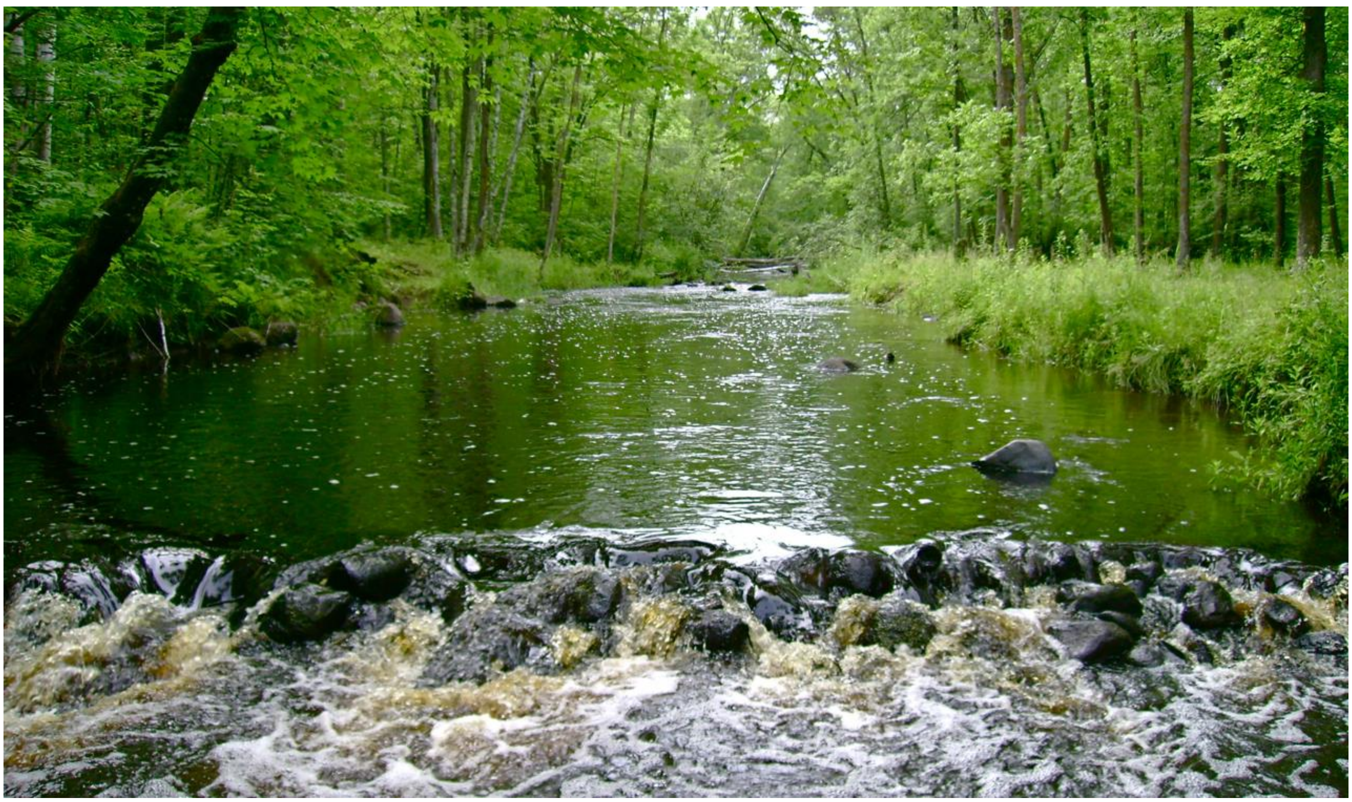
Watershed

August 2026

Snake River Watershed Total Maximum Daily Load Report 2026

E. coli TMDLs for seven impaired streams



MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Abbreviations

1W1P	One Watershed, One Plan
AQC	aquatic consumption
AQL	aquatic life
AQR	aquatic recreation
AU	animal unit
BC	boundary condition
BMP	best management practice
BWSR	Board of Water and Soil Resources
CAFO	Concentrated Animal Feeding Operation
CRP	Conservation Reserve Program
CREP	Conservation Reserve Enhancement Program
CWA	Clean Water Act
DNR	Minnesota Department of Natural Resources
E. coli	*Escherichia coli*
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
HSPF	Hydrologic Simulation Program–Fortran
HUC	Hydrologic Unit Code
ITPHS	imminent threat to public health and safety
IWM	intensive watershed monitoring
LA	load allocation
lb	pound
LDC	load duration curve
LGU	local government unit
m	meter
MAWQCP	Minnesota Agricultural Water Quality Certification Program
mL	milliliter
MDA	Minnesota Department of Agriculture
MOS	margin of safety

MPCA	Minnesota Pollution Control Agency
MS4	municipal separate storm sewer system
MST	Microbial Source Tracking
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PWP	Permanent Wetland Preserve
RIM	Reinvest in Minnesota
SDS	state disposal system
SSO	sanitary sewer overflows
SSTS	subsurface sewage treatment systems
SWCD	soil and water conservation district
TMDL	total maximum daily load
TSS	total suspended solids
WBIF	watershed-based implementation funding
WID	water unit identification
WLA	wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy
WRP	Wetland Reserve Program
WQBEL	water quality-based effluent limit
WWTP	wastewater treatment plant

Executive summary

The Federal Clean Water Act (CWA), Section 303(d) requires total maximum daily loads (TMDLs) to be produced for surface waters that do not meet applicable water quality standards necessary to support their designated uses (i.e., impaired waters). A TMDL determines the maximum amount of a pollutant a receiving water body can assimilate while still achieving water quality standards, and allocates allowable pollutant loads to various sources needed to meet water quality standards. This study is part of the work being completed by the Minnesota Pollution Control Agency (MPCA) as part of the State of Minnesota's Watershed Approach and is a continuation of initial TMDL efforts in the Snake River Watershed that were approved by the U. S. Environmental Protection Agency (EPA) Region 5 in 2013. Since the initial TMDLs, the Snake River Watershed has been re-visited for intensive watershed monitoring (IWM) and re-assessed for meeting water quality standards. This TMDL study addresses seven *Escherichia coli (E. coli)* impairments in the Snake River Watershed in north-central Minnesota affecting streams with aquatic recreation (AQR) designated uses.

This report analyzes the possible sources of the *E. coli* impairments throughout the Snake River Watershed considering land use, septic systems, permitted sources, and human/animal access to the streams. A microbial source tracking (MST) analysis was used to determine the source of the bacteria and detected human originated bacteria most often through impaired and unimpaired reaches. There were few point sources that contributed to the impaired reaches, so further implementation efforts are focused on nonpoint and nonpermitted sources of pollution.

This report used a variety of methods to evaluate current loading contributions from various pollutant sources as well as the allowable pollutant loading capacity for each impaired reach. These methods include monitored flow and water quality data, the Snake River HSPF (Hydrologic Simulation Program–Fortran) model, and the flow duration curve approach. This TMDL report was developed in conjunction with an updated basin-wide watershed restoration and protection strategy (WRAPS) report for the Snake River (MPCA 2014a, MPCA 2026). The WRAPS report provides an update of ongoing efforts throughout the watershed and addresses multiple nonpollutant impairments.

A general strategy and cost estimate for implementation to address the impairments are included in this report. Voluntary nonpoint source load reductions and future MST research will be necessary for the improvement of these water bodies.

1. Project overview

1.1 Introduction

Section 303(d) of the federal CWA requires that TMDLs be developed for waters that do not support their designated uses. These waters are referred to as "impaired" and are included in Minnesota's list of impaired water bodies. The term "TMDL" refers to the maximum amount of a given pollutant a water body can receive on a daily basis and still achieve water quality standards. 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 permitted sources, load allocations (LAs) for nonpermitted sources (including natural background), and the margin of safety (MOS), which is implicitly or explicitly defined, cannot exceed the maximum allowable pollutant load.

This TMDL addresses seven *E. coli* impairments in the Snake River Watershed located in the St. Croix River Basin (Figure 1). The Snake River Watershed is identified as U.S. Geological Survey Hydrologic Unit Code (HUC)-8 07030004. The watershed is approximately 1,006 square miles, or 643,534 acres, and includes portions of six counties: Aitkin, Kanabec, Mille Lacs, Pine, Chisago, and Isanti. The Snake River begins in southeastern Aitkin County, flows south into Kanabec County, and east into Pine County before discharging into the St. Croix River at the border of Minnesota and Wisconsin in the Chengwatana State Forest. This watershed is relatively flat glacial till plain crossed by several east-west moraine belts (MCD 1959). The upper portion of this watershed is mainly undeveloped with extensive forest and wetland cover. Moving south, the gradient decreases and gives way to farming valleys and developed land cover.

This TMDL report is a component of a larger effort to restore and protect the Snake River Watershed. Other components of the larger effort include the *Snake River Watershed WRAPS* and *Snake River Watershed WRAPS Update* (MPCA 2014a, MPCA 2026), *Snake River Comprehensive Watershed Management Plan* (Snake River Watershed Partnership Planning 2023), *Snake River Watershed Monitoring and Assessment Report* (MPCA 2017a), *Snake River Watershed Water Assessment and Trends Update* (MPCA 2020b), *Snake River Watershed Stressor Identification Report* (MPCA 2017b), *Snake River Watershed Stressor Identification Update* (MPCA 2021), *Snake River Watershed Stressor Identification Report-Lakes* (DNR 2021), and *Snake River TMDL* (MPCA 2013).

Figure 1. Location of Snake River Watershed in Minnesota.

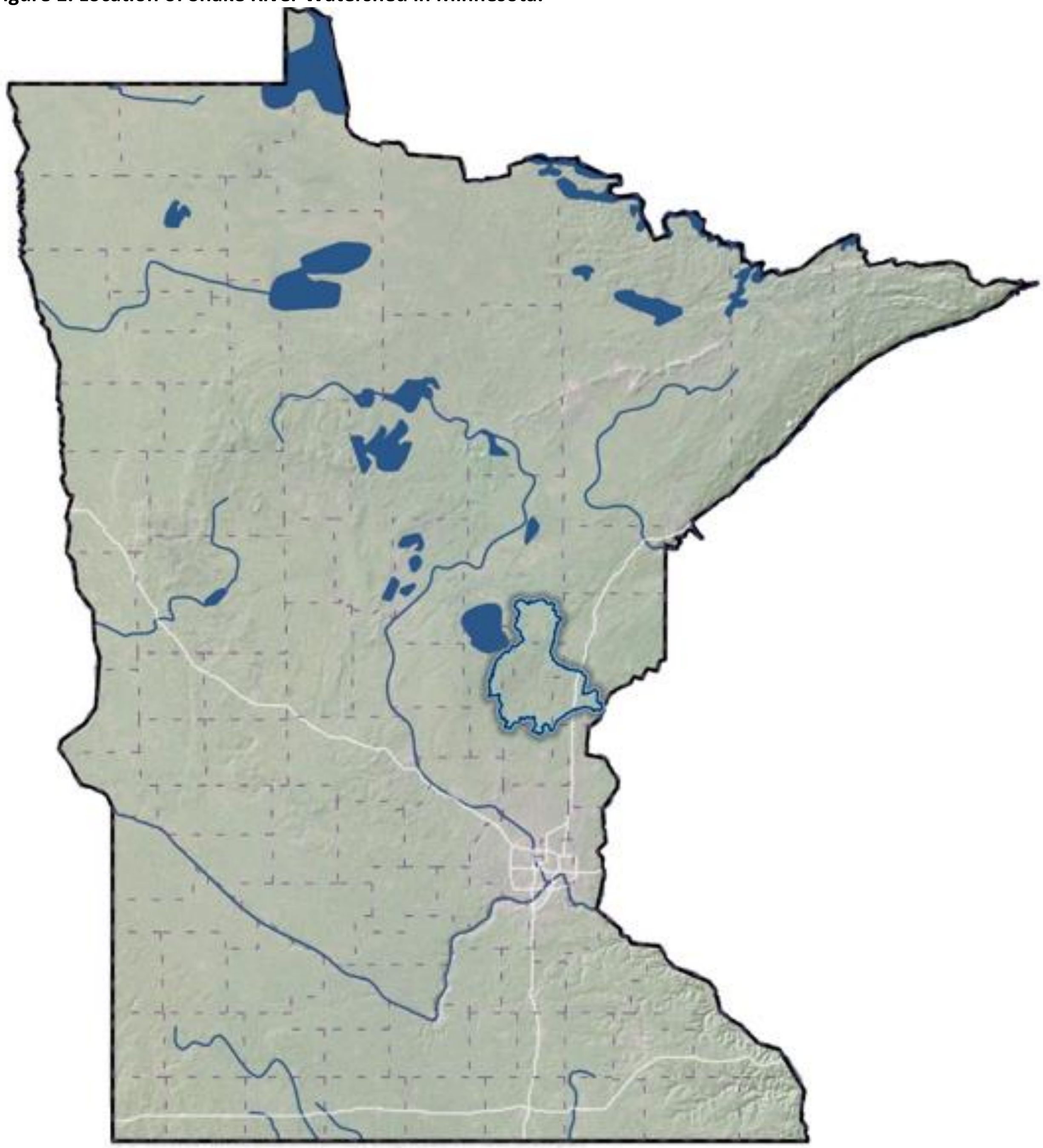
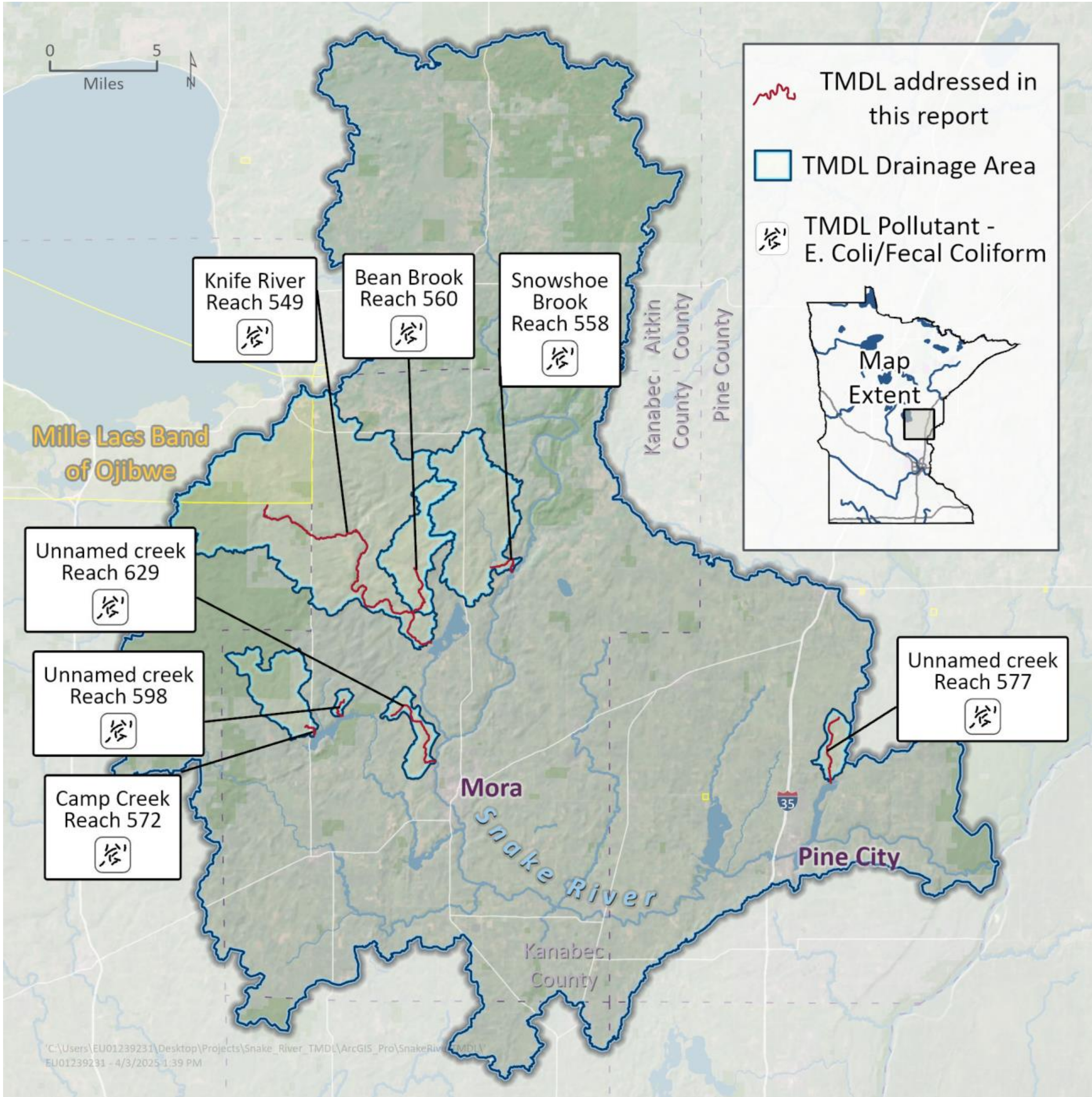


Figure 2. Snake River Watershed impairments overview.



1.2 Identification of water bodies

This report contains *E. coli* TMDLs for stream reaches with AQR *E. coli* impairments (Figure 2). TMDLs in this report address some of the remaining impairments in the watershed that need a TMDL adding to water bodies addressed in Cycle 1 (Wenck 2013). The TMDLs in this report do not replace nor revise previously approved TMDLs. The remaining impairments will be addressed in future TMDL reports when appropriate. The impairments not addressed in this report are biological in nature or represent a culmination of environmental factors, which need appropriate pollutant identification for TMDL development (Table 1 and Appendix B contain a full list of impairments for this watershed).

Although TMDLs are not developed in this report for nonpollutant stressors to biological impairments, all stressors—not just those with associated TMDLs—are addressed in the concurrently developed WRAPS Update (MPCA, 2026). The WRAPS Update provides an opportunity to call for environmental improvements in situations where TMDLs alone would not. Nonpollutant stressors include factors such as habitat alteration or flow, and TMDLs are not developed for nonpollutant stressors because they are not subject to load quantification. Table 1 below and in Appendix B (which includes all impairments in this watershed) summarize Snake River Watershed impairments addressed by TMDLs in this document.

Table 1. Impaired water bodies in the Snake River Watershed addressed in this TMDL report.

WID	Water body name	Water body description	Use class	Listing year	Affected designated use	Listing Parameter	TMDL Pollutant	Category 4A upon TMDL approval [a]
07030004-549	Knife River	Dry Run to Knife Lake	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-558	Snowshoe Brook	Unnamed creek to Snake River	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-560	Bean Brook	Unnamed wetland to Knife River	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-572	Camp Creek	Unnamed creek to Ann Lake	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-629	Unnamed creek	Headwaters to Snake River	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-598	Unnamed creek	Headwaters to Ann Lake	2Bg	2020	Aquatic recreation	*E. coli*	*E. coli*	Y
07030004-577	Unnamed creek	Headwaters to Cross Lake	2Bg	2010	Aquatic recreation	*E. coli*	*E. coli*	Y

a. Impairment will be categorized as 4A (impaired and a TMDL study has been approved by EPA) upon approval of this TMDL and will appear as 4A in the next impaired waters list.

1.3 Tribal lands

The Snake River Watershed is located on the traditional homelands of the Anishinaabe (Chippewa, Ojibwe) and Dakota. A portion of the Mille Lacs Band of Ojibwe Reservation is in the Snake River Watershed (Figure 2), and this land is accounted for in the Knife River TMDL (07030004-549) as a boundary condition (BC; Table 16). Minnesota cannot establish allocations for other jurisdictions, and the boundary condition for the reservation is consistent with Minnesota's water quality standards and not more stringent (Section 4.2). No TMDLs are developed for waters on tribal lands.

Requests to partner with MPCA on this or other water related projects were sent to the Mille Lacs Band of Ojibwe, as well as other potentially interested Tribal organizations, from watershed assessments through development of this TMDL report and the WRAPS Update Report. The Tribal organizations did not express interest in partnering on the studies prior to development of the TMDL report. Nonetheless, the Mille Lacs Band of Ojibwe was notified of the draft Knife River TMDL before public notice to encourage awareness and solicit feedback.

1.4 Priority ranking

The MPCAs TMDL commitments, as indicated on Minnesota's Section 303(d) impaired waters list, reflect Minnesota's priority ranking of the impairments addressed in this report. To meet the needs of EPA's 2022–2032 Vision for the CWA Section 303(d) Program (EPA 2022), the MPCA aligned TMDL commitments with the watershed approach and other statewide strategies and initiatives in *Minnesota's Total Maximum Daily Load Studies Prioritization Framework* (MPCA 2024b). As part of these efforts, the MPCA identified water quality impaired segments to be addressed by TMDLs through the watershed approach and other statewide strategies and initiatives (MPCA 2024c).

2. Applicable water quality standards and numeric water quality targets

The federal CWA requires states to designate beneficial uses for all waters and develop water quality standards to protect each use. Water quality standards consist of several parts:

- Beneficial uses—Identify how people, aquatic communities, and wildlife use our waters
- Numeric standards—Amounts of specific pollutants allowed in a body of water that still protect it for the beneficial uses (note that EPA uses the phrase “numeric criteria” whereas Minnesota uses the phrase “numeric standards")
- Narrative standards—Statements of unacceptable conditions in and on the water (note that EPA uses the phrase “narrative criteria” whereas Minnesota uses the phrase “narrative standards")
- Antidegradation protections—Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative standards, and antidegradation protections provide the framework for achieving CWA goals. Minnesota’s water quality standards are in Minn. R. chs. 7050 and 7052.

2.1 Beneficial uses

The beneficial uses for waters in Minnesota are grouped into one or more classes as defined in Minn. R. 7050.0140. The classes and associated beneficial uses are:

- Class 1 – domestic consumption
- Class 2 – aquatic life (AQL) and AQR
- Class 3 – industrial consumption
- Class 4 – agriculture and wildlife
- Class 5 – aesthetic enjoyment and navigation
- Class 6 – other uses and protection of border waters
- Class 7 – limited resource value waters

The Class 2 AQL beneficial use includes a tiered AQL uses framework for rivers and streams. The framework contains three tiers—exceptional, general, and modified uses.

All surface waters are protected for multiple beneficial uses, and numeric and narrative water quality standards are adopted into rule to protect each beneficial use. TMDLs are developed to protect the most sensitive use of a water body.

2.2 Narrative and numeric standards

Narrative and numeric water quality standards for all uses are listed for four common categories of surface waters in Minn. R. 7050.0220. The four categories are:

- Cold water AQL and habitat, drinking water, and associated use classes: Classes 1B; 2A, 2Ae, or 2Ag; 3; 4A and 4B; and 5
- Cool and warm water AQL and habitat, drinking water, and associated use classes: Classes 1B or 1C; 2Bd, 2Bde, 2Bdg, or 2Bdm; 3; 4A and 4B; and 5
- Cool and warm water AQL and habitat and associated use classes: Classes 2B, 2Be, 2Bg, 2Bm, or 2D; 3; 4A and 4B; and 5
- Limited resource value waters: Classes 3; 4A and 4B; 5; and 7

The narrative and numeric water quality standards for the individual use classes are listed in Minn. R. 7050.0221 through 7050.0227. The procedures for evaluating the narrative standards are presented in Minn. R. 7050.0150.

The MPCA assesses surface waters for the following beneficial uses:

- Class 1: Drinking water and aquatic consumption ([AQC] human health-based standards)
- Class 2: AQL (toxicity-based standards, conventional pollutants, biological indicators)
- Class 2: AQR (*E. coli* bacteria, eutrophication)
- Class 2: AQC (fish tissue and wildlife-based standards)
- Class 4A: Waters used for production of wild rice
- Class 7: Limited value resource waters (toxicity-based standards, *E. coli* bacteria, conventional pollutants)

Class 2 waters are further broken down into Class 2A and 2B waters. Class 2A waters are protected for the propagation and maintenance of a healthy community of cold water AQL and their habitats. Class 2B waters are protected for the propagation and maintenance of a healthy community of cool or warm water AQL and their habitats. Both Class 2A and 2B waters are also protected for AQR activities including bathing and swimming, and for human consumption of fish and other aquatic organisms.

2.3 Antidegradation policies and procedures

The purpose of the antidegradation provisions in Minn. R. ch. 7050.0250 through 7050.0335 is to achieve and maintain the highest possible quality in surface waters of the state. To accomplish this purpose:

- Existing uses and the level of water quality necessary to protect existing uses are maintained and protected.
- Degradation of high water quality is minimized and allowed only to the extent necessary to accommodate important economic or social development.

- Water quality necessary to preserve the exceptional characteristics of outstanding resource value waters is maintained and protected.
- Proposed activities with the potential for water quality impairments associated with thermal discharges are consistent with Section 316 of the CWA, United States Code, title 33, section 1326.

2.4 Snake River Watershed water quality standards

In streams, AQR is assessed by measuring the concentration of *E. coli* in the water, which is used as an indicator species of potential waterborne pathogens. There are two *E. coli* numeric standards for Class 2 waters in Minnesota—one is applied to monthly *E. coli* geometric mean concentrations, and the other is applied to individual samples (Table 2). Exceedances of either *E. coli* standard in class 2 waters indicate that a water body does not meet the AQR designated use. The class 2 standards for *E. coli* apply from April through October. The *E. coli* TMDLs in this report are based on the monthly geometric mean standard of 126 org/100 mL. It is assumed that practices 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. Although the TMDLs are based on the monthly geometric mean standard, both standards apply.

The Mille Lacs Band of Ojibwe water quality standard for fecal coliform bacteria is 200 colonies/100 mL (Minn. R. ch. 7050.0220, subp. 2, § 118 Water-Standards). This fecal coliform concentration is considered equivalent to Minnesota’s 126 org/100 mL *E. coli* water quality standard, in that they both provide the same protection level for swimmers (MPCA 2007). The Mille Lacs Reservation boundary condition loads in the Knife River TMDL (Section 4.2) are consistent with Minnesota’s *E. coli* water quality standard and the Band’s fecal coliform water quality standard.

Table 2. Water quality standards for *E. coli* in rivers and streams (Minn. R. 7050.0222 and 7050.0227).

Parameter	Water body type	Water quality standard	Numeric standard
E. coli	Class 2 (A and B) streams	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 streams	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) ≤ 1,260 organisms/100 mL water (individual sample)

3. Watershed and water body characterization

The Snake River Watershed is an 8-digit HUC located in the St. Croix River Basin. The watershed is approximately 1,006 square miles, or 643,534 acres, and includes portions of six counties: Aitkin, Kanabec, Mille Lacs, Pine, Chisago, and Isanti. The Snake River begins in southeastern Aitkin County, flows south into Kanabec County, and east into Pine County before discharging into the St. Croix River at the border of Minnesota and Wisconsin in the Chengwatana State Forest. The northern part of the watershed is located in the Northern Lakes and Forest Ecoregion and is dominated by forests and wetlands. The southern portion of the watershed is located in the North Central Hardwood Forest ecoregion and is a mixture of forest, grassland, pasture/hay and cropland.

The flow data in this TMDL report is derived from the MPCAs HSPF model application of the Snake River Watershed, which was first developed by RESPEC and simulated the timeframe 1995-2009 (RESPEC 2016). Subsequently the Snake River model was extended by Tetra Tech through 2018 (Tetra Tech 2020). 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. The HSPF model is used to simulate flows in the impaired streams. Model documentation contains additional details about model development (RESPEC 2016, Tetra Tech 2020).

3.1 Climate trends

Climate is a foundational ecological condition that influences hydrology and water quality. *Climate summary for watersheds: Snake River (St. Croix)* (DNR 2019) provides an overview of climate conditions based on data from 1895 through 2018. The report focused on trends in seasonal and annual temperature and precipitation comparing data in the most recent thirty years to the last 120 years. Long-term data show that annual average temperatures in the Snake River Watershed have increased, and that most years during the past two decades have been warmer than average (Figure 3). Monthly average temperatures peak in July, and winter temperatures on average have increased over time (3.0°F), with less change in the summer months (0.5°F) (Figure 4; DNR 2019).

Annual precipitation in the Snake River Watershed also shows an upward trend (Figure 5). Monthly precipitation is typically highest in May and June and increases in precipitation in recent years were most pronounced in April, July and October (Figure 6). The frequency of 1-inch and 3-inch rain events has increased in general in Minnesota, along with the size of the heaviest rainfall of the year. Minnesota has also experienced an increase in devastating, large-area extreme rainstorms (DNR 2022). Climate projections indicate these big rains will continue increasing into the future (DNR 2022).

This increase in the frequency and size of rainfall events affects river and stream flows. Peak flows in this area and downstream have increased over the last few decades with 2.5 times more high-flow years than the last 20 years (Figure 7; MPCA 2024a). Points in Figure 7 represent water year (October-September) flow while the lines represent the trailing five-year moving average using data from the

USGS National Water Information System. Higher flows result in greater stream channel erosion and sediment transport. These in turn impact local pollutant loads and concentrations, downstream habitat for fish and other AQL, and may degrade recreational uses. The frequency of high rainfall events resulting in higher flows can lead to more *E. coli* pollution in streams.

Figure 3. Annual average temperature, Snake River Watershed.

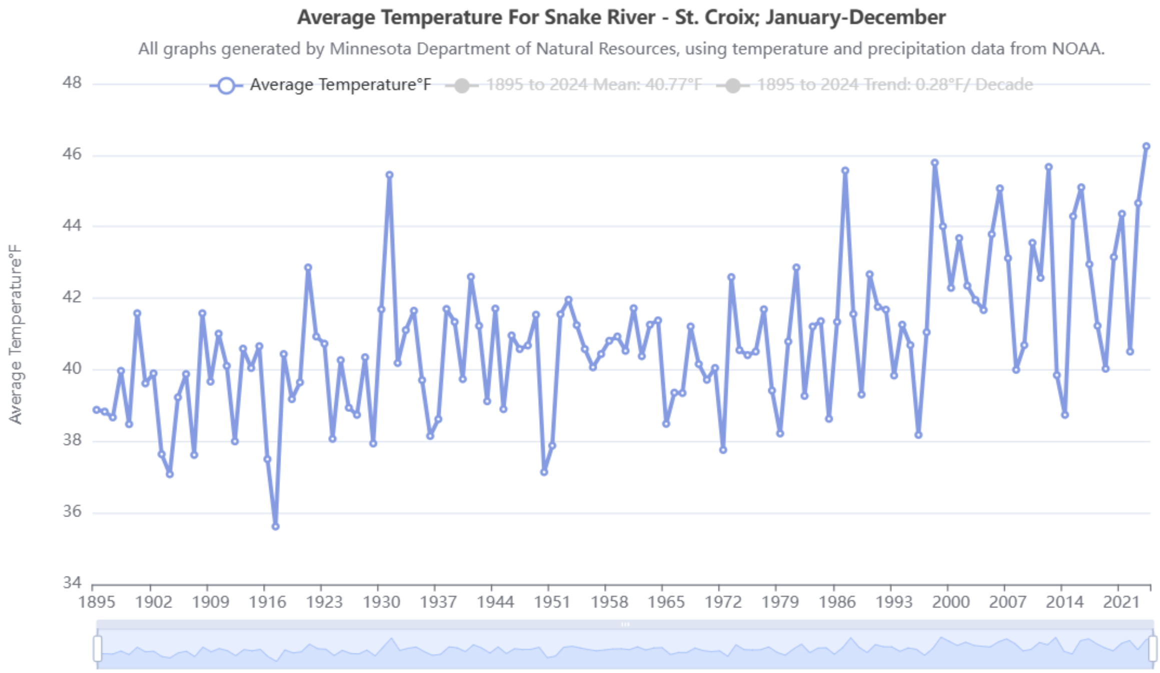


Figure from: Minnesota Climate Explorer (DNR 2024)

Figure 4. Monthly average temperature distribution and departure from record mean, Snake River Watershed (figure from DNR 2019).

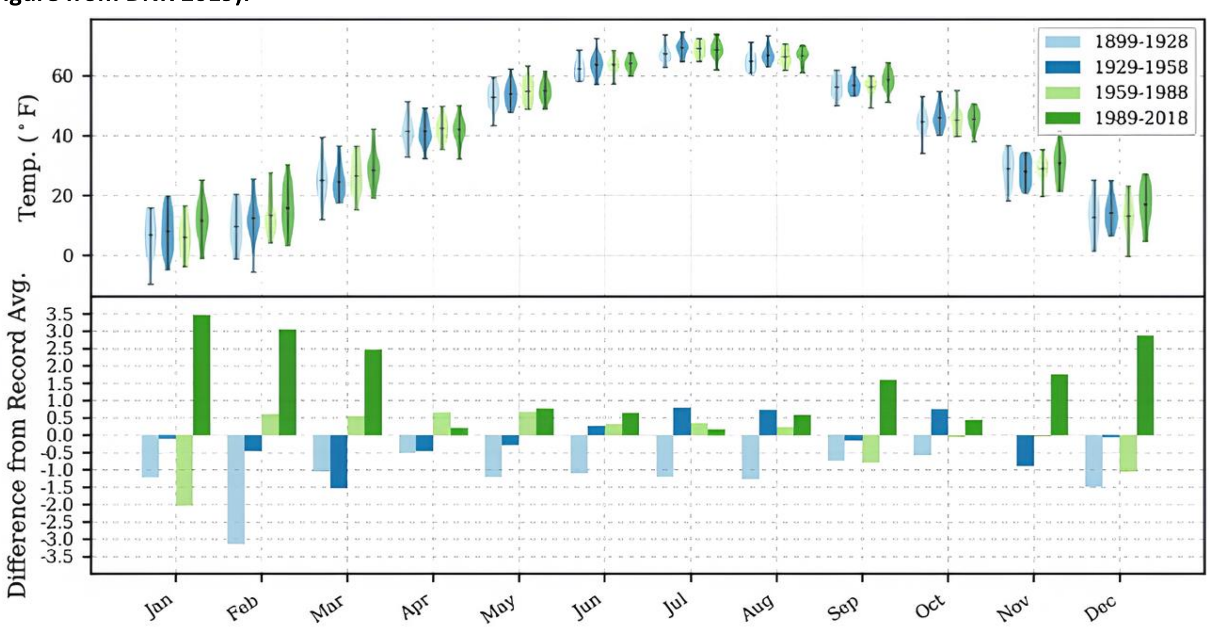


Figure 5. Annual precipitation, Snake River Watershed.

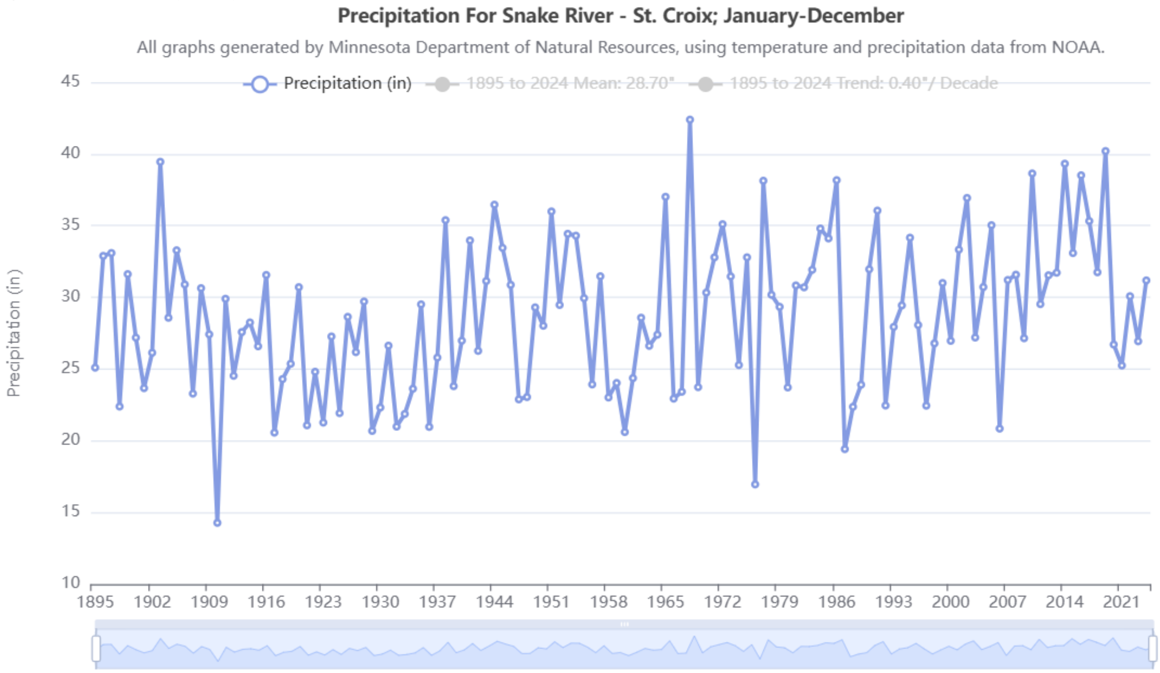


Figure from: Minnesota Climate Explorer (DNR 2024)

Figure 6. Monthly precipitation and departure from record mean, Snake River Watershed (figure from DNR 2019).

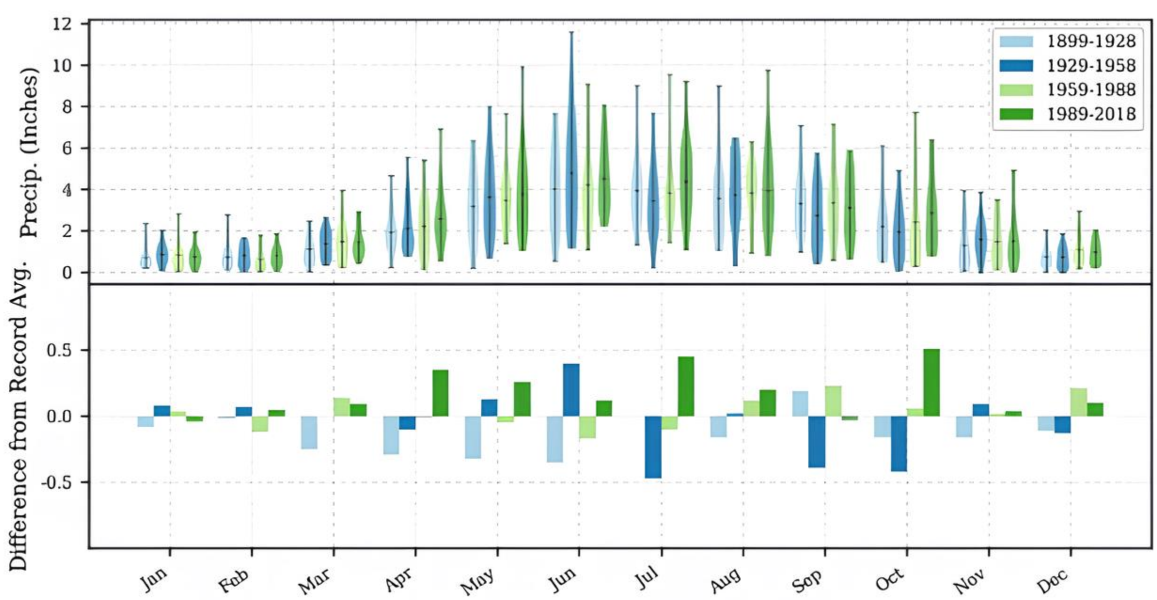


Figure 7. Trends in flood flows: Percent difference from median annual peak.

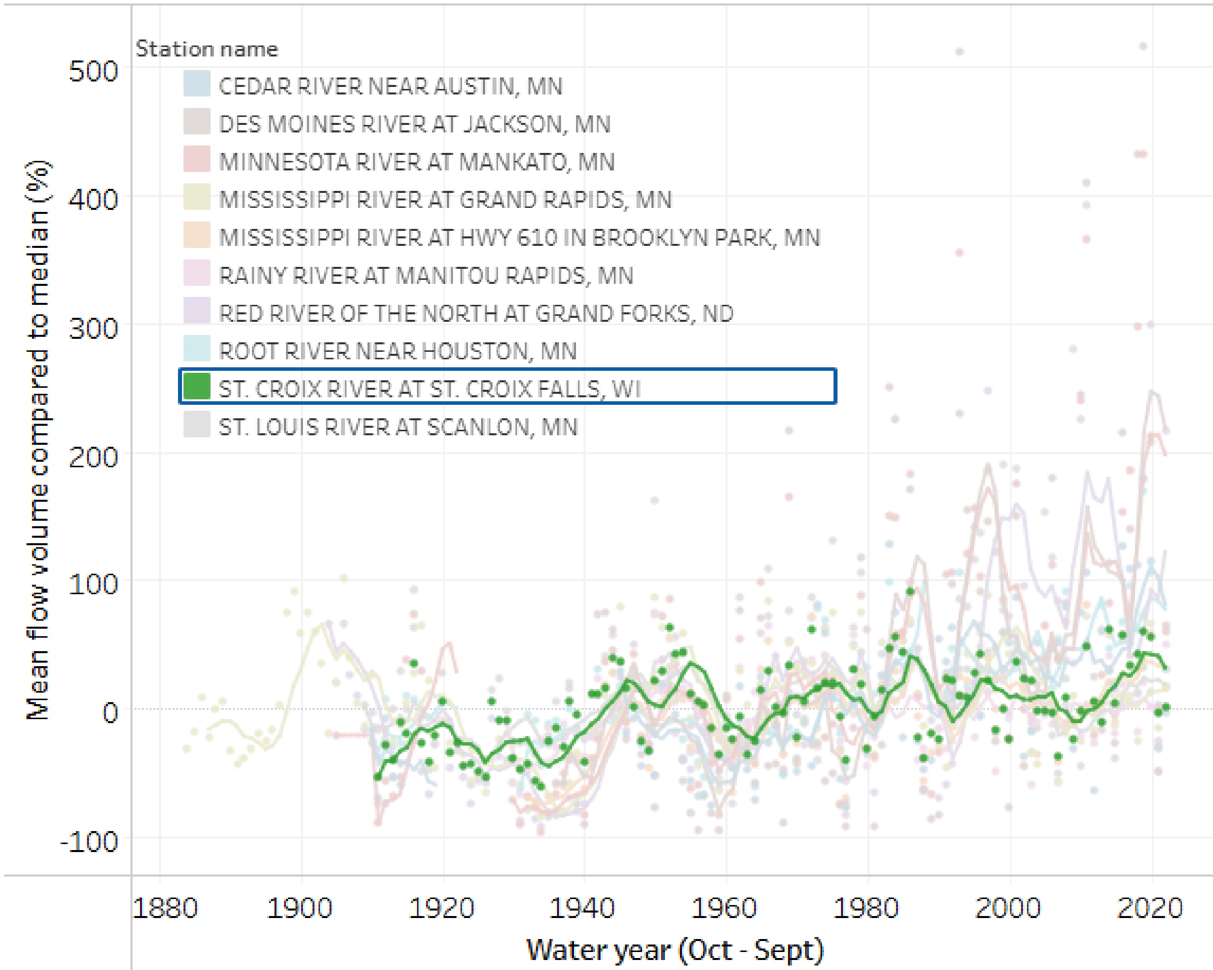


Figure source: Climate Change and Minnesota's Surface Waters (MPCA 2024a).

3.2 Subwatersheds

The watershed boundaries of the impaired streams (Figure 2, Table 3) were developed using the HSPF model.

Table 3. Drainage areas of impaired stream reaches addressed in the Snake TMDL.

WID	Stream Name	Reach Length (miles)	Total Drainage Area	
			(acres)	(sq mi)
07030004-549	Knife River	16.78	54,301	84.8
07030004-558	Snowshoe Brook	2.19	14,207	22.2
07030004-560	Bean Brook	2.94	6,562	10.3
07030004-572	Camp Creek	0.95	6,150	9.6
07030004-629	Unnamed creek	4.94	2,791	4.4
07030004-598	Unnamed creek	1.24	461	0.7
07030004-577	Unnamed creek	3.73	2,180	3.4

3.3 Land use and/or land cover

Pre-European settlement land cover in the Snake River Watershed was primarily coniferous swamps and aspen-birch forests (Figure 8; DNR 2017). Currently, the land cover in the northwest corner of the watershed remains largely forested (Figure 9; DNR 2017). Moving from the northwest corner to the southeast corner, there is increasing human influence with pasture/hay, with pockets of cultivated crops and medium intensity developed areas (Table 4, Figure 9). The watershed contains only 0.61% impervious surface area. The water courses are largely natural waterways (48.7%) though a significant portion has been altered (35.3%; DNR 2017).

Figure 8. Pre-European settlement land cover map of the Snake River Watershed.

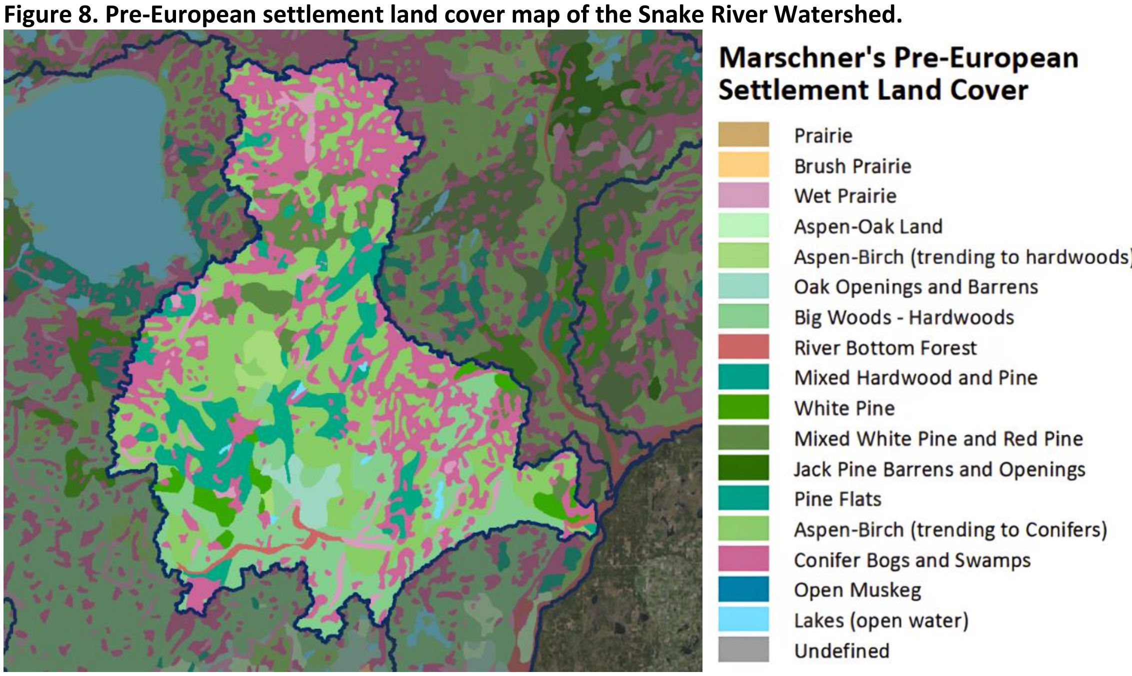


Figure 9. Current land cover map of the Snake River Watershed.

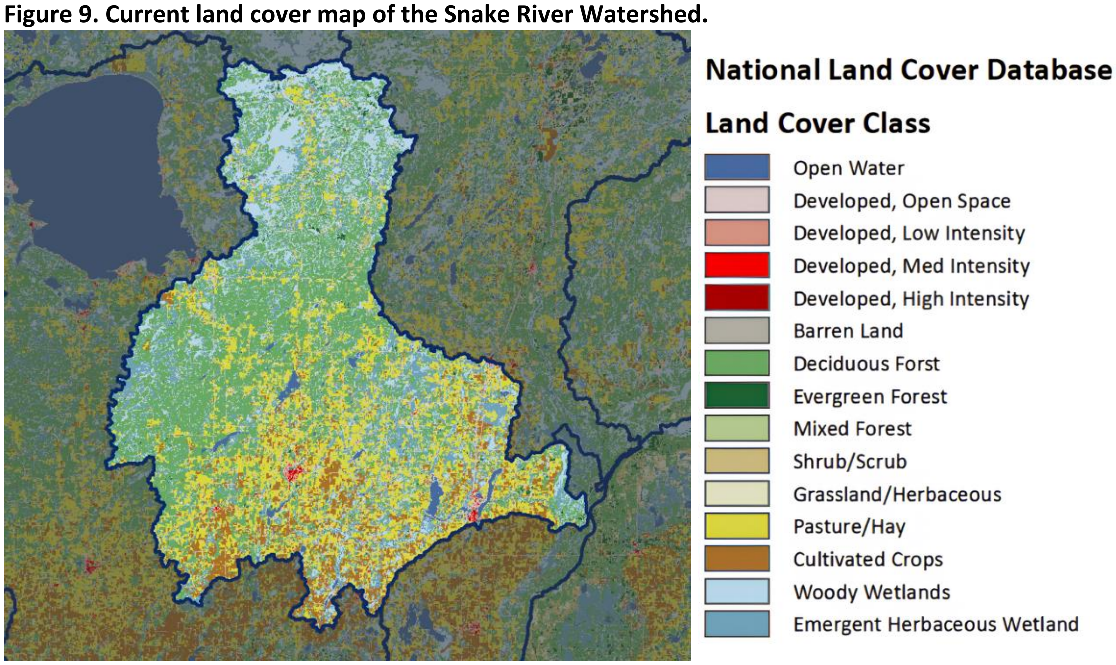


Table 4. Land use/cover within impaired subwatersheds from the National Land Cover Database 2019 (Dewitz, 2021).

WID	Stream Name	Land Use/Land Cover Percentage of Drainage Area [%]					
		Water/ Wetland	Forest/ Shrub	Pasture/ Hay	Cropland	Barren/ Mining	Developed
07030004-549	Knife River	12.6%	68.3%	13.3%	2.1%	0.2%	2.9%
07030004-558	Snowshoe Brook	10.2%	64.2%	20.7%	1.1%	<0.1%	3.3%
07030004-560	Bean Brook	14.8%	71.1%	9.9%	0.6%	<0.1%	3.1%
07030004-572	Camp Creek	10.1%	82.6%	5.3%	0.1%	<0.1%	1.7%
07030004-629	Unnamed Creek	11.0%	23.0%	40.2%	18.3%	<0.1%	7.0%
07030004-598	Unnamed Creek	8.9%	36.4%	36.9%	12.1%	<0.1%	5.7%
07030004-577	Unnamed Creek	17.8%	33.6%	25.6%	17.5%	<0.1%	4.9%

3.4 Water quality

Water quality data are presented to evaluate impairments and trends in water quality. Unless otherwise noted, data from 2005 through 2021 was used in the water quality summary tables. Only water quality data from the MPCA's Environmental Quality Information System (EQuIS) were used for the analyses.

Simulated flow data from the Snake River Watershed HSPF model were evaluated in addition to *E. coli* monitoring data to evaluate the impairments. Flow data were used to approximate the stream flow conditions when each water quality sample was taken. These analyses are described in more detail in this section.

3.4.1 Flow data

Simulated daily average flows from the HSPF model (3/31/2022 version) were used in developing the *E. coli* stream TMDLs (Table 5). The HSPF model is calibrated to flow monitoring data and provides long term, continuous flow estimates. Simulated flows are available at the downstream end of each model reach. In some cases, HSPF-simulated flows 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.

The model reports (RESPEC 2016, Tetra Tech 2020) describe the framework and the data that were used to develop the model. See also the brief summary of HSPF modeling in the MOS section.

Table 5. Model reaches used to simulate stream flow in impaired reaches in the Snake River Watershed. Reach number refers to the Snake River Watershed HSPF model.

Reach Name	WID	Model Reach Number
Knife River	549	112
Snowshoe brook	558	84
Bean brook	560	109

Reach Name	WID	Model Reach Number
Camp creek	572	125
Unnamed creek	629	116
Unnamed creek	598	116 (area-weighted)
Unnamed creek	577	244 (area-weighted)

Flow duration curves, or load duration curves (LDCs) were developed for each impaired reach with the simulated flows. Flow duration curves relate mean daily flow to the percentage 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 simulated daily average flows (2002 through 2018). When the impaired body of water was not the outpoint of the catchment, the flow data from a similar reach and area-weighted the flow data to the impaired reach in question. 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. The flow duration curves were used to develop the *E. coli* LDCs, described in the following section.

3.4.2 *E. coli* data

The *E. coli* samples in the impaired reaches were collected from 2005-2021 during months April-October. To develop LDCs, all daily average flows were multiplied by the monthly geometric mean water quality standard (i.e., 126 org/100 mL *E. coli*) and converted to a daily load to create "continuous" LDCs 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 LDC, based on the concentration of the sample multiplied by the simulated flow on the day that the sample was taken (see Appendix A).

Monitoring sites for each impaired reach are listed in Table 6 and data are summarized in Table 7 and Figure 10. Individual samples of *E. coli* ranged from <1 to 2,400 org/100 mL. Water quality summary tables are presented for each impairment in Appendix A: E. coli data summaries and TMDLs.

Table 6. Monitoring sites used in *E. coli* analysis of impaired reaches in the Snake River Watershed.

Reach Name	WID	Monitoring site(s)
Knife River	549	S002-675, S002-676, S006-130, S006-558
Snowshoe brook	558	S007-151
Bean brook	560	S006-131
Camp creek	572	S004-636
Unnamed creek	629	S006-134
Unnamed creek	598	S004-638
Unnamed creek	577	S003-358, S003-336

Figure 10. *E. coli* monthly geometric mean concentrations (Apr-Oct, 2005-2021) for all impaired reaches in the Snake River Watershed.

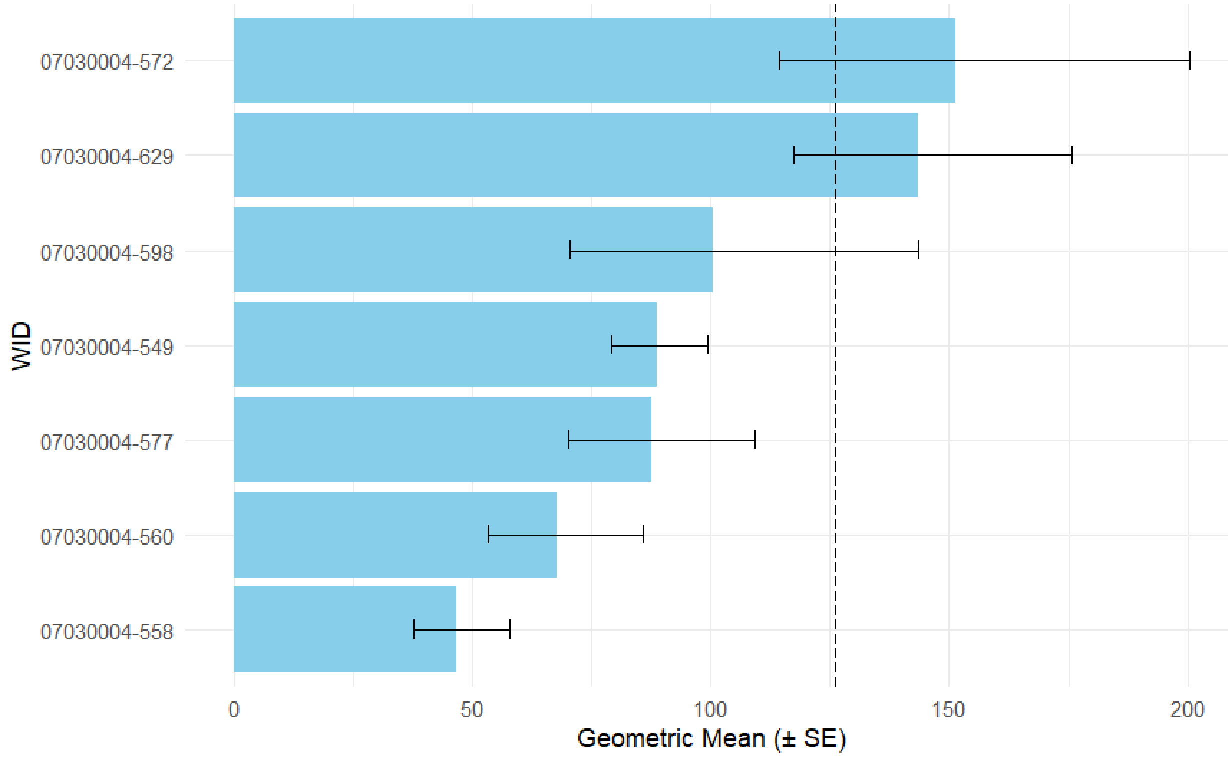


Table 7. Summary of water quality data (2005-2021) for impaired reaches in Snake River Watershed.
E. coli geometric mean and maximum units are org/100mL. All data span from April-October. Additional water quality summary tables are presented for each impairment in Appendix A: *E. coli* data summaries and TMDLs.

Reach name	WID	Sample count	*E. coli* geometric mean	*E. coli* maximum [a]	Frequency of exceedance [b]
Knife River	549	83	89	2,400	13% / 3%
Snowshoe brook	558	45	46	2,400	14% / 2%
Bean brook	560	45	67	1,550	43% / 2%
Camp creek	572	33	151	2,400	71% / 12%
Unnamed creek	629	59	144	2,400	57% / 14%
Unnamed creek	598	32	101	2,400	43% / 22%
Unnamed creek	577	144	84	2,200	20% / 5%

a. The maximum recordable value for *E. coli* concentrations depends on the extent of sample dilution and is often 2400 org/100 mL. Concentrations that are noted as 2400 org/100 mL are likely higher and the magnitude of the exceedances is not known.

b. Frequencies of exceedance: monthly geometric mean standard/individual sample standard. The monthly frequences 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 of data.

3.5 Pollutant source summary

Sources of pollutants in the Snake River Watershed include permitted and nonpermitted sources. The permitted sources discussed here are pollutant sources that require a National Pollutant Discharge Elimination System (NPDES) permit. Most Minnesota NPDES permits are also State Disposal System

(SDS) permits; however, some pollutant sources require SDS permit coverage alone without NPDES permit coverage (e.g., spray, irrigation, large septic systems, land application of biosolids and some feedlots).

The phrase “nonpermitted” does not indicate that the pollutants are illegal, but rather that they do not require an NPDES permit. Some nonpermitted sources are unregulated, and some nonpermitted sources are regulated through non-NPDES programs and permits such as state and local regulations.

3.5.1 Permitted sources

The permitted sources of *E. coli* in the impairment watersheds are two wastewater treatment plants (WWTPs) which are located within the boundaries of the Mille Lacs Band of Ojibwe Reservation but are not owned/operated by the Band. There are no permitted *E. coli* sources of stormwater and no NPDES or SDS permitted animal feedlots.

3.5.1.1 Municipal wastewater

Permitted municipal wastewater can be a source of *E. coli* to surface water. Wastewater is domestic sewage and other wastewater collected and treated by municipalities and industries before being discharged to water bodies as wastewater effluent. Wastewater enters surface water either as treated effluent or through releases of untreated wastewater.

Wastewater dischargers that operate under NPDES permits are required to disinfect wastewater to reduce fecal coliform concentrations to 200 org/100 mL or less as a monthly geometric mean. This standard is protective to the 126 org/100 mL *E. coli* class 2 water standards. Like *E. coli,* fecal coliform is an indicator of fecal contamination. The primary function of 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 2007). 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. There are no permitted combined sewer overflows in the impaired watersheds.

There are two municipal wastewater dischargers, or WWTPs, with fecal coliform effluent limits in the Snake River Watershed and are potential contributors of *E. coli*. The Wahkon and Isle WWTP are located within the Mille Lacs Band of Ojibwe Reservation boundaries and operate under MPCA-issued NPDES permits to the City of Wahkon and City of Isle. The Isle WWTP discharges into a class 2 water and its fecal coliform effluent limit applies between April 1 and October 31. The Wahkon WWTP discharges into a class 7 water and its fecal coliform effluent limit applies from May 1 through October 31. Although this is one month shorter than the April through October time frame of the *E. coli* standard of the downstream impaired reach (water unit identification [WID] 549), the WWTP’s passive (solar) disinfection typical of stabilization ponds is likely to be effective during all months.

A release is an unauthorized discharge of untreated or partially treated wastewater to the environment. Examples include sanitary sewer overflows (SSOs) from a plugged collection system or pumping untreated wastewater out of a manhole to a nearby ditch. Unauthorized releases such as SSOs are most common when wastewater systems are inundated with rain/snow melt or from pump or electrical failures. While NPDES permits do not authorize the discharge of untreated or partially treated wastewater, releases are sometimes necessary or unavoidable for several reasons, including electrical or mechanical failures, flows that exceed the collection system's designed capacity, and treatment system problems. When releases occur, the WWTP operator is required to immediately contact the Minnesota Duty Officer, discontinue the release as soon as possible, recover all substances and materials, if possible, collect representative sample(s) of the release, and report sample results to the MPCA.

There is a meaningful distinction between wet weather and dry weather releases. Wet weather releases occur when flows overwhelm a WWTP or its collection system. The excess rain/snow melt or groundwater can enter the wastewater collection system through inflow and infiltration (I&I) from storms, floods, or groundwater due to leaky sewer systems and noncompliant private service lateral lines, as well as improper connections such as sump pumps, foundation drains, or downspouts that are connected to the sanitary sewer. When excess water overwhelms the designed capacity of the collection system or the WWTP, the release of untreated or partially treated wastewater may be necessary to protect wastewater infrastructure and avoid imminent public health threats associated with sewage backflow into homes and businesses (MPCA 2020a). Wet weather releases are often relatively diluted compared to full strength wastewater, although even dilute wastewater may contain disease causing microorganisms. Because receiving water bodies are typically at high flows during wet weather events, the water quality impact of wet weather releases can be relatively minor. Dry weather releases, which are often due to mechanical failures, can deliver full strength wastewater to water bodies during base flow or low flow, and the resulting water quality impacts can therefore be greater than those associated with wet weather releases.

The degree of environmental harm posed by a release depends on the volume, flow rate, and length of time of the release; the strength of the release; and the volume and flow rate of the receiving water body. For example, a high strength discharge to a small river that is at low summer flow may be harmful. A more diluted discharge to a large river under high flow conditions will have less of an effect. Releases during conditions of flooding may have little measurable impact on water quality.

The wastewater releases that occurred in the Snake River Watershed from 2016 through 2024 were due to mechanical failures (Table 8). Dry weather releases ranged from zero to two releases annually. There were no wet weather releases during this time.

Table 8. Wastewater releases from the WWTPs in the impaired reaches of the Snake River Watershed 2016-2024.

Release type	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Wet weather	0	0	0	0	0	0	0	0	0	0
Mechanical failures	0	0	2	0	1	1	1	0	2	7

Monthly geometric means of effluent monitoring data are used to determine compliance with permits limiting effluent fecal coliform to 200 org/100 mL. There have not been any exceedances at either facility in the last 10 years. Both facilities have also regularly reported values well below the permitted limits over the last year with Wahkon ranging from 2 to 88 org/100 mL fecal coliform, and Isle ranging from 5.6 to 92 org/100 mL. The MPCA has determined that the WWTPs are not significant contributors to *E. coli* impairments in the Snake River Watershed.

The effect of releases of untreated wastewater on *E. coli* concentrations in the impaired waters is not known; quantities, types and treatment levels of the released wastewater, as well as weather and stream flow conditions, across the reported releases were variable and, in some cases, unknown. Additional information and monitoring in the watershed could be used to further evaluate this source and its potential effect on water quality.

3.5.2 Nonpermitted sources

Nonpermitted sources of *E. coli* in the Snake River Watershed include watershed runoff, nonpermitted feedlots and wastewater, natural background sources, and naturalized *E. coli.* Wahkon and Isle WWTP are point sources of *E. coli* in the Knife River (549) Subwatershed, though their discharge has relatively low amounts of *E. coli*. Because they are stabilization ponds, they are prohibited from discharging during much of the summer sampling season; and therefore, most samples do not reflect bacteria directly discharged from these permitted point sources. Counties are aware of straight pipes in the watershed though data are not available for this source.

3.5.2.1 Watershed runoff

Precipitation that falls in a watershed drains across the land surface, and a portion of it eventually reaches lakes and streams. Pollutants such as fecal bacteria are carried with the runoff water and delivered to surface water bodies. The sources of pollutants in watershed runoff may include use of manure fertilizer, and livestock, pet, and wildlife waste. A portion of the *E. coli* in watershed runoff can be considered natural background sources, which are inputs that would be expected under natural, undisturbed conditions.

Manure is one of the primary sources of *E. coli* that is transported to surface water bodies through watershed runoff in the Snake River Watershed from nonpermitted feedlots and from land application of manure. This source is discussed under non-NPDES/SDS permitted animal feeding operations below.

Watershed runoff from developed areas transport *E. coli* through fecal matter from pets and wildlife. Impervious surfaces (e.g., roads, driveways, and rooftops) connect the locations where fecal matter is deposited to surface waters through stormwater that flows across the landscape into lakes, streams, and wetlands.

3.5.2.2 Non-NPDES/SDS permitted animal feedlots and manure application

Feedlots under 1,000 animal units (AUs) and those that are not federally defined as Concentrated Animal Feeding Operations (CAFOs) do not operate with permits. In Minnesota, feedlots with greater than 50 AUs, or greater than 10 AUs in shoreland areas, are required to register with the county feedlot officer if the county is delegated, or with the MPCA if the county is nondelegated. Facilities with fewer AUs are not required to register. Shoreland is defined by Minn. R. 7020.0300 as land within 1,000 feet from the normal high water mark of a lake, pond, or flowage, and land within 300 feet of a river or stream.

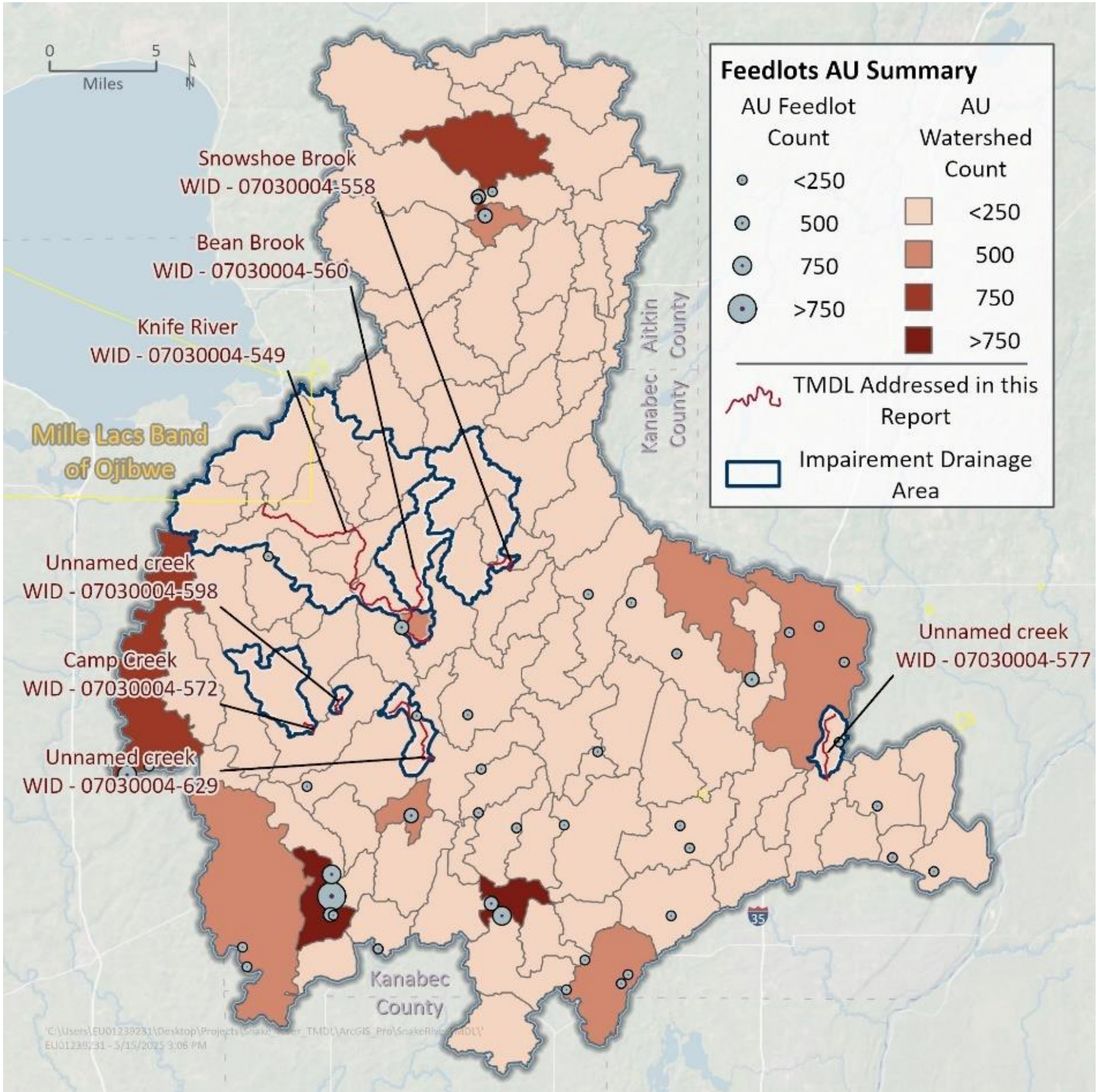
Manure that is generated on feedlots is usually stockpiled on site or on crop fields or stored in liquid manure storage areas on site until field conditions and the crop rotation allows for applying the manure as fertilizer. Manure can be delivered to surface waters from failure of manure containment, runoff from the feedlot itself, or runoff from nearby fields where the manure is applied. The timing of manure spreading, as well as the application rate and method, affects the likelihood of pollutant loading to nearby water bodies. The spreading of manure on frozen soil in the late winter is likely to result in surface runoff with precipitation and snowmelt runoff events. Deferring manure application until snow has melted and soils have thawed decreases overland runoff associated with large precipitation events. Injecting or incorporating manure is a preferred BMP to reduce the runoff of waste and associated pollutants. Incorporating manure into the soil reduces the risk of surface runoff associated with large precipitation events.

Facilities that obtain an interim or construction short form feedlot permit, in addition to feedlots with an operating permit (NPDES or SDS), are required to develop and maintain a manure management plan. Feedlots with more than 300 AUs that use a Commercial Animal Waste Technician to apply their manure and have never obtained a permit are not required to have a manure management plan.

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 possible concern. Minn. R. 7020.2225 contains several requirements for land application of manure*;* however, there are no explicit requirements for *E. coli* treatment prior to land application. Figure 11 shows feedlots throughout the watershed whose manure may be applied to cropland that would be most important as a source of *E. coli* in the impaired regions with 10% to 20% cropland (629, 577, 598); cropland is minimal in the other impairment subwatersheds.

All non-CAFOs are inspected in delegated counties by the county feedlot officer on a routine basis in accordance with the delegated county's Delegation Agreement and Work Plan, which is prepared with and approved by MPCA every other year. Non-CAFOs in nondelegated counties are inspected by MPCA on an as-needed or complaint-driven basis.

Figure 11. Map of registered feedlots and AUs in the Snake River Watershed.



3.5.2.3 Pasture

Pasture is the predominant land use in two of the impaired reaches (WIDs 629 and 598), the second most dominant in two more (WIDs 577 and 558) and a minimal land use in the remaining impaired reaches (WIDs 549, 560, and 572). In many areas, the pastureland crosses the impaired water body suggesting these areas may be impacted more by animals within the streams. Direct contact with animals and the streams could be a significant contributor of *E. coli* in these reaches (Figure 9).

3.5.2.4 Nonpermitted wastewater

Individual subsurface sewage treatment systems

Adequate wastewater treatment is vital to protecting the health, safety, and environment in Minnesota. More than 600,000 Minnesota homes and businesses use subsurface sewage treatment systems (SSTSs). SSTSs that fail to treat wastewater adequately threaten groundwater used for drinking water and surface water used for recreation. Inadequate treatment of wastewater/sewage, which contains bacteria, viruses, parasites, nutrients, and chemicals, can result in contamination of drinking water sources. Additionally, straight-pipe wastewater "systems," which route raw wastewater to the ground or nearby waters, can directly impact lakes, streams, and wetlands.

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 higher levels of pollutant loading to nearby surface waters. To learn more about SSTSs, visit the All about septics webpage provided by the University of Minnesota.

Septic systems that are conforming to industry and design standards do not discharge bacteria. Nonconforming, old or failing septic systems fail to protect groundwater from contamination; these systems include seepage pits, cesspools, drywells, leaching pits, or other pits, and any system with less than the required vertical separating distance from the seasonal high water table. However, these types of failing septic systems are not considered sources of *E. coli* due to longer residence times for groundwater. 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* directly to surface waters. ITPHS typically include straight pipes (i.e., no treatment), effluent ponding at ground surface, effluent backing up into homes, unsafe tank lids, electrical hazards or any other unsafe condition deemed by a certified SSTS inspector. Therefore, not all of the ITPHSs discharge pollutants directly to surface waters.

Currently, the exact number and status of SSTSs in the Snake River Watershed is unknown. However, each year, every county in the state reports estimated SSTS compliance to the MPCA. It should be noted that these rates are county-wide estimates developed using a wide range of methods and resources and are intended for planning purposes only. Estimates of SSTS failure rates in the counties in the Snake River Watershed range from 4% to 20%, and ITPHS rates range from 0% to 7% (Table 12). In general, reported compliance has increased in all counties except for Kanabec County, which has seen a decrease in compliance of 12% compared to 2017 and an increase in ITPHS from 0% to 3%.

Table 9. Average county SSTS failure and ITPHS rates (2017-2024) for counties in the Snake River Watershed. Rates are provided by counties to MPCA and are estimates only; the data does not represent verified compliance status.

County Name	Failing	ITPHS
Kanabec	13%	5%
Mille Lacs	20%	6%
Pine	14%	7%
Isanti	4%	0%

Other potential wastewater sources of *E. coli* in the watershed may include straight pipe discharges, earthen pit outhouses, and land application of septage. 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). Outhouses, or privies, are legal disposal systems and are regulated under Minn. R. 7080.2150, subp. 2F, and Minn. R. 7080.2280. Septage disposal is regulated under Minn. R. 7080, as well as in local and federal regulations. Counties are aware of undocumented straight pipes in the county and working to document and remediate this potential source of *E. coli*.

Areas and communities with SSTS concerns

To ensure that effective sewage treatment occurs across the state, the MPCA regularly conducts surveys of local governmental units to identify areas in the state that may be areas of concern; these areas are defined as five or more homes within a half mile of each other that have inadequate sewage treatment. These areas are generally unincorporated communities, may not have an organized structure, may consist of families with limited financial resources, and often do not qualify for the same financial assistance as large, incorporated communities. As of 2025, there were three communities in the impairment watersheds identified as areas and communities with SSTS concerns. The communities may have been listed because they were known to be noncompliant (i.e., imminent threat to public health and safety that backs up into the house or surface discharges inadequately treated wastewater, or a treatment system that is failing to protect groundwater and has a leaky tank or not enough soil separation under the SSTS before reaching saturated soil conditions) or due to an unknown status of SSTS compliance and were listed because of poor soils in the area, small lot size, or are older systems that may be out of compliance.

3.5.2.5 Natural background sources

"Natural background" is defined in both Minnesota statute and rule. The Clean Water Legacy Act (Minn. Stat. § 114D.15, subd. 10) defines natural background as "characteristics of the water body resulting from the multiplicity of factors in nature, including climate and ecosystem dynamics, which 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." Minn. R. 7050.0150, subp. 4 states, "'Natural causes' means the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a water body in the absence of measurable impacts from human activity or influence."

Natural background sources are inputs that would be expected under natural, undisturbed conditions. Natural background sources can include inputs from wildlife. 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 water body assessment process. Natural background conditions were evaluated within the source assessment portion of this study. These source assessments indicate that natural background inputs are generally low compared to livestock, noncompliant SSTSs, and other anthropogenic sources.

Based on the MPCAs water body assessment process and the TMDL source assessments, there is no evidence at this time to suggest that natural background sources are major drivers of any of the impairments and/or affect the water bodies' ability to meet state water quality standards.

3.5.2.6 Naturalized *E. coli*

The adaptation and evolution of naturalized *E. coli* that allows survival and reproduction in the environment make naturalized *E. coli* physically and genetically distinct from *E. coli* that cannot survive outside of a warm-blooded host. This naturalized *E. coli* may be a source of *E. coli* to the impairments.

The relationship between *E. coli* sources and *E. coli* concentrations found in streams is complex, involving precipitation and flow, temperature, sunlight and shading, livestock management practices, wildlife contributions, *E. coli* survival rates, land use practices, and other environmental factors. 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 warm-blooded host sources. This *E. coli* that persists in the environment outside of a warm-blooded host is referred to as naturalized *E. coli* (Jang et al. 2017). Naturalized *E. coli* can originate from different types of *E. coli* sources, including 1) natural background sources such as wildlife and 2) human attributed sources such as pets, livestock, and human wastewater. Therefore, whereas naturalized *E. coli* can be related to natural background sources, naturalized *E. coli* is not always from a natural background source.

There is diverse and recent evidence for *E. coli* persistence in environments across Minnesota (Ishii et al. 2010, Ishii et al. 2006, Chandrasekaran et al. 2015, Burns & McDonnell Engineering Company, Inc. 2017), though differentiating between naturalized and recent *E. coli* populations requires more testing (Tymensen et al. 2015).

Although naturalized *E. coli* might exist in the watershed, there is no evidence to suggest that naturalized *E. coli* is a major driver of impairment and/or affect the water bodies' ability to meet state water quality standards.

3.5.3 Results of microbial source tracking

The behavior of fecal bacteria in the environment is complex. Concentrations of fecal bacteria in a water body 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, and Burns & McDonnell 2017). See Water Quality and Bacteria

Frequently Asked Questions (MPCA 2019) 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 fecal bacteria make it impossible to definitively state when pathogens are present, though MST helps us to understand more about the source of bacteria in a water body.

Samples were collected for MST to determine the sources of bacteria in the Snake River Watershed. Samples were taken collaboratively with the University of Minnesota in June and August of 2021 from within the impaired reaches and around the larger Snake River Watershed and represent baseflow conditions (Figure 12). Human sources of bacteria were the most common throughout the study and were detected at all sites in June, but in only four of the seven impaired reached in August. Bovine sources were found in two of the impaired reaches in June but were not detected in any of the impaired reaches in August. Goose sources were found in one of the impaired reaches in June but were rare in general and not found in any samples in August (Table 10). Even so, the other subwatersheds, without permitted wastewater discharges, still showed human sources as the dominant bacterial source at the time the samples were collected suggesting that the impairment may not be caused by permitted wastewater sources.

The MST results presented in this study should be interpreted with caution due to several limitations in the sampling design. At each site, only two data points were collected within the same year and under similar flow conditions, reducing the temporal and hydrological variability captured. Furthermore, key ancillary parameters that could corroborate observed bacterial patterns were not measured. Although the experimental framework was intended to encompass both base flow and high flow events, both sampling periods occurred during base flow. Consequently, the dataset reflects a narrow range of environmental conditions, which constrains the generalizability of the findings to broader hydrological scenarios. MST data were used to support the identification and assessment of sources of pathogens. MST data were not used to develop the *E. coli* TMDLs or allocations.

Based on results from the microbial source summary and monitoring of *E. coli*, here are the following key conclusions:

- Knife River (549) had exceedances during very high flows-a flow condition not captured during microbial source sampling- (Figure 20) and had human and bovine markers suggesting manure runoff as one of the primary sources of bacteria in the reach.
- Snowshoe Brook (558) had exceedances during very high flows—a flow condition not captured during the microbial source sampling (Figure 23)—suggesting landscape inputs, though the MST study only detected human originated bacteria so further information on potential human inputs like failing SSTS or straight pipes are important to assess.
- Bean Brook (560) had exceedances throughout all flows with the highest exceedance found during very low flows (Figure 26). The MST study only detected human originated bacteria so further information on potential human inputs like SSTS, or straight pipes are important to assess.

- Camp Creek (572) had exceedances mainly during very high and high flows—conditions not captured during microbial source sampling (Figure 29)—suggesting landscape inputs. The MST study only detected human originated bacteria so further information on potential human inputs like SSTS, or straight pipes are important to assess.
- Unnamed Creek (629) had exceedances at all flow conditions (Figure 32). The MST study found evidence of bovine and human originated bacteria in the June sampling period, and no detection of any of the targeted genes in August. Understanding both human and livestock inputs will be important in this subreach.
- Unnamed Creek (598) had exceedances at all flow conditions except for very low flows (Figure 35). The MST study only detected human originated bacteria, and only in June, so further information on potential human inputs like SSTS or straight pipes are important to assess.
- Unnamed Creek (577) had exceedances at high, mid and low flows (Figure 38) and was not sampled for the MST study. This impaired reach is made up of 17.5% cropland and so sources of bacteria could include manure application to fields, or from SSTS systems.

Figure 12. Bacterial source sampling locations.

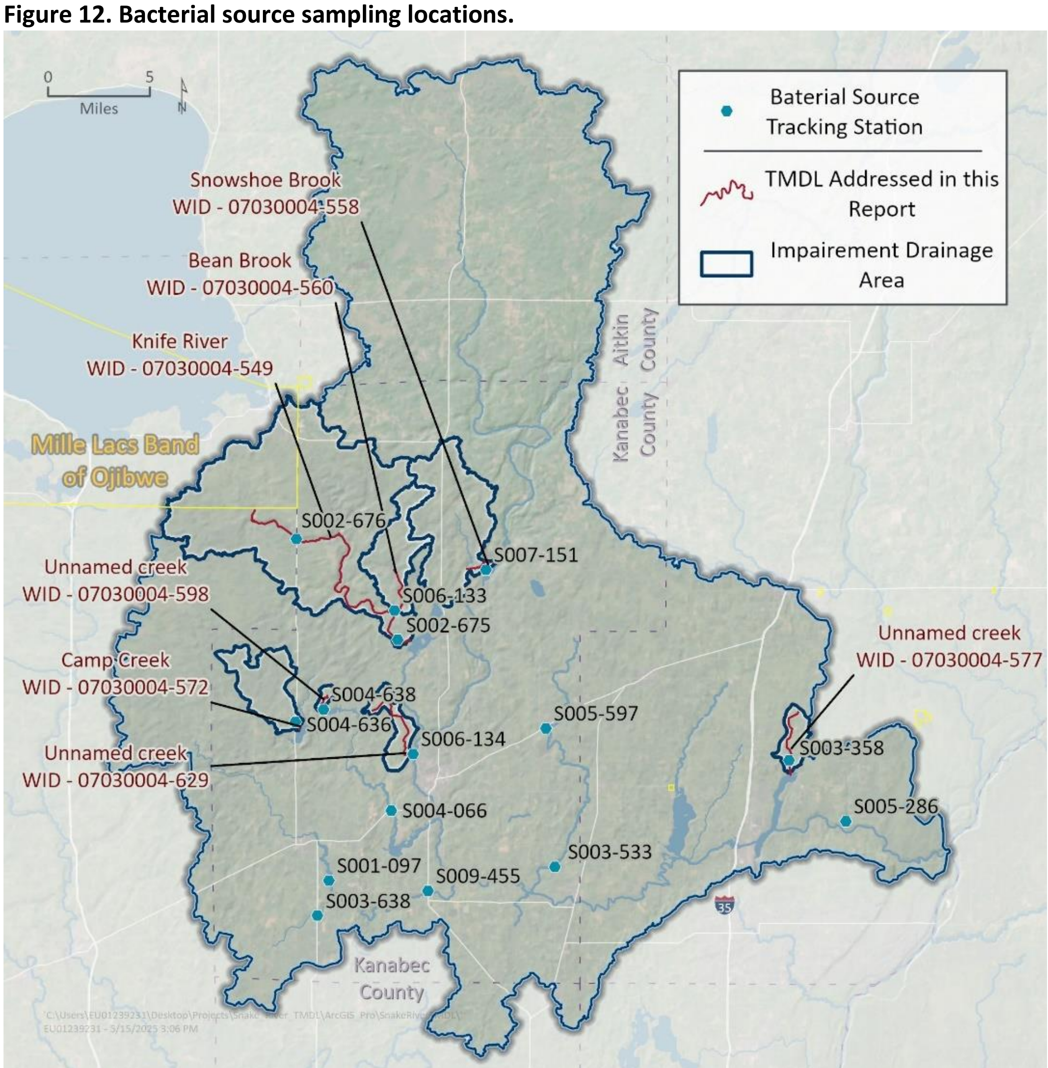


Table 10. Detection of source bacteria listed as detected (D) versus nondetected (N).

June 2021					
WID	**Human**	**Bovine**	**Porcine**	**Beaver**	**Goose**
07030004-511	D	D	N	N	N
07030004-572*	D	N	N	N	N
07030004-629*	D	D	N	N	N
07030004-549*	D	D	N	N	N
07030004-558*	D	N	N	N	N
07030004-598*	D	N	N	N	N
07030004-560*	D	N	N	N	N
07030004-513	D	N	N	N	N
07030004-566	D	N	N	N	N
07030004-512	D	D	N	N	N
07030004-512	D	D	N	N	N
07030004-598*	D	D	N	N	D
07030004-514	D	D	N	N	D
07030004-567	D	N	N	N	D
August 2021					
WID	**Human**	**Bovine**	**Porcine**	**Beaver**	**Goose**
07030004-511	N	D	N	N	N
07030004-572*	D	N	N	N	N
07030004-629*	N	N	N	N	N
07030004-549*	N	N	N	N	N
07030004-558*	D	N	N	N	N
07030004-598*	N	N	N	N	N
07030004-560*	D	N	N	N	N
07030004-513	N	N	N	N	N
07030004-566	D	N	N	N	N
07030004-512	N	D	N	N	N
07030004-512	N	D	N	N	N
07030004-598*	D	N	N	N	N
07030004-514	D	D	N	N	N
07030004-567	N	D	N	N	N

* represents a WID impaired reach in this report

4. TMDL development

A water body's TMDL represents the loading capacity, or the amount of pollutant that a water body can assimilate while still meeting water quality standards. The loading capacity is divided up and allocated to the water body's pollutant sources. The allocations generally include WLAs for NPDES-permitted sources, LAs for nonpermitted sources (including natural background), and an MOS, which is implicitly or explicitly defined. There are no NPDES-permitted sources on nontribal land in these TMDLs, and therefore WLAs are not assigned. The sum of the allocations and MOS cannot exceed the loading capacity, or TMDL. The TMDLs in this report apply April through October.

4.1 Loading capacity methodology

The loading capacities for the *E. coli* impairments were developed using LDCs. See Section 3.4.1 Flow data for a description of LDC development. The loading capacity was calculated as simulated flow at the downstream end of each impaired reach multiplied by the *E. coli* monthly geometric mean standard (126 org/100 mL). The LDC provides loading capacities for all flows observed in the stream along with observed loads calculated from monitoring data and simulated flow. For any given flow in the LDC, the loading capacity is determined by selecting the point on the LDC that corresponds to the flow exceedance (along the x-axis).

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

4.2 Boundary conditions

BCs are used to set aside load for a geographic area in a TMDL watershed without establishing LAs or WLAs for that area. If part of an impairment watershed is in a tribal land, a BC allocates a lump sum load to the area that does not fall under Minnesota's jurisdiction. Minnesota cannot establish allocations for other jurisdictions, and any reductions noted in this TMDL that are needed in the neighboring jurisdiction are consistent with Minnesota's water quality standards and not more stringent (see Section 2.4 for Minnesota and Mille Lacs Band water quality standards).

A BC load is presented in the Knife River TMDL for the portion of the watershed in the Mille Lacs Reservation. The BC load assumes that Minnesota's water quality standards are being met at the boundary and takes into account all point and nonpoint sources in the Mille Lacs Reservation. BCs were calculated using the proportion of the total watershed area in the reservation. Each BC load was calculated as follows:

Boundary condition load =

percent of the total watershed area in Mille Lacs Reservation x loading capacity

4.3 Wasteload allocation methodology

The WLA is allocated to existing or future NPDES-permitted pollutant sources. The two WWTPs in the watershed were not assigned WLAs because they are within the Mille Lacs Reservation BC. Even though the WWTPs' current NPDES permits were issued by the MPCA, states may not establish TMDL allocations (LAs or WLAs) for pollutant sources from tribal lands, per EPA policy.

4.4 Load allocation methodology

The LA is allocated to existing or future nonpermitted pollutant sources. The LA was calculated as:

LA=TMDL-MOS-BC (if present)

Natural background conditions were also evaluated, where possible, within the modeling and source assessment portion of this study (Sections 3.5.2.5). For all impairments addressed in this TMDL report, natural background sources are implicitly included in the LA portion of the TMDL tables, and reductions should focus on the major human attributed sources identified in the source assessment.

4.5 Margin of safety

The MOS accounts for uncertainty concerning the relationship between water quality and allocated loads. The MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as a load set aside). An explicit MOS of 10% was included for the Snake River Watershed *E. coli* TMDLs to account for these uncertainties. The use of an explicit MOS accounts for uncertainty in water quality monitoring, environmental variability in flow and pollutant loading, calibration and validation of modeling efforts, uncertainty in modeling outputs, and limitations associated with the drainage area-ratio method used to extrapolate flow data. This MOS is considered to be sufficient given the robust flow dataset and the calibration results of the HSPF model. Simulated flows from the HSPF model were used to develop the LDCs for the *E. coli* impairments (the HSPF model does not simulate *E. coli* loads). The Snake River HSPF model was calibrated for years 2002 to 2009 and validated between years 1995 and 2001. The model conditions were compared to the U.S. Geological Survey (USGS) Gages 05338500, 05337400 in the Snake River Watershed, and USGS Gage 05336700 in the Kettle River Watershed. Calibration results indicate that the HSPF model is a valid representation of hydrologic conditions in the watershed.

4.6 Seasonal variation and critical conditions

The application of LDCs in the *E. coli* TMDLs addresses seasonal variation and critical conditions. LDCs evaluate pollutant loading across all flow regimes including high flow, which is when pollutant loading from watershed runoff is typically the greatest, and low flow, which is when loading from direct sources to the stream typically has the most impact. Because flow varies seasonally, LDCs address seasonality through their application across all flow conditions in the impaired water body.

Seasonal variation and critical conditions are also addressed by the water quality standards. The *E. coli* standards for AQR apply from April through October. These time periods are when AQR is more likely to occur in Minnesota waters and when high *E. coli* concentrations generally occur.

4.7 Reserve capacity

A reserve capacity was not assigned in these TMDLs. Reserve capacity in Minnesota *E. coli* TMDLs is not needed for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target.

4.8 Baseline year

The monitoring data used to calculate the percent reductions are from 2005 through 2021. The baseline year for implementation is 2012 (end of year), the midpoint of the time period. BMPs present on the landscape during the model simulation time period are implicitly accounted for in the model.

4.9 Percent reduction

The estimated percent reductions provide a rough approximation of the overall reduction needed for the water body to meet the TMDL. The percent reduction is a means to capture the level of effort needed to reduce *E. coli* concentrations in the watershed. The percentage 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 existing concentration was calculated as the maximum monthly observed geometric mean *E. coli* concentration for the impaired reach. The percent reduction needed to meet the standard was calculated as the maximum monthly observed geometric mean concentration minus the geometric mean standard (126 org/100 mL) divided by the maximum monthly observed geometric mean concentration (Table 11). By using the highest observed monthly geometric mean, the percent reduction calculation approximates the reduction in concentration (as opposed to load) needed to meet the monthly geometric mean standard overall, aggregated across all flow conditions.

Table 11. Summary of percent reductions needed to meet the *E. coli* standard in impaired reaches of the Snake River Watershed.

Reach name	WID	Maximum observed monthly geometric mean	Percent reduction needed to meet *E. coli* standards
Knife River	549	169	25%
Snowshoe brook	558	157	20%
Bean brook	560	171	26%
Camp creek	572	337	63%
Unnamed creek	629	373	66%
Unnamed creek	598	435	71%
Unnamed creek	577	205	39%

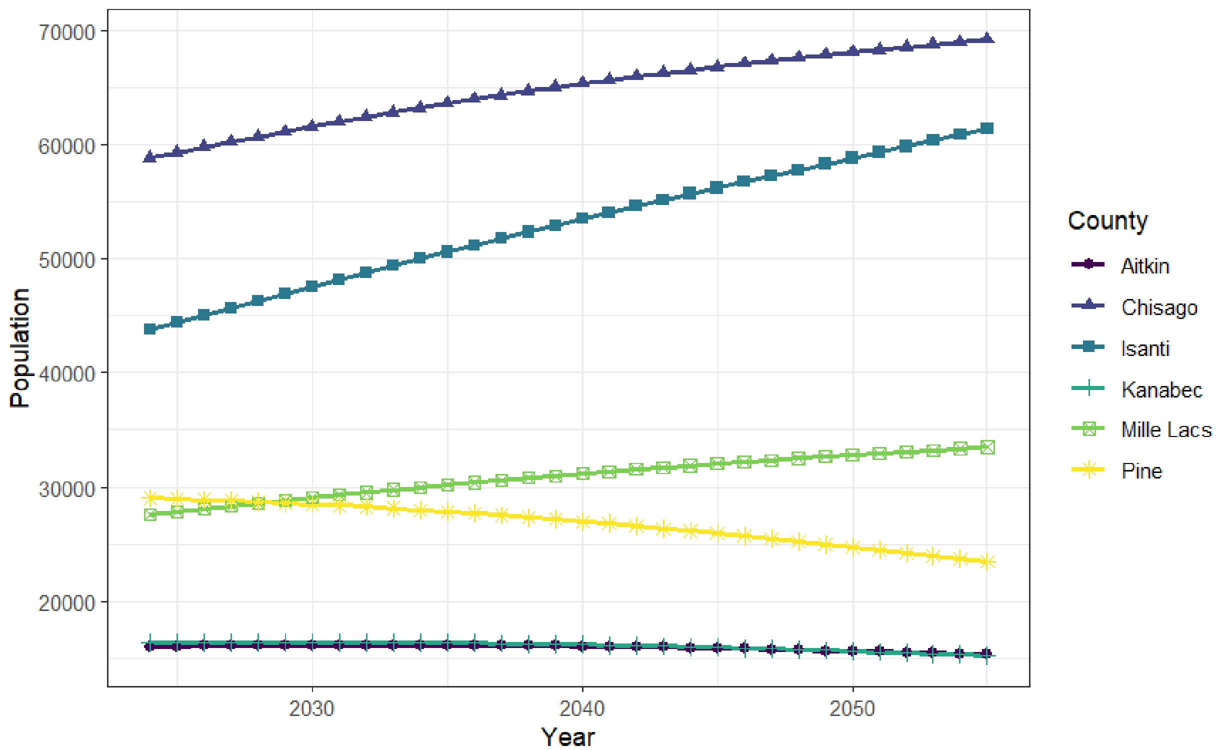
4.10 TMDL summary

The LDCs and TMDL tables are in Appendix A. The estimated percentage reductions needed to meet the *E. coli* TMDLs range from 20% to 71% (Table 11). The LDCs and other *E. coli* analyses were taken as a whole and indicate that the exceedances of the *E. coli* standard occur mostly under mid to very high flows, suggesting landscape interactions, though load reductions are needed to address multiple source types (see 3.5 Pollutant source summary).

5. Future growth considerations

Changes in population and land cover over time in the Snake River Watershed could result in changing pollutant sources and water quality conditions. According to the Minnesota State Demographic Center (Minnesota Department of Administration 2024), the populations in three counties will increase (Chisago, Isanti, Mille Lacs), two counties will experience little change (Aitkin, Kanabec), and one county will decrease (Pine) over the next 30 years (Figure 13). The three counties that are expected to increase are the southernmost counties with some of the largest populations currently in this watershed.

Figure 13. Population projection by county in the Snake River Watershed.



5.1 New or expanding permitted MS4 WLA transfer process

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

1. New development occurs within a permitted municipal separate storm sewer system (MS4). Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.
2. One permitted MS4 acquires land from another permitted MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.
3. One or more nonpermitted MS4s become permitted. If this has not been accounted for in the WLA, then a transfer must occur from the LA.

4. Expansion of a U.S. Census Bureau Urban Area with population over 50,000 encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an urban area at the time the TMDL was completed but are now inside a newly expanded urban area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related source is identified and is covered under an NPDES/SDS 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 permitted MS4, the permittees will be notified of the transfer and have an opportunity to comment.

5.2 New or expanding wastewater

The MPCA, in coordination with the EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to water bodies with an EPA approved TMDL for total suspended solids (TSS) or *E. coli* (described 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.

6. Reasonable assurance

"Reasonable assurance" shows that elements are in place, for both permitted and nonpermitted sources, which are making (or will make) progress toward needed pollutant reductions. In 2014, there were 31 delisted impairments in the Snake River Watershed.

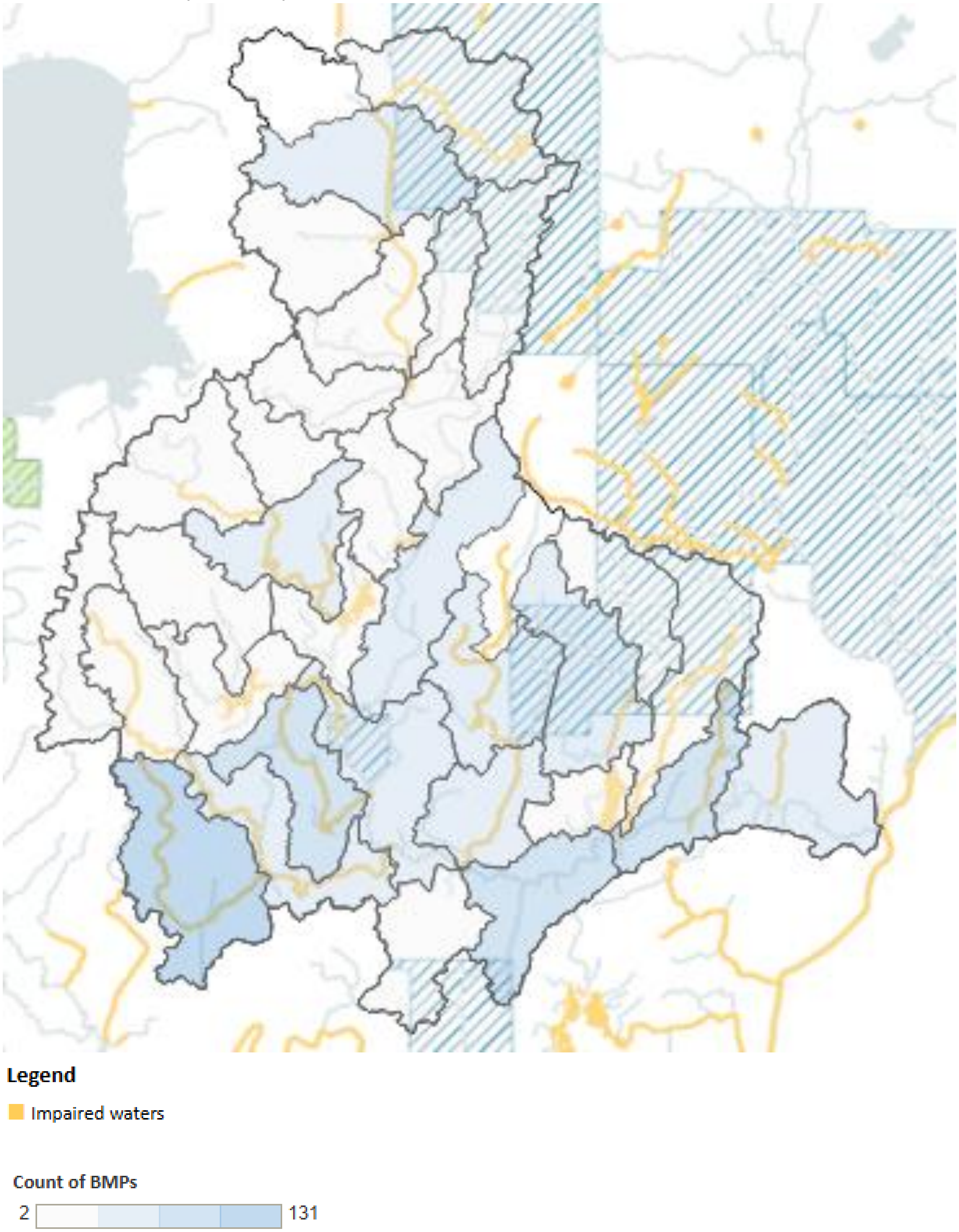
6.1 Reduction of permitted sources

There are two permitted municipal wastewater discharges in the watersheds addressed by these TMDLs. Although these two discharges are not assigned WLAs because they are implicit in the Mille Lacs Reservation BC, permits for any NPDES/SDS permitted facility discharging wastewater that has a reasonable potential to cause or contribute to the water quality impairments addressed by these TMDLs include, or will include upon permit reissuance, effluent limits that are consistent with attainment of water quality standards. Discharge monitoring is conducted by permittees and routinely submitted to the MPCA for review. There are no permitted MS4s, industrial facilities or feedlots in the watersheds of impaired reaches.

6.2 Reduction of nonpermitted sources

Several nonpermitted reduction programs exist to support implementation of nonpoint source reduction BMPs in the Snake River Watershed. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or dedicated funding. Figure 14 shows the number of BMPs that have been implemented per subwatershed, as tracked on the MPCA's Healthier watersheds website. The most common kinds of BMPs in the Snake River Watershed include implementing cover crops, pasture management through prescribed grazing, and installing fencing to help prevent manure entering water ways.

Figure 14. Number of BMPs per subwatershed in the Snake River Watershed; data from the MPCA's Healthier Watersheds website (2004-2024).



Many soil and water conservation districts (SWCDs) coordinate together and are active in the project area, and many provide technical and financial assistance on topics such as septic system assistance, installing buffers and easements, implementing agricultural best management practices (BMP; no till, cover crops, etc.), and limiting livestock access to streams in the area.

The following examples describe large-scale programs that have proven to be effective and/or will reduce pollutant loads going forward.

6.2.1 SSTS Program

SSTS regulation: SSTSs are regulated through Minn. Stat. §§ 115.55 and 115.56. SSTS specific rule requirements can be found in Minn. R. 7080 through 7083. Regulations include the following:

- Minimum technical standards for design and installation of 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 SSTS installation, maintenance, and inspection.

Each county maintains an SSTS ordinance, in accordance with Minn. Stat. and Minn. R., establishing minimum requirements for regulation of SSTS, for the treatment and dispersal of sewage within the applicable jurisdiction of the county, to protect public health and safety, to protect groundwater quality, and to prevent or eliminate the development of public nuisances. Ordinances serve the best interests of the county's residents by protecting health, safety, general welfare, and natural resources. In addition, each county zoning ordinance prescribes the technical standards that on-site septic systems are required to meet for compliance and outlines the requirements for the upgrade of systems found not to be in compliance. This includes systems subject to inspection at transfer of property, upon the addition of living space that includes a bedroom and/or a bathroom, and at discovery of the failure of an existing system.

SSTS assessments: State-sponsored funding programs are available for community-wide septic system assessments. The Public Facilities Authority administers the Small Community Wastewater Treatment Program, which provides grants of up to $60,000 to local government unit (LGUs) to conduct preliminary site evaluations and prepare feasibility reports, provide advice on possible SSTS alternatives, and help develop the technical, managerial, and financial capacity to build, operate, and maintain SSTS systems. These studies assess current SSTS compliance status as well as potential future individual and/or community SSTS solutions.

BWSR has provided grant funds in the past to local governments for large-scale SSTS compliance inspection projects. These projects typically involve riparian communities on impaired water bodies.

SSTS upgrades and replacement: All known imminent threats to public health and safety (ITPHS) are recorded in a statewide database by the MPCA. Some of the alleged straight pipes are typically found to have been abandoned, fixed, or not to be a straight pipe system. The remaining known, unfixed, straight pipe systems receive a notice of noncompliance with a 10-month deadline to be fixed, are issued Administrative Penalty Orders, or are docketed in court.

Many counties and SWCDs offer low interest loan programs for SSTS upgrades or replacement. The MPCA Clean Water Partnership program offers low-interest loans to local units of government for implementing nonpoint source BMPs and other activities that target the restoration and protection of water resources such as lakes, streams, or groundwater aquifers; these funds can be used for SSTS upgrades and replacements. The Small Community Wastewater Program, through the Minnesota Public Facilities Authority, offers grant and loan packages of up to $2,000,000 for the construction of publicly owned community SSTS currently ranked on the MPCA's Project Priority List due to noncomplying septic systems and/or straight pipe systems.

Since 2017, counties within the Snake River Watershed have replaced between 60 to 96 SSTS per year (Table 12). The MPCA, through the Clean Water Partnership Loan Program, has awarded over $4,000,000 to counties within the Snake River Watershed to provide low interest loans for SSTS upgrades since 2010 (Table 13). More information on SSTS financial assistance can be found at the following URL: https://www.pca.state.mn.us/water/ssts-financial-assistance.

Table 12. Estimated SSTS replacements in counties within the Snake River Watershed (2017–2021).

Year	Number of SSTS replaced
2017	60
2018	57
2019	70
2020	96
2021	60

The numbers presented in this figure are county estimates provided to MPCA for reporting purposes and are not intended to be exact values.

Table 13. Clean Water Partnership Loan Program awards per project in the Snake River Watershed.

Project Name	Project Sponsor	Loan Sponsor	Loan Award
Big Sandy	Aitkin County	Aitkin County	$110,080
Big Sandy Continuation	Aitkin County	Aitkin County	$250,000
Snake River Watershed Enhancement	Snake River Watershed Management Board	Kanabec County	$100,000
Snake River Watershed Enhancement Continuation	Snake River Watershed Management Board	Kanabec County	$400,000
Snake River Watershed Resource Protection Project	Snake River Watershed Management Board	Kanabec County	$400,000
Snake River Watershed Resource Protection Project	Snake River Watershed Management Board	Kanabec County	$400,000
Pine County SSTS Upgrades	Pine County	Pine County	$600,000
Pine County SSTS	Pine County	Pine County	$900,000
Mille Lacs County SSTS Upgrades	Mille Lacs County	Mille Lacs County	$200,000
Replacement of Noncompliant Septic Systems	Pine County	Pine County	$750,000
		TOTAL:	**$4,110,080**

6.2.2 Feedlot Program

This section describes the MPCA's Feedlot Program, which addresses both permitted and nonpermitted feedlots. The 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 are subject to this rule. The focus of the rule is on animal feedlots and manure storage areas that have the greatest potential for environmental impact. All feedlots capable of holding 50 or more AUs, or 10 in shoreland areas, are required to register. A feedlot holding 1,000 or more AUs is required to obtain a permit.

The Feedlot Program is implemented through cooperation between MPCA and delegated county governments in 50 counties in the state. There are no delegated counties in the project area for this report and the MPCA is tasked with running the Feedlot Program.

From 2017 through 2025, four feedlot facilities were inspected in the Snake River Watershed, with all four of those inspections occurring at non-CAFO facilities. There have been no additional facilities with manure application reviews within the watershed. Furthermore, beginning in 2025, the MPCA is proposing to amend Minn. R. ch. 7020 to improve land application of manure practices to address nitrate and fish kills, establish additional technical standards to protect water quality and avoid fish kills, address changes in livestock and poultry operational practices, account for new MPCA data services, and modernize outdated rule language.

The Minnesota Department of Agriculture's (MDA's) Agriculture BMP Loan Program provides low interest loans to farmers, rural landowners, and agriculture supply businesses. The purpose is to encourage agricultural BMPs that prevent or reduce runoff from feedlots, farm fields, and other pollution problems identified by the county in local water plans.

6.2.3 Minnesota buffer law

Minnesota's buffer law (Minn. Stat. § 103F.48) requires perennial vegetative buffers of up to 50 feet along lakes, rivers, and streams and buffers of 16.5 feet along ditches. These buffers help filter out phosphorus, nitrogen, pathogens, and sediment. Alternative practices are allowed in place of a perennial buffer in some cases. Amendments enacted in 2017 clarify the application of the buffer requirement to public waters, provide additional statutory authority for alternative practices, address concerns over the potential spread of invasive species through buffer establishment, establish a riparian protection aid program to fund local government buffer law enforcement and implementation, and allowed landowners to be granted a compliance waiver until July 1, 2018, when they filed a compliance plan with the appropriate SWCD.

The Board of Water and Soil Resources (BWSR) provides oversight of the buffer program, which is primarily administered at the local level. Compliance with the buffer law ranges from 99% to 100% for counties in the Snake River Watershed as of January 2024.

6.2.4 Minnesota Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. Those who implement and maintain approved farm management practices will be 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 technical 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. Since the start of the program in 2014, the program has achieved the following (estimates as of January 2026):

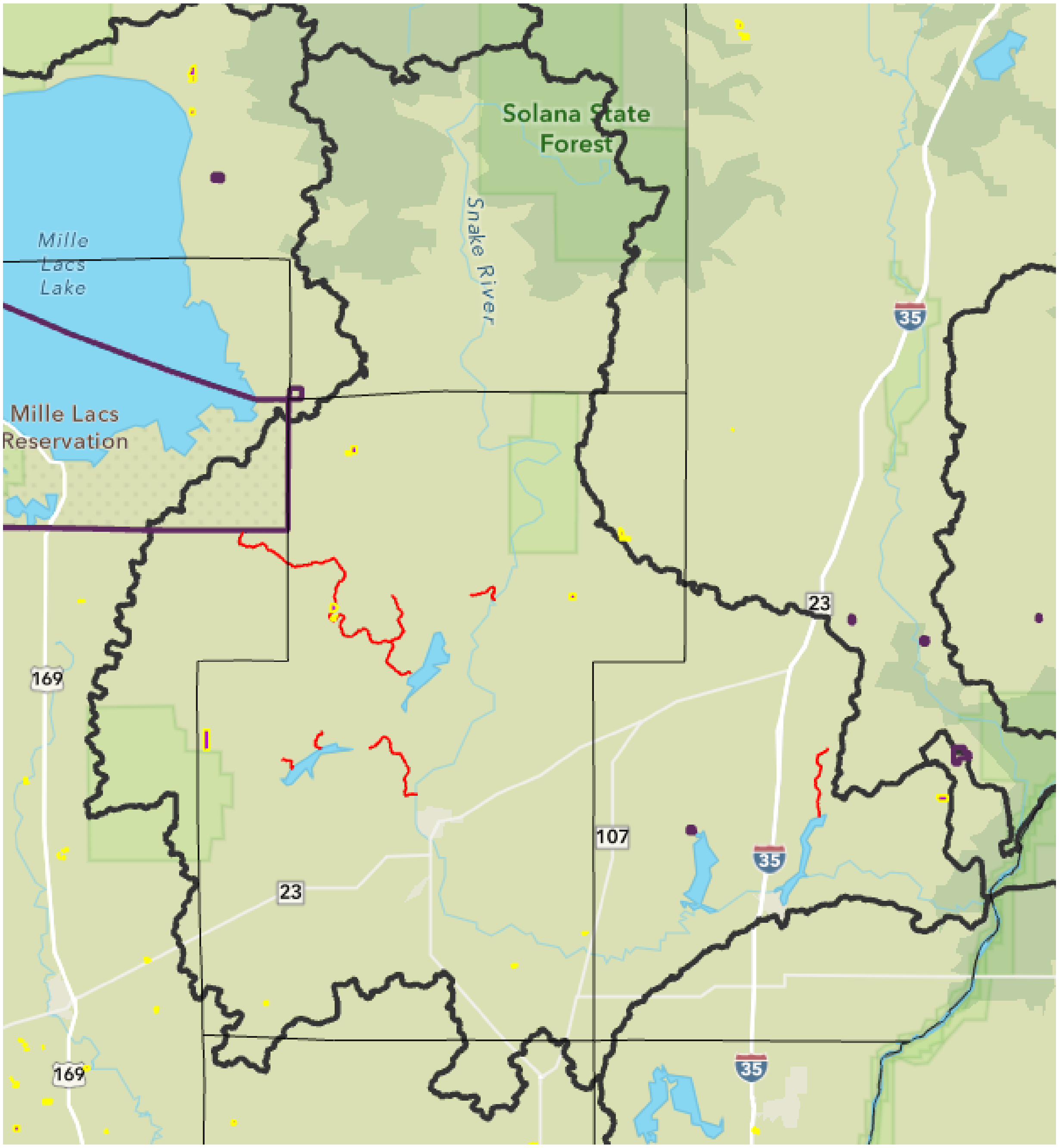
- Enrolled over 1,176,000 acres
- Included 1,739 producers
- Added more than 7,872 new conservation practices
- Kept over 59,000 tons of sediment out of Minnesota rivers
- Saved 166,000 tons of soil and 76,000 lbs of phosphorus on farms
- Cut greenhouse gas emissions by more than 51,000 tons annually

Approximately 15,974 acres in the Snake River Watershed are certified under the MAWQCP (through December 2024.

6.2.5 Conservation easements

Conservation easements are a critical component of the state's efforts to improve water quality by reducing soil erosion, reducing phosphorus and nitrogen loading, and improving wildlife habitat and flood attenuation on private lands. Easements protect the state's water and soil resources by permanently restoring wetlands, adjacent native grassland wildlife habitat complexes, and permanent riparian buffers. In cooperation with county SWCDs, state and federal programs compensate landowners for granting conservation easements and establishing native vegetation habitat on economically marginal, flood prone, environmentally sensitive, or highly erodible lands. These easements vary in length of time from 10 years to permanent/perpetual easements. Conservation easement types in Minnesota include Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP), Reinvest in Minnesota (RIM), and the Wetland Reserve Program (WRP) or Permanent Wetland Preserve (PWP). As of August 2024, in the counties that are located in the Snake River Watershed, there were 1,927 acres of short-term conservation easements such as CRP and 6,692 acres of long term or permanent easements (RIM, WRP), though many of these efforts occur in areas of the county outside the Snake River Watershed (Figure 15).

Figure 15. RIM Reserve state-funded conservation easements in the Snake River Watershed (data from BWSR 2024).



Easements are polygons highlighted in yellow.

6.3 Summary of local plans

Minnesota has a long history of water management by local government, which included developing water management plans along county boundaries since the 1980s. The BWSR-led [One Watershed, One Plan (1W1P)] program is rooted in work initiated by the Local Government Water Roundtable (Association of Minnesota Counties, Minnesota Association of Watershed Districts, and Minnesota Association of SWCDs). The Roundtable recommended that local governments organize to develop focused implementation plans based on watershed boundaries. That recommendation was followed by the legislation (Minn. Stat. § 103B.801) that established the 1W1P program, which provides policy, guidance, and support for developing comprehensive watershed management plans:

- Align local water planning purposes and procedures on watershed boundaries to create a systematic, watershed-wide, science-based approach to watershed management.
- Acknowledge and build off of existing local government structure, water plan services, and local capacity.
- Incorporate and make use of data and information, including WRAPS.
- Solicit input and engage experts from agencies, residents, and stakeholder groups; focus on implementation of prioritized and targeted actions capable of achieving measurable progress.
- Serve as a substitute for a comprehensive plan, local water management plan, or watershed management plan developed or amended, approved, and adopted.

In January of 2023, a 1W1P was published for the Snake River Watershed. Developing the 1W1P involved input from community members, state agencies, counties, and SWCDs. From these efforts, the 1W1P highlights the following goals related to impaired waters:

- Reduce phosphorus loading to impaired lakes by 4,200 lbs over the next 10 years and protect current unimpaired lakes by preemptively reducing phosphorus loads.
- Reduce sediment loading in priority streams and rivers by 1,750 tons over the life of the plan.
- Reduce *E. coli* exceedances in priority impaired streams and rivers by 10%.

There will be a focus on education, outreach, restoration projects, septic upgrades, shoreline protection BMPs, and land protection to achieve these goals. More specifically, work done with the counties will identify and upgrade nonconforming septic systems within shoreline zones, and the SWCDs will promote and install feedlot runoff management (as well as other BMPs) targeting shoreland areas. The plan also identifies a need for more consistent monitoring of impaired reaches.

6.4 Examples of pollution reduction efforts

The Snake River Watershed Plan Partnership, which consists of the Aitkin SWCD, Aitkin County, Kanabec SWCD, Kanabec County, Mille Lacs County SWCD, Pine County SWCD, and Pine County, developed an annual report in 2024 highlighting pollution reduction efforts. The completed efforts highlighted in the report the relate to *E. coli* impairments include septic replacements, livestock watering conversions, and manure pit closures (Snake River Watershed Plan Partnership, 2024). The Snake River Watershed Plan Partnership will continue efforts in each of these categories to improve conditions in the rivers of the Snake River Watershed (Snake River Watershed Partnership Planning 2023).

6.5 Funding

Funding sources to implement TMDLs can come from local, state, federal, and/or private sources. Examples of some of the major funding sources include BWSR's Clean Water Fund Watershed-based Implementation Funding (WBIF), Clean Water Fund Competitive Grants (e.g., Projects and Practices), and conservation funds from Natural Resources Conservation Service (NRCS) (e.g., Environmental Quality Incentives Program and Conservation Stewardship Program).

WBIF is a noncompetitive process to fund water quality improvement and protection projects for lakes, rivers/streams, and groundwater. This funding allows collaborating local governments to pursue timely solutions based on a watershed's highest priority needs. The approach depends on the completion of a comprehensive watershed management plan developed under the 1W1P program to provide assurance that actions are prioritized, targeted, and measurable. The Snake River Watershed was awarded $1,024,471 in WBIF funds in 2024.

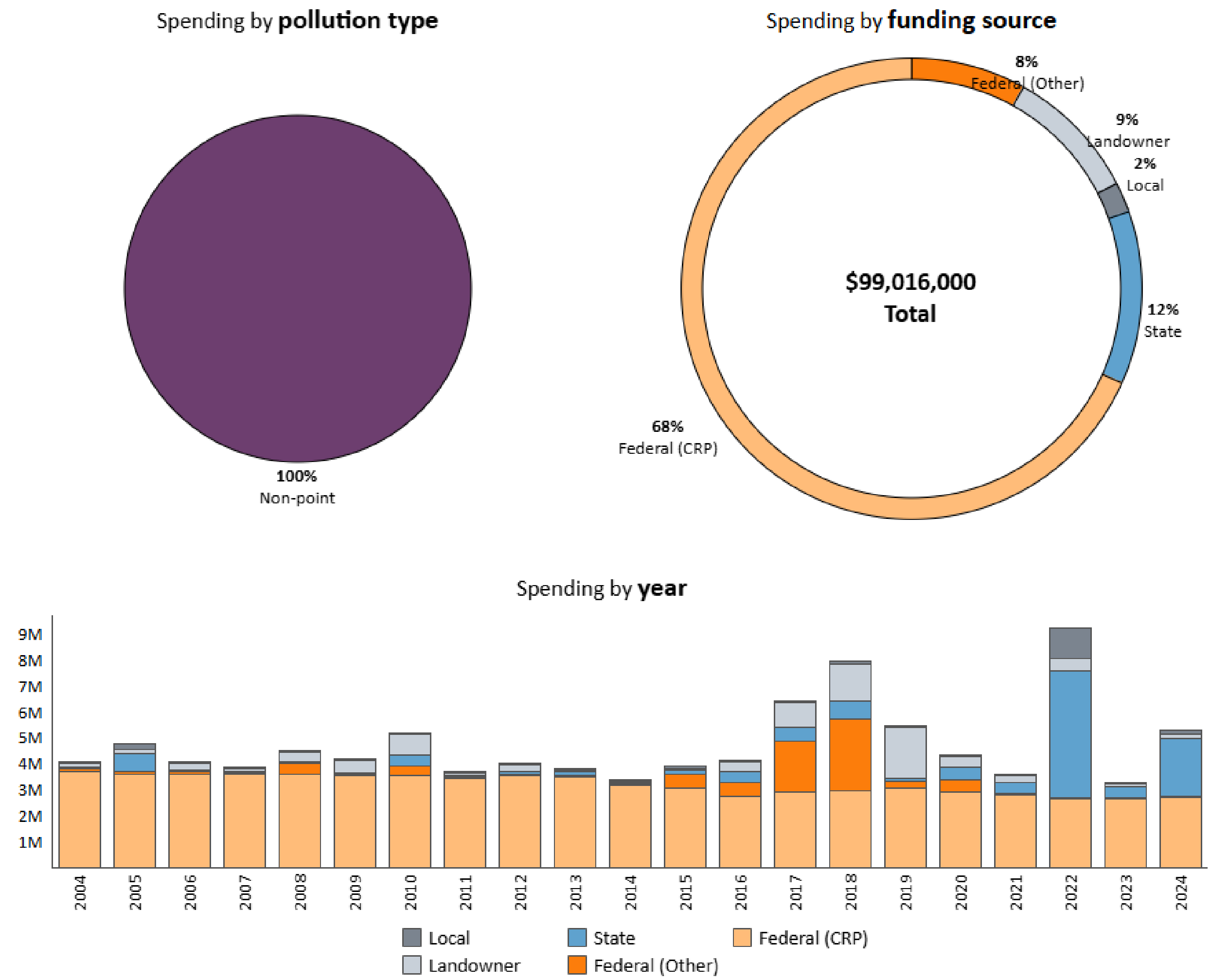
BWSR has been moving more of its available funding away from competitive grants and toward WBIF to accelerate water management outcomes, enhance accountability, and improve consistency and efficiency across the state. This approach allows more clean water projects identified through planning to be implemented without having to compete for funds, helping local governments spend limited resources where they are most needed.

WBIF assurance measures summarize and systematically evaluate how WBIF dollars are being used to achieve clean water goals identified in comprehensive watershed plans. The measures will be used by BWSR to provide additional context about watershed plan implementation challenges and opportunities. The following assurance measures are supplemental to existing reporting and on-going grant monitoring efforts:

- Understand contributions of prioritized, targeted, and measurable work in achieving clean water goals.
- Review progress of programs, projects, and practices implemented in identified priority areas.
- Complete Clean Water Fund grant work on schedule and on budget.
- Leverage funds beyond the state grant.

More than $99,000,000 has been spent cumulatively on watershed implementation projects in the Snake River Watershed from 2004 through 2024 (Figure 16) based on data found on the [MPCA's Healthier watersheds]() website.

Figure 16. Spending for watershed implementation projects in the Snake River Watershed; data from the MPCA's Healthier Watersheds website.



6.6 Other partners and organizations

The Snake River Watershed Landscape Stewardship Plan created by The Nature Conservancy and the Forest Stewards Guild facilitated collaboration between landowners, resource managers, local officials, and other stakeholders to implement landscape stewardship practices to continue to protect the waters in the Snake River Watershed.

6.7 Reasonable assurance conclusion

In summary, significant time and resources have been devoted to identifying the best strategies and BMPs, providing means of focusing them on the Snake River Watershed, and supporting their implementation via state, local, and federal initiatives and dedicated funding. The Snake River WRAPS Update and TMDL process engaged partners to arrive at reasonable scenarios of BMP combinations that attain pollutant reduction goals. Minnesota is a leader in watershed planning and implementation, as well as monitoring and tracking progress toward water quality goals and pollutant load reductions.

7. Monitoring

The monitoring activities below provide an overview of what is expected to occur at many scales in the Snake River Watershed, subject to availability of monitoring resources. The AQR designated uses will be the ultimate measures of water quality. Improving the state of these designated uses depends on many factors, and improvements may not be detected over the next 5 to 10 years or much longer. Consequently, a monitoring plan is needed to track shorter and longer term changes in water quality and land management. Monitoring is important for several reasons:

- Evaluating water bodies 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; and
- Implementing an adaptive management approach to help determine when a change in management is needed.

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

- Monitoring and assessment at the HUC-8 scale associated with Minnesota's watershed approach. This monitoring effort is conducted by the MPCA 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. Intensive water monitoring has been conducted in the Snake River Watershed in 2006, 2017-2018 and is planned for 2028. See the Snake River Watershed Monitoring and Assessment Report (MPCA 2017b) and the Snake River Watershed Assessment and Trends Update (MPCA 2020b) for more information.
- Implementation tracking is conducted by both BWSR (i.e., eLINK) and the U.S. Department of Agriculture (USDA). Both agencies track the locations of BMP installations. Tillage transects and crop residue data are collected periodically and reported through the Minnesota Tillage Transect Survey Data Center. BMP tracking information is readily available through the MPCA's Healthier watersheds webpage.
- Discharges from permitted municipal wastewater sources are reported through discharge monitoring records; these records are used to evaluate compliance with NPDES/SDS permits. Summaries of discharge monitoring records are available through the MPCA's Wastewater Data Browser.

8. Implementation strategy summary

This section summarizes implementation strategies that could be used to help achieve the TMDLs in this report.

For many of the implementation strategies discussed in this section, BMPs will need to be selected, designed, operated, and maintained to account for climate trends, including warmer surface waters and the expected continued increase in the size and frequency of rain events (Section 3.1: Climate trends). Climate change will affect the function of many BMPs, and implementation planning should account for the resilience of BMPs to the impacts of climate change (Johnson et al. 2022).

8.1 Permitted sources

The two wastewater discharges in the Snake River Watershed have existing permit limits that are consistent with attainment of water quality standards. At permit reissuance, water quality-based effluent limit (WQBELs) and/or additional monitoring requirements are considered by permitting staff. Based on review of data available on the MPCA's Wastewater Data Browser, all facilities are currently meeting their fecal coliform effluent limits, which are consistent with this TMDL.

8.2 Nonpermitted sources

Implementation of the Snake River Watershed TMDL will require numerous BMPs that address non-NPDES-permitted sources of *E. coli*. This section provides an overview of the BMPs that may be used for implementation and largely aligns with the goals stated in the 1W1P (Snake River Watershed Partnership Planning 2023). Likely sources of *E. coli* to target for implementation are livestock, manure application, and ITPHS.

Table 14 summarizes example BMPs that can be implemented to achieve goals of the TMDLs. Actual implementation may vary. Descriptions of the BMP examples can be found in *Agricultural BMP Handbook for Minnesota* (Lenhart et al. 2017), the *Minnesota Stormwater Manual* (MPCA 2021), and the University of Minnesota Extension's *Onsite Sewage Treatment Program* website. The Snake River WRAPS Update Report (MPCA 2026) developed concurrently with this report contains a more comprehensive list of implementation strategies.

Table 14. Example BMPs for nonpermitted sources.

Strategy	BMP examples	Targeted pollutant(s)
Agriculture runoff control and manure management	Filter strips and field borders	*E. coli*
Feedlot runoff control	Feedlot reduction and treatment	*E. coli*
	Feedlot manure/storage addition	
Nutrient management	Nutrient management plans	*E. coli*
	Manure incorporation within 24 hours	*E. coli*
Pasture management	Livestock access control	*E. coli*
Septic system improvements	Maintain and replace septic systems	*E. coli*
	Remove straight pipes	
Buffers and filters	Riparian buffers and field boarders	*E. coli*
Education/outreach	Promote BMPs	*E. coli*

8.2.1 SSTS

SSTS assessments, maintenance, and upgrades and replacements address pollutant loading from noncompliant systems (see Section 6.2.1: *SSTS program*). The reductions in loading resulting from upgrading or replacing failing systems in the watershed depend on the level of failure present in the watershed. The most cost-effective approach to managing loads from SSTS is regular maintenance. The EPA recommends that septic tanks be pumped every three to five years depending on the tank size and number of residents in the household (EPA 2002). Annual inspections, in addition to regular maintenance, ensure that systems function properly. Compliance with state and county code is essential to reducing *E. coli* loading from SSTSs.

Education is another crucial component of reducing pollutant loading from SSTS. Education can occur through public meetings, routine SSTS service provider home visits, mass mailings, and radio and television advertisements. An inspection program can also help with public education because inspectors can educate owners about proper operation and maintenance during inspections.

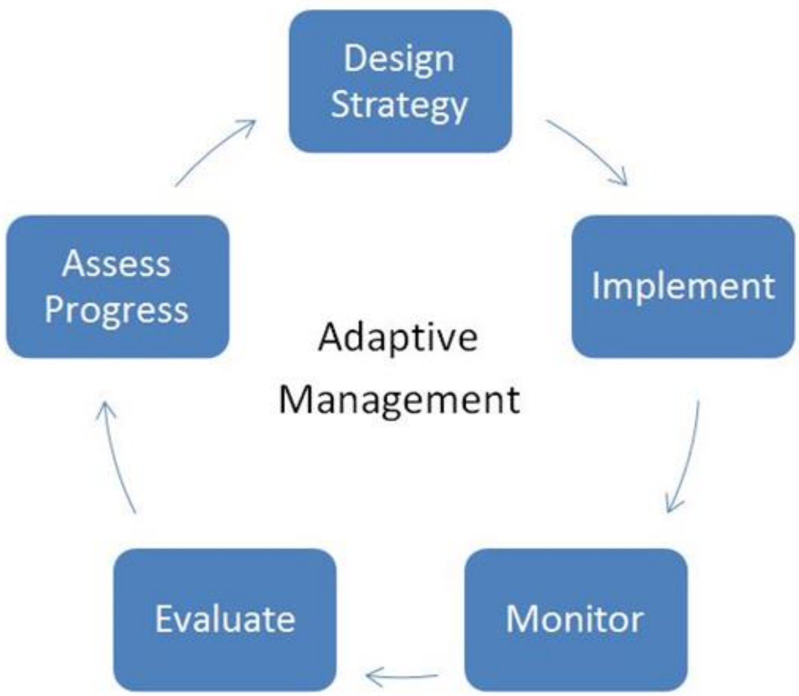
8.3 Cost

The 1W1P for the Snake River Watershed has a goal of reducing *E. coli* exceedances in priority impaired streams and rivers by 10% and estimated it will cost around $2.5 million. This estimate allows for 15 to 20 septic systems to be upgraded and brought into compliance ($400,000), installation of 15 to 20 feedlot runoff management BMPs ($1.5 to $2 million), implementation of 2 to 5 Nutrient Management Plans ($10,000), and the holding of 10 to 30 outreach events ($15,000) educating the public on how to reduce their contributions to the impairments. These reductions would not bring the impaired reaches out of an impaired status given most need greater than 25% reduction, so we estimate the cost to achieve the TMDLs being approximately $7 to $10 million dollars and focus on installing more feedlot runoff management BMPs and upgrading nonconforming septic systems. This range reflects the level of uncertainty in the source assessment and addresses the likely sources identified in Section 3.5.

8.4 Adaptive management

The implementation strategies and the WRAPS Update prepared concurrently with this TMDL report are based on the principle of adaptive management (Figure 17). Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL report. Management activities will be changed or refined as appropriate over time to efficiently meet the TMDL and lay the groundwork for de-listing the impaired water bodies.

Figure 17. Adaptive management



9. Public participation

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from April 13, 2026, through May 13, 2026. There were zero comment letters received and responded to as a result of the public comment period. For further information on public participation for this TMDL report, please see the WRAPS update.

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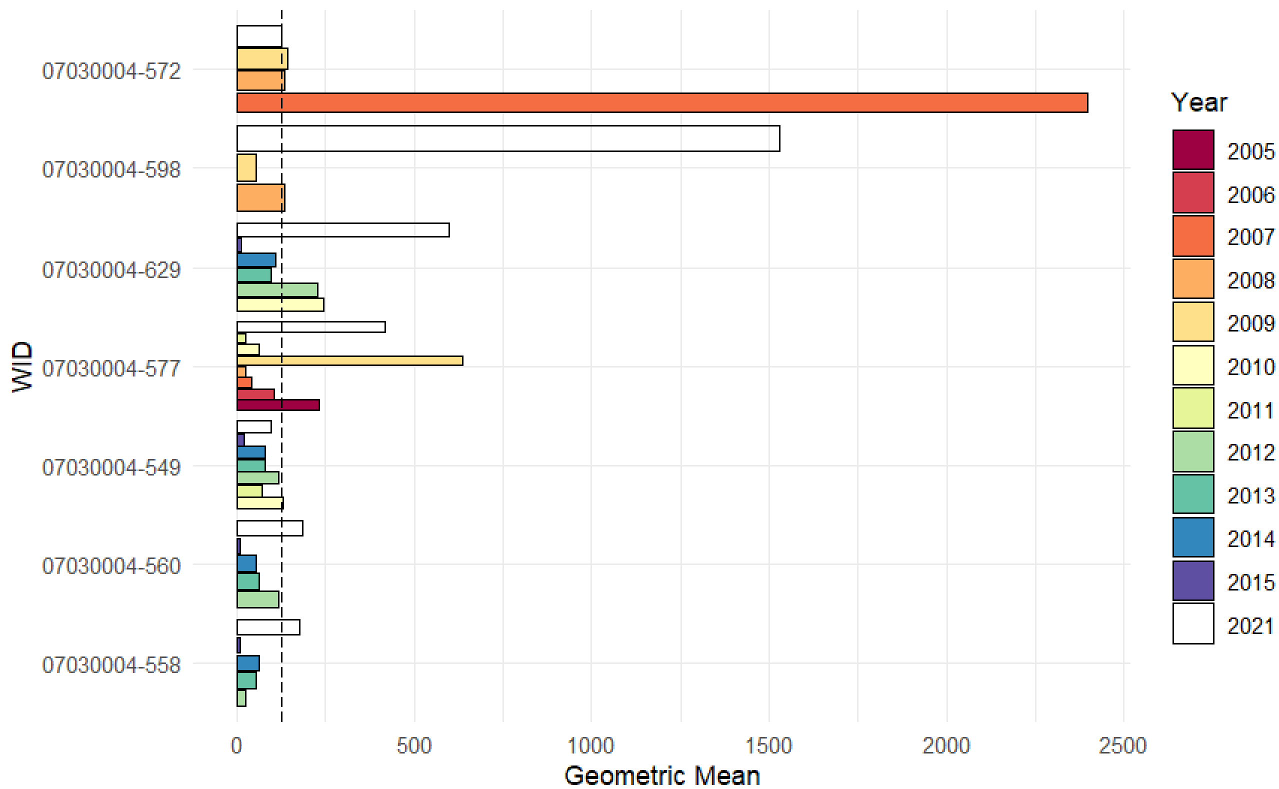
Appendix A. *E. coli* data summaries and TMDLs

All *E. coli* data are from April, May, June, July, August, September, and October spanning the years from 2005 to 2021. The following tables and figures are presented for each impairment:

- *E. coli* data summary by year (Figure 18)
- *E. coli* data summary by month, with all available data across years aggregated
- The LDC displays two curves: (1) The *E. coli* TMDL is based on the monthly geometric mean standard (126 org/100 mL); and (2) the *E. coli* load at the individual sample standard (1,260 org/100 mL) is displayed for reference. The monitoring data are individual sample points.

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.

Figure 18. *E. coli* concentrations (org/100 mL) per WID by year, Apr-Oct.



Knife River (549)

Figure 19. Watershed boundary and land cover for *E. coli* impairment Knife River (549).

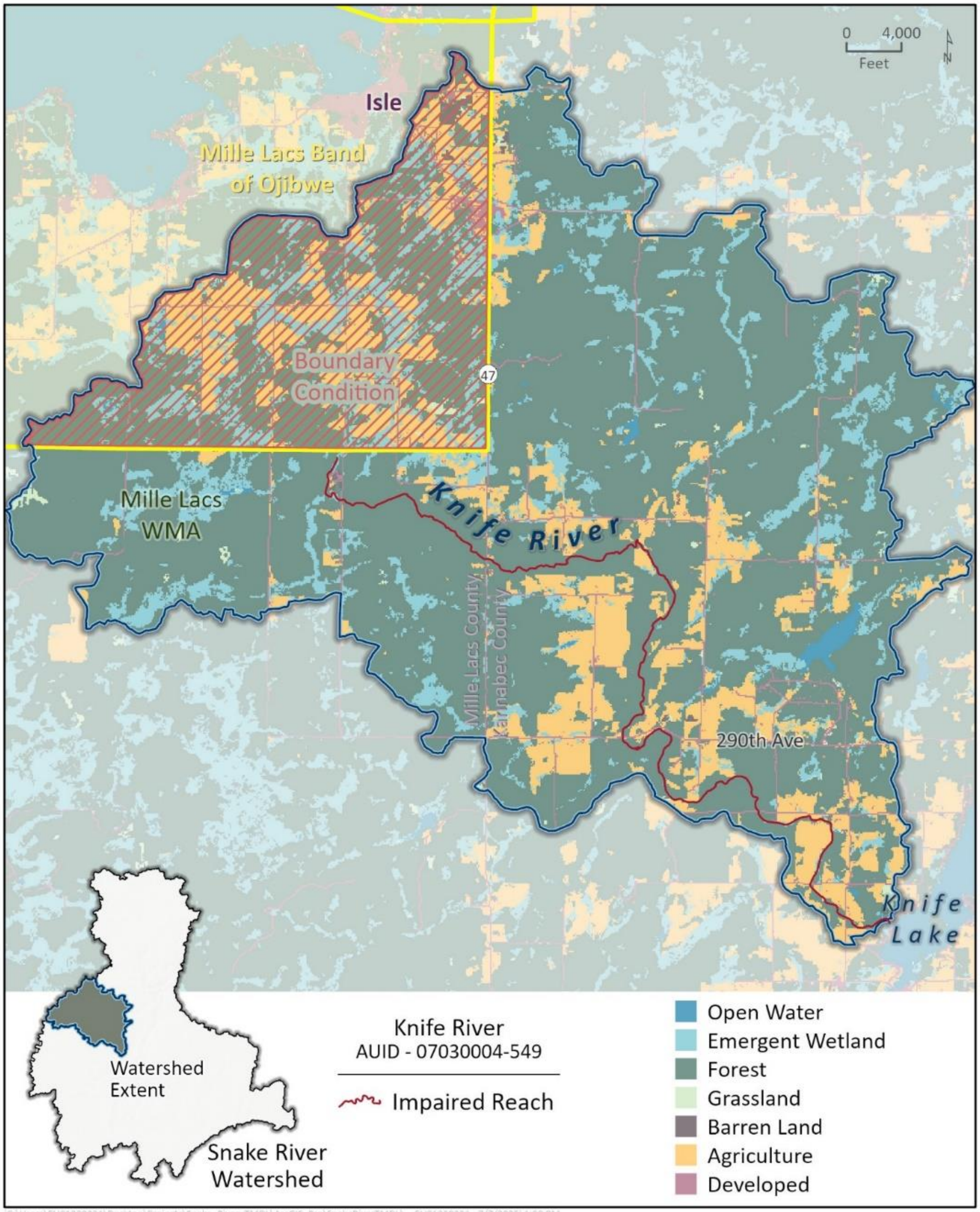


Figure 20. Knife River (07030004-549) *E. coli* load duration curve.

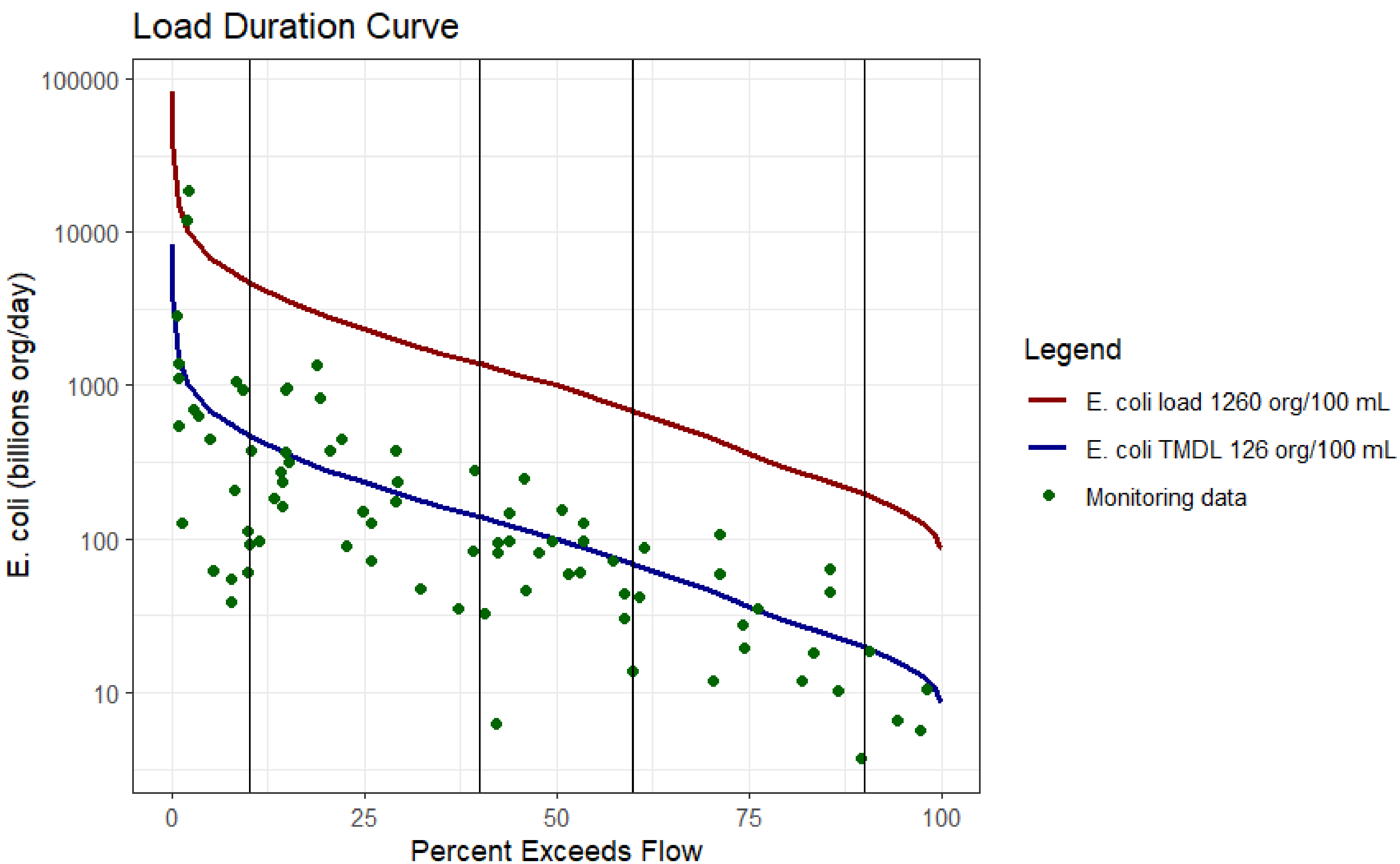


Figure 21. Knife River (07030004-549) *E. coli* concentration with monthly geometric means.

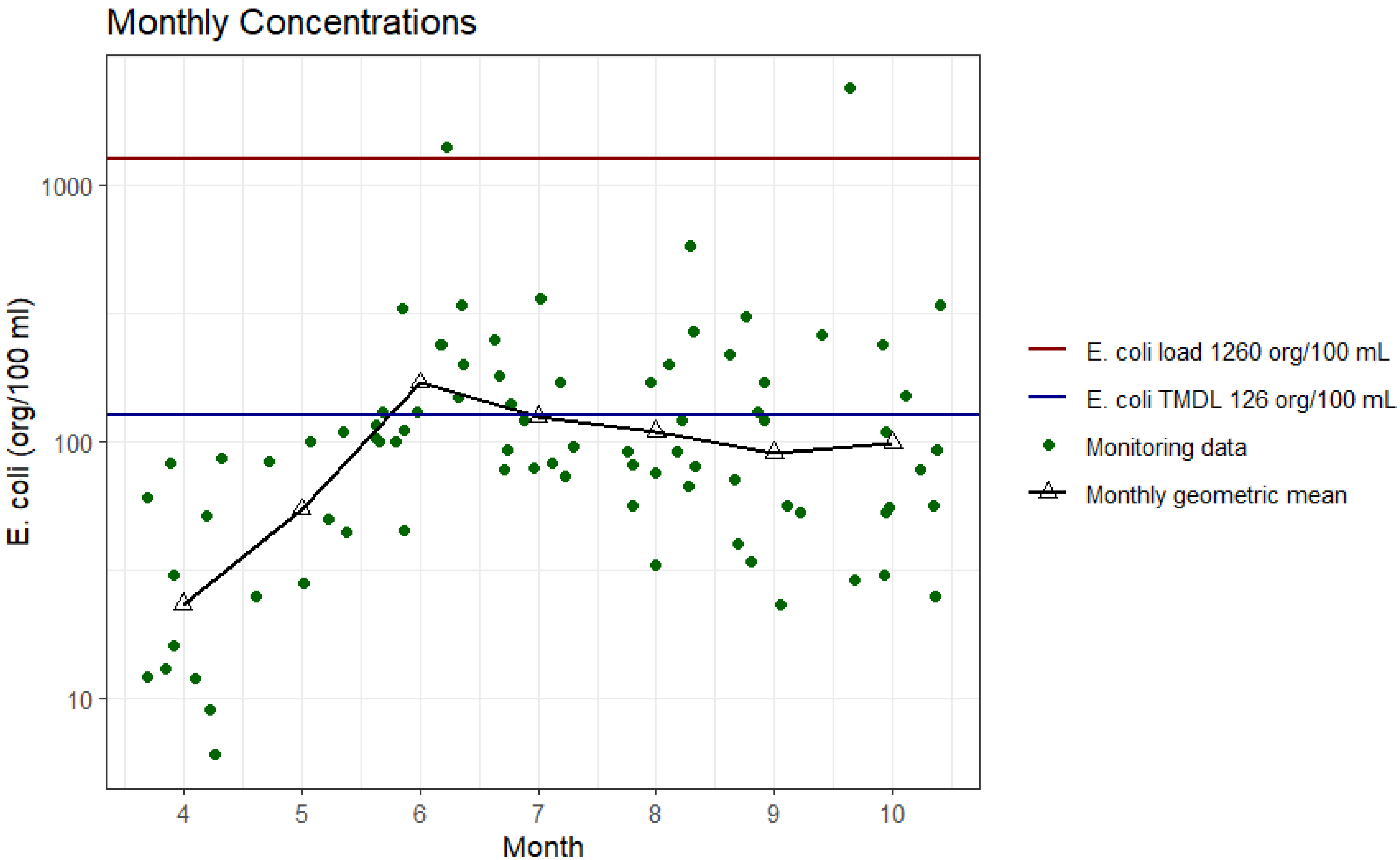


Table 15. Monthly summary of *E. coli* data at Knife River (07030004-549) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	11	23	6	86	0	0%
May	7	54	25	110	0	0%
June	15	169*	45	1400	1	7%
July	12	125	73	360	0	0%
August	13	109	33	580	0	0%
September	12	91	23	310	0	0%
October	13	99	25	2400	1	8%

Table 16. Knife River (07030004-549) *E. coli* TMDL summary

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL E. coli
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	483	150	60	21	10
MOS	53.7	16.7	6.7	2.4	1.1
MN portion of TMDL	537	167	66.7	23.4	11.1
BC (Mille Lacs Reservation)[a]	141	43.9	17.8	6.2	2.9
TMDL	678	211	85	30	14
Maximum monthly geometric mean (org/100 mL)a	169				
Estimated percent reduction[b]	26%				

a. The Mille Lacs Reservation BC implicitly includes discharge from the Wahkon and Isle WWTPs. The BC assumes that the *E. coli* concentration in the Knife River Watershed streams that flow out of the Reservation has a geometric mean of 126 org/100 mL.

b. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Snowshoe Brook (558)

Figure 22. Watershed boundary and land cover for *E. coli* impairment Snowshoe Brook (558).

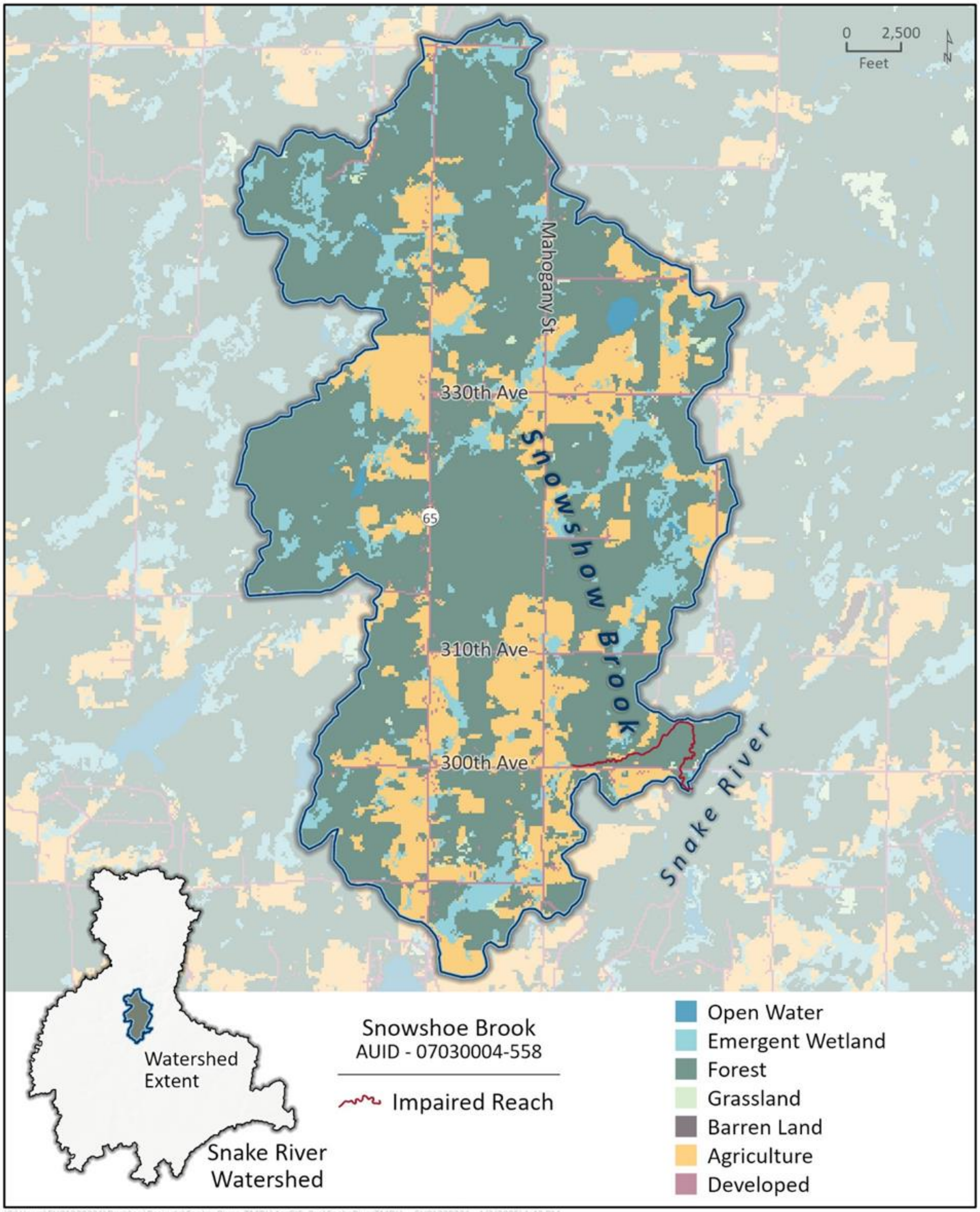


Figure 23. Snowshoe Brook (07030004-558) *E. coli* load duration curve.

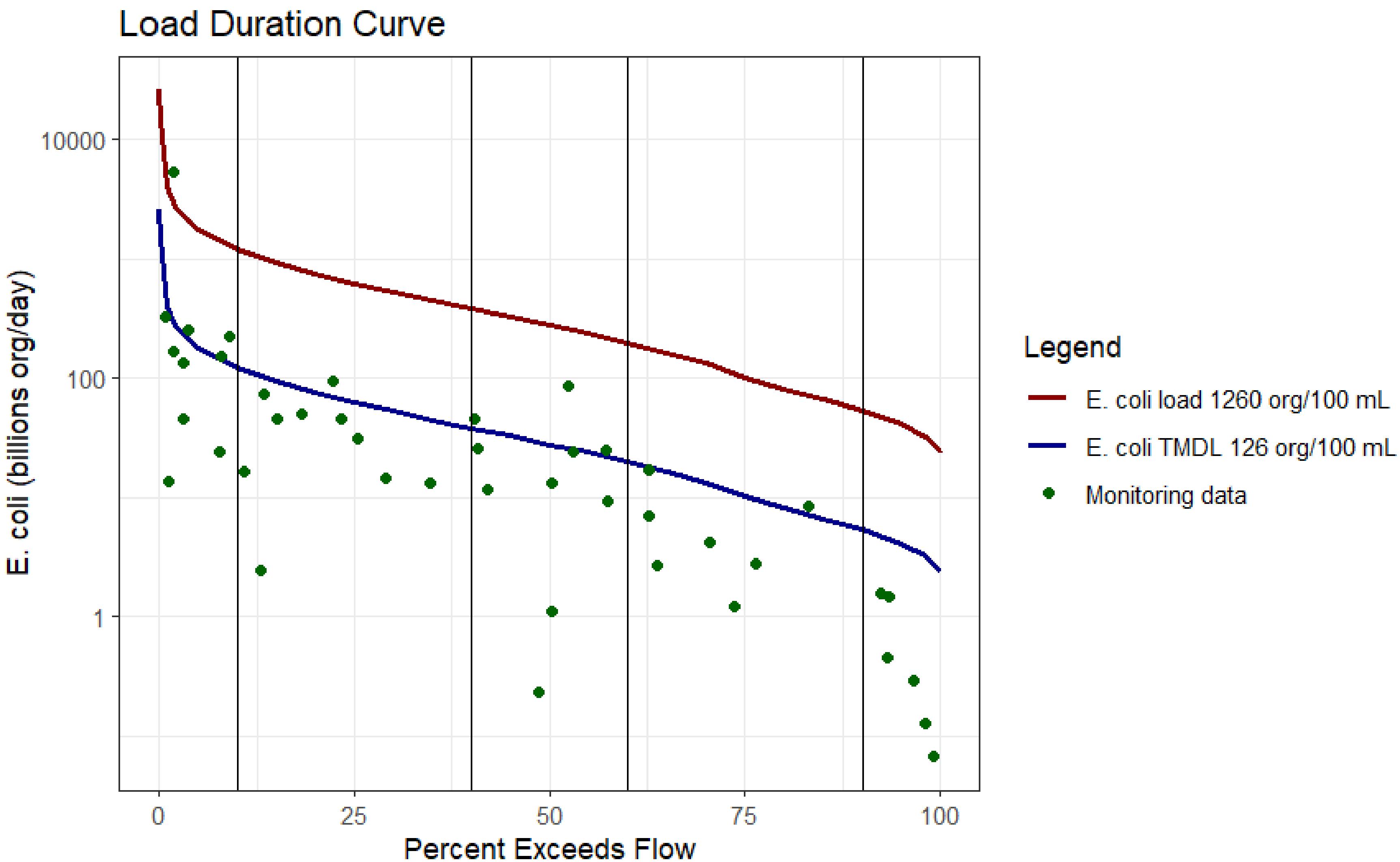


Figure 24. Snowshoe Brook (07030004-558) *E. coli* concentration with monthly geometric means.

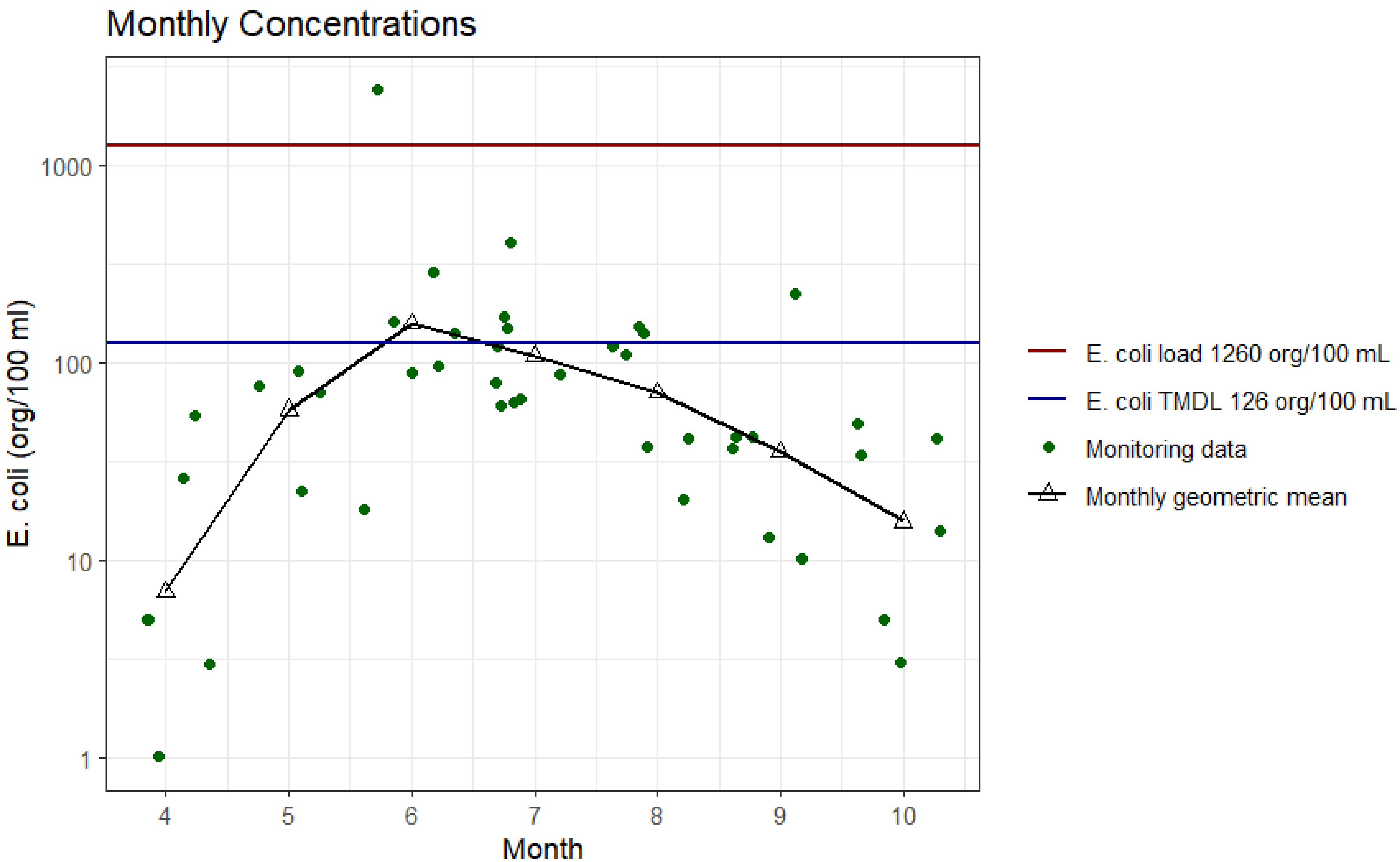


Table 17. Monthly summary of *E. coli* data at Snowshoe Brook (07030004-558) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	6	7	1	53	0	0%
May	4	57	22	91	0	0%
June	7	157*	18	2400	1	14%*
July	9	108	60	410	0	0%
August	7	70	20	150	0	0%
September	6	35	10	220	0	0%
October	6	16	3	49	0	0%

Table 18. Snowshoe Brook (07030004-558) *E. coli* TMDL summary.

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	158	52.2	21.6	7.5	3.5
MOS	17.5	5.8	2.4	0.8	0.4
TMDL	175	58	24	8.3	3.9
Maximum monthly geometric mean (org/100 mL)[a]	157				
Estimated percent reduction[a]	20%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Bean Brook (560)

Figure 25. Watershed boundary and land cover for *E. coli* impairment Bean Brook (560).

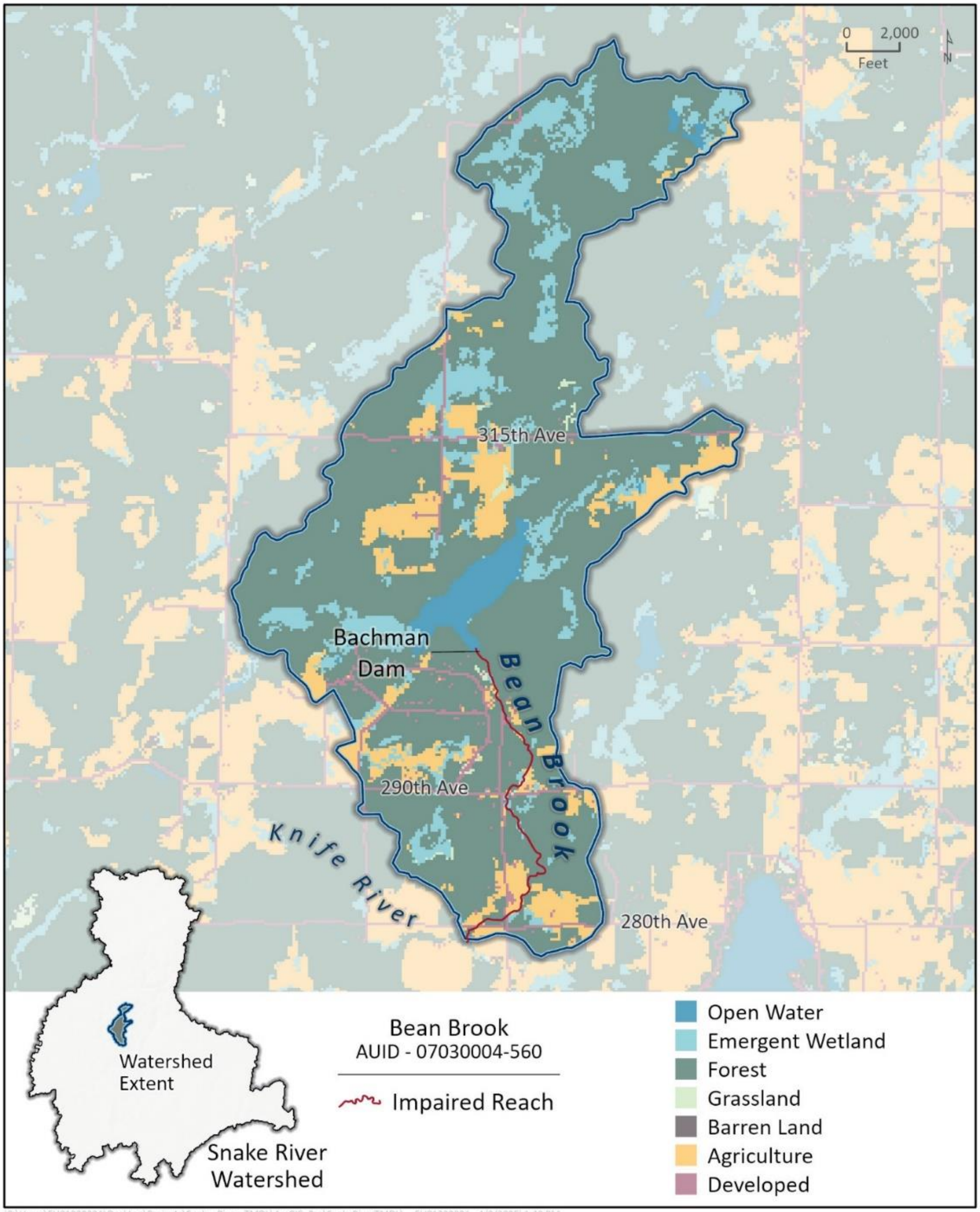


Figure 26. Bean Brook (07030004-560) *E. coli* load duration curve.

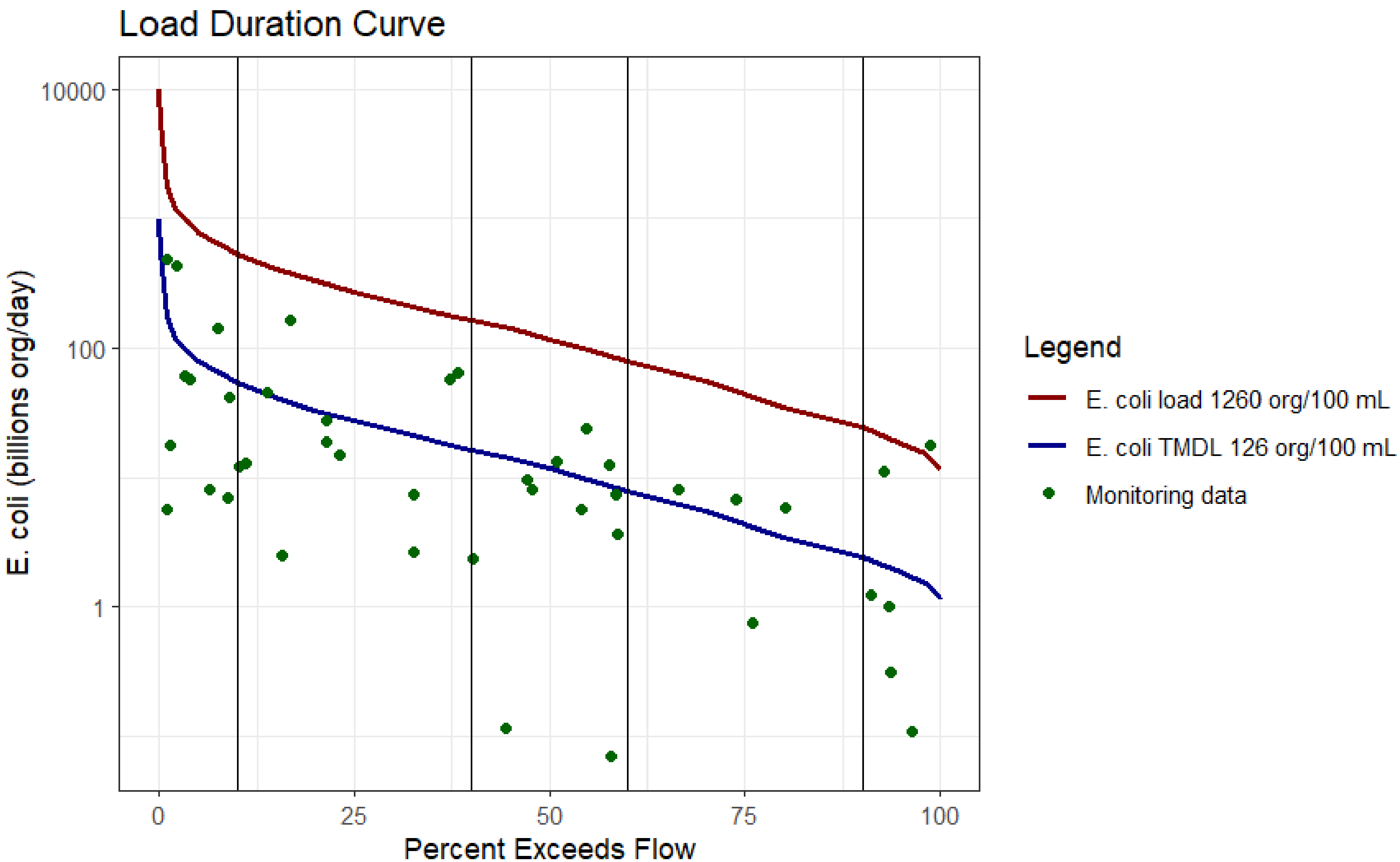


Figure 27. Bean Brook (07030004-560) *E. coli* concentration with monthly geometric means.

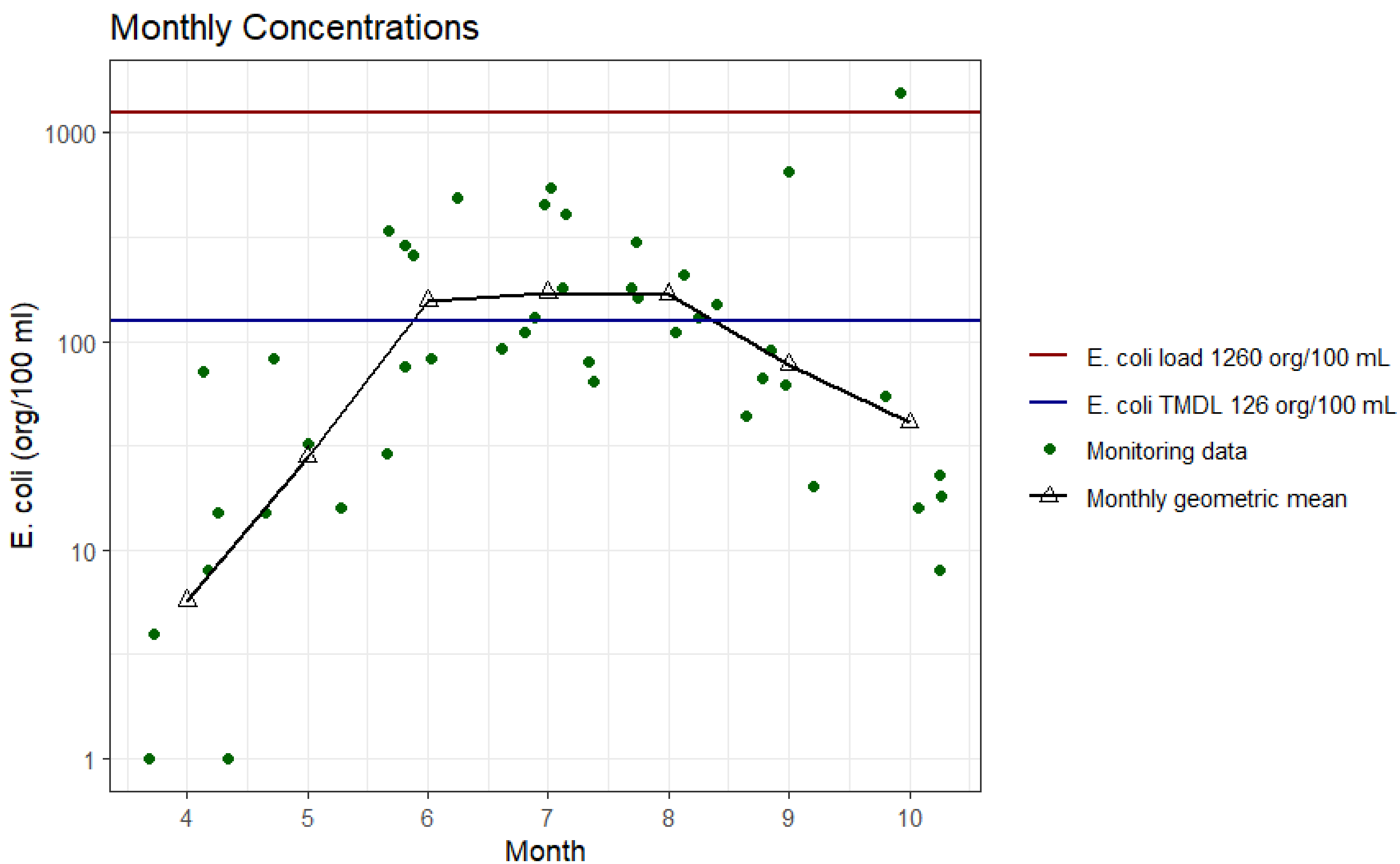


Table 19. Monthly summary of *E. coli* data at Bean Brook (07030004-560) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	6	6	1	71	0	0%
May	4	28	15	82	0	0%
June	7	156*	29	490	0	0%
July	9	171*	64	550	0	0%
August	7	168*	110	300	0	0%
September	6	77	20	650	0	0%
October	6	40	8	1550	1	17%*

Table 20. Bean Brook (07030004-560) *E. coli* TMDL summary.

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	**High**	**Mid**	**Low**	**Very low**
Total LA	69.7	22.4	8.7	3.2	1.5
MOS	7.8	2.5	1.0	0.4	0.2
TMDL	77.5	24.9	9.7	3.6	1.7
Maximum monthly geometric mean (org/100 mL)[a]	171				
Estimated percent reduction[a]	26%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Camp Creek (572)

Figure 28. Watershed boundary and land cover for *E. coli* impairment Camp Creek (572).

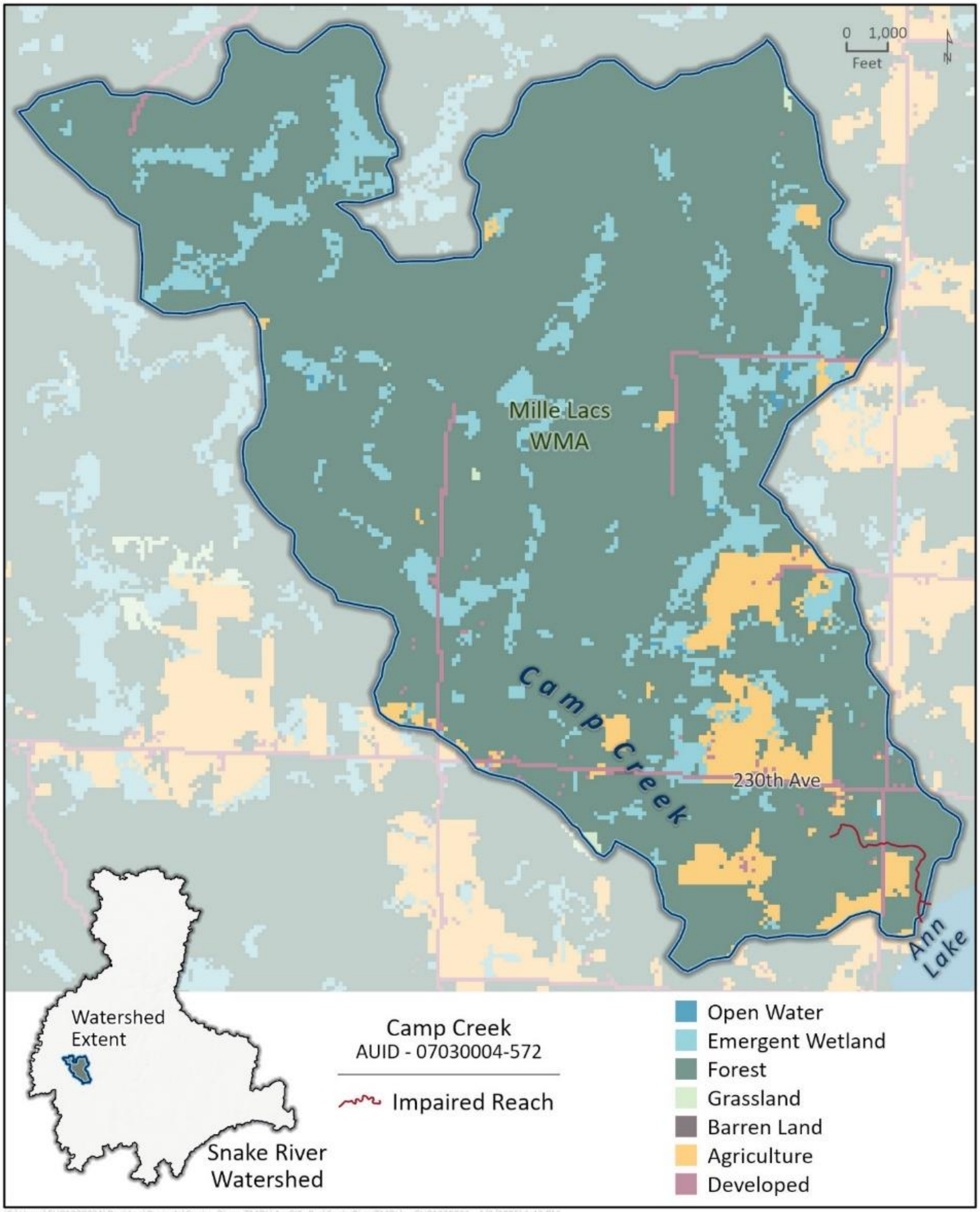


Figure 29. Camp Creek (07030004-572) *E. coli* load duration curve.

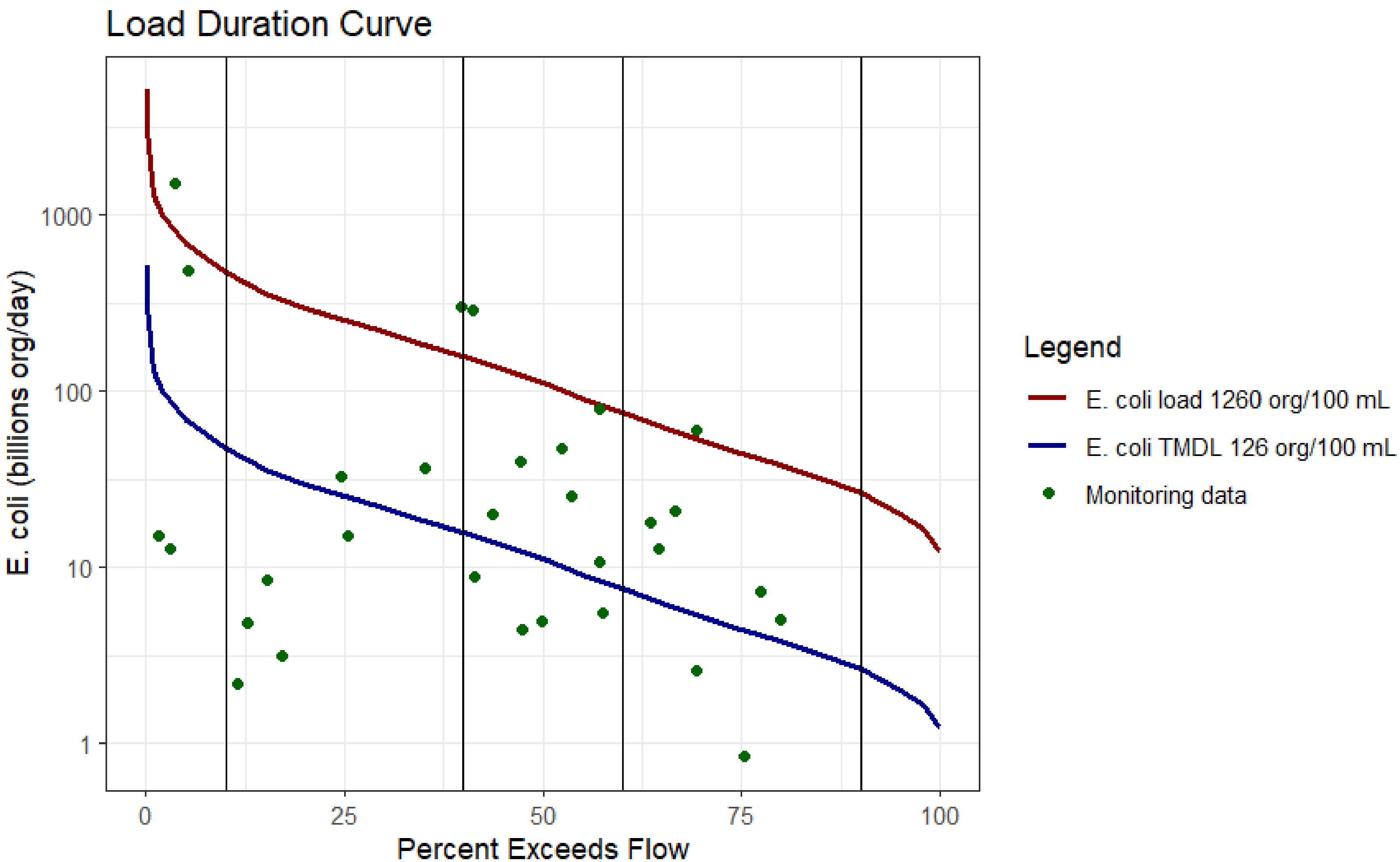


Figure 30. Camp Creek (07030004-572) *E. coli* concentration with monthly geometric means.

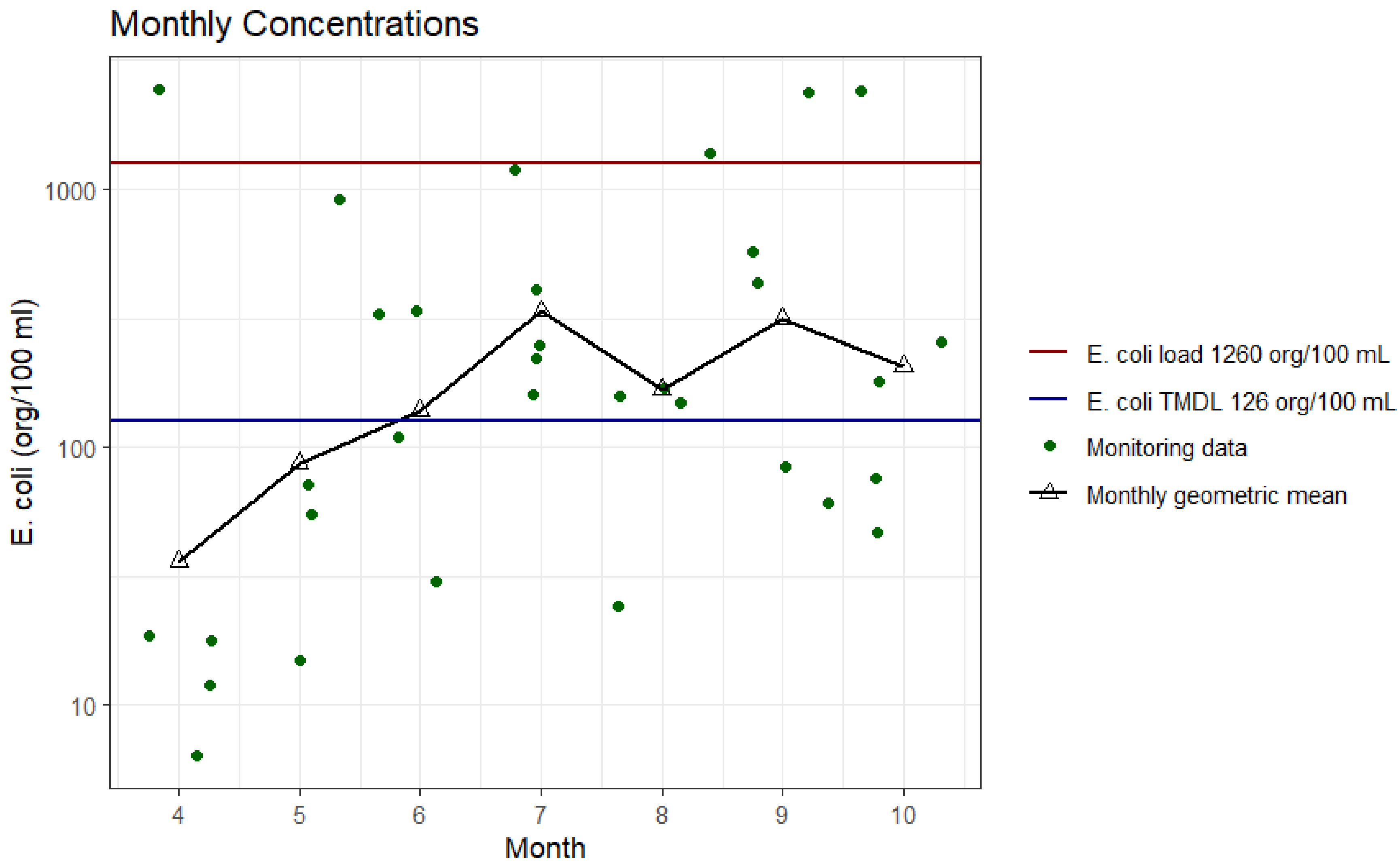


Table 21. Monthly summary of *E. coli* data at Camp Creek (07030004-572) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	5	36	6	2400	1	20%*
May	4	87	15	920	0	0%
June	4	139*	30	345	0	0%
July	5	337*	160	1200	0	0%
August	5	168*	24	1400	1	20%*
September	5	315*	60	2400	1	20%*
October	5	207*	46	2400	1	20%*

Table 22. Camp Creek (07030004-572) *E. coli* TMDL summary.

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	64.7	22.1	8.2	3.5	1.7
MOS	7.2	2.5	0.9	0.4	0.2
TMDL	71.9	24.6	9.1	3.9	1.9
Maximum monthly geometric mean (org/100 mL)[a]	337				
Estimated percent reduction[a]	63%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Unnamed Creek (629)

Figure 31. Watershed boundary and land cover for *E. coli* impairment Unnamed Creek (629).

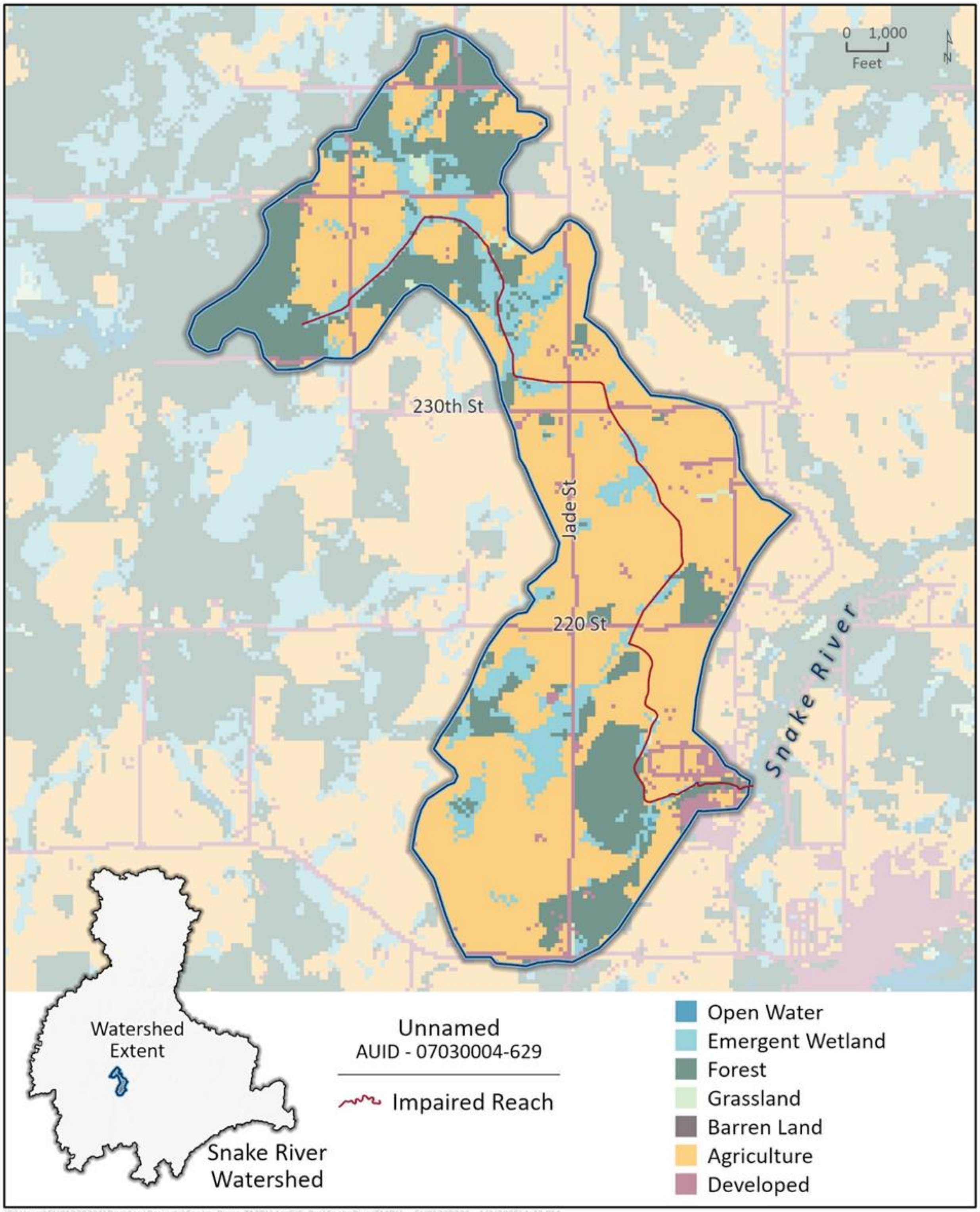


Figure 32. Unnamed Creek (07030004-629) *E. coli* load duration curve.

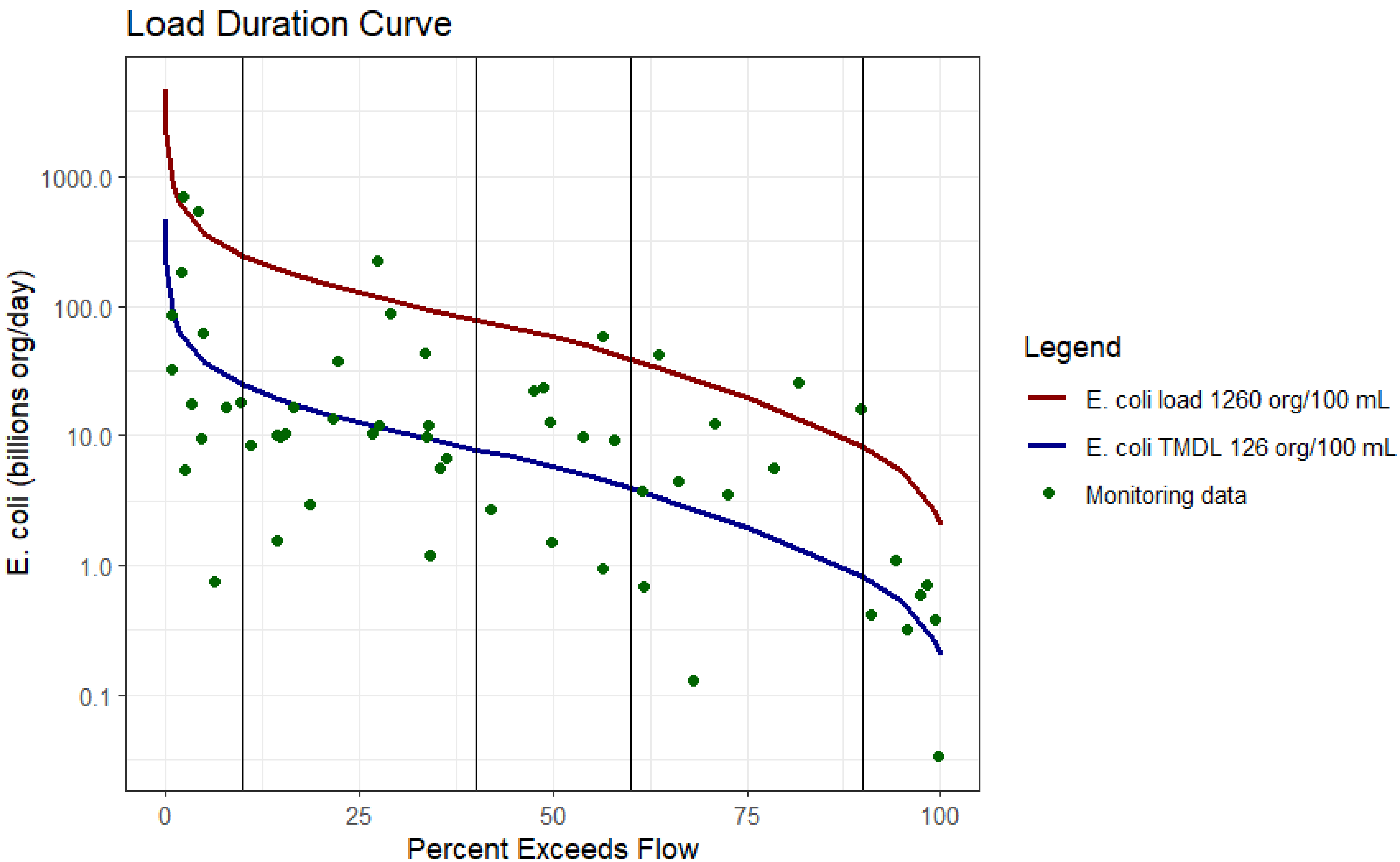


Figure 33. Unnamed Creek (07030004-629) *E. coli* concentration with monthly geometric means.

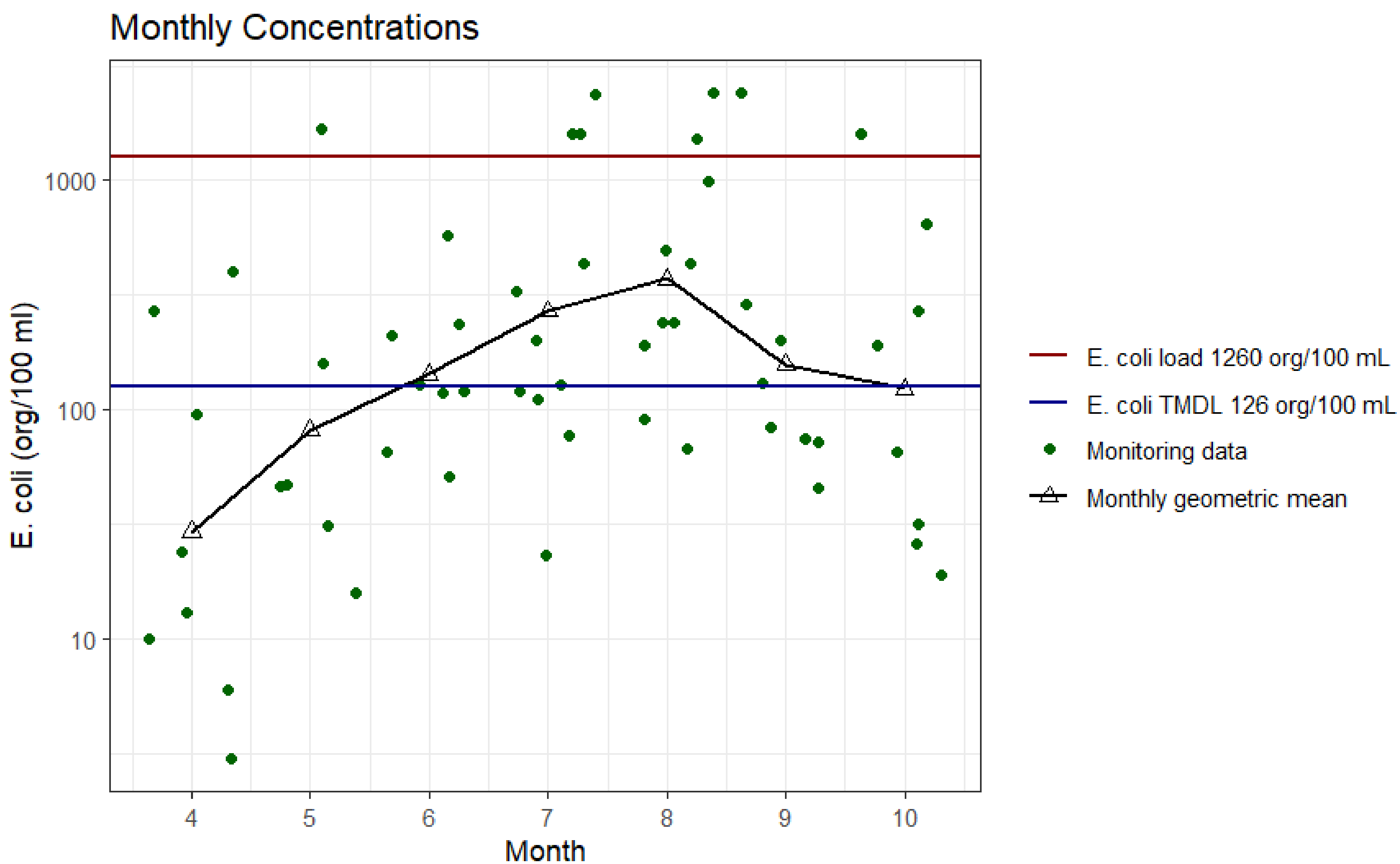


Table 23. Monthly summary of *E. coli* data at Unnamed Creek (07030004-629) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	8	30	3	397	0	0%
May	6	82	16	1700	1	17%*
June	8	144*	51	580	0	0%
July	11	270*	23	2400	3	27%*
August	10	373*	68	2400	2	20%*
September	8	157*	46	2400	1	13%*
October	8	124	19	1600	1	13%*

Table 24. Unnamed Creek (07030004-629) *E. coli* TMDL summary.

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	34	11.2	4.6	1.3	0.41
MOS	3.8	1.3	0.5	0.2	0.05
TMDL	37.8	12.5	5.1	1.5	0.46
Maximum monthly geometric mean (org/100 mL)[a]	373				
Estimated percent reduction[a]	66%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Unnamed Creek (598)

Figure 34. Watershed boundary and land cover for *E. coli* impairment Unnamed Creek (598).

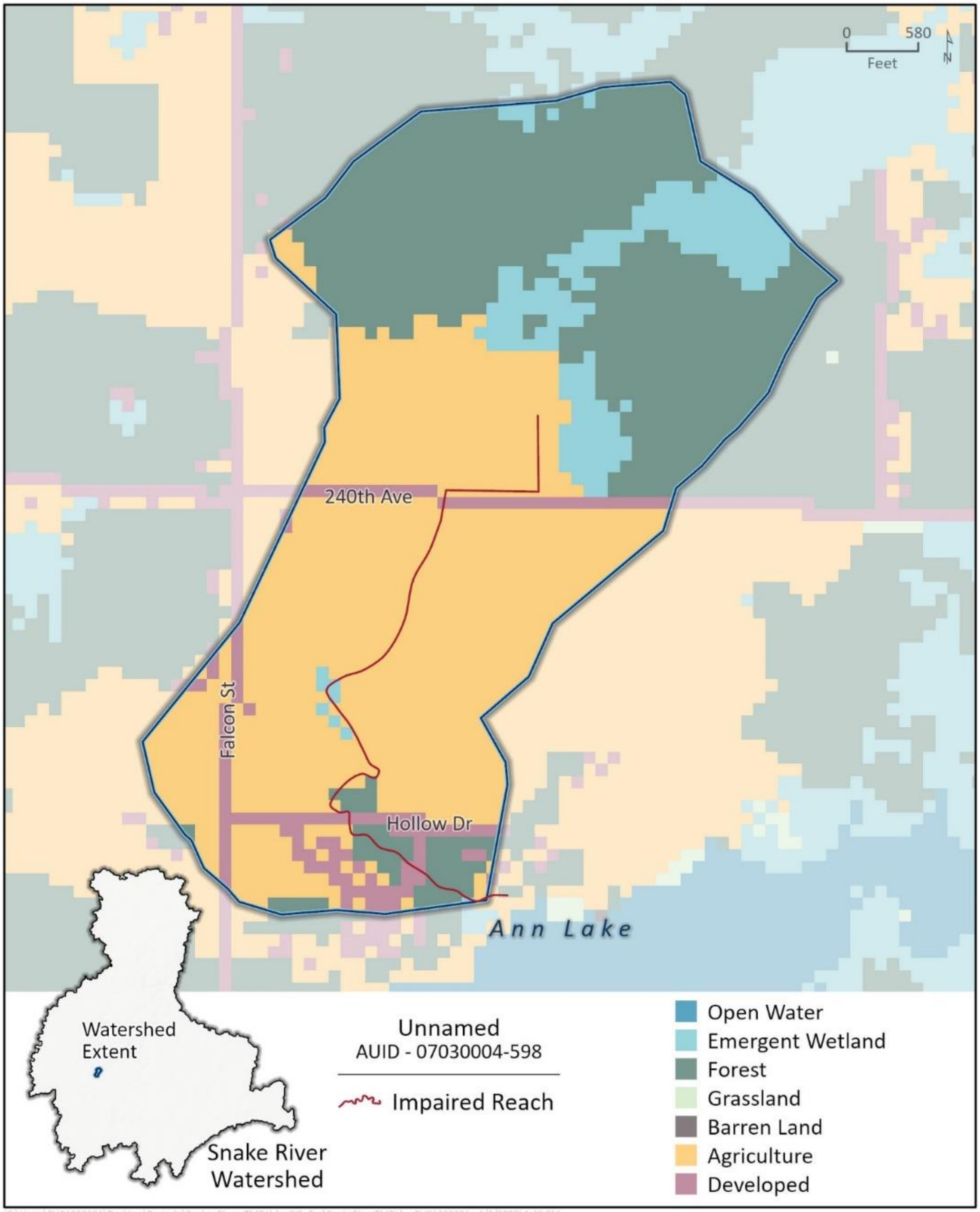


Figure 35. Unnamed Creek (07030004-598) *E. coli* load duration curve.

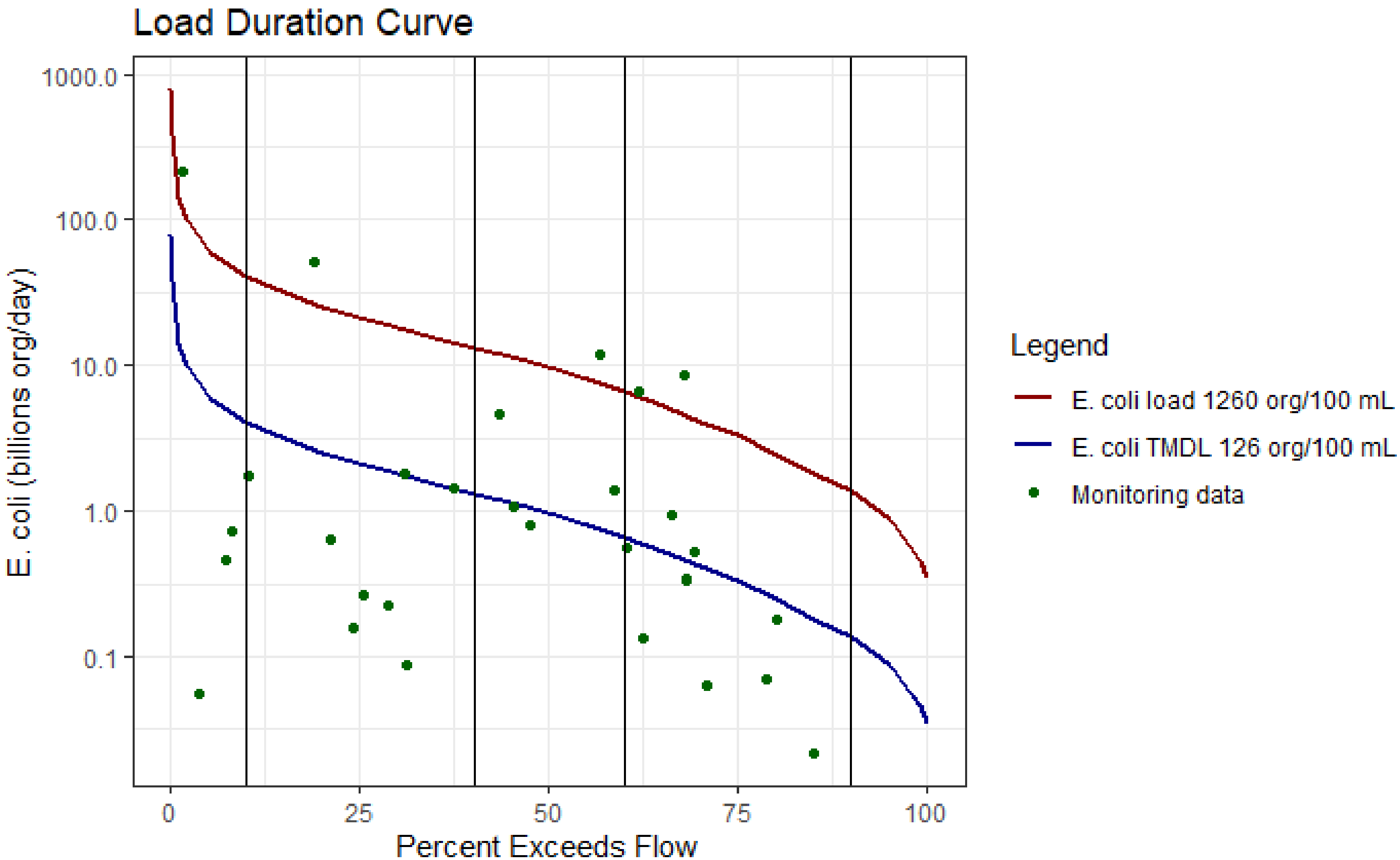


Figure 36. Unnamed Creek (07030004-598) *E. coli* concentration with monthly geometric means.

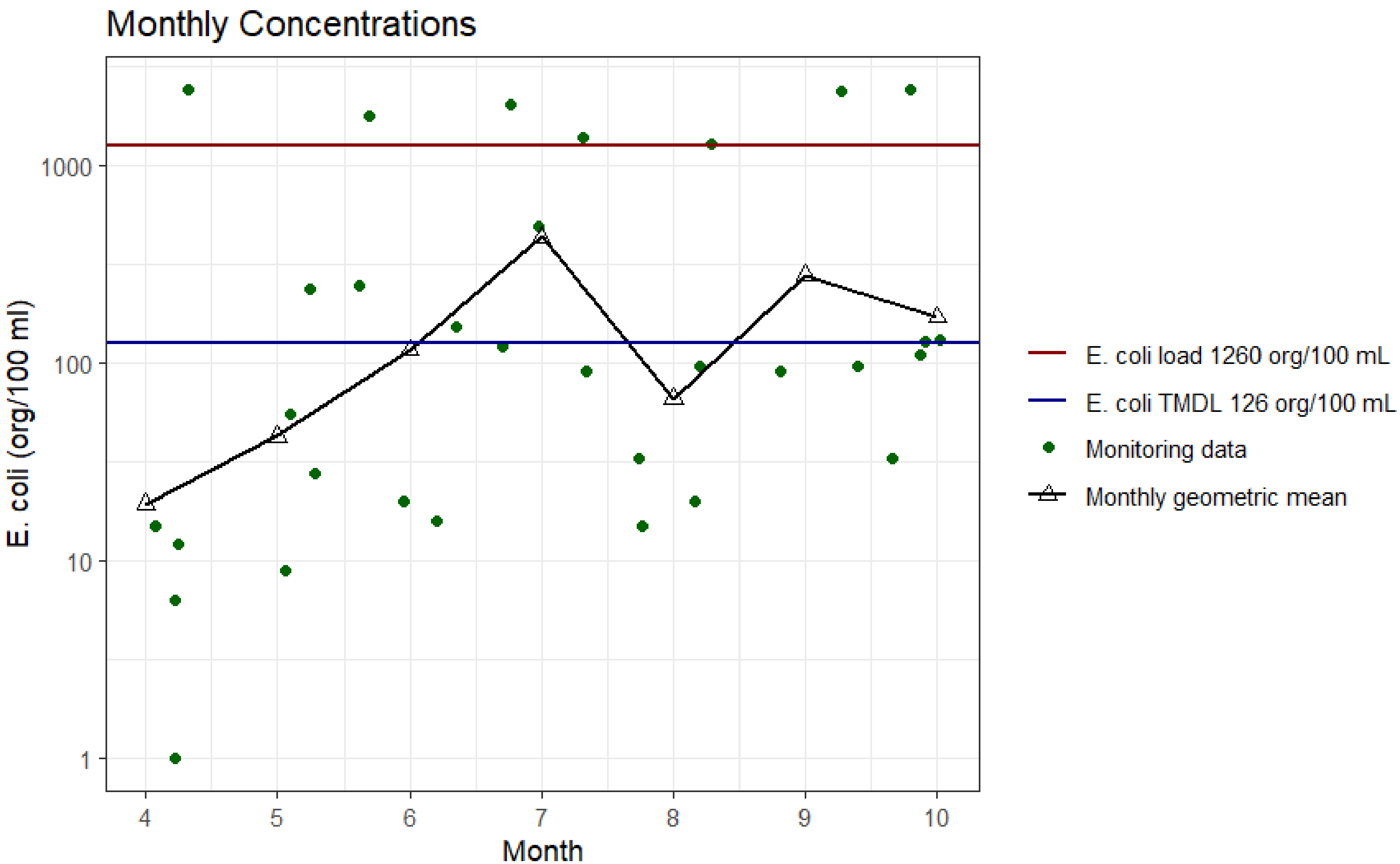


Table 25. Monthly summary of *E. coli* data at Unnamed Creek (07030004-598) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	5	19	1	2400	1	20%*
May	4	43	9	240	0	0%
June	5	117	16	1800	1	20%*
July	5	435*	93	2000	2	40%*
August	5	65	15	1300	1	20%*
September	3	278*	93	2400	1	33%*
October	5	171*	33	2400	1	20%*

Table 26. Unnamed Creek (07030004-598) *E. coli* TMDL summary.

- Listing year: 2020
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	5.7	1.9	0.76	0.23	0.07
MOS	0.63	0.21	0.09	0.03	0.01
TMDL	6.3	2.1	0.85	0.26	0.08
Maximum monthly geometric mean (org/100 mL)[a]	435				
Estimated percent reduction[a]	71%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Unnamed Creek (577)

Figure 37. Watershed boundary and land cover for *E. coli* impairment Unnamed Creek (577).

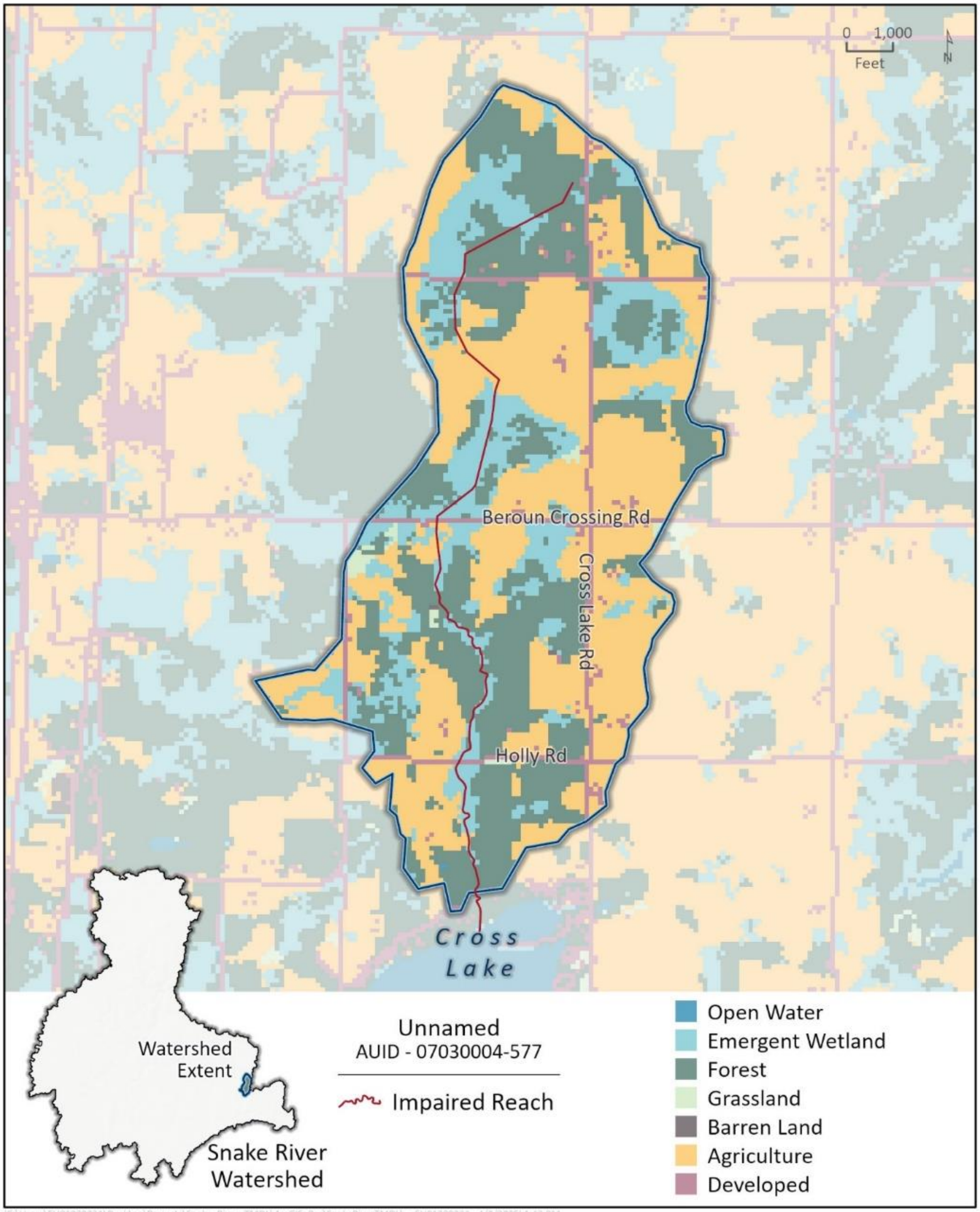


Figure 38. Unnamed Creek (07030004-577) *E. coli* load duration curve.

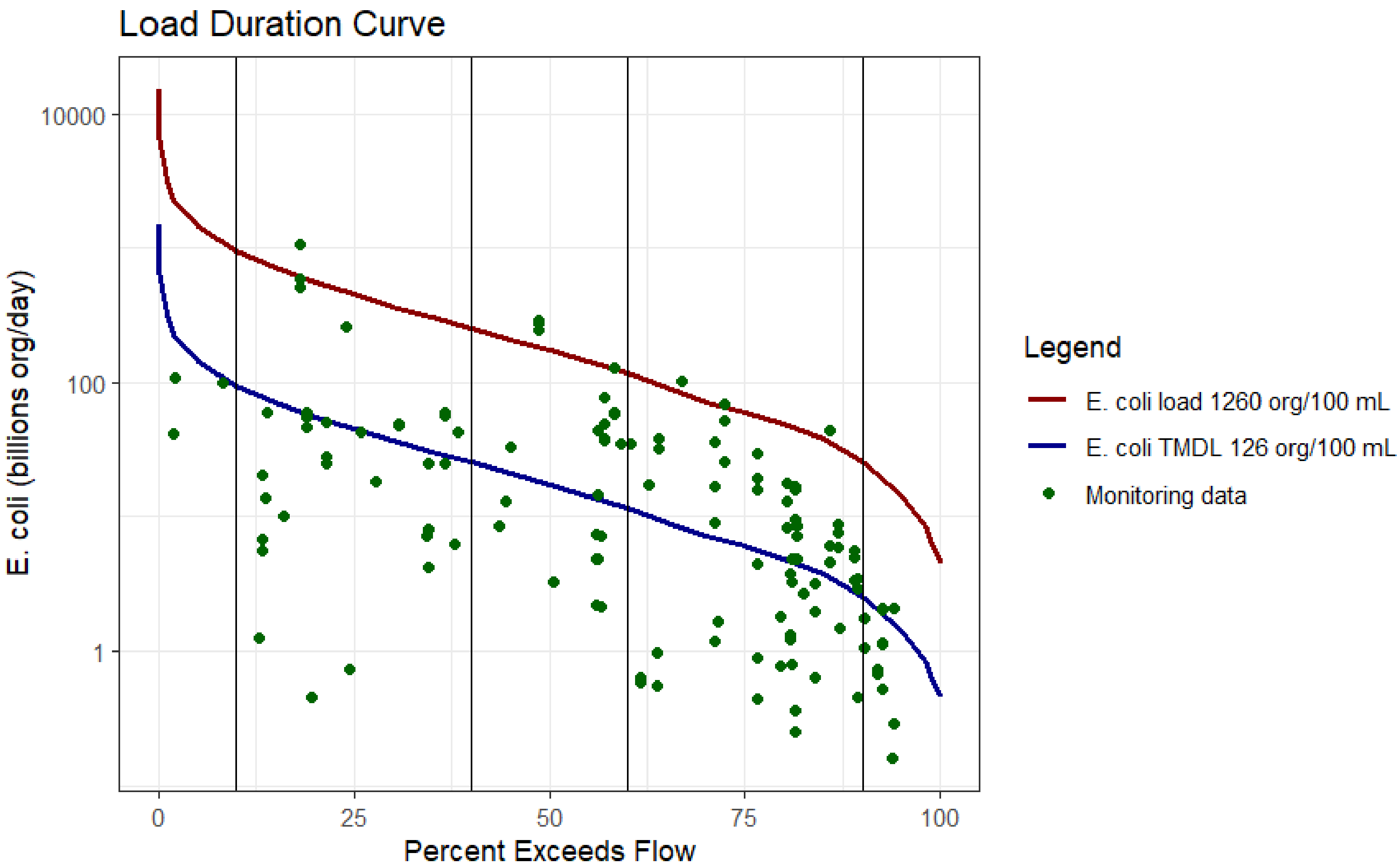


Figure 39. Unnamed Creek (07030004-577) *E. coli* concentration with monthly geometric means.

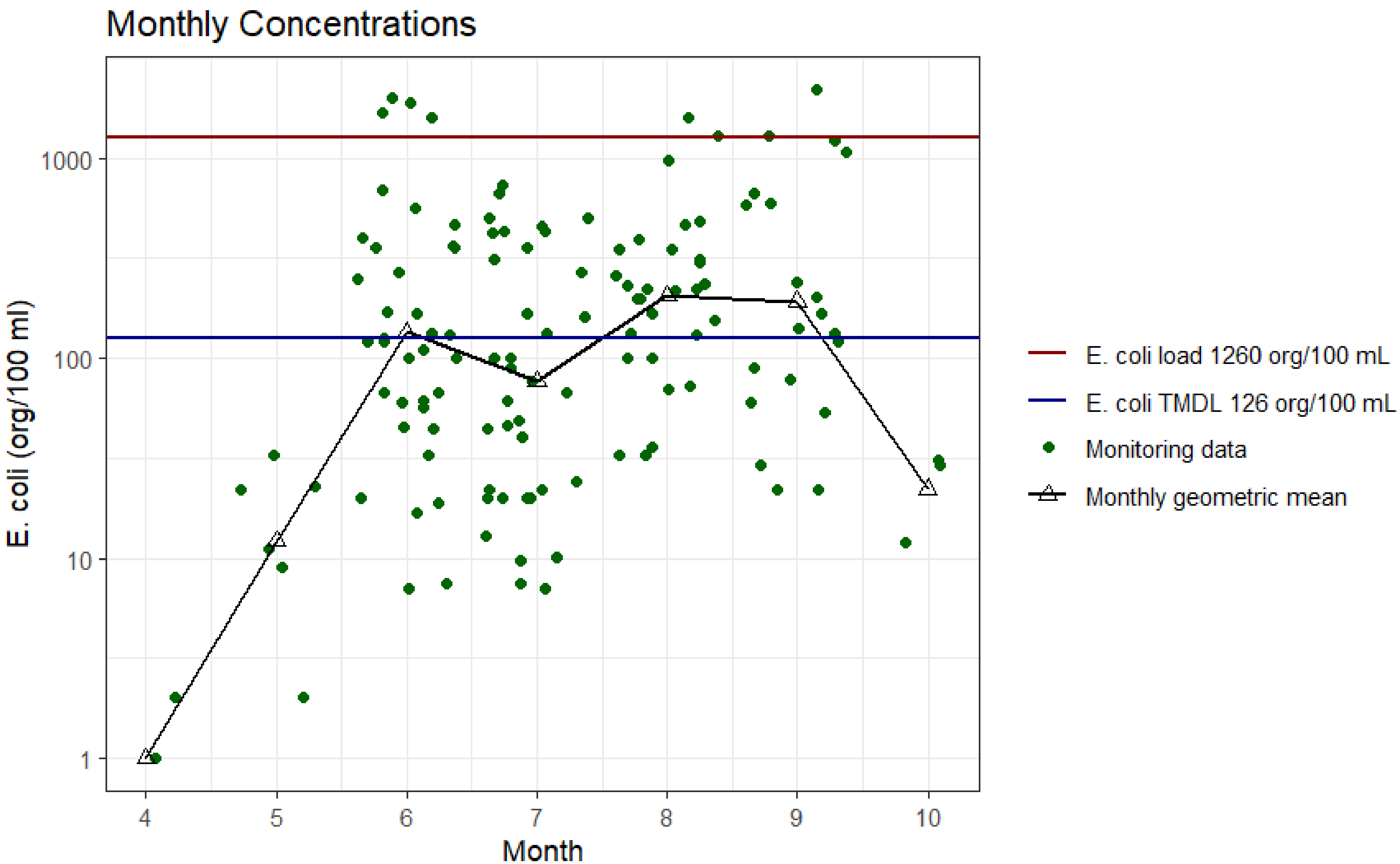


Table 27. Monthly summary of *E. coli* data at Unnamed Creek (07030004-577) 2005-2021.
Values with asterisks indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded, or the individual standard of 1,260 org/100 mL was exceeded in greater than 10% of samples.

Month	Sample count	Geometric mean (org/100 mL)	Minimum (org/100 mL)	Maximum (org/100 mL)	Number of individual standard exceedances	Frequency of exceedance
April	3	1	0.5	2	0	0%
May	6	12	2	33	0	0%
June	36	134*	7	2000	4	11%*
July	36	76	7	730	0	0%
August	29	205*	33	1600	2	7%
September	20	192*	22	2200	2	10%*
October	3	22	12	31	0	0%

Table 28. Unnamed Creek (07030004-577) *E. coli* TMDL summary.

- Listing year: 2010
- Baseline year: 2012
- Numeric standard used to calculate TMDL: 126 org/100 mL *E. coli*
- TMDL and allocations apply Apr–Oct

TMDL parameter	TMDL *E. coli* load (billion org/day) by flow zone				
	Very high	High	Mid	Low	Very low
Total LA	130	40.8	15.6	5.4	1.4
MOS	14.4	4.5	1.7	0.60	0.1
TMDL	144	45.3	17.3	6.0	1.5
Maximum monthly geometric mean (org/100 mL)[a]	205				
Estimated percent reduction[a]	39%				

a. The maximum monthly geometric mean and estimated percent reduction apply to the impairment as a whole and is not dictated by flow zone.

Appendix B. Impaired waters and TMDL status

This appendix lists all of the impairments in the Snake River Watershed along with the TMDL status of each impairment (Table 29).

Table 29. Impaired water bodies in the Snake River Watershed

HUC-10	Water body ID	Water body Name	Description	First Listed	Parameter	Use Class [a]	Affected designated use [b]	EPA Cat in next impaired waters list [c]	TMDL Approval Year	TMDL Pollutant	TMDL developed in this report
0703000401	07030004-508	Snake River	Headwaters to Hay Cr	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
				2002	Fish bio	2Bg	AQL	4C			N
	07030004-523	Snake River	Hay Cr to Chelsey Bk	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-552	Bear Creek	Unnamed cr to Snake R	2008	pH	2Bg	AQL	5			N
				2020	Invert bio	2Bg	AQL	5			N
0703000402	33-0028-00	Knife	Lake or Reservoir	2004	Nutrients	2B	AQR	4A	2014	Phosphorus	N
				2014	Mercury in fish tissue	2B	AQC	4A	2014	Mercury	N
	07030004-549	Knife River	Dry Run to Knife Lk	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
	07030004-560	Bean Brook	Unnamed wetland to Knife R	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
0703000403	33-0036-00	Fish	Lake or Reservoir	1998	Mercury in fish tissue	2B	AQC	4A	2008	Mercury	N
				2004	Nutrients	2B	AQR	4A	2013	Phosphorus	N
	33-0040-00	Ann	Lake or Reservoir	2004	Nutrients	2B	AQR	4A	2013	Phosphorus	N
				2018	Mercury in fish tissue	2B	AQC	4A	2018	Mercury	N
	07030004-511	Ann River	Headwaters (Ann Lk 33-0040-00) to Snake R	2010	*E. coli*	2Bg	AQR	4A	2013	*E. coli*	N
					Invert bio	2Bg	AQL	4A	2013	Sediment	N
	07030004-572	Camp Creek	Unnamed cr to Ann Lk	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
	07030004-598	Unnamed creek	Headwaters to Ann Lk	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
0703 0004	07030004-512	Groundhouse River	S Fk Groundhouse R to Snake R	2008	Fecal coliform	2Bg	AQR	4A	2009	Fecal Coliform	N

HUC-10	Water body ID	Water body Name	Description	First Listed	Parameter	Use Class [a]	Affected designated use [b]	EPA Cat in next impaired waters list [c]	TMDL Approval Year	TMDL Pollutant	TMDL developed in this report
	07030004-513	Groundhouse River	Headwaters to S Fk Groundhouse R	2002	Fecal coliform	2Bg	AQR	4A	2009	Fecal Coliform	N
	07030004-573	Groundhouse River, South Fork	Headwaters to Groundhouse R	2008	Fecal coliform	2Bg	AQR	4A	2009	Fecal Coliform	N
				2010	Dissolved oxygen	2Bg	AQL	5			N
0703000405	07030004-505	Snake River	Fish Lk outlet to Groundhouse R	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-506	Snake River	Chelsey Bk to Knife R	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-524	Snake River	Groundhouse R to Mud Cr	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-525	Snake River	Knife R to Fish Lk outlet	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-558	Snowshoe Brook	Unnamed cr to Snake R	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
	07030004-629	Unnamed creek	Headwaters to Snake R	2020	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
0703000406	33-0015-00	Quamba	Lake or Reservoir	2004	Nutrients	2B	AQR	4A	2014	Phosphorus	N
	07030004-563	Unnamed creek	Headwaters to Mud Cr	2020	Invert bio	2Bg	AQL	5			N
	07030004-566	Mud Creek (County Ditch 10)	Headwaters to Mud Lk (Quamba Lk 33-0015-00)	2002	Fish bio	2Bg	AQL	4A	2014	Sediment	N
				2016	*E. coli*	2Bg	AQR	4A	2014	*E. coli*	N
	07030004-567	Mud Creek (County Ditch 10)	Mud Lk (Quamba Lk 33-0015-00) to Snake R	2008	Fecal coliform	2Bg	AQR	4A	2014	*E. coli*	N
0703000407	58-0142-00	Pokegama	Lake or Reservoir	2004	Nutrients	2B	AQR	4A	2014	Phosphorus	N
				2012	Mercury in fish tissue	2B	AQC	4A	2013	Mercury	N
				2020	Fish bio	2B	AQL	5			N

HUC-10	Water body ID	Water body Name	Description	First Listed	Parameter	Use Class [a]	Affected designated use [b]	EPA Cat in next impaired waters list [c]	TMDL Approval Year	TMDL Pollutant	TMDL developed in this report
	07030004-532	Pokegama Creek	East Pokegama Cr to Unnamed cr	2004	Invert bio	2Bg	AQL	5			N
0703000408	58-0119-00	Cross	Lake or Reservoir	2004	Nutrients	2B	AQR	4A	2014	Phosphorus	N
				2012	Mercury in fish tissue	2B	AQC	5			N
	07030004-503	Snake River	Mud Cr to Mission Cr	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-514	Bear Creek	Headwaters to Snake R	2010	*E. coli*	2Bg	AQR	4A	2014	*E. coli*	N
	07030004-547	Mission Creek	Unnamed lk (58-0173-00) to T39 R21W S30, west line	2002	Fish bio	1B, 2Bdg	AQL	5			N
				2010	Dissolved oxygen	1B, 2Bdg	AQL	5			N
	07030004-548	Mission Creek	T39 R22W S36, east line to Snake R		Dissolved oxygen	2Bg	AQL	5			N
				2008	Fish bio	2Bg	AQL	5			N
	07030004-577	Unnamed creek	Headwaters to Cross Lk	2010	*E. coli*	2Bg	AQR	4A		*E. coli*	Y
	07030004-586	Snake River	Mission Cr to Cross Lk	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N
	07030004-587	Snake River	Cross Lk to St Croix R	1998	Mercury in fish tissue	2Bg	AQC	4A	2008	Mercury	N

a. 1B: domestic consumption; 2Ag: aquatic life and recreation—general cold water habitat; 2Bg: aquatic life and recreation—general warm water habitat; 7: limited resource value water.

b. AQR: aquatic recreation, AQL: aquatic life, AQC: aquatic consumption

c. 4A: Impaired and a TMDL study has been approved by USEPA. All TMDLs needed to result in attainment of applicable water quality standards for this impairment have been approved or established by EPA. For biological impairments, there are no remaining conclusive stressors for which TMDLs are needed.
4C: Impaired but a TMDL study is not required because the impairment is not caused by a pollutant.
4D: Impaired but a TMDL study is not required because the impairment is due to natural conditions with insignificant anthropogenic influence.
5: Impaired and a TMDL study has not been approved by EPA.