Watershed

March 2020

Upper Iowa River and Mississippi River–Reno Watersheds Total Maximum Daily Load

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Abbreviations

1W1P	One Watershed, One Plan
AFO	animal feeding operation
AU	animal unit
AUID	assessment unit identification
BMP	best management practice
BWSR	Board of Water and Soil Resources
CAFO	concentrated animal feeding operation
cfu	colony forming unit
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
DMR	discharge monitoring report
DNR	Minnesota Department of Natural Resources
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information System
HSPF	Hydrologic Simulation Program–Fortran
HUC	hydrologic unit code
ITPHS	imminent threats to public health and safety
LA	load allocation
mg/L	milligrams per liter
MRR	Mississippi River–Reno
MOS	margin of safety
MPCA	Minnesota Pollution Control Agency
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
org/100 mL	organisms per 100 milliliters
org/day	organisms per day
RIM	Reinvest in Minnesota
SDS	State Disposal System

SSTS	subsurface sewage treatment systems
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
TSS	total suspended solids
UIR	Upper Iowa River
USGS	United State Geological Survey
WLA	wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy
WRP	Wetlands Reserve Program
WWTP	wastewater treatment plant

Executive summary

The Clean Water Act (CWA), Section 303(d) requires total maximum daily loads (TMDLs) to be completed for surface waters that do not meet applicable water quality standards necessary to support their designated uses. A TMDL determines the maximum amount of a pollutant a receiving waterbody can assimilate while still achieving water quality standards and allocates allowable pollutant loads to various sources needed to meet water quality standards. This TMDL study addresses the impairments in the Upper Iowa River (UIR) and Mississippi River–Reno (MRR) watersheds in southeast Minnesota. The causes of impairment in the watershed include high levels of *Escherichia coli* (*E. coli*) and total suspended solids (TSS), affecting aquatic life, aquatic recreation, and limited resource value designated uses. Ten TMDLs are provided: nine *E. coli* TMDLs and one TSS TMDL.

Land cover trends shift from west to east in the UIR and MRR watersheds. Cropland (corn, alfalfa, and soybeans) is most dominant in the UIR Watershed, and forested areas increase in Houston County. Grassland/pasture and forested areas are more prevalent in the MRR Watershed with some corn, alfalfa, and soybean in the upland portions of the watershed. Developed land covers are scattered throughout the project area, with more densely developed areas near the towns of Caledonia, Spring Grove, Harmony, and several small communities.

Potential sources of pollutants include watershed surface runoff (both regulated and unregulated), near-channel sources (e.g., channel erosion), municipal wastewater, septic systems and untreated wastewater, livestock, and wildlife. More specifically, pollutant sources that are likely contributing to impairments include noncompliant septic systems, livestock, runoff from cropland, and near channel erosion.

The pollutant load capacity of the impaired streams was determined using load duration curves. These curves represent the allowable pollutant load at any given flow condition. Water quality data were compared with the load duration curves to determine load reduction needs. A 10% explicit margin of safety (MOS) was incorporated into all TMDLs to account for uncertainty. The water quality data, when taken as a whole, indicate that the majority of *E. coli* exceedances occur under high and very high flows, indicating that runoff-driven sources are the primary sources of concern. Load reductions are needed to address multiple source types. The majority of TSS exceedances also occur during higher flows; load reductions will need to come primarily from agricultural runoff and near channel erosion.

The implementation strategy highlights an adaptive management process to achieving water quality standards and restoring beneficial uses. The UIR and MRR watersheds are included in the Root River One Watershed, One Plan (1W1P) adopted in 2016. Implementation strategies recommended by this TMDL align with many of the water quality strategies in the Root 1W1P including agricultural runoff control (e.g., conservation tillage and cover crops); feedlot runoff control; septic system improvements; stream restoration; pasture management; buffers and filter strips; and urban stormwater runoff control. Public participation included meetings with watershed stakeholders to present watershed data. The TMDL study is supported by previous work including the MRR Stressor Identification (SID) Report (MPCA 2018a), UIR Watershed SID Report (MPCA 2018b), UIR, MRR, Mississippi River–La Crescent Watersheds Monitoring and Assessment Report (MPCA 2018c), and the UIR and MRR Watershed hydrology and water quality models (Tetra Tech 2018).

1. Project overview

1.1 Purpose

The CWA and United States Environmental Protection Agency (EPA) regulations require that TMDLs be developed for waters that do not support their designated uses. In simple terms, a TMDL study determines what is needed to attain and maintain water quality standards in waters that are not currently meeting them. A TMDL study identifies pollutant sources and allocates pollutant loads among those sources. The total of all allocations, including wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources (including natural background), and the MOS, which is implicitly or explicitly defined, cannot exceed the maximum allowable pollutant load that will achieve water quality standards.

This TMDL study addresses aquatic life, aquatic recreation, and limited resource value impairments in the UIR Watershed (United States Geological Survey [USGS] Hydrologic Unit Code [HUC] 8 07060002), and the MRR Watershed (HUC8 07060001). The two HUC-8 watersheds cover 1,195 square miles in southeastern Minnesota and northeastern Iowa (Figure 1); this does not include the portion of the MRR Watershed that is in Wisconsin. Both watersheds are included in the *Root River* 1W1P (Root River Planning Partnership 2016) planning area and share many stakeholders. Additionally, these two watersheds are on the same watershed monitoring and assessment cycle; the first year of the Minnesota Pollution Control Agency's (MPCA's) intensive watershed monitoring in these two watersheds began in 2015. The MPCA, therefore, combined TMDLs for these two HUC-8 watersheds into one report.

The only previously completed TMDL in the Minnesota portions of these watersheds is in the Minnesota Statewide Mercury TMDL (MPCA 2007a), which addresses the mercury impairment on the Mississippi River main stem, from the Root River to the Minnesota–Iowa border. This Mississippi River reach also has an aquatic consumption impairment due to high levels of polychlorinated biphenyls in fish tissue. These aquatic consumption impairments are not further addressed in this TMDL.

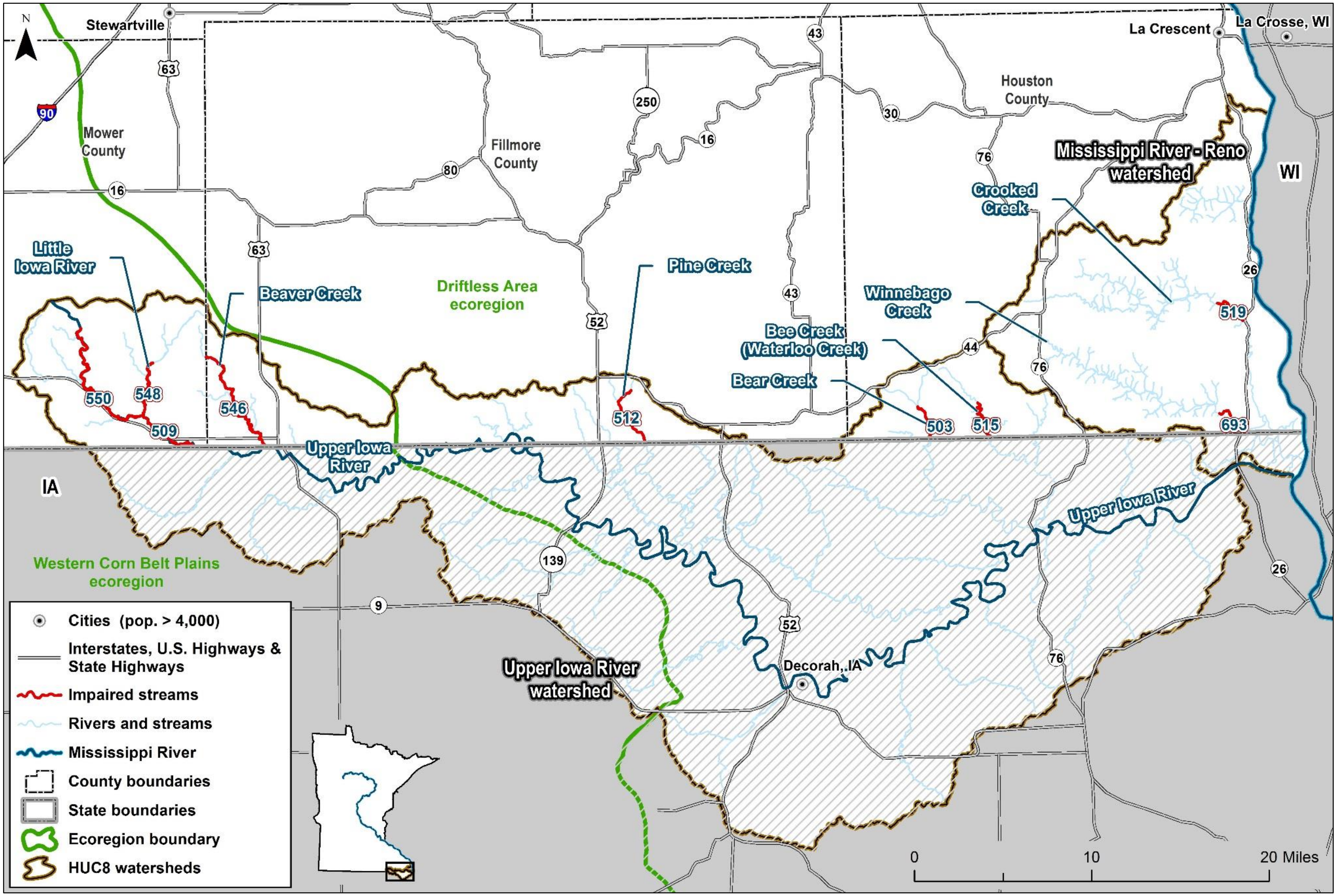


Figure 1. Upper Iowa River and Mississippi River–Reno Watersheds and impairments addressed in this report.

1.2 Identification of waterbodies

There are 15 impaired stream reaches, or assessment units, in the UIR and MRR Watersheds (Table 1, Figure 1); there are no impaired lakes. The stream impairments affect aquatic life, aquatic recreation, and/or limited resource value designated uses based on TSS, *E. coli*, fish bioassessments, or macroinvertebrate assessments. The concentrations of mercury and PCBs in fish tissue from two UIR monitoring sites were used to assess aquatic consumption uses; neither site was found to be impaired (MPCA 2018c).

This TMDL report addresses seven *E. coli* TMDLs in the UIR Watershed and two *E. coli* TMDLs and one TSS TMDL in the MRR Watershed. The remaining impairments are fish and macroinvertebrate impairments, which were investigated in the SID reports (MPCA 2018a and MPCA 2018b). For biological impairments, if the identified stressor(s) is a pollutant (e.g., TSS), and if there is a state water quality standard for that pollutant, a TMDL can be developed. Non-pollutant stressors (e.g., habitat) are not subject to load quantification and therefore do not require TMDLs. For all but one of the fish and macroinvertebrate impairments in these two major watersheds, the stressors are either non-pollutant or are pollutants for which there is no state water quality standard for the relevant use (e.g., nitrate concentrations to support aquatic life uses). TSS was identified as a stressor to the macroinvertebrates in Winnebago Creek (07060001-693) and a TSS TMDL was developed. Supporting documentation can be found in the SID reports (MPCA 2018a and MPCA 2018b). All aquatic life use impairments—not just those with associated TMDLs—are addressed in the Watershed Restoration and Protection Strategies (WRAPS) report (see Section 9 for more information on the MPCA's watershed approach). For example, streams with biota impairments due to flow alteration do not require TMDLs but may still be a focus of future restoration work.

For this report, the impairments are listed in tables ordered from upstream to downstream. All stream assessment unit identifications (AUIDs) begin with the eight-digit HUC for the watershed. The reaches are identified in this report with the last three digits of the full AUID. For example, AUID 07060001-574 is referred to as reach 574.

Table 1. Impaired waterbodies of Upper Iowa River and Mississippi River – Reno Watersheds.

HUC8	Waterbody Name	Reach Description	AUID (HUC8-)	Use Class [a]	Year Added to List	Affected Use	Proposed Category [b]	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Mississippi River–Reno (07060001)	Crooked Creek, South Fork	T102 R5W S26, west line to Crooked Creek	574	1B, 2Ag	2018	Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Temperature Dissolved oxygen/eutrophication	**No:** non-pollutant stressor **No**: dissolved oxygen stressor not conclusively linked to phosphorus load
							4C	Fishes bioassessments	Temperature Dissolved oxygen/eutrophication	**No:** non-pollutant stressor **No**: dissolved oxygen stressor not conclusively linked to phosphorus load
	Crooked Creek	T102 R4W S27, west line to Bluff Slough	519	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Habitat	**No:** non-pollutant stressor
	Clear Creek	T102 R4W S34, south line to Bluff Slough	524	2Bg	2018	Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Habitat	**No:** non-pollutant stressor
	Winnebago Creek	T101 R4W S27, west line to south line	693	1B, 2Ag [c]	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	4A	Aquatic macroinvertebrate bioassessments	TSS	**Yes**: TSS
							4A	TSS	TSS	
Upper Iowa River (07060002)	Unnamed Creek	Unnamed creek to Upper Iowa River	544	2Bg	2018	Aquatic Life	5	Aquatic macroinvertebrate bioassessments	Nitrate Habitat Flow alteration	**No:** water quality standard not established **No**: non-pollutant stressor **No:** non-pollutant stressor
	Upper Iowa River	-92.5901, 43.5985 to Little Iowa River	550	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	5	Aquatic macroinvertebrate bioassessments	Nitrate	**No:** water quality standard not established

HUC8	Waterbody Name	Reach Description	AUID (HUC8-)	Use Class [a]	Year Added to List	Affected Use	Proposed Category [b]	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Upper Iowa River (07060002)									Habitat Flow alteration	**No**: non-pollutant stressor **No:** non-pollutant stressor
	Unnamed Creek	Unnamed creek to Little Iowa River	540	2Bg	2018	Aquatic Life	5	Aquatic macroinvertebrate bioassessments	Nitrate Habitat Flow alteration	**No:** water quality standard not established **No**: non-pollutant stressor **No:** non-pollutant stressor
	Little Iowa River	770th Ave to Upper Iowa River	548	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
	Upper Iowa River	Little Iowa River to Beaver Creek (MN)	509	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
	Unnamed Creek	Unnamed creek to Beaver Creek	537	2Bg	2018	Aquatic Life	5	Aquatic macroinvertebrate bioassessments	Nitrate Habitat Flow alteration	**No:** water quality standard not established **No**: non-pollutant stressor **No:** non-pollutant stressor
	Beaver Creek	Mower-Fillmore Rd to Upper Iowa River	546	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	5	Aquatic macroinvertebrate bioassessments	Nitrate Flow alteration	**No:** water quality standard not established **No:** non-pollutant stressor
	Deer Creek	Unnamed cr to MN/IA border	520	2Bg	2018	Aquatic Life	4C	Fishes bioassessments	Fish passage Flow alteration	**No**: non-pollutant stressor **No:** non-pollutant stressor
	Pine Creek	T101 R10W S24, north line to MN/IA border	512	7	2018	Limited Resource Value	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
	Bear Creek	Unnamed cr to MN/IA border	503	7	2018	Limited Resource Value	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*

HUC8	Waterbody Name	Reach Description	AUID (HUC8-)	Use Class [a]	Year Added to List	Affected Use	Proposed Category [b]	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
	Bee Creek (Waterloo Creek)	T101 R6W S29, north line to MN/IA border	515	1B, 2Ag	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*

a. Use classes—1B: domestic consumption (requires moderate treatment); 2Ag: aquatic life and recreation—general cold water habitat (lakes and streams); 2Bg: aquatic life and recreation—general warm water habitat (lakes and streams); 7: limited resource value water.

b. All waters in the watershed are currently classified as category 5 in the 2018 303(d) list. Category 5 indicates an impaired status and no TMDL plan has been completed. Proposed categories are provided for those listings that have now been further assessed and are proposed for recategorization as either 4A or 4C:

 Category 4a: A water is placed in Category 4a when all TMDLs needed to result in attainment of all applicable water quality water quality standards have been approved or established by EPA.

 Category 4c: A water is placed in Category 4c when the state demonstrates that the failure to meet an applicable water quality standard is not caused by a pollutant, but instead is caused by other types of pollution. Segments placed in Category 4c do not require the development of a TMDL.

c. This reach is currently classified as class 2Bg but is undergoing a use class change to class 2Ag.

1.3 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 its TMDL priorities with the watershed approach and WRAPS cycle. The schedule for TMDL completion corresponds to the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan, Minnesota's TMDL Priority Framework Report (MPCA 2015), to meet the needs of the EPA's national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the CWA Section 303(d) Program (EPA 2013). As part of these efforts, the MPCA identified water quality impaired segments that will be addressed by TMDLs by 2022. The UIR Watershed and MRR Watershed waters addressed by this TMDL are part of the MPCA's prioritization plan to meet EPA's national measure.

2. Applicable water quality standards and numeric water quality targets

Water quality standards are designed to protect designated uses. The standards consist of the designated uses, criteria to protect the uses, and other provisions such as antidegradation policies that protect the waterbody.

2.1 Designated uses

Use classifications are defined in Minn. R. 7050.0140, and water use classifications for individual waterbodies are provided in Minn. R. 7050.0470, 7050.0425, and 7050.0430. This TMDL report addresses the waterbodies that do not meet the standards for class 2 and 7 waters. The impaired streams in this report are classified as class 1B, 2Ag, 2Bg, and/or 7 waters (Table 1); there are no impairments in these watersheds that are based on violations of class 1 water quality standards.

Class 1B waters are protected for domestic consumption (requires moderate treatment). Class 2Ag waters are protected for aquatic life and recreation—general cold water habitat (lakes and streams). Class 2Bg waters are protected for aquatic life and recreation—general warm water habitat. Class 7 waters are limited resource value waters and are protected for aesthetic qualities, secondary body contact use, and groundwater for use as a potable water supply.

2.2 Water quality standards

Water quality standards for class 1 waters are defined in Minn. R. 7050.0221, standards for class 2 waters are defined in Minn. R. 7050.0222, and standards for class 7 waters are defined in Minn. R. 7050.0227. Water quality standards for *E. coli* and TSS are presented in Table 2; these standards serve as targets for the applicable UIR Watershed and MRR Watershed TMDLs.

In Minnesota, *E. coli* is used as an indicator species of potential waterborne pathogens. There are two *E. coli* standards each for class 2 and class 7 waters—one is applied to monthly *E. coli* geometric mean concentrations, and the other is applied to individual samples. Exceedances of either *E. coli* standard in class 2 or 7 waters indicates that a waterbody does not meet the applicable designated use. The class 2 standard applies from April through October, whereas the class 7 standard applies from May through October.

Exceedances of the TSS standard in streams indicate that a waterbody does not meet the aquatic life designated use. Winnebago Creek (07060001-693) in the MRR Watershed is undergoing a use class change from class 2B to class 2A. The TSS TMDL developed in this report is based on the class 2A standard.

The impaired streams that cross the Minnesota–Iowa state boundary were evaluated to identify cases where the standard in a downstream Iowa impairment is more restrictive than the standard in an upstream Minnesota impairment. The impaired Bear Creek (07060002-503) and Pine Creek (07060002-512) reaches in the UIR Watershed in Minnesota are class 7, with a geometric mean standard of 630 organisms per 100 milliliters (org/100 mL). Bear Creek flows into an impaired Bear Creek reach in Iowa (reach 01-UIA-255) that is a class A1 waterbody with a geometric mean standard of 126 org/100 mL (applicable from March 15 through November 15; Table 3). Pine Creek flows into an impaired Pine Creek reach in Iowa (reach 01-UIA-278) that is a class A1 waterbody from April through October, with a geometric mean standard of 126 org/100 ml, and a class A2 waterbody from November through March, with a geometric mean standard of 630 org/100 mL. To protect downstream uses, the TMDL targets for Bear Creek and Pine Creek in Minnesota are 126 org/100 mL, which is based on the more restrictive downstream standard in Iowa. Additional information can be found in Sections 3.5.1 and 4.7.2; no changes are needed to existing wastewater NPDES permits to comply with the more restrictive standard.

Table 2. Water quality standards for impaired streams

Parameter	Stream Class	Water Quality Standard	Numeric Standard/Target
E. coli	Class 2A and 2B	Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 org/100 mL. The standard applies only between April 1 and October 31.	≤ 126 organisms / 100 mL water (monthly geometric mean) ≤ 1,260 organisms / 100 mL water (individual sample)
	Class 7	Not to exceed 630 org/100 mL as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 org/100 mL. The standard applies only between May 1 and October 31.	≤ 630 organisms / 100 mL water (monthly geometric mean) [a] ≤ 1,260 organisms / 100 mL water (individual sample)
TSS	Class 2A	10 mg/L (milligrams per liter); TSS standards for class 2A may be exceeded for no more than 10% of the time. This standard applies April 1 through September 30.	≤ 10 mg/L

a. The only Class 7 segments in the watershed are Bear Creek (07060002-503) and Pine Creek (07060002-512). TMDL targets for these segments are 126 org/100 mL to protect downstream uses in Iowa.

Table 3. Summary of Iowa water quality criteria for *E. coli* in surface waters designated for primary or secondary contact recreation (Iowa Department of Natural Resources 2017)

Standard Type	Class A1: Primary Contact Recreational Use [a]	Class A2: Secondary Contact Recreational Use [a]
Geometric Mean (organisms/100 mL)	126	630
Sample Maximum (organisms/100 mL)	235	2,880

a. Criteria apply from March 15–November 15 except year-round for class A2 waters that are also designated for class B(CW1) [coldwater aquatic life] uses.

3. Watershed and waterbody characterization

This TMDL study addresses the impairments in the UIR and MRR watersheds in southeast Minnesota. The watersheds of these impairments drain portions of Mower, Fillmore, and Houston counties in Minnesota. Municipalities in the watersheds include Taopi, Le Roy, Harmony, Spring Grove, Caledonia, and Brownsville.

The watersheds are in the Driftless Area ecoregion in the east and the Western Corn Belt Plains ecoregion in the west (Figure 1). The Driftless Area was not impacted during the last glaciation, unlike much of the rest of the state was, and therefore retains several bluffs and valleys that were leveled by glaciers elsewhere. The project area is also located within a karst topography area, which is defined by soluble bedrock known for dry depressions in the ground, sinkholes, springs, underground caves, and a strong surface and groundwater connection. Cavities formed in karst bedrock provide water storage and transport and interact with surface waterbodies. For example, water on the land surface may flow via sinkholes or disappearing streams to karst cavities rather than to streams. Interflow and groundwater may also discharge to karst cavities, which may receive flow from upstream cavities and discharge to downstream cavities. Water may also be exchanged between stream reaches and karst cavities.

The UIR Watershed includes the headwaters of the UIR, along with several tributaries. The majority of the UIR flows through Iowa. The UIR is one of the healthiest rivers in Iowa and is vital to maintaining northern Iowa's recreation, tourism, and local economy. It is recognized nationally for its fine fishing and coldwater species, and is eligible for National Wild and Scenic River designation. In 1964, the Minnesota Department of Natural Resources (DNR) completed a major habitat improvement project on Bee Creek, a tributary to the UIR, to support a trout fishery. Bee Creek is classified as an exceptional use class stream for both fish and macroinvertebrates, is a coldwater stream that supports popular fish for anglers, and is a designated trout stream that is actively managed by the Minnesota DNR.

The MRR Watershed contains several popular trout fisheries including rainbow trout, brown trout, and brook trout and offers bluff scenery and habitat for wildlife. The two major drainages addressed in this report in the MRR Watershed are Crooked Creek and Winnebago Creek.

There are no tribal lands in the UIR Watershed. Portions of the Ho-Chunk Nation are in the MRR Watershed (Figure 2); however, these tribal lands are not in the TMDL watersheds and therefore are not affected by the TMDLs in this report.

More information on the watersheds can be found in the UIR, MRR, Mississippi River–La Crescent Watersheds Monitoring and Assessment Report (MPCA 2018c), MRR SID Report (MPCA 2018a), UIR Watershed SID Report (MPCA 2018b), UIR and MRR WRAPS Report (Tetra Tech 2019), and the Root River 1W1P (Root River Planning Partnership 2016).

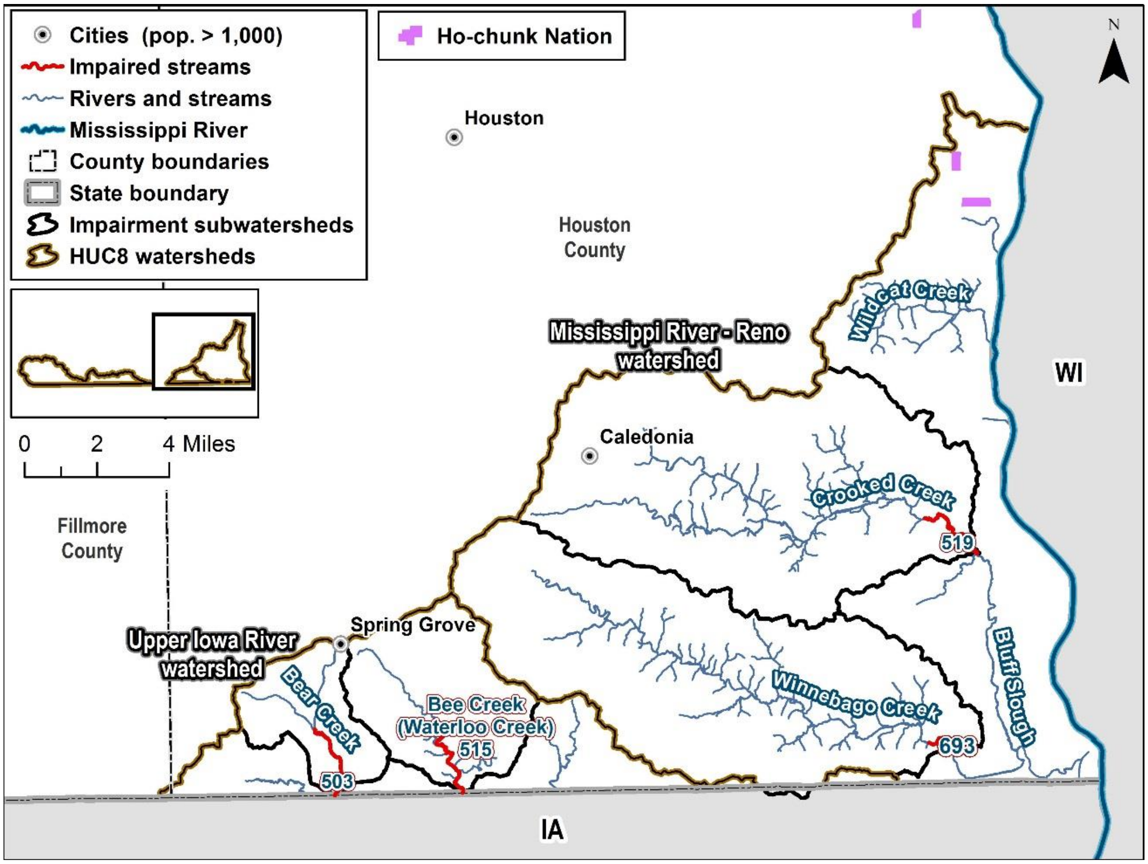


Figure 2. Tribal lands located in the Mississippi River–Reno Watershed.

3.1 Streams

Subwatersheds that drain to impaired streams range from 4,168 to 71,059 acres (Table 4). The impairments and their subwatersheds are shown in Figure 3 and Figure 4.

Table 4. Watershed areas of impaired streams.

HUC8 Name	Waterbody Name	AUID	Watershed Area (acres) [a]
Mississippi River–Reno (07060001)	Crooked Creek	519	40,716
	Winnebago Creek	693	38,442
Upper Iowa River (07060002)	Upper Iowa River	550	23,323
	Little Iowa River	548	17,448
	Upper Iowa River	509	71,059
	Beaver Creek	546	17,062
	Pine Creek	512	6,514
	Bear Creek	503	6,472
	Bee Creek (Waterloo Creek)	515	11,844

a. Watershed area includes all drainage area to the impairment.

3.2 Subwatersheds

The watershed boundaries of the impaired streams (Figure 3 and Figure 4) were developed using multiple data sources, starting with watershed delineations from the MPCA's Hydrologic Simulation Program–Fortran (HSPF) model application of the UIR and MRR watersheds (Tetra Tech 2018). The model watershed boundaries are based on USGS HUC-12 watershed boundaries and modified with DNR Level 7 watershed boundaries or NHDPlus catchments (Version 2.0). Where additional watershed breaks were needed to define the impairment watersheds, DNR Level 8 and Level 9 watershed boundaries and the USGS StreamStats program (Version 4.2.1) were used. StreamStats was developed by the USGS as a web-based geographic information systems application for use in informing water resource planning and management decisions. The tool allows users to locate gages and define drainage basins to determine upstream drainage basin area and other useful parameters.

The impaired reach of the UIR from Little Iowa River to Beaver Creek (07060002-509) is not contiguous within Minnesota. The downstream end of the reach is where Beaver Creek (07060002-546) discharges into the UIR, which is reflected in the subwatershed boundary for AUID 509 (Figure 3).

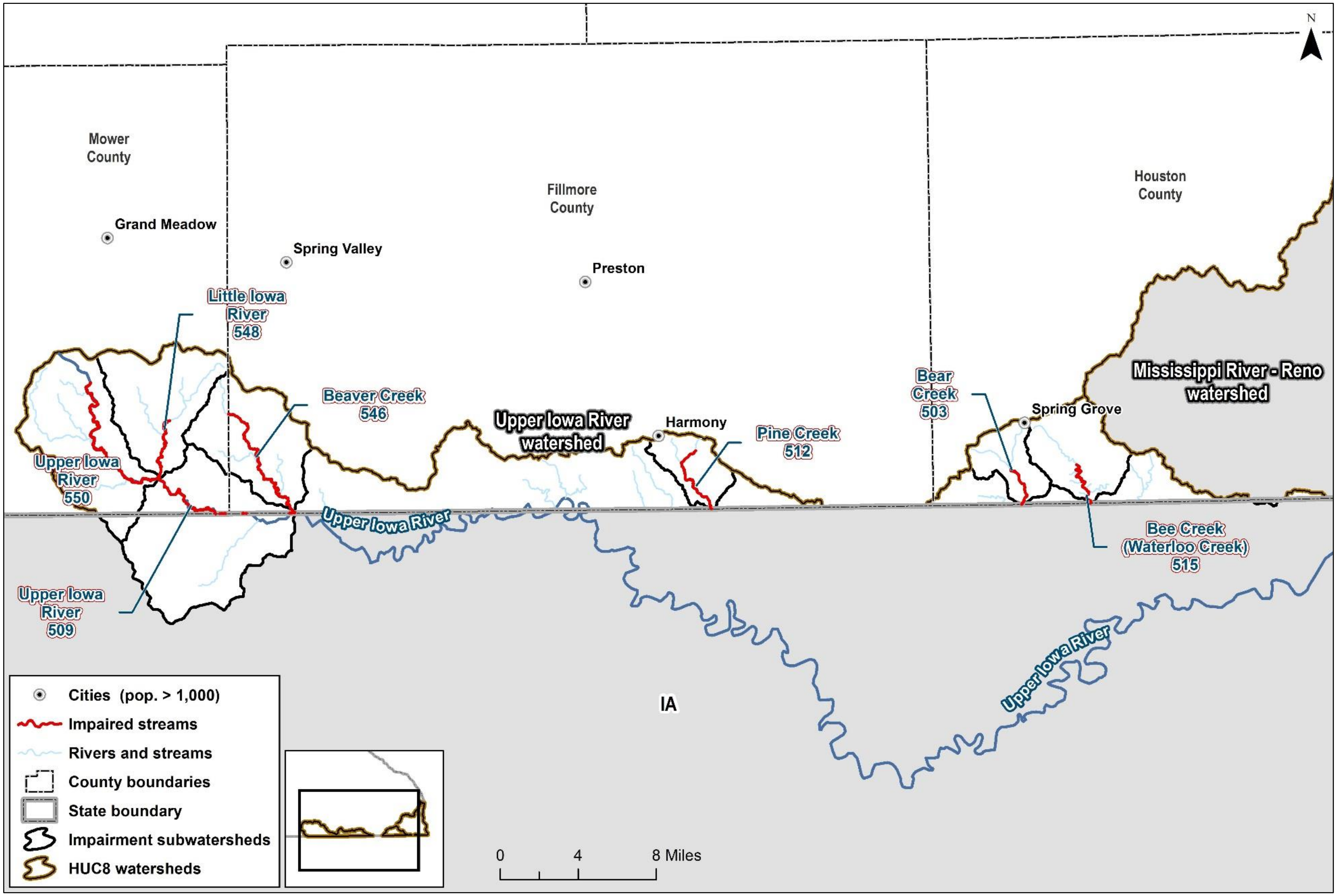


Figure 3. Impairment subwatersheds in the Upper Iowa River Watershed.
Note that the downstream end of the Upper Iowa River AUID 509 is at the confluence with Beaver Creek (AUID 546).

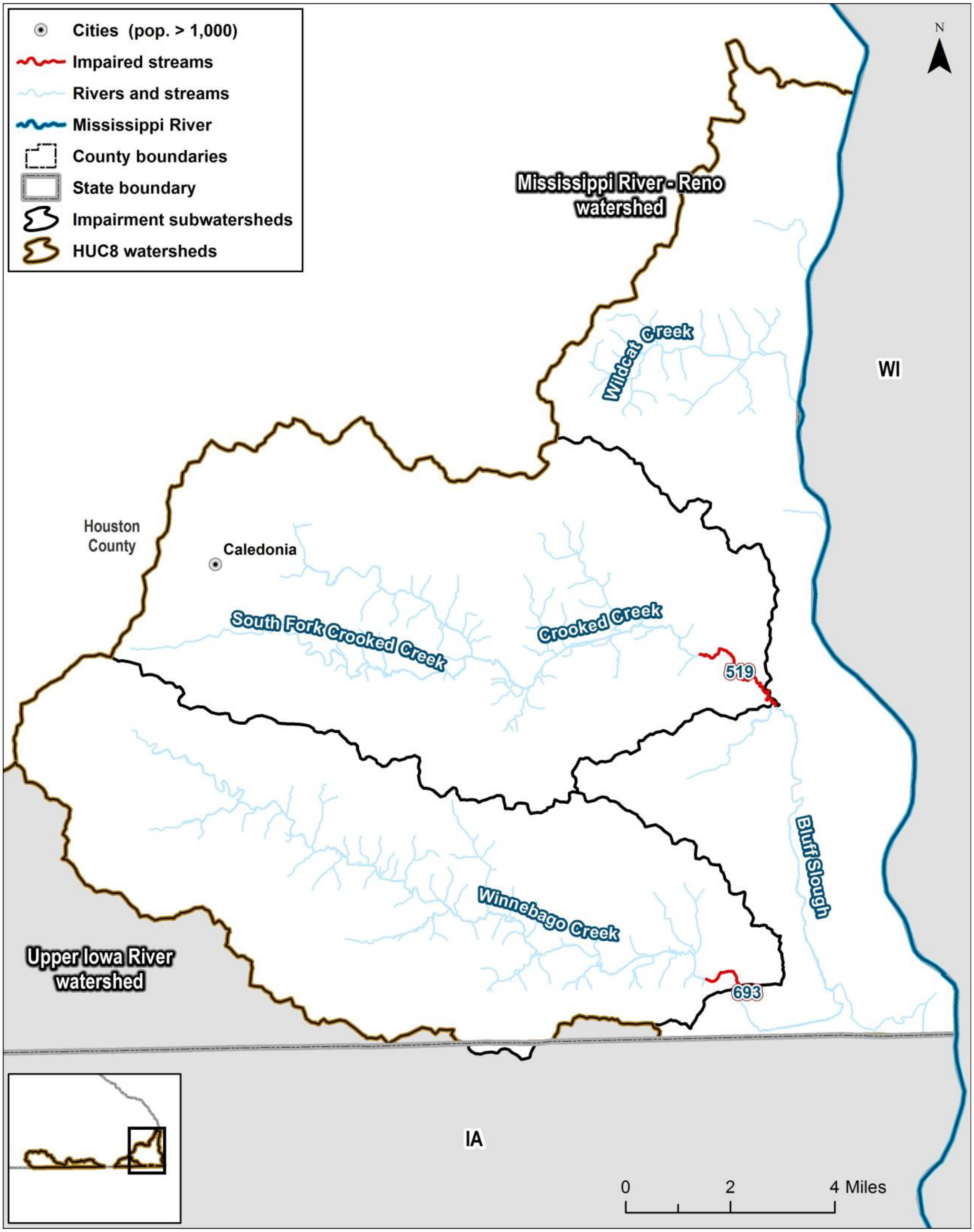


Figure 4. Impairment subwatersheds in the Mississippi River–Reno Watershed.

3.3 Land use

Land cover trends shift from west to east in the UIR and MRR watersheds. Cropland (corn, alfalfa, and soybeans) is most dominant in the UIR Watershed, and forested areas increase in Houston County. Grassland/pasture and forested areas are more prevalent in the MRR Watershed with some corn, alfalfa, and soybean in the upland portions of the watershed. Other crops in the watersheds are minor and include peas, oats, sorghum, rye, and fallow/idle cropland. Developed land covers are scattered throughout the project area, with more densely developed areas near the towns of Caledonia, Spring Grove, Harmony, and several small communities (Table 5, Figure 5 and Figure 6).

Pre-settlement land cover in the Minnesota portion of the UIR and MRR watersheds consisted predominantly of forests of big woods and hardwoods (oak, maple, basswood, and hickory), oak openings, barrens, and several types of prairie (Figure 7 and Figure 8). While the MRR portion of the project area retains much of the pre-settlement forest and wetlands, the increase in agricultural land use and resulting agricultural practices, such as tile drain installation and fire suppression after European settlement in the 1800s, resulted in loss of many ecosystems including prairie systems, oak openings, and oak savannahs in the UIR Watershed. In addition, many of the hardwood forest species such as oak, elm, and walnut were cleared to create new agricultural fields. More information on pre-settlement conditions and land use changes can be found in the Root River 1W1P Appendix B (Root River Planning Partnership 2016).

Table 5. Land cover in the impaired watersheds (2017 Cropland Data Layer).
Percentages rounded to the nearest whole number.

			Percent of Watershed (%)								
HUC8	**Waterbody Name**	**AUID**	**Developed**	**Corn**	**Alfalfa**	**Soybeans**	**Other crops**	**Grassland/Pasture**	**Forest**	**Wetlands**	**Open water**
Mississippi River–Reno (07060001)	Crooked Creek	519	6	11	4	6	<1	30	42	1	<1
	Winnebago Creek	693	4	14	4	7	<1	28	43	<1	<1
Upper Iowa River (07060002)	Upper Iowa River	550	5	46	1	35	1	9	3	<1	<1
	Little Iowa River	548	4	46	1	37	1	9	2	<1	<1
	Upper Iowa River	509	5	45	1	33	1	11	4	<1	<1
	Beaver Creek	546	6	39	1	37	<1	11	6	<1	<1
	Pine Creek	512	9	31	1	40	<1	16	3	<1	<1
	Bear Creek	503	8	19	7	9	1	32	24	<1	<1
	Bee Creek (Waterloo Creek)	515	5	20	5	12	<1	35	23	<1	<1

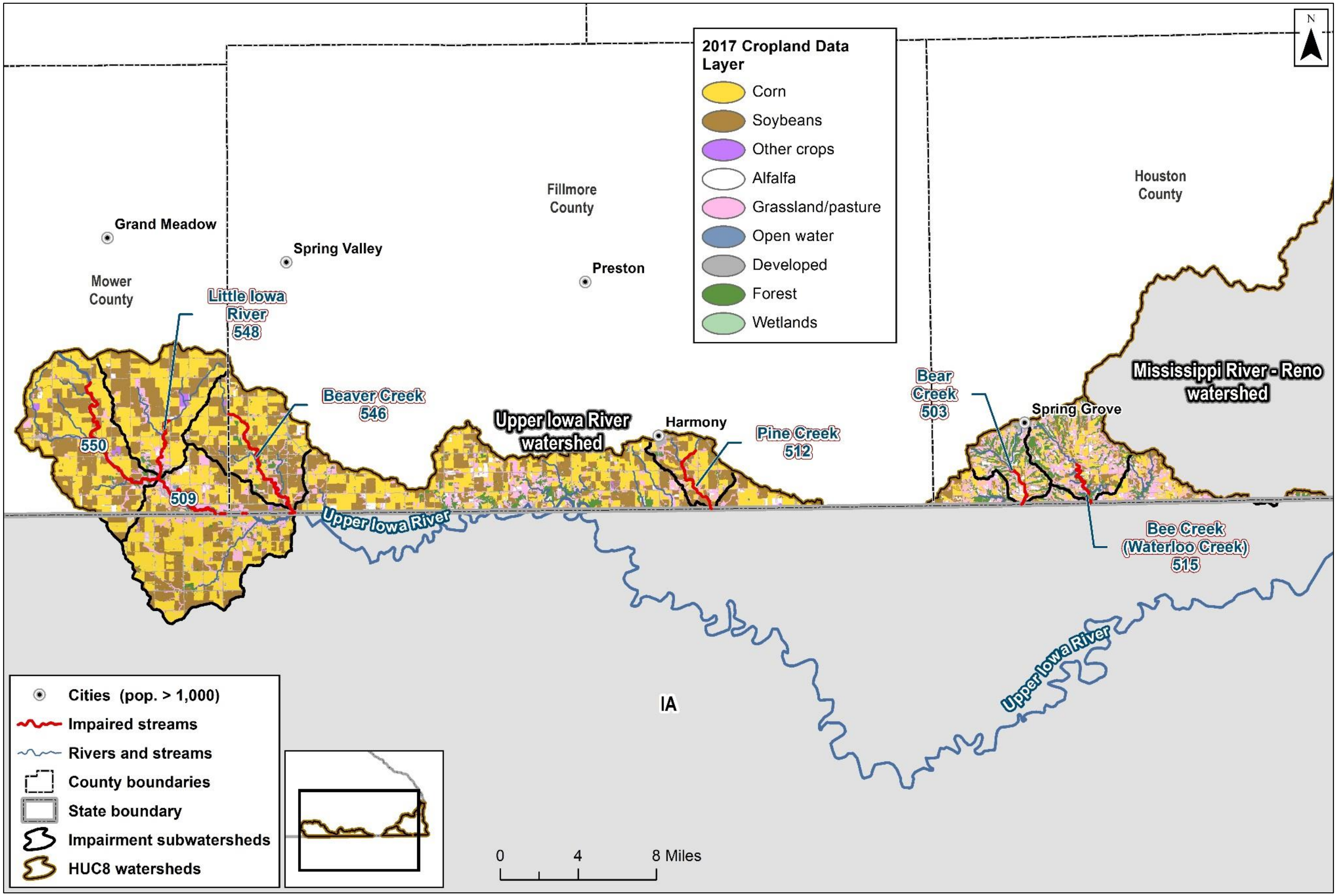


Figure 5. Land cover in the Upper Iowa River Watershed.

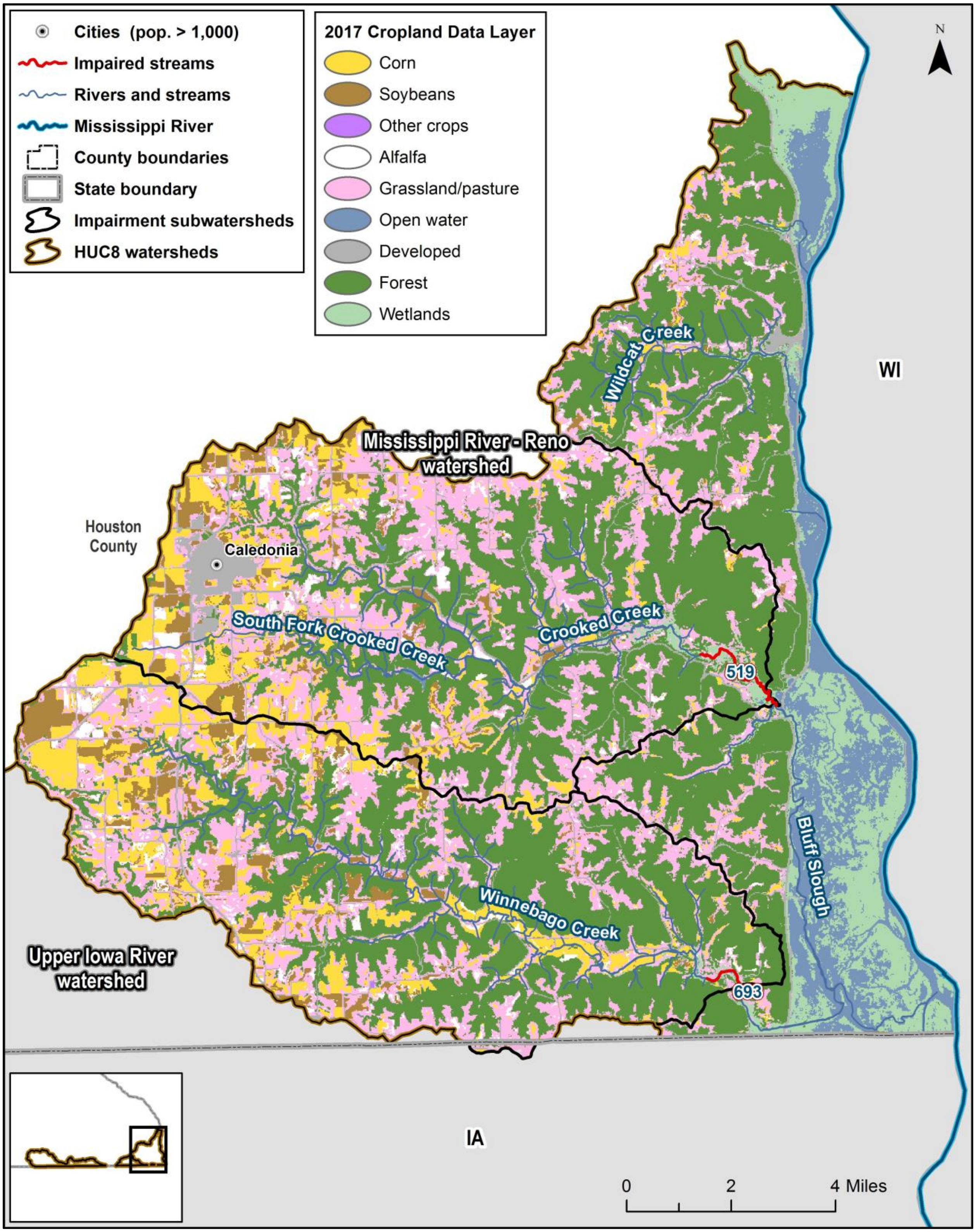


Figure 6. Land cover in the Mississippi River–Reno Watershed.

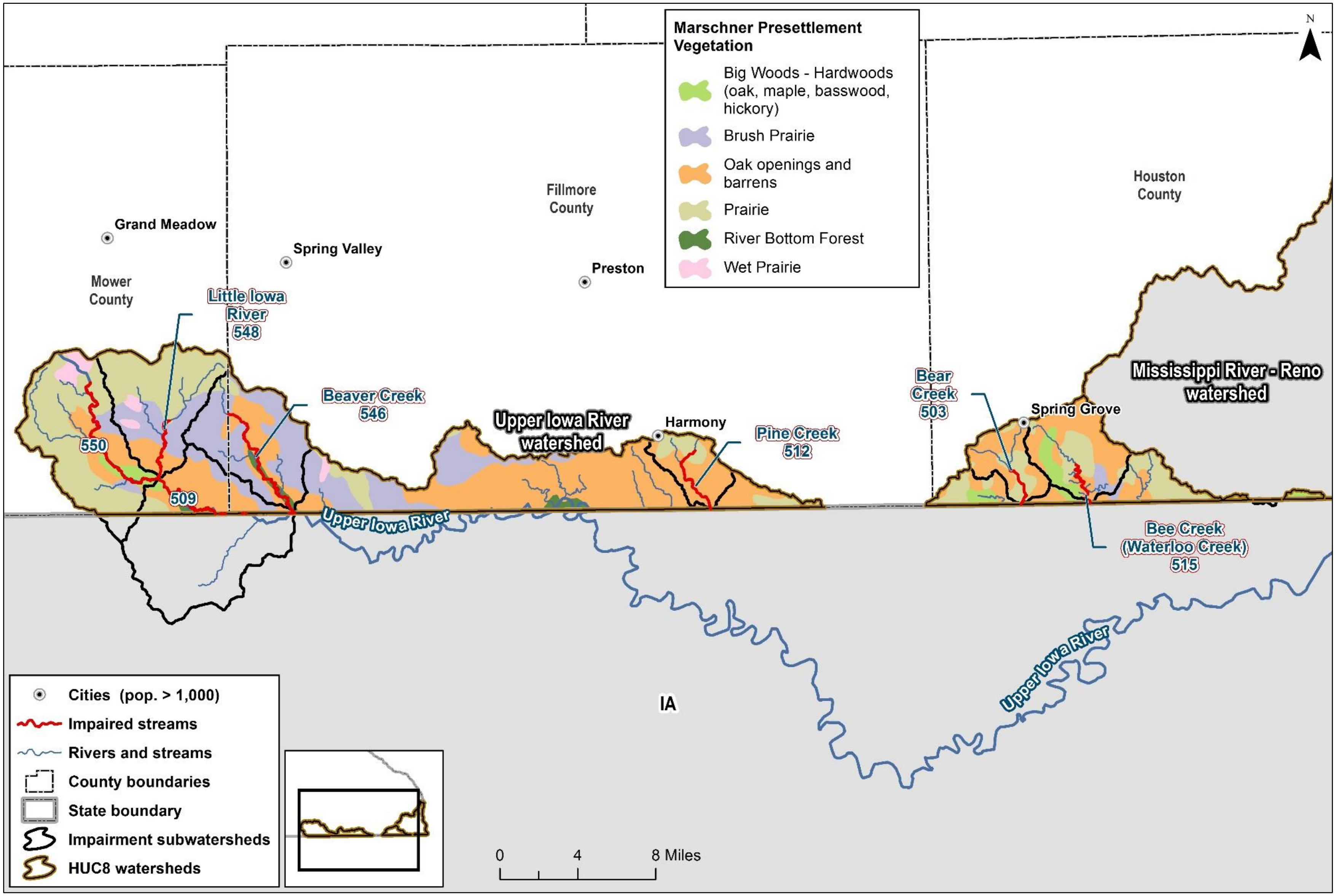


Figure 7. Pre-settlement land cover in the Upper Iowa River Watershed within Minnesota (Marschner's presettlement data, obtained from MN Geospatial commons).

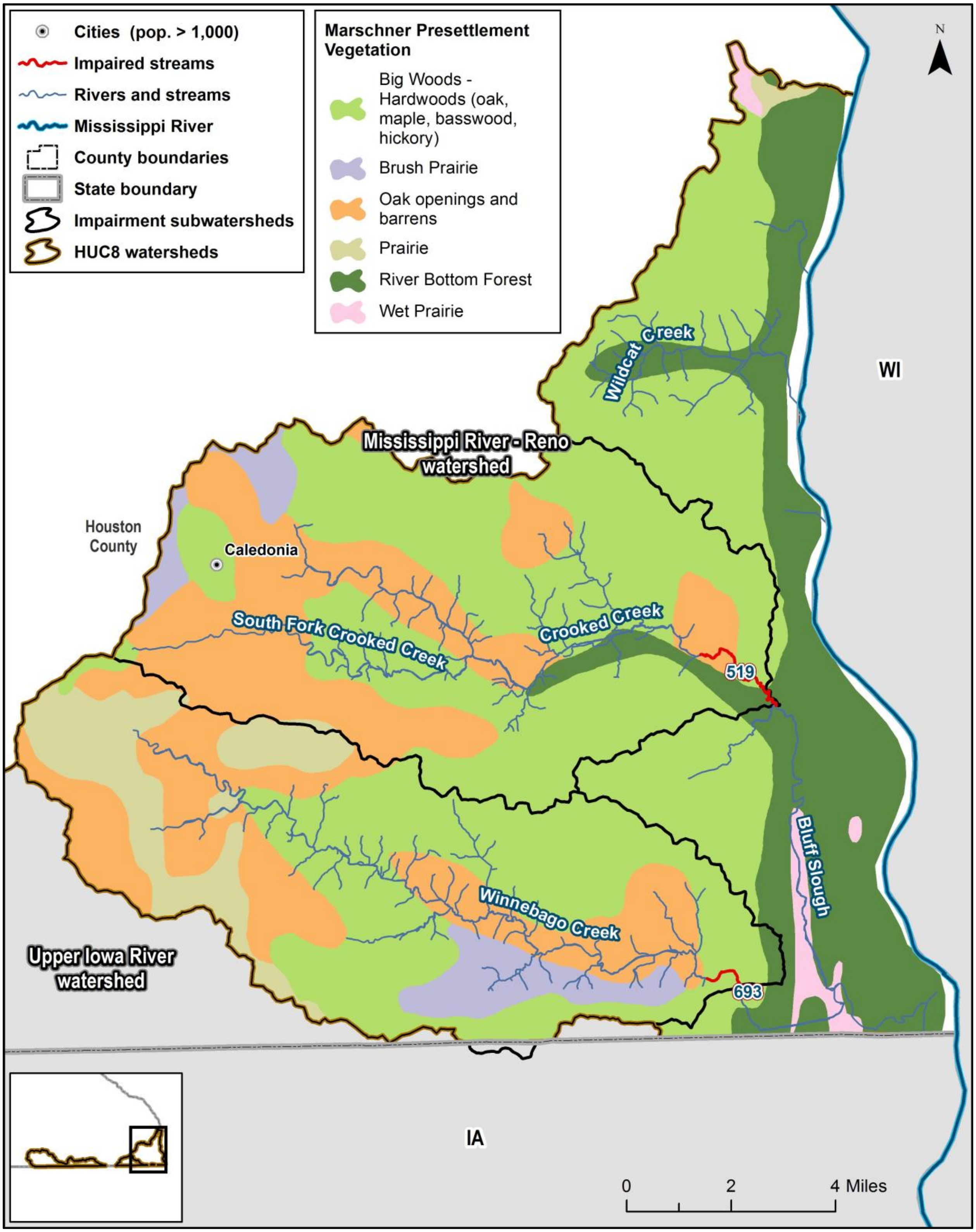


Figure 8. Pre-settlement land cover in the Mississippi River–Reno Watershed within Minnesota (Marschner's presettlement data, obtained from MN Geospatial commons).

3.4 Current/historical water quality

Flow and water quality data are presented to evaluate the impairments and trends in water quality. Data from the last 10 years (2008 through 2017) were used in the water quality summary tables. If data from 2008 through 2017 were not available, data prior to the 10-year time period were evaluated, as available, to examine trends in water quality. Water quality data from the Environmental Quality Information System (EQuIS) database were used for the analysis.

The analyses considered the following sources of flow data:

- The MPCA provided data from Hydstra, a database that stores the MPCA and DNR stream gaging data. However, limited data were available, with gage level data available at one site and no flow data in the watershed.
- USGS flow data were downloaded from the USGS National Water Information System. Data were available at one site on Crooked Creek (site #05387030) for approximately one year.
- Daily average flows were simulated with the MPCA's HSPF model application for the UIR and MRR watersheds (2018-04-02 version). The simulated flows were calibrated and validated with data from flow gaging stations, including the UIR at Bluffton, Iowa (USGS site 05387440). Simulated flows are available at the downstream end of each model reach. The model report (Tetra Tech 2018) describes the framework and the data that were used to develop the model and includes information on calibration.

Due to limited flow gage records in the watersheds, simulated flows from the HSPF model were used in developing the stream TMDLs (Table 6). The HSPF model integrates flow monitoring data and provides long term, continuous flow estimates. In some cases, HSPF-simulated flows from nearby model reaches were drainage area-weighted to impaired stream reaches. The drainage area-weighting approach assigns flow to a given reach based on the proportion of the subwatershed area within the HSPF catchment. For additional information regarding HSPF modeling, see the summary in Section 3.5.2 or modeling documentation (Tetra Tech 2018).

Table 6. Model reaches used to simulate stream flow in impaired reaches
Reach numbers refer to the Upper Iowa River and Mississippi River–Reno watersheds HSPF model (Tetra Tech 2018). The simulation is from 1995–2015.

Reach Name	AUID	Model Reach Number
Crooked Creek	519	509
Winnebago Creek	693	502
Upper Iowa River	550	310
Little Iowa River	548	314
Upper Iowa River	509	309
Beaver Creek	546	318
Pine Creek	512	327
Bear Creek	503	330
Bee Creek (Waterloo Creek)	515	331

Water quality data from 2008 to 2017 were summarized for the *E. coli* and TSS impairments. Data were summarized by year to evaluate trends in long term water quality and by month to evaluate seasonal variation. The summaries of data by year only consider data taken during the time period that the standard is in effect (April/May through October for *E. coli* [for class 2 and class 7 waters, respectively], and April through September for TSS). Where there are multiple sites along one assessment unit, data from the sites were combined and summarized together. The frequency of exceedances represents the percentage of samples that exceed the water quality standard.

Load duration curves are provided for each impaired stream in Section 5: *TMDLs and water quality data summaries*. Water quality is often a function of stream flow, and load duration curves are used to evaluate the relationships between hydrology and water quality. For example, sediment concentrations typically increase with rising flows as a result of factors such as channel scour from higher velocities. Other parameters may be more concentrated at low flows and diluted by increased water volumes at higher flows. The load duration curve approach provides a visual display of the relationship between stream flow and water quality. Load duration curves were developed as follows:

<u>Develop flow duration curves</u>: Flow duration curves relate mean daily flow to the percent of time those values have been met or exceeded. For example, an average daily flow at the 50% exceedance value is the midpoint or median flow value; average daily flow in the reach equals the 50% exceedance value 50% of the time. The curve is divided into flow zones, including very high flows (0% to 10%), high flows (10% to 40%), mid-range flows (40% to 60%), low flows (60% to 90%), and very low flows (90% to 100%).

Flow duration curves were developed using daily averaged modeled flows (1995 through 2015) from HSPF modeling (Tetra Tech 2018). Table 6 presents the modeled stream segment number used to develop the flow duration curve for each impaired segment. Simulated flows from all months (even those outside of the time period that the standard is in effect) were used to develop the flow duration curves.

<u>Develop load duration curves</u>: To develop load duration curves, all average daily flows were multiplied by the water quality standard (i.e., 126 or 630 org/100 mL *E. coli* and 10 mg/L TSS) and converted to a daily load to create “continuous” load duration curves that represent the load in the stream when the stream meets its water quality standard under all flow conditions. Loads calculated from water quality monitoring data are also plotted on the load duration curve, based on the concentration of the sample multiplied by the simulated flow on the day that the sample was taken. Two nearby gages (USGS gages on Crooked Creek [05387030] and the UIR [05387440]) were used to estimate the flow exceedance to plot water quality samples from 2016 and 2017, which are not simulated in the HSPF model. The flow exceedance was then used to determine the corresponding HSPF flow (at that flow exceedance) for which to calculate a load for the water quality sample. Each load calculated from a water quality sample that plots above the load duration curve represents an exceedance of the water quality target whereas those that plot below the load duration curve are less than the water quality target.

Water quality summary tables and load duration curves are presented for each impairment in Section 5: *TMDLs and water quality data summaries*, and Table 7 summarizes the water quality data.

The number of *E. coli* samples per impaired reach ranges from 15 to 34. The maximum recorded *E. coli* concentration per reach ranges from 1,220 to 2,139,392 org/100 mL[1]. The frequencies of exceedance of the monthly geometric mean standard range from 67 to 100%, and the frequencies of exceedance of the individual sample standard range from 0% to 33% (Table 7). Median *E. coli* concentrations per flow zone were highest in the two highest flow zones (Figure 9), and a higher percent of observations exceeded the single sample standard in the very high flow zone (Table 8).

There are 27 TSS samples for Winnebago Creek with a maximum recorded TSS concentration of 98 mg/L. The frequency of exceedance is 59% (Table 7). TSS concentrations on average are highest under high flow conditions and decrease with decreasing flow (Figure 109).

[1] The maximum recordable value for *E. coli* concentration in a water sample is often 2,420 org/100 mL. Concentrations that are noted as higher than 2,420 org/100 mL were diluted before sample analysis. There were several samples in the dataset that were substantially higher than 2,420.

Table 7. Summary of water quality data (2008–2017) for impaired reaches

Summaries include data for months during which the standard applies (see Section 2.2). *E. coli* units are org/100 mL and TSS units are mg/L. Water quality summary tables are presented for each impairment in Section 5: *TMDLs and water quality data summaries*.

HUC8	Reach Name (description)	AUID	Pol-lutant	Sample Count	Mean [a]	Max-imum [b]	Number of Exceed-ances of Individual Standard	Frequency of Exceedance [c]
Mississippi River–Reno (07060001)	Crooked Creek (T102 R4W S27, west line to Bluff Slough)	519	*E. coli*	15	970	2,723	4	100% / 27%
	Winnebago Creek (T101 R4W S27, west line to south line)	693	*E. coli*	15	499	2,490	2	100% / 13%
			TSS	27	21	98	16	59% [d]
Upper Iowa River (07060002)	Upper Iowa River (-92.5901, 43.5985 to Little Iowa River)	550	*E. coli*	34	408	4,900	8	83% / 24%
	Little Iowa River (770th Ave to Upper Iowa River)	548	*E. coli*	33	162	3,600	2	80% / 6%
	Upper Iowa River (Little Iowa River to Beaver Creek - MN)	509	*E. coli*	15	250	1,220	0	100% / 0%
	Beaver Creek (Mower-Fillmore Rd to Upper Iowa River)	546	*E. coli*	34	254	1,800	1	83% / 3%
	Pine Creek (T101 R10W S24, north line to MN/IA border)	512	*E. coli*	15	781	≥ 2,420	1	100% / 7%
	Bear Creek (Unnamed cr to MN/IA border)	503	*E. coli*	15	917	5,172	5	67% / 33%
	Bee Creek (Waterloo Creek; T101 R6W S29, north line to MN/IA border)	515	*E. coli*	27	358	2,139,392	6	67% / 22%

a. Geometric means are provided for *E. coli* data and arithmetic means are provided for TSS.

b. The maximum recordable value for *E. coli* concentration depends on the extent of sample dilution and is often 2,420 org/100 mL. Concentrations that are noted as 2,420 org/100 mL are likely higher, and the magnitude of the exceedances is not known.

c. For *E. coli* impairments, the frequencies of exceedance are presented first for the monthly geometric mean standard and second for the individual sample standard. The monthly frequencies of exceedance are calculated as the number of months (aggregated across all years of data) when the monthly standard was exceeded divided by the number of months that have five or more samples.

d. The TSS water quality standard allows for 10% of the samples to exceed the standard concentration (i.e., 10 mg/L for Winnebago Creek) and still be in compliance with the water quality standard.

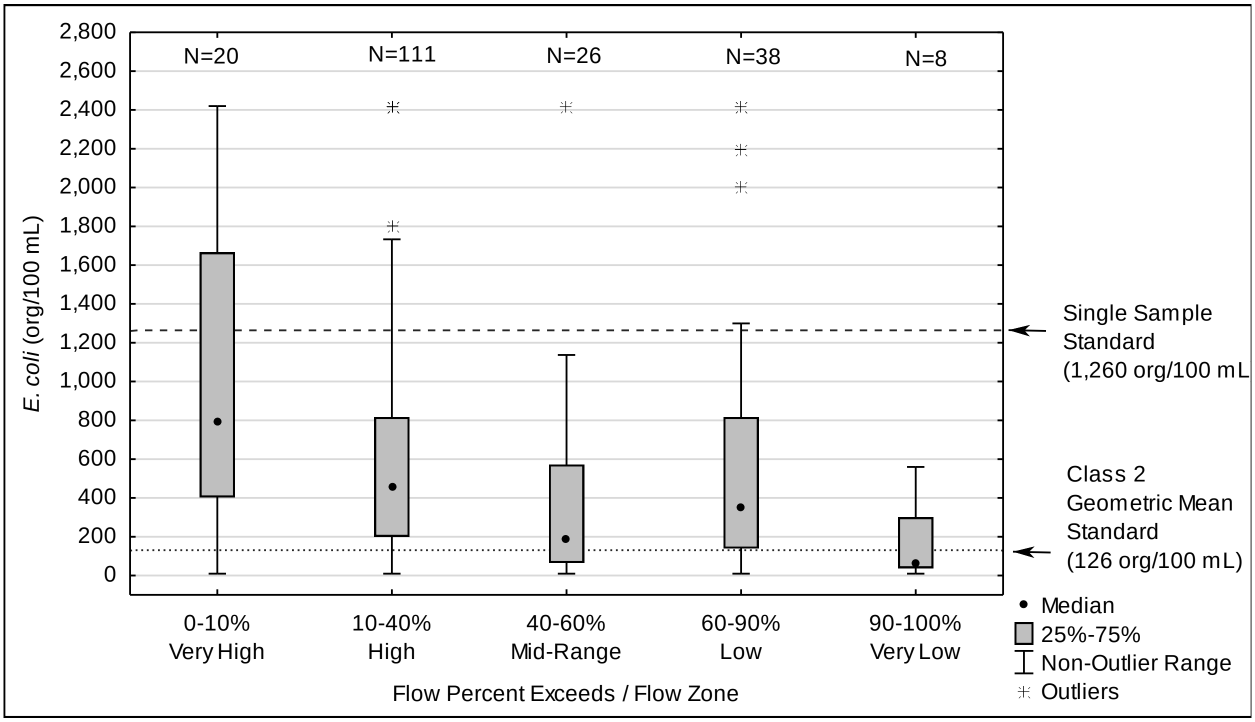


Figure 9. Box plot of *E. coli* concentration by flow zone for all reaches with *E. coli* impairments.
The maximum recordable *E. coli* concentration depends on the extent of sample dilution and is often 2,420 org/100 mL. However, 12 samples in this data set were diluted before the laboratory analysis, and high *E. coli* concentrations are reported. In this figure, concentrations > 2,420 were lowered to 2,420 to remove the influence that the diluted samples have on the overall statistics of each group.

Table 8. Number of *E. coli* individual standard exceedances by flow zone.

Flow Zone	Number of Single Sample Standard Exceedances	Sample Count	Percent of Single Sample Standard Exceedances
Very High	6	20	30%
High	17	111	15%
Mid-Range	1	26	4%
Low	5	38	13%
Very Low	0	8	0%
Total	*29*	*203*	*14%*

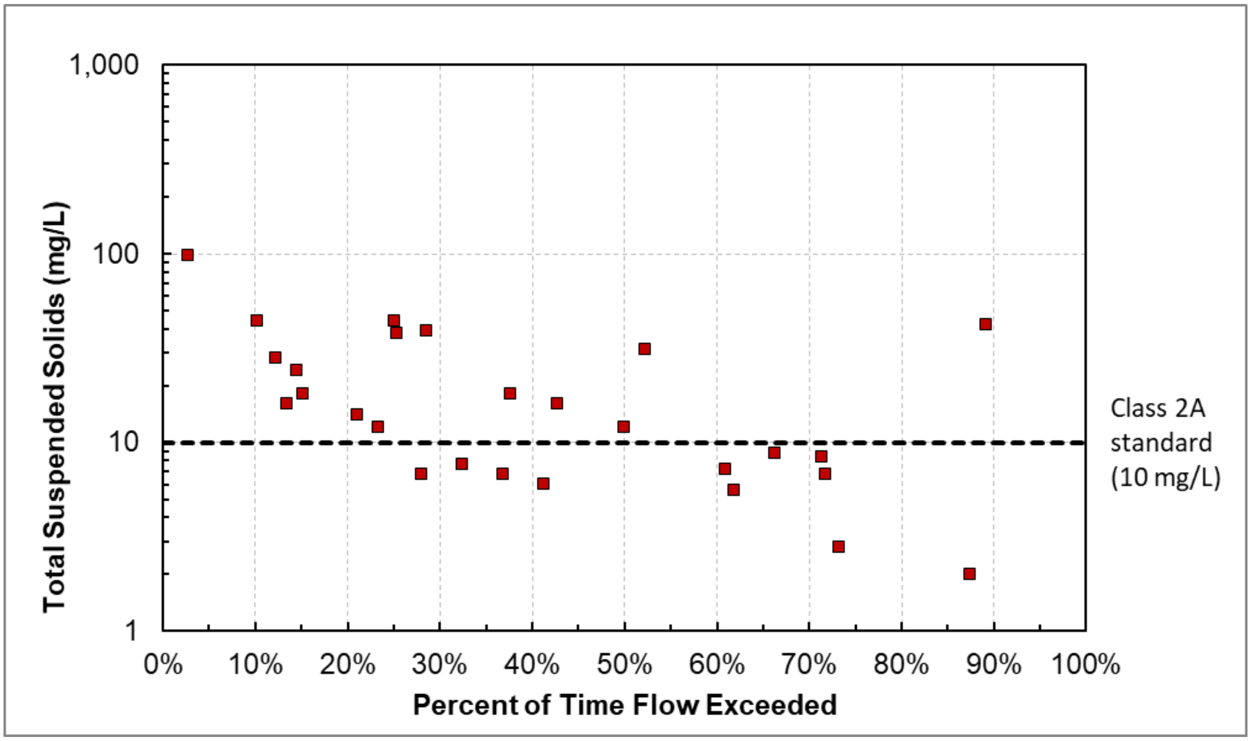


Figure 10. TSS concentration duration curve for Winnebago Creek.
Note log scale on y-axis.

3.5 Pollutant source summary

Source assessments are used to evaluate the type, magnitude, timing, and location of pollutant loading to a waterbody. Source assessment methods vary widely with respect to their applicability, ease-of-use, and acceptability. The purpose of this source assessment is to identify possible sources of *E. coli* and TSS in the watersheds of the impaired waterbodies.

Pollutant sources to the impaired waterbodies are evaluated in this report and include National Pollutant Discharge Elimination System (NPDES)-permitted and non-NPDES permitted or non-point sources. In this TMDL report, permitted sources of pollution only include those sources that are regulated through NPDES permits in the impaired watersheds and include permitted stormwater, wastewater, and NPDES-permitted concentrated animal feeding operations (CAFOs). Non-permitted or non-point sources include such things as unregulated watershed runoff, septic systems, non-NPDES permitted animal feeding operations (AFOs) and near channel sources influenced by altered hydrology. Some of the pollutant loading is from natural background, which is the landscape condition that occurs outside of human influence (see Section 4.6 for more information). Natural background sources of E. coli and TSS can include runoff from undisturbed land, wildlife waste, and natural stream development. See Section 3.3 for information on pre-settlement land cover.

3.5.1 *E. coli* sources

E. coli sources evaluated in this study are AFOs, wildlife, pets, subsurface sewage treatment systems (SSTS), natural growth of *E. coli*, stormwater runoff, and wastewater. *E. coli* is unlike other pollutants in that it is a living organism and can multiply and persist in soil and water environments (Ishii et al. 2006, Chandrasekaran et al. 2015, Sadowsky et al. n.d., and Burns & McDonnell 2017). Use of watershed models for estimating relative contributions of *E. coli* sources delivered to streams is difficult and generally has high uncertainty. Thus, a weight of evidence approach was used to determine the likely primary sources of *E. coli*, with a focus on the sources that can be effectively reduced with management practices. The majority of *E. coli* exceedances occur under very high flows, indicating that runoff-driven sources are the primary pollutants of concern (Figure 9).

3.5.1.1 Non-NPDES-permitted sources of *E. coli*

Animal feeding operations

While there are state and county programs and rules for animal agriculture (as described below), in some circumstances livestock waste can be a source of *E. coli* to surface waters, such as through failure of manure containment and runoff from AFOs, direct deposition to surface waters, and manure that is improperly applied to cropland and subsequent runoff.

Animal waste from non-NPDES-permitted AFOs can be delivered to surface waters from failure of manure containment, runoff from the AFO itself, or runoff from nearby fields where the manure is applied. While a full accounting of the fate and transport of manure was not conducted for this project, a large portion of it is ultimately applied to the land surface and, therefore, this source is of concern. Minn R. 7020.2225 contains several requirements for land application of manure; however, there are no explicit requirements for *E. coli* or bacteria treatment prior to land application. Manure application practices that inject or incorporate manure pose lower risk to surface waters than surface application with little or no incorporation. In addition, manure application on frozen/snow covered ground in late winter months presents a high risk for runoff (Frame et al. 2012).

The primary goal of the state program for AFOs is to ensure that surface waters are not contaminated by the runoff from feeding facilities, manure storage or stockpiles, and cropland with improperly applied manure. Counties may be delegated by the MPCA to administer the program for feedlots that are not under federal (i.e., NPDES) regulation.

In Minnesota, AFOs are required to register with their respective delegated county or the state if they are 1) an animal feedlot capable of holding 50 or more animal units (AU), or a manure storage area capable of holding the manure produced by 50 or more AUs outside of shoreland; or 2) an animal feedlot capable of holding 10 or more AUs, or a manure storage area capable of holding the manure produced by 10 or more AUs, that is located within shoreland. Further explanation of registration requirements can be found in Minn. R. 7020.0350. AFOs under 1,000 AUs and those that are not federally defined as CAFOs do not operate with permits. However, the facilities must operate in compliance with applicable portions of Minn. R. 7020. The numbers of organisms of *E. coli* produced per animal in registered feedlots that are not NPDES-permitted was estimated based on animal type (Table 9). The MPCA Data Desk provided the feedlot locations and numbers and types of animals in registered feedlots, and the information was supplemented with databases from MPCA feedlot staff (Figure 11 and Figure 12). *E. coli* generated by livestock does not necessarily translate into *E. coli* delivered to waters. The amount of *E. coli* to reach surface waters depends on manure management, land application practices, and other factors.

Some feedlot owners have signed open lot agreements with the MPCA. In an open lot agreement, a feedlot owner commits to correcting open lot runoff problems. In exchange for this commitment, the open lot agreement provides a flexible time schedule to feedlot owners to correct open lot runoff problems and a conditional waiver from retroactive enforcement penalties.

Livestock are also part of hobby farms, which are small-scale farms that are not large enough to require registration but may have small-scale feeding operations and associated manure application or stockpiles. Livestock are also potential sources of fecal bacteria when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas.

Further information on livestock and feedlots in the UIR and MRR watersheds, including compliance information and primary livestock types, is provided in the UIR and MRR WRAPS Report (Tetra Tech 2019).

Table 9. *E. coli* production by livestock animal type in non-NPDES-permitted, registered feedlots.

There are no CAFOs that operate without NPDES permits in the impairment watersheds.

HUC8	Waterbody Name	AUID (HUC8-)	Percent of *E. coli* Production (%) [a]					Total *E. coli* Production Generated from Non-NPDES-Permitted Feedlots (billion colony forming units [cfu]/day)
			Cattle	Poultry	Goats/Sheep	Horses	Pigs	
Mississippi River–Reno (07060001)	Crooked Creek	519	95%	1%	1%	< 1%	3%	34,497
	Winnebago Creek	693	38%	< 1%	4%	< 1%	58%	98,661
Upper Iowa River (07060002)	Upper Iowa River	550	10%	< 1%	< 1%	< 1%	90%	78,501
	Little Iowa River	548	9%	0%	0%	< 1%	91%	43,736
	Upper Iowa River	509 (MN)	9%	3%	< 1%	< 1%	88%	152,433
		509 (IA)	0%	0%	0%	0%	100%	78,390
	Beaver Creek	546	5%	< 1%	4%	< 1%	91%	36,004
	Pine Creek	512	1%	0%	0%	0%	99%	33,143
	Bear Creek	503	88%	1%	5%	< 1%	6%	3,500
	Bee Creek (Waterloo Creek) [b]	515	27%	< 1%	4%	< 1%	69%	48,390

a. Production rates for cattle (2.7×10^9), poultry (1.3×10^8), goats and sheep (9.0×10^9), and pigs (4.5×10^9) are from Metcalf and Eddy (1991). The production rate for horses (2.1×10^8) is from American Society of Agricultural Engineers (1998). The production rates are provided in the literature as fecal coliform organisms produced per animal per day; these rates were converted to *E. coli* production rates by multiplying by 0.5 (Doyle and Erickson 2006). Production rate units are organisms per day per head.

b. There are no non-NPDES-permitted feedlots within the Iowa portion of this subwatershed. A mink farm located within in the Minnesota portion of the Bee Creek Subwatershed was not included in this table as it produces less than 1% of non-NPDES-permitted *E. coli* production.

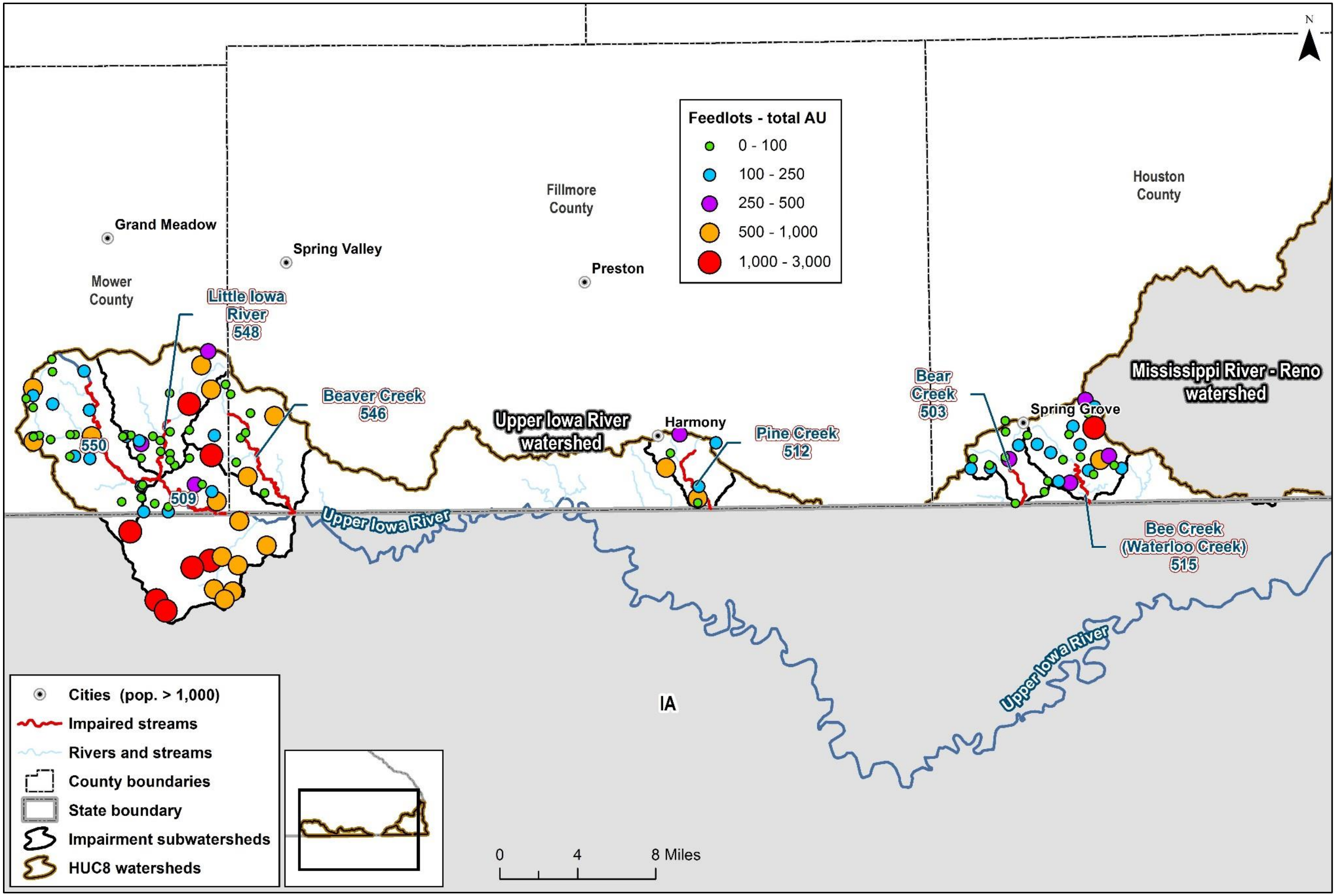


Figure 11. Registered feedlots in impaired watersheds in the Upper Iowa River Watershed.

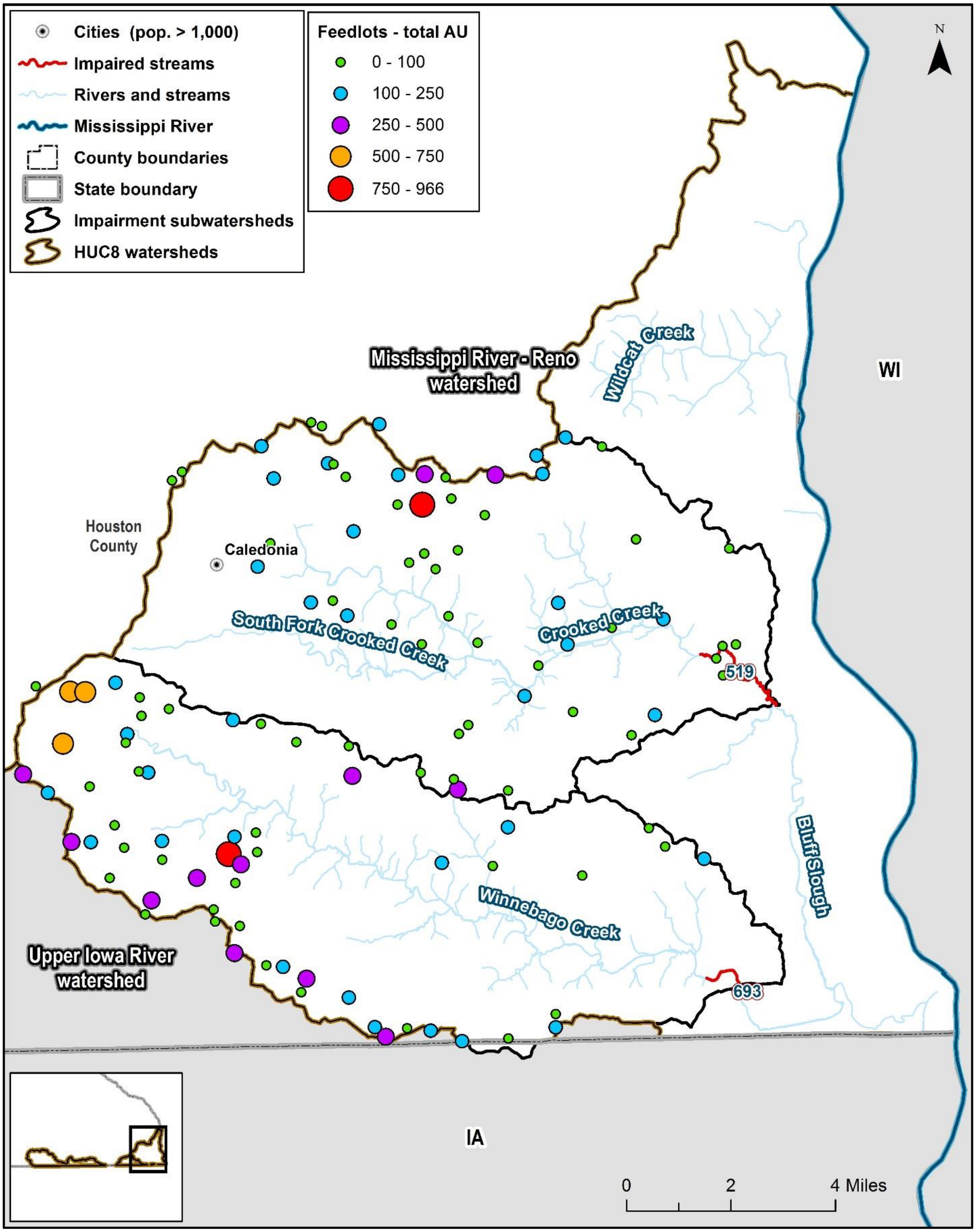


Figure 12. Registered feedlots in impaired watersheds in the Mississippi River–Reno Watershed.

Wildlife

In the rural portions of the watershed, there are deer, waterfowl, and other animals, with greater numbers in conservation and remnant natural areas, wetlands and lakes, and river and stream corridors that may be contributing to *E. coli* impairments. Deer densities in the deer permit areas within the UIR and MRR watersheds were estimated at 7 to 20 deer per square mile in 2016 (Farmland Wildlife Populations Research Group 2016), while non-NPDES-permitted livestock animal densities in *E. coli* impaired subwatersheds ranged from 140 to 560 animals per square mile. Additionally, the per animal *E. coli* production rates of deer and waterfowl are substantially less than the production rates of pigs and cattle, the most common livestock types in the watershed (Table 10). There may be, however, some instances of large geese or other waterfowl populations in impaired reaches with high levels of natural areas. For example, Winnebago Creek and Crooked Creek are tributaries to the Mississippi River and have a high percentage of forested area (Figure 5). In addition, Bee Creek flows through a wildlife management area. Given the much larger volume of livestock waste compared to wildlife waste, it appears unlikely that the production of *E. coli* from wildlife substantially contributes to the impairments.

Table 10. *E. coli* production rates of wildlife relative to livestock.

Animal Type	Production Rate (organisms per day [org/day] per head)	Reference
Deer	1.8×10^8	Zeckoski et al. 2005
Waterfowl	1.0×10^7	Alderisio and DeLuca 1999 and City of Eden Prairie 2008
Cattle	2.7×10^9	Metcalf and Eddy 1991
Pigs	4.5×10^9	Metcalf and Eddy 1991

Domestic pets

When pet waste is not disposed of properly, it can be picked up by runoff and washed into nearby waterbodies. Waste from pets can be a source of concern in watersheds with a higher density of developed area. Compared to rural areas, developed areas have higher densities of pets and a higher delivery of waste to surface waters due to connected impervious surfaces. Due to the rural nature of the watersheds, pet waste is not considered a significant source of *E. coli*.

Humans

SSTSs can contribute *E. coli* from human waste to nearby waters. SSTSs can fail for a variety of reasons, including excessive water use, poor design, physical damage, and lack of maintenance. Common limitations that contribute to failure include seasonal high water table, fine-grained soils, bedrock, and fragipan (i.e., altered subsurface soil layer that restricts water flow and root penetration). Septic systems can fail hydraulically through surface breakouts or hydrogeologically from inadequate soil filtration. Failure potentially results in *E. coli* discharges.

Septic systems that discharge untreated sewage to the land surface or directly to streams are considered imminent threats to public health and safety (ITPHS) and can contribute *E. coli* to surface waters. ITPHS also typically include straight pipes and effluent ponding at the ground surface, in addition to effluent backing up into a home, unsafe tank lids, electrical hazards, or any other unsafe condition deemed by a certified SSTS inspector (Minn. R. 7080.1500, subp. 4A). Therefore, not all of the ITPHS discharge pollutants directly to surface waters. Overall estimated percentages of ITPHS are low, ranging from three to 5% of total systems, and likely do not contribute a significant amount of *E. coli* to impaired streams unless they are located near or adjacent to an impaired stream (Table 11).

Septic systems with inadequate soil filtration are considered to be failing to protect groundwater from pollutants (Minn. R. 7080.1500, subp. 4B). Due to the unique below ground conduits common in karst areas where groundwater and surface waters are highly connected, SSTSs that are failing to protect groundwater are also potential sources of *E. coli* to impaired streams. In Houston and Mower counties, 45 and 40% of SSTSs are estimated to be failing to protect groundwater, respectively (Table 11). Without location information and knowledge of the specific hydrogeologic conditions at each SSTS drain field, the extent of these SSTSs as a source of *E. coli* to impaired streams is unknown.

Table 11. Estimated ITPHS by county.
Data from MPCA (2017; direct correspondence with Brandon Montgomery on October 25, 2018). These percentages are reported as estimates by local units of government for planning purposes and general trend analysis. These values may be inflated due to relatively low total SSTS estimated per jurisdiction. Additionally, estimation methods for these figures can vary depending on local unit of government resources available.

County	Estimated Percentage ITPHS (%)	Estimated Percentage of SSTS Failing to Protect Groundwater (%)
Fillmore	3	5
Houston	5	45
Mower	5	40

As part of the source assessment, information on SSTSs was also requested from Howard County, Iowa, which contains a portion of the impaired subwatershed 509. According to Iowa Code Chapter 69, SSTS inspections are 1) conducted upon the transfer of ownership of a property serviced by an SSTS and 2) after initial installation of an SSTS. Per this code, a system is required to be replaced or updated to meet current code if it is determined to be failing to ensure effective wastewater treatment or is otherwise improperly functioning during the inspection. Information on SSTS compliance is not available for the county; however, it was noted that a “push for new and updated systems” was underway with seemingly good support (personal communication, Marshall Rogne).

Other human-derived sources of pollutants in the watershed include straight pipe discharges and earthen pit outhouses. Straight pipe systems are unpermitted and illegal sewage disposal systems that transport raw or partially treated sewage directly to a lake, stream, drainage system, or the ground surface. Straight pipe systems are required to be addressed 10 months after discovery (Minn. Stat. § 115.55, subd. 11). Earthen pit outhouses likely exist in the watershed, but their numbers and locations are unknown and were not quantified. Outhouses, or privies, are legal disposal systems and are regulated under Minn. R. 7080.2150, subp. 2F, and Minn. R. 7080.2280.

Application of biosolids from wastewater treatment plants (WWTPs) and land application of sewage sludge from septic tanks could also be potential sources of pollutants. 40 CFR Part 503 establishes general requirements, pollutant limits, management practices, and operational standards for the disposal of domestic sewage sludge. Minn. R. ch. 7041 offers additional guidance for pathogen reduction practices to implement during the application of biosolids.

Non-NPDES-permitted stormwater runoff

Stormwater runoff acts as a delivery mechanism of multiple *E. coli* sources including wildlife, domestic pets, and humans. Impervious areas (such as roads, driveways, and rooftops) can directly connect the location where *E. coli* is deposited on the landscape to points where stormwater runoff carries *E. coli* into surface waters. For example, there is a greater likelihood that uncollected pet waste in an urban area will reach surface waters through stormwater runoff than it would in a rural area with less impervious surface. Wildlife, such as birds and raccoons, can be another source of *E. coli* in urban stormwater runoff (Wu et al. 2011, Jiang et al. 2007).

Natural growth of *E. coli*

When evaluating sources of *E. coli* in the UIR and MRR watersheds, it is important to recognize the natural growth of *E. coli* in soil and sediment. Research in the last 15 years has found the persistence of *E. coli* in soil, beach sand, and sediments throughout the year in the north central United States without the continuous presence of sewage or mammalian sources. An Alaskan study (Adhikari et al. 2007) found that total coliform bacteria in soil were able to survive for six months in subfreezing conditions. A study of cold water streams in southeastern Minnesota completed by the MPCA staff found the resuspension of *E. coli* in the stream water column due to stream sediment disturbance. A recent study near Duluth, Minnesota (Ishii et al. 2010) found that *E. coli* were able to grow in agricultural field soil. A study by Chandrasekaran et al. (2015) of ditch sediment in the Seven Mile Creek Watershed in southern Minnesota found that strains of *E. coli* had become naturalized to the water−sediment ecosystem. Survival and growth of fecal coliform has been documented in stormsewer sediment in Michigan (Marino and Gannon 1991). The growth and persistence of *E. coli*, which has been studied and documented in our region and beyond, greatly complicates the clear identification of sources of pathogens to surface waters. As such, the information provided in this section includes the most likely sources based on the best available information.

3.5.1.2 NPDES-permitted sources of *E. coli*

Permitted wastewater

Permitted municipal wastewater is a source of *E. coli* in the impaired watersheds. Municipal wastewater is the domestic sewage and wastewater collected and treated by municipalities before being discharged to waterbodies as municipal wastewater effluent. Municipal wastewater dischargers that operate under NPDES permits are required to disinfect wastewater to reduce fecal coliform concentrations to 200 organisms/100 mL or less as a monthly geometric mean. This standard is protective to the 126 org/100 mL class 2 water standards. Like *E. coli*, fecal coliform are an indicator of fecal contamination. The primary function of a fecal bacteria effluent limit is to assure that the effluent is being adequately treated and disinfected to assure a complete or near complete kill of fecal bacteria prior to discharge (MPCA 2007b). Dischargers to class 2 waters are required to disinfect from April 1 through October 31, and dischargers to class 7 waters are required to disinfect from May 1 through October 31. In addition, if a facility discharges in a known karst area and has the potential to affect groundwater drinking water, disinfection is required year-round (Minn. R. 7053.0215, subp.1). Year-round disinfection applies to Caledonia WWTP, Harmony WWTP, and Spring Grove WWTP. There are no permitted combined sewer overflows in the impaired watersheds.

Monthly geometric means of effluent monitoring data are used to determine compliance with permits. There are five wastewater dischargers with fecal coliform limits in the impaired watersheds (Figure 13 and Figure 14). Of these facilities, one facility has documented fecal coliform permit exceedances as provided in discharge monitoring reports (DMRs) for the time period between 2008 and 2017—the Caledonia WWTP, which is located in the Crooked Creek Watershed (AUID 07060001-519), reported four exceedances of the monthly geometric mean. These exceedances ranged from 290–600 org/100 mL and occurred between 2008 and 2015; there were no observed exceedances in 2016 or 2017. There are no documented exceedances of the in-stream *E. coli* standard in the receiving impaired reach at the same time as the wastewater discharge permit exceedances. These exceedances of wastewater fecal coliform permit limits could lead to exceedances of the in-stream *E. coli* standard at times. However, because the wastewater exceedances are infrequent, wastewater is not considered a significant source.

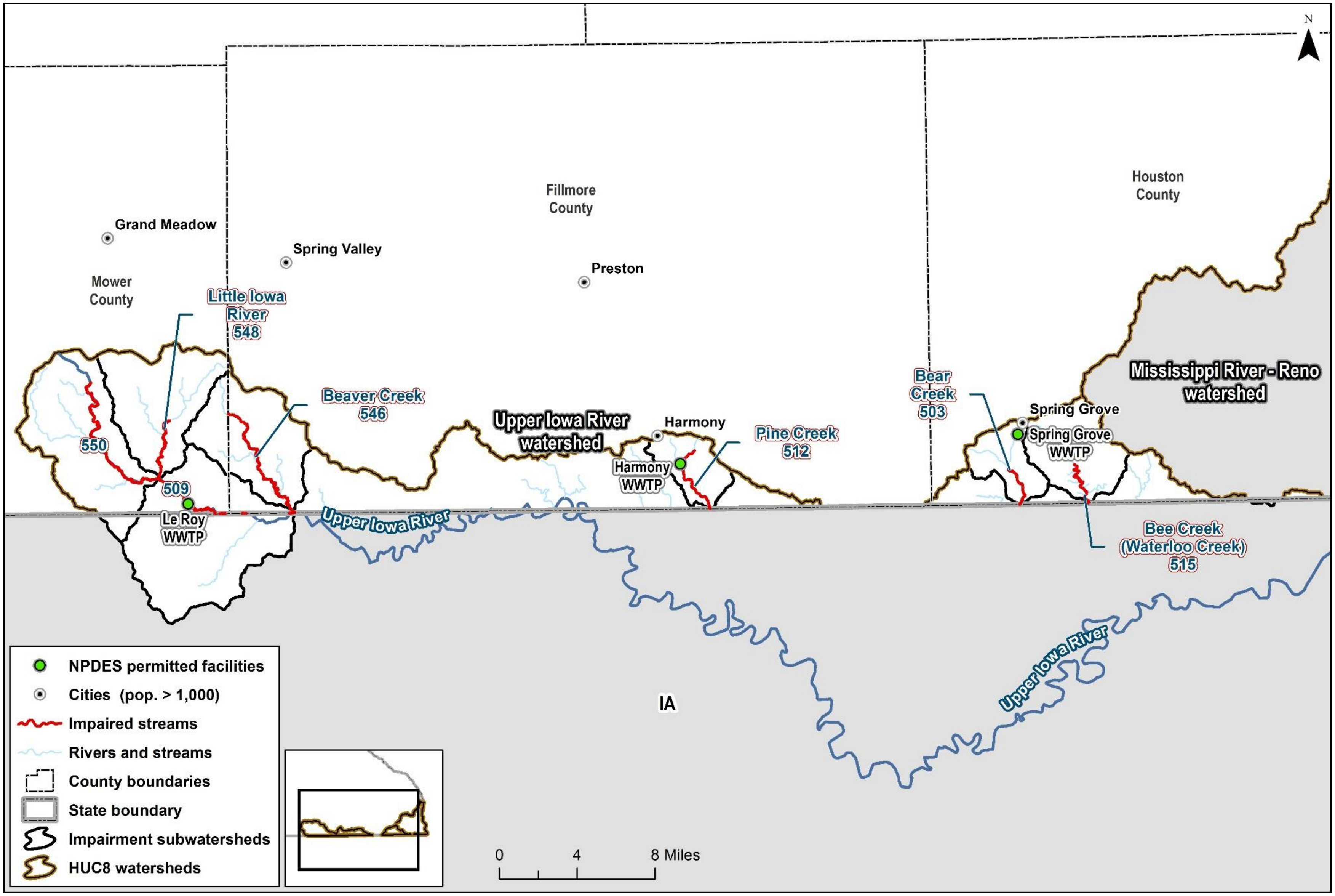


Figure 13. NPDES-permitted wastewater facilities in impaired watersheds in Upper Iowa River Watershed.

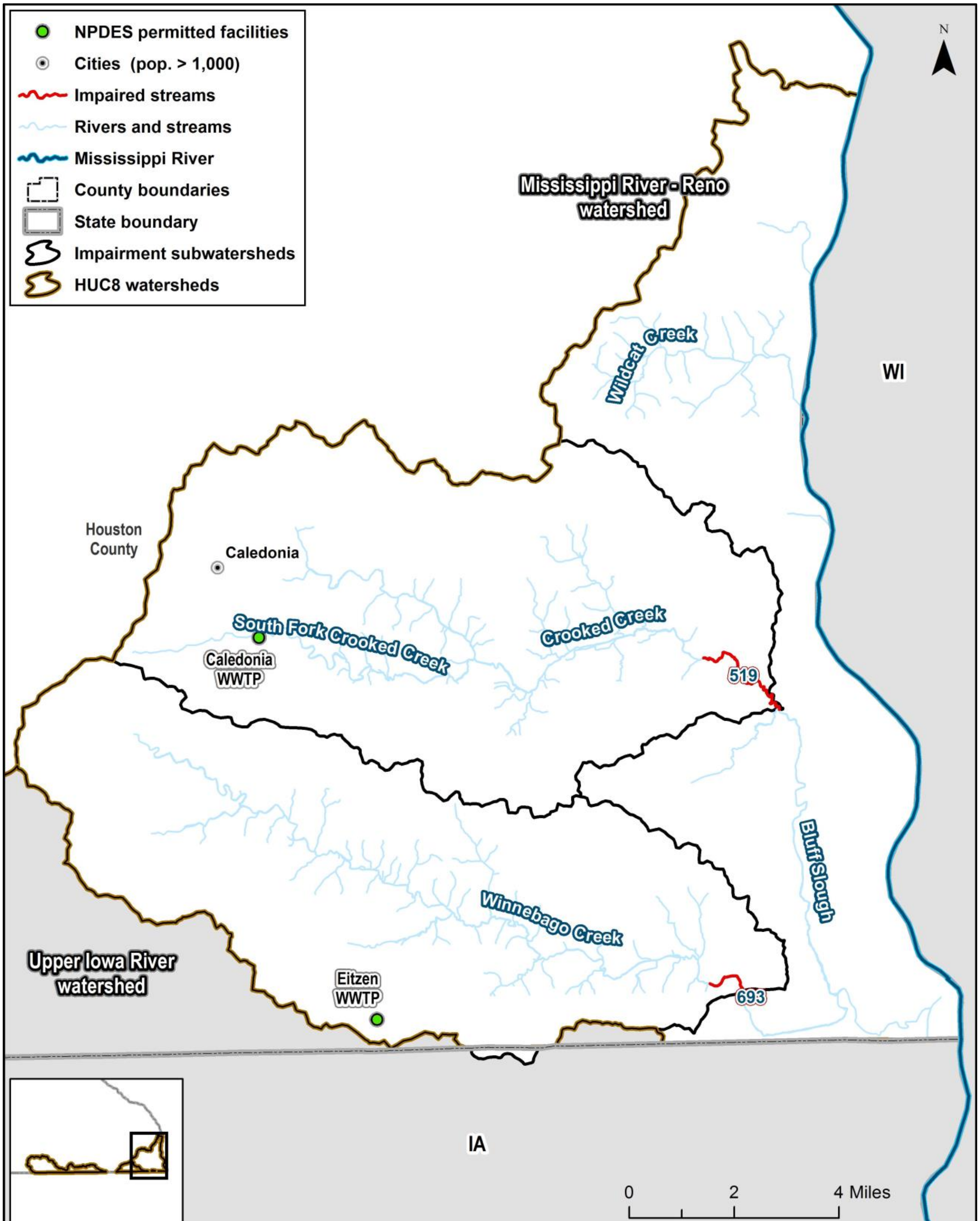


Figure 14. NPDES-permitted wastewater facilities in impaired watersheds in Mississippi River–Reno Watershed.

Permitted animal feeding operations (NPDES and SDS)

CAFOs are defined by the EPA based on the number and type of animals. The MPCA currently uses the federal definition of a CAFO in its permit requirements of animal feedlots along with the definition of an AU. In Minnesota, the following types of livestock facilities are required to operate under a NPDES Permit or a state issued State Disposal System (SDS) Permit: a) all federally defined CAFOs that have had a discharge, some of which are under 1,000 AUs in size; and b) all CAFOs and non-CAFOs that have 1,000 or more AUs.

CAFOs and AFOs with 1,000 or more AUs must be designed to contain all manure and manure contaminated runoff from precipitation events of less than a 25-year - 24-hour storm event. Having and complying with an NPDES permit allows some enforcement protection if a facility discharges due to a 25-year 24-hour precipitation event (approximately 5.3" in 24 hours) and the discharge does not contribute to a water quality impairment. Large CAFOs permitted with an SDS permit or those not covered by a permit must contain all runoff, regardless of the precipitation event. Therefore, many large CAFOs in Minnesota have chosen to have a NPDES permit, even if discharges have not occurred in the past at the facility. A current manure management plan that complies with Minn. R. 7020.2225, and the respective permit, is required for all CAFOs and AFOs with 1,000 or more AUs.

CAFOs are inspected by the MPCA in accordance with the MPCA NPDES Compliance Monitoring Strategy approved by the EPA. All CAFOs are inspected by the MPCA on a routine basis with an appropriate mix of field inspections, offsite monitoring and compliance assistance.

All NPDES-and SDS-permitted feedlots are designed to have zero discharge. Any NPDES/SDS permitted feedlots located in the UIR or MRR watersheds will be listed in the respective TMDL table (see Section 4) with a WLA of zero.

In the watersheds of the *E. coli* impairments, there are seven AFOs that operate under NPDES/SDS permits (Figure 11, Figure 12, and Table 12). There are no AFOs or CAFOs operating under NPDES/SDS permits within the MRR Watershed. Due to the requirement of NPDES-permitted AFOs and CAFOs to completely contain runoff, these facilities are not expected to be significant *E. coli* contributors.

Table 12. NPDES-permitted CAFOs.

Name	Permit Number	Impaired Waterbody Name	Impaired Waterbody AUID
Baarsch Farms LLC – Field	MNG440066	Upper Iowa River	07060002-550 07060002-509
Baarsch Farms LLC – Hollyhock	MNG440684	Upper Iowa River	07060002-509
Baarsch Farms LLC – Pass	MNG440067	Beaver Creek	07060002-546
LeRoy Site	MNG441983	Little Iowa River Upper Iowa River	07060002-548 07060002-509
M & R Pork Farm – Site 1	MNG440541	Upper Iowa River	07060002-550 07060002-509
M & R Pork Farm – Site 2	MNG440541	Upper Iowa River	07060002-550 07060002-509
Wiebke Feedlot LLC – Main Feedlot	MNG440906	Bee Creek (Waterloo Creek)	07060002-515

3.5.1.3 Summary of *E. coli* sources

The behavior of fecal bacteria in the environment is complex. Concentrations of fecal bacteria in a waterbody depend not only on their source but also factors such as weather, flow, and water temperature. As these factors fluctuate, the concentrations of fecal bacteria in the water may increase or decrease. Some fecal bacteria can survive and grow in the environment while others tend to die off with time (Ishii et al. 2006, Chandrasekaran et al. 2015, Sadowsky et al. n.d., and Burns & McDonnell 2017). See *Water Quality and Bacteria Frequently Asked Questions* (MPCA 2019a) for additional background information about sources of fecal bacteria. The MPCA uses the *E. coli* water quality standard to identify water bodies that may be contaminated with fecal waste. Higher levels of *E. coli* in the water may or may not be accompanied by higher levels of pathogens and an increased risk of harm; varying survival rates of bacteria make it impossible to definitively state when pathogens are present.

Sources in the entire drainage area to each impaired waterbody were considered. The summary of *E. coli* sources (Table 133) identifies which source types exist in each impaired watershed and which of the source types should be a source of concern, based on the following:

- Waste from livestock is a source of concern when feedlots are numerous and/or are located close to surface waterbodies. Non-NPDES-permitted feedlots are typically more of a concern than CAFOs or NPDES-permitted AFOs because non-NPDES-permitted feedlots are not required to completely contain runoff.
- Waste from wildlife may be a source of *E. coli* in Crooked Creek and Winnebago Creek due to their heavily forested watersheds and in Bee Creek because it flows through a wildlife management area. Any potential contributions from these areas are considered natural.
- Non-NPDES-permitted stormwater runoff is considered a likely source of *E. coli* for streams that flow through developed areas of cities. Stormwater runoff is considered a potential but less-likely source of *E. coli* to streams that do not flow directly through developed areas in their watershed. If there is minimal developed area in the watershed, stormwater runoff is considered an unlikely source of *E. coli*. Waste from pets is considered with stormwater runoff because waste from this source is delivered to surface waters through stormwater runoff.
- Effluent from WWTPs is typically below the *E. coli* standard and is not considered a significant source.
- ITPHSs do not make up a large percentage of total SSTSs in the impaired watersheds; however, they should be addressed as they pose a threat to human and environmental health and are a potential source of *E. coli*. SSTSs that are failing to protect groundwater make up a larger percentage of total SSTSs in Mower and Houston counties. Without information on their location relative to the impaired streams, however, SSTSs that are failing to protect groundwater are also considered a potential source of *E. coli.*

The monitoring data indicate that *E. coli* concentrations increase with flow (Figure 9), suggesting that runoff driven sources are of most concern. Livestock is the primary source of concern in the majority of impaired watersheds. In the watersheds with developed areas, stormwater runoff has the potential to be a primary source.

Table 13. Summary of *E. coli* sources.
● Likely *E. coli* source; ○ Potential *E. coli* source; – Unlikely *E. coli* source

HUC 8 Name	Waterbody Name	AUID	Source				
			Livestock	Wildlife	Stormwater Runoff	ITPHS and SSTSs that are Failing to Protect Groundwater[a]	Permitted Wastewater
Mississippi River–Reno (07060001)	Crooked Creek	519	●	○ [b]	○	○	Caledonia WWTP –
	Winnebago Creek	693	○	○ [b]	–	○	Eitzen WWTP –
Upper Iowa River (07060002)	Upper Iowa River	550	●	–	–	○	–
	Little Iowa River	548	●	–	–	○	–
	Upper Iowa River	509	●	–	●	○	Le Roy WWTP –
	Beaver Creek	546	●	–	–	○	–
	Pine Creek	512	●	–	○	○	Harmony WWTP –
	Bear Creek	503	●	–	○	○	Spring Grove WWTP –
	Bee Creek (Waterloo Creek)	515	●	○ [b]	–	○	–

a. Relatively low percentages of SSTSs in the Upper Iowa River and Mississippi River–Reno watersheds are estimated to be ITPHS. However, until location specific information is known about the ITPHS, they remain a potential source *of E. coli* to the impaired streams.
b. Waste from wildlife is identified as a potential source to several impairments due to either heavily forested watershed areas or flow through a wildlife management area. Any potential contributions from these areas are considered natural.

3.5.2 TSS sources

Sources of sediment to Winnebago Creek were quantified in the UIR and MRR Watershed HSPF models (Tetra Tech 2018), along with additional studies. HSPF is a comprehensive model of watershed hydrology and water quality that allows the integrated simulation of point sources, land and soil contaminant runoff processes, and in-stream hydraulic and sediment-chemical interactions. The results provide hourly runoff flow rates, sediment concentrations, and nutrient concentrations, along with other water quality constituents, at the outlet of any modeled subwatershed. Within each subwatershed, the upland areas are separated into multiple land use categories, and loads generated from these land cover categories were tabulated from the HSPF model. The model evaluated both permitted and non-NPDES-permitted sources including watershed runoff, near channel, and wastewater point sources. Model documentation contains additional details about the model development and calibration (Tetra Tech 2018).

Flow through the soluble rock formations that make up the karst bedrock is represented in the HSPF model. Due to its unique below ground conduits, the karst system can be thought of as a second, parallel network of subsurface stream reaches. The HSPF model setup for the UIR and MRR watersheds uses a parallel karst reach representation to allow the exchange of water and associated pollutants between surface and groundwater. Sediment derived from upland areas that are routed to karst reaches is included in the TSS source summary.

A description of permitted and non-NPDES-permitted sources of sediment is provided below, followed by the HSPF results for the impaired subwatersheds.

3.5.2.1 Non-NPDES-permitted sources of TSS

Watershed runoff

Watershed runoff sources of sediment are largely the result of sheet, rill, and gully erosion occurring as water runs off over the land surface. High TSS levels can occur when heavy rains fall on unprotected soils, dislodging soil particles that are then transported by surface runoff into rivers and streams. First-order streams, ephemeral streams, and gullies are typically higher up in the watershed and can flow intermittently, which makes them highly susceptible to disturbance. These sensitive areas have a very high erosion potential, which can be exacerbated by farming practices, but can also be protected by best management practices (BMPs) such as grassed waterways.

Agricultural activities such as livestock over-grazing and plowing or tilling crop fields can result in devegetated, exposed soil that is susceptible to erosion. Land use in the Winnebago Creek Subwatershed is predominantly forest, cropland and grassland/pasture. These land covers are likely contributing sediment to watershed runoff.

Near channel sources

Near channel sources of pollutants are those in close proximity to the stream channel, including bluffs, banks, ravines, and the stream channel itself.

Hydrologic changes in the landscape and altered precipitation patterns driven by climate change can lead to increased TSS in surface waters. Channelization of waterways and land cover alteration decrease detention time in the watershed and increase flows. The straightening and ditching of natural rivers increase the slope of the original watercourse and moves water off the land at a higher velocity in a shorter amount of time. These changes to the way water moves through a watershed and how it makes its way into a river can lead to increases in water velocity, scouring of the river channel, and increases erosion of the riverbanks (Schottler et al. 2014). The MRR SID Report notes that bank erosion was common in Winnebago Creek and could be a substantial sediment source to the impaired reach (MPCA 2018a).

3.5.2.2 Permitted sources of TSS

Permitted stormwater

Permitted 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 the air, road salt, and oil and grease from vehicles. Two types of permitted stormwater exist in the watershed: (1) construction stormwater and (2) industrial stormwater. There are no permitted Municipal Separate Storm Sewer Systems (MS4) in the watershed.

- *Construction stormwater* is regulated through an NPDES permit. Untreated stormwater that runs off a construction site often carries sediment to surface waterbodies. Phase II of the stormwater rules adopted by the EPA requires an NPDES permit for a construction activity that disturbs one acre or more of soil; a permit is needed for smaller sites if the activity is either part of a larger development or if the MPCA determines that the activity poses a risk to water resources. Coverage under the construction stormwater general permit requires sediment and erosion control measures that reduce stormwater pollution during and after construction activities. TSS from construction stormwater is inherently incorporated in the watershed runoff estimates. It is estimated that a small percent of the project area is permitted through the construction stormwater permit, and construction stormwater is not considered a significant source.
- *Industrial stormwater* is regulated through an NPDES permit when stormwater discharges have the potential to come into contact with materials and activities associated with the industrial activity. TSS loading from industrial stormwater is inherently incorporated in the watershed runoff estimates. It is estimated that a small percent of the project area is permitted through the industrial stormwater permit, and industrial stormwater is not considered a significant source.

Permitted construction and industrial stormwater are not prevalent in the impaired watershed and therefore are not considered significant sources.

Permitted wastewater

Wastewater from municipal sources is a potential source of sediment to impaired waters—Eitzen WWTP (Figure 14) is permitted to discharge wastewater in the Winnebago Creek Subwatershed. Eitzen WWTP is primarily a spray irrigation facility, which is only authorized to discharge in emergency situations when weather conditions do not allow land application; the facility discharged only three times between 2008 and 2017. Eitzen WWTP's NPDES permit limits the load and concentration of sediment, as TSS, that the WWTP may discharge; the concentration limit is 45 mg/L as a calendar monthly average. Although this concentration is higher than the stream TSS standard of 10 mg/L, the wastewater discharges are infrequent, and wastewater is not considered a significant source.

There are no permitted industrial wastewater discharges impacting the impaired watersheds.

3.5.2.3 Summary of TSS sources

The UIR and MRR watershed HSPF models (Tetra Tech 2018) indicate that watershed runoff from cropland and grassland/pasture along with near channel sources account for the majority of the TSS load in Winnebago Creek (Table 1414). Forest contributes 13% of the TSS load but is also a primary land cover in this watershed (i.e., 33% of the watershed is forested). Point sources contribute negligible loads to Winnebago Creek. This source assessment is corroborated by the monitoring data—the majority of TSS exceedances occur during higher flows, indicating that runoff-driven sources such as watershed runoff and near channel erosion are the primary sources of concern (Figure 10).

Table 14. TSS loading in Winnebago Creek Watershed (07060001-693) from HSPF model results (Tetra Tech 2018).

TSS Source	Land cover area in watershed model (% of watershed) [a]	Percent of mean annual load (%) [b]
Cropland runoff	27%	27%
Pasture/grassland runoff	33%	22%
Developed runoff	3%	4%
Forest runoff	36%	13%
Barren land runoff	<1%	2%
Near channel [c]	--	32%
Point sources	--	<1 %

a. The composition of land cover differs in the model compared to Table 5. The model uses land cover from 2001 whereas Table 5 uses land cover from 2017.
b. Percentages (rounded to the nearest integer) were calculated as the average of the annual percent.
c. Near channel sources were calculated based on the net deposition and scour for all reaches in the watershed.

A 2012 through 2015 study on erosion and sediment dynamics in the Root River Watershed indicates that agricultural soil erosion and streambank erosion are substantial sediment sources, with agricultural soil erosion representing 60% to 70% of overall sediment loading at small watershed scales (Belmont et al. nd). Results from this research were used in calibration of the HSPF model of the Root River, UIR, and MRR watersheds. The findings from Belmont et al. are comparable to the source assessment results derived from the HSPF model. Differences between the HSPF model outputs and findings from Belmont et al. could be attributed to factors including precipitation intensity/frequency, soil type, slope, upland transport distance to the stream network, and differences in tillage and manure application practices in these areas.

4. TMDL development approach

A TMDL is the total amount of a pollutant that a receiving waterbody can assimilate while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. A TMDL for a waterbody that is impaired as a result of excessive loading of a particular pollutant can be described by the following equation:

TMDL = WLA + LA + MOS

where:

TMDL = total maximum daily load, also known as loading capacity, which is the greatest pollutant load a waterbody can receive without violating water quality standards.

WLA = wasteload allocation, or the portion of the TMDL allocated to existing or future permitted point sources of the relevant pollutant.

LA = load allocation, or the portion of the TMDL allocated to existing or future nonpoint sources of the relevant pollutant.

MOS = margin of safety, or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The MOS can be provided implicitly through analytical assumptions or explicitly by reserving a portion of the loading capacity (EPA 1999).

This section describes the general approach used to derive the TMDLs and allocations. The allocations for each of the various sources and parameters are provided in Section 5: *TMDLs and water quality data summaries*.

Assimilative loading capacities for the streams were developed using load duration curves. See Section 3.4 for a description of load duration curve development. The load duration curves provide assimilative loading capacities and show load reductions necessary to meet water quality standards. For any given flow in the load duration curve, the loading capacity is determined by selecting the point on the load duration curve that corresponds to the flow exceedance (along the x-axis). Load duration curves were developed for each impaired reach.

The load duration curve method is based on an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes, virtually the full spectrum of allowable loading capacities is represented by the resulting curve. In the TMDL equation tables in this report (Section 5), only five points on the entire load duration curve are depicted (the midpoints of the designated flow zones). The entire curve; however, represents the TMDL and is what is ultimately approved by the EPA.

Additional details on the approaches used to develop the TMDL components are provided in the following sections.

4.1 Margin of safety

The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. Section 303(d) of the CWA and EPA's regulations in 40 CFR 130.7 require that:

TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS, which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

The MOS can either be implicitly incorporated into conservative assumptions used to develop the TMDL or be added as a separate explicit component of the TMDL (EPA 1991). An explicit MOS of 10% was included in the TMDLs to account for uncertainty that the pollutant allocations would attain the water quality targets. The use of an explicit MOS accounts for environmental variability in pollutant loading, variability in water quality monitoring data, calibration and validation processes of modeling efforts, uncertainty in modeling outputs, conservative assumptions made during the modeling efforts, and limitations associated with the drainage area-ratio method used to extrapolate flow data. This MOS is considered to be sufficient given the robust datasets used and quality of modeling, as described below.

The UIR and MRR watersheds HSPF model is part of the Root River Watershed HSPF model, which was calibrated and validated using 10 stream flow gaging stations. One of the calibration stations is the UIR near Bluffton, Iowa (USGS site # 05387440). Mean monthly simulated flows match closely with mean monthly observed flows at this location, and a close fit was achieved across high to low flows in a cumulative distribution function plot (see Figure 3-20 and Figure 3-21 in Tetra Tech 2018). The sediment calibration used 12 sediment monitoring stations in the Root River Watershed (Tetra Tech 2018).

Calibration results indicate that the HSPF model is a valid representation of hydrologic and water quality conditions in the modeled watersheds. Flow data used to develop the stream TMDLs are derived from HSPF-simulated daily flow data, and the sediment source assessment is derived from HSPF-simulated sediment.

4.2 Seasonal variation and critical conditions

The CWA requires that TMDLs take into account critical conditions for flow, loading, and water quality parameters as part of the analysis of loading capacity. Both seasonal variation and critical conditions are accounted for through the application of load duration curves. Load duration curves evaluate water quality conditions across all flow regimes including high flow, which is the runoff condition where pollutant transport and loading from upland sources tend to be greatest, and low flow, when loading from wastewater and other direct sources to the waterbodies has the greatest impact. Seasonality is accounted for by addressing all flow conditions in a given reach. Seasonal variation is also addressed by the water quality standards' application during the period when high pollutant concentrations are expected via storm event runoff. Using this approach, it has been determined that load reductions are needed for specific flow conditions.

4.3 Baseline year

The monitoring data used to calculate the percent reductions are from 2008 through 2017. Because projects undertaken recently may take a few years to influence water quality, the baseline year for crediting load reductions for a given waterbody is 2012, the midpoint of the time period. Any activities implemented during or after the baseline year that led to a reduction in pollutant loads to the waterbodies may be considered as progress towards meeting a WLA or LA.

4.4 Boundary conditions

A boundary condition allocation is provided for impaired segments that contain a portion of their watershed in Iowa:

- Winnebago Creek (07060001-693)
- Upper Iowa River (07060002-550)
- Upper Iowa River (07060002-509)

The boundary condition allocation assumes that that water quality standards are being met at the state line and takes into account the MOS and any applicable wastewater WLAs. Boundary conditions are calculated using the proportion of the total watershed area in Iowa. The boundary condition allocation is equal to the percent of the total watershed area in Iowa, multiplied by the loading capacity, minus the MOS minus wastewater WLAs (where applicable).

4.5 Construction and industrial stormwater WLAs

Construction stormwater is permitted through the Construction Stormwater General Permit MNR100001, and a single categorical WLA for construction stormwater is provided for TSS impaired stream Winnebago Creek, located in Houston County. The average annual percent area of Houston County that is permitted through the construction stormwater permit is 0.019% (Minnesota Stormwater Manual contributors 2018). The construction stormwater WLA was calculated as the percent area multiplied by the loading capacity (i.e., TMDL) less the MOS and wastewater WLA. It is assumed that loads from permitted construction stormwater sites that operate in compliance with their permits are meeting the WLA.

Industrial stormwater is permitted through the General Permit MNR050000 for Industrial Stormwater Multi-Sector. A single categorical WLA for industrial stormwater is provided for Winnebago Creek. There are three permitted industrial stormwater discharges in the Winnebago Creek Watershed associated with quarry operations and address stormwater from Eitzen Quarry and Shultz Quarry (MNG490087) and Winnebago Quarry Houston County (MNG490115). Permitted industrial stormwater sources are not expected to be sources of *E. coli* and are not provided WLAs. The MPCA's industrial stormwater permit does not regulate discharges of *E. coli*. The permit does not contain *E. coli* benchmarks; industrial stormwater permittees are required to sample their stormwater for parameters that more closely match the potential contribution of pollutants for their industry sector or subsector. For example, recycling facilities and auto salvage yards are required to sample for TSS, metals, and other pollutants likely present at these types of facilities.

Permitted industrial activities make up a small portion of the watershed areas, and the industrial stormwater WLA was set equal to the construction stormwater WLA. It is assumed that loads from permitted industrial stormwater sites that operate in compliance with the permit are meeting the WLA.

4.6 Natural background consideration

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 of *E. coli* are inputs that would be expected under natural, undisturbed conditions. The relationship between bacterial sources and bacterial concentrations found in streams is complex, involving precipitation and flow, temperature, livestock management practices, wildlife activities, survival rates, land use practices, and other environmental factors. However, for each impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment, and therefore natural background is accounted for and addressed through the MPCA's waterbody assessment process.

Natural background TSS 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; atmospheric deposition; wildlife; and loading from grassland, forests, and other natural land covers. In 2016, when considering a challenge to the MPCA's approach to natural background in the Little Rock Creek TMDL, the Minnesota Court of Appeals held that the MPCA is not required to develop a LA for natural background independent from other nonpoint sources. In that case, the MPCA gathered and considered natural background sources but did not assign a separate LA to those sources due to their marginal impact on Little Rock Creek's overall water quality. The MPCA followed a similar approach for this TMDL. The court also held that, as allowed by Minn. R. 7050.0170, background levels can be predicted based on data from watersheds with similar characteristics.

The TSS standard inherently addresses natural background conditions. 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 2011a).

Based on the MPCA's waterbody assessment process and the TMDL source assessment exercises, there is no evidence at this time to suggest that natural background sources are a major driver of any of the impairments and/or affect the waterbodies' ability to meet state water quality standards. For all impairments addressed in this TMDL study, 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.

4.7 *E. coli* TMDL approach

4.7.1 Loading capacity and percent reductions

Loading capacities were developed using load duration curves developed from simulated flows. (See Section 3.4 for a description of load duration curve development and Section 4 for more background on the load duration curve method). The loading capacity was calculated as flow multiplied by the *E. coli* geometric mean standard (126 org/100 mL for class 2 streams and 630 org/100 mL for the class 7 streams). A second *E. coli* TMDL target of 126 org/100 mL is provided for Bear Creek (07060002-503) and Pine Creek (07060003-512), which is based on the more restrictive downstream standard in Iowa (see Section 2.2).

It is assumed that practices that are implemented to meet the geometric mean standard will also address the individual sample standard (1,260 org/100 mL), and that the individual sample standard will also be met.

Percent reductions for *E. coli* TMDLs are provided based on monitored concentration data and the water quality standard. Ideally, sufficient data would exist to calculate current actual *E. coli* loads to compare directly to the TMDLs, which would allow for load reduction projections. However, the amount of data required for load calculations is much greater than that required for simple impairment assessment. As such, a load reduction is not provided. Instead, the estimated percent reduction provided for each TMDL was calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). Monthly geometric means were used to estimate percent reduction only if they are based on five or more samples. The estimated percent reductions provide a rough approximation of the overall reduction needed for the waterbody to meet the TMDL. 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. The percent reduction should be interpreted as a means to capture the level of effort needed to reduce *E. coli* concentrations in the watershed. Calculations come from the best available data and support the conclusion that *E. coli* sources need to be addressed.

4.7.2 Wasteload allocation methodology

4.7.2.1 Permitted wastewater

The *E. coli* WLAs for permitted municipal wastewater are based on the *E. coli* geometric mean standard of 126 organisms per 100 mL and the facility’s average wet weather design flow (

Table 155). For WWTPs with controlled discharge, the maximum daily discharge volume for each facility was used.

Disinfection requirements for each permitted facility are provided in

Table 15. Disinfection time periods vary depending on the class of water (e.g., class 2 or 7) and if the facility discharges to stream in a karst region with a direct connection to groundwater and nearby drinking water wells. While a facility may be required to disinfect year-round, the WLA only applies to the water quality standard window. There are no instances when disinfection requirements need to be changed. It is assumed that if a facility meets the fecal coliform limit of 200 organisms per 100 mL it is also meeting the *E. coli* WLA.

All wastewater WLAs for *E. coli* are listed in the TMDL tables in Section 5 and in

Table 155.

Table 15. Wastewater wasteload allocations for *E. coli*.

Facility	Permit Number	Design Flow (mgd) [a]	Disinfection Required under Current Permit	*E. coli* WLA (billion organisms per day)	Time Period the WLA Applies	Impaired Waterbody Name	Impaired Waterbody AUID
Caledonia WWTP	MN0020231	0.57	Jan 1–Dec 31	2.72	Apr 1–Oct 31	Crooked Creek	07060001-519
Eitzen WWTP	MN0049531	0.209	Apr 1–Oct 31	0.995	Apr 1–Oct 31	Winnebago Creek	07060001-693
Harmony WWTP	MN0022322	0.194	Jan 1–Dec 31	0.93	Jan 1–Dec 31 [b]	Pine Creek	07060002-512
Le Roy WWTP	MN0021041	0.912	Apr 1–Oct 31	4.351	Apr 1–Oct 31	Upper Iowa River	07060002-509
Spring Grove WWTP	MN0021440	0.378	Jan 1–Dec 31	1.80	Mar 15–Nov 15 [c]	Bear Creek	07060002-503

a. Average wet weather design flow or maximum daily pond flow, in million gallons per day (mgd).
b. Harmony WWTP: The *E. coli* standard of the downstream impaired reach in Iowa applies from Jan–Dec.
c. Spring Grove WWTP: The *E. coli* standard of the downstream impaired reach in Iowa applies from Mar 15–Nov 15.

4.7.2.2 Permitted animal feeding operations

All NPDES- and SDS-permitted AFOs in the UIR Watershed are designed to have zero discharge, and as such they do not receive a WLA. All other non-CAFO feedlots and the land application of all manure are accounted for in the LA. There are no NPDES- or SDS-permitted AFOs in the MRR Watershed.

4.7.3 Load allocation methodology

The LA represents the portion of the loading capacity that is allocated to pollutant loads that are not permitted through an NPDES permit (e.g., non-NPDES-permitted watershed runoff, ITPHS, and natural background [see Section 4.6]). The LA for each *E. coli* TMDL was calculated as the loading capacity minus the MOS minus the WLAs.

4.8 Total suspended solids TMDL approach

4.8.1 Loading capacity and percent reductions

The loading capacity was calculated as flow multiplied by the TSS standard (10 mg/L). The existing concentration was calculated as the 90th percentile of observed TSS concentrations from the months that the standard applies (April through September). The 90th percentile was used because the TSS standard states that the numeric criterion may be exceeded for no more than 10% of the time. The TSS water quality standard is included in the TMDL table to provide a comparison for existing conditions.

4.8.2 Wasteload allocation methodology

WLAs are provided for municipal wastewater and permitted construction and industrial stormwater.

4.8.2.1 Wastewater

There is only one wastewater facility, Eitzen WWTP, which is authorized through an NPDES permit to discharge TSS in the Winnebago Creek Watershed. The Eitzen WWTP is primarily a spray irrigation facility that is only authorized to discharge in emergency situations, including when weather conditions do not allow land application. The facility discharged three times between 2008 and 2017: June 2008, July 2013, and September 2016. The TSS WLA is based on the calendar monthly average TSS load limit in the facility's NPDES permit (Table 166); the calendar monthly average concentration limit is 45 mg/L TSS. This concentration limit is higher than the stream water quality standard, which is 10 mg/L TSS. Because of the infrequency of discharge, Eitzen WWTP is not considered to contribute to TSS impairment in Winnebago Creek, and the current TSS permit limits are sufficient to protect water quality in Winnebago Creek. The wastewater WLA for TSS is listed in the TMDL table in Section 5 and in Table 16.

Table 16. Wastewater wasteload allocation for TSS.

Facility	Permit Number	Maximum Daily Pond Flow (mgd)	TSS Wasteload Allocation (pounds per day)	Impaired Waterbody Name	Impaired Waterbody AUID
Eitzen WWTP	MN0049531	0.209	78	Winnebago Creek	07060001-693

4.8.2.2 Construction and industrial stormwater WLAs

Categorical WLAs are provided for construction and industrial stormwater. See Section 4.5 for more details.

5. TMDLs and water quality data summaries

This section provides the water quality summary tables, load duration curves, and TMDL tables for all the impairments addressed in this report. See Sections 3.4, 3.5, and 4 for an explanation of the data analyses.

The water quality data, when taken as a whole, indicate that the majority of *E. coli* exceedances occur under high and very high flows (Figure 9, Table 8), indicating that runoff-driven sources such as stormwater runoff and runoff from AFOs are the primary sources of concern. Load reductions are needed to address multiple source types (see Section 0: Stream *E. coli* source summary).

The maximum recordable value for *E. coli* concentration depends on the extent of sample dilution and is often 2,420 org/100 mL. Concentrations that are noted as 2,420 org/100 mL are likely higher, and the magnitude of the exceedances is not known.

The majority of TSS exceedances also occur during higher flows (Figure 10); load reductions will need to come primarily from agricultural runoff and near channel erosion (see Section 3.5.2.3: *Summary of TSS sources*).

Loads in the TMDL tables are rounded to two significant digits, except in the case of values greater than 100, which are rounded to the nearest whole number. Percent reductions are rounded to the nearest whole number.

5.1 Mississippi River–Reno Watershed

5.1.1 Crooked Creek, T102 R4W S27, west line to Bluff Slough (07060001-519)

5.1.1.1 *E. coli*

Table 17. Annual summary of *E. coli* data at Crooked Creek (AUID 07060001-519; April–October).

Year		Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008		0	–	–	–	–	–
2009		0	–	–	–	–	–
2010		0	–	–	–	–	–
2011		0	–	–	–	–	–
2012		0	–	–	–	–	–
2013		0	–	–	–	–	–
2014		0	–	–	–	–	–
2015		9	1,080	644	2,723	3	33
2016		6	825	613	1,300	1	17
2017		0	–	–	–	–	–

Table 18. Monthly summary of *E. coli* data at Crooked Creek (AUID 07060001-519; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	0	–	–	–	–	–
May	0	–	–	–	–	–
Jun	5	1,270	727	2,723	3	60
Jul	5	841	613	990	0	–
Aug	5	855	644	1,300	1	20
Sep	0	–	–	–	–	–
Oct	0	–	–	–	–	–

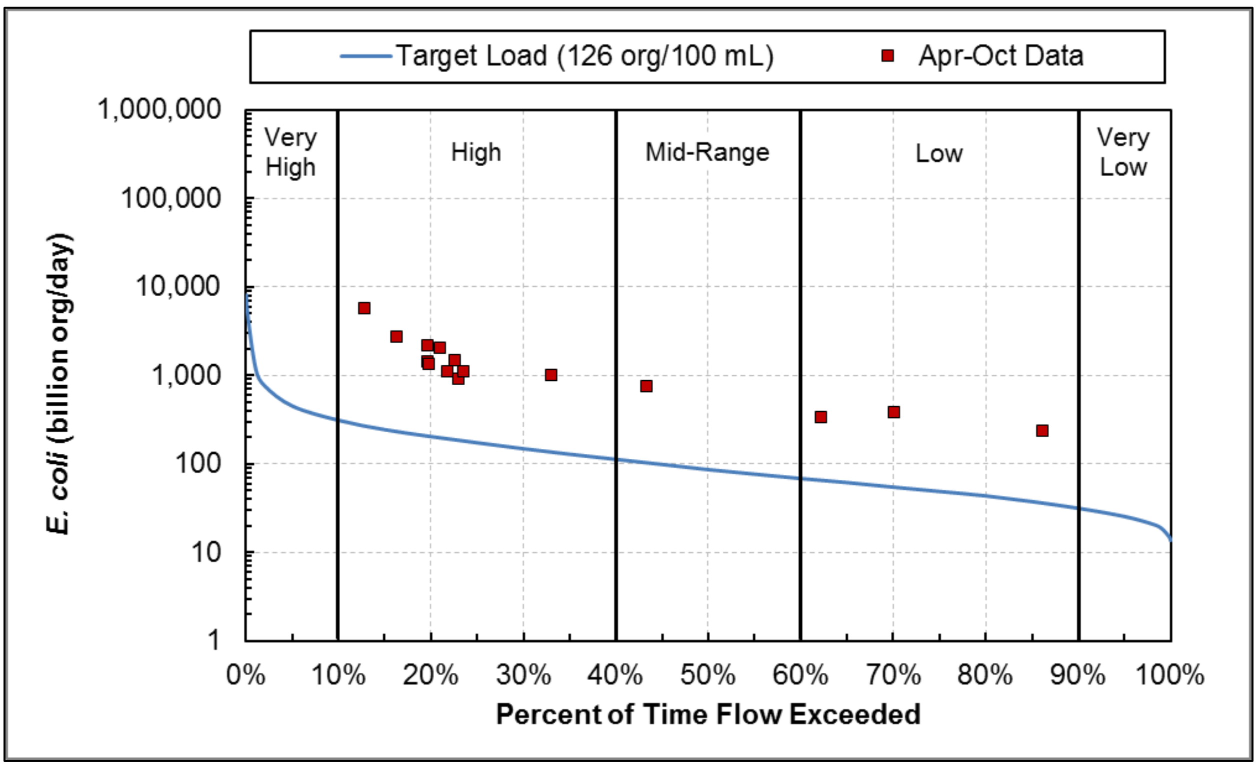


Figure 15. *E. coli* load duration curve, Crooked Creek (AUID 07060001-519).

Table 19. ***E. coli*** **TMDL summary, Crooked Creek (AUID 07060001-519).**

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter		Flow zones				
		Very high	High	Mid-range	Low	Very low
		2,587-101 cfs	100-37 cfs	36-23 cfs	22-11 cfs	10-4.4 cfs
Sources		*E. coli* load (B org/d)				
Wasteload	Caledonia WWTP (MN0020231)	2.72	2.72	2.72	2.72	2.72
	Total WLA	2.7	2.7	2.7	2.7	2.7
Load	Total LA	397	152	74	40	20
MOS		45	17	8.5	4.8	2.5
Total load		445	172	85	48	25
Maximum monthly geomean (org/100 mL)		1,270				
Overall estimated percent reduction [a]		90%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.1.2 Winnebago Creek, T101 R4W S27, west line to south line (07060001-693)

5.1.2.1 *E. coli*

Table 20. Annual summary of E. coli data at Winnebago Creek (AUID 07060001-693; April–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	0	–	–	–	–	–
2009	0	–	–	–	–	–
2010	0	–	–	–	–	–
2011	0	–	–	–	–	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	9	612	261	2,490	2	22
2016	6	368	228	816	0	–
2017	0	–	–	–	–	–

Table 21. Monthly summary of *E. coli* data at Winnebago Creek (AUID 07060001-693; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	0	–	–	–	–	–
May	0	–	–	–	–	–
Jun	5	990	387	2,490	2	40
Jul	5	352	228	637	0	–
Aug	5	358	292	579	0	–
Sep	0	–	–	–	–	–
Oct	0	–	–	–	–	–

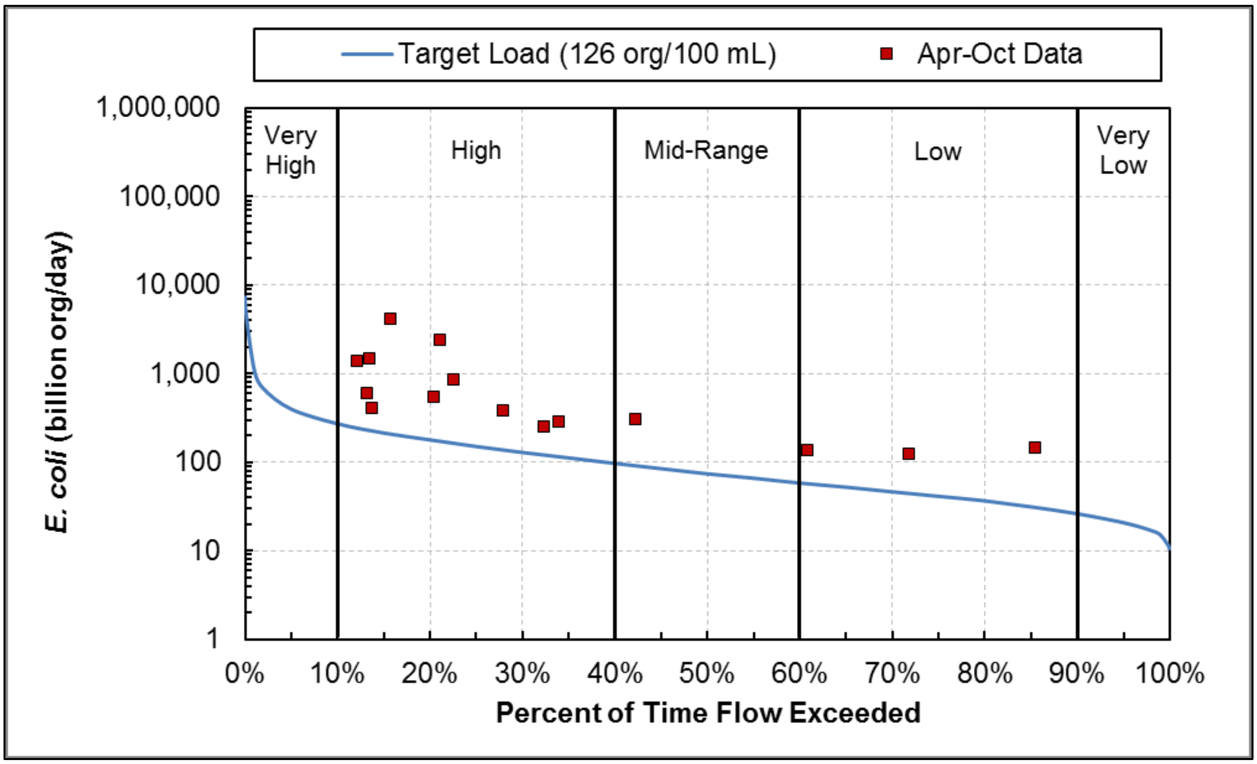


Figure 16. *E. coli* load duration curve, Winnebago Creek (AUID 07060001-693).

Table 22. *E. coli* TMDL summary, Winnebago Creek (AUID 07060001-693).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter		Flow zones				
		Very high	High	Mid-range	Low	Very low
		2,391-89 cfs	88-32 cfs	31-20 cfs	19-8.6 cfs	8.5-3.4 cfs
Sources		*E. coli* load (B org/d)				
Boundary Condition at Iowa State Line [a]		1.6	0.59	0.29	0.16	0.078
Wasteload	Eitzen WWTP (MN0049531)	0.995	0.995	0.995	0.995	0.995
	Total WLA	1.0	1.0	1.0	1.0	1.0
Load	Total LA	355	134	65	36	18
MOS		40	15	7.4	4.1	2.1
Total load		398	151	74	41	21
Maximum monthly geomean (org/100 mL)		990				
Overall estimated percent reduction [b]		87%				

a. The boundary condition allocation is equal to the percent of the total watershed area in Iowa multiplied by the loading capacity minus the MOS minus wastewater WLAs.
b. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.1.2.2 TSS

Table 23. Annual summary of TSS data Winnebago Creek (AUID 07060001-693; April–September).
Values in red indicate years in which the individual standard of 10 mg/L was exceeded in greater than 10% of the samples.

Year	Sample count	Mean (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Number of exceedances	Frequency of exceedances
2008	0	–	–	–	–	–
2009	8	21	3	98	4	50%
2010	0	–	–	–	–	–
2011	0	–	–	–	–	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	10	19	2	42	6	60%
2016	5	28	7	44	3	60%
2017	4	17	9	31	3	75%

Table 24. Monthly summary of TSS data at Winnebago Creek (AUID 07060001-693; 2008–2017).
Values in red indicate months in which the individual standard of 10 mg/L was exceeded in greater than 10% of the samples. Standard applies only to months April–September.

Month	Sample count	Mean (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Number of exceedances	Frequency of exceedances
Apr	2	38	31	44	2	100%
May	4	28	18	39	4	100%
Jun	7	32	12	98	7	100%
Jul	6	10	6	24	1	17%
Aug	5	8	3	16	1	20%
Sep	3	17	2	42	1	33%
Oct	1	19	19	19	NA	NA

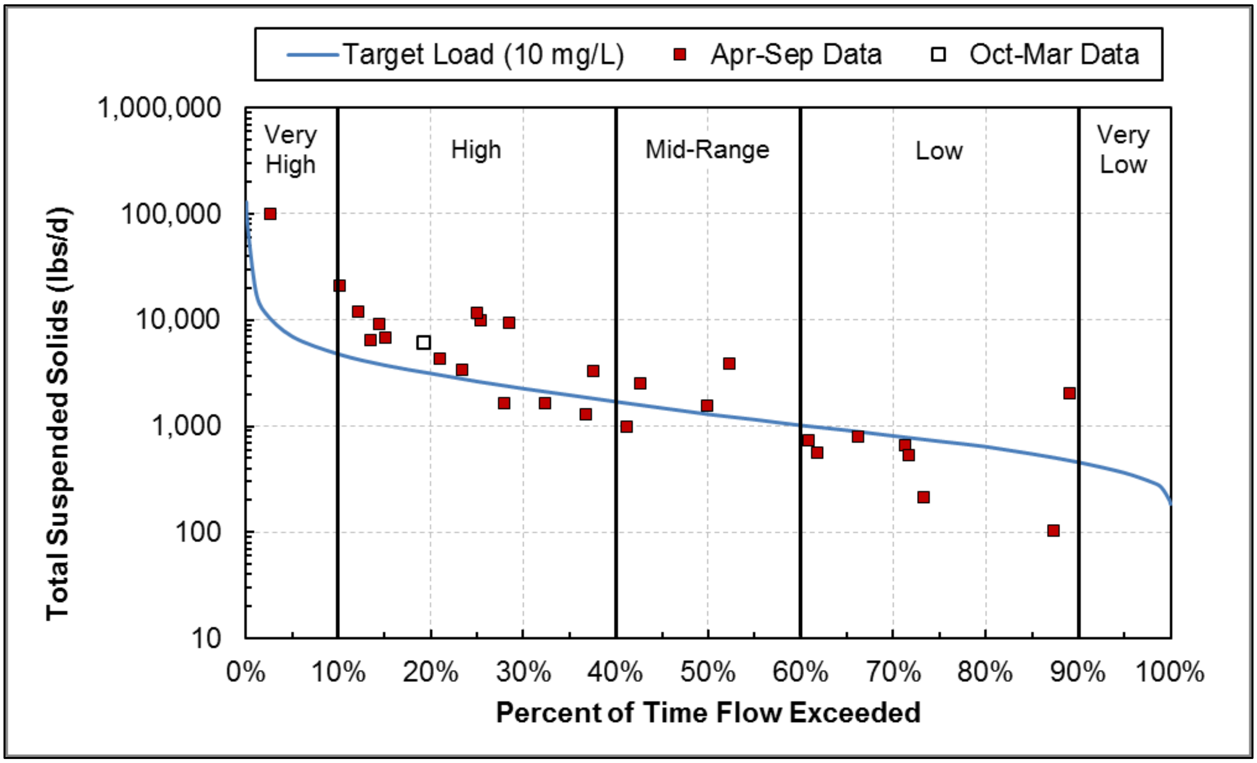


Figure 17. TSS load duration curve, Winnebago Creek (AUID 07060001-693).

Table 25. TSS TMDL summary, Winnebago Creek (AUID 07060001-693).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter		Flow zones				
		Very high	**High**	**Mid-range**	**Low**	**Very low**
		2,391-89 cfs	**88-32 cfs**	**31-20 cfs**	**19-8.6 cfs**	**8.5-3.4 cfs**
Sources		**TSS Load (lb/d)**				
Boundary Condition at Iowa State Line [a]		27	10	4.7	2.5	1.1
Wasteload	Construction Stormwater	1.2	0.44	0.21	0.11	0.047
	Industrial Stormwater	1.2	0.44	0.21	0.11	0.047
	Eitzen WWTP (MN0049531)	78	78	78	78	78
	Total WLA	80	79	78	78	78
Load	**Total LA**	6,161	2,282	1,081	567	247
MOS		697	263	129	72	36
Total load		6,965	2,634	1,293	720	362
Existing 90th percentile concentration (mg/L)		43				
TSS water quality standard (mg/L)		10				

Note: Existing TSS concentrations are more than 3 times higher than the water quality standard for Winnebago Creek. Estimated percent reduction to meet the TSS standard (10 mg/L) is approximately 77%. The overall estimated percent reduction needed to meet the TMDL was calculated as the existing concentration minus the TSS standard divided by the existing concentration. This calculation approximates the reduction in concentration needed to meet the standard. The percent reduction does not necessarily apply to each of the sources/allocations individually.

a. The boundary condition allocation is equal to the percent of the total watershed area in Iowa multiplied by the loading capacity minus the MOS minus wastewater WLAs.

5.2 Upper Iowa River Watershed

5.2.1 Upper Iowa River, -92.5901, 43.5985 to Little Iowa River (07060002-550)

5.2.1.1 *E. coli*

Table 26. Annual summary of *E. coli* data at Upper Iowa River (AUID 07060002-550; April–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	7	652	10	3,800	3	43
2009	7	548	10	4,900	3	43
2010	7	355	110	3,300	1	14
2011	6	286	63	780	0	–
2012	7	296	52	1,600	1	14
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	0	–	–	–	–	–
2016	0	–	–	–	–	–
2017	0	–	–	–	–	–

Table 27. Monthly summary of *E. coli* data at Upper Iowa River (AUID 07060002-550; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	4 [a]	73	10	500	0	–
May	5	73	10	270	0	–
Jun	5	623	160	1,700	2	40
Jul	5	777	190	3,300	1	20
Aug	5	787	550	1,300	1	20
Sep	5	1,007	490	2,200	2	40
Oct	5	654	85	4,900	2	40

a. Not enough samples to assess compliance with the monthly geometric mean standard.

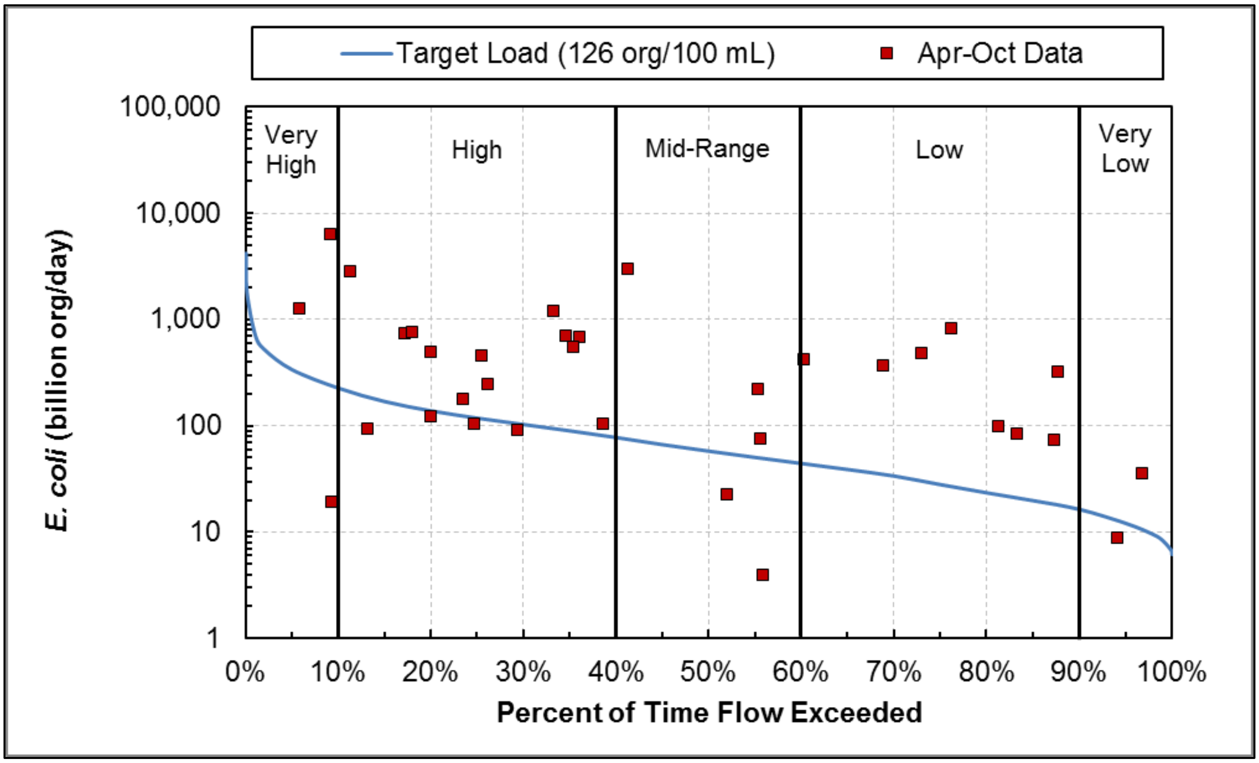


Figure 18. ***E. coli*** **load duration curve, Upper Iowa River (AUID 07060002-550).**

Table 28. ***E. coli*** **TMDL summary, Upper Iowa River (AUID 07060002-550).**

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter	Flow zones				
	Very high	**High**	**Mid-range**	**Low**	**Very low**
	1,348-74 cfs	**73-26 cfs**	**25-15 cfs**	**14-5.4 cfs**	**5.3-2.0 cfs**
Sources	***E. coli*** **load (B org/d)**				
Boundary Condition at Iowa State Line [a]	14	4.7	2.3	1.1	0.48
Total WLA	0	0	0	0	0
Total LA	288	101	50	24	10
MOS	34	12	5.8	2.8	1.2
Total load	336	118	58	28	12
Maximum monthly geomean (org/100 mL)	1,007				
Overall estimated percent reduction [b]	87%				

a. The boundary condition allocation is equal to the percent of the total watershed area in Iowa multiplied by the loading capacity minus the MOS.
b. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.2 Little Iowa River, 770th Ave to Upper Iowa River (07060002-548)

5.2.2.1 *E. coli*

Table 28. Annual summary of *E. coli* data at Little Iowa River (AUID 07060002-548; April–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	7	177	60	460	0	–
2009	7	111	20	610	0	–
2010	7	410	30	3,600	2	29
2011	5	247	52	830	0	–
2012	7	63	10	500	0	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	0	–	–	–	–	–
2016	0	–	–	–	–	–
2017	0	–	–	–	–	–

Table 29. Monthly summary of *E. coli* data at Little Iowa River (AUID 07060002-548; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	4 [a]	49	20	150	0	–
May	5	105	52	500	0	–
Jun	5	406	250	660	0	–
Jul	5	368	31	930	0	–
Aug	5	150	31	1,600	1	20
Sep	5	140	10	3,600	1	20
Oct	4 [a]	137	31	330	0	–

a. Not enough samples to assess compliance with the monthly geometric mean standard.

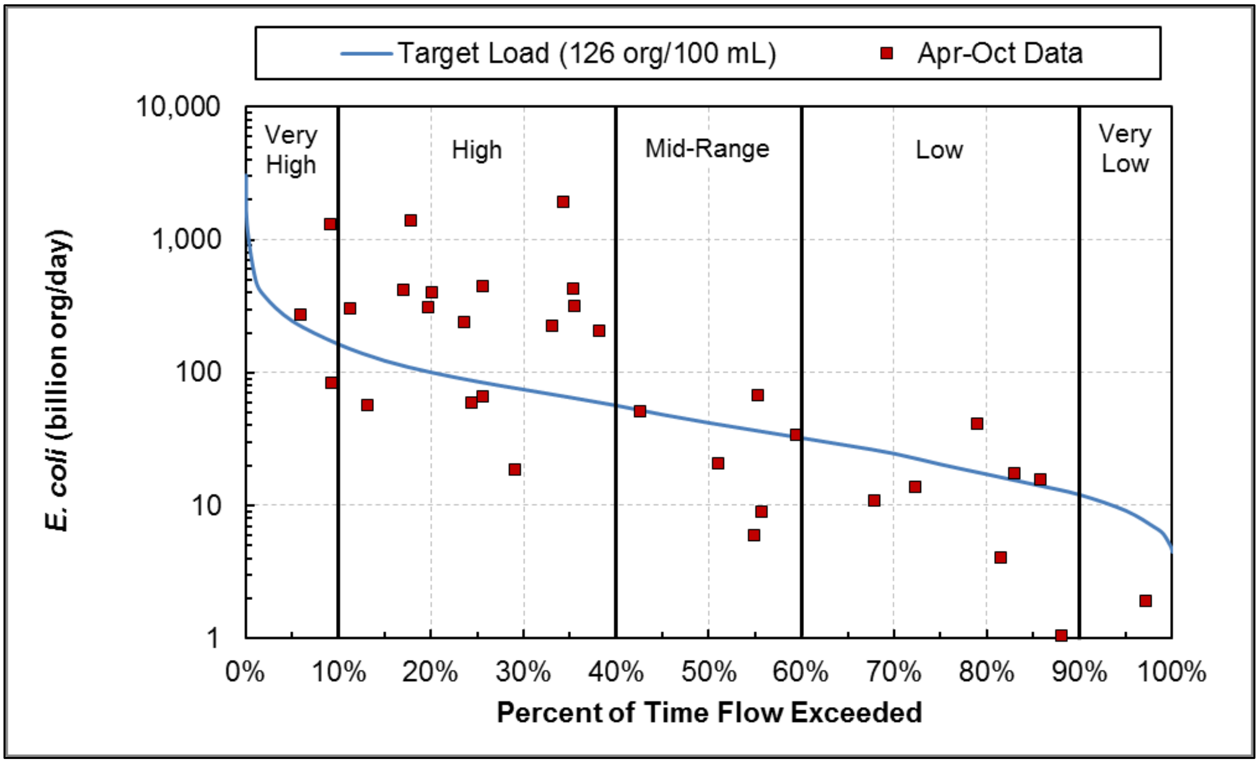


Figure 19. ***E. coli*** **load duration curve, Little Iowa River (AUID 07060002-548).**

Table 29. ***E. coli*** **TMDL summary, Little Iowa River (AUID 07060002-548).**

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter		Flow zones				
		Very high	High	Mid-range	Low	Very low
		998-54 cfs	53-19 cfs	18-12 cfs	11-4.0 cfs	3.9-1.5 cfs
Sources		*E. coli* load (B org/d)				
Wasteload	Total WLA	0	0	0	0	0
Load	Total LA	221	77	38	18	8.3
	MOS	25	8.6	4.2	2.0	0.92
	Total load	246	86	42	20	9.2
Maximum monthly geomean (org/100 mL)		406				
Overall estimated percent reduction [a]		69%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.3 Upper Iowa River, Little Iowa River to Beaver Creek (MN; 07060002-509)

5.2.3.1 E. coli

Table 30. Annual summary of *E. coli* data at Upper Iowa River (AUID 07060002-509; April–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	0	–	–	–	–	–
2009	0	–	–	–	–	–
2010	0	–	–	–	–	–
2011	0	–	–	–	–	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	9	277	100	1,220	0	–
2016	6	215	134	689	0	–
2017	0	–	–	–	–	–

Table 31. Monthly summary of *E. coli* data at Upper Iowa River (AUID 07060002-509; 2006–2015).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	0	–	–	–	–	–
May	0	–	–	–	–	–
Jun	5	250	134	1,220	0	–
Jul	5	270	100	689	0	–
Aug	5	233	121	816	0	–
Sep	0	–	–	–	–	–
Oct	0	–	–	–	–	–

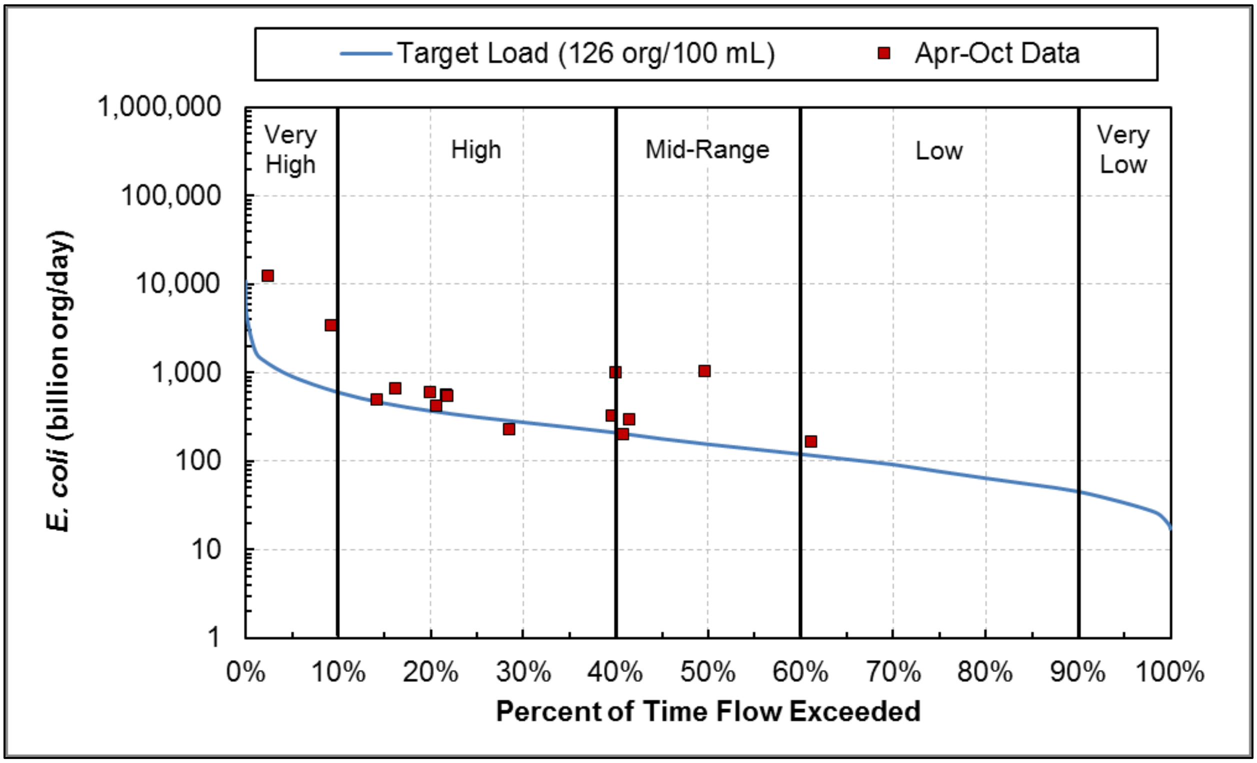


Figure 20. *E. coli* load duration curve, Upper Iowa River (AUID 07060002-509).

Table 32. *E. coli* TMDL summary, Upper Iowa River (AUID 07060002-509).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter		**Flow zones**				
		Very high	**High**	**Mid-range**	**Low**	**Very low**
		3,453-195 cfs	**194-69 cfs**	**68-40 cfs**	**39-16 cfs**	**15-5.6 cfs**
Sources		***E. coli* load (B org/d)**				
Boundary Condition at Iowa State Line [a]		254	87	42	20	8.2
Wasteload	Le Roy WWTP (MN0021041)	4.351	4. 351	4. 351	4. 351	4. 351
	Total WLA	4.4	4.4	4.4	4.4	4.4
Load	**Total LA**	557	192	94	45	18
MOS		91	32	16	7.7	3.4
Total load		906	315	156	77	34
Maximum monthly geomean (org/100 mL)		270				
Overall estimated percent reduction [b]		53%				

a. The boundary condition allocation is equal to the percent of the total watershed area in Iowa multiplied by the loading capacity minus the MOS minus wastewater WLAs.
b. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.4 Beaver Creek, Mower-Fillmore Rd to Upper Iowa River (07060002-546)

5.2.4.1 E. coli

Table 33. Annual summary of *E. coli* data at Beaver Creek (AUID 07060002-546; April–October).

Year		Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008		7	296	20	780	0	–
2009		7	233	30	1,200	0	–
2010		7	331	74	1,800	1	14
2011		6	257	10	1,000	0	–
2012		7	180	74	540	0	–
2013		0	–	–	–	–	–
2014		0	–	–	–	–	–
2015		0	–	–	–	–	–
2016		0	–	–	–	–	–
2017		0	–	–	–	–	–

Table 34. Monthly summary of *E. coli* data at Beaver Creek (AUID 07060002-546; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	4 [a]	105	30	500	0	–
May	5	51	10	230	0	–
Jun	5	406	200	1,000	0	–
Jul	5	680	400	1,200	0	–
Aug	5	306	84	710	0	–
Sep	5	321	120	1,800	1	20
Oct	5	397	240	760	0	–

a. Not enough samples to assess compliance with the monthly geometric mean standard.

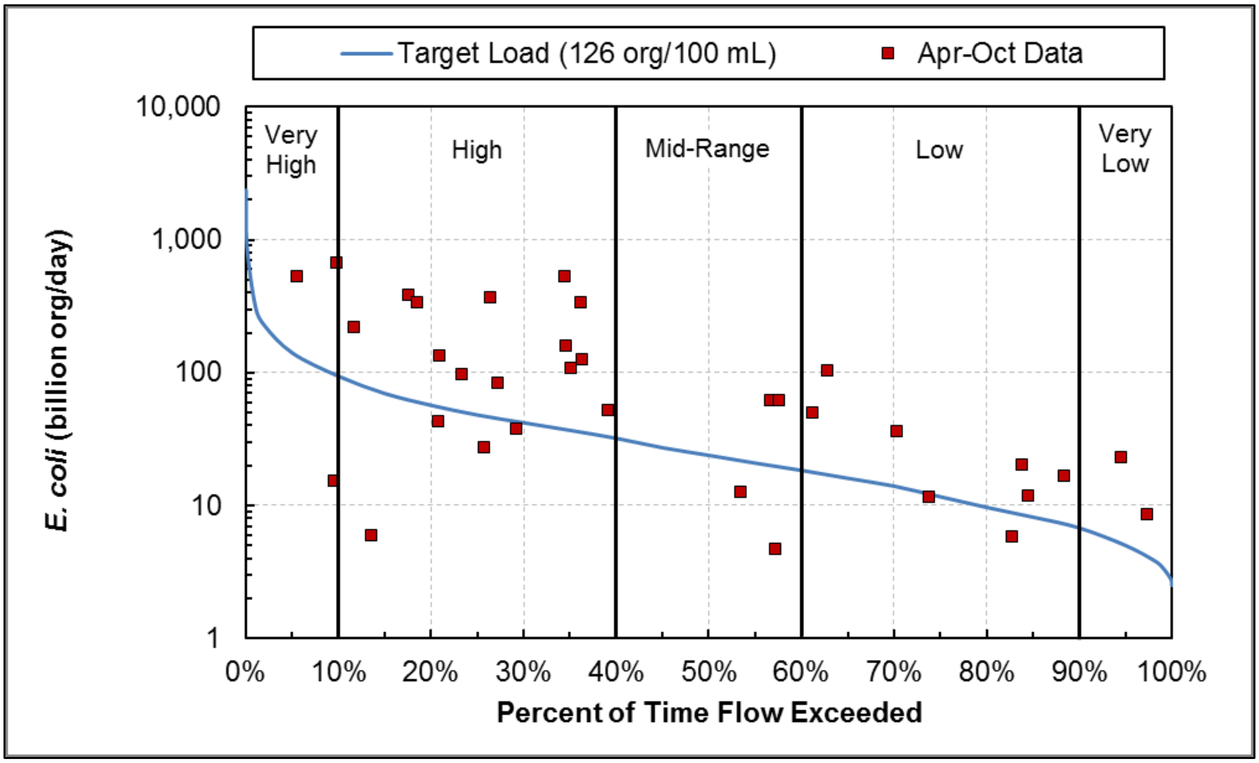


Figure 21. *E. coli* load duration curve, Beaver Creek (AUID 07060002-546).

Table 35. *E. coli* TMDL summary, Beaver Creek (AUID 07060002-546).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter	Flow zones				
	Very high	High	Mid-range	Low	Very low
	766-31 cfs	30-11 cfs	10-6.0 cfs	5.9-2.3 cfs	2.2-0.8 cfs
Sources	***E. coli* load (B org/d)**				
Total WLA	0	0	0	0	0
Total LA	126	43	22	11	4.5
MOS	14	4.8	2.4	1.2	0.50
Total load	140	48	24	12	5.0
Maximum monthly geomean (org/100 mL)	680				
Overall estimated percent reduction [a]	81%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.5 Pine Creek, T101 R10W S24, north line to MN/IA border (07060002-512)

The *E. coli* TMDL target for Pine Creek (07060002-512), which is a class 7 waterbody, is 126 org/100 mL. This TMDL target is based on the more restrictive downstream standard in Iowa (see report Section 2.2). The *E. coli* data summary tables (37 and 38) use the class 7 Minnesota standard (monthly geometric mean: 630 org/100 mL and individual sample: 1,260 org/100 mL) to evaluate exceedances of the standard.

5.2.5.1 *E. coli*

Table 37. Annual summary of *E. coli* data at Pine Creek (AUID 07060002-512; May–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	0	–	–	–	–	–
2009	0	–	–	–	–	–
2010	0	–	–	–	–	–
2011	0	–	–	–	–	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	9	986	712	≥ 2,420	1	11
2016	6	550	393	1,046	0	–
2017	0	–	–	–	–	–

Table 38. Monthly summary of *E. coli* data at Pine Creek (AUID 07060002-512; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 630 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months May–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
May	0	–	–	–	–	–
Jun	5	651	393	1,220	0	–
Jul	5	736	488	1,046	0	–
Aug	5	993	411	≥ 2,420	1	20
Sep	0	–	–	–	–	–
Oct	0	–	–	–	–	–

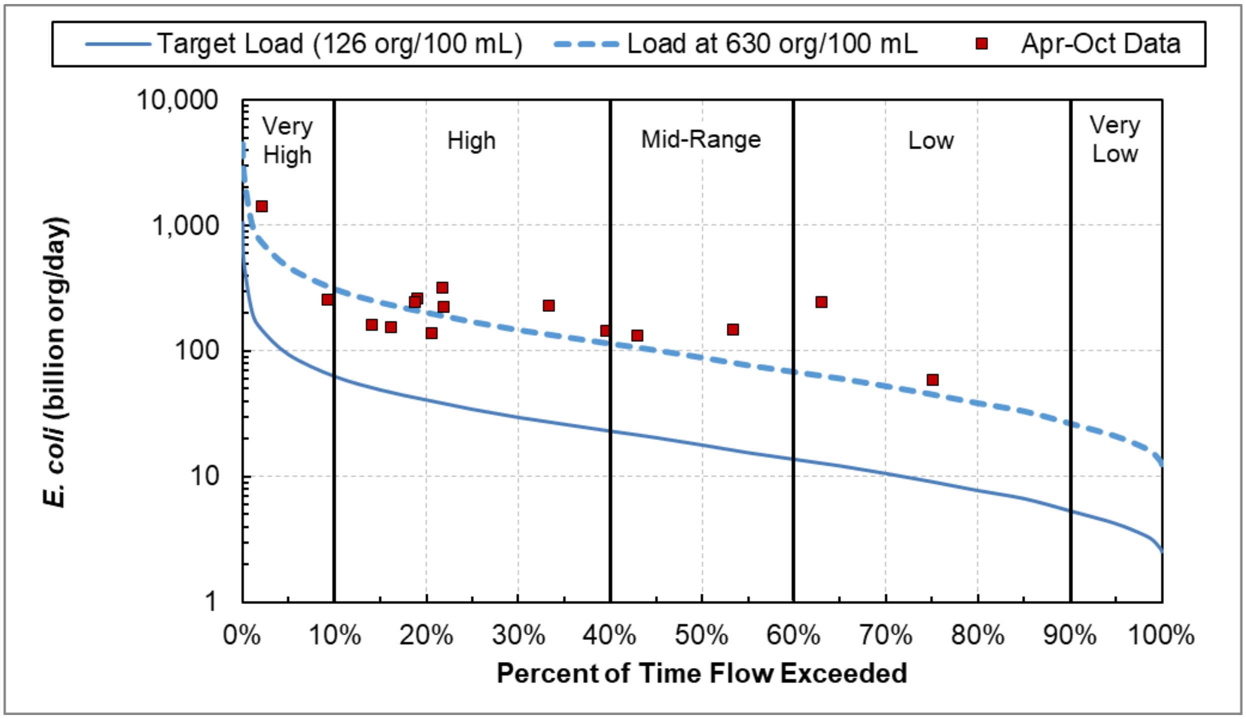


Figure 22. *E. coli* load duration curve, Pine Creek (AUID 07060002-512).

A load duration curve is provided for both the Minnesota class 7 water quality standard (630 org/100 ml) and the more restrictive downstream water quality standard in Iowa (126 org/100 mL). See Section 2.2 for more information. The more restrictive target is used to develop the TMDL table below.

Table 39. *E. coli* TMDL summary, Pine Creek (AUID 07060002-512).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**
- **Water quality target: 126 org/100 mL**

TMDL parameter		Flow zones				
		Very high	**High**	**Mid-range**	**Low**	**Very low**
		341-21 cfs	**20-7.6 cfs**	**7.5-4.5 cfs**	**4.4-1.8 cfs**	**1.7-0.8 cfs**
Sources		***E. coli* load (B org/d)**				
Wasteload	Harmony WWTP (MN0022322)	0.93	0.93	0.93	0.93	0.93
	Total WLA	0.93	0.93	0.93	0.93	0.93
Load	**Total LA**	83	30	15	7.3	2.8
MOS		9.3	3.4	1.8	0.91	0.42
Total load		93	34	18	9.1	4.2
Maximum monthly geomean (org/100 mL)		993				
Overall estimated percent reduction [a]		87%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.6 Bear Creek, Unnamed cr to MN/IA border (07060002-503)

5.2.6.1 *E. coli*

The *E. coli* TMDL target for Bear Creek (07060002-503), which is a class 7 waterbody, is 126 org/100 mL. This TMDL target is based on the more restrictive downstream standard in Iowa (see report Section 2.2). The *E. coli* data summary tables (36 and 37) use the class 7 Minnesota standard (monthly geometric mean: 630 org/100 mL and individual sample: 1,260 org/100 mL) to evaluate exceedances of the standard.

Table 36. Annual summary of *E. coli* data at Bear Creek (AUID 07060002-503; May–October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	0	–	–	–	–	–
2009	0	–	–	–	–	–
2010	0	–	–	–	–	–
2011	0	–	–	–	–	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	9	1,387	411	5,172	5	56
2016	6	494	365	613	0	–
2017	0	–	–	–	–	–

Table 37. Monthly summary of *E. coli* data at Bear Creek (AUID 07060002-503; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 630 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months May–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
May	0	–	–	–	–	–
Jun	5	1,488	461	5,172	3	60
Jul	5	875	517	≥ 2,420	2	40
Aug	5	593	365	980	0	–
Sep	0	–	–	–	–	–
Oct	0	–	–	–	–	–

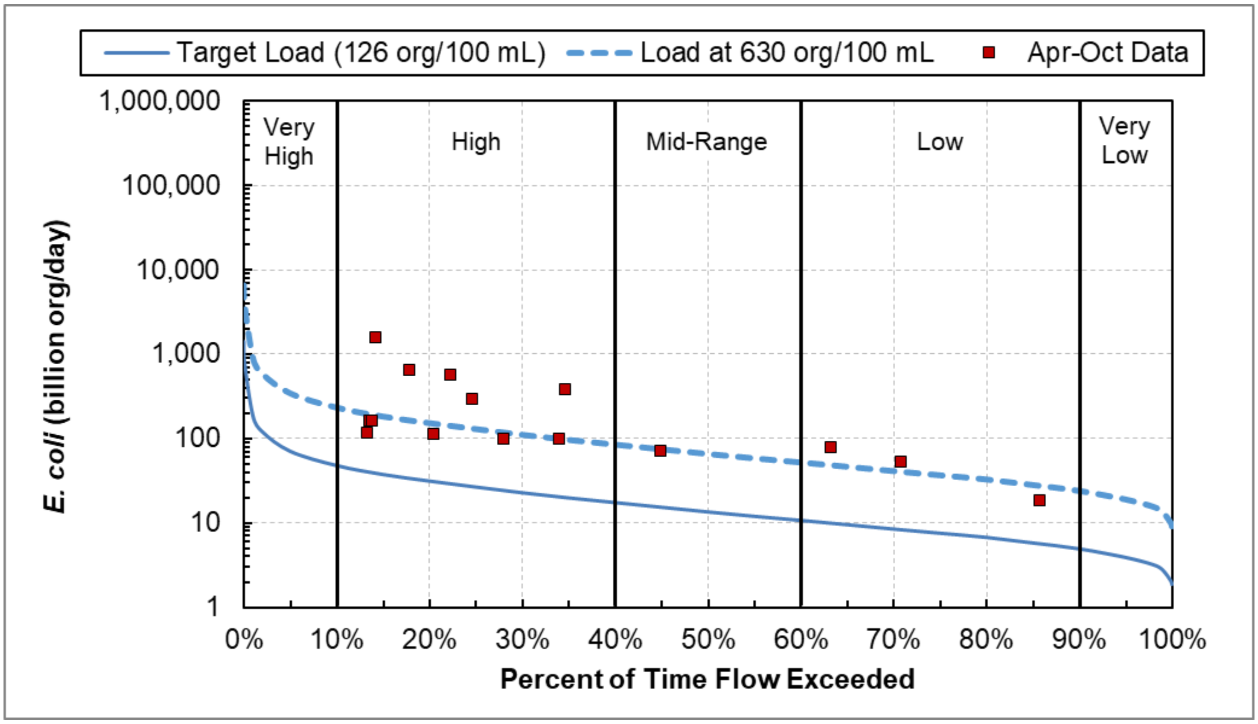


Figure 23. *E. coli* load duration curve, Bear Creek (AUID 07060002-503).
A load duration curve is provided for both the Minnesota class 7 water quality standard (630 org/100 ml) and the more restrictive downstream water quality standard in Iowa (126 org/100 mL). See Section 2.2 for more information. The more restrictive target is used to develop the TMDL table below.

Table 38. *E. coli* TMDL summary, Bear Creek (AUID 07060002-503).

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**
- **Water quality target: 126 org/100 mL**

TMDL parameter		**Flow zones**				
		Very high	**High**	**Mid-range**	**Low**	**Very low**
		450-16 cfs	**15-5.7 cfs**	**5.6-3.5 cfs**	**3.4-1.7 cfs**	**1.6-0.6 cfs**
Sources		***E. coli* load (B org/d)**				
Wasteload	Spring Grove WWTP (MN0021440)	1.80	1.80	1.80	1.80	1.80
	Total WLA	1.8	1.8	1.8	1.8	1.8
Load	**Total LA**	61	22	9.9	4.9	1.7
MOS		7.0	2.6	1.3	0.75	0.39
Total load		70	26	13	7.5	3.9
Maximum monthly geomean (org/100 mL)		1,488				
Overall estimated percent reduction [a]		92%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

5.2.7 Bee Creek (Waterloo Creek), T101 R6W S29, north line to MN/IA border (07060002-515)

5.2.7.1 *E. coli*

Table 39. Annual summary of *E. coli* data at Bee Creek (Waterloo Creek) (AUID 07060002-515; April - October).

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
2008	0	–	–	–	–	–
2009	0	–	–	–	–	–
2010	17	998	36	2,139,392	6	35
2011	10	62	10	645	0	–
2012	0	–	–	–	–	–
2013	0	–	–	–	–	–
2014	0	–	–	–	–	–
2015	0	–	–	–	–	–
2016	0	–	–	–	–	–
2017	0	–	–	–	–	–

Table 40. Monthly summary of *E. coli* data at Bee Creek (Waterloo Creek) (AUID 07060002-515; 2008–2017).
Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples. Standard applies only to months April–October.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Standard Exceedances	Percent of Individual Standard Exceedances
Apr	0	–	–	–	–	–
May	3 [a]	1,023	80	121,716	1	33
Jun	5	104	23	708	0	–
Jul	5	658	42	29,083	2	40
Aug	4 [a]	53	36	66	0	–
Sep	6	3,728	47	2,139,392	3	50
Oct	4 [a]	72	10	589	0	–

a. Not enough samples to assess compliance with the monthly geometric mean standard.

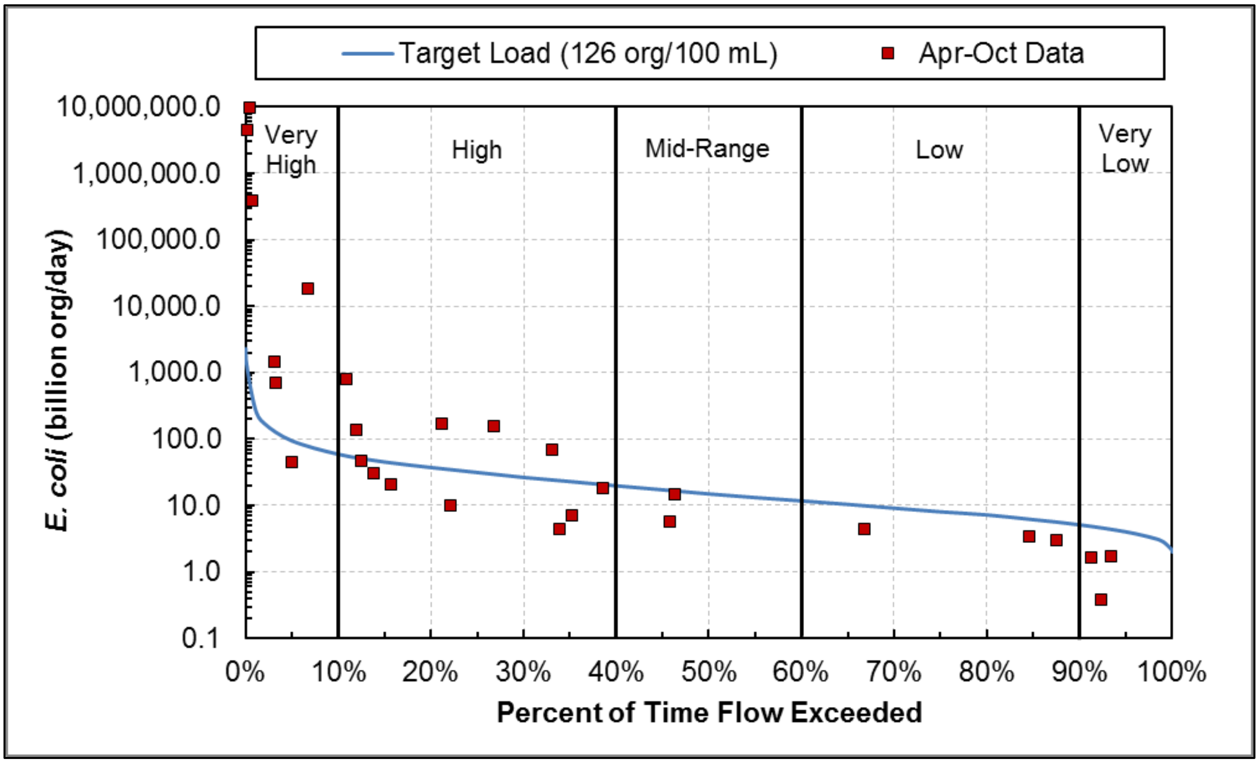


Figure 24. ***E. coli*** **load duration curve, Bee Creek (Waterloo Creek) (AUID 07060002-515).**

Table 41. ***E. coli*** **TMDL summary, Bee Creek (Waterloo Creek) (AUID 07060002-515).**

- **303(d) listing year or proposed year: 2018**
- **Baseline year: 2012**

TMDL parameter	Flow zones				
	Very high	High	Mid-range	Low	Very low
	728-20 cfs	19-6.6 cfs	6.5-3.9 cfs	3.8-1.8 cfs	1.7-0.7 cfs
Sources	***E. coli*** **load (B org/d)**				
Total WLA	0	0	0	0	0
Total LA	85	29	14	7.3	3.7
MOS	9.4	3.2	1.5	0.81	0.41
Total load	94	32	15	8.1	4.1
Maximum monthly geomean (org/100 mL)	3,728				
Overall estimated percent reduction [a]	97%				

a. Calculated by comparing the highest observed (monitored) monthly geometric mean concentration from the months that the standard applies to the geometric mean standard, as a concentration, (monitored – standard/monitored). See Section 4.7.1 for more information.

6. Future growth considerations

Land use in the watersheds is predominantly agricultural and forested, with small cities and towns dispersed throughout. Fillmore, Mower, and Houston counties are projected to increase in population by 11%, 22%, and 8%, respectively (Minnesota Forest Resource Council 2014).

6.1 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 project watershed boundaries.

1. One or more non-regulated MS4s become regulated. A transfer must occur from the LA.
2. A new MS4 or other stormwater-related point source is identified and is covered under an NPDES Permit. In this situation, a transfer must occur from the LA.

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

6.2 New or expanding wastewater

The MPCA, in coordination with the EPA Region 5, developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to waterbodies with an EPA approved TMDL (described in Section 3.7.1 *New and Expanding Discharges* in 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.

7. 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 pollutant loading in the UIR and MRR watersheds, already required point source controls will be effective in improving water quality if accompanied by considerable reductions in nonpoint source loading. Reasonable assurance for permitted sources such as stormwater, CAFOs, and wastewater is provided via compliance with their respective NPDES permit programs, as described in Section 3.5.

Reasonable assurance for non-NPDES-permitted sources discussed in Section 3.5 includes supporting evidence that there:

- are reliable means for addressing pollutant loads (i.e., BMPs and pollution reduction programs) (see Section 7.1 *Non-NPDES-permitted source reduction programs* and 7.2 *Example non-NPDES-permitted source reduction projects and partners*)
- are reliable means for prioritizing and focusing management (see Section 7.1.1 *Root River* 1W1P)
- is a strategy for implementation (see Section 9 *Implementation strategy summary* and the UIR and MRR Watershed WRAPS (Tetra Tech 2019)
- are available funds to execute projects (see Section 7.3 *Funding availability*)
- is a system of tracking progress and monitoring water quality response (see Sections 8 *Monitoring plan* and 9.5.1 *Adaptive management)*
- are non-point source reduction projects at multiple scales (see Section 7.2 *Example non-NPDES-permitted source reduction projects and partners*)

Reasonable assurance of these six elements is provided by the numerous nonpoint source reduction programs, local planning efforts, funding sources, and the project implementation efforts of partners and participating organizations that continue to work towards improving water quality in the UIR and MRR watersheds as described in the following sections. The goals and objectives for the UIR and MRR Watershed TMDLs are consistent with state-wide source reduction programs and the Root River 1W1P, and will be incorporated into the MPCA’s WRAPS report for the watersheds.

7.1 Examples of non-NPDES-permitted source reduction programs and plans

Several non-NPDES-permitted reduction programs and plans exist to support implementation of nonpoint sediment and *E. coli* reduction BMPs in the UIR and MRR watersheds. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or provide dedicated funding. The following examples describe large-scale programs that have proven to be effective and/or will reduce sediment and *E. coli l*oads going forward.

7.1.1 Root River One Watershed, One Plan

Minnesota has a long history of water management by local governments. 1W1P is rooted in this history and in work initiated by the Minnesota Local Government Water Roundtable (an affiliation of the Association of Minnesota Counties, Minnesota Association of Watershed Districts, and Minnesota Association of Soil and Water Conservation Districts [SWCD]). Roundtable members recommended that the local governments charged with water management responsibility organize and develop focused implementation plans on a watershed scale.

The recommendation was followed by legislation that authorizes the Board of Water and Soil Resources (BWSR) to adopt methods to allow comprehensive plans, local water management plans, or watershed management plans to serve as substitutes for one another or to be replaced with one comprehensive watershed management plan. This legislation is referred to as "1W1P" (Minn. Stat. §103B.101, subd. 14). Further legislation defining purposes and outlining additional structure for 1W1P, officially known as the Comprehensive Watershed Management Planning Program (Minn. Stat. § 103B.801), was passed in May 2015.

BWSR's vision for 1W1P is to align local water planning on major watershed boundaries with state strategies towards prioritized, targeted, and measurable implementation plans—the next logical step in the evolution of water planning in Minnesota and an important component of the reasonable assurance framework. The Root River 1W1P (Root River Planning Partnership 2016) was finalized in December 2016 and encompasses the UIR and MRR watersheds TMDL project area, in addition to the entire Root River Watershed to the north. Participants in the Root River 1W1P are able to track BMP implementation through BWSR's conservation tracking system eLINK. Practices recorded in eLINK from 2004 through 2017 are provided in Figure 25 for the UIR Watershed and Figure 26 for the MRR Watershed. This data is accessible through MPCA's Healthier Watersheds webpage: https://www.pca.state.mn.us/water/best-management-practices-implemented-watershed.

The 1W1P does not directly address the impaired streams in this TMDL, as they were not listed on the impaired waters list at the time of 1W1P development. However, the TMDL and WRAPS will be incorporated into the 1W1P at the five-year review scheduled to occur in 2021.

Figure 25. Number of BMPs reported as implemented for the Upper Iowa River Watershed from 2004–2018 (MPCA 2019b).

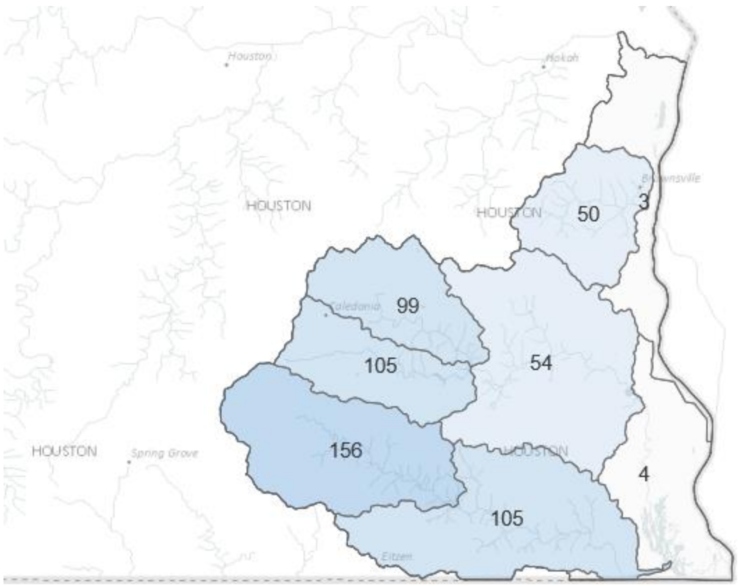


Figure 26. Number of BMPs reported as implemented in the Mississippi River–Reno Watershed from 2004–2018 (MPCA 2019b).

7.1.2 MPCA feedlot program

The MPCA Feedlot Program implements rules governing the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes. Minn. R. ch. 7020 regulates feedlots in the state of Minnesota. All feedlots capable of holding 50 or more AUs, or 10 in shoreland areas, are subject to this rule. A feedlot holding 1,000 or more AUs is permitted in the state of Minnesota. The focus of the rule is on animal feedlots and manure storage areas that have the greatest potential for environmental impact.

The Feedlot Program is implemented through a cooperation between MPCA and county governments in 50 counties in the state. The MPCA works with county representatives to provide training, program oversight, policy and technical support, and formal enforcement support when needed. County feedlot officers in Fillmore, Houston, and Mower counties administer the feedlot program. The MPCA is responsible for the CAFOs in these counties.

7.1.3 SSTS implementation and enforcement

SSTS are regulated through Minn. Stat. §§ 115.55 and 115.56. Regulations include:

- Minimum technical standards for individual and mid-size SSTS
- A framework for local units of government to administer SSTS programs

- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee
- Various ordinances for septic installation, maintenance, and inspection

In 2008, the MPCA amended and adopted rules concerning the governing of SSTS. In 2010, the MPCA was mandated to appoint a SSTS Implementation and Enforcement Task Force. Members of the task force include representatives from the Association of Minnesota Counties, Minnesota Association of Realtors, Minnesota Association of County Planning and Zoning Administrators, and the Minnesota Onsite Wastewater Association. The group was tasked with:

- Developing effective and timely implementation and enforcement methods to reduce the number of SSTS that are an ITPHS and enforce all violation of the SSTS rules (see MPCA 2011b)
- Assisting MPCA in providing counties with enforcement protocols and inspection checklists

Currently, a system is in place in the state such that when a straight pipe system or other ITPHS location is confirmed, county health departments send notices of non-compliance. Upon doing do, a 10-month deadline is set for the system to be brought into compliance. All known ITPHS are recorded in a statewide database by the MPCA. From 2006 to 2017, 742 straight pipes were tracked by the MPCA statewide. Seven hundred-one of those were abandoned, fixed, or were found not to be a straight pipe system. There have been 17 Administrative Penalty Orders issued and docketed in court. The remaining straight pipe systems received a notification of non-compliance and are currently within the 10-month deadline. The MPCA, through the Clean Water Partnership Loan Program, awarded $2.45 million to local partners to provide low interest loans for SSTS upgrades in 2016. More information on SSTS financial assistance can be found on the MPCA’s website.

7.1.4 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. ch. 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 allow landowners to be granted a compliance waiver until July 1, 2018, when they have filed a compliance plan with the SWCD.

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 on the state's *Minnesota Buffer Law* website. Table 422 summarizes the level of compliance estimates, as of July 2018, for counties located in the UIR and MRR watersheds. All counties in the UIR and MRR watersheds were found to have high compliance rates.

Table 42. Preliminary compliance with Minnesota Buffer Law as of January 2019 (BWSR).

County	Preliminary Compliance with MN Buffer Law (%)
Fillmore	95–100
Houston	95–100
Mower	90–94

7.1.5 Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect waters. Those who implement and maintain approved farm management practices are certified and in turn obtain regulatory certainty for a period of 10 years.

Through this program, certified producers receive:

- **Regulatory certainty**: Certified producers are deemed to be in compliance with any new water quality rules or laws during the period of certification.
- **Recognition**: Certified producers may use their status to promote their business as protective of water quality.
- **Priority for assistance**: Producers seeking certification can obtain specially designated technical and financial assistance to implement practices that promote water quality.

Through this program, the public receives assurance that certified producers are using conservation practices to protect Minnesota's lakes, rivers, and streams. As of August 2019, over 500,000 acres on 772 farms have been certified in the state, with many additional acres under review.

7.1.6 Minnesota's soil erosion law

Minnesota's soil erosion law is found in Minn. Stat. §§ 103F.401 through 103F.455. The law, which dates back to 1984, sets forth a strong public policy stating that a person may not cause excessive soil loss. The law was entirely permissive, however, in that it only encouraged local governments to adopt soil erosion ordinances and could not be implemented without a local government ordinance. The soil erosion law was changed in 2015 when a number of revisions were made by the Legislature and approved by the Governor to broaden its applicability.

Minnesota Laws 2015, regular and first special sessions changed the law by (1) repealing Minn. Stat. 103F.451, "Applicability," which eliminates the requirement that the law is only applicable with a local government ordinance; (2) creating specific Administrative Penalty Order authority in Minn. Stat. 103B.101, subd. 12a. for BWSR and counties to enforce the law; and 3) amending Minn. Stat. 103F.421, "Enforcement," to remove local enforcement only through civil penalty, and to revise requirements for state cost-share of conservation practices required to correct excessive soil loss. By definition, *excessive* *soil loss* means soil loss that is greater than established soil loss limits or evidenced by sedimentation on adjoining land or in a body of water. The result of the combined changes now sets forth statewide regulation of excessive soil loss regardless of whether a local government has a soil loss ordinance (BWSR 2016).

7.1.7 Minnesota Nutrient Reduction Strategy

The Minnesota Nutrient Reduction Strategy ([NRS] MPCA 2014) calls for activities that support nitrogen and phosphorus reductions in Minnesota waterbodies and those downstream of the state (e.g., Lake Winnipeg, Lake Superior, and the Gulf of Mexico). While the strategies outlined in the NRS primarily target nutrients, many also reduce sediment and/or *E. coli* loading to surface waters. For example, agricultural practices such as cover crops target sediment-bound phosphorus by reducing erosion, and improvements to septic systems reduce nutrient and *E. coli* loading. The NRS was developed by an interagency coordination team with help from public input. Fundamental elements of the NRS include:

- Defining progress with clear goals
- Building on current strategies and success
- Prioritizing problems and solutions
- Supporting local planning and implementation
- Improving tracking and accountability

Included in the strategy discussion are alternatives and tools for consideration by drainage authorities, information on available tools and approaches for identifying areas of phosphorus and nitrogen loading and tracking efforts within a watershed, and additional research priorities. The NRS is focused on incremental progress and provides meaningful and achievable nutrient load reduction milestones that allow for better understanding of incremental and adaptive progress toward final goals. It has set a reduction of 45% for both phosphorus and nitrogen in the Mississippi River.

Successful implementation of the NRS will require broad support, coordination, and collaboration among agencies, academia, local government, landowners and private industry. The MPCA is implementing a framework to integrate its water quality management programs on a major watershed scale, a process that includes:

- Intensive watershed monitoring
- Assessment of watershed health
- Development of WRAPS reports
- Management of NPDES and other regulatory and assistance programs

This framework and the implementation efforts it calls for will result in nutrient reduction for the basin as a whole and the major watersheds in the basin.

7.1.8 Conservation Easements and Reinvest in Minnesota Reserve

The Reinvest in Minnesota (RIM) Reserve was created in 1986 through the enactment of the RIM Resources Act. RIM Reserve is the primary land acquisition program for state-held conservation easements, wetland restoration, and native grassland restoration on private land in Minnesota, and aims to restore marginal and environmentally sensitive agricultural land to protect soil, water quality, and fish and wildlife habitat. The program partners with public and private landowners; state, federal, and local government entities; non-profit organizations; and the citizens of Minnesota. When private landowners participate, the land is acquired through BWSR on behalf of the state and placed under permanent easement. The RIM Reserve provides the funds to compensate participating landowners. Statewide participation in the RIM Reserve program through February 2019 is provided in Figure 27.

In addition, BWSR regularly tracks conservation easements throughout the state. Table 43 provides a summary of the acres within Fillmore, Houston, and Mower counties that are currently in easements.

Table 43. Conservation lands summary for Fillmore, Houston, and Mower counties (BWSR 2018).

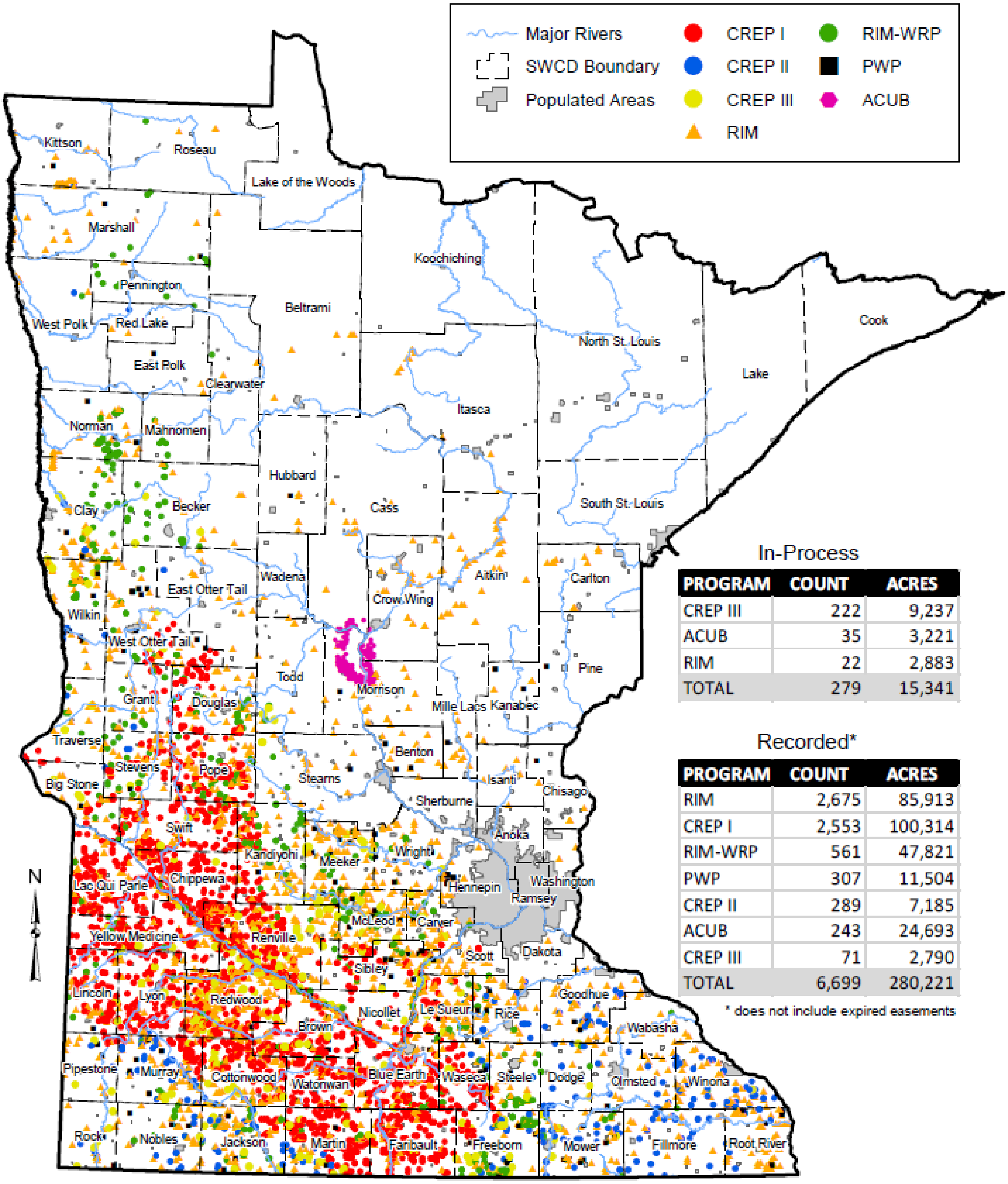
County	Conservation Lands Summary (acres)						Cropland Acres	Percent Enrolled
	CRP	CREP	RIM	RIM WRP	WRP	Total		
Fillmore	17,864	308	461	0	0	18,633	350,144	5.3%
Houston	11,027	188	2330	0	208	13,753	147,571	9.3%
Mower	8,666	726	1,325	601	658	11,976	384,388	3.1%

CRP: Conservation Reserve Program
CREP: Conservation Reserve Enhancement Program
RIM: Reinvest in Minnesota
WRP: Wetlands Reserve Program

BWSR

Reinvest in Minnesota (RIM) Reserve Conservation Easements (by Type)

Active Easements through February 7, 2019



In-Process

PROGRAM	COUNT	ACRES
CREP III	222	9,237
ACUB	35	3,221
RIM	22	2,883
TOTAL	279	15,341

Recorded*

PROGRAM	COUNT	ACRES
RIM	2,675	85,913
CREP I	2,553	100,314
RIM-WRP	561	47,821
PWP	307	11,504
CREP II	289	7,185
ACUB	243	24,693
CREP III	71	2,790
TOTAL	6,699	280,221

* does not include expired easements

Figure 27. Reinvest in Minnesota Reserve conservation easements by type.

7.2 Example non-NPDES-permitted source reduction projects and partners

Numerous local partners are active within the project area. In addition to the state-wide programs listed above, several non-NPDES-permitted source reduction projects that are located in the watershed or influence the watershed were completed in recent years. The following are examples by participating organization.

7.2.1 1W1P Committees

To support continued implementation of the Root River 1W1P, the three committees created for the development of the plan (Advisory, Policy, and Planning Committees) meet on a regular basis to implement recommendations from the 1W1P. The committees are made up of county and SWCD representatives, BWSR representatives, community members, and several others. Numerous projects were identified by these committees for the UIR and MRR watershed portions of the Root River 1W1P. They include:

- Water storage efforts in the Bee Creek Subwatershed
- U.S. Fish and Wildlife Service wetland restoration work in the MRR Watershed
- Easement acquisitions in Winnebago and Crooked Creek subwatersheds
- DNR led geomorphology work in the Crooked and Bee Creek subwatersheds
- A planned channel restoration on a Winnebago Creek tributary with support from DNR, townships, and the county

7.2.2 Fillmore, Mower, and Root River Soil and Water Conservation Districts

Fillmore, Mower, and the Root River (located in Houston County) SWCDs are active partners in the UIR and MRR watersheds. Their recent work includes but is not limited to:

- The Root River Field to Stream Partnership is a water monitoring project in southeast Minnesota, funded by the Minnesota Clean Water Land and Legacy Amendment. Partners include Fillmore and Mower SWCDs and the Minnesota Department of Agriculture, the Minnesota Agricultural Water Resource Center, the Nature Conservancy, Monsanto, and academic researchers. The partnership was founded in 2009 and conducts intensive surface and groundwater monitoring at multiple scales in order to provide an assessment of pollution loads and sources and determine the effectiveness of conservation practices. Since 2016, 90 grassed waterways, 13 water and sediment control structures, 200 acres of cover crops, 74 acres of conservation reserve pollinator habitat, and 5,000 feet of new or renovated waterways were put in place through the project. Edge of field and in-stream monitoring will be used to determine water quality impacts from these practices.
- A buffer compliance plan for Fillmore County checks one third of the county every year for compliance, completes a random spot check via aerial photos, and conducts on-site reviews on 5% of parcels each year.

- Fillmore County has a soil loss ordinance in place to sustain the productive capacity of the soil that requires farming practices to be implemented that reduce soil loss to no more than is necessary.
- Several events are held in the counties:
    - Root River SWCD held a soil health field day in April of 2018 in Spring Grove, Minnesota
    - Mower SWCD hosted a “Cover Crops 101” workshop in January 2019 and a field day focused on cover crops in November 2018 for local producers
    - Each SWCD hosts annual rain barrel and/or tree sales
    - Each SWCD sponsors the Envirothon educational competition event for local junior high and high school students.

More information on their work can be found on the SWCD websites.

7.2.3 Crooked Creek Watershed District

The Crooked Creek Watershed District plays an active role in the water retention and flood control efforts in Crooked Creek in addition to other water quality improvement projects. Their work includes but is not limited to property easements for flood storage and control projects, funding private land owner projects to stabilize streambanks, and invasive weed control and removal.

7.2.4 Upper Iowa River Alliance and Watershed Management Authority

The UIR Alliance is a nonprofit organization in the Iowa portion of the larger UIR Watershed. Their mission is to promote, protect, and enhance the UIR, and they work alongside the UIR Watershed Management Authority, which is composed of representatives from cities, counties, and SWCDs in Iowa. While outside of Minnesota’s jurisdiction, these Iowa partners have participated in this TMDL project and efforts have been made to coordinate projects between the two states. These organizations and their partners have completed a significant amount of work within the UIR Watershed, including the development of the UIR *Watershed Assessment and Management Strategies* (The UIR Watershed Project 2005) and completing a survey to research farmer’s opinions on conservation practices (Sand 2004). More information on these plans, programs, and projects can be found at their homepage.

7.3 Funding availability

Local partner projects listed above demonstrate a reasonable assurance that local partners are capable of acquiring funding for watershed management projects. Potential state and federal funds available to the various watershed entities include grants from Clean Water, Land and Legacy funds, EPA’s CWA Section 319 Grant Program for States and Territories, and various Natural Resources Conservation Service programs. Because the Root River 1W1P is complete, the watershed planning area that includes the UIR and MRR watersheds receives “automatic” watershed based implementation funding each biennium from the Clean Water Fund. The area received over $850,000 in the 2018 - 2019 biennium, and will receive a similar amount for the 2020 - 2021 biennium. Local sources of funding for counties and other organizations may include county taxes, levies, and fees. In some cases, these local financial resources provide funding for significant water quality and quantity improvement projects, local grants, staff, monitoring, and engineering costs.

7.4 Summary

In summary, significant time and resources have been devoted to identifying the best BMPs, providing means of focusing them in the UIR and MRR watersheds, and supporting their implementation via state initiatives and dedicated funding. The UIR and MRR WRAPS and TMDLs, and the Root River 1W1P processes 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. 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 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.*

8. Monitoring plan

This monitoring plan provides an overview of what is expected to occur at many scales in multiple watersheds in the UIR and MRR watersheds. The designated uses aquatic life, aquatic recreation, and limited resource value will be the ultimate measures of water quality. Improving these designated uses depends on many factors, and improvements may not be detected over the next 5 to 10 years. Consequently, a monitoring plan is needed to track shorter term changes in water quality and land management. Monitoring is important for several reasons:

- Evaluating waterbodies to determine if they are meeting water quality standards and tracking trends
- Assessing potential sources of pollutants
- Determining the effectiveness of implementation activities in the watershed
- Delisting of waters that are no longer impaired

Monitoring is also a critical component of an adaptive management approach and can be used to help determine when a change in management is needed. Several types of monitoring will be important to measuring success. The six basic types of monitoring listed below are based on the EPA's *Protocol for Developing Sediment TMDLs* (EPA 1999).

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.

Implementation monitoring—tracks implementation of sediment reduction practices such as through the use of BWSR's eLink or other tracking mechanisms.

Flow monitoring—is combined with water quality monitoring at the site to allow for the calculation of pollutant loads.

Effectiveness monitoring—determines whether a practice or combination of practices are effective in improving water quality.

Trend monitoring—allows the statistical determination of whether water quality conditions are improving.

Validation monitoring—validates the source analysis and linkage methods in sediment source tracking to provide additional certainty regarding study findings. For instance, longitudinal sampling along *E. coli* impaired streams can identify key sources of *E. coli* to the reach. Longitudinal sampling can be paired with a watershed assessment to further identify sources of *E. coli.* This assessment could include field evaluation of potential sources, compliance inspections for septic systems, and feedlot inspections.

There are many monitoring efforts in place to address each of the six basic types of monitoring. Several key monitoring programs will provide the information to track trends in water quality and evaluate compliance with TMDLs:

- Intensive monitoring and assessment at the HUC8 scale associated with Minnesota's watershed approach. This monitoring effort is conducted approximately every 10 years for each HUC-8. An outcome of this monitoring effort is the identification of waters that are impaired (i.e., do not meet standards and need restoration) and waters in need of protection to prevent impairment. Over time, condition monitoring can also identify trends in water quality. This helps determine whether water quality conditions are improving or declining, and it identifies how management actions are improving the state's waters overall. The next round of this type of monitoring is scheduled for 2025 - 2026.

- Implementation practice monitoring is conducted by both BWSR (i.e., eLINK) and the United States Department of Agriculture. Both agencies track the locations of BMP installations. This data is accessible through MPCA's Healthier Watersheds webpage: https://www.pca.state.mn.us/water/best-management-practices-implemented-watershed-implemented-watershed. In addition, the University of Minnesota Department of Soil, Water, and Climate and the Iowa State University Department of Agricultural and Biosystems Engineering are developing a long-term program to systematically collect tillage data and soil erosion estimates to better analyze trends in tillage adoption and retention.
- Discharges from permitted municipal and industrial wastewater sources are reported through discharge monitoring records (see Section 3.5.1.2); these records are used to evaluate compliance with NPDES permits. Summaries of discharge monitoring records are available through the MPCA's Wastewater Data Browser.

9. Implementation strategy summary

Minnesota's watershed approach to restoring and protecting water quality is based on a major watershed, or HUC-8, scale. This watershed-level approach begins with intensive watershed monitoring (which occurs on a 10-year cycle) and culminates in local implementation (Figure 28). A WRAPS report is produced as part of this approach and addresses restoration of impaired watersheds and protection of unimpaired waters in each HUC-8 watershed. The WRAPS for each HUC-8 watershed includes elements such as implementation strategies and timelines for achieving the needed pollutant reductions. These high-level reports are then used to inform watershed management plans that focus on local priorities and knowledge to identify prioritized, targeted, and measurable actions and locally based strategies. These plans further define specific actions, measures, roles, and financing for accomplishing water resource goals. Implementation activities in the UIR and MRR WRAPS Report will heavily influence and support implementation of this TMDL. The following sections provide an overview of potential implementation strategies to address the likely pollutant sources including ITPHSs and septic systems that are failing to protect groundwater, AFOs, near channel sources, and agricultural runoff. Additional implementation activities are provided in the UIR and MRR WRAPS report and the Root River 1W1P.

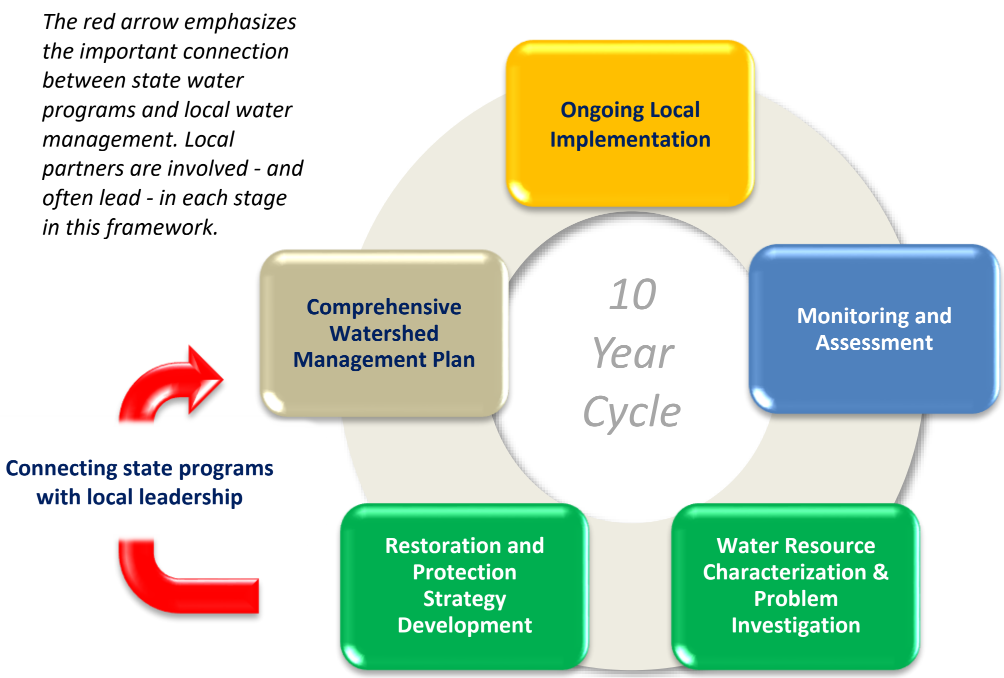


Figure 28. Minnesota's watershed approach.

9.1 Non-NPDES-permitted sources

Implementation of the UIR and MRR watersheds TMDL will require numerous BMPs that address likely non-NPDES-permitted sources of *E. coli* and sediment. This section provides an overview of example BMPs that may be used for implementation. The BMPs included in this section are not exhaustive, and the list may be amended. Likely sources of *E. coli* to target for implementation are livestock in AFOs and ITPHS. Sediment sources to target for implementation are near channel sources and runoff from pasture and grasslands.

Table48 and Table49 summarize example BMPs that can be implemented to achieve goals of the TMDLs. The tables are not an exhaustive list of all applicable BMPs and actual implementation may vary. Descriptions of BMP examples can be found in the Agricultural BMP Handbook for Minnesota (Lenhart et al. 2017), the Minnesota Stormwater Manual (Minnesota Stormwater Manual contributors 2019a) and the University of Minnesota Extension's Onsite Sewage Treatment Program website.

Table 48. Example BMPs for non-NPDES-permitted sources of *E. coli* in the Upper Iowa River and Mississippi River–Reno Watersheds.

Strategy	BMP Examples
Feedlot runoff control and manure management	Feedlot runoff reduction and treatment
	Feedlot manure/storage addition
	Rainwater diversions at feedlots
	Manure incorporation and injection
Pasture management	Conventional pasture to prescribed rotational grazing
	Livestock access control
Septic system improvements	Septic system improvement (maintenance and replacement)
Converting land to perennials	Conservation cover perennials
Buffers and filters	Riparian buffers and field borders
Urban stormwater runoff control	Green infrastructure

Table 49. Example BMPs for non-NPDES-permitted sources of sediment to Winnebago Creek (07060001-693).

Strategy	BMP Examples
Pasture management	Conventional pasture to prescribed rotational grazing
	Livestock access control
Stream banks, bluffs and ravines restored	Stream channel stabilization
	Riparian herbaceous cover
	Stream habitat improvement and management

9.2 NPDES-permitted sources

Implementation of the UIR and MRR Watersheds TMDLs for NPDES-permitted sources will consist of permit compliance as explained below.

9.2.1 Construction stormwater (for TSS)

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 Minnesota's NPDES/SDS General Stormwater Permit for Construction Activity (MNR100001). If a construction site owner/operator obtains coverage under the NPDES/SDS General Stormwater Permit and properly selects, installs, and maintains all BMPs required under the permit, including those related to impaired waters discharges and any applicable additional requirements found in Appendix A of the Construction General Permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Construction activity must also meet all local government construction stormwater requirements.

9.2.2 Industrial stormwater (for TSS)

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 Minnesota's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or NPDES/SDS General Permit for Construction Sand and Gravel, Rock Quarrying and Hot Mix Asphalt Production facilities (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS Permit and properly selects, installs, and maintains all BMPs required under the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Industrial activity must also meet all local government construction stormwater requirements.

9.2.3 Wastewater (for bacteria)

NPDES permits for municipal and industrial wastewater include effluent limits designed to meet *E. coli* water quality standards along with monitoring and reporting requirements to ensure effluent limits are met. Five municipal wastewater treatment facilities receive *E. coli* WLAs from this TMDL report. It is assumed that if a facility meets the fecal coliform limit of 200 organisms per 100 mL (as required by permit) it is also meeting the *E. coli* WLA.

9.3 Regional Fecal Coliform Implementation Plan

The *Revised Regional Fecal Coliform Implementation Plan* (Cannon River Watershed Partnership and MPCA 2006) was developed following the regional fecal coliform TMDL for the Lower Mississippi River and Cedar River basins of southeast Minnesota was completed in the early 2000s. The plan provides a guide for projects and activities to implement in order to address *E. coli* impaired streams in the planning area. These projects and activities were included based on regional stakeholder input and can also be implemented in the UIR and MRR watersheds. The full plan is available on the PCA website, TMDL project page.

9.4 Coordination with Iowa

Several of the impaired streams addressed in this TMDL are either upstream or downstream of impaired streams in Iowa. Where a Minnesota impaired reach flows into an impaired reach in Iowa with a more restrictive standard, the more restrictive downstream standard was used to develop the TMDL to protect downstream designated uses (see Section 2.2 for more information). In addition, Staff Creek (01-UIA-288) in Iowa has an *E. coli* impairment and flows into the UIR *E. coli* impairment (from Little Iowa River to Beaver Creek, 07060002-509) in Minnesota. Because Staff Creek has a less stringent water quality standard (monthly geometric mean of 630 org/100 mL) than the Minnesota standard for the UIR (monthly geometric mean standard of 126 org/100 mL), continued coordination between the MPCA and the Iowa DNR will support successful implementation of this TMDL.

9.5 Cost

9.5.1 Implementation cost

TMDLs are required to include an overall approximation of implementation costs (Minn. Stat. § 114D.25). The costs to implement the activities outlined in the strategy are approximately $7 to $10 million dollars over the next 20 years. This range reflects the level of uncertainty in the source assessment and addresses the likely sources identified in Section 3.5. The cost includes increasing local capacity to oversee implementation in the watershed and the voluntary actions needed to achieve necessary TMDL reductions. Costs for implementing the TMDL and achieving the required pollutant load reductions were estimated by developing an implementation scenario with cost effective and practical options. Actual implementation will likely differ.

The cost of required actions, including compliance with the Minnesota Buffer Law, replacement of ITPHS systems, and SSTS maintenance, were not considered in the overall cost calculation because their costs are already accounted for in existing programs. The expected pollutant reductions of these required actions; however, were accounted for in the implementation scenario to achieve required TMDL reductions.

9.5.2 TSS reduction cost methodology

Costs for TSS impaired stream Winnebago Creek (07060001-693) were calculated using aerial images and field level information and recommendations provided in the SID (MPCA 2018a and MPCA 2018b) and monitoring and assessment (MPCA 2018c) reports. BMPs used in the TSS scenario for Winnebago Creek include stream restoration of four miles of upstream segment and exclusion fencing for cattle along the pastureland adjacent to the stream. A cost range of $130,000 to $350,000 per stream mile was estimated from a review of stream restoration projects in Minnesota.

9.5.3 *E. coli* reduction cost methodology

Costs to achieve the required *E. coli* reductions were calculated using the most likely sources (Table 13) and the overall estimated percent reductions needed to meet each TMDL (Section 5). This cost assessment accounts for the uncertainty of a qualitative *E. coli* source assessment. BMPs used in the *E. coli* scenario calculation include:

- Feedlot BMPs and livestock access control
- Green infrastructure (biofiltration)
- SSTS maintenance and ITPHS replacement

Feedlot BMPs include buffer strips around feedlots and compost facilities and were applied to all *E. coli* impaired subwatersheds. A feedlot BMP cost of $390 per AU was calculated for the impaired watersheds based on AUs provided by the MPCA and the 2019 EQIP payments for Minnesota. This cost is similar to the costs provided in the Root River TMDL (MPCA 2016). It was assumed that approximately 60% of existing feedlots were already implementing feedlot BMPs and did not need improvements. In addition to feedlot BMPs, biofiltration practices were applied to the UIR (Little Iowa River to Beaver Creek, 07060002-509) to address stormwater runoff from Le Roy. Bioretention design criteria were obtained from the Minnesota Stormwater Manual (Minnesota Stormwater Manual contributors 2019b).

9.5.4 Cost references

BMP costs and removal efficiencies used in cost calculation were predominantly obtained from Minnesota EQIP dollars for 2019, the Minnesota NRS (MPCA 2014), Minnesota Agricultural BMP Handbook (Lenhart et al. 2017), and the MPCA BMP Estimator for stormwater BMPs (Minnesota Stormwater Manual contributors 2019c).

9.6 Adaptive management

The implementation strategy and the accompanying WRAPS report focus on adaptive management. An adaptive management approach is an overall system of continuous improvements and feedback loops that allows for changes in the management strategy if environmental indicators suggest that the strategy is inadequate or ineffective. Continued monitoring and course corrections responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL.

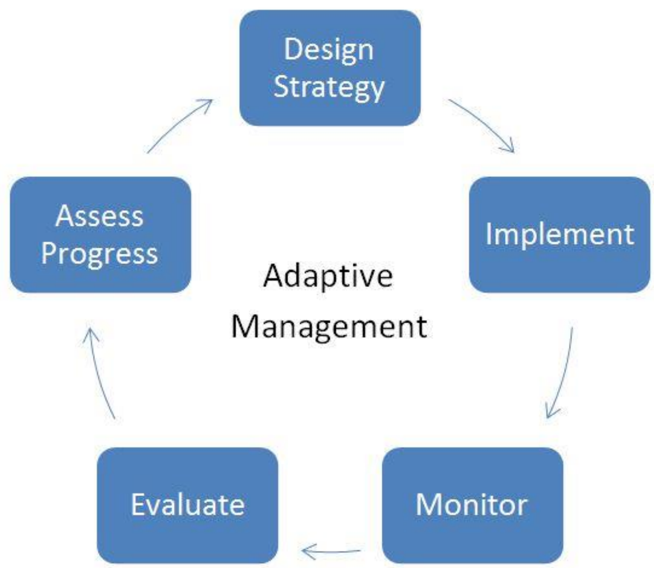


Figure 29. General adaptive management process.

Natural resource management involves a series of actions and associated feedback loops that help to inform next steps to achieve overarching goals. In the simplest of terms, adaptive management is a cyclical process or loop in which actions are implemented, monitored, evaluated, compared to anticipated progress, and redesigned if needed (Figure 26). In actuality, adaptive management in natural resource management consists of many of these feedback loops, all of which can occur at different speeds and durations. These loops or cycles can be large and programmatic in nature such as Minnesota's watershed approach, while others can be small and on a scale such as an individual field (Nelson et al. 2017). As a structured iterative implementation process, adaptive management offers the flexibility for responsible parties to monitor implementation actions, determine the success of such actions, and ultimately base management decisions on the measured results of completed implementation actions and the current state of the system. This process enhances the understanding and estimation of predicted outcomes and ensures refinement of necessary activities to better guarantee desirable results. In this way, understanding of the resource can be enhanced over time and management can be improved (Williams et al. 2009).

10. Public participation

10.1 Public notice

Multiple meetings were held with stakeholders throughout the TMDL development process. Throughout March and April of 2019, the MPCA attended four meeting with local stakeholders in the watersheds. These meetings provided a summary of the impairment status of streams in the watersheds and the identified stressors and pollutants impacting those streams. Local stakeholders included SWCD staff and board advisors from Mower and Houston counties, and Fillmore county staff and township officials. MPCA also attended a Root River 1W1P Advisory Committee meeting on March 19, 2019, to discuss TMDL project updates. In attendance were advisory committee members including staff from BWSR, Fillmore SWCD, Root SWCD, Winona SWCD, The Nature Conservancy, and DNR. On May 15, 2019, two meetings were held in Mabel, Minnesota with county and SWCD staff to provide an overview of the TMDL and discuss implementation activities for the TMDL and WRAPS.

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from December 30, 2019 through January 29, 2020. There was one comment letter received and responded to as a result of the public comment period.

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