The assessment period for these samples is April through September; any TSS data collected outside of this period was not considered for assessment purposes. The TSS standard for all class 2B streams in the North River Nutrient Region is 15 mg/L. For assessment, this concentration is not to be exceeded in more than 10% of samples within a 10-year period. TSS results are available for the watershed from state-certified laboratories, and the existing data covers a large spatial and temporal scale in the watershed. TSS LDCs and TMDLs were developed for the four stream segments outlined in Section 1.2.

For more information, refer to the Aquatic Life Water Quality Standards Draft Technical Support Document for TSS (Turbidity), http://www.pca.state.mn.us/index.php/view-document.html?gid=14922, and the Minnesota Nutrient Criteria Development for Rivers Report, https://www.pca.state.mn.us/sites/default/files/wq-s6-08.pdf.

3. Watershed and Waterbody Characterization

The Little Fork River Watershed drains approximately 1,872 square miles (1,298,296 acres) in portions of Koochiching, St. Louis, and Itasca Counties. The Little Fork River begins in the north-central portion of St. Louis County near the town of Cook and flows generally north and west approximately 160 miles to its confluence with the Rainy River, 11 miles west of International Falls. Portions of the watershed lie within both the Northern Lakes and Forest and the Northern Minnesota Wetlands ecoregions. The watershed is sparsely populated and is commonly referred to as remote and wild.

Prior to intensive logging, beginning in the 1890s, the Little Fork River Watershed was densely covered with vast stands of mixed conifers and hardwoods. During the time of logging, the Little Fork River served as an important means of transporting the harvested timber downstream to the Rainy River. Today, the primary economic activities within the watershed are logging of second-growth timber and tourism. See the 2006 MPCA Report: *Effects of Historical Logging on Geomorphology, Hydrology, and Water Quality in the Little Fork River Watershed* for more information.

Bois Forte Band of Chippewa tribal lands are located within the Little Fork River Watershed, including portions of the Nett Lake River Subwatershed and portions of the subwatersheds of two impaired reaches of the Little Fork River: Prairie Creek to Nett Lake River (-508) and Willow River to Valley River (-506; Figure 1). A significant portion of the Nett Lake River Subwatershed (45%) and of the entire Little Fork River Watershed (4%) is tribal land.

3.1 Streams

The direct drainage area and total watershed area of each impaired stream reach are summarized in Table 3. Direct drainage and total watershed areas were delineated from United States Geologic Survey (USGS) Hydrologic Unit Code (HUC) 10 watershed boundaries and USGS StreamStats (http://water.usgs.gov/osw/streamstats/). The direct drainage area is the portion of the HUC 10 watershed containing the impaired reach that is located down stream of any upstream impaired reach also contained within the HUC 10 boundary. The total watershed area includes the entire area that drains to the impaired reach, including upstream impaired reach watersheds.

Table 3. Impaired stream reach direct drainage and total watershed areas

AUID 09020306-XXX	Impaired Reach Description	Direct Drainage Area (ac)	Total Drainage Area (ac)
-506	Willow River to Valley River	27,038	652,800
-508	Prairie Creek to Nett Lake River	168,528	870,400
-510	Cross River to Beaver Brook	85,021	1,094,400
-501	Beaver Brook to Rainy River	28,138	1,298,296

3.2 Subwatersheds

The individual impaired stream subwatersheds are illustrated in Figure 2 below.

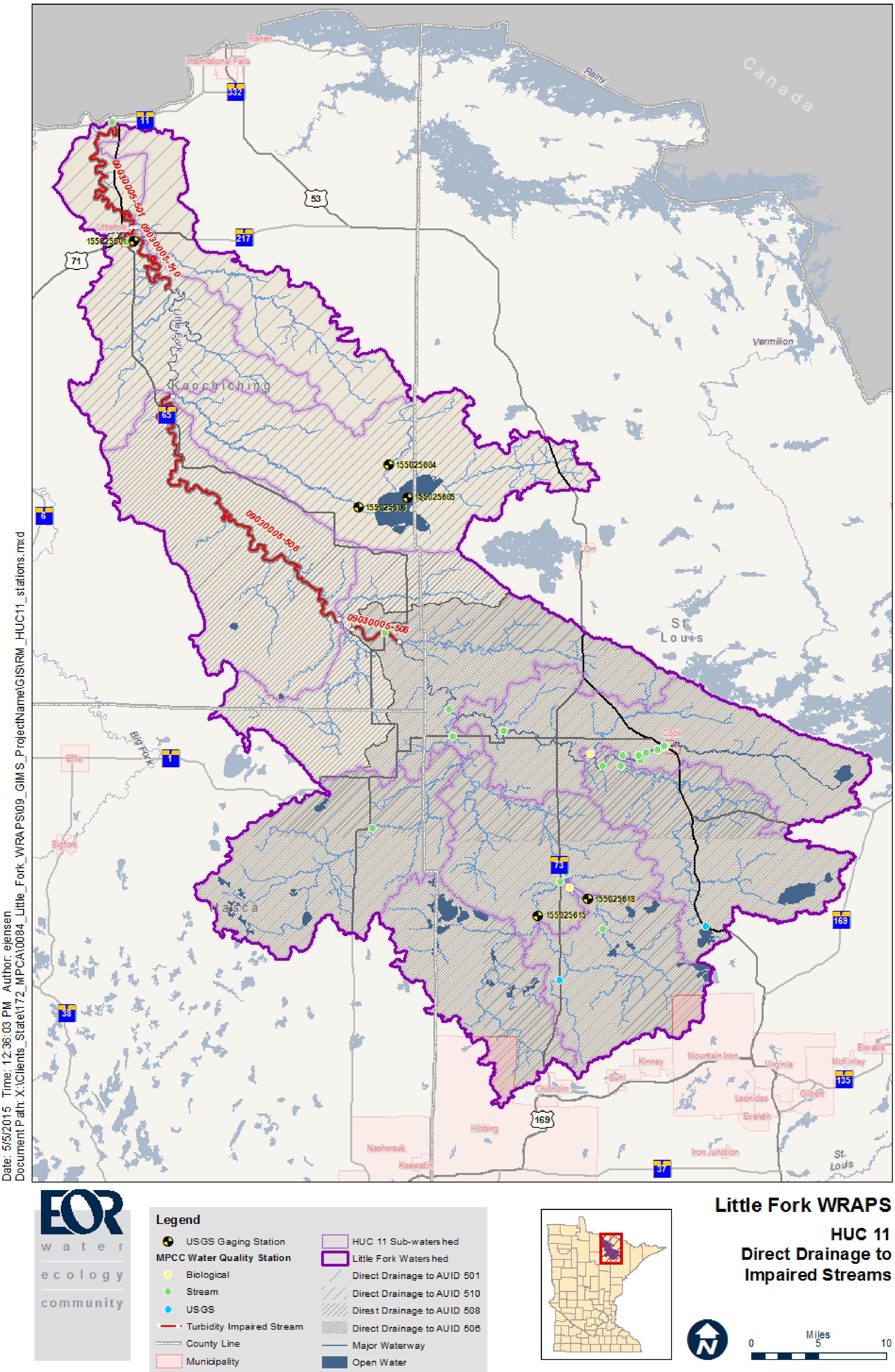

Figure 2. Impaired stream reach subwatersheds in the Little Fork River Watershed

3.3 Land Use

Land cover in the Little Fork River Watershed was assessed using the Multi-Resolution Land Characteristics Consortium 2011 National Land Cover Dataset (NLCD) (http://www.mrlc.gov/nlcd2006.php). This information is necessary to draw conclusions about pollutant sources and BMPs that may be applicable within each subwatershed. The land cover distribution within impaired stream watersheds is summarized in Table 4 and shown in Figure 3. This data was simplified to reduce the overall number of categories. Developed includes developed open space, and low, medium and high density developed areas. Undeveloped includes evergreen forests, deciduous forests, mixed forests, and shrub/scrub. Cropland includes all annually planted row crops (corn, soybeans, wheat, oats, barley, etc.), and fallow crop fields. Grassland includes native grass stands, alfalfa, clover, long term hay, and pasture. Open Water/Wetland includes wetlands and marshes as well as all lakes and rivers.

Primary land covers within the Little Fork River Watershed are wetland (46.5%) and forest (45.8%). Areas of direct drainage for impaired stream reaches have land cover distributions very similar to the Little Fork River Watershed as a whole (Table 4, Figure 3). The watershed is classified into three major Common Resource Areas (CRA): Northern Minnesota Till Moraine, Northern Minnesota Glacial Lake Basins, and Superior Upland Bedrock Till Complex (NRCS 2007). All three CRAs are highly erodible types composed of loamy, clayey, and silty soil structures.

It is important to consider the post-glacial history of the Little Fork River Valley when assessing the sediment loading dynamics seen in the Little Fork River system today. Heavy clay deposits can be found along much of the mainstem channel below more recent fluvial sediments. These clay deposits are the legacy of Glacial Lake Agassiz, which covered much of the Little Fork River Watershed during the post-glacial period. Glacial lake clays, which lie under more recent fluvial sediments, can affect slope and bank stability. Infiltrating groundwater may pool on the surface of low permeability clays creating a failure plane. This mechanism for generating bank and slope failures has been recognized in other parts of the Glacial Lake Agassiz basin (Gran et al. 2007). Surficial geology maps show lake clays and silts from either Lake Agassiz or other glacial lakes extending halfway up the Sturgeon River Subwatershed and covering most of the upper Little Fork River subwatershed near Cook (Helgeson et al. 1976). Additional information on the geologic history of the Little Fork River Watershed is described in Anderson et al. 2006 and Gran et al. 2007.

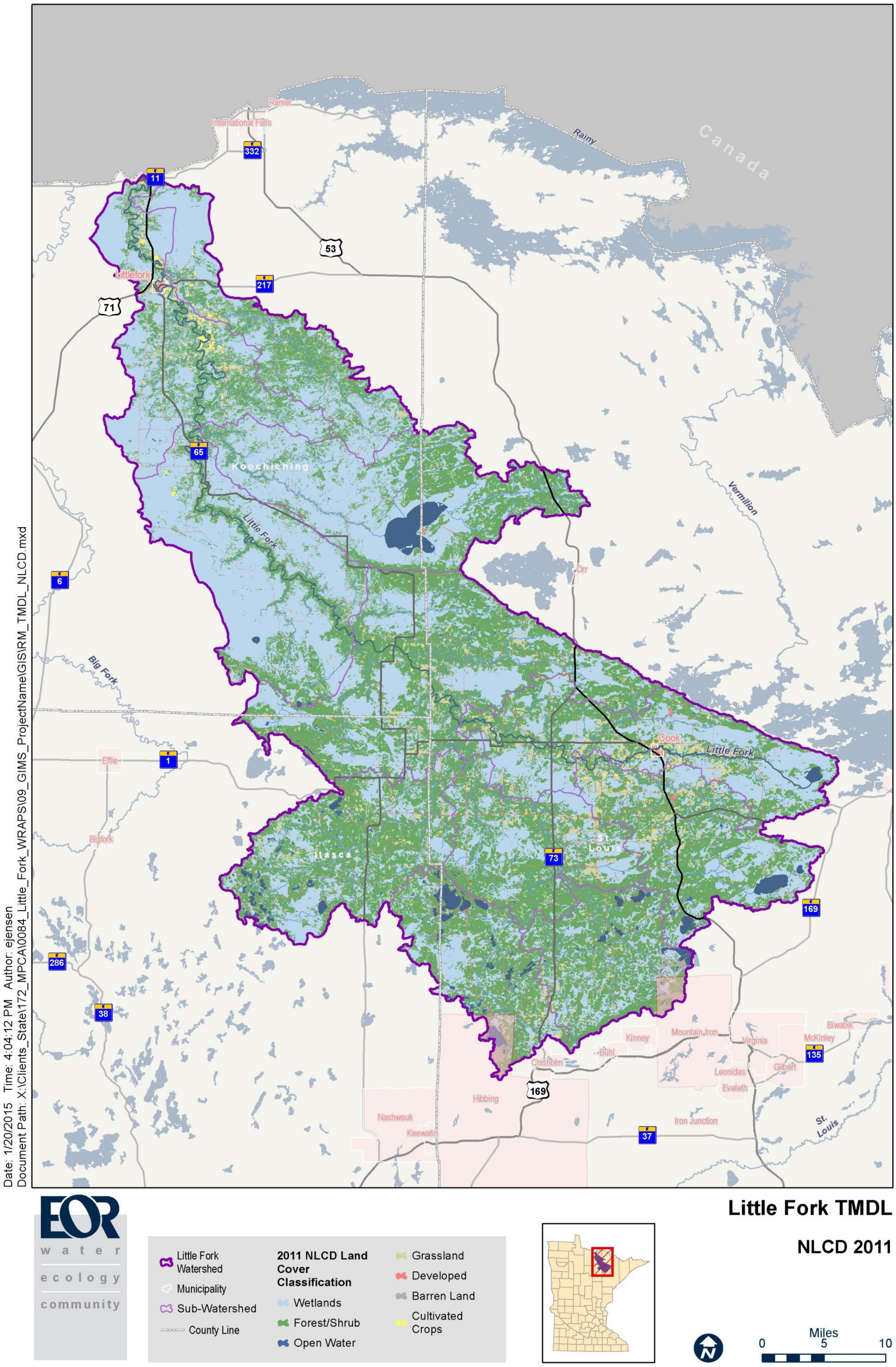

Figure 3. Land cover in the Little Fork River Watershed (NLCD 2011)

Table 4. Land Cover Summary for the TMDL Project Area and impaired AUID subwatersheds (NLCD 2011)

Land cover class	TMDL Project Area (Total Drainage Area for AUID 09030005-501)		Little Fork River, Impaired Reach Subwatersheds, Direct Drainage							
			Willow River to Valley River -506		Prairie Creek to Nett Lake River -508		Cross River to Beaver River -510		Beaver Brook to Rainy River -501	
	acres	% total	acres	% total	acres	% total	acres	% total	acres	% total
Open Water	29,024	2.50%	116	0.10%	919	0.70%	3,273	3.00%	1,153	1.10%
Developed	22,407	1.90%	1,016	1.30%	1,666	1.20%	2,303	2.10%	2,284	2.10%
Barren Land	4,998	0.40%	2	0.00%	19	0.00%	13	0.00%	57	0.10%
Forest	529,543	44.90%	31,269	39.70%	33,762	24.80%	62,475	57.80%	32,749	30.40%
Grassland	41,022	3.50%	1,272	1.60%	1,141	0.80%	3,946	3.70%	2,996	2.80%
Cultivated Crops	5,493	0.50%	612	0.80%	241	0.20%	138	0.10%	2,430	2.30%
Wetlands	548,024	46.40%	44,526	56.50%	98,255	72.20%	35,849	33.20%	66,139	61.30%
Total	1,180,510	100.00%	78,811	100.00%	136,003	100.00%	107,997	100.00%	107,808	100.00%

3.4 Current/Historic Water Quality

TSS data were summarized by year for the period 2004 through 2013. Data summaries and general trends are discussed in Section 3.4.1. Only the past 10 years of current data were used to determine the TMDL for each impaired reach. However, historical data sets have been used to understand the current changes in the system as it relates to sediment. The USGS has monitored flow on the Little Fork River at the city of Littlefork since 1909; and the MPCA and Minnesota Department of Natural Resources (DNR) have monitored this river system periodically since 1970. See Section 7.1 for more information on the MPCA monitoring program.

Although flow and water quality data sets for the Little Fork River at Littlefork are fairly robust, on a larger scale, the Little Fork River is a remote wilderness system, which makes monitoring difficult. Mainstem reaches AUID 09030005-509, -508, and -506, totaling over 50 river miles, are all located in a remote section of the watershed that lies south of State Highway 65, much of which is difficult to access by land due to a lack of a road network. One AUID on the mainstem of the Little Fork River has not been assessed because there are no road crossings along 40 miles of the river. Also, the Nett Lake River Subwatershed (AUID 09030005-507) is also serviced by few roads, and much of it is owned by Bois Forte Band of Chippewa.

The Bois Forte Band of Chippewa, Nett Lake Reservation, is located within the Little Fork River Watershed. A significant portion of the Nett Lake River Subwatershed (45%) and of the entire Little Fork River Watershed (4%) is tribal land. Little monitoring data has been collected by the MPCA in these areas because waters within the reservation are under the jurisdiction of the Bois Forte Band of Chippewa, not the state of Minnesota. However, the state of Minnesota works closely with tribal partners on mutual water quality issues of concern.

3.4.1 Total Suspended Solids (TSS)

TSS data were summarized by month for each impaired stream reach for the period 2004 through 2013 (Table 5). Observed TSS concentrations exceeded the TSS standard (15 mg/L) in the Little Fork River, Willow River to Valley River (-506) and in the Little Fork River, Prairie Creek to Nett Lake River (-508) most often in spring and early summer when mean daily flows were greatest. TSS concentration exceedances extended throughout the year in the Little Fork River, Cross River to Beaver Brook (-510) and in the Little Fork River, Beaver Brook to Rainy River (-501). TSS concentrations were highest in the spring, which corresponds to the period of highest flows. This makes sense since sediment transport in streams is dependent on unit stream power. This principle is also demonstrated in Figure 4, which shows that TSS concentrations are best predicted from mean daily flow using a power equation at the USGS gage in the town of Littlefork.

Table 5. Observed total suspended solids (TSS) by month for each impaired reach, Little Fork River Watershed, 2004-2013

AUID 09030005-XXX Description	Monitoring Station	Year	Number of Samples	Min-Max TSS	Samples >15 mg/L	
					N	%
-506 Willow River to Valley River	S002-551	Mar	2	13.0 – 22.0	1	50%
		Apr	13	7.0 – 140.0	11	85%
		May	5	11.0 – 50.0	2	40%
		Jun	9	6.0 – 42.0	6	67%
		Jul	3	3.2 – 35.0	1	33%
		Aug	2	2.0 – 3.0	---	---
		Sep	1	2.0	---	---
		Oct	1	2.0	---	---
		ALL	**36**	**2.0 – 140.0**	**21**	**58%**
-508 Prairie Creek to Nett Lake River	S002-552	Mar	2	16.0 – 37.0	2	100%
		Apr	9	16.0 – 180.0	9	100%
		May	8	11.0 – 86.0	5	63%
		Jun	6	4.0 – 42.0	3	50%
		Jul	4	4.4 – 7.0	---	---
		Aug	5	2.0 – 7.0	---	---
		Sep	3	2.0 – 3.2	---	---
		Oct	1	2.0 – 2.0	---	---
		ALL	**38**	**2.0 – 180.0**	**19**	**50%**
-510 Cross River to Beaver Brook	S002-556	Jan	2	6.0 – 7.0	---	---
		Feb	4	4.0 – 7.6	---	---
		Mar	10	13.0 – 76.0	7	70%
		Apr	48	10.0 – 390.0	46	96%
		May	30	6.0 – 169.0	19	63%
		Jun	40	2.8 – 69.0	25	63%
		Jul	20	1.6 – 128.0	7	35%
		Aug	22	1.6 – 70.0	3	14%
		Sep	19	1.6 – 73.0	5	26%
		Oct	16	2.0 – 86.0	4	25%
		Nov	6	4.0 – 27.0	1	17%
		Dec	4	4.0 – 9.0	---	
		ALL	**221**	**1.6 – 390.0**	**117**	**53%**

AUID 09030005-XXX Description	Monitoring Station	Year	Number of Samples	Min-Max TSS	Samples >15 mg/L	
					N	%
-501 Beaver Brook to Rainy River	S000-179	Jan	1	5.2	---	---
		Feb	2	4.0 – 16.0	1	50%
		Mar	3	4.4 – 380.0	1	33%
		Apr	5	10.0 – 100.0	3	60%
		May	8	8.8 – 46.0	5	63%
		Jun	7	3.2 – 69.0	3	43%
		Jul	7	4.8 – 24.0	1	14%
		Aug	6	5.6 – 53.0	2	33%
		Sep	5	8.0 – 27.0	3	60%
		Oct	3	8.8 – 24.0	1	33%
		Nov	3	5.4 – 16.0	1	33%
		ALL	**50**	**3.2 – 380.0**	**21**	**42%**

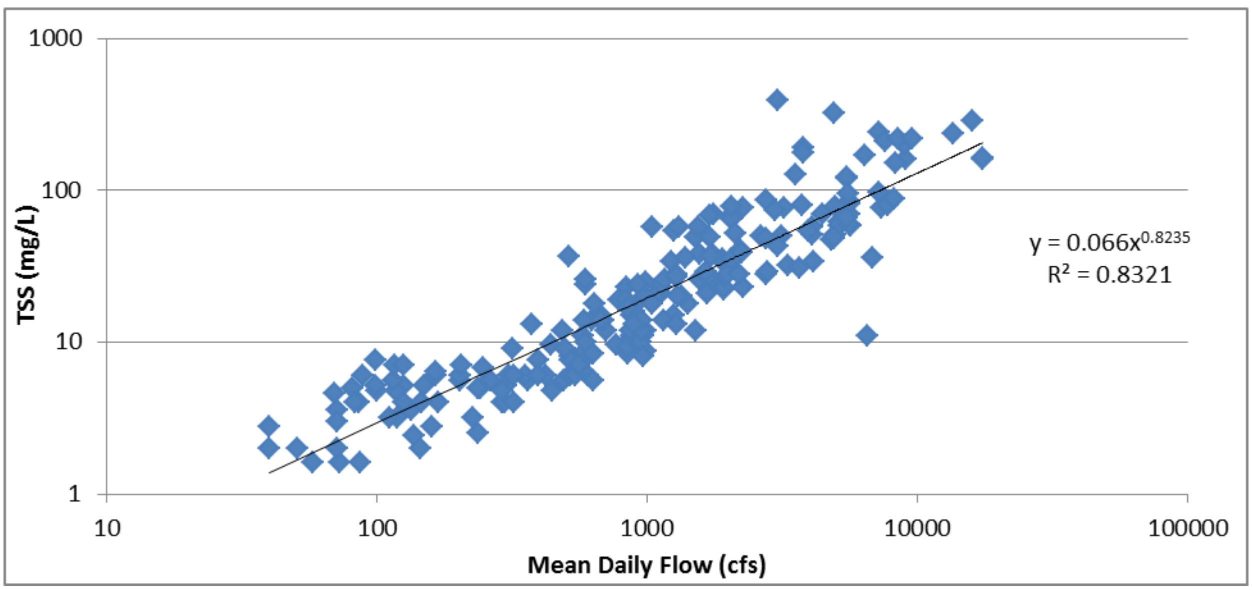

Figure 4. Relationship between total suspended solids (TSS) and mean daily flow at USGS gage 05131500 on the Little Fork River at Littlefork, MN

3.5 Pollutant Source Summary

3.5.1 Total Suspended Solids

3.5.1.1 NPDES permitted

The regulated sources of TSS within the watersheds of the impaired stream reaches addressed in this TMDL study include construction stormwater, industrial stormwater, and wastewater treatment facilities (WWTFs). TSS loads from National Pollutant Discharge Elimination System (NPDES) permitted stormwater were accounted for using the methods described in Sections 4.2 and 4.3 below.

3.5.1.2 Non-NPDES permitted

Recent studies have linked excess turbidity and sediment loading in the Little Fork River to historic logging activity in the watershed (Anderson et al. 2006; Gran et al. 2007; MPCA 2013). Deforestation and land use changes during and following periods of logging resulted in loss of flow attenuation (faster runoff) on the landscape. Peak flows have increased in the Little Fork River as a result of both increased runoff potential (loss of flow attenuation) and increased precipitation. These changes in watershed hydrology have affected sediment loss and transport in the watershed. The following sources of sediment, not requiring NPDES Permit coverage, were evaluated for altered watershed hydrology:

- Upland erosion
- Near bank erosion
- Channel erosion
    - Stream bank erosion
    - Near bank erosion
    - Stream bed erosion
- Tributaries

Upland Erosion

The rate of sediment export from upland areas depends on: soil type; land cover type, condition, and practice; slope; and precipitation patterns. Forested land cover makes up a larger percentage of the land area in upstream areas of the watershed, while wetlands comprise a larger percentage of land cover in downstream regions of the Little Fork River Watershed (Figure 3). Soil erodibility susceptibility indices, a rating of the combined inherent erodibility of soil by soil type and slope factor, is moderate to high in the watershed with the higher susceptibility generally located in downstream areas (DNR Watershed Health Assessment, http://arcgis.dnr.state.mn.us/ewr/whaf/Explore/index.html).

Sediment delivery from uplands can occur via several pathways: sheet, rill and gully erosion. Upland areas that are overgrazed, cleared, or otherwise disturbed are susceptible to sheet erosion. Rills and gullies are more likely to form where disturbed soils are located on steep slopes, and all types of soil erosion can be accelerated when flow volume increases. Historic logging activities (Figure 5), which disturbed native soils (clearing), destabilized stream banks (log driving and logjams), and increased peak runoff volumes (loss of flow attenuation through lowered evapotranspiration rates) increased the susceptibility of upland areas to sediment loss. While some upland areas may have recovered from the effects of historic logging, other land use changes, continued logging, and mining activities limit the recovery potential for other areas. Sediment loss in such areas must be mitigated through BMPs. General TMDL implementation strategies and associated BMPs are discussed in Section 8. A detailed assessment of implementation strategies and targeted BMPs is provided in the Little Fork River WRAPS Report.

More research to differentiate between sources of sediment entering the river from upland areas is needed. At this point, it appears that most sediment sources in the system are from in-channel sources. More data collection in WRAPS Cycle 2, starting in 2018, will focus in on geographic areas of concern to determine sediment inputs.

Figure 5. Logjams on the Little Fork River in 1920 (left) and 1937 (right). Courtesy of the Minnesota Historical Society (as printed in Anderson et al. 2006).

Channel Erosion

Channel erosion includes all types of erosion that occur within the stream channel. Channel erosion is estimated to contribute the majority of the sediment load within the direct drainage area of the Little Fork River main stem. Sources of sediment from several types of channel erosion are discussed by type below.

Stream Bank Erosion

Stream bank erosion occurs when stream flow cuts into the banks of the active channel, eroding soil grains, or when stream bank integrity is compromised causing sediment to slough off banks into the channel. When flow volume increases, so does the erosive power of a stream. In addition to increased peak flows, much of the main stem of the Little Fork River was historically used to transport timber. The combined effect of increased flows and battering/scouring of stream banks during log drives likely destabilized extended stretches of stream bank (Anderson et al. 2006). Destabilization of stream banks may have left stretches of river vulnerable to accelerated stream bank erosion even after timber transport was discontinued (Figure 6).

Geomorphic characteristics of the Little Fork River were assessed in a study by the University of Minnesota (Gran et al. 2007). The river was subdivided into six reaches with similar geomorphic characteristics (Figure 8) using evidence from digital elevation models (DEMs), surficial geology/geomorphology data, aerial photos, and previous studies. Sediment release is most likely along sections of the river that are deeply entrenched (confined within river valley walls without access to the historic flood plain). Much of the Little Fork River is entrenched, with entrenchment more common in Reaches II and III (Figure 8). Reach III includes impaired reach AUID 0903005-506, the furthest upstream of the four impaired reaches. Field observations and long-term monitoring in the watershed provide evidence that entrenchment has increased as a result of altered hydrology and land disturbance.

Figure 6. Stream bank erosion, Little Fork River near Silverdale (source: Anderson et al. 2006).

<u>Near Bank Erosion</u>

Near bank erosion occurs when the upper banks of the valley walls fail. Examples include gullies, landslides, rotational bank failures, and mass wasting (Figure 6). These types of erosion have the potential to release very large amounts of sediment in single events. Bank and slope failures have been observed along many sections of the main stem of the Little Fork River (Gran et al. 2007). Near bank erosion can be exacerbated by changes in upstream hydrology. Gullies may form where concentrated overland flows intersect valley walls. Loss of vegetation and steep valley walls may also accelerate bank and slope failure by decreasing soil cohesion along upper banks and valley walls.

<u>Stream Bed Erosion</u>

Stream bed erosion occurs when stream flow cuts into the bottom of the channel making it deeper. This leads to incision or down-cutting of the channel within the valley and can lead to the stream becoming entrenched. Observed entrenchment and steep stream slopes along much the Little Fork River main stem provides evidence that bed erosion has occurred (Gran et al. 2007).

Figure 7. Examples of stream bank erosion (left) and channel incision (left and right) in the Little Fork River Watershed (source: Anderson et al. 2006).

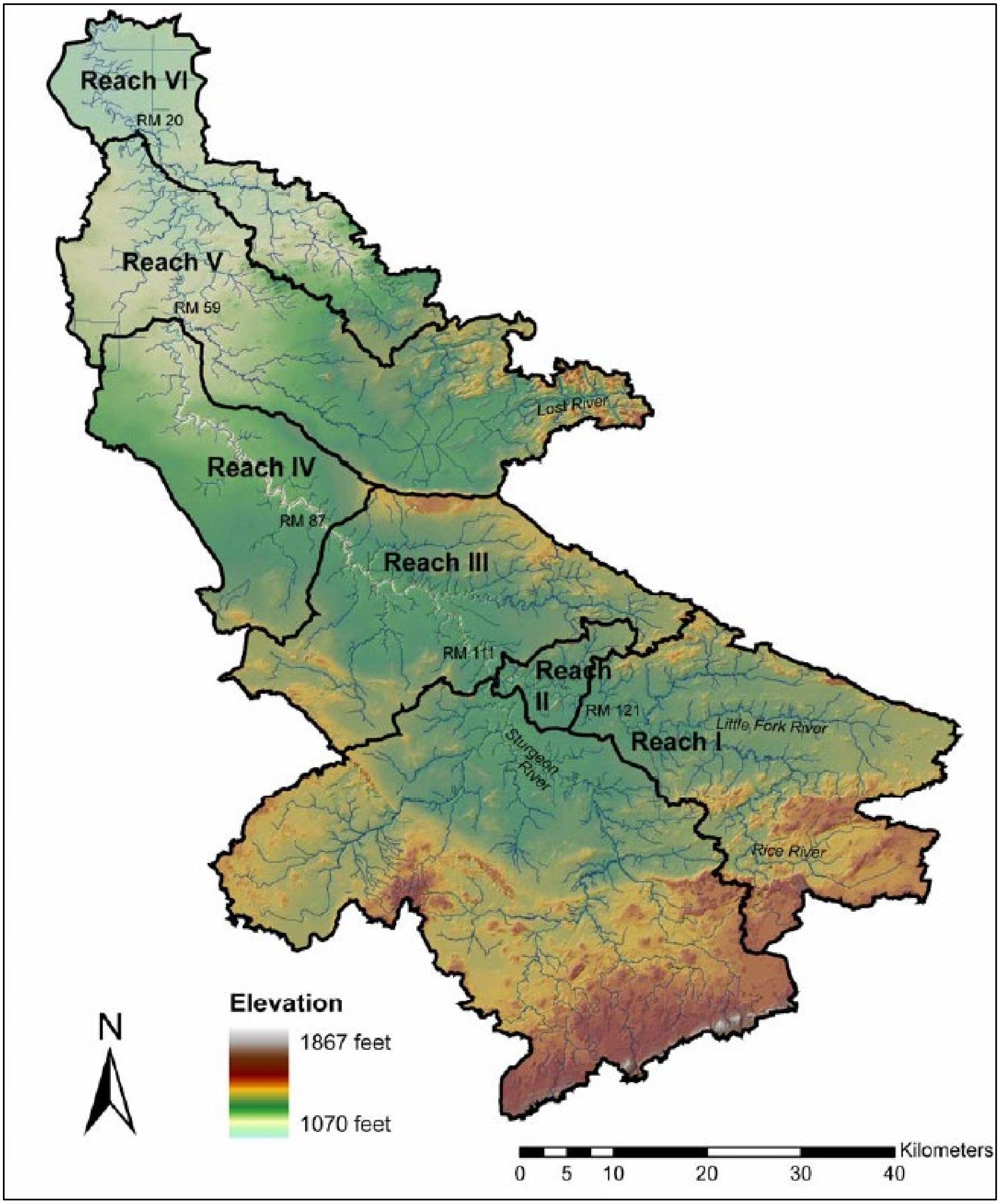

Figure 8. Geomorphically similar reaches of the Little Fork River from "Little Fork River Channel Stability and Geomorphic Assessment" (Gran et al. 2007)

Tributaries

Because soil and land use characteristics vary within the watershed, the sediment contribution of major tributaries to the Little Fork River also varies. For the sake of relative comparisons, annual TSS loads were estimated for each major tributary subwatershed using predicted TSS loads at each tributary outlet (modeled in Hydrologic Simulation Program-Fortran (HSPF)) and subwatershed areas. Annual loads are shown as both total and areal, or combined source loads, in Table 6. On a per acre basis, the largest sediment contribution to the Little Fork River is from the Willow River Subwatershed. Additional monitoring is required to determine the relative contributions of sediment sources within tributary drainage areas.

Table 6. Total suspended solids loads modeled by HSPF at the outlet of major tributaries in the Little Fork River Watershed

Tributary	Subwatershed Area (ac)	Annual TSS Load (kg/yr)	Annual TSS Load as Areal Load* (kg/yr/ac)
Upper Little Fork River	211,637	3,630,061	17
Bear River	108,444	3,447,820	32
Sturgeon River	258,772	4,104,116	16
Willow River	47,654	1,899,633	40
Valley River	46,528	1,612,514	35
Nett Lake River	138,878	4,784,585	34
Beaver Brook	77,613	2,605,222	34

*Includes all sources of sediments, including near channel, stream bank and streambed erosion within tributary drainage areas.

4. TMDL Development

This section presents the overall approach to estimating the components of the TMDL. The pollutant sources were first identified and estimated in the pollutant source assessment. The loading capacity (TMDL) of each stream was then estimated using a stream load duration curves (LDCs) and was divided among WLAs and LAs. A TMDL for a waterbody that is impaired as the result of excessive loading of a particular pollutant can be described by the following equation:

$$\boxed{\textbf{TMDL} = \textbf{LC} = \sum \textbf{WLA} + \sum \textbf{LA} + \textbf{MOS} + \textbf{RC}}$$

Where:

Loading capacity (LC): the greatest pollutant load a waterbody can receive without violating water quality standards;

Wasteload allocation (WLA): the pollutant load that is allocated to point sources, including WWTFs, regulated construction stormwater, and regulated industrial stormwater, all covered under NPDES Permits for a current or future permitted pollutant source;

Load allocation (LA): the pollutant load that is allocated to sources not requiring NPDES Permit coverage, including non-regulated stormwater runoff, atmospheric deposition, and internal loading;

Margin of safety (MOS): an accounting of uncertainty about the relationship between pollutant loads and the water quality of the receiving waters.

Reserve capacity (RC): the portion of the loading capacity attributed to the growth of existing and future load sources.

4.1 Total Suspended Solids

4.1.1 Loading Capacity

The loading capacities for impaired stream reaches receiving a TMDL, as a part of this study, were determined using load duration curves. Flow and LDCs are used to determine the flow conditions (flow regimes) under which exceedances occur. Flow duration curves provide a visual display of the variation in flow rate for the stream. The x-axis of the plot indicates the percentage of time that a flow exceeds the corresponding flow rate as expressed by the y-axis. LDCs take the flow distribution information constructed for the stream and factor in pollutant loading to the analysis. A standard curve is developed by applying a particular pollutant standard or criteria to the stream flow duration curve and is expressed as a load of the pollutant per day. The standard curve represents the upper limit of the allowable in-stream pollutant load (loading capacity) at a particular flow. Monitored loads of a pollutant are plotted against this curve to display how they compare to the standard. Monitored values that fall above the curve represent an exceedance of the standard.

For the stream TMDL derivation, Hydrological Simulation Program - FORTRAN (HSPF) modeled flows for the period 2000 through 2009 were used to develop flow duration curves. The loading capacities were determined by applying the TSS standard (15 mg/L) to the flow duration curve to produce a TSS standard curve. Loading capacities presented in the allocation tables represent the median TSS load (in kg/day) along the TSS standard curve within each flow regime. Existing TSS loads were determined from HSPF modeled TSS loads for the period 2000 through 2009. Existing loads presented in the allocation tables represent the 90^{th} percentile TSS load (in kg/day) within each flow regime to satisfy the 90% compliance rate requirement of the TSS standard (i.e., no more than 10% of samples can exceed the standard). A TSS load duration curve with HSPF-modeled existing data and a TMDL allocation table are provided for each stream in Section 4.1.6. Load duration curve data sources for each stream are reported in Appendix A.

The LDC method is based on an analysis that encompasses the cumulative frequency of historical 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 tables of this report only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, it should be understood that the entire curve represents the TMDL and is what is ultimately approved by the EPA.

The HSPF model was built and calibrated by RESPEC, an environmental consulting company contracted by the MPCA. It is used for various water quality pollutants (such as sediment, phosphorus, DO, and others) and flow in the Little Fork River Watershed; this output was used for analysis and TMDL calculations.

The HSPF model is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants. HSPF incorporates a watershed-scale Agricultural Runoff Model (ARM) and nonpoint source models into a basin-scale analysis framework that includes fate and transport in one dimensional stream channels. It is a comprehensive model of watershed hydrology and water quality that allows the integrated simulation of point sources and land and soil contaminant runoff processes with in-stream hydraulic and sediment-chemical interactions. The result of this simulation is a time history of the runoff flow rate, sediment load, and nutrient and pesticide concentrations, along with a time history of water quantity and quality at the outlet of any subwatershed.

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

Multiple spatial and temporal data sources are used to inform the model. Meteorological data originated from the National Weather Service's North Central River Forecasting Center and from the EPA's Basins software, as well as from other Northeastern Minnesota sources. Land use/land cover data is taken from the NLCD. Soil data for each subbasin is based on U.S. Department of Agricultural Soil Survey Geographic Database (SSURGO) GIS data and slope data was calculated using 30 meter DEM data. Land use/land cover, soil, and slope data inform the development of subwatersheds within HSPF and therefore the movement of water and other model constituents from the landscape to stream reaches. The subbasins are delineated based on DNR GIS data.

One USGS gage and three non-USGS gages were used to calibrate flow. The non-USGS gages usually only operated from April to September. For some gage data, the frequency at which rating curves were field-measured and adjusted was less than USGS standards. The gages used for the model are:

- Little Fork River at Littlefork (Gage # USGS 05131500)
- Little Fork River near Littlefork (Gage # MPCA/DNR 76099001)
- Little Fork River near Silverdale (Gage #MPCA/DNR 76106001)
- Little Fork River near Lindon Grove (Gage #MPCA/DNR 76023001)

The accuracy of the information used for HSPF is reflected by the strong hydrologic calibration of the model. There is a good fit between observed and simulated flow data. Because of this strong calibration of simulated data, the model is appropriate in the use of Load Duration Curves. The MPCA has used HSPF models to support many TMDLs across the state that have been approved by the EPA.

4.1.2 Load Allocation Methodology

LAs were derived from HSPF modeling results for each impaired stream reach for the period 2000 through 2009. The LA includes all sources of sediment that do not require NPDES Permit coverage: watershed runoff, and channel and stream-bed erosion as described in Section 3.5.1. The remainder of the loading capacity (TMDL) after subtraction of the MOS and calculation of the WLA was used to determine the LA for each impaired reach, within each defined flow regime.

4.1.3 Wasteload Allocation Methodology

4.1.3.1 Regulated Construction Stormwater

Construction stormwater is regulated by NPDES permitting for any construction activity disturbing: a) one acre or more of soil, b) less than one acre of soil if that activity is part of a "larger common plan of development or sale" that is greater than one acre, or c) less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources. The WLA for stormwater discharges from sites where there is construction activities reflects the number of construction sites greater than one acre expected to be active in the impaired subwatershed at any one time. See Section 8.1.1 for more information regarding the NPDES Construction Stormwater Permit.

A categorical WLA is assigned to all construction activity in each impaired stream reach subwatershed. First, the median annual fraction of the impaired stream reach area under construction activity over a five-year period was calculated based on MPCA Construction Stormwater Permit data from January 1, 2007 to October 6, 2012 (Table 7), and area weighted based on the fraction of the subwatershed located in each county. This percentage was multiplied by the watershed runoff load, which is equal to the total TMDL (loading capacity) minus the sum of all individual WLAs (none in this TMDL) and MOS to determine the construction stormwater WLA.

Table 7. Average Annual NPDES/SDS Construction Stormwater Permit Activity by County (1/1/2007-10/6/2012)

County	Total Area (ac)	Median Annual Construction Activity (% Total Area)
Koochiching	2,018,168	0.052%
St. Louis	4,312,245	0.003%
Itasca	1,872,385	0.019%

4.1.3.2 Regulated Industrial Stormwater

Industrial stormwater is regulated by NPDES Permits if the industrial activity has the potential for significant materials and activities to be exposed to stormwater discharges. The WLA for stormwater discharges from sites where there is industrial activity reflects the number of sites in an impaired stream subwatershed for which NPDES Industrial Stormwater Permit coverage is required. Facilities included under the industrial stormwater WLA are listed by impaired stream reach in Table 8. Facilities located upstream of Shannon Lake are implicit in the LA for Shannon Lake in the TMDL for impaired reach AUID 09030005-506, Little Fork River, Willow River to Valley River (see also Section 4.1.3.3).

A categorical WLA was assigned to all industrial activity in each impaired stream subwatershed. The industrial stormwater WLA was set equal to the construction stormwater WLA because industrial activities make up a very small fraction of the watershed area.

Table 8. Industrial stormwater permitted facilities located within the direct drainage area of impaired streams

Impaired Stream/AUID	Facility Name	Permit ID
Little Fork River, Willow River to Valley Creek (AUID 09030005-506)	Cook Municipal Airport	MNR0535GV
	Cook Transfer Station	MNR05342P
	Hancock Fabrications, Inc	MNR0534DT
	Hill Biomass, Inc.	MNR053469
	Hillwood Products, Inc.	MNR0535M3
	KGM Contractors, Inc.	MNG490090
	Seppi Brothers Concrete, Inc.	MNG490256
	St. Louis County Land Dept	MNG490177
	Ulland Brothers Concrete	MNG490256
Little Fork River, Prairie Creek to Nett Lake River (AUID 09030005-508)	Wanner Engineering, Inc.	MNR053WQ
Little Fork River, Beaver Brook to Rainy River (AUID 09030005-501)	Boise Remote Site 17 Landfill	MNR05344Y
	Green Forest, Inc.	MN50536KD

4.1.3.3 MS4 Stormwater

The city of Hibbing is a regulated MS4 stormwater community, a portion of which discharges to the Shannon River, an upstream tributary to the Little Fork River (09030005-506, Willow River to Valley River). The drainage area under regulation is located upstream of Shannon Lake, a flowage lake along the Shannon River, and boundary condition of the TMDL. An upstream allocation equal to the TSS target (15 mg/L) multiplied by the median outflow from the lake basin at each flow volume was written in the TMDL for the impaired reach 09030005-506 (Section 4.1.6.1) to account for permitted discharges upstream of the lake. The Hibbing MS4 permitted discharge is implicit in this allocation.

If Municipal Separate Storm Sewer System (MS4) communities come under permit coverage in the future, a portion of the LA will be shifted to the WLA to account for the regulated MS4 stormwater. MS4 permits for state (Minnesota Department of Transportation) and county road authorities apply to roads within the U.S. Census Bureau Urban Area. None of the impaired stream subwatersheds are located within the U.S. Census Bureau Urban Area. Therefore, no roads are currently under permit coverage and no WLAs were assigned to the corresponding road authorities. If, in the future, the U.S. Census Bureau Urban Area extends into an impaired subwatershed and these roads come under permit coverage, a portion of the LA will be shifted to the WLA.

4.1.3.4 Municipal and Industrial Waste Water Treatment Systems

Minnesota's TSS water quality standard is intended to protect aquatic life from the damaging effects of inorganic non-volatile suspended solids (NVSS) to the gills and filter feeding organs of fish and aquatic invertebrates. TSS associated with municipal wastewater discharges are predominantly organic volatile suspended solids (VSS), which do not tend to persist in the environment. WLAs developed for these TMDLs will be expressed in terms of TSS. The NPDES Permits for WWTFs may contain water quality based effluent limits that account for the NVSS characteristics of the discharge. Such limits would be consistent with the assumptions and requirements of the TMDLs' WLAs.

An individual WLA was provided for all NPDES permitted WWTFs whose surface discharge stations fall within an impaired stream subwatershed. The WLA was calculated as the permitted discharge concentration multiplied by the permitted facility design flow. Continuously discharging municipal WWTF WLAs were calculated based on the average wet weather design flow, equivalent to the wettest 30-days of influent flow expected over the course of a year. The WLAs for controlled (ponds) discharges and from municipal WWTFs were calculated based on the maximum daily volume that may be discharged in a 24-hour period. There are a total of seven NPDES permitted WWTFs located with the drainage are of TSS impaired streams. WLAs for WWTFs are listed by impaired stream reach in Table 9.

Table 9. Permitted municipal and industrial wastewater facilities located within the direct drainage area of impaired streams

Impaired Stream Reach/AUID	Facility Name	Permit ID	Design flow (mgd)	Daily TSS Effluent Limit (mg/L)	Wasteload Allocation (kg/day)
Little Fork River, Willow River to Valley Creek (AUID 09030005-506)	Cook WWTF	MNG580179	1.43	45	243.8
	ISD 2142	MN0069850	0.008	16	0.5
	US Steel Corp.	MN0057207	0.32	30	36.4
	Hibbing Taconite Co - Tails Basin Area	**MN0049760**	*	*	*
Little Fork River, Beaver Brook to Rainy River (AUID 09030005-501)	Littlefork WWTF	MNG580081	0.73	45	124.7

* This facility is located upstream of a boundary condition (unimpaired Shannon Lake) and was not assigned a WLA

4.1.4 Margin of Safety

An explicit 10% margin of safety (MOS) was accounted for in the TMDL for each impaired stream reach. This MOS is sufficient to account for uncertainties in predicting TSS loads to the Little Fork River. This explicit MOS is considered to be appropriate based on good agreement between the TSS loading predicted by watershed HSPF modeled (Section 4.1.6) and observed values (Appendix A). Since the models reasonably reflect the conditions in impaired stream reaches, the 10% MOS is considered to be adequate to address the uncertainty in the TMDL, based upon the data available. In addition, implicit margins of safety are provided through conservative assumptions in estimating existing loads (Section 4.1.6).

4.1.5 Seasonal Variation

Critical conditions and seasonal variation in stream water quality are addressed in this TMDL through the use of LDCs and the evaluation of load variability in five flow regimes: from high flows, such as flood events, to low flows, such as baseflow. Both observed (Appendix A) and modeled (Section 4.1.6) loads in each month were plotted against flow to evaluate seasonal variation.

4.1.6 TMDL Summary

Load duration curves and allocation tables are provided for each impaired stream reach in Section 4.1.6.1 through Section 4.1.6.4 below.

The total LA for each impaired reach includes one allocation for an upstream boundary condition and one allocation for the remaining drainage area ('Watershed and Channel'). Where the upstream boundary condition is another impaired reach (AUIDS 09030005-501, -508, -510), this LA is set equal to the sum of the WLAs and the LAs for the upstream impaired reach. In the TMDL for AUID 09030005-506, the upstream boundary for the TMDL was set at the outlet of Shannon Lake (Figure 9) which is expected to provide natural "treatment" for tributaries located further upstream in the system. In this case, the upstream LA is set equal to the median modeled outflow volume for Shannon Lake at each flow regime multiplied by the TSS target for the impaired reach. The LA for the 'Watershed and Channel' includes all sources of sediment described in Section 3.5.1.2 located within the drainage area of the impaired reach, excluding areas included in the upstream boundary condition.

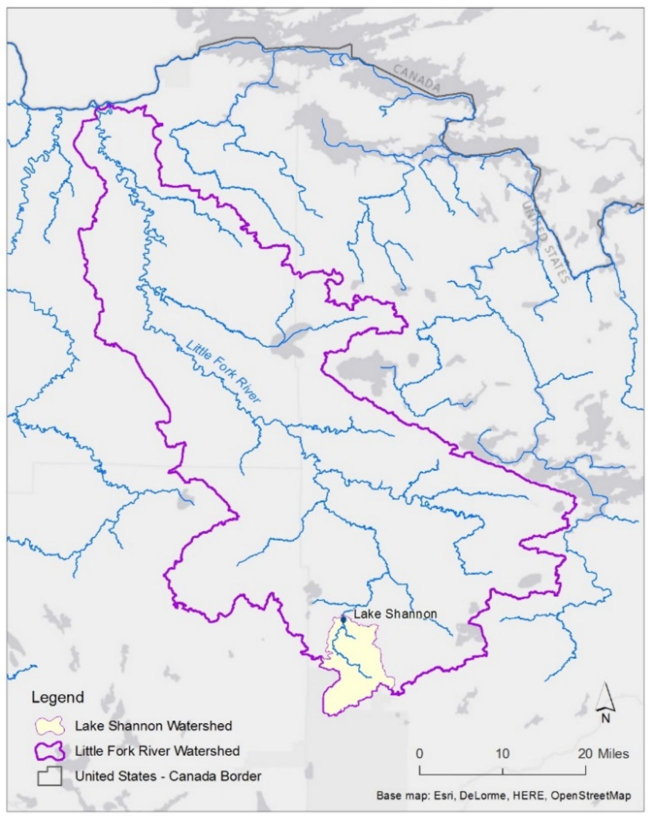

Figure. 9. Lake Shannon upstream boundary for -506 TMDL

Modeling results and monitoring data (Appendix A) show that most TSS exceedances in impaired stream reaches occur under mid to high flow conditions. HSPF modeled TSS load reductions of 83% to 95% are required under very high flow conditions, 45% to 83% under high flow conditions, and 4% to 18% under mid-range flow conditions for the impaired stream reaches. Nonpoint sources of sediment dominate TSS loads under these conditions (Section 3.5.1.2). To address this set of conditions, implementation efforts should include BMPs, which attenuate runoff volume. General implementation strategies are discussed in Section 8. Detailed implementation strategies are defined in the Little Fork River WRAPS Report.

Point sources comprise a very small portion of the TMDL for all impaired reaches even under 'very low' flow conditions. The TMDL does not require a reduction in permitted discharge limits for facilities included in the WLAs for the impaired streams. Provisions for future growth of permitted sources are covered in Section 5.

4.1.6.1 Little Fork River (Willow River to Valley River, 09030005-506) TSS TMDL

Figure 9. Little Fork River (Willow River to Valley River, 09030005-506) TSS load duration curve

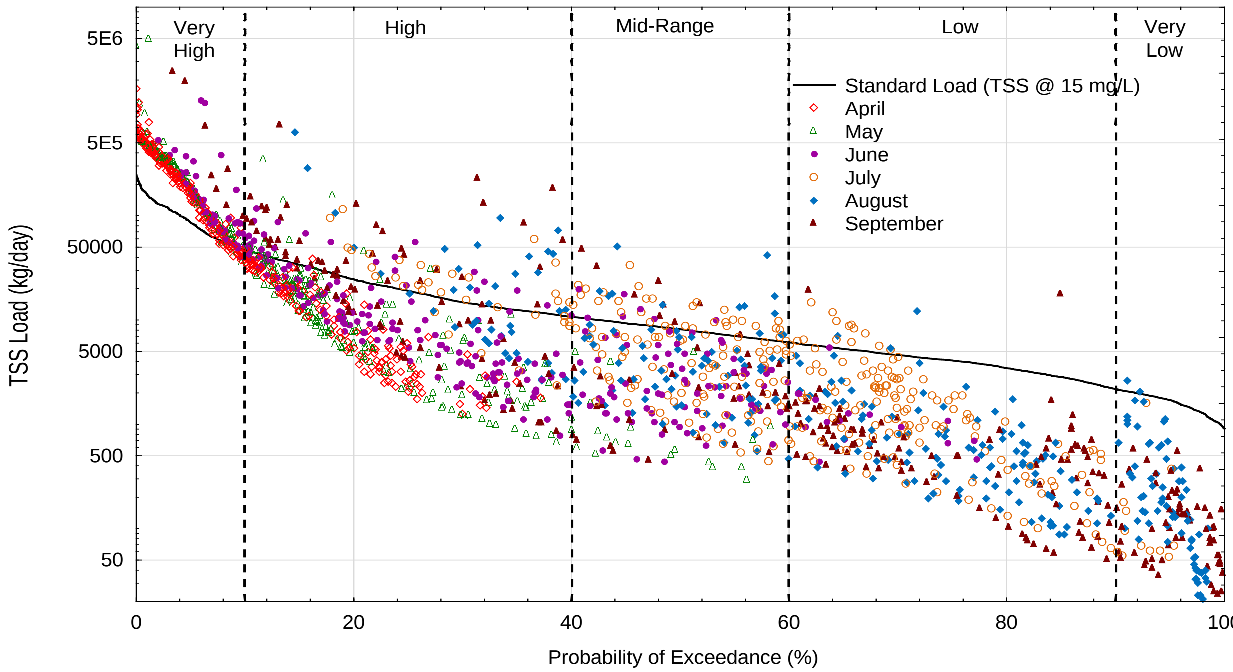

Table 10. Little Fork River (Willow River to Valley River, 09030005-506) TSS TMDL and allocations

Little Fork River 09030005-506 Load Component		Very High	High	Mid	Dry	Very Dry
		Flow Regime (kg per day)				
Existing Load (estimated by the HSPF model)		*532,166*	*35,649*	*7,581*	*1,676*	*369*
Wasteload Allocation	*Cook WWTP (MNG580179)*	*244*	*244*	*244*	*244*	*244*
	ISD 2142 MN0069850	*1*	*1*	*1*	*1*	*1*
	US Steel Corp, MN0057207	*36*	*36*	*36*	*36*	*36*
	Construction stormwater (MNR100001)	*3.5*	*0.8*	*0.32*	*0.15*	*0.06*
	Industrial stormwater (MNR50000)	*3.5*	*0.8*	*0.32*	*0.15*	*0.06*
	Total WLA	**288**	**282**	**281**	**281**	**281**
Load Allocations	*Upstream Boundary Condition*: Shannon Lake watershed*	*1,450*	*451*	*184*	*59*	*0*
	Watershed and Channel§	*77,499*	*16,808*	*7,041*	*3,426*	*1,292*
	Total LA	**78,949**	**17,259**	**7,224**	**3,485**	**1,292**
10% MOS		**8,804**	**1,949**	**834**	**418**	**175**
Total Loading Capacity		**88,041**	**19,490**	**8,339**	**4,184**	**1,748**
Estimated Load Reduction		*444,125* *83%*	*16,159* *45%*	*0* *0%*	*0* *0%*	*0* *0%*

*** Upstream boundary condition is set equal to the median outlet flow for Shannon Lake in each flow regime (HSPF model) multiplied by the TSS target for the impaired reach.**

§ Includes upland sources + stream bank, near bank, and stream bed erosion within the watershed, excluding areas included in the upstream boundary condition.

4.1.6.2 Little Fork River (Prairie Creek to Nett Lake River, 09030005-508) TSS TMDL

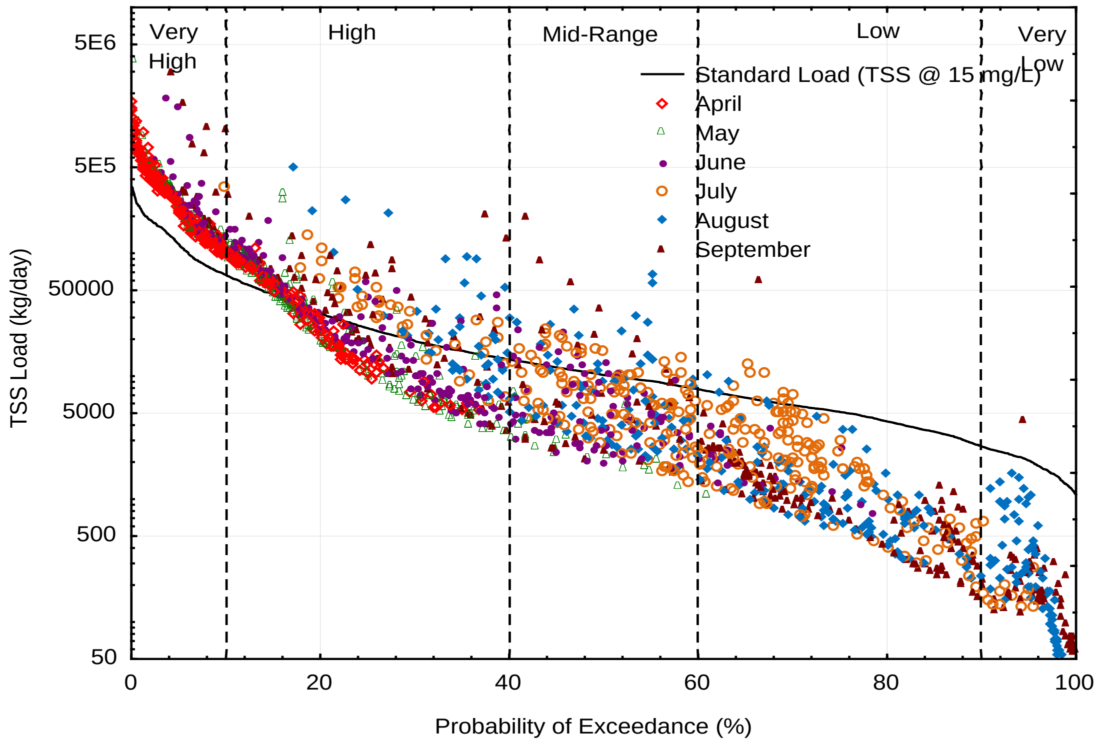

Figure 10. Little Fork River (Prairie Creek to Nett Lake River, 09030005-508) TSS load duration curve

Table 11. Little Fork River (Prairie Creek to Nett Lake River, 09030005-508) TSS TMDL and allocations

Little Fork River 09030005-508 Load Component		Flow Regime				
		Very High	High	Mid	Dry	Very Dry
		kg per day				
Existing Load (estimated by the HSPF model)		*693,437*	*85,999*	*10,657*	*2,405*	*389*
Wasteload Allocation	*Construction stormwater (MNR100001)*	*12.7*	*2.1*	*0.8*	*0.4*	*0.1*
	Industrial stormwater (MNR50000)	*12.7*	*2.1*	*0.8*	*0.4*	*0.1*
	Total WLA	**25**	**4**	**2**	**1**	**0.2**
Load Allocations	*Upstream Boundary Condition*: Little Fork River - 506*	*79,237*	*17,541*	*7,505*	*3,766*	*1,572*
	Watershed and Channel [§]	*28,080*	*4,614*	*1,690*	*835*	*281*
	Total LA	**107,317**	**22,155**	**9,195**	**4,601**	**1,853**
10% MOS		**11,927**	**2,462**	**1,022**	**511**	**206**
Total Loading Capacity		**119,269**	**24,621**	**10,219**	**5,113**	**2,059**
Estimated Load Reduction		*574,168* *83%*	*61,378* *71%*	*438* *4%*	*0* *0%*	*0* *0%*

*** Upstream boundary condition = ∑WLAs + LAs for the upstream impaired reach (AUID 09030005-506).**

[§] Includes upland sources + stream bank, near bank, and stream bed erosion within the watershed, excluding areas included in the upstream boundary condition.

4.1.6.3 Little Fork River (Cross River to Beaver Brook, 09030005-510) TSS TMDL

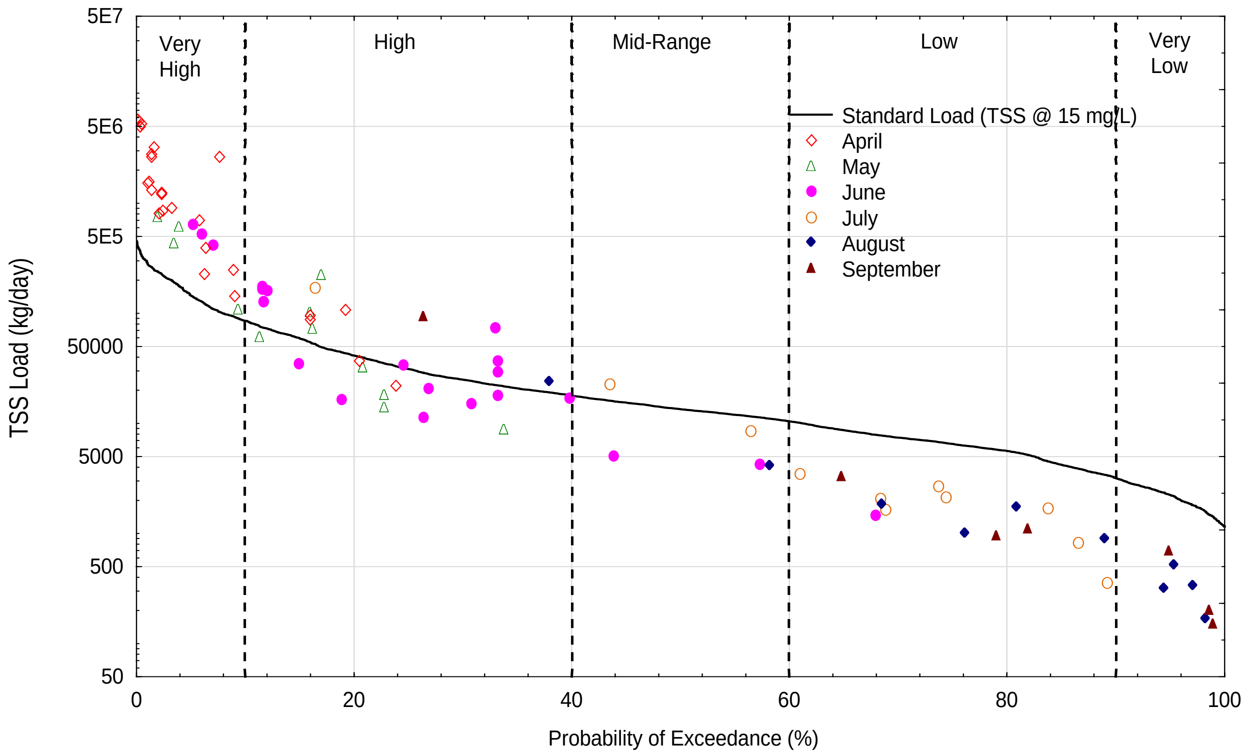

Figure 11. Little Fork River (Cross River to Beaver Brook, 09030005-510) TSS load duration curve

Table 12. Little Fork River (Cross River to Beaver Brook, 09030005-510) TSS TMDL and allocations

Little Fork River 09030005-510 Load Component		Flow Regime				
		Very High	High	Mid	Dry	Very Dry
		kg per day				
Existing Load (estimated by the HSPF model)		*2,992,027*	*166,053*	*16,493*	*4,052*	*453*
Wasteload Allocation	*Construction stormwater (MNR100001)*	*13*	*3*	*1.5*	*0.7*	*0.1*
	Industrial stormwater (MNR50000)	*13*	*3*	*1.5*	*0.7*	*0.1*
	Total WLA	**26**	**6**	**3**	**1.4**	**0.2**
Load Allocations	*Upstream Boundary Condition*: Little Fork River -508*	*107,342*	*22,160*	*9,197*	*4,602*	*1,853*
	Watershed and Channel [§]	*24,942*	*5,963*	*2,940*	*1,264*	*162*
	Total LA	**132,284**	**28,123**	**12,137**	**5,866**	**2,015**
10% MOS		**14,701**	**3,125**	**1,349**	**652**	**224**
Total Loading Capacity		**147,011**	**31,254**	**13,489**	**6,519**	**2,239**
Estimated Load Reduction		*2,845,016* *95%*	*134,799* *81%*	*3,004* *18%*	*0* *0%*	*0* *0%*

*** Upstream boundary condition = ∑WLAs + LAs for the upstream impaired reach (AUID 09030005-508).**

[§] Includes upland sources + stream bank, near bank, and stream bed erosion within the watershed, excluding areas included in the upstream boundary condition.

4.1.6.4 Little Fork River (Beaver Brook to Rainy River, 09030005-501) TSS TMDL

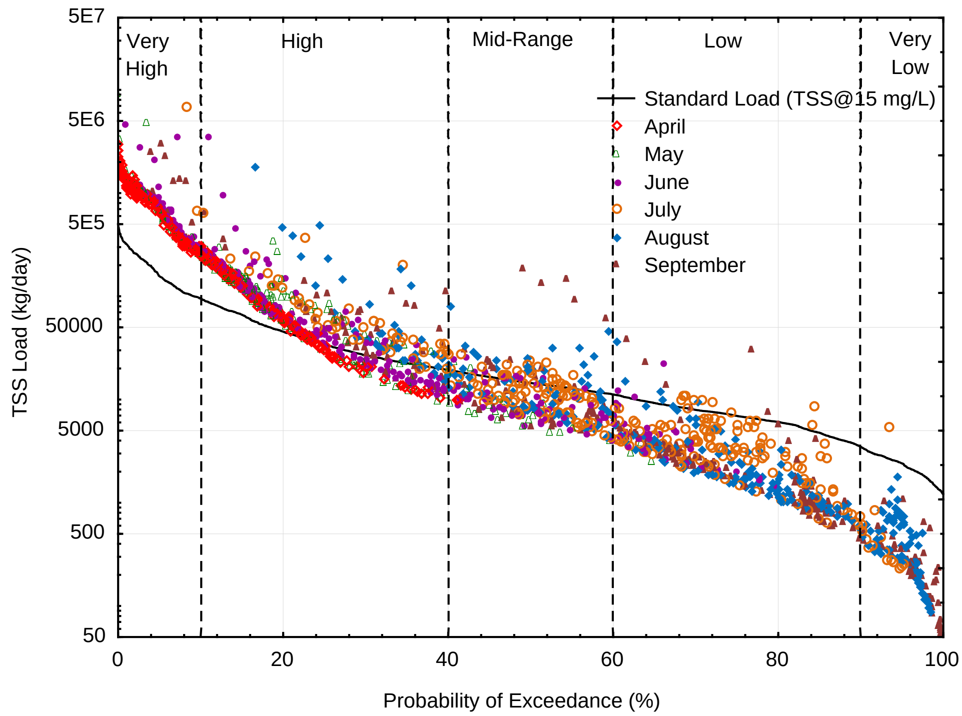

Figure 12. Little Fork River (Beaver Brook to Rainy River, 09030005-501) TSS load duration curve

Table 13. Little Fork River (Beaver Brook to Rainy River, 09030005-501) TSS TMDL and allocations

Little Fork River 09030005-501 Load Component		Very High	High	Mid	Dry	Very Dry
		Flow Regime				
		kg per day				
Existing Load (estimated by the HSPF model)		*1,443,898*	*197,440*	*17,358*	*4,878*	*576*
Wasteload Allocation	*Littlefork WWTP MNG580081*	*125*	*125*	*125*	*125*	*125*
	Construction stormwater (MNR100001)	*4.5*	*1.4*	*0.4*	*0.14*	*0.01*
	Industrial stormwater (MNR50000)	*4.5*	*1.4*	*0.4*	*0.14*	*0.01*
	Total WLA	**134**	**128**	**126**	**125**	**125**
Load Allocations	*Upstream Boundary Condition*: Little Fork River -510*	*132,310*	*28,129*	*12,140*	*5,867*	*2,015*
	Watershed and Channel[§]	*8,805*	*2,807*	*769*	*262*	*27*
	Total LA	**141,115**	**30,936**	**12,909**	**6,128**	**2,042**
10% MOS		**15,694**	**3,451**	**1,448**	**695**	**241**
Total Loading Capacity		**156,943**	**34,515**	**14,483**	**6,948**	**2,408**
Estimated Load Reduction		*1,286,955* *89%*	*162,925* *83%*	*2,875* *17%*	*0* *0%*	*0* *0%*

*** Upstream boundary condition = ∑WLAs + LAs for the upstream impaired reach (AUID09030005-510).**

[§] Includes upland sources + stream bank, near bank, and stream bed erosion within the watershed, excluding areas included in the upstream boundary condition.

4.1.7 TMDL Baseline

Sediment TMDLs are based on modeled flow and water quality data for the period 2000 through 2009. Any activities implemented during or after 2009 that lead to a reduction in stream loads or an improvement in an impaired stream TSS may be considered as progress towards meeting a WLA or LA.

5. Future Growth Considerations

Potential changes in population and land use over time in the Little Fork River Watershed could result in changing sources of pollutants. How these changes may impact TMDL allocations are discussed below. However, growth is not expected in this watershed due to the large percentage of publicly owned land.

5.1 New or Expanding Permitted MS4 WLA Transfer Process

The likelihood of development in the Little Fork River Watershed that would necessitate the development of an MS4 Permit in the near future is very low. However, in the event that development should occur at a level that triggers the need for an MS4 Permit, the following approach is followed. 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 (see Section 4.1.2 and Section 4.1.3). One transfer rate was defined for each impaired stream as the total WLA (kg/day) divided by the watershed area downstream of any upstream impaired waterbody (acres). In the case of a load transfer, the amount transferred from LA to WLA will be based on the area (acres) of land coming under permit coverage multiplied by the transfer rate (kg/day). The MPCA will make these allocation shifts. In cases where a WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

5.2 New or Expanding Wastewater

The MPCA, in coordination with the 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. As described in Section 4.1.3.4, in situations where municipal WWTF discharges are predominantly TSS, which do not persist in the environment, the effluent limits may be listed as exceeding the standard for TSS in the Little Fork River system. The MPCA believes the effects of these solids on aquatic life to be minimal. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, Region 5, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA, Region 5, 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

6.1 Non-regulatory

At the local level, the Koochiching SWCD, North St. Louis SWCD, Itasca SWCD and other local entities currently implement programs that target improving water quality and have been actively involved in projects to improve water quality in the past. Willing landowners within this watershed have implemented many practices in the past including: buffer strips, urban BMPs, gully stabilizations, etc. It is assumed that these activities will continue. Potential state funding of restoration and protection projects include Clean Water Fund grants and Clean Water Partnership loans. At the federal level, funding can be provided through CWA Section 319 grants that provide cost-share dollars to implement activities in the watershed. Various other funding and cost-share sources may also be available. Moreover, forestry on public lands in the watershed is subject to the Voluntary Site Level Forest Management Guidelines (http://mn.gov/frc/index.html). Detailed implementation strategies for achieving sediment and nutrient loading reductions can be found in the Little Fork River WRAPS Report (available online at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/little-fork-river.html). The implementation strategies described in the report have demonstrated their effectiveness in reducing pollutant loading to lakes and streams. There are programs in place within the watershed to continue implementing the recommended activities. Monitoring will continue and adaptive management will be in place to evaluate the progress made towards achieving water quality goals.

6.2 Regulatory

6.2.1 Regulated Construction Stormwater

State implementation of the TMDL will be through action on NPDES Permits for regulated construction stormwater. To meet the WLA for construction stormwater, construction stormwater activities are required to meet the conditions of the Construction Stormwater General Permit under the NPDES program and properly select, install, and maintain all BMPs required under the permit, including any applicable additional BMPs required in Appendix A of the Construction Stormwater General Permit for discharges to impaired waters, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

6.2.2 Regulated Industrial Stormwater

To meet the WLA for industrial stormwater, industrial stormwater activities are required to meet the conditions of the State's NPDES/State Disposal System (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). Under the NPDES program, these activities must properly select, install and maintain all BMPs required under the permit.

6.2.3 Municipal Separate Storm Sewer System (MS4) Permits

The MPCA has not assigned TSS loads to a regulated MS4 community as part of this TMDL, as the city of Hibbing is located upstream of an impaired stream boundary condition. There are currently no other MS4 communities in the Little Fork River Watershed.

6.2.4 Wastewater & State Disposal System (SDS) Permits

The MPCA issues permits for WWTFs that discharge into waters of the state. The permits have site-specific limits on TSS that are based on water quality standards. Permits regulate discharges with the goals of: 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. In addition, SDS permits set limits and establish controls for land application of sewage.

7. Monitoring Plan

7.1 Stream Monitoring

Monitoring of the Little Fork River system has included biological, water quality chemistry and flow sampling of the river. Flow and water quality monitoring stations located in the Little Fork River Watershed are shown in Figure 13. Water samples are collected annually at sites for the MPCA Major Watershed Pollutant Load Monitoring Network Program (WPLMN) (http://www.pca.state.mn.us/index.php/view-document.html?gid=17006) and at 10-year intervals for the MPCA Intensive Watershed Monitoring (IWM) Program. Under the protocol of the WPLMN program, approximately 35 water quality samples are collected annually at basin and major watershed sites and 25 samples collected seasonally at subwatershed sites. Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can shift between storms or with the season, computation of accurate pollutant loads requires frequent sampling of all major runoff events. Low flow periods are sampled less frequently as concentrations are generally more stable when compared to periods of elevated flow.

The MPCA biological monitoring of the river was completed in 2009, after two years of field work as a part of the IWM program. Data collected and evaluated included fish and macro-invertebrates. This monitoring is scheduled to begin again in 2018. DNR Fisheries monitoring and assessments occur per scheduled updates of fisheries plans in the Little Fork system.

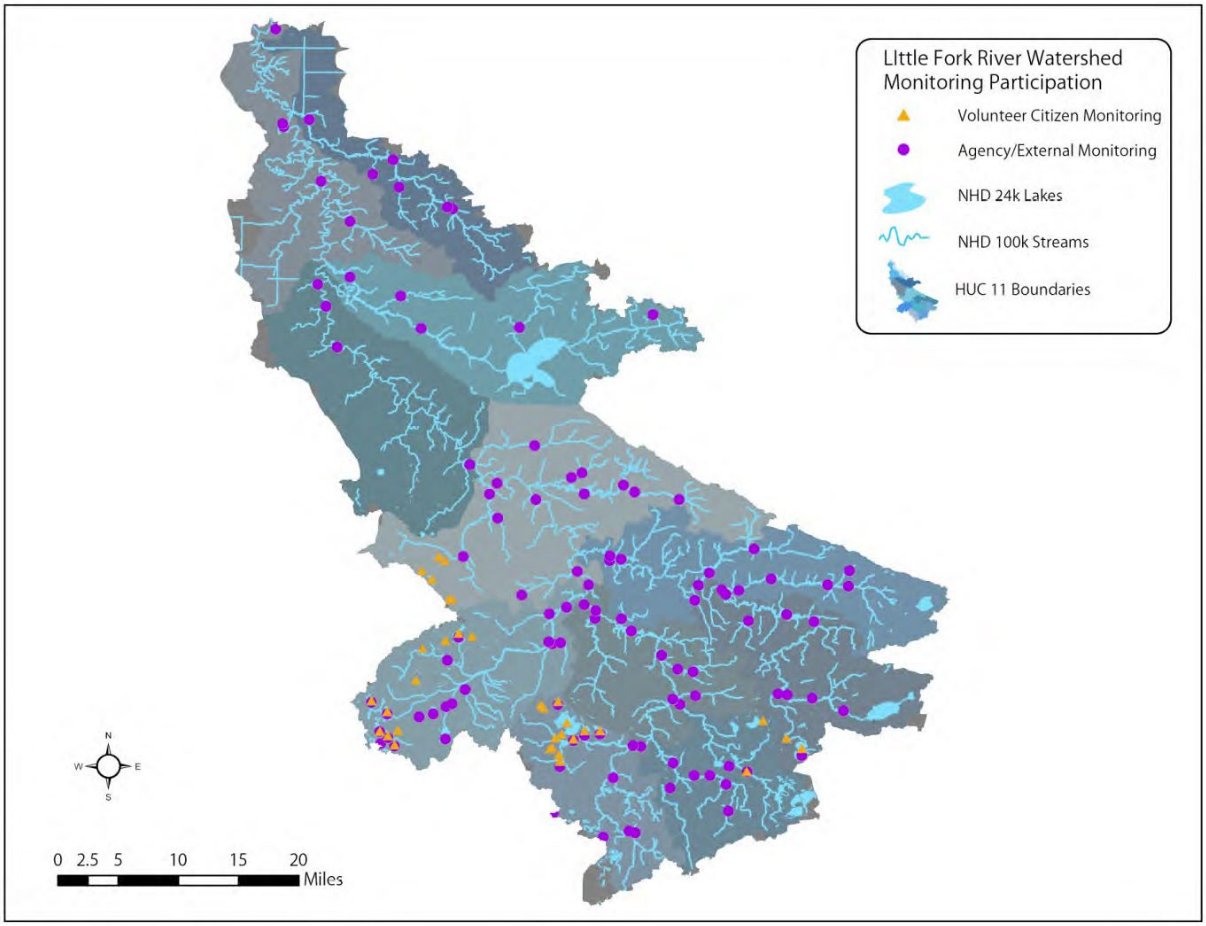

Figure 13. Monitoring locations of local groups, citizens, and the MPCA monitoring staff in the Little Fork River Watershed (MPCA 2011).

7.2 Best Management Practices (BMP) Monitoring

Onsite monitoring of implementation practices is recommended in order to better assess BMP effectiveness. A variety of criteria such as land use, soil type, and other watershed characteristics, as well as monitoring feasibility, will be used to determine which BMPs to monitor. Under these criteria, monitoring of a specific type of implementation practice can be accomplished at one site but can be applied to similar practices under similar criteria and scenarios. Effectiveness of other BMPs can be extrapolated based on monitoring results. BMP monitoring roles and responsibilities are described in greater detail in the Little Fork River WRAPS Report.

8. Implementation Strategy Summary

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 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. All local construction stormwater requirements must also be met.

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 Municipal Separate Storm Sewer System (MS4)

The MPCA has not assigned TSS loads to a regulated MS4 community as part of this TMDL, as the city of Hibbing is located upstream of an impaired stream boundary condition. There are currently no other MS4 communities in the Little Fork River Watershed.

If a regulated MS4 community is defined in the future, the MPCA oversees all regulated MS4 entities in stormwater management accounting activities. All regulated MS4s in the watershed fall under the category of Phase II. MS4 NPDES/SDS Permits require regulated municipalities to implement BMPs to reduce pollutants in stormwater runoff to the Maximum Extent Practicable (MEP).

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, including the following six minimum control measures:

- Public education and outreach
- Public participation
- Illicit Discharge Detection and Elimination (IDDE) Program
- Construction-site runoff controls
- Post-construction runoff controls
- Pollution prevention and municipal good housekeeping measures

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 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, which have been completed within the previous year, analyze implementation activities already installed, and outline any changes within the SWPPP from the previous year.

8.1.4 Wastewater

There currently are five permitted municipal and industrial wastewater facilities in the Little Fork River Watershed (Table 9). The MPCA issues permits for WWTFs that discharge into waters of the state. The permits have site specific limits that are based on water quality standards. Permits regulate discharges with the goals of: 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. In addition, SDS Permits set limits and establish controls for land application of sewage. Any new facilities would also be subject to this permitting process.

8.2 Non-Permitted Sources

8.2.1 Best Management Practices (BMPs)

A variety of BMPs to restore and conservation practices to protect the lakes and streams within the Little Fork River Watershed are outlined and prioritized in the Little Fork River WRAPS Report. Conservation practices may include, but are not limited to: BMPs – regulated stormwater (municipal, industrial, and construction), agricultural and rural BMPs, riparian buffers, targeted stream bank stabilization and stream restoration projects, and targeted restoration of watershed hydrology. More information about types of practices and implementation of BMPs is discussed in the Little Fork River WRAPS Report.

8.2.2 Education and Outreach

A crucial part in the success of the restoration and protection plan that will be designed to clean up the impaired streams and protect the non-impaired water bodies will be participation from local citizens. In order to gain support from these citizens, education and civic engagement opportunities will be necessary. A variety of educational avenues can and will be used throughout the watershed. These include, but are not limited to, press releases, meetings, workshops, focus groups, trainings, websites, etc. Local staff (conservation district, watershed, county, non-profits, etc.) and board members work to educate the residents of watersheds about ways to clean up their lakes and streams on a regular basis. Education will continue throughout the watershed.

8.2.3 Technical Assistance

The counties and soil and water conservation districts (SWCDs) within the watershed provide assistance to landowners for a variety of projects that benefit water quality. Assistance provided to landowners varies from agricultural and rural BMPs to urban and lakeshore BMPs. This technical assistance includes education and one-on-one training. Many opportunities for technical assistance are the result of educational workshops or trainings. It is important that these outreach opportunities for watershed residents continue. Programs such as state cost share, Clean Water Legacy funding, Lessard-Sams Fund, Environmental Quality Incentives Program (EQIP), and Conservation Reserve Program (CRP) are available to help target and implement the best conservation practices for each parcel of land. Marketing is necessary to motivate landowners to participate in voluntary cost-share assistance programs.

8.2.4 Partnerships

Partnerships with counties, cities, townships, citizens, businesses, watersheds, lake associations, and the Bois Forte Band of Chippewa are one mechanism through which the Koochiching SWCD, North St. Louis SWCD, and Itasca SWCD, will protect and improve water quality. Strong partnerships with Tribal, state and local governments to protect and improve water resources and to bring waters within the Little Fork River Watershed into compliance with state standards will continue. A partnership with local government units (LGUs) and regulatory agencies such as cities, townships and counties may be formed to develop and update ordinances to protect the area's water resources.

8.3 Cost

The Clean Water Legacy Act requires that a TMDL include an overall estimate of the cost to implement a TMDL [Minn. Stat. § 114D.25]. A detailed analysis of the cost to implement the TSS TMDLs was not conducted. An interagency work group (Board of Water and Soil Resources, Department of Agriculture, MPCA, Association of SWCDs, Association of Watershed Districts, Natural Resources Conservation Service) assessed restoration costs for several TMDLs with an average cost estimate of $117,000/square mile for a watershed based treatment approach. Multiplied by the total area of the TSS impaired stream watersheds (482 square miles) results in a total cost of $56.4M.

8.4 Adaptive Management

This list of implementation elements and the more detailed Little Fork River WRAPS report focus on adaptive management (Figure 14). Continued monitoring and "course corrections" 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.

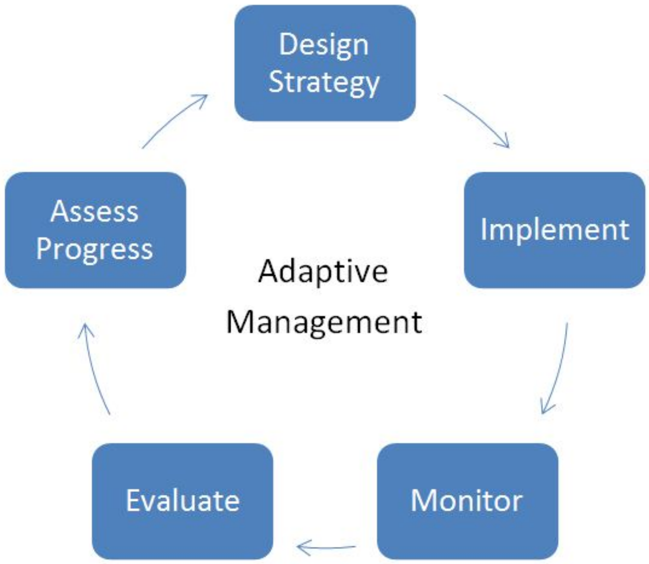

Figure 14. Adaptive Management

9. Public Participation

9.1 Technical Committee Meetings

The Little Fork River Watershed is made up of numerous local partners who have been involved at various levels throughout the project. A technical committee has been meeting since 2012 and is made up of members representing the MPCA, DNR, Minnesota Department of Health, Minnesota Department of Agriculture, counties, and SWCDs within the watershed. The following table outlines the meetings that occurred regarding the Little Fork River monitoring and assessment, TMDL development, and WRAPS Report planning. In addition to these formal meetings, many one-on-one conversations and small group discussions were held with both technical committee members, local politicians, and interested citizens throughout this process.

Table 14. Little Fork River Watershed Technical Committee Meetings

Date	Location	Meeting Focus
4/10/14	Grand Rapids	Monitoring and Assessment Meeting
6/6/14	Conference Call	Monitoring and Assessment Meeting
6/26/14	Duluth, MN	TMDL Initial Meeting
7/16/14	Conference Call	Technical Advisory Meeting
9/17/14	Conference Call	Technical Advisory Meeting
11/25/14	Conference Call	TMDL Planning Meeting
12/15/14	Conference Call	TMDL Planning Meeting

9.2 Civic Engagement Meetings

The MPCA along with the local partners and agencies in the Little Fork River Watershed recognize the importance of public involvement in the watershed process. The following table outlines the opportunities used to engage the public and targeted stakeholders in the watershed. In addition to these formal meetings, many one-on-one conversations and small group discussions were held at local venues throughout the watershed. An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from July 24, 2017 to August 23, 2017.

Table 15. Little Fork River Watershed Civic Engagement Meetings

Date	Location	Meeting Focus
9/30/13	Cook	TMDL Kick-off
10/22/13	Littlefork	TMDL Kick-off
4/23/14	Carpenter Township	Coffee With the Commissioners
7/11/14-7/13/14	Littlefork	Northern District Fair
7/18/14	Side Lake	Public Event
1/14/15	Littlefork	TMDL Results
1/15/15	Cook	TMDL Results
3/18/15	Littlefork	Forestry
3/18/15	Littlefork	WRAPS Kick-off
3/19/15	Side Lake	Forestry
3/19/15	Side Lake	WRAPS Kick-off
5/21/15	Littlefork	WRAPS development
7/23/15	Littlefork	WRAPS development
9/24/15	Cook	WRAPS development
3/29/16	Cook	WRAPS development

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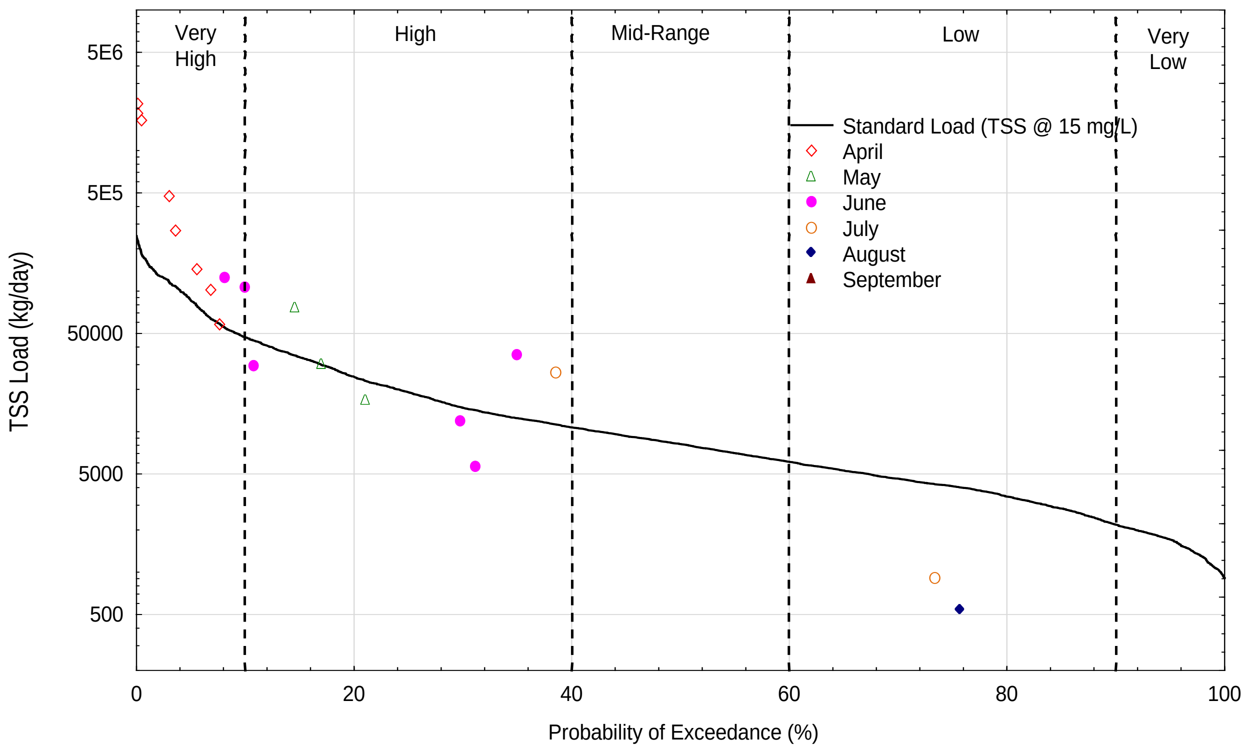

Figure 15. Little Fork River (Willow River to Valley River, 09030005-506) TSS Load Duration Curve

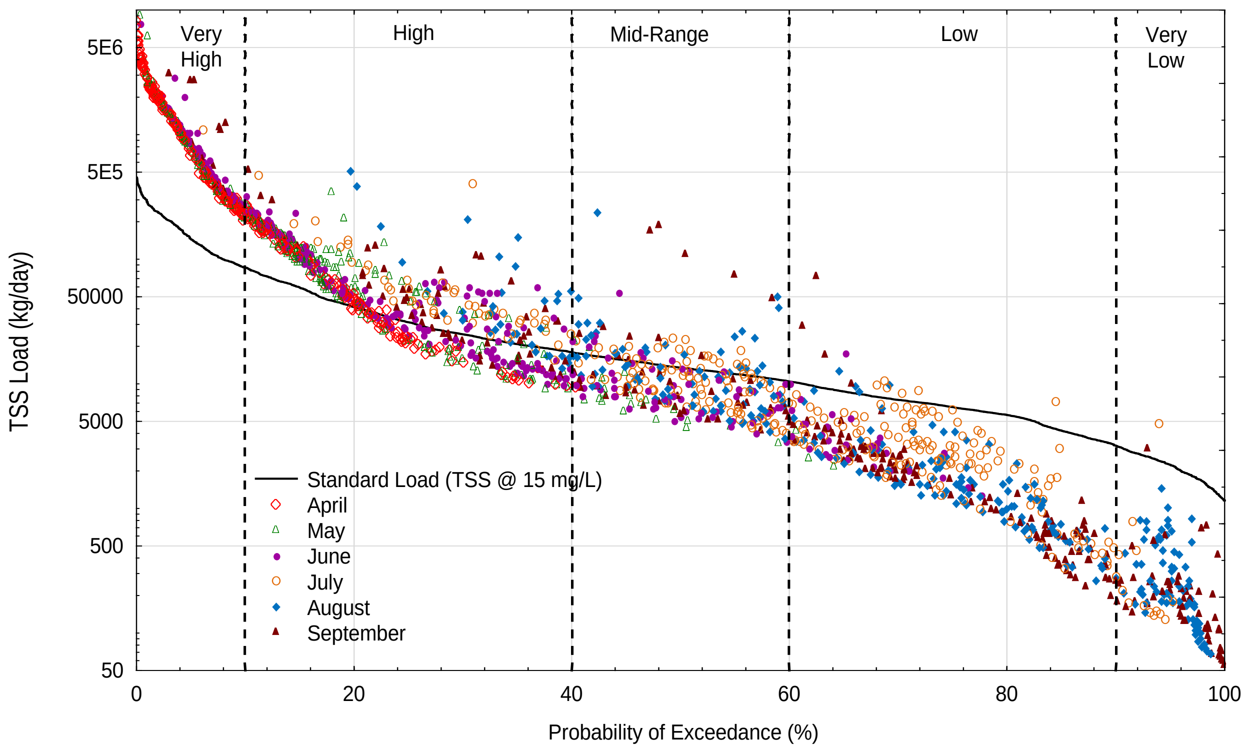

Figure 16. Little Fork River (Cross River to Beaver Brook, 09030005-510) TSS Load Duration Curve

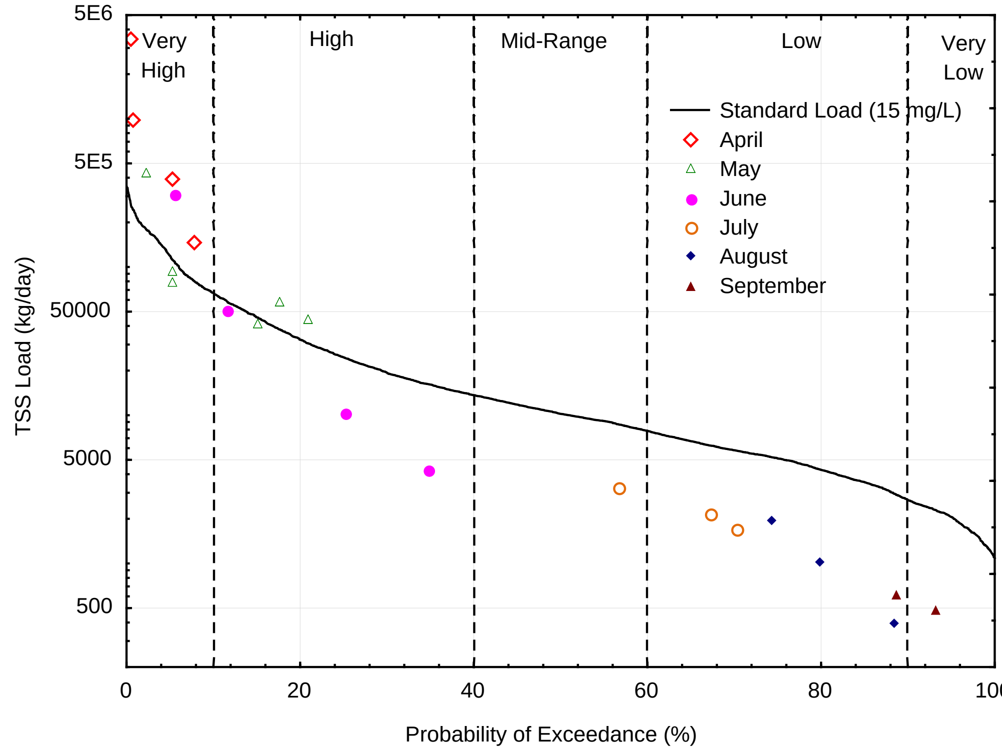

Figure 17. Little Fork River (Prairie Creek to Nett Lake River, 09030005-508) TSS Load Duration Curve

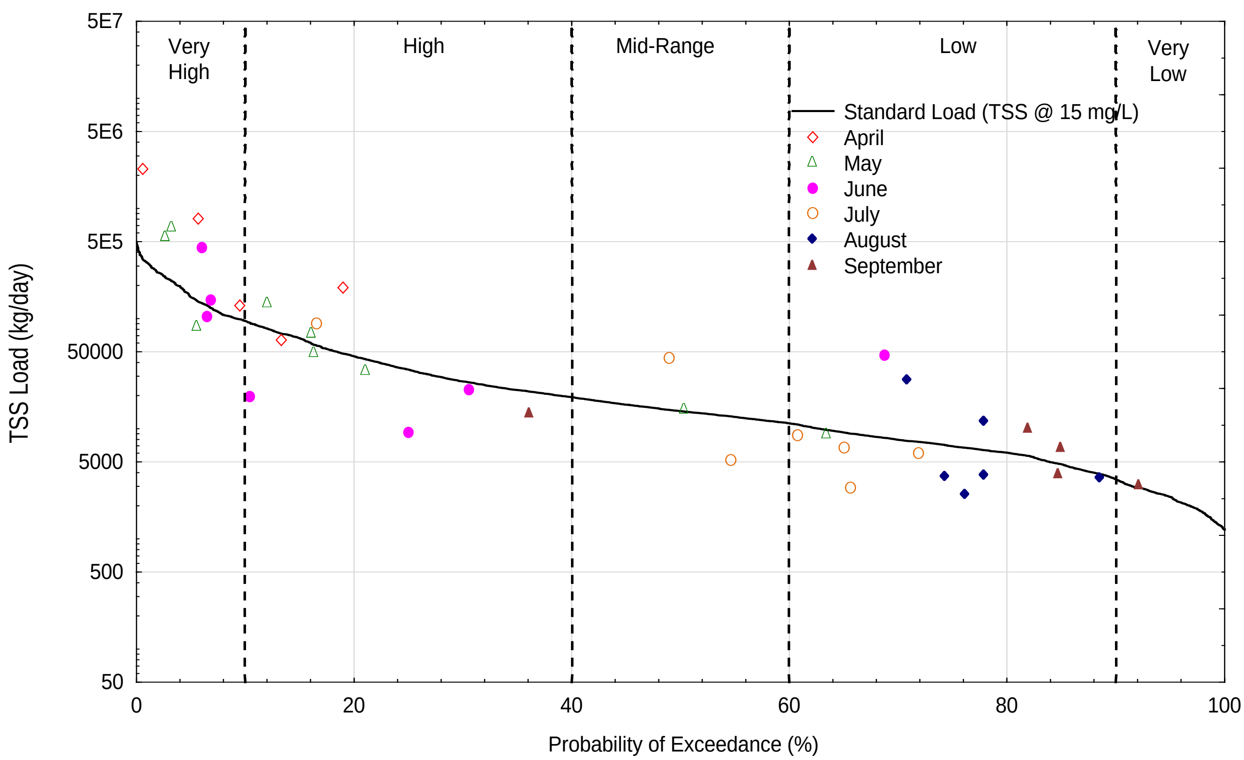

Figure 18. Little Fork River (Beaver Brook to Rainy River, 09030005-501) TSS Load Duration Curve

Appendix B. Data Summary – Load Duration Curve Analysis

Table 16. LDC Data Summary Table, Little Fork River Watershed

Impaired Reach Name/AUID	Modeled Flow & TSS Loads		Monitoring Data		
	HSPF Subbasin ID	Date Range	Water Quality Station	Date Range of TSS Samples	Comments
Little Fork River 09030005-506	HSPF subbasin 370	2000-2009	**S002-551**	2004, 2006-2008, 2012	WQ station located approx. 3.7 miles upstream of reach outlet (closer to upstream end of reach - about 1.5 mi downstream of reach inlet)
Little Fork River 09030005-508	HSPF subbasin 430		**S002-552**	2004, 2008, 2012	WQ station located approx. 3.9 miles upstream of reach outlet
Little Fork River 09030005-510	HSPF subbasin 510		**S002-556**	2004, 2006-2013	WQ station located approx. 1.9 miles upstream of reach outlet
Little Fork River 09030005-501	HSPF subbasin 530		**S000-179**	2002-2005, 2007-2010	WQ station located near reach outlet

USGS gage 05131500 is located approximately 2.8 miles upstream of the outlet for reach AUID 9030005-510