Watershed

November 2020

Upper Mississippi River Total Suspended Solids Total Maximum Daily Load Report

This report quantifies the total amount of total suspended solids that can be received by the Upper Mississippi River and maintain its ability to support healthy biological communities, and identifies needed reductions.

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Acronyms

AUID	Assessment Unit Identification
AWWDF	annual wet weather design flow
BC	Boundary condition
BMP	best management practice
BOD	biochemical oxygen demand
BWSR	Board of Water and Soil Resources
cfs	cubic feet per second
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
DNR	Minnesota Department of Natural Resources
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
F-IBI	Fish Index of Biological Integrity
gSSURGO	Gridded Soil Survey Geographic Database
HSPF	Hydrologic Simulation Program-FORTRAN
HUC	Hydrologic Unit Code
IDDE	Illicit Discharge Detection and Elimination
kg	kilogram
LA	load allocation
Lb	pound
LiDAR	Light Detection and Ranging
m	meter
MAWQCP	Minnesota Agricultural Water Quality Certification Program
MDA	Minnesota Department of Agriculture
MDF	maximum design flow
mg/L	milligrams per liter
MGS	Minnesota Geological Survey
mL	milliliter
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MR-B	Mississippi River-Brainerd
MR-GR	Mississippi River-Grand Rapids

MS4	Municipal Separate Storm Sewer Systems
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRS	Nutrient Reduction Strategy
NTU	Nephelometric Turbidity Unit
NVSS	nonvolatile suspended solids
OHWM	ordinary high water mark
ORVW	Outstanding Resource Value Water
PWP	Permanent Wetland Preserve
RIM	Reinvest in Minnesota
SFIA	Sustainable Forest Incentive Act
sq. mi.	square mile
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TP	total phosphorus
TSS	total suspended solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
VSS	volatile suspended solids
WLA	wasteload allocation
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	Watershed Restoration and Protection Strategy
WRP	Wetland Reserve Program
WWTF	wastewater treatment facility
WWTP	wastewater treatment plant

Executive summary

The Clean Water Act (1972) requires that each state develop a Total Maximum Daily Load (TMDL) Study for any waterbody that is deemed impaired by state regulations. A TMDL identifies the pollutant that is causing the impairment and how much of that pollutant can enter the waterbody and still meet water quality standards.

This TMDL study addresses total suspended solids (TSS) impairments in three reaches of the Upper Mississippi River that are on Minnesota's 2018 303(d) list of impaired waters: Swan River to Willow River (07010103-708); Willow River to Pine River (07010104-655); and Pine River to Crow Wing River (07010104-656). The Upper Mississippi River is located in North Central Minnesota, and the impaired reaches extend from near Grand Rapids in Itasca County to near Brainerd in Crow Wing County.

Information from multiple sources was used to evaluate the ecological health of each waterbody:

- All available water quality data from the TMDL 10-year time period (2009 through 2018)
- Mississippi River-Grand Rapids (MR-GR) Watershed Hydrologic Simulation Program – FORTRAN (HSPF) model
- Mississippi River-Brainerd (MR-B) Watershed HSPF model
- U.S. Army Corps of Engineers Dam Operation and Maintenance Reports
- Relevant biological observation data
- Stakeholder input

The following pollutant sources were evaluated for each stream: loading from upstream waterbodies; point sources; geologic conditions; near stream development; and watershed runoff. This TMDL study used a load duration curve for each impaired stream based on TSS concentration data from April through September during the TMDL 10-year time period of 2009 through 2018, paired with HSPF simulated flows by date. These models were then used to determine the pollutant reductions needed for the impaired waterbodies to meet water quality standards.

The dominant source of sediment to the Upper Mississippi River within the TMDL Study Area is nonpoint sources, in particular bed and bank erosion of the finely-grained, easily erodible Glacial Lake Aitkin/Upham clay deposits. Historical ditching in peatlands has resulted in a significant amount of altered watercourses in the Study Area. Consequences of altered hydrology include channel instability characterized by bank erosion and streambed material alteration, as well as increasing the amount of water in downstream reaches. Land use conversions near the river channel also contribute sediment through greater soil erosion from physical trampling of the banks from livestock, less stabilization of the soil from shallow rooted plants, more areas of exposed soil, and more concentrated runoff flowpaths. Watershed runoff and regulated wastewater and stormwater sources contribute a small fraction of the total sediment to the Upper Mississippi River TMDL Study Area.

The TMDL study's results will aid in the future management and improvement in the watershed. Following completion of the TMDL process, the Upper Mississippi River TMDL Report will be publically available on the Minnesota Pollution Control Agency (MPCA) MR-GR and MR-B Watershed websites:

https://www.pca.state.mn.us/water/watersheds/mississippi-river-grand-rapids https://www.pca.state.mn.us/water/watersheds/mississippi-river-brainerd

1. Project overview

1.1 Purpose

The large rivers of Minnesota are managed using a similar monitoring, assessment, planning, and restoration process as other waterbodies in the state. The MPCA began monitoring large rivers in 2013, starting with the Mississippi River from its headwaters to the St. Anthony Falls in Minneapolis, Minnesota. The results from the first monitoring and assessment study completed in 2013/2014 are summarized in the Upper Mississippi River: Monitoring and Assessment Study summary (MPCA 2017) and in Figure 1 below.

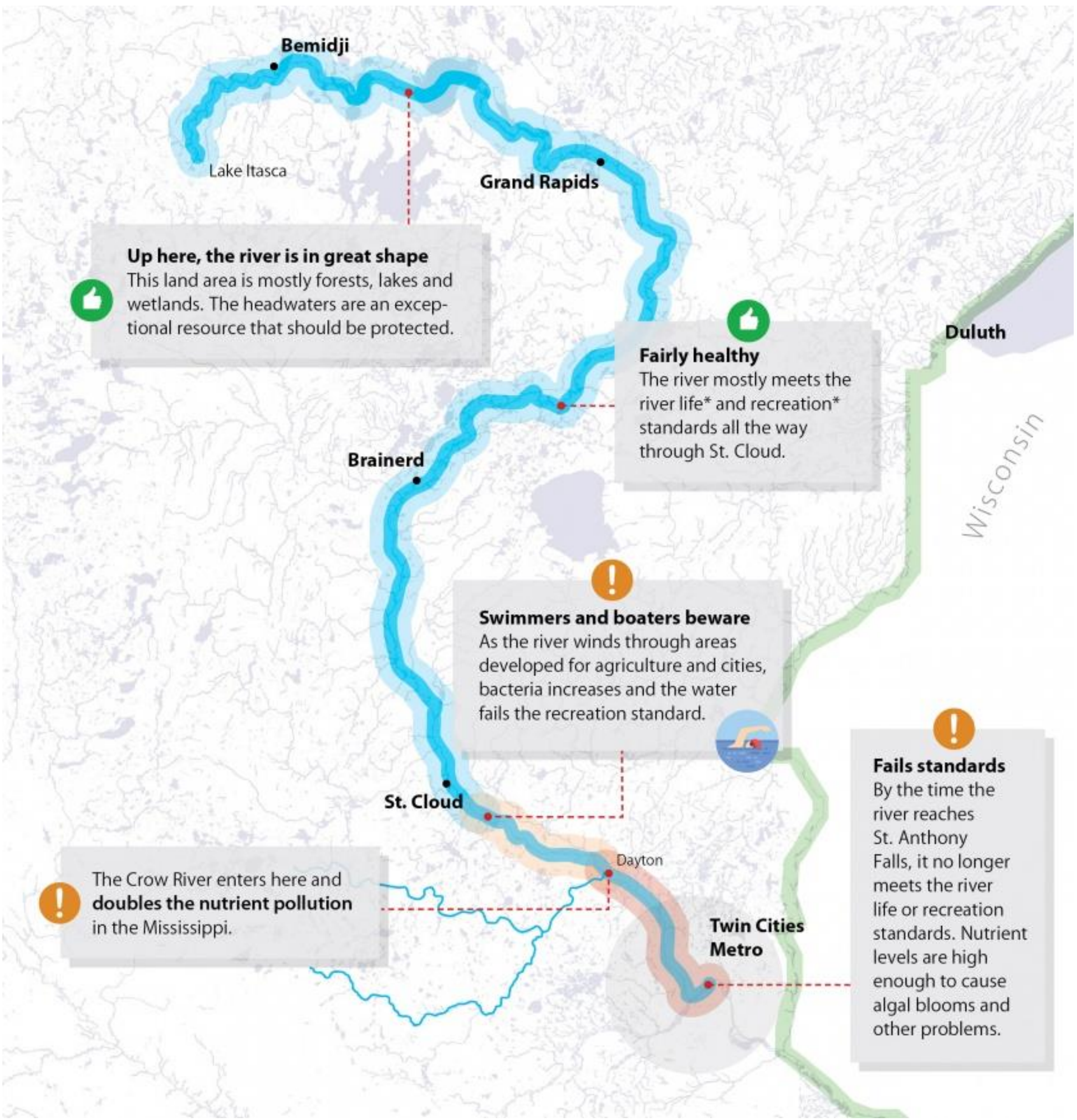


Figure 1. Upper Mississippi River 2013/2014 Monitoring and Assessment Study Summary.

The State of Minnesota has determined that three reaches of the Upper Mississippi River - Swan River to Willow River (07010103-708), Willow River to Pine River (07010104-655), and Pine River to Crow Wing River (07010104-656) - are impaired because they exceed established state water quality standards for TSS and do not support their designated aquatic life uses. In accordance with the Clean Water Act, the state must conduct TMDL studies on the impaired waters. The goals of this TMDL are to provide wasteload allocations (WLA) and load allocations (LA) for pollutant sources within the TMDL Study Area for the impaired portions of the Upper Mississippi River mainstem, and to quantify the pollutant reductions needed to meet Minnesota water quality standards.

Other watershed studies completed that are referenced in this TMDL include:

- Mississippi River – Brainerd Watershed TMDL Study
- Mississippi River – Grand Rapids Watershed TMDL Study

1.2 Identification of waterbodies

This TMDL study addresses three turbidity/TSS impairments on the mainstem of the Upper Mississippi River located between Grand Rapids and Brainerd (Table 1).

Table 1. Upper Mississippi River Mainstem Impairments.

Affected Use: Pollutant/Stressor	AUID	Stream Name	Location/Reach Description	Designated Use Class	Listing Year	Impairment Addressed by:
Aquatic Life: TSS	07010103-708	Mississippi River	Swan River to Willow River	2Bg, 3C	2016	**TSS TMDL**
Aquatic Life: Turbidity	07010104-655	Mississippi River	Willow River to Pine River	2Bg, 3C	1998*	**TSS TMDL**
Aquatic Life: TSS	07010104-656	Mississippi River	Pine River to Crow Wing River	2Bg, 3C	2016	**TSS TMDL**

* The turbidity impairment was originally listed based on nephelometric turbidity unit (NTU) data; however, this reach also exceeds the TSS standard and will be addressed by a TSS TMDL based on TSS monitoring data collected during the TMDL 10-year timeframe (2009-2018).

1.3 TMDL Study Area

The Upper Mississippi River begins at Lake Itasca in northern Minnesota. It flows first north, and then easterly through Lake Winnibigoshish and Pokegama Lakes, before turning south and west through Aitkin and Brainerd (Figure 2). The total drainage area to the most downstream segment of the impaired portion of the Upper Mississippi River at the confluence with the Crow Wing River includes all of four major watersheds (Upper Mississippi River-Headwaters, MR-GR, Pine River, and Leech Lake River) and a portion of one major watershed (MR-B), for a total of 7,061 square miles in portions of Clearwater, Becker, Hubbard, Beltrami, Itasca, Cass, St. Louis, Carlton, Aitkin, and Crow Wing counties.

The MPCA completes assessments and TMDLs for lakes and streams within each major watershed separately from the large river mainstems. Therefore, only a portion of the total drainage area to the impaired reaches of the Upper Mississippi River were included in this TMDL (the TMDL Study Area). Only pollutant sources within the TMDL Study Area are addressed by this TMDL. The TMDL Study Area was defined as the drainage area located downstream of any subwatershed with a monitoring station located near its outlet that has less than 10% of TSS samples exceeding the water quality standard of 15 mg/L based on all data collected between 2007 through 2016 (Table 2). TSS monitoring station locations are depicted in Figure 5.

The TMDL Study Area and upstream subwatersheds are depicted for the Mississippi River, Swan River to Willow River (07010103-708) in Figure 2, for the Mississippi River, Willow River to Pine River (07010104-655) in Figure 3, and for the Mississippi River, Pine River to Crow Wing River (07010104-656) in Figure 4.

Table 2. TMDL Study Area (shaded red) and upstream subwatershed area TSS monitoring data.

Subwatershed Name (HUC)	Subwatershed Area (sq. mi.)	Monitoring Station	Number of Samples	Number of Exceedances	Percentage of Exceedances
Mississippi River Headwaters (07010101)	1,920	S003-656	320	0	0%
Leech Lake River (07010102)	1,341				
Prairie River (0701010301 & 0701010302)	508	S003-667	12	0	0%
Swan River (0701010304)	328	S001-922	166	10	6%
Big Sandy River (0701010305 & 0701010306)	409	NA	NA	NA	NA
Swan River to Willow River (07010103-708) TMDL Study Area	321	S000-153	28	12	43%
		S003-663	56	44	79%
Willow River (2 HUC10s) (0701010307, 0701010308)	516	S008-442	20	0	0%
Rice River (HUC10) (0701010401)	297	S002-951	16	1	6%
Willow River to Pine River (07010104-655) TMDL Study Area	428	S002-010	370	296	80%
		S000-152	36	32	89%
Pine River (HUC8) (07010105)	783	S000-181	184	2	1%
Pine River to Crow Wing River (07010104-656) TMDL Study Area	210	S000-572	36	10	28%
		S007-337	36	10	28%
		S000-570	36	10	28%

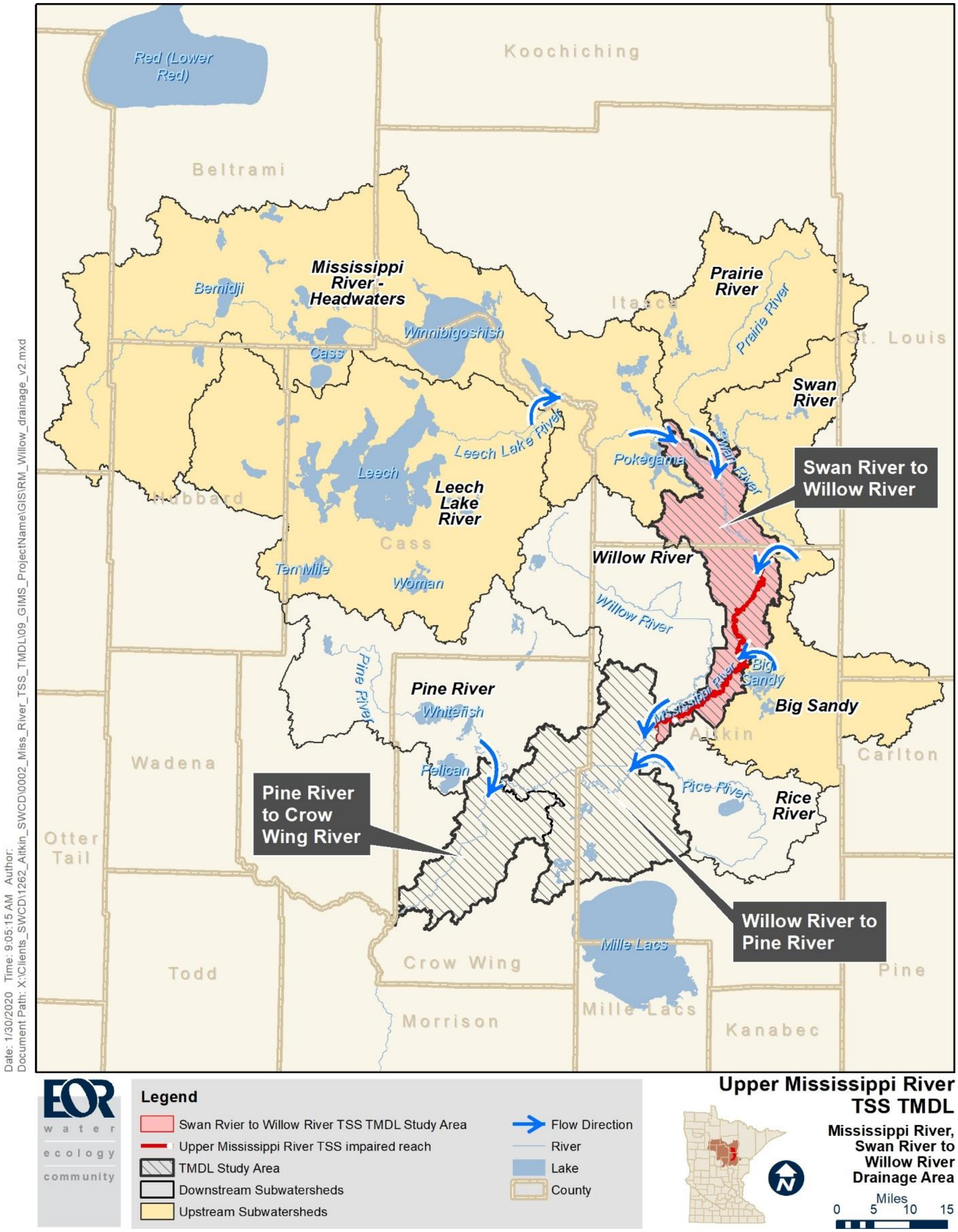


Figure 2. Mississippi River, Swan River to Willow River (7010103-708) TMDL Study Area and upstream subwatersheds.

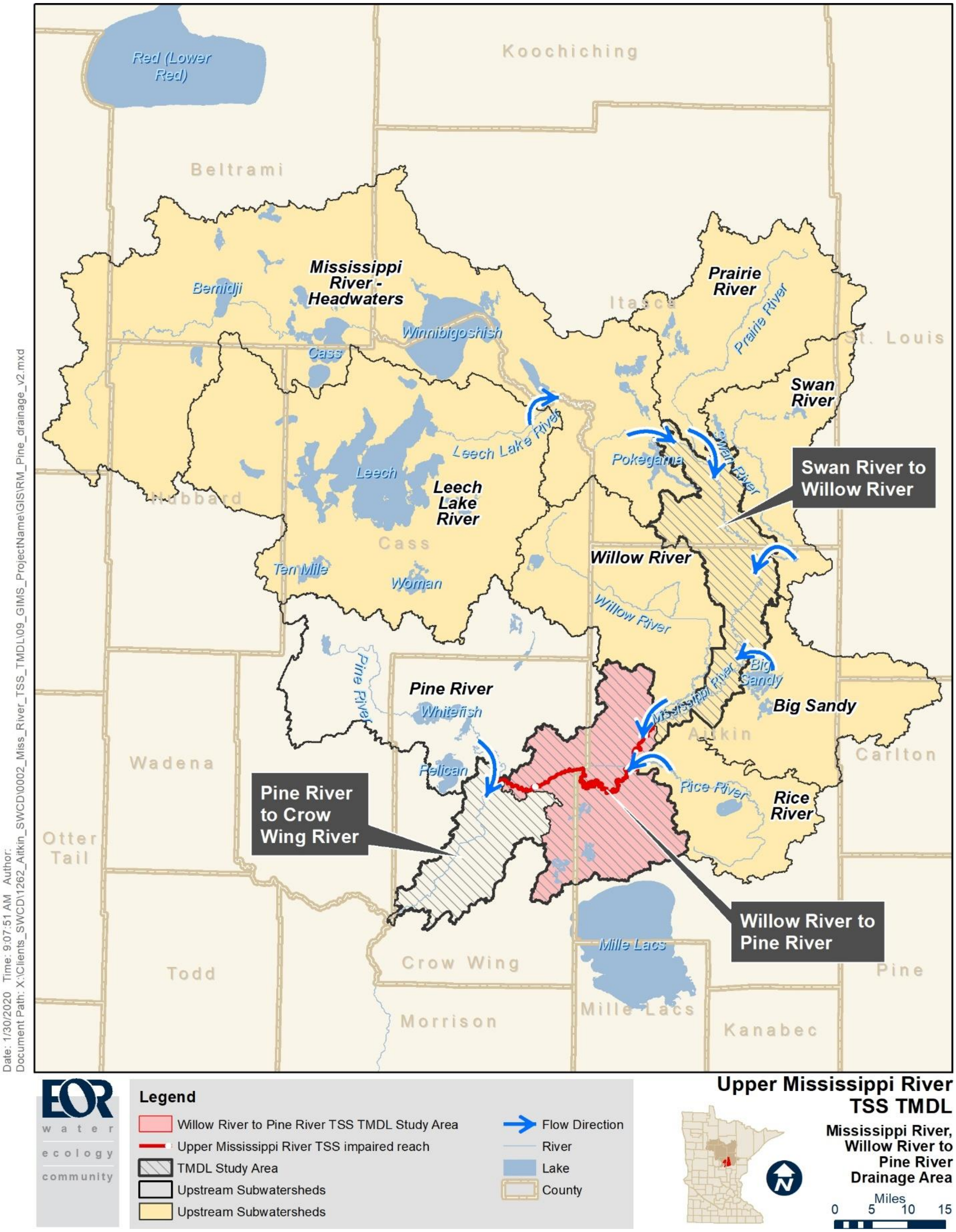


Figure 3. Mississippi River, Willow River to Pine River (7010104-655) TMDL Study Area and upstream subwatersheds.

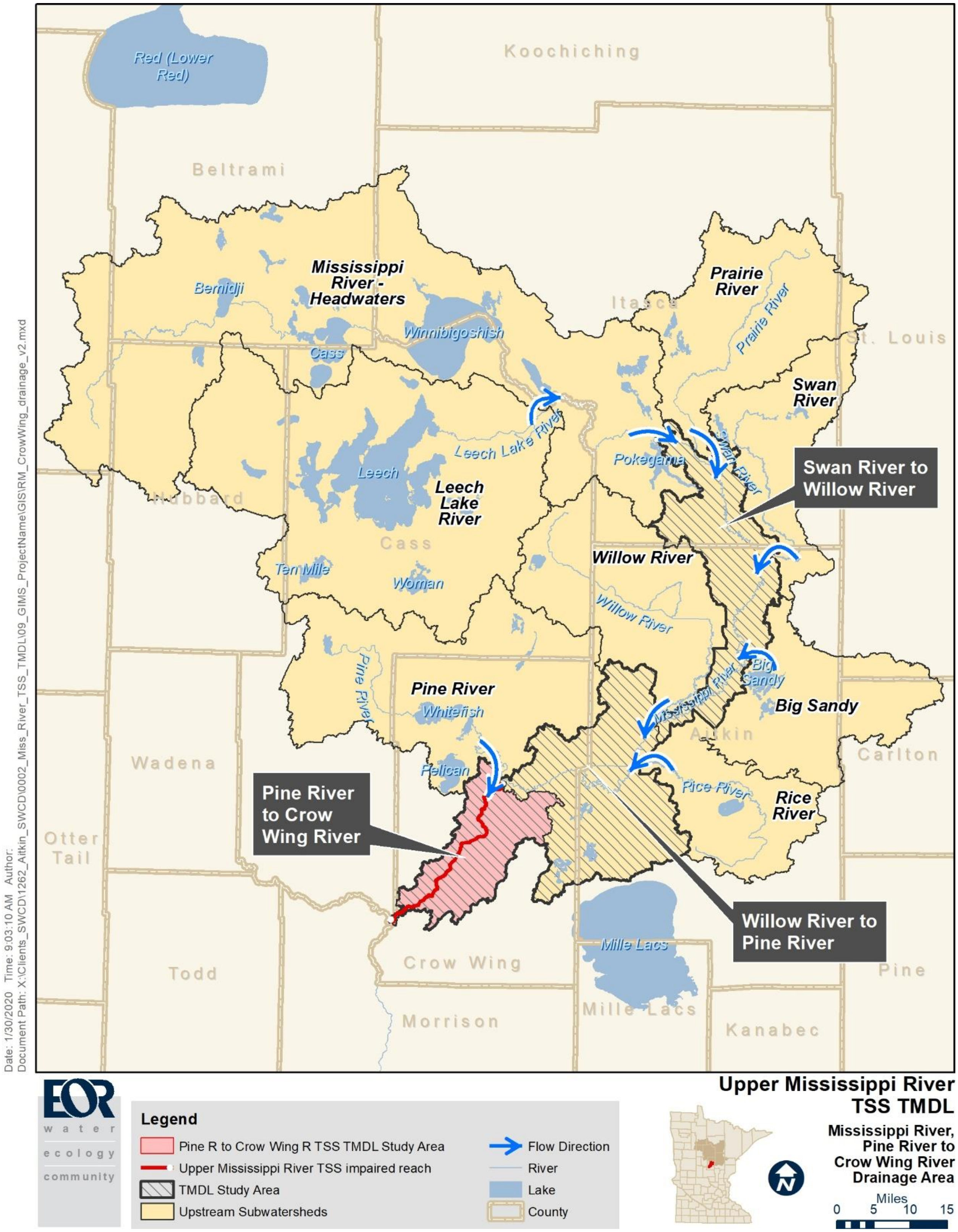


Figure 4. Mississippi River, Pine River to Crow Wing River (7010104-656) TMDL Study Area and upstream watersheds.

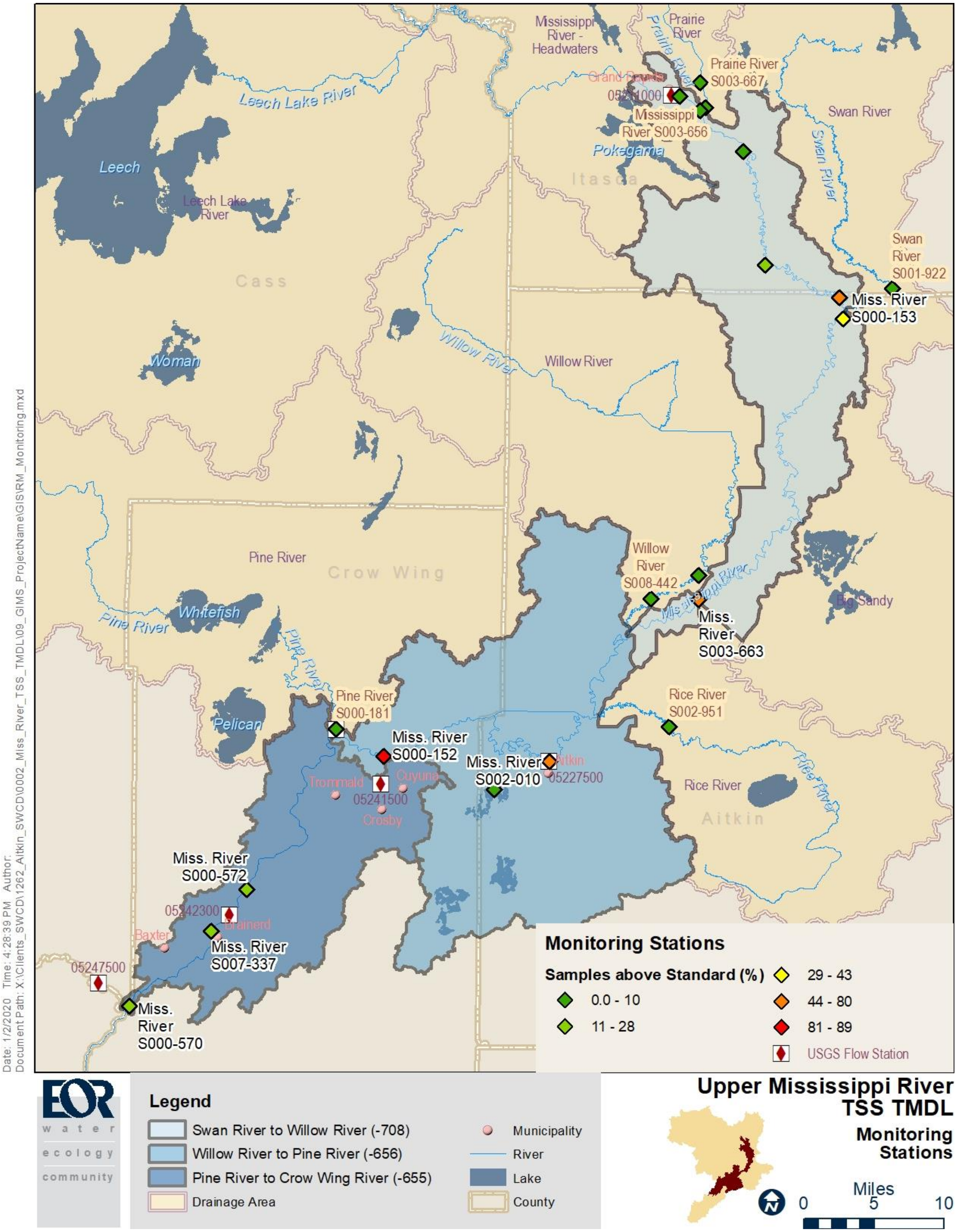


Figure 5. TMDL Study Area and TSS monitoring station locations.

2. Applicable water quality standards and numeric water quality targets

Water quality standards are the fundamental regulatory and policy foundation to preserve and restore the quality of all waters of the state. They consist of three elements:

- Classifying waters with designated beneficial uses;
- Narrative and numeric standards to protect those uses; and
- Antidegradation policies to maintain existing uses, protect high quality waters, and preserve waters of outstanding value.

2.1 Designated uses

As part of Minnesota's water quality standards, each stream in the state 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 designated use classification:

- 2Bg, 3C – Cool or warm water stream capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the General Use biological criteria; industrial cooling and materials transport without high level of treatment

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 designated use class in this study is 2Bg, for which water quality standards are provided below.

2.2 Priority ranking

The MPCA's schedule for TMDL completions, as indicated on Minnesota's Section 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 Watershed Restoration and Protection Strategy (WRAPS) cycle. As the TMDL Study Area crosses two watersheds, it was completed outside of, but concurrent with, the MR-GR and MR-B WRAPS cycles. 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 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 Upper Mississippi River waters addressed by this TMDL are part of that MPCA prioritization plan to meet EPA's national measure.

2.3 Numeric standards for turbidity/TSS

2.3.1 Turbidity/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 Section 2.1 for a definition of the designated use classes). One portion of the Upper Mississippi River Basin was assessed against the class 2B turbidity standard first established in 1967 (25 NTU). A minimum of 20 independent observations was required for the turbidity assessment, and a stream was listed as impaired by turbidity if 10% or more of the observations were in violation of the turbidity standard.

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). The turbidity impairment for the Mississippi River, Willow River to Pine River, was originally listed in 1998 based on turbidity NTU data; however, this reach also exceeds the TSS standard and will be addressed by a TSS TMDL based on TSS monitoring data collected during the TMDL 10-year timeframe (2009 through 2018).

The TSS criteria for Minnesota are stratified by geographic region and stream class due to regional differences in geology and biological sensitivity differences based on stream size. The assessment window for these samples is April-September, so any TSS data collected outside of this period will not be considered for assessment purposes. The TMDL Study Area is located in the Northern River Nutrient Region with a TSS standard for streams of 15 milligrams per liter (mg/L). For assessment, this concentration is not to be exceeded in more than 10% of samples within a 10-year data window. TSS samples are analyzed by state-certified laboratories. TSS load duration curves and TMDLs were developed for three stream impairments.

For more information, refer to the *Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity)* (Markus 2011), and the *Minnesota Nutrient Criteria Development for Rivers* report (Heiskary et al. 2013).

2.4 Antidegradation/Outstanding resource value waters

Antidegradation (formerly referred to as nondegradation) is the third element of water quality standards. Antidegradation protections help maintain high quality waters (waters better than what is necessary to protect aquatic life and recreation) from deterioration. Antidegradation protections were established to provide future generations with the opportunity to enjoy high quality and highly valued recreational and aesthetic resources that might suffer degradation without them. Preventing degradation is almost always less costly and more effective than restoration, which cannot always be fully achieved.

Three levels of protection are incorporated into antidegradation rules:

- Existing uses of the water body must be maintained and protected.
- Existing high water quality must be maintained unless a lowering of water quality is deemed necessary to accommodate important economic and social development.
- The exceptional characteristics of specific waters designated in Minnesota rules as outstanding, very sensitive, or unique resources – called “outstanding resource value waters” or ORVWs (Minn. R. 7050.0335) -- must be maintained and protected.

The three impaired reaches of the Upper Mississippi River addressed by this TMDL are designated as ORVW – Restricted as defined in Minn. R. 7050.0335, subp. 1B: “portions of the Mississippi River from Lake Itasca to the southerly boundary of Morrison County that are included in the Mississippi River Headwaters Board comprehensive plan dated February 12, 1981.” If there is an improvement (in exceptional characteristics) of an ORVW as a result of changes to control conditions specified in a permit/control document, or if a regulated activity ceases to discharge or adversely impact an ORVW, then the ‘bar’ is reset at a higher level to prevent any degradation of the (improved) ORVW.

3. Watershed and waterbody characterization

The majority of the TMDL Study Area is located in either the Tamarack Lowlands subsection or the St. Louis Moraines subsection of Minnesota’s ecological classification system. Much of the Tamarack Lowlands subsection is occupied by glacial lacustrine sediments from the Glacial Lake Upham and Glacial Lake Aitkin, including extensive areas of peat over both fine-textured silts and clays, and sandy lacustrine deposits. These fine-grained soils are highly susceptible to erosion when disturbed, and bank erosion is frequently observed along the Mississippi River where the channel cuts through these glacial lake clays. The underlying geology of the TMDL Study Area is a contributor to high TSS levels in the impaired reaches of the Upper Mississippi River; see Section 3.5.2.1 for more details.

Pre-European settlement vegetation consisted of conifer and hardwood forests with extensive sedge meadows in the lowlands (https://www.dnr.state.mn.us/ecs/212Nd/index.html). The St. Louis Moraines subsection is recognizable by the distinct end moraines of the St. Louis and Koochiching Sublobes. Loamy calcareous soils make up the majority of the soils in this region. Pre-European settlement vegetation was defined by large areas of white pine-red pine forests and northern hardwoods south of Grand Rapids (https://www.dnr.state.mn.us/ecs/212Nb/index.html).

Natural conditions in this stretch of the Mississippi River were first modified in the late 1800s and early 1900s, with the construction of the Mississippi Headwater dams to improve navigation and support logging activity. More information about the history of the Mississippi River Headwaters Reservoirs can be found in the Mississippi River Headwaters Reservoirs Master Plan (U.S. Army Corps of Engineers 2016). During this time, riverboats were an important form of navigation with at times multiple companies competing with each other. Many of these riverboats were built too long to maneuver along the sinuous Mississippi River and therefore would occasionally rub up against the banks, destabilizing them and causing erosion (Hart 1952).

There are two small areas of Mille Lacs Band of Ojibwe Off-Reservation Trust Land located within the TMDL Study Area (see Figure 6). The Mille Lacs Band of Ojibwe was invited to participate in the WRAPS process by MPCA in August of 2016.

3.1 River reaches

The three impaired reaches of the Upper Mississippi River are all located within the Northern Lakes and Forest Ecoregion and the Northern River Nutrient Region. The United States Geological Survey Hydrologic Unit Code (HUC) Level 8 (HUC-8) watershed and reach length for each impaired large river reach are summarized in Table 3.

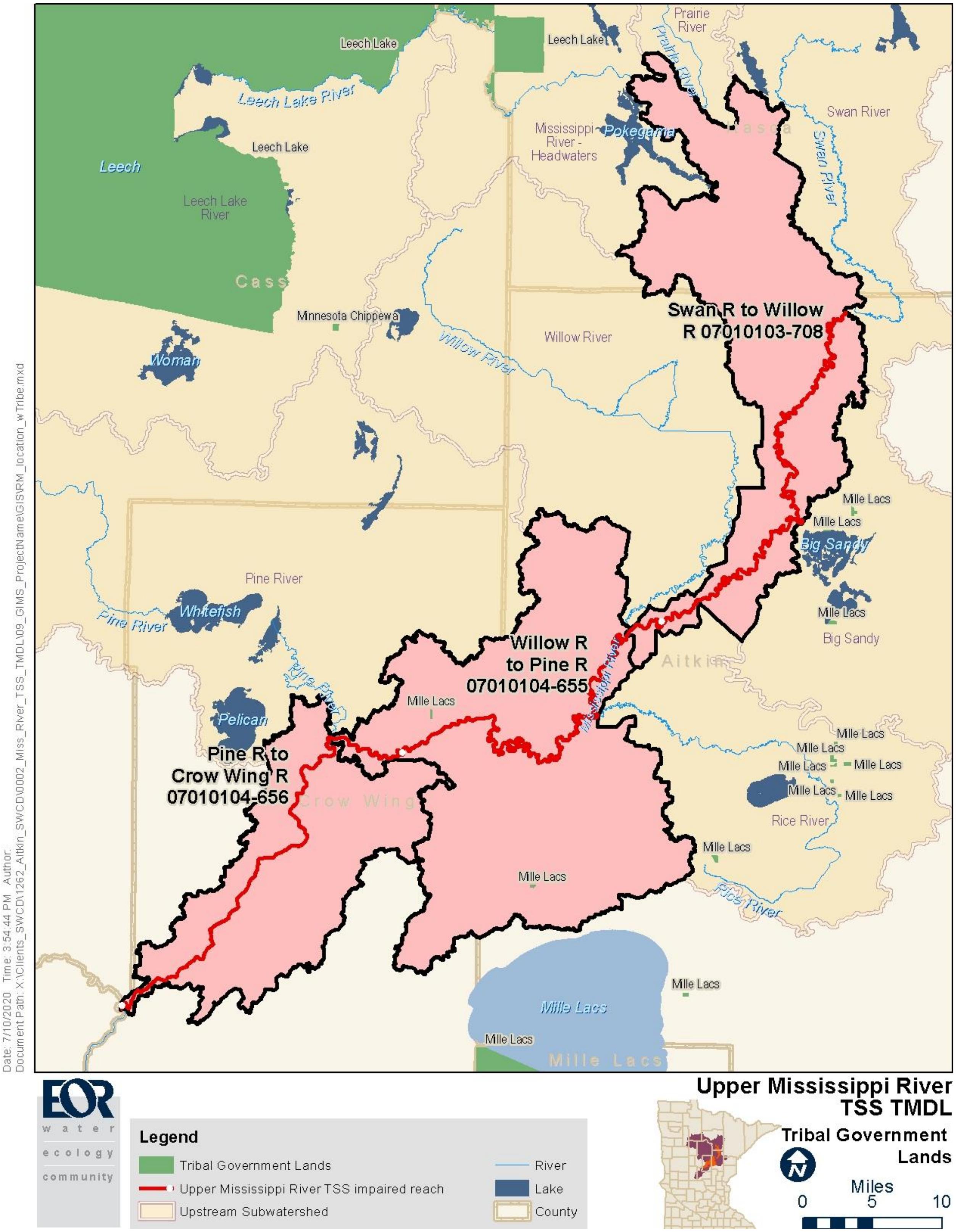


Figure 6. Tribal Government Lands in the Upper Mississippi River TSS TMDL Study Area

Table 3. Impaired Stream Reach HUC-8 watershed and reach length (miles)

Impaired AUID	Impaired Reach Description	HUC 8 Watershed	Length (miles)
07010103-708	Mississippi River, Swan River to Willow River	Mississippi River – Grand Rapids	60.13
07010104-655	Mississippi River, Willow River to Pine River	Mississippi River – Brainerd	54.4
07010104-656	Mississippi River, Pine River to Crow Wing River	Mississippi River – Brainerd	33.21

3.2 Subwatersheds

The TMDL Study Area in acres for each impaired reach are listed in Table 4 and shown with flow direction arrows in Figure 7. See Section 1.2 for the method for how the TMDL Study Area was determined and the upstream subwatersheds of each impaired reach.

Table 4. Impaired Stream Reach Direct Drainage and Total Drainage Areas

Impaired AUID	Impaired Reach Description	TMDL Study Area (sq. mi.)	Upstream Subwatershed Area (sq. mi.)	Total Drainage Area (sq. mi.)
07010103-708	Mississippi River, Swan River to Willow River	321	4,506	4,827
07010104-655	Mississippi River, Willow River to Pine River	428	5,640	6,068
07010104-656	Mississippi River, Pine River to Crow Wing River	210	6,851	7,061

3.3 Land use

Land cover in the TMDL Study Area was assessed using the Multi-Resolution Land Characteristics Consortium 2016 National Land Cover Database (NLCD) (https://www.mrlc.gov/national-land-cover-database-nlcd-2016). Land cover is necessary to draw conclusions about pollutant sources and best management practices (BMP) that may be applicable within each subwatershed. The land cover distribution within the drainage area to each impaired stream reach is summarized in Table 5 and Figure 8. The land cover categories in Table 5 are simplified to reduce the overall number of categories. Wetlands include woody wetlands and emergent herbaceous wetlands. Forest includes deciduous forest, evergreen forest, and mixed forest. Agriculture includes hay pasture and cultivated crops. Developed includes developed open space, developed low intensity, developed medium intensity and developed high intensity. Wetlands and forest make up the majority of the land cover in the TMDL Study Area with 40% and 33%, respectively.

Table 5. Land Cover Summary for the TMDL Study Area (NLCD 2016).

Impaired Large River AUID	TMDL Study Area (sq. mi.)	Open Water	Barren Land	Wetlands	Grasslands	Forest & Shrubs	Agriculture	Developed
07010103-708	321	4%	0.1%	50%	1%	33%	8%	4%
07010104-655	428	9%	0.1%	40%	1%	31%	15%	4%
07010104-656	210	11%	0.2%	26%	1%	40%	11%	10%

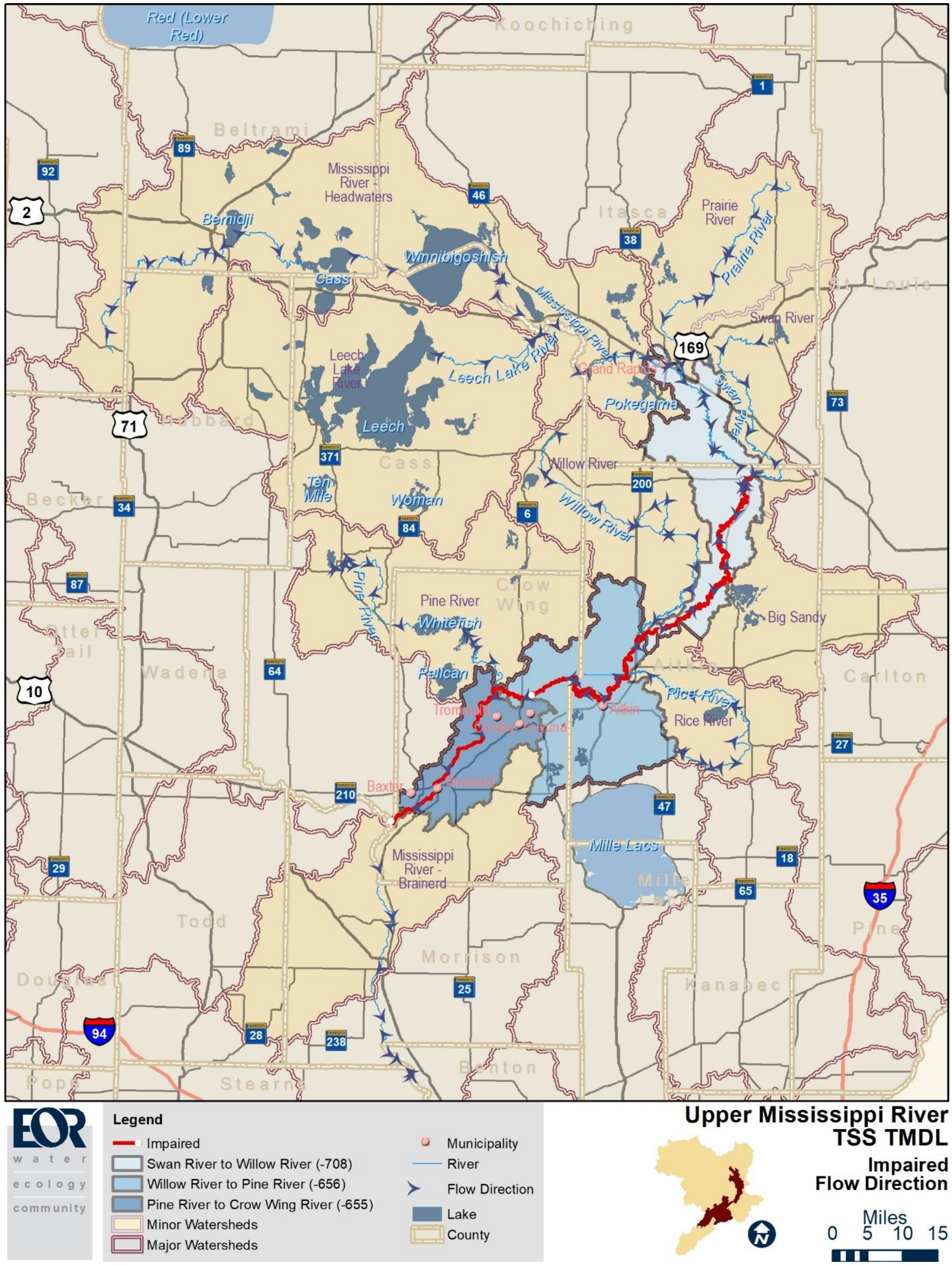


Figure 7. TMDL Study Area subwatersheds and flow direction.

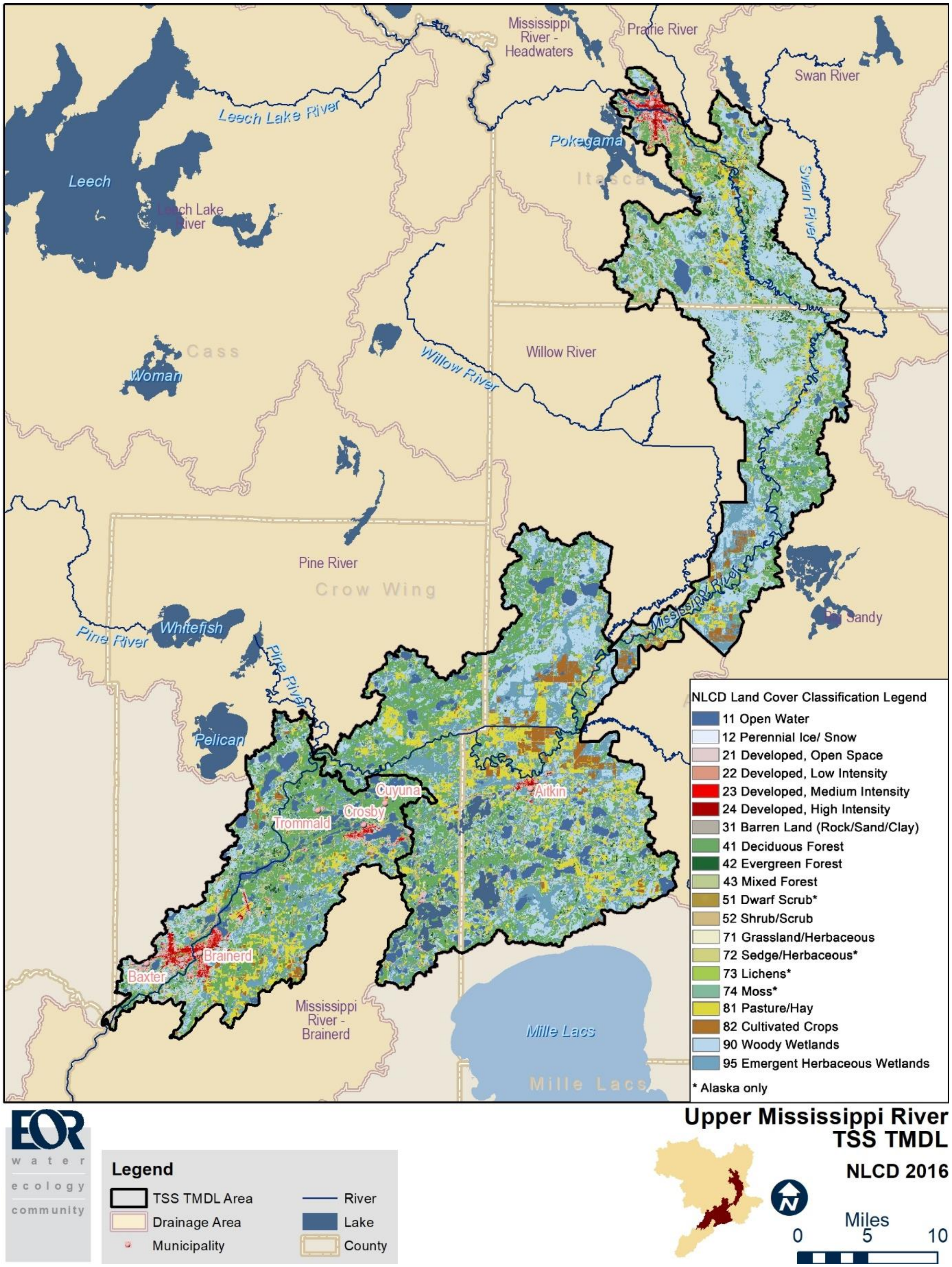


Figure 8. TMDL Study Area land cover (NLCD 2016).

3.4 Current/historical water quality

3.4.1 Total Suspended Solids

Sediment transport in a watershed is a naturally occurring process that shapes everything from the shape of the uplands to the shape and characteristics of the riparian areas. Human activity such as agriculture and urbanization can augment this natural process. In the TMDL Study Area, the sediment transport process has been changed by land use change caused from logging, agriculture, and urbanization, and from flow alteration caused by the Mississippi River Headwaters Reservoirs and legacy peatland ditching.

TSS data in the TMDL Study Area for the period of 2009 through 2018 were compared to the water quality standards described in Section 2. The percentage of TSS exceedances was greater than 10% at every monitoring station along the impaired stream reaches of the TMDL Study Area (Table 6). The distribution of TSS concentrations between April and September for each monitoring station in the project study area is shown in **Figure** 9. TSS concentrations begin to increase above the water quality standard before the impaired stream reach at monitoring station S007-332, 7.9 miles south of Warba. The number of TSS exceedances continues to increase downstream until station S000-152, north of Crosby, with a peak percentage of exceedances of 89%. Downstream of the Pine River confluence with the Mississippi River mainstem, TSS concentrations begin to decrease. The locations of the water quality monitoring stations are shown in Figure 5 in Section 1.3.

The monthly distribution of TSS concentrations in the TMDL Study Area was characterized using the full dataset (808 measurements) at station S002-010, Mississippi River at CSAH Bridge in Aitkin (Figure 10). The highest TSS concentrations occurred from March through July (Figure 10), which is the time period that corresponds to the highest flow in the Mississippi River. This relationship is also shown in Figure 11, which shows larger flows being associated with higher TSS concentrations as the water has more energy to carry sediment.

Table 6. Observed TSS Exceedances from April to September (2009-2018).

Impaired Reach (AUID)	Monitoring Station (Upstream to Downstream)	Number of Samples	Number of Exceedances (> 15 mg/L)	Percentage of Exceedances	90th Percentile Concentration (mg/L)
Mississippi River, Swan River to Willow River (07010103-708)	S000-153	28	12	43%	18
	S003-663	56	44	79%	39
Mississippi River, Willow River to Pine River (07010104-655)	S002-010	370	296	80%	38
	S000-152	36	32	89%	30.5
Mississippi River, Pine River to Crow Wing River (07010104-656)	S000-572	36	10	28%	19
	S007-337	36	10	28%	20.5
	S000-570	36	10	28%	20.5

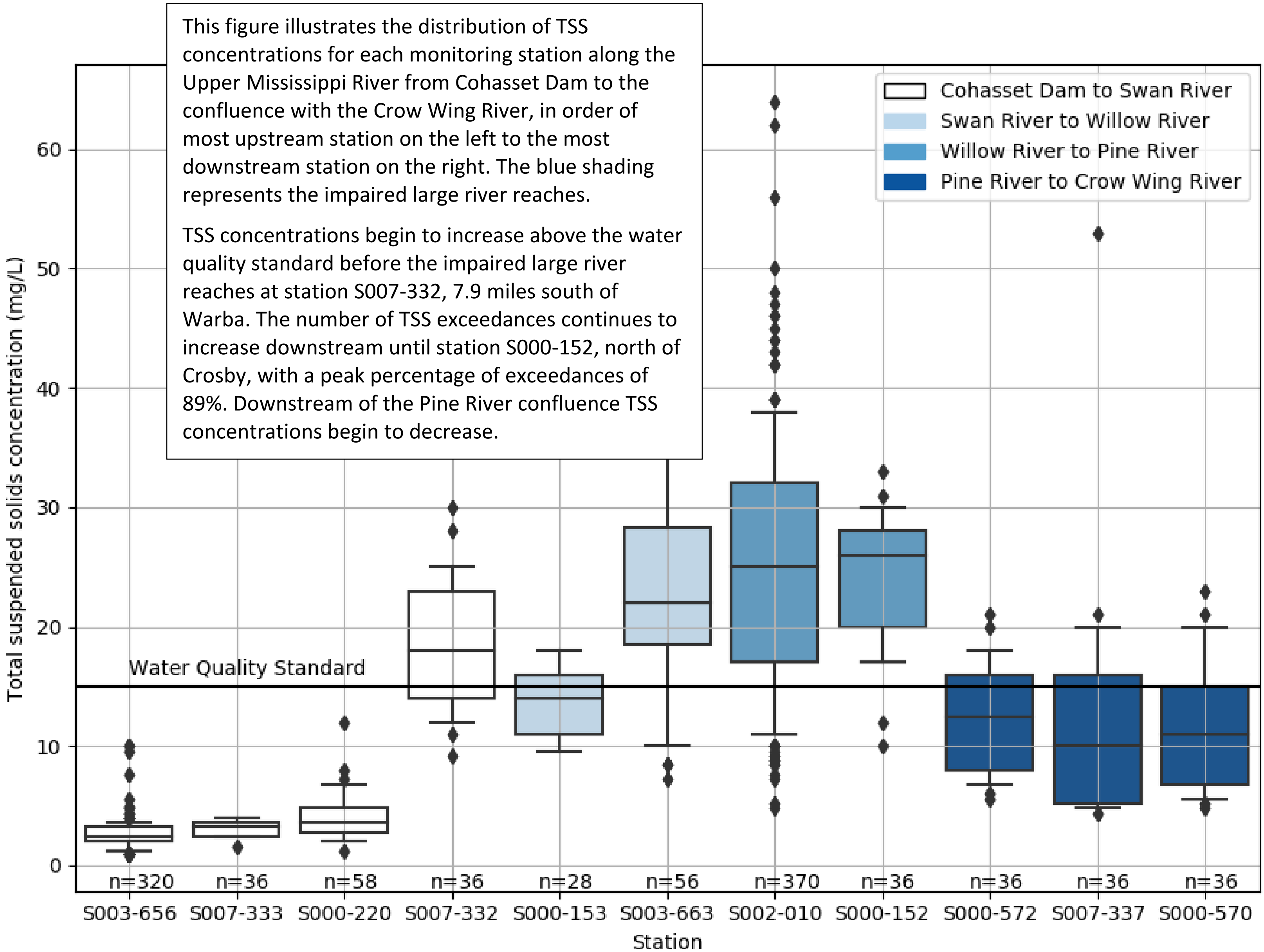


Figure 9. Distribution of total suspended solids concentrations along the main stem of the Mississippi River from Cohasset Dam to Crow Wing River moving upstream to downstream (April-September, 2009-2018).
Whiskers represent the 10th percentile and 90th percentile TSS concentrations. The sample size is displayed below the corresponding box plot.

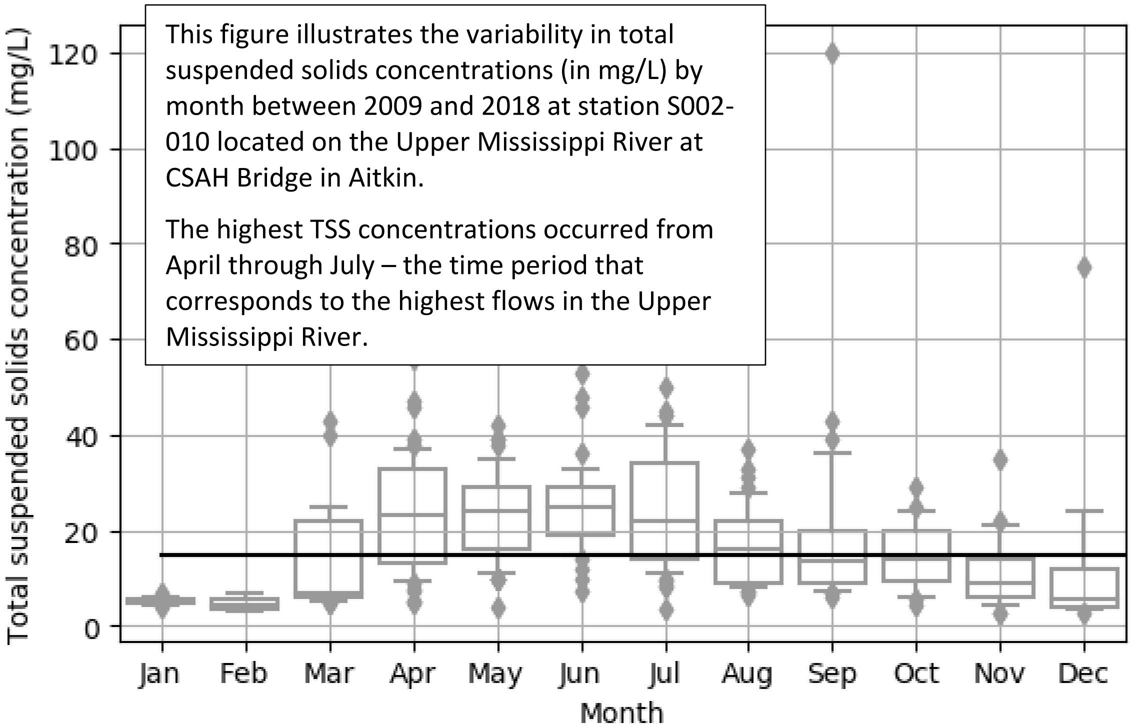


Figure 10. Monthly distribution of TSS concentrations at CSAH 1 Bridge at Aitkin (07010104-655 at S002-010).

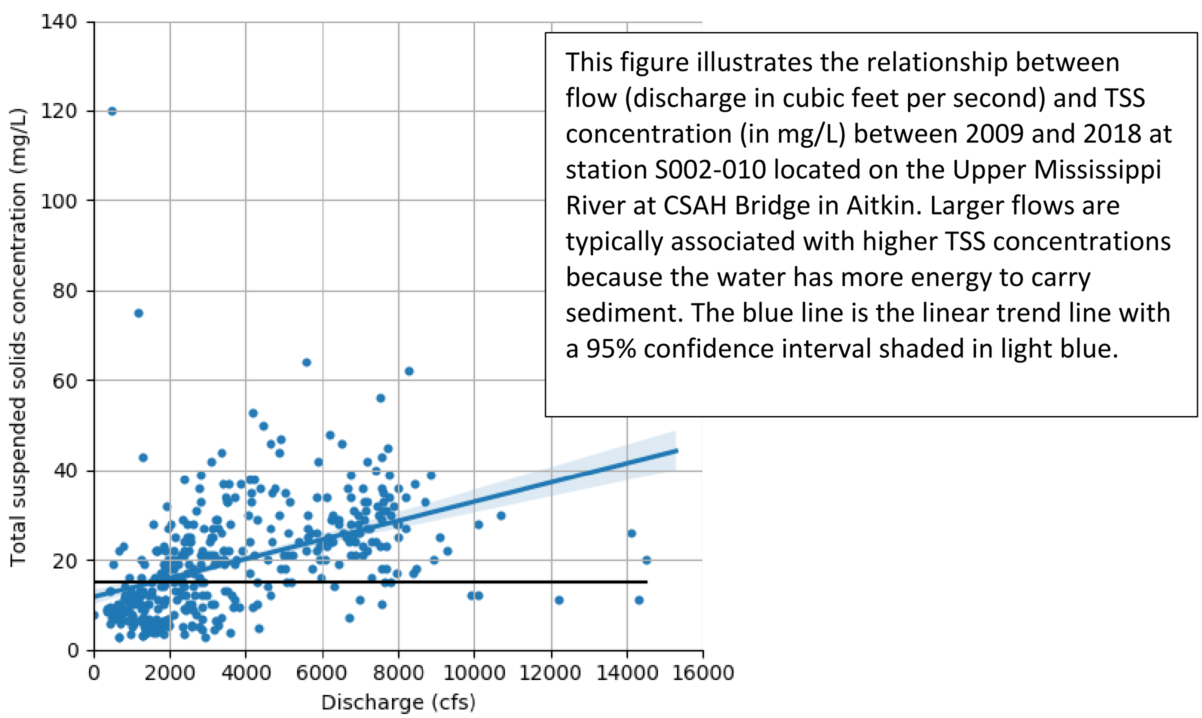


Figure 11. Total suspended solids concentration (in mg/L) and discharge flow (in cubic feet per second) relationship at CSAH 1 Bridge at Aitkin (07010104-655 at S002-010, USGS station 05227500) plotted with a statistically significant linear trend line and 95% confidence interval with a p-value of less than 0.001.

3.4.2 Fish bioassessments

The Fish Index of Biological Integrity (F-IBI) is a biological monitoring framework used to quantify changes in the composition of biological communities. The presence of a diverse and reproducing aquatic community is a good indication that the aquatic life beneficial use is being supported by a stream. The aquatic community integrates the cumulative impacts of pollutants, habitat alteration, and hydrologic modification on a waterbody over time. Degradation of surface waters can lead to changes in biological communities as pollutant intolerant species are replaced by pollutant tolerant species. Characterization of an aquatic community is accomplished using the IBI, which incorporates multiple attributes of the aquatic community, called "metrics," to evaluate complex biological systems. These metric scores are summed within each class and rescaled to a 0-100 range, with 100 being the highest score. For further information regarding the development of stream Index of Biological Integrity (IBIs), refer to the Development of a F-IBI for Minnesota's Rivers and Streams (MPCA 2014a).

F-IBI scores along the Upper Mississippi River mainstem reaches impaired by TSS all exhibited good fish ratings, with F-IBI scores above the upper confidence interval (Table 7, Figure 12). The total number of fish species observed at each monitoring station ranged from 11 to 24. The good F-IBI metric scores and ratings indicate that the current biology is either not impacted by the existing TSS exceedances, or is adapted to the existing TSS exceedances. F-IBI scores represent the cumulative impacts of pollutants, habitat alteration, and hydrologic modification on a waterbody to the fish community over time. Therefore, good F-IBI scores indicate that the fish community is not negatively impacted by pollutants (in this case high TSS levels), habitat alteration, and hydrologic modifications to the impaired portions of the Mississippi River.

Table 7. Fish bioassessment results for the TMDL Study Area (2013), in order from most upstream to most downstream monitoring station.

Impaired AUID	Monitoring Station	Location Description	Sample Date	Total Species	F-IBI	Rating
07010103-708	13UM019	Upstream of Pokegama Creek	August 14, 2013	11	71	Good
	13UM018	Upstream of Sandy River	July 23, 2013	18	66	Good
07010104-655	13UM017	Upstream of Rice River	July 22, 2013	19	69	Good
			August 8, 2013	17	70	Good
	13UM016	Upstream of Dean Brook	July 29, 2013	19	67	Good
07010104-656	13UM015	Between Mission Creek and Ironton (Blackhoof) Creek	August 7, 2013	17	62	Good
	13UM014	West of Brainerd Lakes Regional Airport	August 1, 2013	14	56	Good
	13UM033	Near Washington Street in Brainerd, MN	August 1, 2013	24	59	Good
	13UM013	Upstream of Crow Wing River	July 29, 2013	21	75	Good
			August 13, 2013	13	83	Good

Good = above upper confidence interval (Source: MPCA Surface Water Environmental Data Access website)

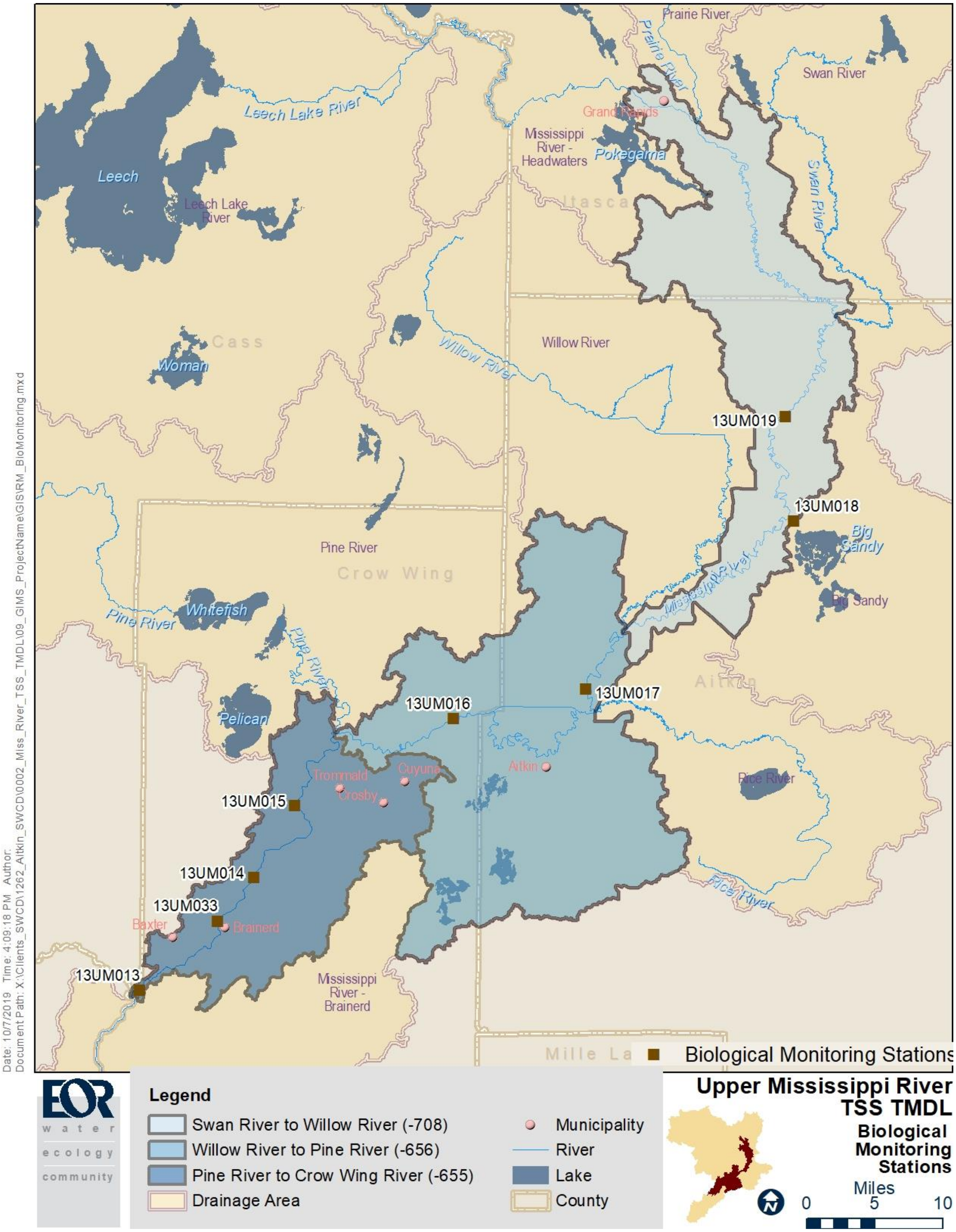


Figure 12. TMDL Study Area 2013 biological monitoring sites.

3.5 Pollutant source summary

3.5.1 Permitted source types

Regulated National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) permitted sources of pollutants include wastewater treatment plant (WWTP) effluent, permitted feedlots, municipal separate storm sewer systems (MS4s), construction stormwater, and industrial stormwater. TSS loads from NPDES/SDS permitted wastewater and stormwater sources were accounted for using the methods described in subsequent Section 4.2.3. There are no permitted feedlots within the TMDL Study Area.

3.5.1.1 Regulated stormwater

Regulated stormwater delivers and transports pollutants to surface waters and is generated in the watershed during precipitation events. The sources of pollutants in stormwater are many, including decaying vegetation (leaves, grass clippings, etc.), domestic and wild animal waste, soil, deposited particulates from air, road salt, and oil and grease from vehicles. There are three types of regulated stormwater in the watershed:

Regulated MS4 Stormwater

The MPCA defines an MS4 on the Municipal Stormwater (MS4) webpage as a conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, etc.) that is also:

- Owned or operated by a public entity (which can include cities, townships, counties, military bases, hospitals, prison complexes, highway departments, universities, sewer districts, etc.),
- Designed or used for collecting or conveying stormwater,
- Not a combined sewer, and;
- Not part of a publicly owned treatment works.

NPDES/SDS Permits administered by the MPCA regulate certain MS4 discharges. The cities of Grand Rapids (MS400269) and Brainerd (MS400266) are regulated MS4 communities because they have a population of at least 10,000 people and discharge to an ORVW. The City of Baxter (MS400231) is a regulated MS4 community because they have a population of at least 5,000 people and discharge, or have the potential to discharge, to an impaired or ORVW. The jurisdictional MS4 boundary for these three communities are shown in Figure 13. Jurisdictional boundaries account for future growth of the stormwater infrastructure to expand to the entire municipal boundary. The TMDL MS4 regulated area only applies to the existing stormwater infrastructure, as described in Section 4.2.1. There are no regulated county or Minnesota Department of Transportation roadways in the TMDL Study Area. For more information on the MPCA MS4 program see: The Municipal Stormwater page.

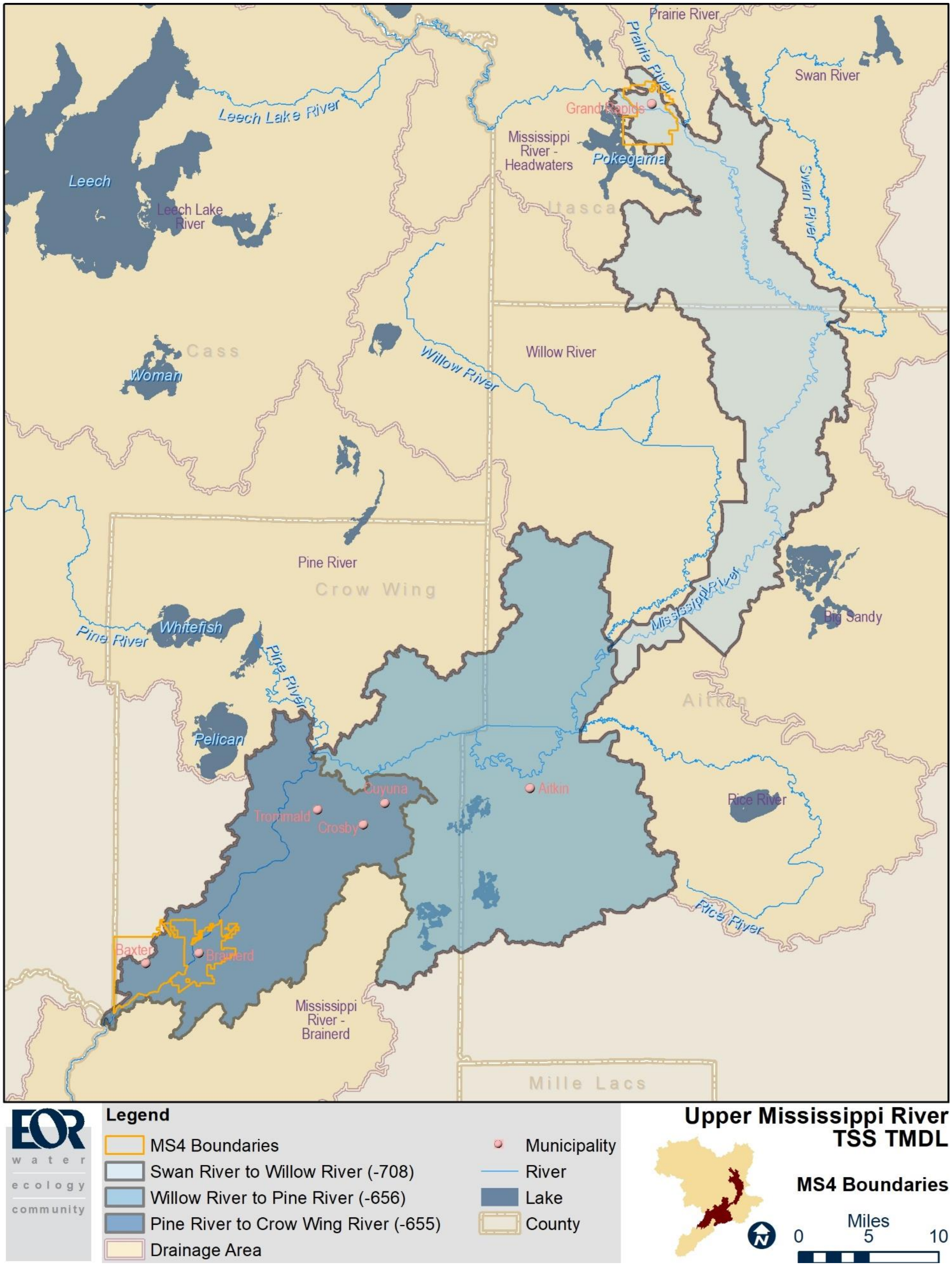


Figure 13. MS4 jurisdictional boundaries within the TMDL Study Area.

Regulated Construction Stormwater

Construction stormwater is regulated by NPDES/SDS permits (MNR100001) 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 are construction activities, reflects the number of construction sites greater than one acre in size that are expected to be active in the impaired lake or stream subwatershed at any one time. Less than one percent of the TMDL Study Area discharges regulated construction stormwater.

Regulated Industrial Stormwater

Industrial stormwater is regulated by NPDES/SDS Industrial Stormwater Multi- Sector General Permit (MNR050000) or NPDES/SDS Nonmetallic Mining/Associated Activities General Permit (MNG490000), 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 lake or stream subwatershed for which NPDES/SDS industrial stormwater permit coverage is required. Less than one percent of the TMDL Study Area discharges regulated industrial stormwater.

3.5.1.2 Municipal wastewater

Municipal wastewater is the domestic sewage and wastewater collected and treated by municipalities before being discharged to waterbodies as treated effluent. Seven WWTPs discharge to the impaired reaches of the TMDL Study Area.

Table 8. Permitted Municipal Wastewater sources within TMDL Study Area.

Impaired Reach AUID	**Facility Name** Permit ID
Mississippi River, Swan River to Willow River 07010103-708	**Grand Rapids WWTP** MN0022080
	Palisade WWTP MN0050997
	Minnesota Power - Rapids Energy Center MN0066559
Mississippi River, Willow River to Pine River 07010104-655	**Aitkin WWTP** MN0020095
	American Peat Technology LLC MN0057533
Mississippi River, Pine River to Crow Wing River 07010104-656	**Brainerd WWTP** MN0049328
	Serpent Lake WWTP MNG585215

The discharge for Minnesota Power consists of once-through, noncontact cooling water sourced from the Mississippi River, and therefore the TSS concentration of the discharge reflects the TSS water quality of the Mississippi River at the location of the intake structure.

Minnesota's TSS water quality standard is intended to protect aquatic life from the damaging effects of inorganic nonvolatile 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. As such, municipal wastewater is not a significant source of TSS to the impaired reaches.

3.5.2 Nonpermitted sources

Nonpermitted sources of pollutants may include in-stream erosion, near stream disturbance, unregulated watershed runoff, unpermitted feedlots, and unpermitted urban stormwater. Contributions of sediment from in-stream erosion, near stream disturbance, and unregulated watershed runoff are described in detail below. Contributions of sediment from unpermitted feedlots and unpermitted urban stormwater are insignificant in this TMDL Study Area and therefore are not described below.

3.5.2.1 In-stream erosion

Glacial Lake Aitkin is a dominant surficial geological feature in the area. It is the remnants of a large proglacial lake that was formed by ice and meltwater from the St. Louis Sublobe, the most recent glacial advance in the area. Proglacial lakes form at the top of a retreating glacier and accumulate sediment carried by meltwater running into the lake.

The soils associated with Glacial Lake Aitkin (and other proglacial lakes) are fine, interbedded layers of sand, silt, and clay with very little coarse sand and gravel. Laminated beds of silt and clay are found in areas where the lake was deepest. Sand and gravel can be found in areas where the lake was shallow and along beach ridges (MGS 2004). As Glacial Lake Aitkin began to drain, peat deposits developed in the bog areas that remained.

The flat topography associated with Glacial Lake Aitkin soils generally prevents erosion. However, these fine-grained soils are highly susceptible to erosion when disturbed, particularly along stream banks where the soil is on a slope or incline. Rotational and planar failures are frequently found along the banks in areas where the channel cuts through glacial lake clays. A rotational failure occurs when a large chunk of the stream bank soil slips into the stream along a curved surface, as if the soil was scooped out of the stream bank. A planar failure occurs when a large chunk of the stream bank soil slips into the stream along a flat surface, as if the soil was pushed down an incline.

The location of Glacial Lake Aitkin with respect to the impaired reaches is shown in the TMDL Study Area geomorphology (denoted by Lake Upham/Aitkin in Figure 14). The portion of the Upper Mississippi River that flows through Glacial Lake Aitkin soils is the only portion of the Upper Mississippi River that has high levels of TSS; TSS levels in the Mississippi River upstream of Grand Rapids and downstream of Brainerd are below the TSS standard. This suggests that the high erodibility of Glacial Lake Aitkin soils contributes TSS to the Mississippi River between Grand Rapids and Brainerd, Minnesota. In addition, the F-IBI scores are good in this portion of the Mississippi River (see Table 7 in Section 3.4.2) suggesting that high TSS levels are not a recent change and causing stress to the fish community.

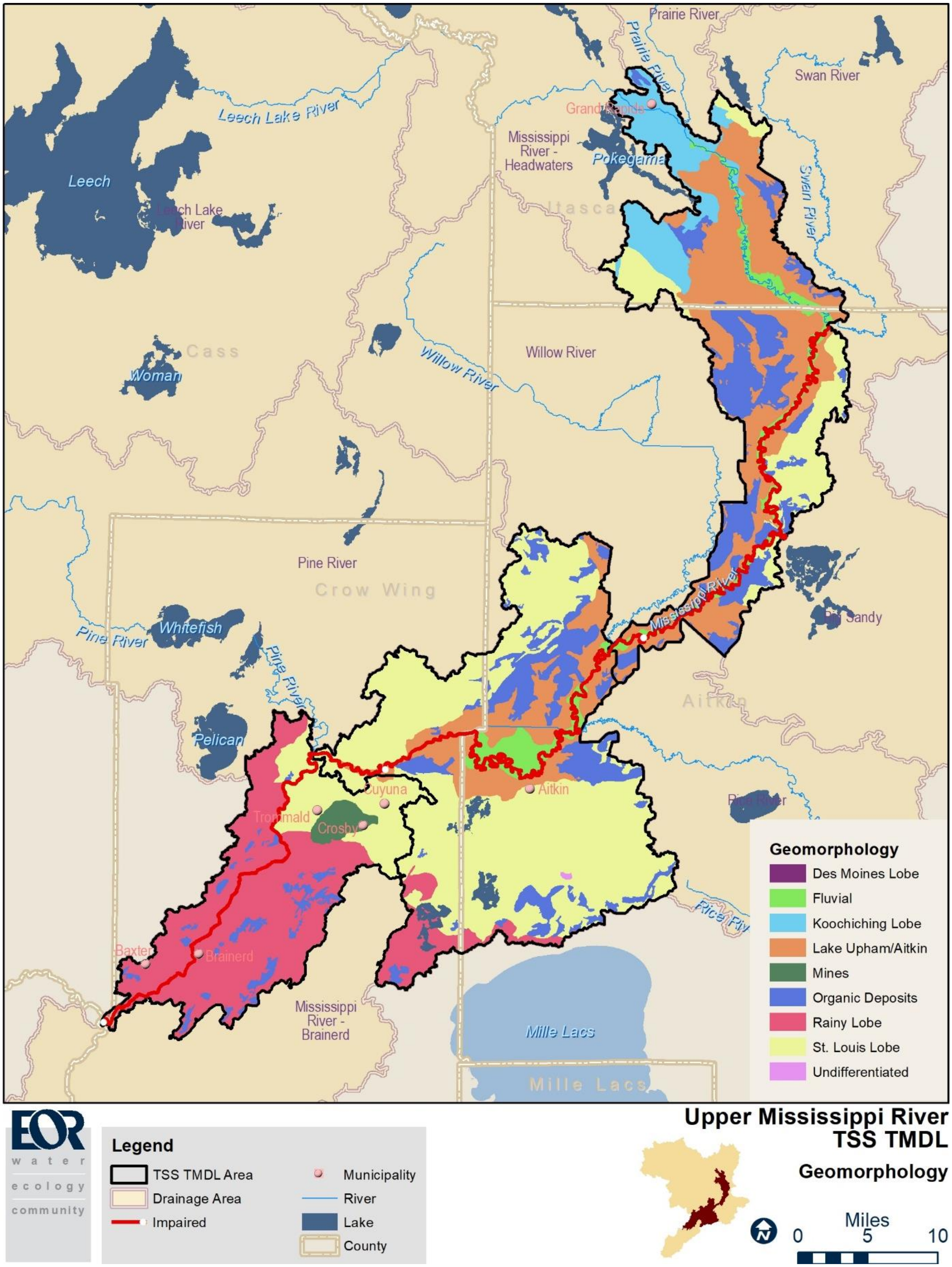
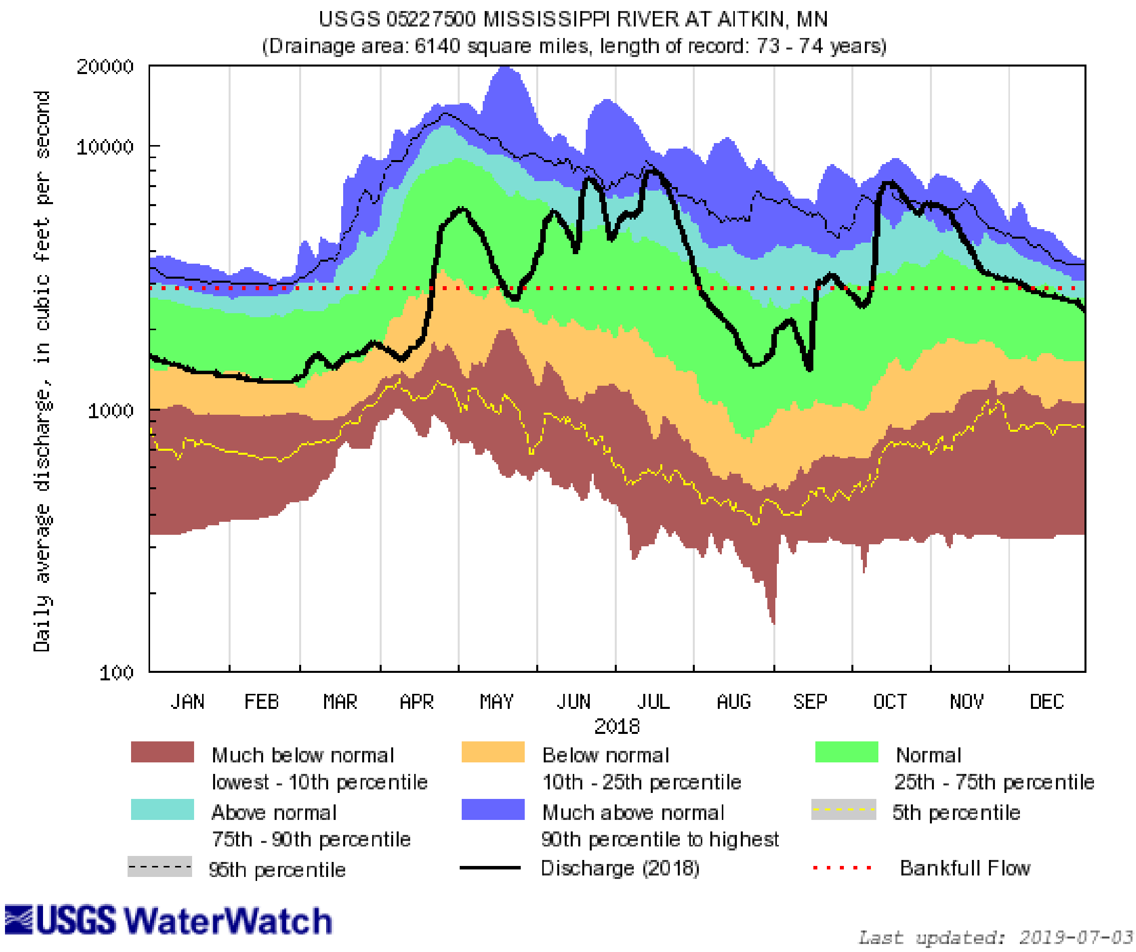


Figure 14. TMDL Study Area geologic associations.

Flow alteration - Mississippi Headwaters Reservoirs

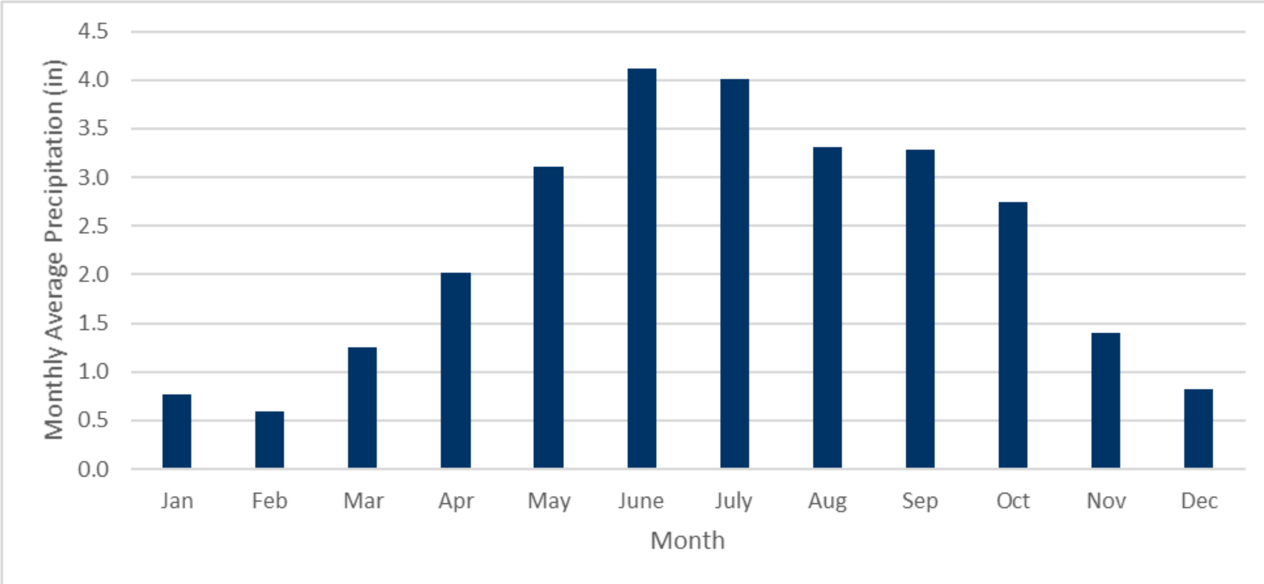
Within the TMDL Study Area, the U.S. Army Corps of Engineers operates six large dams (Winnibigoshish, Leech, Pokegama, Sandy, Cross Lake, and Gull dams) to prevent flooding downstream. These dams alter the flow in the TMDL Study Area throughout the year. Starting in October, all of the dams begin to drawdown the lake levels to prepare for the large flows associated with spring snowmelt. Normal drawdown elevations range between 0.9 ft and 3.0 ft below the summer level with the actual drawdown being dictated by snow surveys in March. Lake level drawdowns are very gradual. For instance, Big Sandy Lake aims for a drawdown rate of five inches per month with a goal of reaching the final drawdown elevation by March 1. Because of the gradualness of the drawdown, winter flows are fairly stable. The signature of the drawdowns are shown in the annual duration hydrograph for the USGS station at Aitkin where median daily average discharge increases starting in September through early November (Figure 15). This trend contradicts the natural flow expected from the monthly precipitation. The normal monthly precipitation is highest during the summer and decreases throughout the fall and winter (Figure 16).

Figure 15. USGS streamflow annual duration hydrograph for the Mississippi River at Aitkin, MN (USGS 05227500).



*Dotted line is the estimated bankfull discharge from the USGS rating curve.

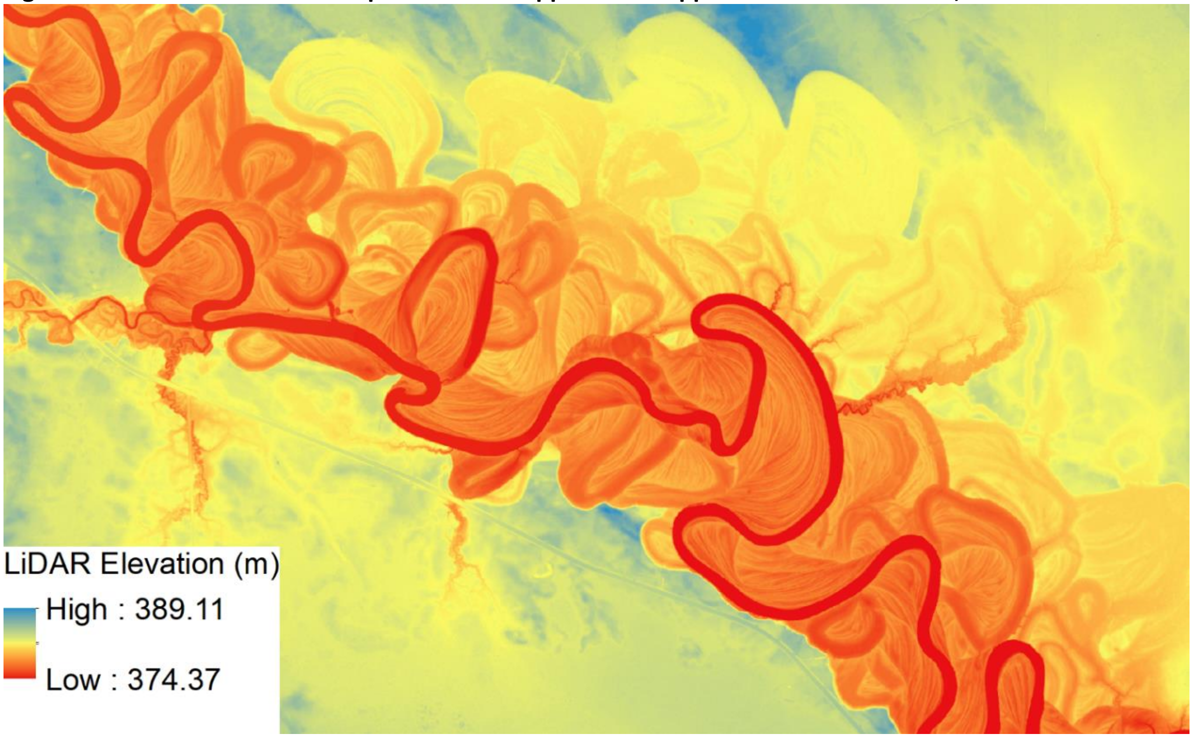
Figure 16. PRISM 1981-2010 normal monthly precipitation for the Upper Mississippi River Watershed (PRISM Climate Group).



During the spring, snowmelt and precipitation increase the lake levels as the lakes are used to prevent high flows downstream. Typically, the high lake levels are discharged by the end of May. Then during the summer months, the lakes are managed for flood control and for recreational purposes. Therefore, the normal summer lake level band has a range of six inches for most of the dams. More significant rainfall events in the summer result in more releases. These releases have lower peak flow, but are longer in duration. Therefore, flows may stay at or close to bankfull conditions more frequently and for longer time periods. Bankfull flow is generally considered to be the channel forming discharge because in a stable alluvial channel it represents the breakpoint between the process of channel formation and the process of floodplain formation. The historic stream development in the TMDL Study Area is depicted by Light Detection and Ranging (LiDAR) imagery in Figure 17. The current channel is the darkest red band and the old channels get lighter with age as the valley has developed over 10,000 years.

In addition to the altered streamflow downstream of the reservoirs, the lakes themselves alter the sedimentation processes in the watershed. The slower flows associated with the ponding water allows greater deposition to occur within the reservoirs. This has the potential to alter the natural sediment transport in the Mississippi River. However, the lakes also can contribute to an increase in erosion with wind created wave action and ice heaving eroding reservoir banks.

Figure 17. Historic stream development of the Upper Mississippi River south of Warba, MN shown in LiDAR.



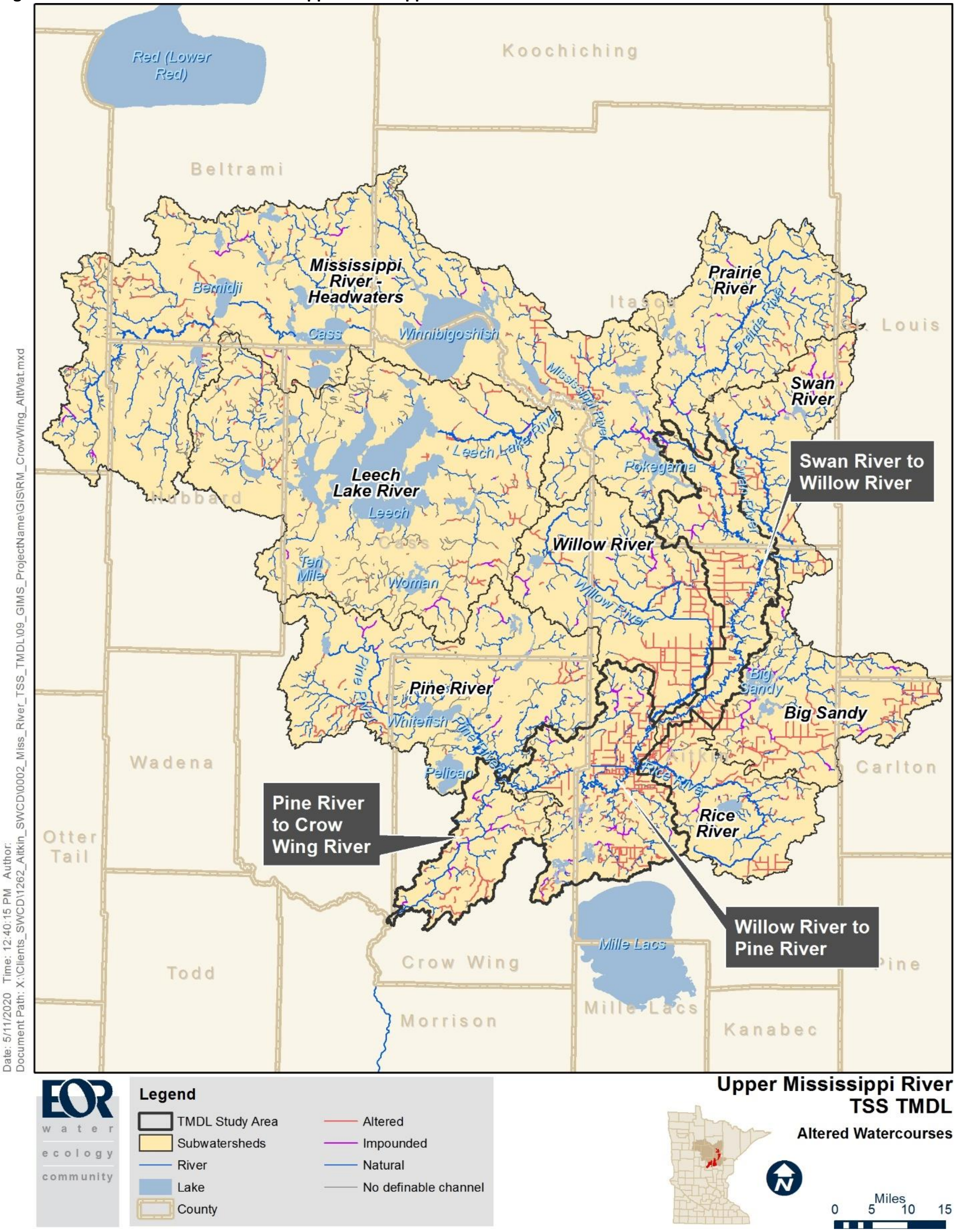
Flow alteration- altered watercourses

As part of the MR-GR WRAPS effort, the stressor identification process called out legacy ditching in peatlands as impacting hydrology and water quality. In both the MR-GR and MR-B watersheds, a significant amount of altered watercourses exist in the affected subwatersheds, as shown in Figure 18 and Table 9.

Table 9. Summary of types of watercourses in each subwatershed in the TMDL Study Area

	Altered		Impounded		Natural		No definable Channel	
Subwatershed	**feet**	**% total**	**feet**	**% total**	**feet**	**% total**	**feet**	**% total**
Big Sandy	707,209	34%	794,648	38%	241,334	12%	345,941	17%
Leech Lake River	541,607	11%	1,458,698	28%	90,014	2%	3,042,023	59%
Mississippi River - Headwaters	855,696	10%	3,992,855	47%	745,758	9%	2,852,840	34%
Pine River	301,788	10%	1,778,053	57%	153,230	5%	912,724	29%
Pine River to Crow Wing River	216,060	23%	386,672	42%	126,413	14%	199,158	21%
Prairie River	93,224	4%	1,417,453	60%	124,725	5%	708,604	30%
Rice River	545,046	35%	720,351	47%	28,254	2%	253,598	16%
Swan River	290,237	18%	826,127	52%	149,428	9%	330,173	21%
Swan River to Willow River	592,558	31%	950,464	50%	64,902	3%	307,836	16%
Willow River	923,007	38%	1,102,549	45%	106,099	4%	315,190	13%
Willow River to Crow Wing River	1,040,211	35%	1,290,220	43%	281,591	9%	393,474	13%

Figure 18. Altered watercourses in the Upper Mississippi River watersheds.



Alteration of peatland hydrology by ditching can result in numerous consequences. One possible result of peatland hydrologic alterations is an increase in peak flows in downstream channel reaches. This result was found in a number of studies in fairly analogous situations in European ditched peatlands

(Holden et al. 2004). In some cases, ditched peatlands seemed to reduce the peak flows due to a lowered water table allowing for greater storage of rainwater. There are numerous variables that can influence how downstream hydrology is affected by ditching, and these factors are still being studied (Holden et al. 2004). Consequences of altered hydrology include channel instability characterized by bank erosion and streambed material alteration, leading to poor biological habitat. Channel instability was found at several streams with upstream peatland ditches in the MR-GR Watershed, and also in WRAPS projects in several other north central Minnesota watersheds. Increasing the flow from peatlands can also exacerbate flooding downstream. The ditched peatlands in the MR-GR Watershed add flow to the Mississippi River, which increases flooding to downstream areas such as the city of Aitkin (MPCA 2019a).

3.5.2.2 Near stream disturbance

In the TMDL Study Area, riparian areas have been converted to both agricultural and urban land. Native vegetation along streams limit bank erosion due to a sufficient root structure and efficient use of soil moisture throughout the year. Conversion from native vegetation to agricultural or urban land uses can worsen streambank erosion due to shallower and less dense root structure, exposed soil, greater runoff, and physical disturbance by livestock.

Table 10 shows the percentage of developed, agricultural, and natural land within a 150 m buffer of the river. Communities along this stretch of the Mississippi River include: Jacobson, Palisade, Aitkin, and Brainerd. The most upstream reach has the lowest percentage of agriculture, while the most downstream reach has the highest developed percentage due to Brainerd. Urban soils tend to have higher rates of erosion than undisturbed soils due to less root stabilization of the soil, more areas of exposed soil, and more concentrated runoff flowpaths. In rural areas conversion from native vegetation to pastureland increases streambank erosion because of the replacement of deep rooted vegetation with shallow rooted plants. In addition, livestock access to streams can increase erosion by trampling streambanks and disturbing the channel which loosens the soil and increases the amount of bare soils near the stream. An example of streambank erosion along stretches of cleared forest is shown in Figure 19.

Table 10. Land use within a 150 m Buffer of the TMDL Study Area Impaired Stream Reaches (NLCD 2016)

AUID	Developed	Agricultural Land	Natural Land
07010103-708	4%	10%	86%
07010104-655	5%	25%	70%
07010104-656	8%	1%	91%

*Percentages exclude open water.

Figure 19. Example of streambank erosion in rural areas at biological monitoring station 13UM017. Photo taken by MPCA Staff August 8, 2013.

3.5.2.3 Watershed runoff

To assist the development of TMDLs and WRAPS in the TMDL Study Area, the MPCA facilitated the development of a linked HSPF model for the eight HUC-8 watersheds of the Upper Mississippi River. The original model was constructed in 2011-2012 to model flow, sediment, temperature, dissolved oxygen, and nutrients, and was calibrated using data from 1996 through 2009 (RESPEC 2015). In 2018, the MR-GR and MR-B models were recalibrated to incorporate new measurements through 2015 and improved evapotranspiration, snow melt, and land use data (Tetra Tech 2018). HSPF is capable of identifying sources of sediment (TSS) and the processes that drive sediment erosion, delivery, and transport in the watershed as well as point sources.

An important component of modeling the flow and TSS in HSPF is the land use. The Upper Mississippi River model depicts the change in land use from the Northern Lakes and Forest Ecoregion, dominated by coniferous forests, to the North Central Hardwood Forest Ecoregion, dominated by crops and pasture. The original models used land use from the 2006 NLCD, while the updated models use the University of Minnesota's Remote Sensing and Geospatial Analysis group's 2013 Minnesota Land Cover Classification and Impervious Surface Area by Landsat and LiDAR 2013 Update -Version 2 dataset. In addition, soils information from the Gridded Soil Survey Geographic Database (gSSURGO) and Universal Soil Loss Equations (USLE) were used to parameterize and calibrate the TSS concentrations in the model. Agricultural practices affect the amount of sediment transported by overland flow. The RESPEC calibration adjusted sediment erosion rates to account for this.

Other updates were made to the sediment simulation, including establishment of critical shear stress parameters for in-stream deposition and scour, incorporation of clay load with active groundwater flow, and recalibration of instream sediment parameterization based on long-term net sediment bed balance and instream suspended sediment data.

The results of recalibration predicted watershed-wide sediment loading rates of 31.5 lb/ac/yr in the MR-GR Watershed, and 24 lb/ac/yr in the MR-B Watershed (Tetra Tech 2018). The modeled subwatershed sediment yield for the study area is shown in Figure 20. Generally, subwatershed sediment yields increase from upstream to downstream with the lowest yields in the upstream portion of the TMDL Study Area and the highest sediment yields near Brainerd in the downstream portion of the TMDL Study Area. The seeming inconsistency between the watershed-wide average loading rates and the subwatershed rates can be attributed to geology, land use and other local factors.

Figure 20. HSPF Predicted subbasin TSS yield (lb/acre/year) for the TMDL Study Area (1996-2015).

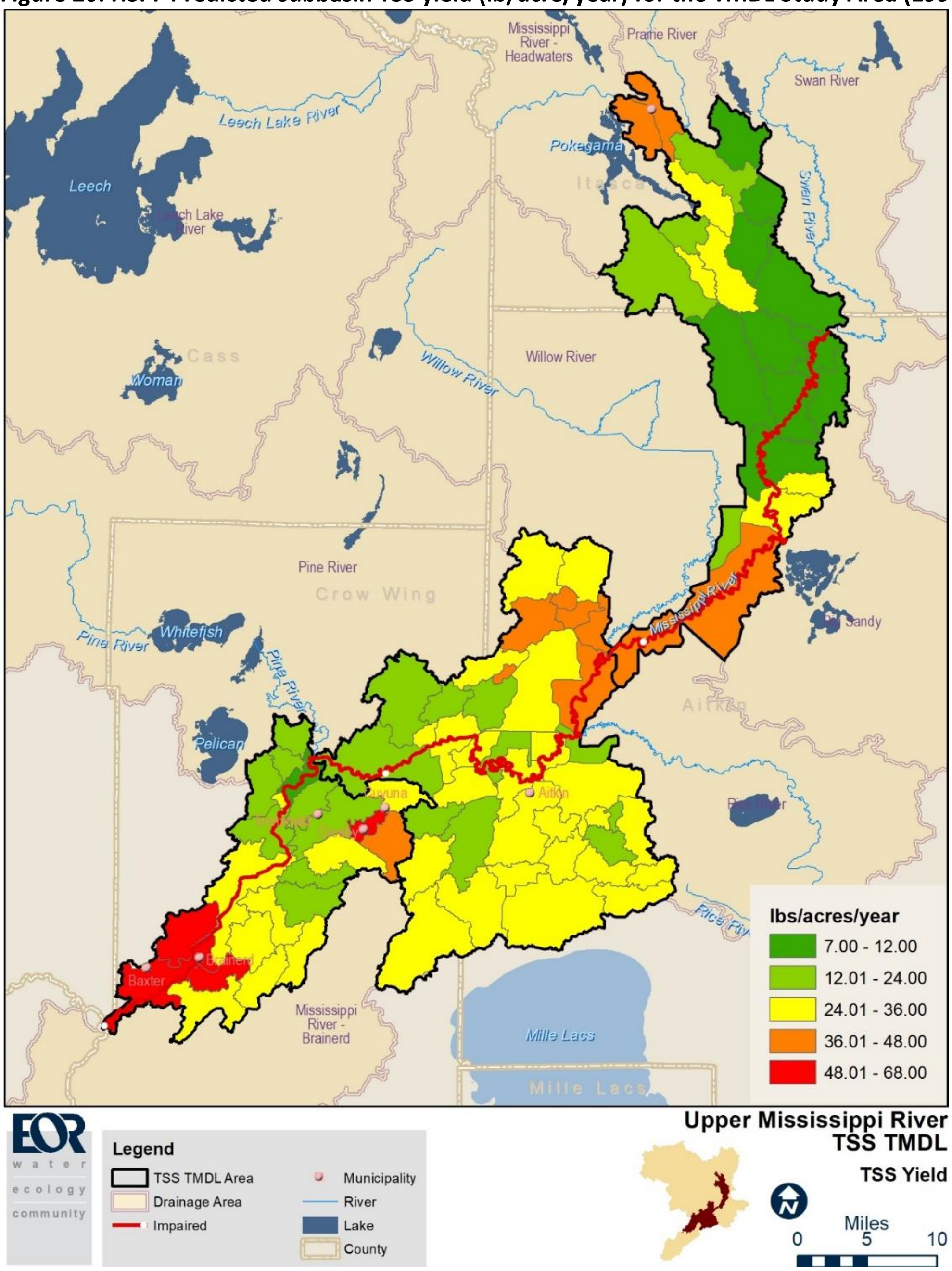
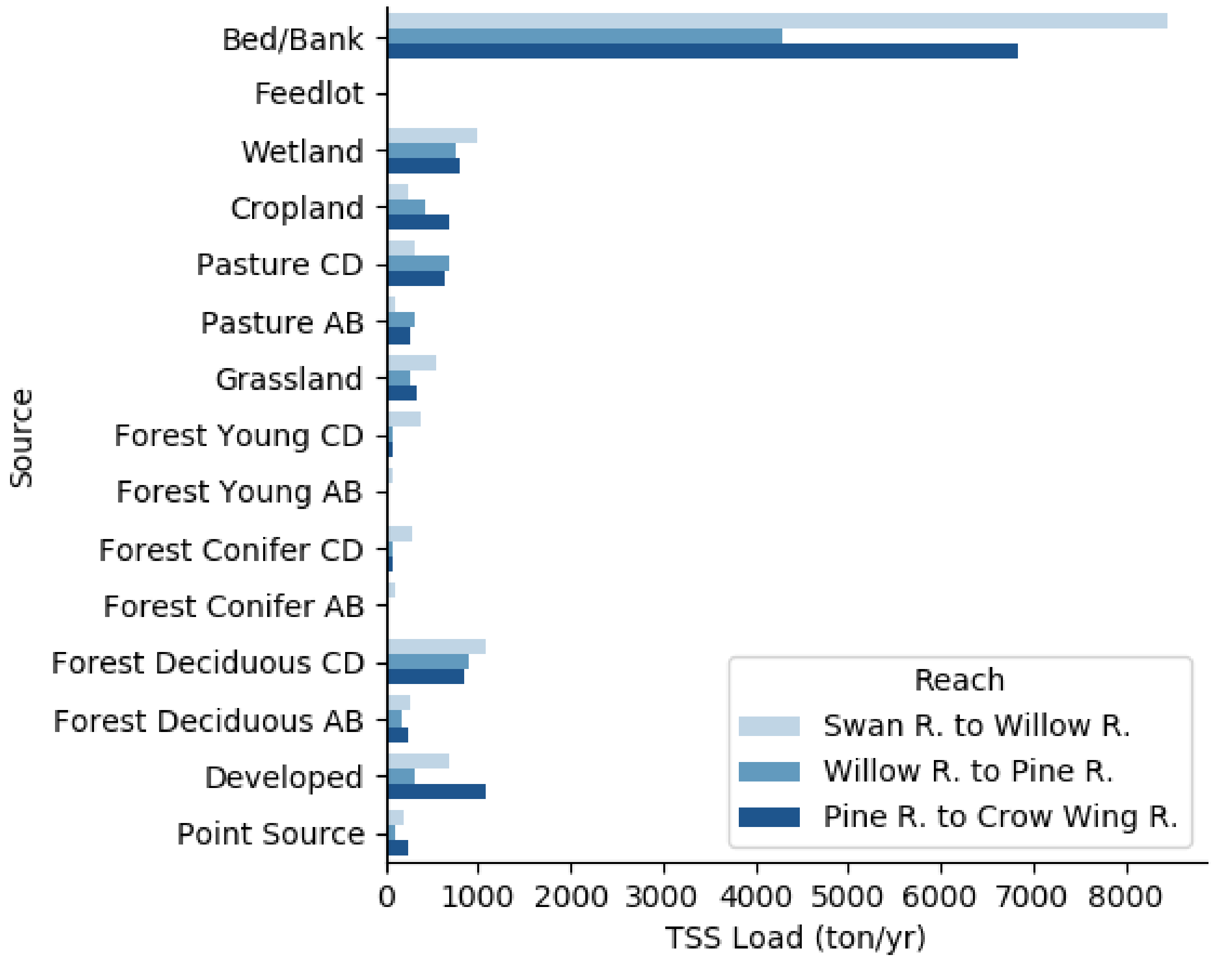


Figure 21 shows the sediment load contribution of each source in the MR-GR and MR-B watersheds. The model predicts that the majority of the sediment load comes from in-stream processes (Bed/Bank), with greater per acre yields of sediment derived from developed, cropland[1] and pastureland, compared to forests and wetlands. More information on the HSPF models are in the Hydrologic and Water Quality Calibration for the Upper Mississippi River (RESPEC 2015) and the Mississippi River – Grand Rapids HSPF Model Recalibration (Tetra Tech 2018).

Figure 21. HSPF modeled TSS loads by source and impaired reach.



AB and CD refer to USDA-NRCS Soil Survey Geographic Database Hydrologic Soil Groups.

A = high infiltration rates (sandy),
B = moderate infiltration rates (silt loam or loam),
C = low infiltration rates (sandy clay loam),
D = clay (lowest infiltration rates) and or denotes an A,B,C soils with a permanent high water table (wetted).

[1]The extent of CAFOs and permitted AFOs in a watershed can provide information on the potential effects that feedlots have on water quality through application of manure to nearby agricultural fields. There are no CAFOs or NPDES/SDS permitted AFOs within the TMDL Study Area.

3.5.3 Sediment Source Summary

The dominant source of sediment to the Upper Mississippi River within the TMDL Study Area is nonpoint sources (Table 11). Key nonpoint sources include:

- bed and bank (in-stream) erosion of the finely grained, easily erodible Glacial Lake Aitkin/Upham clay deposits (see Section 3.5.2.1), and
- near stream disturbance from land use conversions near the river channel that contribute sediment through greater soil erosion from physical trampling of the banks from livestock, less stabilization of the soil from shallow rooted plants, more areas of exposed soil, and more concentrated runoff flowpaths.

Due to the geologic setting of the Upper Mississippi River between Swan River and Crow Wing River (see Section 3.5.2.1), there are natural background sources of sediment to the impaired reaches. However, there is not enough available data to determine the relative contribution of natural background sources compared to other human influenced sources. There is no evidence at this time to suggest that the impairments are solely due to natural background sources.

Table 11. HSPF modeled TSS loads by source and impaired reach.

	TSS loads to Upper Mississippi River impaired reaches:					
	Pine R. to Crow Wing R.		Swan R. to Willow R.		Willow R. to Pine R.	
Source	(ton/yr)	(% total load)	(ton/yr)	(% total load)	(ton/yr)	(% total load)
Bed/Bank	6,840	56%	8,456	61%	4,295	51%
Cropland	689	6%	254	2%	420	5%
Developed	1,094	9%	678	5%	302	4%
Feedlot	5	0%	1	0%	5	0%
Forest	1,308	11%	2,232	16%	1,264	15%
Grassland	327	3%	538	4%	264	3%
Pasture	899	7%	422	3%	996	12%
Point Sources	250	2%	201	1%	111	1%
Wetland	814	7%	991	7%	768	9%
Grand Total	**12,225**		**13,772**		**8,425**	

4. TMDL development

This section presents the overall approach to estimating the components of the TMDL. The TSS sources were first identified and estimated in the TSS source assessment. The loading capacity (TMDL) of each impaired stream reach was then estimated using a load duration curve and divided among WLAs and LAs. The TMDLs for the impaired streams can be described by the following equation:

$$\text{TMDL} = \text{LC} = \sum \text{WLA} + \sum \text{LA} + \sum \text{BC} + \text{MOS}$$

Where:

Loading capacity (LC): the greatest TSS load the impaired stream reaches can receive without violating water quality standards;

Wasteload allocation (WLA): the TSS load that is allocated to point sources, including wastewater treatment facilities (WWTFs), regulated MS4 stormwater, regulated construction stormwater, and regulated industrial stormwater, all covered under NPDES permits for a current or future permitted pollutant source;

Load allocation (LA): the TSS load that is allocated to sources not requiring NPDES permit coverage, including nonregulated stormwater runoff, and bed/bank erosion;

Boundary condition (BC): the TSS load that is allocated to sources located within upstream subwatersheds;

Margin of Safety (MOS): an accounting of uncertainty about the relationship between TSS loads and receiving water quality.

4.1 Loading capacity methodology

The loading capacities for impaired stream reaches receiving a TMDL, as a part of this study, were determined using load duration curves. Flow and load duration curves 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. Load duration curves 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 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 each load duration curve, continuous flow data was based on HSPF model simulations for 1996 through 2015. The existing TSS loads were based on TSS concentration data from April through September during the TMDL 10-year time period of 2009 through 2018, paired with HSPF simulated flows by date (Table 12). The TSS loading capacities presented in the allocation tables represent the median TSS load (in kg/day) along the TSS standard curve within each flow regime. A TSS load duration curve and a TMDL allocation table are provided for each stream segment in Section 4.2.5.

The load duration curve 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, 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, the entire curve represents the TMDL and is what is ultimately approved by the EPA.

Table 12. Load duration curve data sources

Impaired Reach (AUID)	HSPF simulated continuous flows (1996-2015)	TSS Monitoring Stations (years available)
Mississippi River, Swan River to Willow River (07010103-708)	HSPF MR-GR Model Reach 470	S003-663 (2009, 2013-2014)
Mississippi River, Willow River to Pine River (07010104-655)	HSPF MR-B Model Reach 190	S000-152, S002-010 (2009-2015)
Mississippi River, Pine River to Crow Wing River (07010104-656)	HSPF MR-B Model Reach 290	S000-570, S007-337 (2013-2014)

4.2 Wasteload allocation methodology

All regulated stormwater and wastewater were assigned a WLA based on the methods described in the following section.

4.2.1 Regulated MS4 stormwater

The regulated MS4 area for each impaired reach was determined based on the area of NLCD 2016 developed land uses (developed open space, developed low intensity, developed medium intensity, and developed high intensity) within the jurisdictional MS4 boundary and the TMDL Study Area. The NLCD 2016 developed land uses were used to approximate the area within each MS4 boundary with stormwater conveyances, as those are the areas that received WLAs. The percent of regulated MS4 area within the TMDL Study Area (Table 13) within an MS4 boundary was multiplied by the watershed runoff load component to determine the WLA for each MS4. The watershed runoff load component is equal to the total TMDL (loading capacity) minus the sum of wastewater WLAs, BCs (upstream subwatersheds), and the MOS.

Table 13. Regulated MS4 area by impaired reach

Impaired Reach (AUID)	MS4 Community	Regulated Area in TMDL Study Area (sq. mi.)	Regulated Area in TMDL Study Area (% total TMDL Study Area)
Mississippi River, Swan River to Willow River (07010103-708)	Grand Rapids	4.64	1.4%
Mississippi River, Pine River to Crow Wing River (07010104-656)	Brainerd	5.66	2.7%
	Baxter	5.60	2.7%

4.2.2 Regulated construction stormwater

A categorical WLA was assigned to all regulated construction activity in each impaired subwatershed. First, the average annual fraction of the watershed area under regulated construction activity over the past five years was calculated based on MPCA Construction Stormwater Permit data from January 1, 2014, to January 1, 2019 for each county (Table 14). The fraction of each county area under regulated construction activity was area weighted by the percent of each county within each impaired subwatershed (Table 15) to determine the 2014 through 2018 annual average percent of the TMDL Study Area under construction activity (Table 16), and then multiplied by the watershed runoff load component to determine the construction stormwater WLA. The watershed runoff load component is equal to the total TMDL (loading capacity) minus the sum of wastewater WLAs, BCs (upstream subwatersheds), and the MOS.

Table 14. 2014-2018 annual average percent of total county area under construction activity.

Parameter	Aitkin County	Crow Wing County	Itasca County
2014-2018 annual average percent of total county area under construction activity	0.22%	0.42%	0.29%

Table 15. Percent of TMDL Study Area within each county.

Percent of TMDL Study Area within each county	Aitkin County	Crow Wing County	Itasca County
Mississippi River, Swan River to Willow River (07010103-708)	54%	0%	46%
Mississippi River, Willow River to Pine River (07010104-655)	70%	30%	0%
Mississippi River, Pine River to Crow Wing River (07010104-656)	0%	100%	0%

Table 16. 2014-2018 annual average percent of TMDL Study Area under regulated construction activity.

Parameter	Swan River to Willow River	Willow River to Pine River	Pine River to Crow Wing River
2014-2018 annual average percent of TMDL Study Area under construction activity	0.25%	0.28%	0.42%

4.2.3 Regulated industrial stormwater

A categorical WLA was assigned to all regulated industrial activity in each impaired subwatershed. The area of all regulated industrial stormwater facilities within the TMDL Study Area was estimated using aerial photography. The fraction of the TMDL Study Area for each impaired reach under regulated industrial activity (Table 17) was multiplied by the watershed runoff load component to determine the industrial stormwater WLA. The watershed runoff load component is equal to the total TMDL (loading capacity) minus the sum of wastewater WLAs, BCs (upstream subwatersheds), and the MOS.

Table 17. Proportion of TMDL Study Area under regulated industrial activity.

Parameter	Unit	Swan River to Willow River	Willow River to Pine River	Pine River to Crow Wing River
Area under regulated industrial activity	% of TMDL Study Area	0.11%	0.06%	0.21%

4.2.4 Regulated municipal and industrial wastewater

An individual WLA was provided for each NPDES/SDS permitted municipal or industrial wastewater facility whose surface discharge stations fall within an impaired stream subwatershed. There are a total of seven NPDES/SDS permitted municipal or industrial wastewater facilities located in the TMDL Study Area. The WLAs were set equal to the current NPDES/SDS permit effluent limits (Table 15), except for Minnesota Power, which currently does not have a permit TSS effluent limit. The WLA concentration assumptions for Minnesota Power is set in accordance with Minn R. ch. 7053.0225, subp. 1(B) and is consistent with existing effluent limits assigned to nearby WWTPs. Future NPDES/SDS permits for this WWTFs may contain water quality based effluent limits that account for the NVSS characteristics of the discharge. American Peat Technology has been assigned a TSS WLA for this TMDL that represents the product of calendar month average TSS effluent limits, the average reported daily flow rate for station SD001, the maximum permitted daily flow rate for Station SD003 and a unit conversion factor.

Minnesota's TSS water quality standard is intended to protect aquatic life from the damaging effects of inorganic NVSS to the gills and filter feeding organs of fish and aquatic invertebrates. TSS associated with municipal wastewater discharges are predominantly organic VSS that do not tend to persist in the environment. Therefore, the existing limits would be consistent with the assumptions and requirements of the TMDLs' WLAs, as well as the water quality standard, even though the standard is lower than the limit.

Table 18. Regulated wastewater AWWDF, effluent limit assumptions, and WLAs.

Impaired Reach AUID	**Facility Name** Permit ID	**Surface Discharge Station**	**AWWDF/MDF (million gallons per day)**	**Effluent limit and/or WLA concentration assumption**	
				(kg/day)	**(mg/L)**
Mississippi River, Swan River to Willow River 07010103-708	**Grand Rapids WWTP** MN0022080	SD004	15.2 (13.25 from Blandin)	1,726	30
	Palisade WWTP MN0050997	SD001	0.0226	2.56	30
	Minnesota Power - Rapids Energy Center MN0066559	SD001	22.54	2,559	30*
Mississippi River, Willow River to Pine River 07010104-655	**Aitkin WWTP** MN0020095	SD004	0.69	78	30
	American Peat Technology LLC MN0057533	SD001	0.29	37	30~
		SD003	0.04		
Mississippi River, Pine River to Crow Wing River 07010104-656	**Brainerd WWTP** MN0049328	SD003	6.0	355**	30
	Serpent Lake WWTP MNG585215	SD002	6.26	1,065	45

AWWDF = annual wet weather design flow; MDF = maximum design flow

* The MN Power permit does not currently contain a TSS effluent limit. The WLA concentration assumption was set equal to nearby existing WWTP effluent limits.

~American Peat Technology's 30 mg/L TSS concentration assumption is consistent with the permit's calendar month average TSS limits.

** The existing TSS permit effluent limit for Brainerd WWTP is based on a mass load limit of 355 kg/day based on the facility's antidegradation design flow of 3.13 mgd.

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4.3 Load allocation methodology

The remainder of the loading capacity (TMDL) after subtraction of the MOS, BCs (upstream subwatersheds), and WLAs was allocated to the LA for each impaired stream. The LA includes nonpoint pollution sources that are not subject to permit requirements, including near-channel sources and watershed runoff (as described in Section 3.5.2). The LA also includes natural background sources of sediment.

Natural background is defined in both Minnesota rule and statute:

Minn. R. 7050.0150, subp. 4:

> "Natural causes" means the multiplicity of factors that determine the physical, chemical or biological conditions that would exist in the absence of measurable impacts from human activity or influence.

The Clean Water Legacy Act (Minn. Stat. § 114D.10, subd. 10) defines natural background as:

> … characteristics of the water body resulting from the multiplicity of factors in nature, including climate and ecosystem dynamics that affect the physical, chemical or biological conditions in a water body, but does not include measurable and distinguishable pollution that is attributable to human activity or influence.

Natural background sources are inputs that would be expected under natural, undisturbed conditions. Natural background sources can include inputs from natural geologic processes such as: soil loss from stream development and upland erosion of areas not disturbed by human activity; wildlife; and loading from grassland, forests, and other natural land covers.

Minnesota TSS standards inherently address some amount of natural background TSS loading. Minnesota's regional TSS standards are based on reference or least-impacted streams and take into account differing levels of sediment present in streams and rivers in the many ecoregions across the state, depending on factors such as topography, soils, and climate (MPCA 2011). Natural background conditions were evaluated, where possible, within the modeling and source assessment portion of this study (see Section 3.5.2). Natural background sources are implicitly included in the LA portion of the TMDL allocation tables, and TMDL reductions should focus on the major anthropogenic sources identified in the source assessment.

4.4 Boundary condition (upstream subwatershed) allocation methodology

TSS delivery along the Mississippi River mainstem is not conservative due to sedimentation and resuspension processes within the river channel. Over timescales of decades to hundreds of years, the Mississippi River mainstem is actively moving in its floodplain (see Figure 17 in Section 3.5.2.1). Over timescales of years to decades, not all of the sediment loads from the upstream portions of each modeled Missssissippi River mainstem HUC-8 reach are delivered to the model outlet. A small proportion of the sediment load (<4%; see Figure 22 and Figure 23) is temporarily stored in the system through aggradation processes (such as the build-up of a sand bar in the channel).

Because of these small in-stream losses, the HSPF model outputs could not be used directly to determine the BC (upstream subwatershed) allocations. BC (upstream subwatershed) allocations along the Mississippi River mainstem were derived based on applying a delivery ratio to the LA at the HSPF model outlets. A linear regression equation was developed for predicting the proportion of total TSS load delivered to the model outlet based on the distance upstream along the Mississippi River from the model outlet. HSPF-SAM TSS load delivery regressions are shown for the MR-GR Watershed in Figure 22 and the MR-B Watershed in Figure 23.

Note that these losses are relatively small given the large-scale of the TMDL study area (nearly 150 miles of large river reach, see Table 3 in Section 3.1). Stored sediment within the river channel will become resuspended under extreme flow events; the frequency of these extreme flow events is much less than the applicable time period of the TSS water quality standard (not to exceed 10% of sample events in a 10-year period). But to be conservative, these in-stream losses are only applied to LAs; WLAs are assumed to have 100% delivery to downstream reaches.

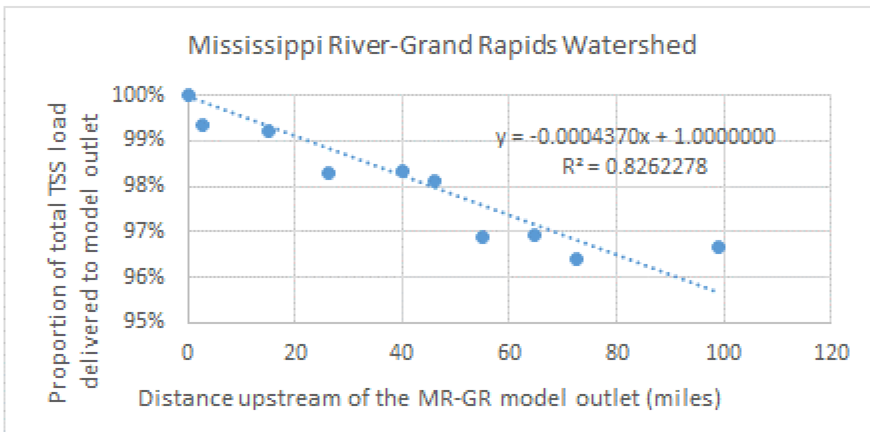


Figure 22. HSPF TSS delivery to model outlet regression equations for the Mississippi River-Grand Rapids Watershed.

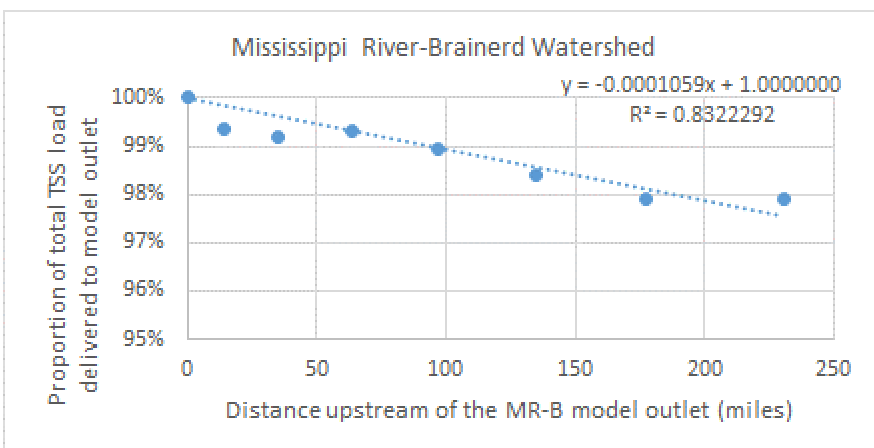


Figure 23. HSPF TSS delivery to model outlet regression equations for the Mississippi River-Brainerd Watershed.

4.5 Margin of safety

An explicit MOS equal to 10% of the loading capacity was used for the stream TMDLs based on the following considerations:

- There is some inherent uncertainty in flow estimates by HSPF models.
- Only two years of monitoring data (2013 and 2014) collected during the TMDL 10-year time period (2009 through 2018) overlapped with HSPF flow estimates (1996 through 2015) to estimate existing TSS loads for the load duration curves, which may not capture the full range of observed year to year variability in TSS.
- Allocations are a function of flow, which varies from high to low flows. This variability is accounted for through the development of a TMDL for each of five flow regimes.

4.6 Seasonal variation

The TSS water quality standard applies for the period April through September, which corresponds to the open water season when aquatic organisms are most active and when high stream TSS concentrations generally occur. TSS loading varies with the flow regime and season. Spring is associated with large flows from snowmelt, the summer is associated with the growing season as well as periodic storm events and receding streamflows, and the fall brings increasing precipitation and rapidly changing agricultural landscapes.

Critical conditions and seasonal variation are addressed in this TMDL through several mechanisms. The TSS standard applies during the open water months, and data was collected throughout this period. The water quality analysis conducted on these data evaluated variability in flow through the use of five flow regimes: from high flows, such as flood events, to low flows, such as baseflow. Through the use of load duration curves and monthly summary figures, TSS loading was evaluated at actual flow conditions at the time of sampling (and by month).

4.7 TMDL Summary

4.7.1 TSS TMDL: Mississippi River, Swan River to Willow River (07010103-708)

- **303(d) listing year:** 2016
- **Baseline year(s):** 2014, based on the mid-range year of the data used for development of the TSS load duration curve.

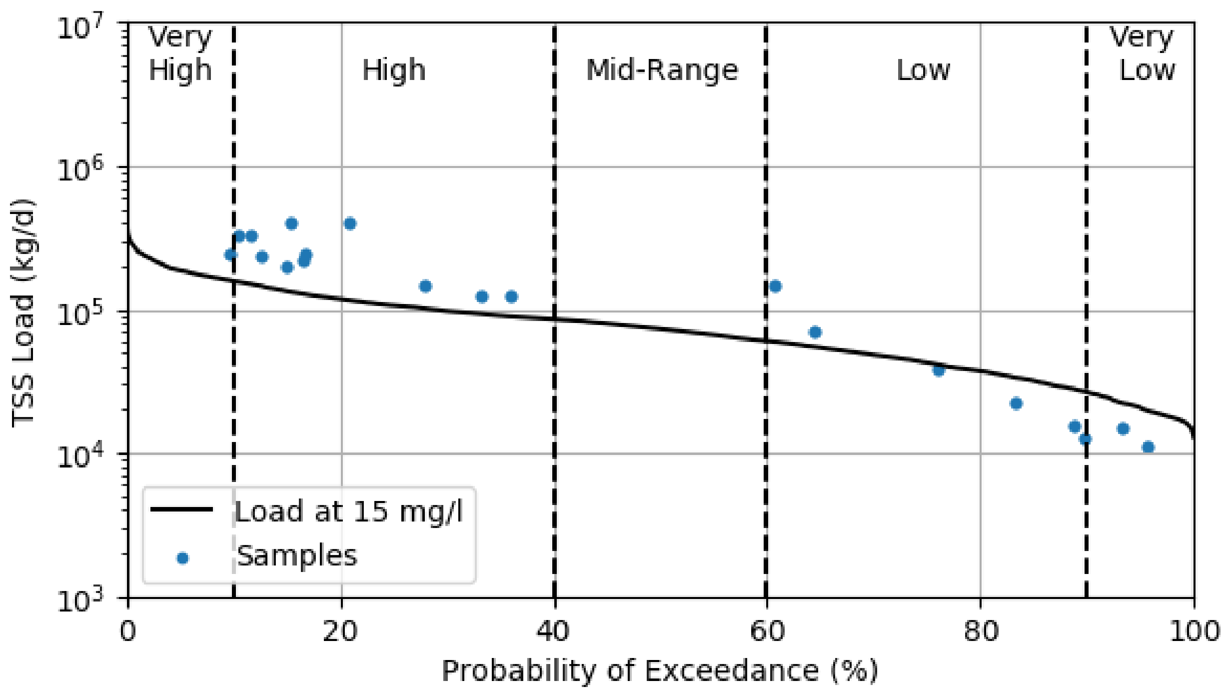


Figure 24. TSS load duration curve: Mississippi River, Swan River to Willow River (07010103-708)
Existing TSS loads were based on TSS concentration data at S003-663 for the months of April through September and the years 2009-2015 paired with HSPF simulated flows by date. Note that HSPF simulated flows were only available through 2015.

Table 19. TSS TMDL summary: Mississippi River, Swan River to Willow River (07010103-708)

Mississippi River Swan River to Willow River 07010103-708 Load Component		Flow Regime Mid-Point (cfs)				
		Very High	High	Mid	Low	Very Low
		5,111	2,904	2,000	1,163	561
		Total Suspended Solids (lb per day)				
Existing Load*		*13,403,822*	*856,692*	*604,036*	*46,954*	*7,994*
Wasteload Allocations	*City of Grand Rapids (MS400269)*	*5,346*	*3,115*	*2,105*	*1,314*	*639*
	Grand Rapids WWTP (MN0022080)	*3,805*	*3,805*	*3,805*	*3,805*	*3,805*
	Palisade WWTP (MN0050997)	*6*	*6*	*6*	*6*	*6*
	Minnesota Power - Rapids Energy Center (MN0066559)	*5,642*	*5,642*	*5,642*	*5,642*	*5,642*
	Construction stormwater (MNR100001)	*930*	*542*	*366*	*229*	*112*
	Industrial stormwater (MNG490000, MNR050000)	*401*	*234*	*158*	*98*	*48*
	Total WLA	**16,130**	**13,344**	**12,082**	**11,094**	**10,252**
Load Allocations	*Nonregulated sources*	*312,402*	*178,675*	*117,445*	*70,325*	*29,479*
	Total LA	**312,402**	**178,675**	**117,445**	**70,325**	**29,479**

Mississippi River Swan River to Willow River 07010103-708 Load Component		Flow Regime Mid-Point (cfs)				
		Very High	High	Mid	Low	Very Low
		5,111	2,904	2,000	1,163	561
		Total Suspended Solids (lb per day)				
Boundary Conditions (Upstream Subwatersheds)	*Headwaters of the Mississippi River*	*23,818*	*16,863*	*15,957*	*3,214*	*1,093*
	Prairie River	*13,942*	*2,130*	*95*	*24*	*4*
	Swan River	*3,322*	*298*	*53*	*11*	*2*
	Big Sandy River	*2,529*	*117*	*20*	*0.9*	*0.2*
	Total BC	**43,611**	**19,408**	**16,125**	**3,250**	**1,099**
10% MOS		**41,349**	**23,492**	**16,184**	**9,407**	**4,537**
Total Loading Capacity		**413,492**	**234,919**	**161,836**	**94,076**	**45,367**

* Existing TSS loads were based on the 90th percentile TSS concentration from Table 22 of all samples collected at S003-663 during the months of April-September and the years 2009-2015 multiplied by the HSPF simulated median flow for each flow regime. Note that HSPF simulated flows were only available through 2015.

4.7.2 TSS TMDL: Mississippi River, Willow River to Pine River (07010104-655)

- **303(d) listing year:** 1998, based on the old turbidity standard but also currently exceeding the TSS standard
- **Baseline year(s):** 2014, based on the mid-range year of the data used for development of the TSS load duration curve.

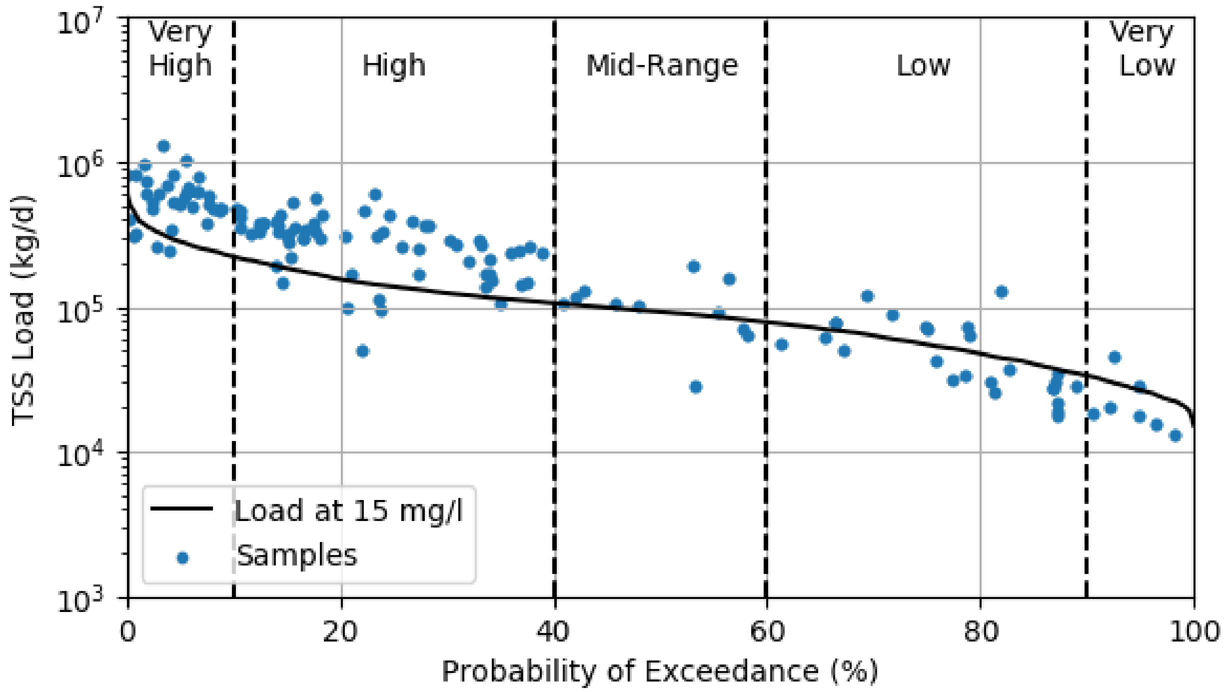


Figure 25. TSS load duration curve: Mississippi River, Willow River to Pine River (07010104-655)
Existing TSS loads were based on TSS concentration data at S002-010 and S000-152 or the months of April through September and the years 2009-2015 paired with HSPF simulated flows by date. Note that HSPF simulated flows were only available through 2015.

Table 20. TSS TMDL summary: Mississippi River, Willow River to Pine River (07010104-655)

Mississippi River Willow River to Pine River 07010104-655 Load Component		Flow Regime Mid-Point (cfs)				
		Very High	High	Mid	Low	Very Low
		7,716	3,763	2,516	1,499	722
		Total Suspended Solids (lb per day)				
Existing Load*		*4,844,053*	*354,416*	*220,321*	*24,449*	*5,002*
Wasteload Allocations	*American Peat Technology (MN0057533)*	*82*	*82*	*82*	*82*	*82*
	Aitkin WWTP (MN0020095)	*172*	*172*	*172*	*172*	*172*
	Construction stormwater (MNR100001)	*1,453*	*816*	*562*	*337*	*163*
	Industrial stormwater (MNG490000, MNR050000)	*313*	*176*	*121*	*73*	*35*
	Total WLA	**2,020**	**1,246**	**937**	**664**	**452**
Load Allocations	*Nonregulated sources*	*44,685*	*26,415*	*18,951*	*14,191*	*6,692*
	Total LA	**44,685**	**26,416**	**18,951**	**14,191**	**6,692**
Boundary Conditions (Upstream Subwatersheds)	*Upstream impaired reach (07010103-708)*	*413,492*	*234,919*	*161,836*	*94,076*	*45,367*
	Willow River	*32,910*	*9,826*	*1,307*	*203*	*51*
	Rice River	*68,709*	*1,603*	*134*	*24*	*2*
	Total BC	**515,111**	**246,348**	**163,277**	**94,303**	**45,420**
10% MOS		**62,424**	**30,445**	**20,352**	**12,129**	**5,840**
Total Loading Capacity		**624,240**	**304,454**	**203,517**	**121,287**	**58,404**

* Existing TSS loads were based on 90th percentile TSS concentration from Table 22 of all samples collected at S002-010 and S000-152 during the months of April-September and the years 2009-2015 multiplied by the HSPF simulated median flow for each flow regime. Note that HSPF simulated flows were only available through 2015.

4.7.3 TSS TMDL: Mississippi River, Pine River to Crow Wing River (07010104-656)

- **303(d) listing year or proposed year:** 2016
- **Baseline year(s):** 2014, based on the mid-range year of the data used for development of the TSS load duration curve.

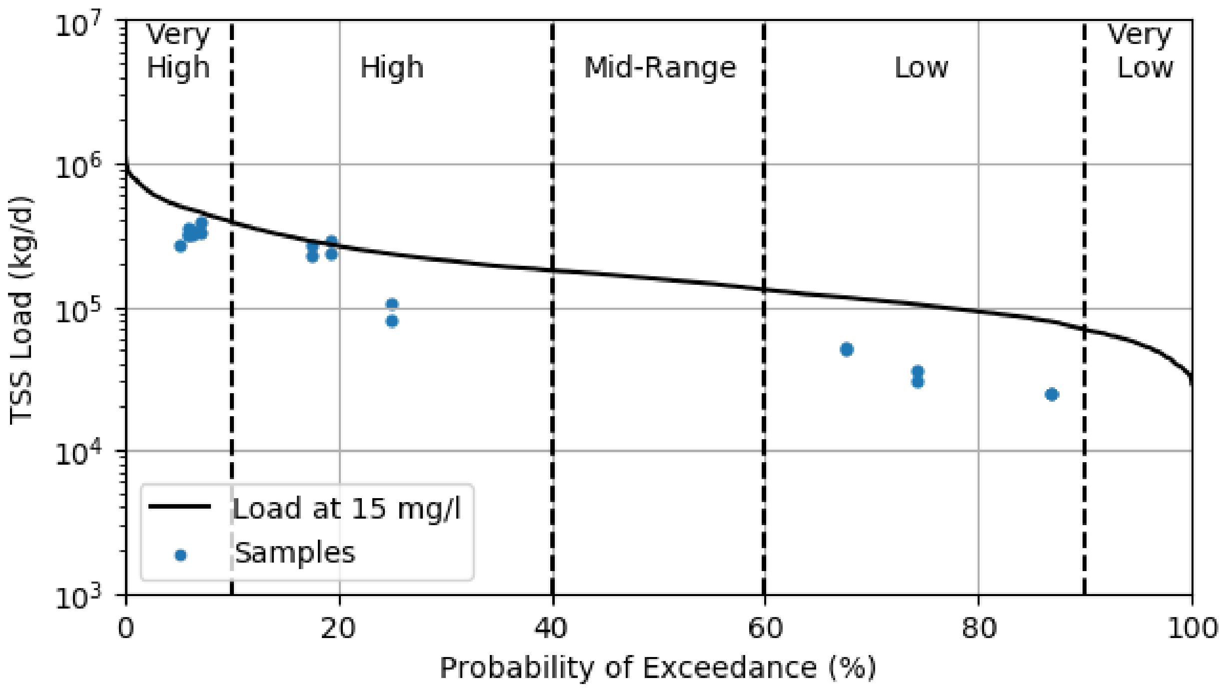


Figure 26. TSS load duration curve: Mississippi River, Pine River to Crow Wing River (07010104-656)
Existing TSS loads were based on TSS concentration data at S000-570 and S007-337 for the months of April through September and the years 2009-2015 paired with HSPF simulated flows by date. Note that HSPF simulated flows were only available through 2015. Most of the existing TSS exceedances were observed since 2015 and therefore are not represented on the load duration curve.

Table 21. TSS TMDL summary: Mississippi River, Pine River to Crow Wing River (07010104-656)

Mississippi River Pine River to Crow Wing River 07010104-656 Load Component		Flow Regime Mid-Point (cfs)				
		Very High	High	Mid	Low	Very Low
		13,825	6,356	4,265	2,781	1,505
		Total Suspended Solids (lb per day)				
Existing Load*		***5,394,630***	***1,105,078***	***379,652***	***170,640***	***67,276***
Wasteload Allocations	*City of Brainerd (MS400266)*	*12,588*	*5,456*	*3,752*	*2,754*	*1,700*
	City of Baxter (MS400231)	*12,454*	*5,399*	*3,713*	*2,723*	*1,682*
	Brainerd WWTP (MN0049328)	*783*	*783*	*783*	*783*	*783*
	Serpent Lake WWTP (MNG585215)	*2,347*	*2,347*	*2,347*	*2,347*	*2,347*
	Construction stormwater (MNR100001)	*1,944*	*842*	*580*	*425*	*262*
	Industrial Stormwater (MNG490000, MNR050000)	*960*	*416*	*286*	*210*	*130*
	Total WLA	**31,076**	**15,243**	**11,461**	**9,242**	**6,904**
Load Allocations	*Nonregulated sources*	*324,029*	*135,756*	*93,247*	*70,375*	*43,947*
	Total LA	**324,029**	**135,756**	**93,247**	**70,375**	**43,947**
Boundary Conditions (Upstream Subwatersheds)	*Upstream impaired reach (07010103-655)*	*624,240*	*304,454*	*203,517*	*121,287*	*58,404*
	Pine River	*27,324*	*7,363*	*2,339*	*1,618*	*353*
	Total BC	**651,564**	**311,817**	**205,856**	**122,905**	**58,757**
10% MOS		**111,852**	**51,424**	**34,507**	**22,502**	**12,179**
Total Loading Capacity		**1,118,521**	**514,240**	**345,071**	**225,024**	**121,787**

* Existing TSS loads were based on the 90th percentile TSS concentration from Table 22 of all samples collected at S000-570 and S007-337 during the months of April-September and the years 2009-2015 multiplied by the HSPF simulated median flow for each flow regime. Note that HSPF simulated flows were only available through 2015.

4.8 TSS Reductions

The average annual TSS load reduction needed to meet the TMDL was estimated for each impaired reach, based on achieving the TSS standard 90th percentile concentration of 15 mg/L from the existing 90th percentile concentration of samples collected between April and September in 2009 through 2018 for the existing load monitoring station(s) listed in Table 22. TSS reductions needed are highest for the most upstream impaired reach of the Upper Mississippi River (62%, Swan River to Willow River), and lowest for the most downstream reach of the Upper Mississippi River (25%, Pine River to Crow Wing River).

The estimated percent reductions provide a rough approximation of the overall reduction needed for the water body to meet the TMDL. The percent reduction is a means to capture the level of effort needed to reduce TSS concentrations in the impaired reaches. The percent reductions should not be construed to mean that each of the separate sources listed in the TMDL table needs to be reduced by that amount.

Table 22. TSS reductions needed by impaired reach

Impaired Reach (AUID)	Existing Load Monitoring Station(s)	90th Percentile Concentration (mg/L)	TSS Standard 90th Percentile Concentration (mg/L)	TSS Reductions needed to meet TMDL (%)
Mississippi River, Swan River to Willow River (07010103-708)	S003-663	39	15	**62%**
Mississippi River, Willow River to Pine River (07010104-655)	S002-010 & S000-152	37	15	**59%**
Mississippi River, Pine River to Crow Wing River (07010104-656)	S000-570 & S007-337	20	15	**25%**

5. Future growth considerations

According to the 2010 Census, over 2.8 million people reside in the Upper Mississippi Basin, mostly in the Twin cities downstream of the Study Area. Population growth trends show increasing pressure on the upper part of the basin, particularly along the river. How changing sources of pollutants may or may not impact TMDL allocations are discussed below, in the event that population and land use in the TMDL Study Area do change over time.

5.1 New or expanding permitted MS4 WLA transfer process

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

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 nonregulated 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 Sections 4.1 and 4.2.1). 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.

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. 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 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

A TMDL needs to provide reasonable assurance that water quality targets will be achieved through the specified combination of point and nonpoint source reductions reflected in the LAs and WLAs, respectively. According to EPA guidance (EPA 2002):

> "When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint-source load reductions will occur ... the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for the EPA to determine that the TMDL, including the LA and WLAs, has been established at a level necessary to implement water quality standards."

In order to address sediment load reductions in the TMDL Study Area, already required point source controls will continue to be effective in improving water quality if accompanied by considerable reductions in nonpoint source loading.

The following sections provide reasonable assurance that implementation will occur and result in pollutant load reductions in the TMDL Study Area. These reasonable assurances are outlined in the following areas:

- Availability of reliable means of addressing pollutant loads (see Section 6.1);
- A means of prioritizing and focusing management (see Section 6.2);
- Development of a strategy for implementation (see Section 6.2 and Section 8);
- Availability of funding to execute projects (see Section 6.3);
- A system of tracking progress and monitoring water quality response (see Section 6.4, Section 7 Monitoring plan and Section 8.7 Adaptive management);
- Nonpoint source pollution reduction examples at multiple scales (see Section 6.2)

6.1 Reliable means of addressing pollutant loads

Elements are in place for both point sources and nonpoint sources to make progress toward needed pollutant reductions in this TMDL. A range of local partners is involved in water resource management and implementation, including counties and SWCDs from Aitkin and Itasca counties, and numerous cities and townships. In addition, state agencies (MPCA, Board of Water and Soil Resources (BWSR), DNR and Minnesota Department of Agriculture (MDA)) receive Clean Water Funds for various water resource management duties, including technical assistance.

Management will be prioritized and focused on the dominant sources of sediment to the TMDL Study Area; primarily conservation of land that has been converted to urban or agricultural uses within the Upper Mississippi River corridor. Management will be focused on practices that reduce soil erosion from physical trampling of the banks from livestock, increase stabilization of the soil from planting deep-rooted vegetation, and water storage in the drainage area to reduce the number of concentrated runoff flowpaths resulting in gullies or bank failures.

6.1.1 Regulatory approaches

Regulatory approaches help reduce the amount of pollutants entering the impaired reaches and reduce the volume of water that can contribute to bank erosion, but address only the small fraction of sediment sources in this TMDL Study Area that are regulated.

6.1.1.1 MS4 stormwater

The MPCA is responsible for applying federal and state regulations to protect and enhance water quality in Minnesota. 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. 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, 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; and
- 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 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 which have been completed within the previous year, analyze implementation activities already installed, and outline any changes within the SWPPP from the previous year. For more information on the MPCA MS4 program see: The Municipal Stormwater page.

This TMDL assigns TSS WLAs to permitted MS4s in the TMDL Study Area (Section 4.7). The Small MS4 General Permit requires permittees to develop compliance schedules for EPA approved TMDL WLAs not already being met at the time of permit application. A compliance schedule includes BMPs that will be implemented over the permit term, a timeline for their implementation, and a long term strategy for continuing progress towards assigned WLAs. For WLAs being met at the time of permit application, the same level of treatment must be maintained in the future. Regardless of WLA attainment, all permitted MS4s are still required to reduce pollutant loadings to the maximum extent practicable.

The MPCA's stormwater program and its NPDES Permit program are regulatory activities providing reasonable assurance that implementation activities are initiated, maintained, and consistent with WLAs assigned in this study.

6.1.1.2 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.

6.1.1.3 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 Nonmetallic Mining/Associated Activities General Permit (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.

6.1.1.4 Wastewater

The MPCA issues NPDES/SDS permits for WWTFs that discharge into waters of the state. The permits have site specific limits on pollutants 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. Discharge monitoring is conducted by permittees and routinely submitted to the MPCA for review.

6.1.1.5 Buffer program

The Buffer Law signed by Governor Dayton in June 2015 was amended on April 25, 2016, and further amended by legislation signed by Governor Dayton on May 30, 2017. The Buffer Law requires the following:

- For all public waters, the more restrictive of:
  - a 50-foot average width, 30-foot minimum width, continuous buffer of perennially rooted vegetation, or
  - the state shoreland standards and criteria.
- For public drainage systems established under Minn. Stat. 103E, a 16.5-foot minimum width continuous buffer.

Alternative practices are allowed in place of a perennial buffer in some cases. The amendments enacted in 2017 clarify the application of the buffer requirement to public waters, provide additional statutory authority for alternative practices, address concerns over the potential spread of invasive species through buffer establishment, establish a riparian protection aid program to fund local government buffer law enforcement and implementation, and allowed landowners to be granted a compliance waiver until July 1, 2018, when they filed a compliance plan with the soil and water conservation district (SWCD).

The BWSR provides oversight of the buffer program, which is primarily administered at the local level; compliance with the Buffer Law in the state is displayed at the Buffer Program Update webpage. As of January 2019, over 95% of all parcels in Aitkin, Crow Wing, and Itasca Counties are in compliance with the buffer law.

6.1.2 Nonregulatory

Nonregulatory approaches are volunteer based and necessary to reduce the majority of sediment entering the impaired reaches and the volume of water that can contribute to bank erosion. The following examples describe large-scale programs that have proven to be effective and/or will reduce pollutant loads going forward.

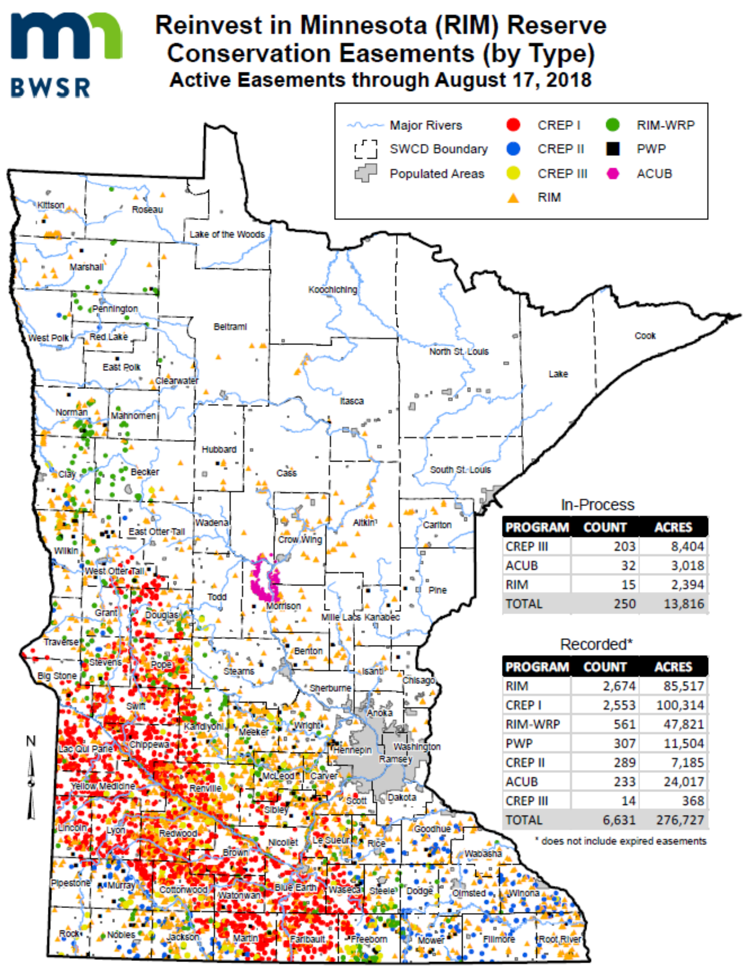
6.1.2.1 Mississippi River Headwaters Board implementation programs

At the local level, the Mississippi River Headwaters Board currently implements programs that target improving water quality and have been actively involved in projects to improve water quality in the past. The Mississippi River Headwaters Board has recently updated their Comprehensive Management Plan for the first 400 miles of the Mississippi River (from headwaters to the Morrison and Stearns county boundary, which encompasses the TMDL Study Area), and has received the following Accelerated Implementation Grants from the BWSR to prioritize and focus management efforts:

- $100,000 in 2012 to complete a study to prioritize conservation project implementation based on areas of concern where: 1) water quality is showing degradation, and 2) areas that are critical to long-term water quality protection. The MHB also worked in conjunction with the member counties to develop implementation plans and strategies geared specifically for the Mississippi River and incorporated them into the individual County Comprehensive Local Water Plans (http://mississippiheadwaters.org/grants/MHB%20CWF%20story%202014.pdf).
- $81,000 in 2015 to complete a stormwater project analysis for 12 cities on the Mississippi River – including Baxter, Brainerd, Aitkin, Palisade, Riverton, Grand Rapids, and La Prairie within the TMDL study area – to identify places where stormwater practices would best remove pollutants and help protect the water quality of the Mississippi River. Projects are ranked based on sediment reduction cost-effectiveness. http://mississippiheadwaters.org/files/regmanagement/MHB%20CWF%20story%202015.pdf.

6.1.2.2 Conservation easements

Conservation easements are a critical component of the state's efforts to improve water quality by reducing soil erosion, phosphorus and nitrogen loading, and improving wildlife habitat and flood attenuation on private lands. Easements protect the state's water and soil resources by permanently restoring wetlands, adjacent native grassland wildlife habitat complexes and permanent riparian buffers. In cooperation with county SWCDs and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), BWSR's programs compensate landowners for granting conservation easements and establishing native vegetation habitat on economically marginal, flood-prone, environmentally sensitive or highly erodible lands. These easements vary in length of time from 10 years to permanent/perpetual easements. Types of conservation easements in Minnesota include: Sustainable Forest Incentive Act (SFIA)/Forest Stewardship planning, Conservation Reserve Program (CRP); Conservation Reserve Enhancement Program (CREP); Reinvest in Minnesota (RIM); and



In-Process

PROGRAM	COUNT	ACRES
CREP III	203	8,404
ACUB	32	3,018
RIM	15	2,394
TOTAL	250	13,816

Recorded*

PROGRAM	COUNT	ACRES
RIM	2,674	85,517
CREP I	2,553	100,314
RIM-WRP	561	47,821
PWP	307	11,504
CREP II	289	7,185
ACUB	233	24,017
CREP III	14	368
TOTAL	6,631	276,727

* does not include expired easements

the Wetland Reserve Program (WRP) or Permanent Wetland Preserve (PWP) https://bwsr.state.mn.us/reinvest-minnesota-overview.

The following table shows easements in place in the counties included in the TMDL Study Area as of August 2019.

Table 23. Current easements within TMDL Study Area.

County	CRP Acres	RIM	Total Resource Acres	Cropland Acres	Percent Enrolled
Aitkin	0	1,950	1,950	71,040	2.7%
Crow Wing	7	6,422	6,429	52,789	12.2%
Itasca	167	918	1,085	29,241	3.7%

6.2 Implementation strategy

Based on the findings from the sediment source summary for the TMDL Study Area (see Section 3.5), an implementation strategy (see Section 8) was developed by EOR and MPCA based on input from LGUs (cities, counties, and SWCDs), the Mississippi Headwaters Board, and state agencies (DNR, MPCA, BWSR). These partners and other stakeholders were also able to provide input on the overall implementation strategy as part of the public participation process for this TMDL (see Section 9).

The main implementation drivers will be the Mississippi Headwater Board and the MS4 Cities, in coordination with the SWCDs.

6.3 Funding availability

At the local level, the Mississippi Headwaters Board has received over $6M for the Mississippi Headwaters Habitat Corridor Easement and Acquisition Program and $181,000 for project prioritization studies. At the state level, there are a variety of funding sources to help cover some of the cost to implement practices that reduce pollutants from entering surface waters and groundwater. There are several programs listed below that contain web links to the programs and contacts for each entity. The contacts for each grant program can assist in the determination of eligibility for each program, as well as funding requirements and amounts available.

- Agriculture BMP Loan Program (MDA)
- Agricultural Water Quality Certification Program (MDA)
- Clean Water Fund Grants (BWSR)
- Clean Water Partnership Loans (MPCA)
- Environment and Natural Resources Trust Fund (Legislative-Citizen Commission on Minnesota Resources)
- Environmental Assistance Grants Program (MPCA)
- Phosphorus Reduction Grant Program (Minnesota Public Facilities Authority)
- Clean Water Act Section 319 Grant Program (MPCA)

- Small Community Wastewater Treatment Construction Loans & Grants (Minnesota Public Facilities Authority)
- Source Water Protection Grant Program (Minnesota Department of Health)
- Surface Water Assessment Grants (MPCA)
- Wastewater and storm water financial assistance (MPCA)
- Conservation Partners Legacy Grant Program (DNR)
- Environmental Quality Incentives Program (NRCS)
- Conservation Reserve Program (USDA)
- Clean Water State Revolving Fund (EPA)

6.4 Tracking progress and monitoring water quality response

Tracking progress towards achieving the TMDL sediment load reduction goals and monitoring the water quality response of the Upper Mississippi River will be based on water quality monitoring (see Section 7) and tracking progress of implementing the key strategies outlined in Section 8: Implementation strategy summary.

6.5 Nonpoint source pollution reduction trends

Analysis of water quality data from 80 monitoring locations across Minnesota has shown over a 30 year period that five pollutants, TSS, total phosphorus (TP), ammonia, biochemical oxygen demand (BOD), and bacteria have significantly decreased, while nitrate and chloride concentrations have increased (MPCA 2014b). These trends are a result of the state's efforts to control municipal and industrial discharges and a continuing effort by state, county and local groups to reduce nonpoint source pollution. At a local level, the Mississippi Headwaters Board and SWCDs promote soil and water conservation through technical, educational and financial assistance.

In summary, significant time and resources have been devoted to identifying the most effective BMPs, providing means of focusing them in the TMDL Study Area, and supporting their implementation via state initiatives and dedicated funding. The Upper Mississippi River TSS TMDL process engaged partners to arrive at reasonable examples of BMP combinations that attain pollutant reduction goals. Minnesota is a leader in watershed planning as well as monitoring and tracking progress toward water quality goals and pollutant load reductions. Finally, examples cited herein confirm that BMPs and restoration projects have proven to be effective over time, and as stated by the State of Minnesota Court of Appeals in A15-1622 MCEA vs MPCA and MCES:

> We conclude that substantial evidence exists to conclude that voluntary reductions from nonpoint sources have occurred in the past and can be reasonably expected to occur in the future. The Nutrient Reduction Strategy (NRS) […] provides substantial evidence of existing state programs designed to achieve reductions in nonpoint source pollution as evidence that reductions in nonpoint pollution have been achieved and can reasonably be expected to continue to occur.

7. Monitoring plan

Several types of monitoring will be important to measuring success. These efforts will be conducted contingent on resources available and priorities. The six basic types of monitoring listed below are based on the EPA's Protocol for Developing Sediment TMDLs (EPA 1999).

1. **Baseline monitoring**—identifies the environmental condition of the water body to determine if water quality standards are being met, and identify temporal trends in water quality. Every five years, the MPCA will complete intensive monitoring of the major rivers, including the TMDL Study Area (chemistry three times per month in the first year, chemistry and biology two times per month in the fifth year). More information about MPCA's Large River Monitoring is available online: https://www.pca.state.mn.us/water/large-river-monitoring.

2. **Implementation monitoring**—tracks implementation of sediment reduction practices using BWSR's eLINK or other tracking mechanisms. BMP implementation monitoring is conducted by both BWSR (i.e., eLINK) and USDA. Both agencies track the locations of BMP installations. The Healthier Watersheds webpage displays both implementation funding and practices: https://www.pca.state.mn.us/water/healthier-watersheds.

   Discharges from permitted municipal and industrial wastewater sources are reported through discharge monitoring records; these records are used to evaluate compliance with NPDES permits. Summaries of discharge monitoring records are available through the MPCA's Wastewater Data Browser: https://www.pca.state.mn.us/data/wastewater-data-browser.

3. **Flow monitoring**—is combined with water quality monitoring at the site to allow for the calculation of pollutant loads. Long-term flow monitoring within the TMDL Study Area is at three locations on the Mississippi River mainstem: Mississippi River at Grand Rapids (USGS 05211000), Mississippi River at Aitkin (USGS 05227500), and Mississippi River at Brainerd (USGS 05242300). Flow data is available from USGS: https://waterdata.usgs.gov/mn/nwis/rt.

4. **Effectiveness monitoring**—determines whether a practice or combination of practices are effective in improving water quality. Effectiveness monitoring would be completed by the Mississippi Headwaters Board, SWCDs, or cities on a project specific basis.

5. **Trend monitoring**—allows the statistical determination of whether water quality conditions are improving. The MPCA's Watershed Pollutant Load Monitoring Network (WPLMN) measures and compares data on pollutant loads from Minnesota's rivers and streams and tracks water quality trends. WPLMN data will be used to assist with assessing impaired waters, watershed modeling, determining pollutant source contributions, developing watershed and water quality reports, and measuring the effectiveness of water quality restoration efforts. Data are collected along major river mainstems, at major watershed (i.e., HUC-8) outlets to major rivers, and in several subwatersheds. This long-term monitoring program began in 2007. Long-term trend records are available from MPCA's WPLMN: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring.

6. **Validation monitoring**—validates the source analysis and linkage methods in sediment source tracking to provide additional certainty regarding study findings. One of the implementation strategy recommendations is a sediment fingerprinting analysis to verify the contribution of

sediment bed and bank erosion in the TMDL Study Area, particularly erosion of Glacial Lake Aitkin clay deposits within the stream channel versus watershed runoff. Sediment fingerprinting is an analytical method used to determine different sources of sediment from various erosion processes, both natural and management-related. The underlying principle is that different sediment sources (i.e., stream banks, in-stream channel stream beds, floodplains, and uplands) can be characterized using a number of chemical and physical properties. Each source of sediment has a unique set of properties, referred to as a "fingerprint." The source sampling can be used to: a) better define the concentrations of the tracers derived from different sources of sediment within the watershed; b) characterize floodplain deposition rates and floodplain/bank tracer concentrations; and c) determine the extent to which groundwater seeps may influence fingerprinting estimates. An example of a completed sediment fingerprinting study completed in Minnesota is MDA's Root River Integrated Sediment Budget: https://www.mda.state.mn.us/integrated-sediment-budget-root-river-southeastern-minnesota.

8. Implementation strategy summary

8.1 Permitted sources

8.1.1 MS4 stormwater

MS4 stormwater represents a small contribution of the total TSS load to the impaired reaches of the Upper Mississippi River mainstem, with the dominant source of TSS from bed/bank erosion due to the underlying erodibility of glacial lake soils. Implementation of the stormwater retrofit projects identified by the cities of Baxter, Brainerd, and Grand Rapids (as described below) will provide TSS reduction benefits to the impaired reaches of the Mississippi River through direct TSS load reductions and indirectly through rate and volume reductions that reduce in-stream erosion.

The NPDES/SDS permit requirements must be consistent with the assumptions and requirements of an approved TMDL and associated WLAs. For the purposes of this TMDL, the baseline year for implementation will be the mid-range year of the data years used for development of the TSS load duration curve, or 2014.

Stormwater retrofit projects:

In 2014 and 2015, MHB received funding to complete a stormwater project analysis for 12 cities on the Mississippi River – including Baxter, Brainerd Aitkin, Palisade, Riverton, Grand Rapids, and La Prairie within the TMDL Study Area – to identify places where stormwater practices would best remove pollutants and help protect the water quality of the Mississippi River. Projects included extended detention ponds, stormwater reuse, boulevard bioretention cells, porous asphalt, iron-enhanced sand filters, and iron-chloride treatment systems. Projects are ranked based on sediment reduction cost-effectiveness. Implementation of these ranked practices from the completed stormwater project analyses in the major communities within the TMDL Study Area (Baxter, Brainerd, and Grand Rapids) will reduce urban runoff sediment loads to the Upper Mississippi River. The stormwater reports are available from the Mississippi Headwaters Board Natural Protection Grants webpage.

8.2 Nonpermitted sources

This section provides an overview of example BMPs that may be used for implementation to address nonpermitted sources of TSS. Key implementation strategies by sediment source are described below:

- **Land conservation through easement and acquisition**:

  The Mississippi Headwaters Board in collaboration with the Trust for Public Land, BWSR, The Nature Conservancy, 7 SWCDs in the Headwaters region and DNR has developed the Mississippi Headwaters Habitat Corridor Easement and Acquisition Program to protect and preserve the natural qualities of the Mississippi River. The goal of the program is to create and expand contiguous complexes of permanently protected shoreland and upland for the benefit of fish and wildlife habitat, migratory waterfowl, reduction of forest fragmentation, enhanced recreational opportunities and protection of water quality. Land protection is achieved via fee-title acquisition of land or enrolling land in The RIM conservation easement program. Since the project began in 2016 it, has received $12 million in four appropriations for permanent protection of fish and wildlife habitat in the minor watershed of the first 400 miles of the Mississippi River. To date, over $6 million has been spent achieving permanent protection of 3,441 acres and 31 miles shoreland. Projects in process or committed will protect another 1,000 acres and 8 miles of shoreland.

- **Riparian buffers:**

  Establishing or enhancing long-rooted, native vegetation buffers along the river banks will stabilize the banks and reduce erosion. Riparian buffers and filter strips that include perennial vegetation and trees can filter runoff from adjacent cropland, provide shade and habitat for wildlife, and reinforce streambanks to minimize erosion. The root structure of the vegetation uses enhanced infiltration of runoff and subsequent trapping of pollutants. Both, however, are only effective in this manner when the runoff enters the BMP as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully will quickly pass through the vegetation offering minimal opportunity for retention and uptake of pollutants. In addition, deep rooted vegetation can protect the streambanks from gouging by ice chunks in the river during spring snowmelt.

- **Livestock exclusion:**

  In some parts of the Upper Mississippi River corridor, livestock grazing along the river banks is resulting in streambank erosion due to physical trampling of the banks from livestock. Working with farmers to exclude livestock from direct access to the river banks will reduce bank erosion.

- **Performance standards:**

  The Minnesota Legislature has empowered the Mississippi Headwaters Board to protect the Mississippi Headwaters Corridor through regulation of land use above the ordinary high water mark (OHWM). Some activities on the shoreland are permitted by the DNR and other agencies with review by the MHB to promote consistent administration of minimum standards. Performance Standards are listed in Appendix 1 of the September 2019 Mississippi Headwaters Board Comprehensive Plan. In addition, there are local ordinances within city boundaries. Continued implementation of these standards and coordination between MHB and LGUs will protect the riparian area of the Upper Mississippi River from development and land use changes with the goal of reducing bank erosion.

8.3 Education and outreach

A crucial part in the success of the Implementation Strategy that will restore the impaired river reaches 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 have been and will continue to be used throughout the TMDL Study Area. These include (but are not limited to): press releases, meetings, workshops, focus groups, trainings, websites, etc. Local staff (conservation district, county, etc.) and board members work to educate the residents of the watersheds about ways to improve their waters on a regular basis.

Websites:

- Mississippi River Headwaters Board: http://mississippiheadwaters.org/
- Aitkin SWCD: https://aitkincountyswcd.org/
- Crow Wing SWCD: https://crowwingswcd.org/
- Itasca SWCD: https://itascaswcd.org/
- MPCA's Upper Mississippi River Basin: https://www.pca.state.mn.us/featured/upper-mississippi-river-what-protect-what-fix

8.4 Technical assistance

The SWCDs, NRCS, and county staff within the watersheds provide assistance to landowners for a variety of projects that benefit water quality. Assistance provided to landowners varies based on whether they are implementing urban, agricultural or shoreline BMPs. This technical assistance includes education and one-on-one training. Many opportunities for technical assistance result from educational workshops or trainings. It is important that these outreach opportunities for watershed residents continue. Marketing is necessary to motivate landowners to participate in voluntary cost-share assistance programs.

Programs such as state cost share, CREP, and RIM are administered through the county. In addition, assistance is available from state and federal sources, including: Clean Water Legacy funding, Environmental Quality Incentives Program (EQIP), CRP, State Buffer Law Implementation, Minnesota Agricultural Water Quality Certification Program (MAWQCP), and Conservation Stewardship Program (CSP). All of these programs are available to help implement the best conservation practices that each parcel of land is eligible for to target the best conservation practices per site. Conservation practices may include, but are not limited to: stormwater bioretention and other BMPs, septic system upgrades, feedlot improvements, invasive species control, wastewater treatment practices, agricultural BMPs, forest stewardship planning, and shoreline restorations.

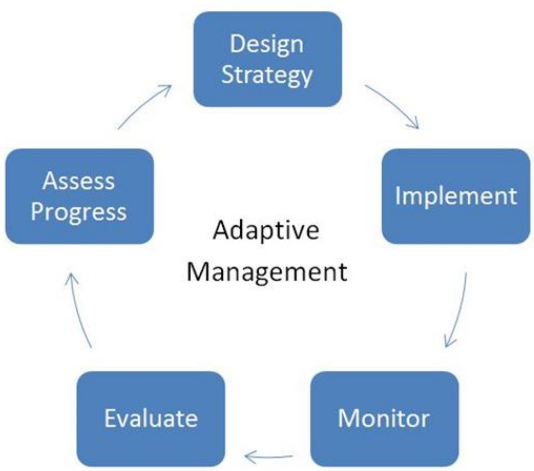
8.5 Partnerships

Partnerships with counties, cities, townships, citizens, and co-ops are one mechanism through which the MHB, along with Aitkin, Crow Wing, and Itasca SWCDs, will protect and improve water quality. Strong partnerships with state and local government to protect and improve water resources and to bring waters within the TMDL Study Area into compliance with state standards will continue. A partnership with local government units and regulatory agencies such as cities, townships and counties may be formed to develop and update ordinances to protect the area's water resources.

8.6 Cost

The Clean Water Legacy Act requires that a TMDL study include an overall approximation of the cost to implement the TMDL study (Minn. Stat. 2007, section 114D.25). The total cost estimate for this TMDL is $17.3M based on the costs to implement the stormwater retrofit projects (see Section 8.1.1) identified by the cities of Baxter ($1.5M), Brainerd ($2.4M), and Grand Rapids ($4.4M); plus $9M to protect an additional 4,500+ acres and 38+ miles of shoreline along the Upper Mississippi River (see Section 8.2, calculated from the existing cost to protect the first 4,500 acres and 38 miles times a 1.5 multiplier).

8.7 Adaptive management



This list of implementation activities listed in this report focuses on adaptive management (Figure 27). 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 waterbodies.

Figure 27. Adaptive management

9. Local Partner and Public Participation

Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from August 17, 2020 through September 16, 2020. One comment letter was received and responded to as a result of the public comment period.

9.1 Technical committee meetings

The Technical Advisory Committee (TAC) was comprised of representatives from the SWCDs and state agencies. **Table** 24 outlines the date, location and meeting focus of TAC meetings held during the TMDL development process. In addition, the Mississippi River Headwaters Board provided detailed information regarding their conservation easement and stormwater BMP management efforts and grant funding along the Upper Mississippi River corridor.

Table 24. Upper Mississippi River TSS TMDL Technical Advisory Committee Meetings.

Date	Location	Meeting Focus
5/7/2019	Webex	Planning meeting for project
5/15/2019	Skype	Near stream erosion sources
5/15/2019	Skype	Point sources
5/16/2019	Skype	Chemical and Biological Monitoring
5/29/2019	Skype	Hydrology and HSPF
6/10/2019	Webex	USACE
8/21/2019	Phone	Draft Report Check-in
9/12/2019	Skype	Draft Report Check-in
12/3/2019	Brainerd MPCA	Discuss Draft Comments

9.2 Public Participation

The MPCA along with the local partners and agencies recognize the importance of public involvement in the watershed process. The opportunities used to engage the public and targeted stakeholders in the watershed are outlined below:

- A meeting with affected MS4s and SWCDs within the TMDL Study Area was held with Agency staff on December 3, 2019, to discuss the TSS impairment and TMDL MS4 Permit Requirements, Stormwater BMPs, and Resources.
- A public meeting was held via Webex on August 18, 2020 to present the draft TMDL report and allocations and receive public comments and concerns at the start of public notice.

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