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& the Minnesota Department of Health

Upper Mississippi River Bacteria TMDL Study & Protection Plan

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Cover Images

Left Image: Mississippi River, Ramsey County

Right Image: Little Two Rivers, Morrison County

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Upper Mississippi River Bacteria TMDL Study and Protection Plan

November 2014

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TMDL Summary Table

<table>
<tr><th>EPA/MPCA Required Elements</th><th colspan="5">Summary</th><th>TMDL Page #</th></tr>
<tr><td>Location</td><td colspan="5">Southern portion of the Upper Mississippi River Basin (HUC 0701) in central Minnesota, including portions of the following counties: Anoka, Benton, Dakota, Hennepin, Morrison, Ramsey, Sherburne, Stearns, Washington, Wright.</td><td>23</td></tr>
<tr><td rowspan="20">303(d) Listing Information</td><td colspan="5">The following waterbodies are identified on the State's 303(d) list, impaired for aquatic recreation due to E. coli:</td><td rowspan="20">30</td></tr>
<tr><td>Reach Name</td><td>Reach AUID</td><td>Reach Description</td><td>Year Listed[1]</td><td>Target Start/ Completion</td></tr>
<tr><td>Little Two River</td><td>07010201-516</td><td>Headwaters to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Two River</td><td>07010201-523</td><td>North & South Two R to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Watab River</td><td>07010201-528</td><td>Rossier Lk to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Watab River, North Fork</td><td>07010201-529</td><td>Headwaters (Stump Lk 73-0091-00) to S Fk Watab R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>County Ditch 12</td><td>07010201-537</td><td>Unnamed cr to Watab R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>South Two River</td><td>07010201-543</td><td>Two River Lk to Two R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Watab River, South Fork</td><td>07010201-554</td><td>Little Watab Lk to Watab R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>County Ditch 13</td><td>07010201-564</td><td>Bakers Lk to Watab R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Unnamed creek</td><td>07010203-528</td><td>T121 R23W S19, south line to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Silver Creek</td><td>07010203-557</td><td>Locke Lk to Mississippi R</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Unnamed creek (Luxemburg Creek)</td><td>07010203-561</td><td>T123 R28W S30, south line to Johnson Cr</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Plum Creek</td><td>07010203-572</td><td>Warner Lk to Mississippi R</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Johnson Creek (Meyer Creek)</td><td>07010203-635</td><td>Unnamed cr to Unnamed cr</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Johnson Creek (Meyer Creek)</td><td>07010203-639</td><td>T123 R28W S14, west line Mississippi R</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Unnamed creek (Robinson Hill Creek)</td><td>07010203-724</td><td>CD 14 to CSAH 136</td><td>2012</td><td>2008/2015</td></tr>
<tr><td>Shingle Creek (County Ditch 13)</td><td>07010206-506</td><td>Headwaters (Eagle Cr/Bass Cr) to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Unnamed creek (Plymouth Creek)</td><td>07010206-526</td><td>Headwaters to Medicine Lk</td><td>2014</td><td>2008/2015</td></tr>
<tr><td>Unnamed creek (Interstate Valley Creek)</td><td>07010206-542</td><td>Unnamed cr to Mississippi R</td><td>2014</td><td>2008/2015</td></tr>
</table>

<table>
<tr><td rowspan="6"></td><td>Unnamed creek (North Branch, Bassett Creek)</td><td>07010206-552</td><td>Unnamed lk to Bassett Cr</td><td>2014</td><td>2008/2015</td><td rowspan="6"></td></tr>
<tr><td>Rice Creek</td><td>07010206-584</td><td>Long Lk to Locke Lk</td><td>2014</td><td>2008/2015</td></tr>
<tr><td colspan="5">The following waterbodies are identified on the State's 303(d) list, impaired for aquatic recreation due to fecal coliform:</td></tr>
<tr><td>Reach Name</td><td>Reach AUID</td><td>Reach Description</td><td>Year Listed</td><td>Target Start/ Completion</td></tr>
<tr><td>Spunk Creek</td><td>07010201-525</td><td>Lower Spunk Lk to Mississippi R</td><td>2008</td><td>2008/2015</td></tr>
<tr><td>Bassett Creek</td><td>07010206-538</td><td>Medicine Lk to Mississippi R</td><td>2008</td><td>2008/2015</td></tr>
<tr><td rowspan="10">Applicable Water Quality Standards/ Numeric Targets</td><td colspan="5">Class 2 waters, MN E. coli Standards,
MN Rule 7050.0220 Subp. 5a</td><td rowspan="10">19</td></tr>
<tr><td colspan="2">Standard</td><td colspan="3">Notes</td></tr>
<tr><td colspan="2">126 orgs per 100 ml</td><td colspan="3">Geometric mean of ≥5 samples per month (April – October)</td></tr>
<tr><td colspan="2">1,260 orgs per 100 ml</td><td colspan="3"><10% of all samples per month (April – October) individually exceed</td></tr>
<tr><td colspan="5">Prior to March 17, 2008, Class 2 waters, MN Fecal Coliform Standards, MN Rule 7050.0220 Subp. 5a</td></tr>
<tr><td colspan="2">Standard</td><td colspan="3">Notes</td></tr>
<tr><td colspan="2">200 orgs per 100 ml</td><td colspan="3">Geometric mean of ≥5 samples per month (April – October)</td></tr>
<tr><td colspan="2">2,000 orgs per 100 ml</td><td colspan="3"><10% of all samples per month (April – October) individually exceed</td></tr>
<tr style="display:none"></tr>
<tr style="display:none"></tr>
<tr><td rowspan="2">Loading Capacity (expressed as daily load)</td><td colspan="5">Loading capacity was derived for five flow regimes for each AUID; refer to Table 7-1.</td><td>101, 181</td></tr>
<tr><td colspan="5">Critical condition:
• Bacteria concentrations tend to increase into the fall.
• Tributary sites tend to experience more exceedances above the E. coli standard than Mississippi River mainstem sites.
• Bacteria concentrations along the Mississippi River mainstem peak around the metropolitan area.
• Stormsewer data exhibit high E. coli concentrations and some of the greatest concentrations of all monitoring sites.
• Exceedances of the standard are experienced under all flow regimes.
For additional detail refer to Section 5.10.</td><td>110</td></tr>
<tr><td rowspan="15">Wasteload Allocation [billion org/d]</td><td colspan="2">Source</td><td>Permit #</td><td>AUID</td><td>WLA (billion org/d)</td><td></td></tr>
<tr><td colspan="2">Upsala WWTF</td><td>MNG580053</td><td>07010201-516</td><td>3.03</td><td rowspan="9">181+ Table 7-2</td></tr>
<tr><td colspan="2">Avon WWTF</td><td>MN0047325</td><td>07010201-525</td><td>2.01</td></tr>
<tr><td colspan="2">Order of St Benedict WWTF</td><td>MN0022411</td><td>07010201-529</td><td>1.15</td></tr>
<tr><td colspan="2">Albany WWTF</td><td>MN0020575</td><td>07010201-543</td><td>23.8</td></tr>
<tr><td colspan="2">Bowlus WWTF</td><td>MN0020923</td><td>07010201-543</td><td>2.38</td></tr>
<tr><td colspan="2">Holdingford WWTF</td><td>MN0023710</td><td>07010201-543</td><td>1.07</td></tr>
<tr><td colspan="2">Albertville WWTF</td><td>MN0050954</td><td>07010203-528</td><td>4.43</td></tr>
<tr><td colspan="2">Otsego WWTF West</td><td>MN0066257</td><td>07010203-528</td><td>3.43</td></tr>
<tr><td colspan="2">Straight Pipes</td><td>None</td><td>All</td><td>0</td></tr>
<tr><td colspan="2" rowspan="5">MS4 Stormwater (Categorical)</td><td rowspan="5">MNR040000</td><td>07010201-523</td><td rowspan="5">Five flow regimes for each applicable AUID; refer</td><td rowspan="5">181</td></tr>
<tr><td>07010201-525</td></tr>
<tr><td>07010201-528</td></tr>
<tr><td>07010201-529</td></tr>
<tr><td>07010201-537</td></tr>
</table>

			07010201-554	to Table 7-1 + Table 7-3	
			07010201-564		
			07010203-528		
			07010203-572		
			07010203-639		
			07010203-724		
			07010206-506		
			07010206-526		
			07010206-538		
			07010206-542		
			07010206-552		
			07010206-584		

Load Allocation	The load allocation is based on the following sources of *E. coli* that do not require NPDES permit coverage, as applicable to each reach: · Humans (e.g. land application of septage) · Pets (e.g. cats and dogs) · Livestock (e.g. grazing, animal feeding operations) · Wildlife (e.g. deer, raccoons, geese)	105, 181

Reach Name	AUID	LA (billion org/d)
Little Two River	07010201-516	Five flow regimes for each AUID; refer to Table 7-1
Two River	07010201-523	
Spunk Creek	07010201-525	
Watab River	07010201-528	
Watab River, North Fork	07010201-529	
County Ditch 12	07010201-537	
South Two River	07010201-543	
Watab River, South Fork	07010201-554	
County Ditch 13	07010201-564	
Unnamed creek	07010203-528	
Silver Creek	07010203-557	
Unnamed creek (Luxemburg Creek)	07010203-561	
Plum Creek	07010203-572	
Johnson Creek (Meyer Creek)	07010203-635	
Johnson Creek (Meyer Creek)	07010203-639	
Unnamed creek (Robinson Hill Creek)	07010203-724	
Shingle Creek (County Ditch 13)	07010206-506	
Unnamed creek (Plymouth Creek)	07010206-526	
Bassett Creek	07010206-538	
Unnamed creek (Interstate Valley Creek)	07010206-542	
Unnamed creek (North Branch, Bassett Creek)	07010206-552	
Rice Creek	07010206-584	

Margin of Safety	**Explicit MOS:** 10% of loading capacity	105
Seasonal Variation	Critical conditions for bacteria concentrations in these streams often occur in the fall and tend to be independent of flow regime. The water quality standard is applicable during the recreational season (April through October). The load reductions are designed so that the streams will meet the water quality standard during this period over each of five flow regimes.	110
Reasonable Assurance	Reasonable assurance is addressed through a combination of regulatory and non-regulatory measures. Existing regulatory programs that will limit bacteria concentrations in discharge include NPDES/SDS Permits (including wastewater treatment facility NPDES permit limits), the SSTS Program and Feedlot Rules. Non-regulatory approaches to reducing bacteria discharges include landowner education programs and agricultural and urban runoff	196

	management practices that are constructed by the numerous, active watershed management entities and County Soil and Water Conservation Districts throughout the area.	
Monitoring	***Monitoring Plan included?*** Yes	198
Implementation	***1. Implementation Strategy included?*** yes ***2. Cost estimate included?*** Yes	190
Public Participation	· Eight stakeholder meetings were held in several locations throughout the TMDL project area for over 200 project partners and regulated entities · Public Comment period was held from April 7, 2014 through May 6, 2014 · Nine comment letters were received during public notice	189

[1]Note that 2014 listings are aquatic recreation impairments due to *E. coli* listed on MPCA's Draft 2014 303(d) list.

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Abbreviations

AFO	Animal feeding operation
ASAE	American Society of Agricultural Engineers
AU	Animal unit
AUID	Assessment unit identification
AVMA	American Veterinary Medical Association
BMP	Best management practice
CAFO	Concentrated animal feeding operation
CFR	Code of Federal Regulations
Ch	Chapter
Cr	Creek
CSAH	County State-Aid Highway
CSO	Combined sewer overflow
DNR	Department of Natural Resources
E. coli	*Escherichia coli*
ELTR	Existing load of TMDL Reach
ELUR	Existing load of upstream reaches
EOR	Emmons & Olivier Resources, Inc.
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
EQuIS	Environmental Quality Information System
GIS	Geographic information system
HGIC	Home and Garden Information Center
HSG	Hydrologic soil group
HUC	Hydrologic unit code
ID	Insufficient data
IDUL	Impairment due to upstream load
ISTS	Individual sewage treatment system
ITPHS	Imminent threat to public health and safety
LA	Load allocation
lbs	pounds
LCTR	Loading capacity of TMDL Reaches
LCUR	Loading capacity of upstream reaches
LDC	Load duration curve
Lk	Lake
MCES	Metropolitan Council Environmental Services
MCM	Minimum Control Measure
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
Min	Minnesota
Miss	Mississippi
MN	Minnesota
mgd	Million gallons per day
MnDOT	Minnesota Department of Transportation
MOS	Margin of safety
MPCA	Minnesota Pollution Control Agency
MPN	Most probable number
MS4	Municipal Separate Storm Sewer System
Ml	Milliliters
NASS	National Agricultural Statistics Service
NHD	National Hydrography Dataset
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
org	Organisms

R	River
RM	River mile
ROW	Right of way
SDS	State Disposal System
subp	Subpart
SPI	Stream power index
SSO	Sanitary sewer overflow
SSTS	Subsurface sewage treatment system
SWCD	Soil and Water Conservation District
SWPPP	Stormwater pollution prevention program
TAC	Technical advisory committee
TMDL	Total Maximum Daily Load
US	United States
US ACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet
WD	Watershed District
WLA	Wasteload allocation
WMO	Watershed Management Organization
WRAPS	Watershed Restoration and Protection Strategy
WWTF	Wastewater treatment facility
WWTP	Wastewater treatment plant (the term Wastewater treatment facility, WWTF, is used in this document with the exception of cases where the official name of the river reach includes reference to a Wastewater treatment plant. In those cases the acronym WWTP is used)

1 EXECUTIVE SUMMARY

The ultimate goal of this project is to describe the reduction in pollutant loading and implementation activities needed so that Upper Mississippi River reaches can meet the water quality standard for aquatic recreation due to *Escherichia coli (E. coli*), a bacteria used to indicate the potential presence of waterborne pathogens that can be harmful to human health. In meeting this goal, the implementation of best management practices (BMPs) in critical areas may also help reduce other contaminants of concern investigated during this study.

This project is a joint effort between the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) in close coordination with a multitude of project partners.

The project is located in central Minnesota along the Mississippi River Corridor from Royalton to Hastings.

A large number of Minnesota's residents rely on the Mississippi River for both drinking water and as a place for recreational activities. While specific recreational user data (boating, swimming, wading) is not known at this time, between 940,000 and 950,000 Minnesotans use the Mississippi River between Royalton and Hastings for drinking water.

All surface waters in Minnesota, including lakes, rivers, streams, and wetlands, are protected for aquatic recreation where this use is attainable. This beneficial use is associated with a specific numeric water quality standard for bacteria that reduces the risk of illness from this pollutant in water. Although most are harmless themselves, fecal indicator bacteria are used as an easy-to-measure surrogate to evaluate the microbiological suitability of recreational and drinking waters, specifically, the presence of pathogens. Water contaminated with pathogenic bacteria from human or animal fecal material can cause illness in humans such as nausea, vomiting, fever, headache, and diarrhea, but more serious illness is a possibility. The Total Maximum Daily Load (TMDL) study and protection plan uses the standard for *E. coli* and addresses 22 impaired reaches and 29 protection reaches (Table 2-3 and Table 2-4).

The majority of the TMDL study and protection plan focuses on the Mississippi River Corridor, and, specifically, portions of three Major Watersheds (8-digit HUCs): Mississippi River – Sartell Watershed (07010201), Mississippi River – St. Cloud Watershed (07010203), and the Mississippi River – Twin Cities Watershed (07010206).

The following analyses were conducted for the TMDL Study Reaches (22 TMDL study reaches impaired for aquatic recreation due to bacteria) and the corresponding TMDL Subwatersheds:

- Potential Bacteria Sources (Section 4)
- Water Quality Analysis Including Load Duration Curves (Section 6)
- TMDL Calculations (Section 7)
- Implementation Strategies (Section 9)

TMDLs were derived for five flow regimes (from low to high flows) using the load duration curve method. TMDLs range from 0.833 billion org/d to 53.7 billion org/d for low flows and from 32.1 billion org/d to 514 billion org/d for high flows. The impaired reaches require load reductions from 0% to 97%, varying for each reach and flow regime, to meet the *E. coli* standard.

Additional subwatersheds (Protection Subwatersheds) were identified in order to support the protection of surface waters that are not known to be impaired for bacteria. The Protection Subwatersheds (independent of the TMDL Subwatersheds) focus on the Mississippi River corridor from Royalton to Hastings. They are composed of drainage areas to 1) reaches not known to be impaired for bacteria, including Mississippi River mainstem reaches and their direct drainage areas, 2) five impaired Mississippi River mainstem reaches for which TMDLs have been deferred, and 3) downstream portions of tributaries that directly discharge to the Mississippi River and that are not known to be impaired (for details refer to Section 2.6). The following project components were completed for the Protection Subwatersheds and their corresponding Protection Reaches:

- Potential Bacteria Sources (Section 4)
- Water Quality Analysis Including Load Duration Curves (Section 6)
- Implementation Strategies (Section 9)

Additional water quality analyses were also conducted for tributaries that directly discharge to the Mississippi River and are part of an existing or future/planned TMDL (Appendix E).

2 PROJECT OVERVIEW

2.1 Purpose of TMDL Study and Protection Plan

The ultimate goal of this project is to describe the reduction in pollutant loading and implementation activities needed so that 1) Upper Mississippi River tributaries can meet the water quality standard for *Escherichia coli (E. coli*), a type of bacteria used to indicate the potential presence of waterborne pathogens that can be harmful to human health, and 2) so that non-impaired reaches are equipped with the tools necessary to protect the existing water quality. In meeting this goal, the implementation of best management practices (BMPs) in critical areas may also help reduce other contaminants of concern investigated during this study.

This project is a joint effort between the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) in close coordination with a multitude of project partners.

2.2 Surface Water Uses & Water Quality Standards

A large number of Minnesota's residents rely on the Mississippi River for both drinking water and as a place for recreational activities. These two uses, drinking water and aquatic recreation, are directly affected by fecal contamination and are addressed here.

2.2.1 Aquatic Recreation

All surface waters in Minnesota, including lakes, rivers, streams, and wetlands, are protected for aquatic recreation where this use is attainable. This beneficial use is associated with numeric water quality standards for bacteria, in this case *Escherichia coli* (*E. coli*), which are protective concentrations for short- and long-term exposure to this pollutant in water. See Minnesota Rules Chapter 7050 for a more detailed description of beneficial uses at https://www.revisor.leg.state.mn.us/rules/?id=7050.

The past fecal coliform and current *E. coli* numeric water quality standards for Class 2 waters are shown in Table 2-1. *E. coli* and fecal coliform are fecal bacteria used as indicators for waterborne pathogens that have the potential to cause human illness. Although most are harmless themselves, fecal indicator bacteria are used as an easy-to-measure surrogate to evaluate the suitability of recreational and drinking waters, specifically, the presence of pathogens and probability of illness. Pathogenic bacteria, viruses, and protozoa pose a health risk to humans, potentially causing illnesses with gastrointestinal symptoms (nausea, vomiting, fever, headache, and diarrhea), skin irritations, or other symptoms. Pathogen types and quantities vary among fecal sources; therefore, human health risk varies based on the source of fecal contamination.

The Total Maximum Daily Load (TMDL) study and protection plan will use the standard for *E. coli*. The change in the water quality standard from fecal coliform to *E. coli* is supported by an EPA guidance document on bacteriological criteria (USEPA 1986). As of March 17, 2008, Minnesota Rules Chapter 7050 water quality standards for *E. coli* are:

> *Escherichia (E.) coli - Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.*

Although surface water quality standards are now based on *E. coli*, wastewater treatment facilities are permitted based on fecal coliform (not *E. coli*) concentrations.

Table 2-1. Past and current numeric water quality standards of bacteria (fecal coliform and *E. coli*) for the beneficial use of aquatic recreation (primary and secondary body contact).

Past Standard	Units	Current Standard	Units	Notes
Fecal coliform	200 orgs per 100 ml	*E. coli*	126 orgs per 100 ml	Geometric mean of ≥5 samples per month (April – October)
Fecal coliform	2,000 orgs per 100 ml	*E. coli*	1,260 orgs per 100 ml	<10% of all samples per month (April – October) individually exceed

Geometric mean is used in place of arithmetic mean in order to measure the central tendency of the data, dampening the effect that very high or very low values have on arithmetic means. In fact, the geometric mean is really a log-transformation of data; it is equivalent to the arithmetic mean of the logarithmic values of a data set, converted back to a base 10 number. Since bacteria data sets often contain a few very high values, the geometric mean more appropriately characterizes the central tendency of the data.

The MPCA's *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* provides details regarding how waters are assessed for conformance to the *E. coli* standard (MPCA 2012b).

2.2.2 Drinking Water

Between 940,000 and 950,000 Minnesotans rely on the Mississippi River between Royalton and Hastings for drinking water. The Mississippi River is the exclusive drinking supply for St. Cloud (also serves St. Augusta) and the Minneapolis Water Treatment and Distribution Services (serves the cities of Golden Valley, Crystal, New Hope, Columbia Heights, Hilltop, Fort Snelling, parts of Bloomington and Edina (Morning Side), and the Minneapolis/St. Paul airport). It is also one of the main sources for the St. Paul Regional Water Services (serves at least part of the cities of Falcon Heights, Lauderdale, Maplewood, Arden Hills, Little Canada, Saint Paul, West Saint Paul, South Saint Paul, Lilydale, Mendota and Mendota Heights, Roseville, and Sunfish Lake).

Many of Minnesota's 24 community water supply systems that use surface water have expressed interest in developing protection plans. The cities of St. Cloud, St. Paul, and Minneapolis have State endorsed Source Water Protection Plans following the MDH guidance for surface water intakes from the Mississippi River. In each of these plans, cities have identified "contaminants of concern" and have designated priority areas for drinking water protection (Figure 2-1). A few examples of these contaminants of concern are *Cryptosporidium*, fecal coliform, *Giardia*, other viruses, total suspended solids, sediment, and suspended organics. More information about the Upper Mississippi River Source Water Protection Project can be found at http://www.umrswpp.com/.

Figure 2-1 depicts all of the reaches impaired for aquatic recreation due to bacteria concentrations within the entire study area regardless of their inclusion in the TMDL. The impaired reaches for which TMDLs are being developed as part of this project are depicted in Figure 2-2 for the Mississippi River- Sartell HUC, in Figure 2-4 for the Mississippi River – St. Cloud HUC and in Figure 2-6 for the Mississippi River – St. Paul HUC. The reaches where TMDLs are being deferred to a later date and the protection reaches are depicted in Figure 2-3 for the Mississippi River- Sartell HUC, in Figure 2-5 for the Mississippi River – St. Cloud HUC and in Figure 2-7 for the Mississippi River – St. Paul HUC.

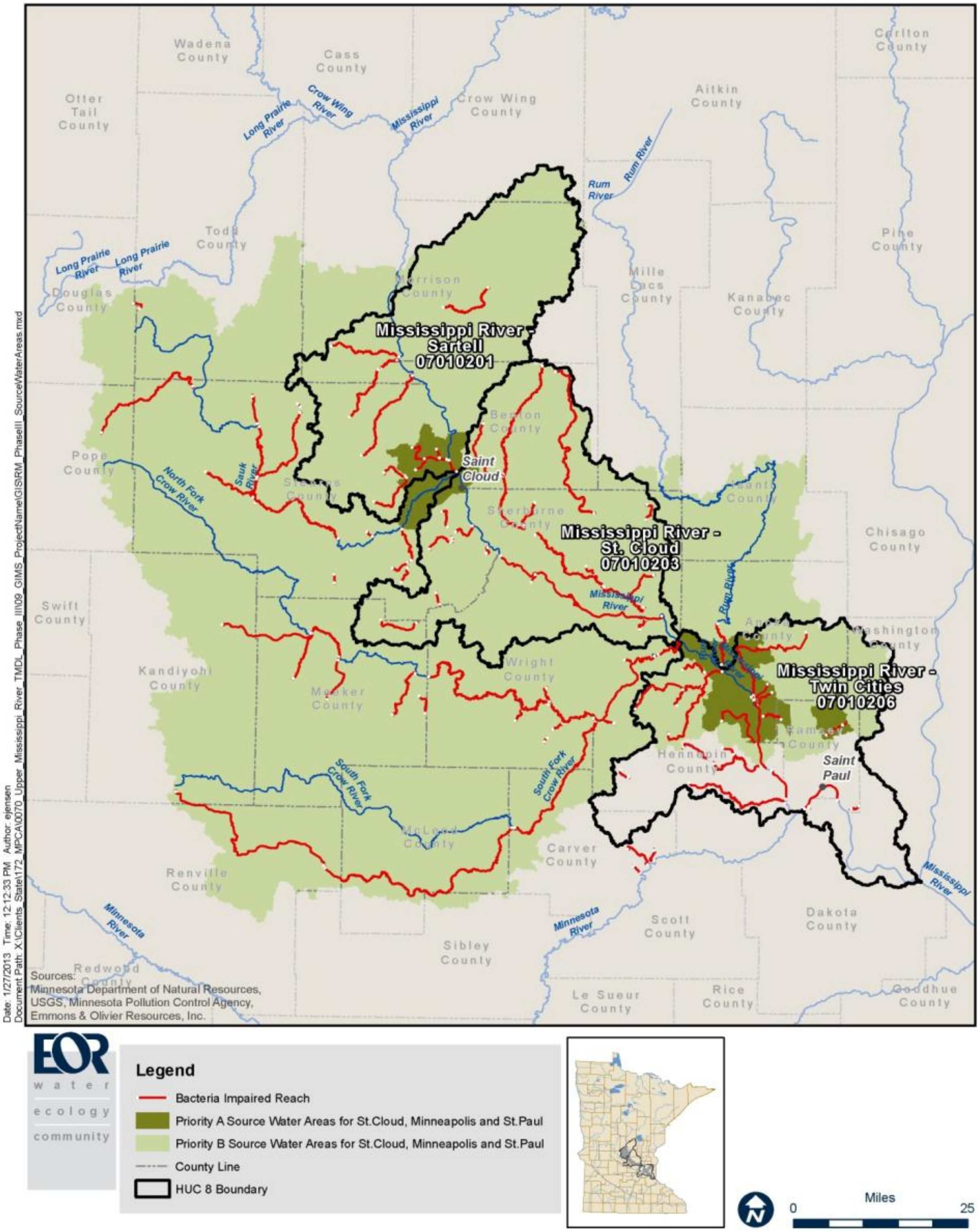


Figure 2-1. Composite Source Water Protection areas for Minneapolis, St. Cloud, St. Paul within the three focus HUC 8 watersheds of the TMDL and Protection Plan.

2.3 Stakeholders

Stakeholders were involved in guiding the project's approach and reviewing deliverables. See the MPCA's project website for meeting agendas, presentations, and meeting minutes: http://www.pca.state.mn.us/water/tmdl/project-uppermiss-bacteria.html. A summary of stakeholder and technical advisory group meetings is provided in Section 7 *Stakeholder Participation*. Table A-1, in Appendix A, lists the stakeholder organizations that were invited to participate in these meetings.

2.4 Project Location

This study focuses on the Mississippi River Corridor, which includes portions of three Major Watersheds (8-digit HUCs): Mississippi River – Sartell Watershed (07010201), Mississippi River – St. Cloud Watershed (07010203), and Mississippi River – Twin Cities Watershed (07010206). The impaired reaches for which TMDLs are being developed are depicted in Figure 2-2, Figure 2-4 and in Figure 2-6. The reaches where TMDLs are being deferred to a later date and the protection reaches are depicted in Figure 2-3, Figure 2-5 and Figure 2-7.

The hydrologic unit system is a standardized watershed classification system that was developed by the USGS. Table 2-2 identifies the 8-digit HUCs for the three Major Watersheds on which this study is focused.

Table 2-2. Major Watersheds of the TMDL Study and Protection Plan

Major Watershed 8-Digit HUC	MPCA Major Watershed Name (EPA Watershed Name)
07010201	Mississippi River – Sartell (Platte – Spunk)
07010203	Mississippi River – St. Cloud (Clearwater – Elk)
07010206	Mississippi River – Twin Cities (Twin Cities)

The Mississippi River – Sartell Watershed (HUC 07010201) covers approximately 1,020 square miles. The watershed includes parts of Benton, Crow Wing, Mille Lacs, Morrison, Stearns, and Todd Counties. Major communities located in the watershed include Lastrup, Pierz, Buckman, Royalton, Upsala, Bowlus, Rice, Hodingford, Avon, St. Joseph, and Sartell. The Mississippi River – Sartell Watershed has 879 total river miles.

The Mississippi River – St. Cloud Watershed (HUC 07010203) covers approximately 1,080 square miles. The watershed includes all or parts of Benton, Meeker, Mille Lacs, Morrison, Sherburne, Stearns and Wright Counties. Communities located in the watershed include Sauk Rapids, Elk River, Big Lake, Monticello, and parts of St. Cloud. The Mississippi River – St. Cloud Watershed has 907 total river miles. St. Cloud, at the upstream end of this watershed, is the first city along the Mississippi River to obtain its drinking water from the Mississippi River.

The Mississippi River – Twin Cities Watershed (HUC 07010206) covers approximately 1,030 square miles. The watershed includes portions of Hennepin, Anoka, Ramsey, Washington, Dakota, Carver, and Sherburne Counties, 99 cities including Minneapolis and St. Paul, and 14 watershed management organizations (WMOs). The Mississippi River in the Mississippi River – Twin Cities Watershed is a major drinking water supply for the Twin Cities. About 1.5 million people live in this watershed.

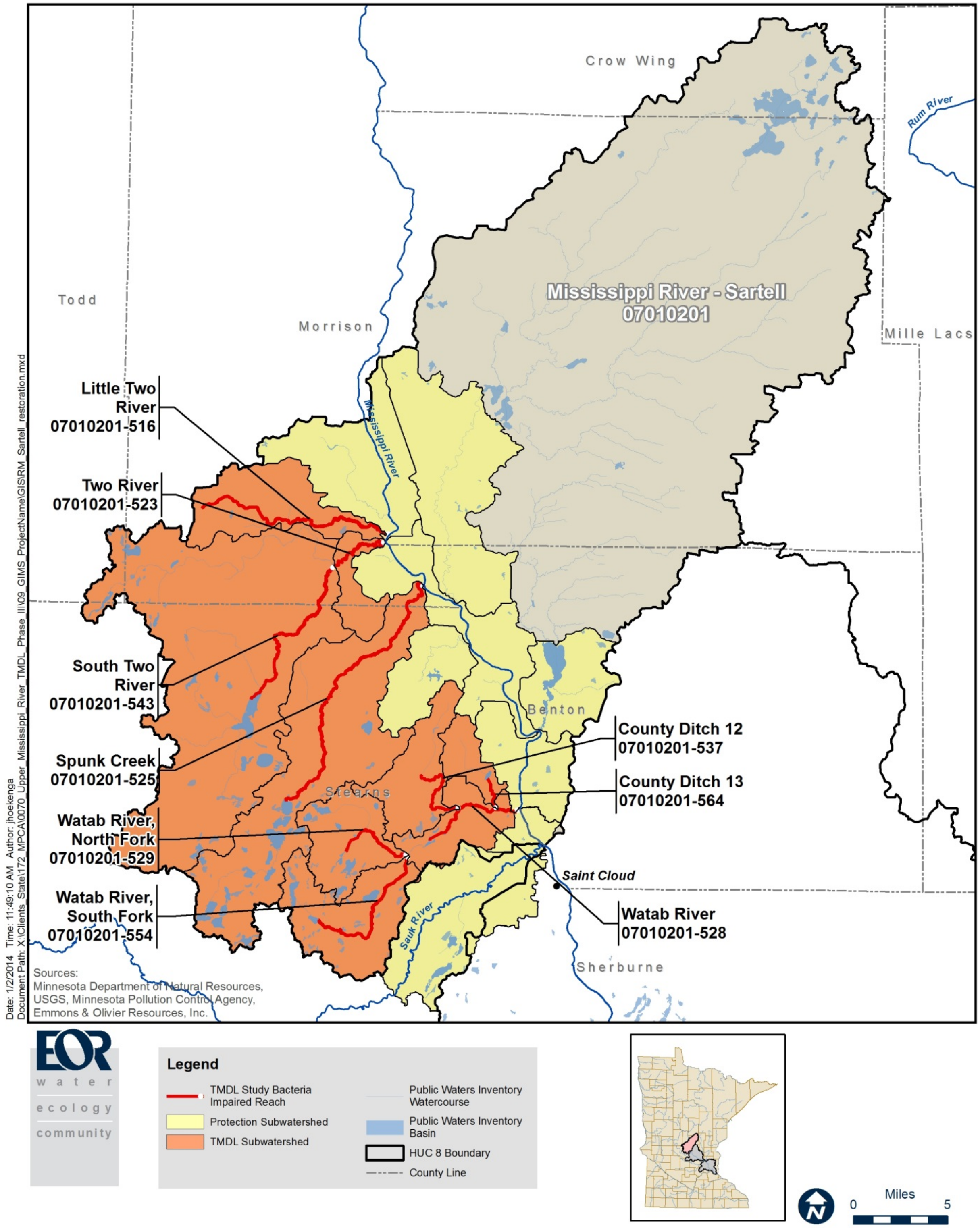


Figure 2-2. Impaired reaches and Subwatersheds of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – Sartell (HUC 07010201).

Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

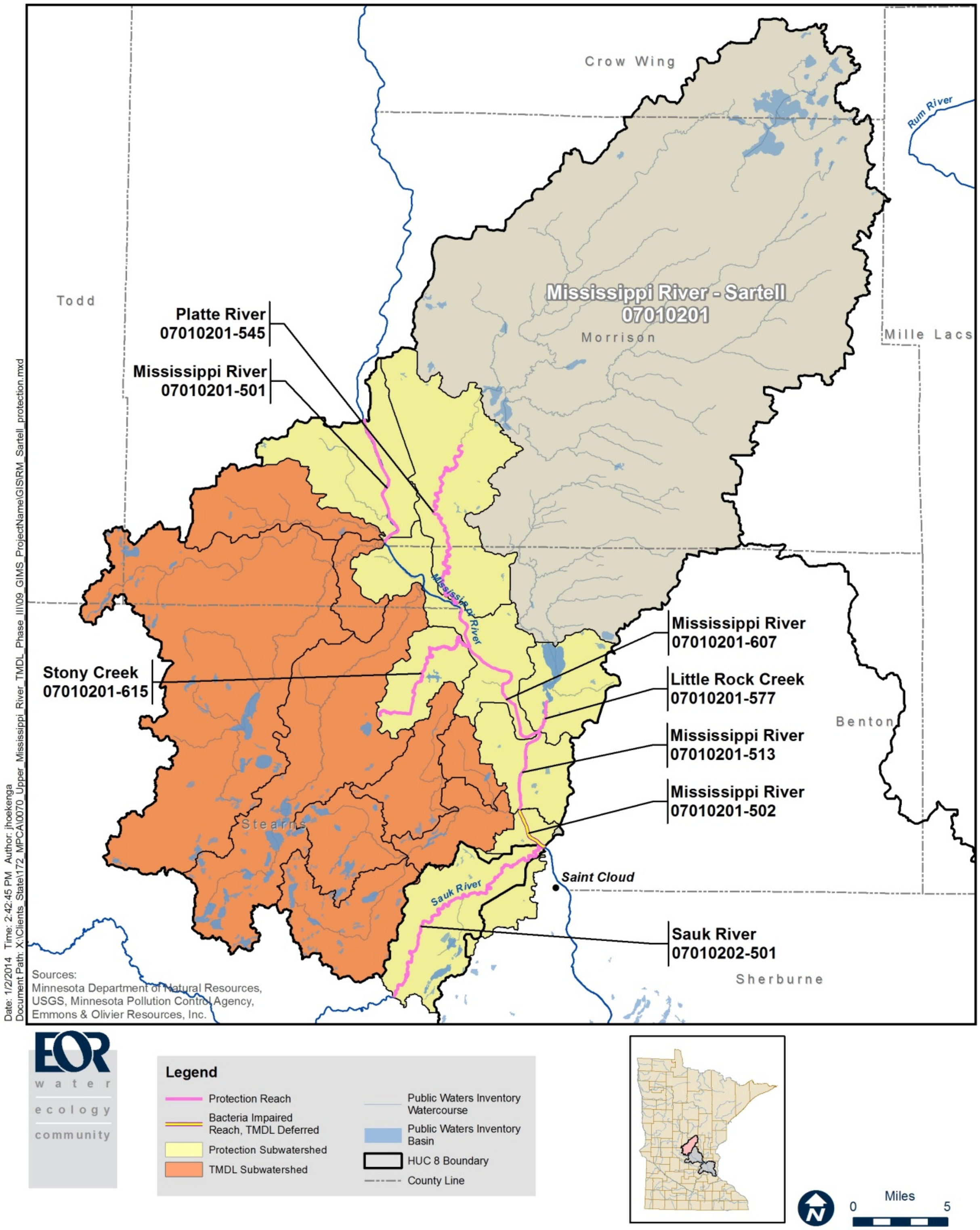


Figure 2-3. Protection reaches and deferred reaches of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – Sartell (HUC 07010201).

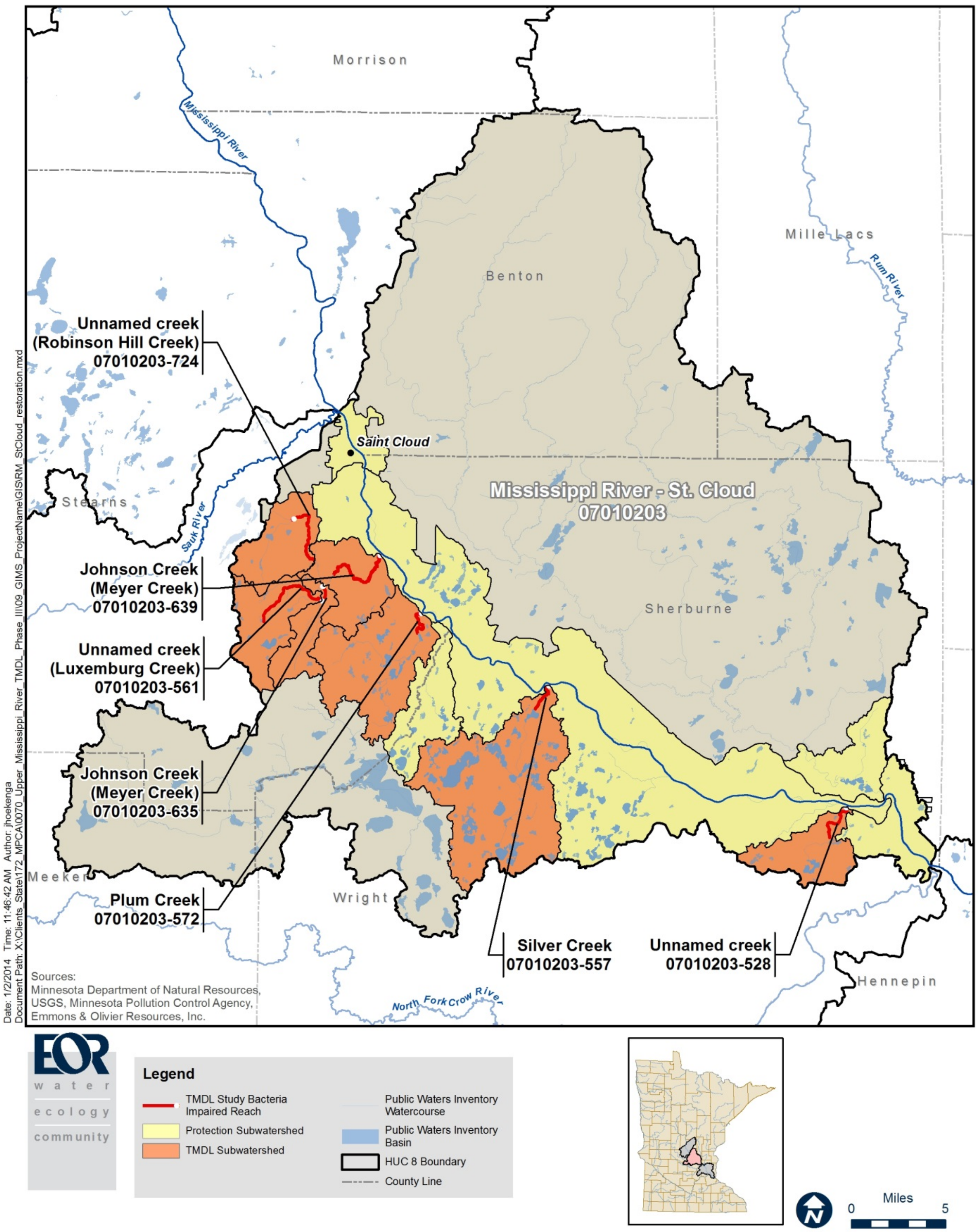


Figure 2-4. Impaired reaches and Subwatersheds of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – St. Cloud (HUC 07010203).

Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

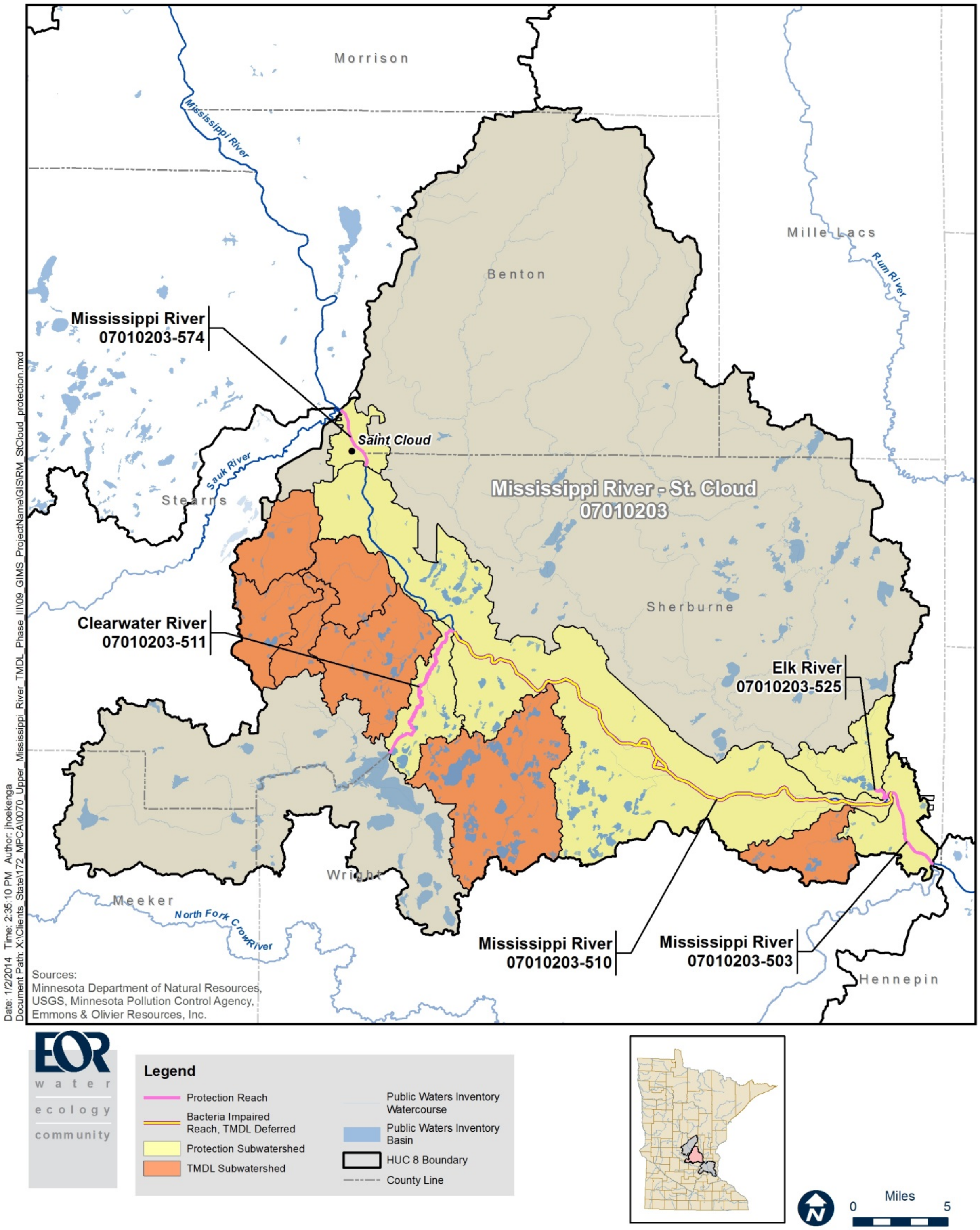


Figure 2-5. Protection reaches and deferred reaches of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – St. Cloud (HUC 07010203).

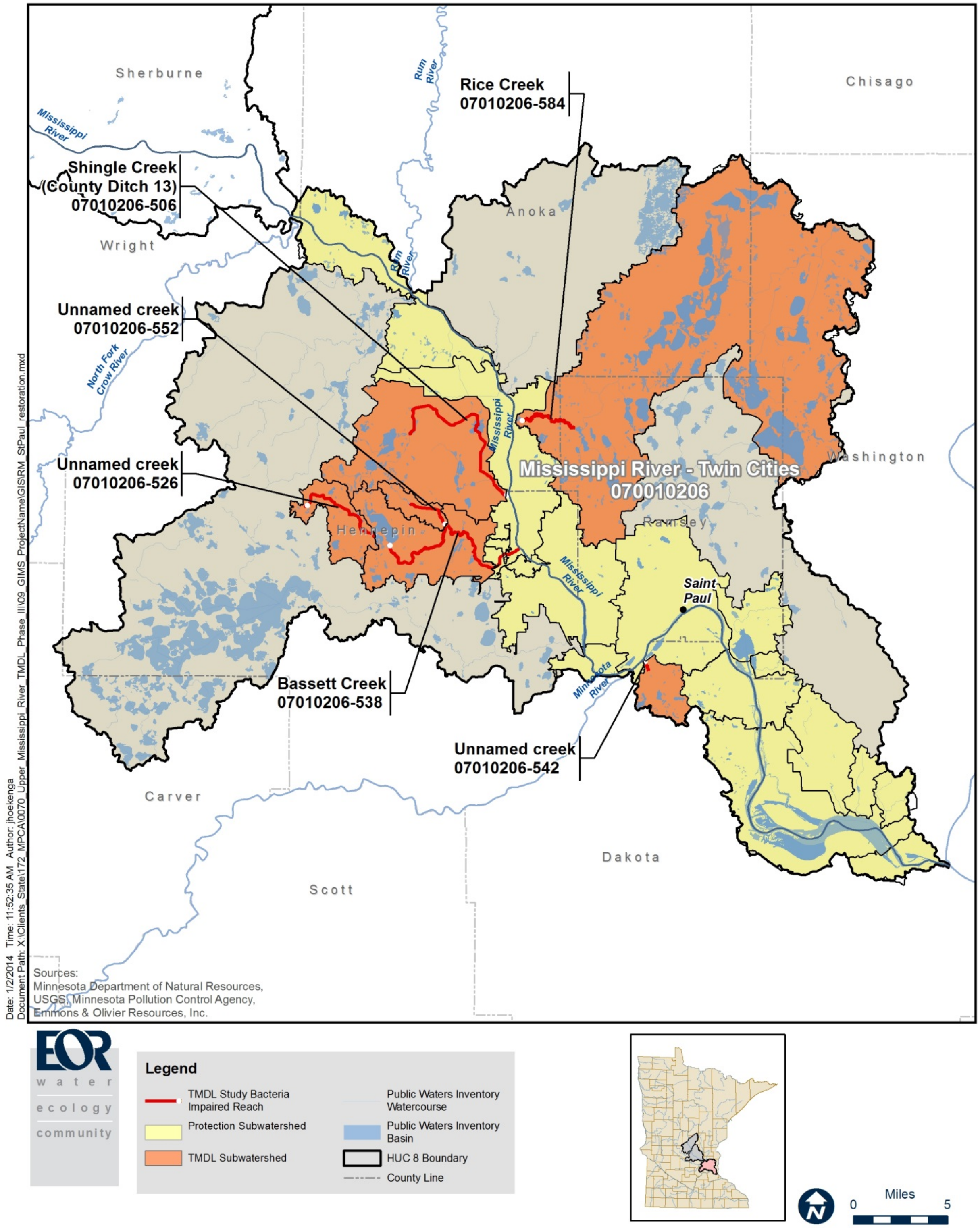


Figure 2-6. Impaired reaches and Subwatersheds of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – Twin Cities (HUC 07010206).

Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

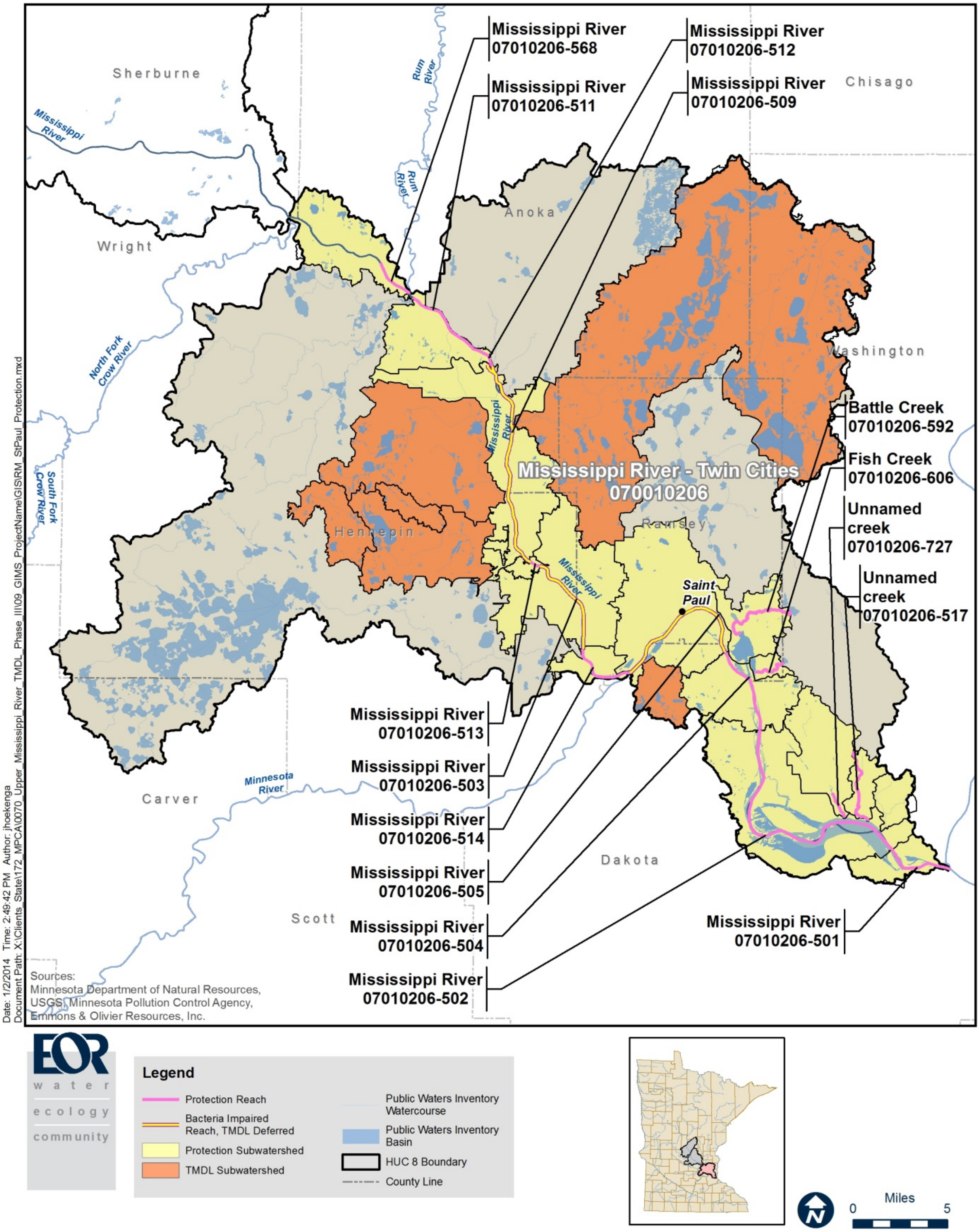


Figure 2-7. Protection reaches and deferred reaches of the Upper Mississippi River Bacteria TMDL Study and Protection Plan: Mississippi River – Twin Cities (HUC 07010206).

2.5 TMDL Study Reaches and Subwatersheds

The following analyses were conducted for the TMDL Study Reaches (TMDL study reaches impaired for aquatic recreation due to bacteria) and Subwatersheds:

- Potential Bacteria Sources (Section 4)
- Water Quality Analysis Including Load Duration Curves (Section 6)
- TMDL Calculations (Section 7)
- Implementation Strategies (Section 9)

2.5.1 TMDL Study Reaches

The MPCA assesses the state's water bodies periodically to evaluate which waterbodies meet water quality standards. Using protocols in the *MPCA Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (MPCA 2012b), water bodies are classified as one of the following:

- Not impaired: meets water quality standards
- Impaired: does not meet water quality standards
- Insufficient data: additional data needed to complete the assessment

Waterbodies that are designated as impaired are placed on the state's 303(d) list of impaired waterbodies, named after the section in the federal Clean Water Act that requires states to assess and list their water bodies.

TMDLs were developed for 22 reaches tributary to the Mississippi River, which are impaired for aquatic recreation due to fecal coliform or *E. coli*. Table 2-3 summarizes the impairments. Refer to Figure 2-2 through Figure 2-4 for a map of the TMDL study impaired reaches (TMDL Reaches) and corresponding subwatersheds (TMDL Subwatersheds).

Reaches addressed as a part of this TMDL study are impaired tributary reaches that directly discharge to the Mississippi River ('T1' in Table 2-3), and impaired reaches within the watersheds of T1 reaches (marked as 'T2' in Table 2-3). The TMDLs for the five impaired Mississippi River reaches are being deferred; these reaches have been designated as Protection Reaches throughout this study (refer to *Section 2.6.1 TMDL-Deferred Reaches* for more information). This TMDL study also excludes those impaired reaches that are being (have been or are planned to be) addressed in another project (refer to Appendix B, Table B-1).

Stream reaches in MN are divided into assessment units, and each assessment unit has a unique assessment unit identification number (AUID). The first eight digits of the AUID indicate the Major Watershed (8-digit HUC) that the water body is in. Throughout this report, an AUID will be referred to simply as a reach (i.e. a river reach). Note that reaches or tributaries not listed as impaired may have not yet been assessed. Note that reaches impaired for fecal coliform are being addressed through development of an *E. coli* TMDL since that is the current water quality standard (refer to *Section 2.2 Surface Water Uses & Water Quality Standards*); additional *E. coli* monitoring data was collected for some of these reaches as a part of this project (refer to *Section 5.1 Monitoring*).

Table 2-3. Reaches known to be impaired for bacteria and for which TMDLs are established as a part of the Upper Mississippi River Bacteria TMDL Study and Protection Plan.

TMDL Reach Name	TMDL Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed[1]	TMDL Start/ Completion	Beneficial Use Class[2]	Source Water Area[3]	Why Included in TMDL Study[4]
Little Two River	Headwaters to Mississippi R	07010201-516	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area B (St. Cloud)	T1
Two River	North & South Two R to Mississippi R	07010201-523	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area B (St. Cloud)	T1
Spunk Creek	Lower Spunk Lk to Mississippi R	07010201-525	Fecal Coliform	Aquatic recreation	2008	2008/2015	2B, 3C	Priority Area B (St. Cloud)	T1
Watab River	Rossier Lk to Mississippi R	07010201-528	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (St. Cloud)	T1
Watab River, North Fork	Headwaters (Stump Lk 73-0091-00) to S Fk Watab R	07010201-529	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (St. Cloud)	T2
County Ditch 12	Unnamed cr to Watab R	07010201-537	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (St. Cloud)	T2
South Two River	Two River Lk to Two R	07010201-543	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area B (St. Cloud)	T2
Watab River, South Fork	Little Watab Lk to Watab R	07010201-554	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (St. Cloud)	T2
County Ditch 13	Bakers Lk to Watab R	07010201-564	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (St. Cloud)	T2
Unnamed creek	T121 R23W S19, south line to Mississippi R	07010203-528	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area B (Minneapolis, St. Paul)	T1
Silver Creek	Locke Lk to Mississippi R	07010203-557	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	2B, 3C	Priority Area B (Minneapolis, St. Paul)	T1
Unnamed creek (Luxemburg Creek)	T123 R28W S30, south line to Johnson Cr	07010203-561	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	1B, 2A, 3B	Priority Area B (Minneapolis, St. Paul)	T2
Plum Creek	Warner Lk to Mississippi R	07010203-572	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	2B, 3C	Priority Area B (Minneapolis, St. Paul)	T1
Johnson Creek (Meyer Creek)	Unnamed cr to Unnamed cr	07010203-635	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	1B, 2A, 3B	Priority Area B (Minneapolis, St. Paul)	T2
Johnson Creek (Meyer Creek)	T123 R28W S14, west line Mississippi R	07010203-639	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	2B, 3C	Priority Area B (Minneapolis, St. Paul)	T1

TMDL Reach Name	TMDL Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed[1]	TMDL Start/ Comple-tion	Beneficial Use Class[2]	Source Water Area[3]	Why Included in TMDL Study[4]
Unnamed creek (Robinson Hill Creek)	CD 14 to CSAH 136	07010203-724	*Escherichia coli*	Aquatic Recreation	2012	2008/2015	1B, 2A, 3B	Priority Area B (Minneapolis, St. Paul)	T2
Shingle Creek (County Ditch 13)	Headwaters (Eagle Cr/Bass Cr) to Mississippi R	07010206-506	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area A and B (Minneapolis, St. Paul)	T1
Unnamed creek (Plymouth Creek)	Headwaters to Medicine Lk	07010206-526	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	Priority Area B (Minneapolis, St. Paul)	T2
Bassett Creek	Medicine Lk to Mississippi R	07010206-538	Fecal Coliform	Aquatic recreation	2008	2008/2015	2B, 3C	Priority Area B (Minneapolis)	T1
Unnamed creek (Interstate Valley Creek)	Unnamed cr to Mississippi R	07010206-542	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	None	T1
Unnamed creek (North Branch, Bassett Creek)	Unnamed lk to Bassett Cr	07010206-552	*Escherichia coli*	Aquatic recreation	2014	2008/2015	2B, 3C	None	T2
Rice Creek	Long Lk to Locke Lk	07010206-584	*Escherichia coli*	Aquatic recreation	2014	2008/2015	1C, 2Bd, 3C	Priority Area A and B (Minneapolis, St. Paul), Priority Area B (Vadnais)	T2

[1]Note that 2014 listings are aquatic recreation impairments due to *E. coli* listed on MPCA's Draft 2014 303(d) list.
[2]All waters, whether designated with a specific beneficial use classification or not, are also classified as 3C, 4A, 4B, 5, and 6 waters. For waters with multiple classifications, the more restrictive standards apply.
[3]The cities of St. Cloud, St. Paul, and Minneapolis have State endorsed Source Water Protection Plans following the Minnesota Department of Health guidance for surface water intakes from the Mississippi River. In each of these plans, cities have designated priority areas for drinking water protection, called Source Water Protection Areas (illustrated in Figure 2-1). If a subwatershed of an impaired reach overlaps with a Priority Source Water Area for St. Cloud, St. Paul, or Minneapolis that source water area is noted in the table.
[4]T1 – Impaired tributary reach that directly discharges to the Mississippi River (i.e. adjacent reach); T2 – Impaired reach that does not directly discharge to the Mississippi River, but it is in the watershed of an impaired tributary reach that does.

2.5.2 TMDL Study Subwatersheds

Refer to Figure 2-2, Figure 2-4, and Figure 2-6 for maps of the TMDL study impaired reaches (TMDL Reaches) and corresponding subwatersheds (TMDL Subwatersheds). One TMDL Subwatershed boundary was defined for each TMDL Reach (there is exactly one TMDL Reach in each TMDL Subwatershed). For example if the drainage area of a TMDL Reach includes a second TMDL Reach, the drainage area is split into two separate subwatersheds; the outlet of each of the subwatersheds is the downstream end of the TMDL Reach. Within these watersheds, there were no reaches that had been assessed by the MPCA *and* determined to be unimpaired; these would have been excluded from the TMDL Subwatersheds. DNR Catchments were the base layer used to delineate the TMDL Subwatersheds. The following edits to the DNR Catchments were made:

- The DNR Catchments were subdivided where needed (using USGS StreamStats) so that the downstream end of the TMDL Reach corresponds to the downstream end of the TMDL Subwatershed.
- A request was made to the regulated MS4 entities for stormwater drainage information (based on stormsewer conveyances) that substantially differs from the DNR Catchments. Information received from the regulated MS4 entities was used to edit the TMDL watersheds.

2.6 Protection Plan Reaches and Subwatersheds

Refer to Figure 2-3, Figure 2-5 and Figure 2-7 for maps of the Protection Plan Subwatersheds (Protection Subwatersheds). The Protection Subwatershed identification numbers correspond to the downstream reach of the Protection Subwatershed as found in Table 2-4[1]. The following project components were completed for the Protection Reaches and Subwatersheds:

- Potential Bacteria Sources (Section 4)
- Water Quality Analysis Including Load Duration Curves (Section 6)
- Implementation Strategies (Section 9)

A loading capacity was not calculated for Protection Subwatersheds (in contrast to the TMDL Subwatersheds). Although the Protection Subwatersheds do not have a numeric goal, implementation strategies were identified (Section 9) based on the potential bacteria sources (Section 4) and the load duration curves (Section 6).

The Protection Subwatersheds (Figure 2-2, Figure 2-4 and Figure 2-6) include areas draining to the Mississippi River with a focus on the Mississippi River corridor. Protection Subwatersheds include:

- Mainstem reaches: The direct drainage area (as defined by DNR Catchments) to all Mississippi River mainstem reaches that are not already part of the TMDL Subwatersheds.
- Mainstem reaches: The subwatersheds to the impaired Mississippi River mainstem reaches for which TMDLs were deferred (refer to *Section 2.6.1 TMDL-Deferred Reaches* for more information).

[1] Note: Mississippi River Reach 07010206-511 does not have a unique Protection Subwatershed, rather, it is within the Mississippi River Reach 07010206-512 Protection Subwatershed

- Tributaries: Direct drainage areas (as defined by DNR Catchments) to the downstream-most reach of adjacent tributaries that are NOT 1) already part of the TMDL, nor 2) part of a future planned TMDL. A tributary is considered to be adjacent when it is the downstream most reach or AUID that directly flows into the Mississippi River. If the downstream-most reach was less than 2 miles long (excluding reaches that pass through lakes), an additional upstream DNR catchment was included. In order to keep with the spirit and intent of focusing on the Mississippi River Corridor, two exceptions to this rule apply: 1) In the case of an unnamed stream in Cottage Grove (AUID 07010206-517), the DNR catchment included upstream reaches that were many times the length of the downstream-most reach and, therefore, a significant distance away from the Mississippi River. Drainage boundaries submitted by the City of Cottage Grove during the stakeholder review of TMDL Subwatersheds were used to reduce the drainage area to include just the downstream-most reach. 2) The downstream-most reach of the Minnesota River was not included. Its downstream-most reach is 24 miles long and, again, departs from the intent of focusing on the Mississippi River Corridor.

Table 2-4 identifies the 29 Protection Reaches, which include the Mississippi mainstem river reaches and downstream-most adjacent tributaries that are included in the protection plan (and in the Protection Subwatersheds) of the Upper Mississippi River Bacteria TMDL Study and Protection Plan.

Table 2-4. Protection Reaches of the Upper Mississippi River Bacteria TMDL Study and Protection Plan.

Protection Reach Name	Reach Description	AUID	Beneficial Use Class[1]
Mississippi River	End HUC 07010104 (below Swan R) to Two R	07010201-501	1C, 2Bd, 3C
Mississippi River	Watab R to Sauk R	07010201-502[1]	1C, 2Bd, 3C
Mississippi River	Little Rock Cr to Sartell Dam	07010201-513	1C, 2Bd, 3C
Platte River	Unnamed cr (above RR bridge) to Mississippi R	07010201-545	2B, 3C
Little Rock Creek	Little Rock Lk to Mississippi R	07010201-577	2B, 3C
Mississippi River	Morrison/Stearns County border to Little Rock Cr	07010201-607	1C, 2Bd, 3C
Stony Creek	Headwaters to Mississippi R	07010201-615	2B, 3C
Sauk River	Mill Cr to Mississippi R	07010202-501	2B, 3C
Mississippi River	Elk R to Crow R	07010203-503	1C, 2Bd, 3C
Mississippi River	Clearwater R to Elk R	07010203-510[1]	1C, 2Bd, 3C
Clearwater River	Clearwater Lk to Mississippi R	07010203-511	2B, 3C
Elk River	Orono Lk to Mississippi R	07010203-525	2B, 3C
Mississippi River	Sauk R to University Dr S bridge in St Cloud	07010203-574	1C, 2Bd, 3C
Mississippi River	L & D #2 to St Croix R (RM 815.2 to 811.3)	07010206-501	2B, 3C
Mississippi River	Rock Island RR bridge to L & D #2 (RM 830 to 815.2)	07010206-502	2B, 3C
Mississippi River	Lower St Anthony Falls to L & D #1 (RM 853.3 to RM 847.6)	07010206-503[1]	2B, 3C
Mississippi River	Metro WWTP to Rock Island RR bridge (RM 835 to 830)	07010206-504	2C, 3C
Mississippi River	Minnesota R to Metro WWTP (RM 844 to 835)	07010206-505[1]	2B, 3C
Mississippi River	Coon Cr to Upper St Anthony Falls	07010206-509[1]	1C, 2Bd, 3C
Mississippi River	Elm Cr to Coon Rapids Dam	07010206-511	1C, 2Bd, 3C
Mississippi River	Coon Rapids Dam to Coon Cr	07010206-512	1C, 2Bd, 3C
Mississippi River	Upper St Anthony Falls to Lower St Anthony Falls	07010206-513	2B, 3C
Mississippi River	L & D #1 to Minnesota R	07010206-514	2B, 3C
Unnamed creek	Headwaters to Mississippi R	07010206-517	2B, 3C
Mississippi River	NW city limits of Anoka to Rum R	07010206-568	1C, 2Bd, 3C
Battle Creek	Battle Creek Lk to Pigs Eye Lk	07010206-592	2B, 3C
Fish Creek	Carver Lk to Unnamed (North Star) lk	07010206-606	2C
Unnamed creek	Unnamed lk (82-0086-00) to Mississippi R	07010206-727	2B, 3C
Unnamed, Unassessed	[Discharges to Mississippi River Reach 07010206-502]	07010206-xxx	2B, 3C

[1]These reaches are impaired for aquatic recreation due to bacteria, and the TMDLs are being deferred (refer to Section 2.6.1 for more information).

2.6.1 TMDL-Deferred Reaches

The TMDLs of five impaired Mississippi River reaches (listed in Table 2-4) for which a TMDL study has not yet been completed are being deferred; these reaches have been designated as Protection Reaches throughout this study. Initially, these reaches were selected as TMDL Reaches (with corresponding TMDL Subwatersheds). However, the TMDL and loading reductions required to meet the TMDL (using the methods described in Section 5) found a 0% required load reduction. MPCA assessment notes corroborate and explain these results in that the trigger for impairment was slight. As a result, MPCA is deferring the TMDLs of these reaches until further data analysis and/or reassessment undertaken as a part of the monitoring plan (Section 11) and adaptive management process (refer to Section 9 *Implementation Strategies*).

Although these impaired Mississippi River reaches are evaluated as Protection Reaches, the detailed methods used to identify the subwatersheds (before it was decided to defer the TMDLs) are provided in the interest of aiding any possible future TMDL derivation. The subwatersheds to the impaired Mississippi River reaches were considered to be those portions of the watershed that contribute to exceedances of the water quality standard.

3 WATERSHED CHARACTERIZATION

The three Major Watersheds on which the TMDL and Protection Study is focused are Mississippi River – Sartell Watershed (HUC 07010201), Mississippi River – St. Cloud Watershed (HUC 07010203), and Mississippi River – Twin Cities Watershed (HUC 07010206). These watersheds are the framework for watershed characterization. Population, topography and soil characteristics are illustrated here. For more detailed land cover and impairment maps, refer to *Section 4.1.6 2006 NLCD Land Cover Maps*.

3.1 Population

Table 3-1 identifies the 2010 population and the projected 2030 population for each of three Major Watersheds based on the 2010 US Census and the Minnesota State Demographic Center.

Table 3-1. US Census 2010 population data for three Major Watersheds.

Major Watershed	2010	2030
Mississippi River – Sartell (07010201)	62,000	74,900
Mississippi River – St. Cloud (07010203)	162,000	222,500
Mississippi River – Twin Cities (07010206)	1,545,200	1,755,100

Source: 2010 US Census and, for projections, Minnesota State Demographic Center; all values rounded to the nearest hundred

3.2 Topography and Soils

In the Mississippi River – Sartell Watershed (Figure 3-1 and Figure 3-2), the Mississippi River experiences one of its greatest drops in elevation within the Upper Mississippi River Basin. From the community of Little Falls to Royalton, the river drops 6.5 feet for every mile of river. The excessively drained sand plain regions are some of the most intensively used lands within the watershed, and much of these areas are situated along the Mississippi River.

The stretch of the Mississippi River in the Mississippi River – St. Cloud Watershed (Figure 3-3 and Figure 3-4) has been designated as a Wild and Scenic River. This segment of the river is a popular recreational route due to the rolling forested bluffs, wildlife, fishing opportunities, and numerous accesses.

The Mississippi River – Twin Cities Watershed (Figure 3-5 and Figure 3-6) is largely characterized by developed shorelines and urban areas. Soils in the metropolitan area that once held water have been covered with impervious pavement and stormwater infrastructure, which convey stormwater more quickly to surface waters like the Mississippi River. Of all the Mississippi River locks and dams, the one having the largest drop is located in this watershed at the Upper St. Anthony Falls Lock and Dam, which is also the uppermost lock and dam on the Mississippi River. St. Anthony Falls is the only true waterfall on the entire Mississippi River. The entire length of the Mississippi River in this Major Watershed has been a National Park since 1988, the Mississippi National River and Recreation Area, from the mouth of the Crow River to south of the confluence with the Saint Croix River. This same stretch of the river is designated the Mississippi River Critical Area by the State of Minnesota.

Soils are classified into groups based upon the hydrologic characteristics of the soils. Soil hydrologic groups are used to estimate the amount of runoff generated for a given rainfall event.

Vegetation, organic/mineral or physical composition and slope all contribute to the runoff potential of a soil. There are four hydrologic soil groups: A, B, C and D. Table 3-2 presents a description for each of the hydrologic soil groups. Certain wet soils are placed in group D based solely on the presence of a water table within two feet of the surface but may have properties that would otherwise make them capable of infiltration. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their infiltration characteristics. The first letter applies to the drained condition and the second to the undrained condition (USDA NRCS, 2007).

Table 3-2. Hydrologic soil group descriptions.

Hydrologic Soil Group	Description
A	Soils having high infiltration rates when thoroughly wet (low runoff potential). Deep, well drained to excessively drained sand or gravelly sand.
B	Soils having a moderate infiltration rate when thoroughly wet. Moderately deep or deep, moderately well drained or well drained with moderate to moderately coarse texture.
C	Soils having a slow infiltration rate when thoroughly wet: soils have a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.
D	Soils having very slow rates of infiltration when thoroughly wet (high runoff potential): soils consist of clays with high shrink-swell potential; soils have a high permanent water table; soils that have a claypan or clay layer at or near the surface and soils that are shallow over nearly impervious material.

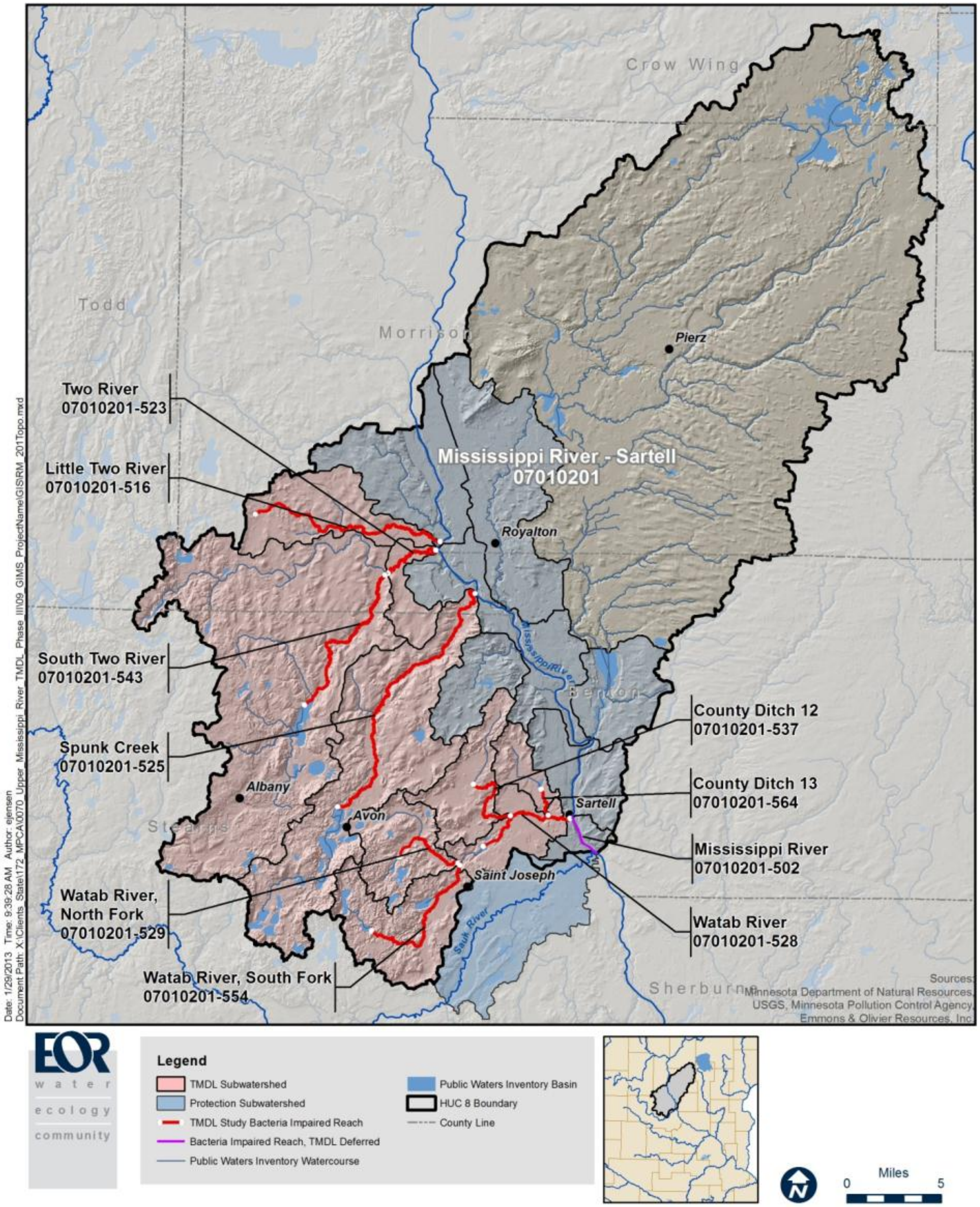


Figure 3-1. Mississippi River – Sartell Watershed (HUC 07010201) topography.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

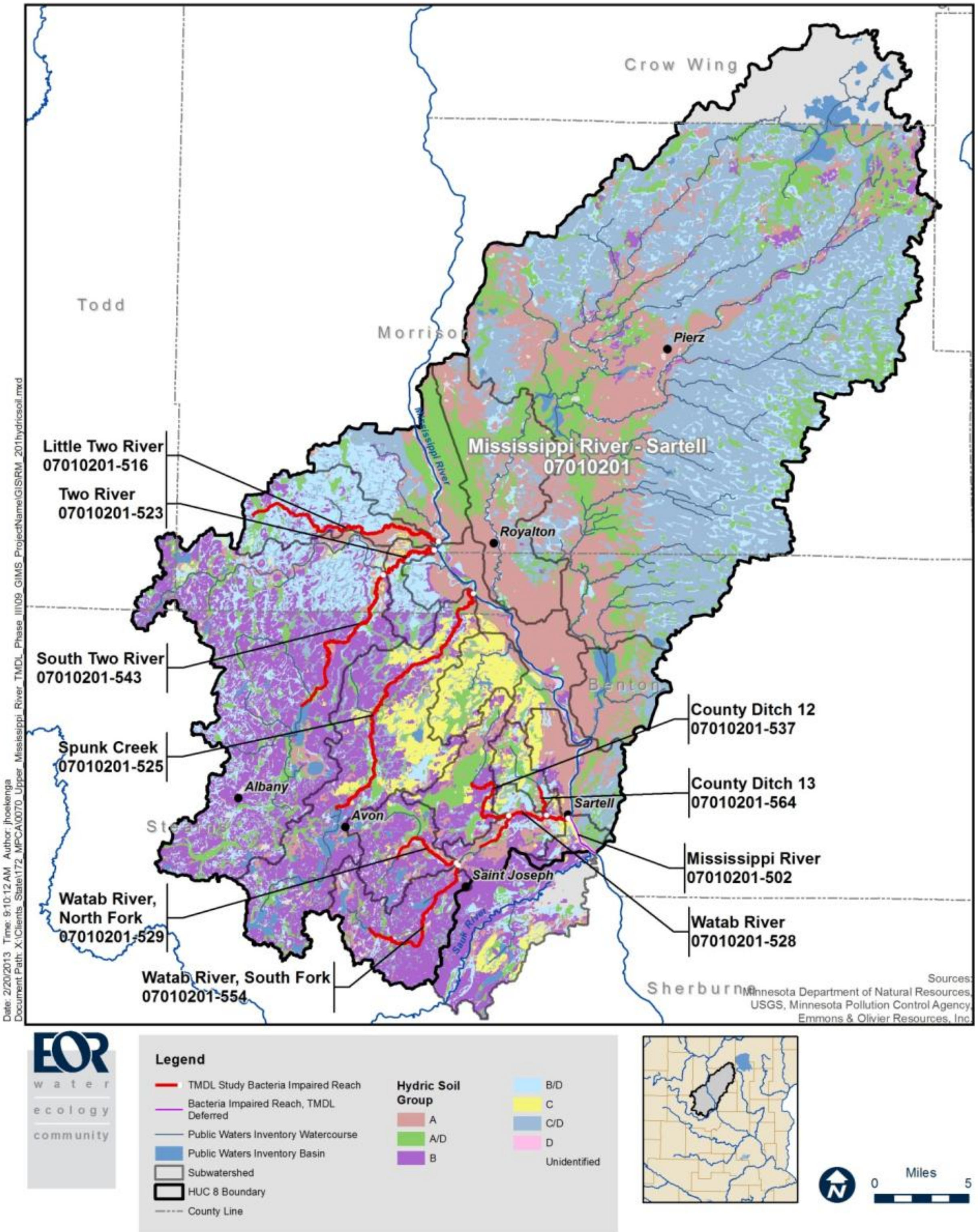


Figure 3-2. Mississippi River – Sartell Watershed (HUC 07010201) soils.
Note: Soils data is not available for Crow Wing County; Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

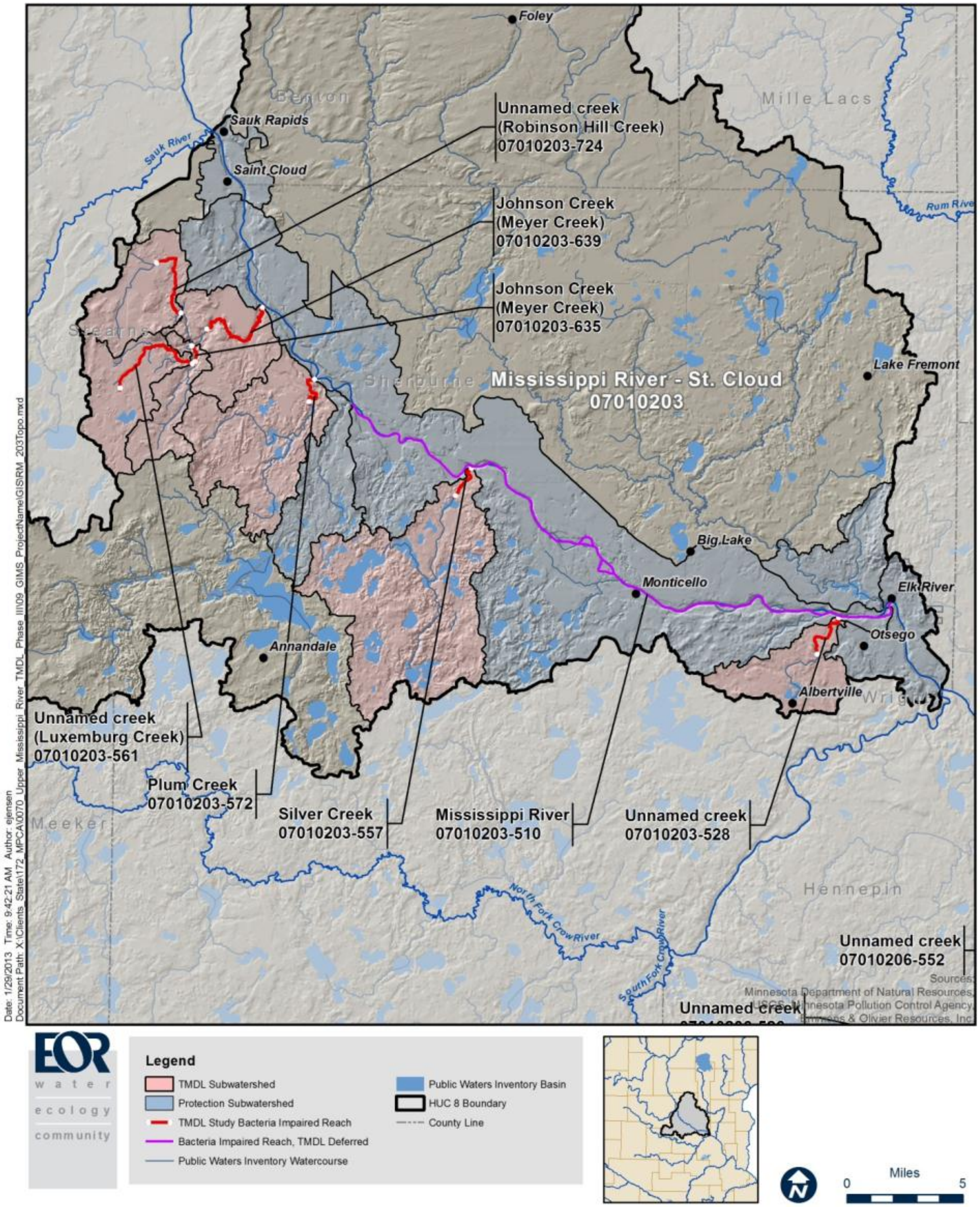


Figure 3-3. Mississippi River – St. Cloud Watershed (HUC 07010203) topography.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

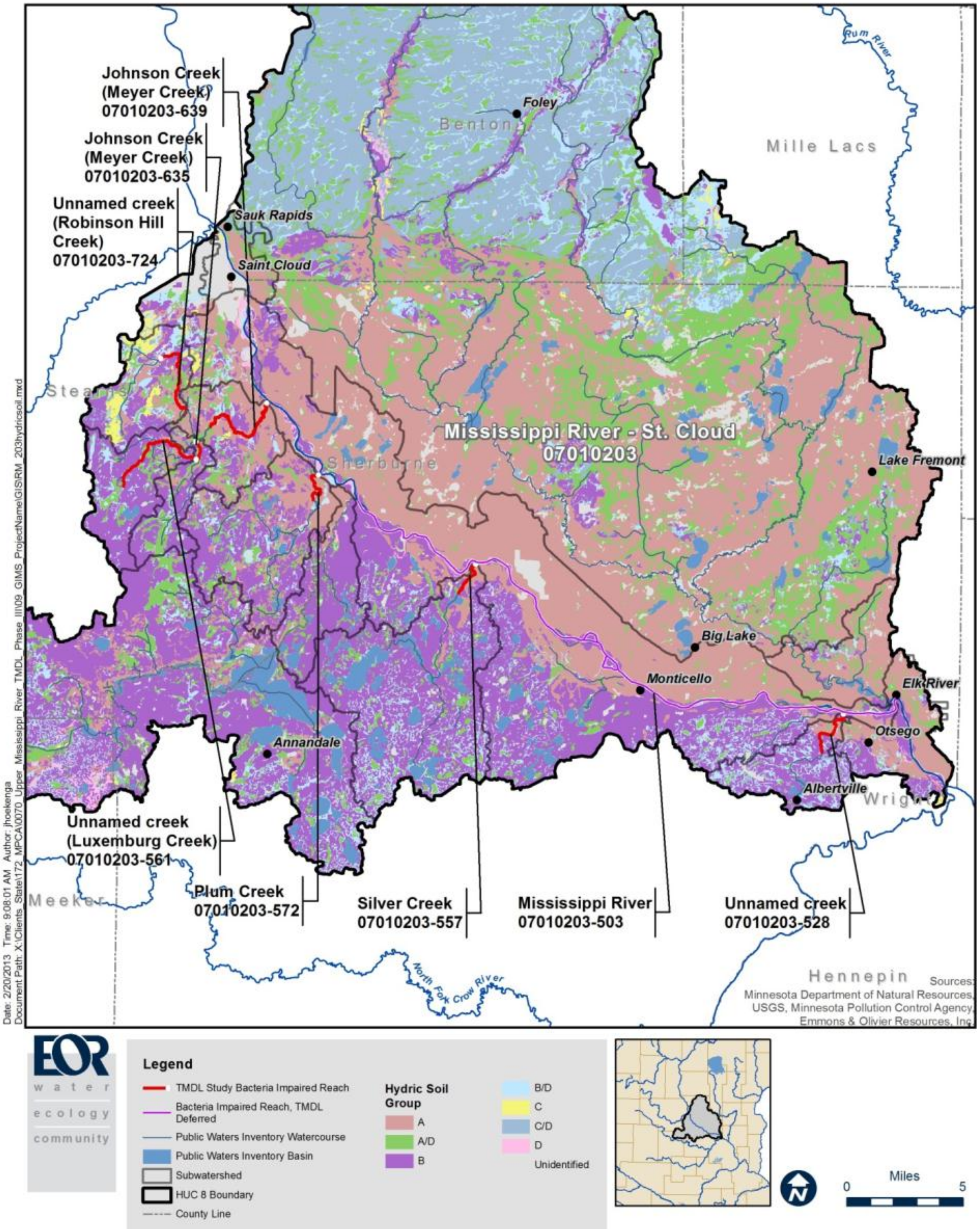


Figure 3-4. Mississippi River – St. Cloud Watershed (HUC 07010203) soils.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

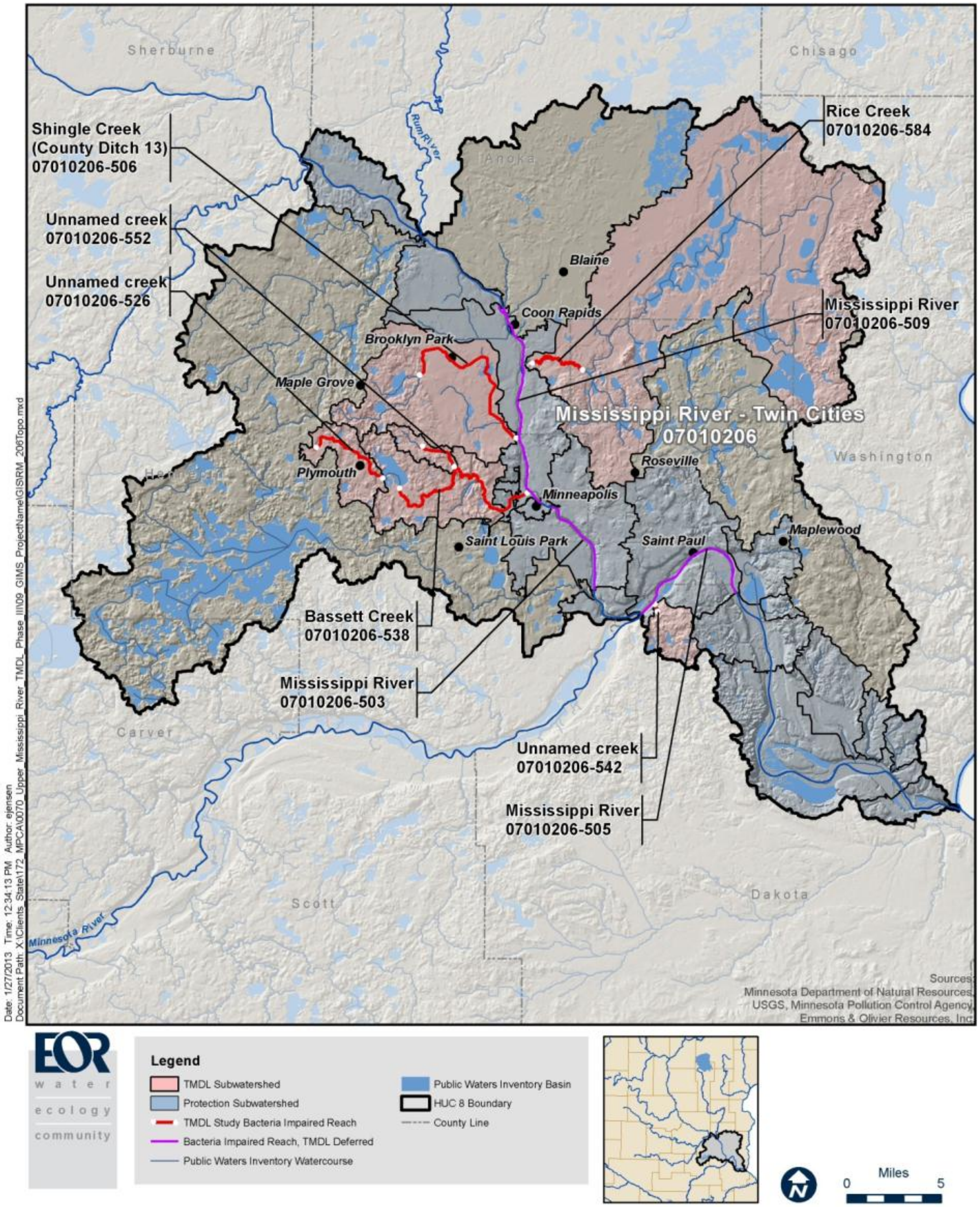


Figure 3-5. Mississippi River – Twin Cities Watershed (HUC 07010206) topography.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

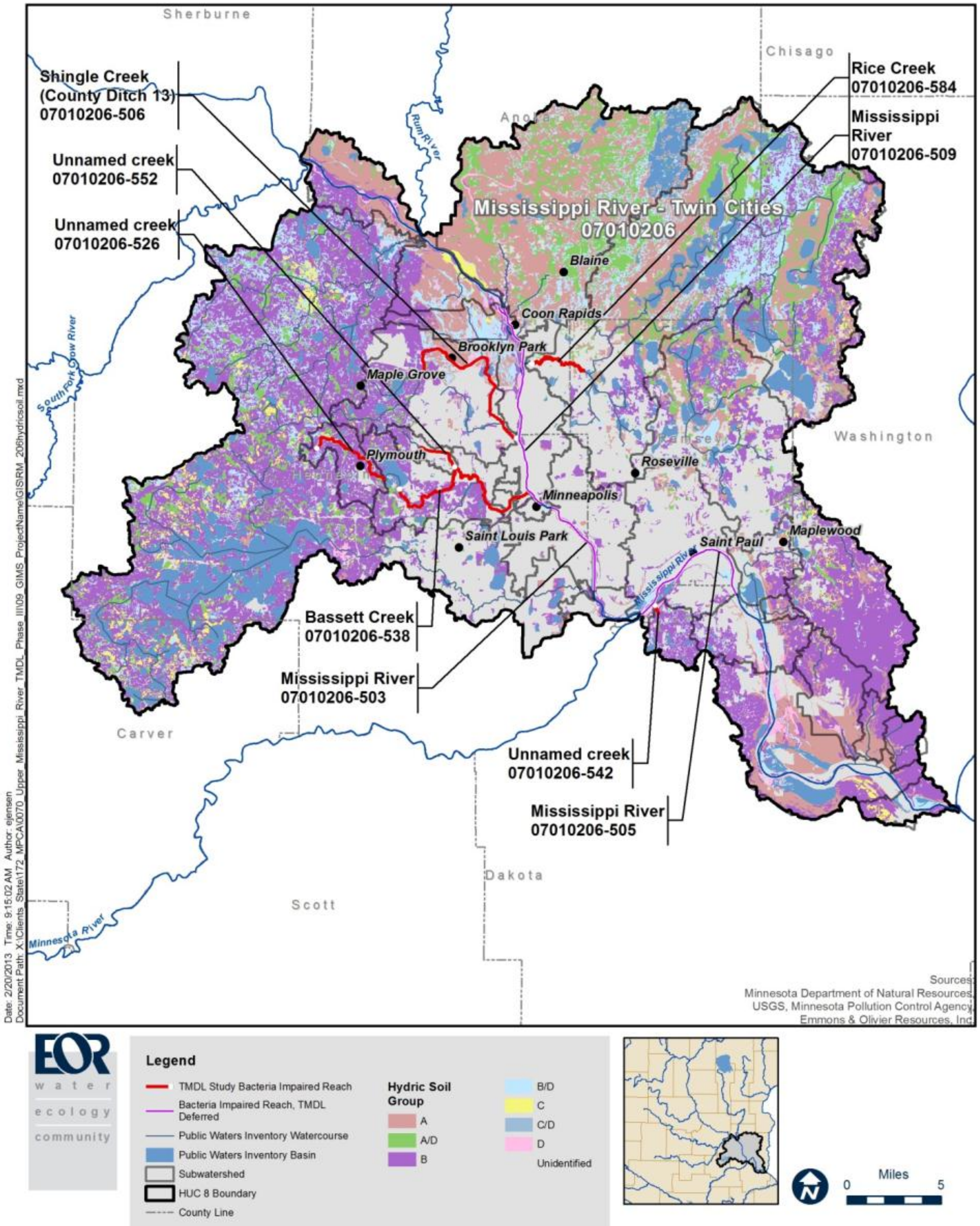


Figure 3-6. Mississippi River – Twin Cities Watershed (HUC 07010206) soils.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

4 POTENTIAL BACTERIA SOURCES

Potential sources of bacteria to surface waters were investigated at two different scales: the Phase I Project Area (approximately 8,900 square miles) and the TMDL and Protection Subwatersheds. Potential bacteria sources identified for the Phase I Project Area provide guidance for restoration and protection, but the Phase I Project Area bacteria source estimates are less detailed than that of the TMDL and Protection Subwatersheds. Methods and results for the Phase I Project Area can be found in *Phase I Project Area Potential Bacteria Sources*, which will be posted on the project website at http://www.pca.state.mn.us/ktqha48. Methods and results for the TMDL and Protection Subwatersheds are presented here. Section 4.1 provides a general discussion of bacteria sources and delivery mechanisms including details applicable to the TMDL and Protection Subwatersheds. Section 4.2 describes the approach used in the estimation of potential bacteria sources for the TMDL and Protection Subwatersheds. Section 4.3 presents findings with respect to potential bacteria sources.

In Phase I of the Upper Mississippi River Bacteria TMDL project, a preliminary investigation of bacteria sources (a separate effort preceding the *Phase I Project Area Potential Bacteria Sources* report) entailed gathering and summarizing preliminary information regarding potential bacteria sources in the watershed. The report, *Upper Mississippi River Bacteria TMDL: Data Analysis, Source Assessment, and Monitoring Recommendations* (MPCA and MDH 2009), can be found on the project website at http://www.pca.state.mn.us/ktqha48. Source categories included human sources, livestock, pets, wildlife, urban stormwater, and sediments. The more detailed analyses presented in this report build on previous findings.

4.1 Discussion of Potential Bacteria Sources and Delivery Mechanisms

Humans, pets, livestock, and wildlife contribute bacteria to the environment, where they can survive for long periods in sand and sediments. These bacteria, after appearing in fecal material, are dispersed throughout the environment by an array of natural and man-made mechanisms. Bacteria fate and transport is affected by, for example, human waste disposal and treatment mechanisms, methods of manure reuse, imperviousness of land surfaces, and natural decay and die-off due to environmental factors such as UV exposure and detention time in the landscape. It is the complexity of these fate and transport mechanisms that make it particularly difficult to decipher and quantify bacteria loading sources. The following discussion highlights *potential* sources of bacteria in the environment and mechanisms that drive the delivery of bacteria to surface waters. Details specific to the TMDL and Protection Subwatersheds informed the approach to estimating potential bacteria sources, which is discussed in Section 4.2.

4.1.1 Humans

Wastewater Treatment Facilities (WWTFs) and Collection Systems

WWTFs

WWTFs are required to monitor effluent fecal coliform bacteria levels at frequencies specified in their NPDES permits. Dischargers to Class 2 waters are required to disinfect from April through October, and dischargers to Class 7 waters are required to disinfect from May through October. Wastewater disinfection is required during all months for dischargers within 25 miles upstream of a water intake for a potable water supply system (Min. Rules Ch. 7053.0215, subp. 1). The geometric mean for all samples collected in a month must not exceed 200 cfu/100 ml fecal coliform bacteria. MPCA enforcement action varies based on frequency, severity, and circumstances of violation(s). MPCA enforcement actions can range from discussions with facility staff to letters of warning to notices of Violation, Administrative Penalty Orders or Stipulation Agreements with monetary penalties. Enforcement actions are more aggressive for repeated or serious violations than for a minor one-time violation. Mechanical failures and precipitation-driven flood events are examples of circumstances under which enforcement actions for violations are dependent on the cause(s) of the event and the way in which the facility responded to it.

Table 4-1 and Table 4-2 identify the WWTFs in the TMDL and Protection Subwatersheds, respectively, and include design flows and bacteria loads. The WWTF locations are shown on the land cover maps in Section 4.1.6.

Table 4-1. WWTFs, design flows, and bacteria loads in TMDL Subwatersheds.

Subwatershed ID	Facility Name	Permit No.	Design Flow [mgd]	Permitted Bacteria Load as *E. coli* at 126 org / 100 ml* [billion org/day]
07010201-516	Upsala WWTF	MNG580053	0.635	3.03**
07010201-525	Avon WWTF	MN0047325	0.422	2.01
07010201-529	Order of St Benedict WWTF	MN0022411	0.242	1.15
07010201-543	Albany WWTF	MN0020575	5.0	23.8***
	Bowlus WWTF	MN0020923	0.5	2.38****
	Holdingford WWTF	MN0023710	0.224	1.07
07010203-528	Albertville WWTF	MN0050954	0.93	4.43
	Otsego WWTF West	MN0066257	0.72	3.43

* WWTF permits are regulated for fecal coliform (200 org/ 100 ml), not *E. coli*. Loads in this table are reported as *E. coli* at the surface water quality standard of 126 org / 100 ml using three significant figures.
** Controlled discharge (not continuous). Load calculated based on 0.635 mgd maximum permitted flow rate from 3.9 acre secondary cell.
*** Controlled discharge (not continuous). Load calculated based on 5.0 mgd maximum permitted flow rate from 9.66 acre secondary cell.
**** Controlled discharge (not continuous). Load calculated based on 0.5 mgd maximum permitted flow rate from 1.7 acre secondary cell.

Table 4-2. WWTFs, design flows, and bacteria loads in Protection Subwatersheds.

Subwatershed ID	Facility Name	Permit No.	Design Flow [mgd]	Permitted Bacteria Load as *E. coli* at 126 org / 100 ml[1] [billion org/day]
07010201-513	Lake Andrew WWTF	MN0067733	0.0152	0.0725
	New Pirates Cove WWTF	MN0066109	0.103	0.490
07010201-577	Benton Utilities WWTF	MN0065391	0.15	0.715
07010201-607	Rice WWTF	MN0056481	1.39	6.63[2]
07010203-503	Elk River WWTF	MN0020788	3.98	19.0
	Riverbend Mobile Home Park WWTF	MN0042251	0.06	0.286
07010203-510	Big Lake WWTF	MN0041076	0.84	4.01
	Clear Lake/Clearwater WWTF	MN0047490	0.484	2.31
	Monticello WWTF	MN0020567	2.36	11.3
	Saint Cloud WWTF	MN0040878	17.9	85.4
07010206-501	Met Council - Hastings WWTF	MN0029955	2.69	12.8
07010206-502	Met Council - Eagles Point WWTF	MN0029904	11.9	56.8
07010206-504	Met Council - Metropolitan WWTF	MN0029815	314	1,500
07010206-517	3M Cottage Grove Center	MN0001449	3.6	17.2

[1] WWTF permits are regulated for fecal coliform, not *E. coli*. Loads are reported with three significant figures.
[2] Controlled discharge (not continuous). Load calculated based on 1.39 mgd maximum permitted flow rate from 4.27 acre secondary cell.

Combined Sewer Overflows

A combined sewer overflow event, or CSO, is a discharge of untreated sewage mixed with stormwater runoff (from buildings, parking lots, streets and so on) to the Mississippi River. The occurrence of a CSO can result in adversely affecting downstream use of the resource. Combined sewer systems were designed to collect sanitary sewage and stormwater runoff in a single pipe system. These systems were designed to overflow in the event of heavy rain, if the combined total of wastewater and stormwater exceeded the capacity of the sewer system, to protect property and prevent sewer backups into homes and other buildings.

Minneapolis, Saint Paul and Metropolitan Council Environmental Services have been actively working on sewer separation since the construction of the first wastewater treatment plant in the 1930s. The City of Minneapolis and the Metropolitan Council hold a joint CSO Permit and are actively working to minimize CSO events to the river as well as other system requirements. CSOs have become relatively rare in the Twin Cities. There were zero overflow events in the years 2007, 2008, 2009, 2011 and 2012. In 2010 there were two overflow events that lasted a total of 2 hours with an estimated 211,000 gallons of combined stormwater and sewage being discharged[2]. By comparison, in 1984 there were 77 overflow events in the Twin Cities, with over 1 billion gallons of overflow.

There are nine CSO regulator locations remaining, one in Saint Paul, and the others in Minneapolis. The locations in applicable TMDL and Protection Subwatersheds are shown in Table 4-3. The elimination of overflow structures may not be feasible in every case without causing a public health or safety hazard. Some overflow regulators may need to remain operational for emergency bypasses necessitated by extreme storm or flood events, or to minimize damage due to accidents or system failures. The MPCA is currently working with the City of St. Paul and the City of Minneapolis, along with its joint permittee, the Metropolitan Council Environmental Services, to upgrade or eliminate the remaining CSOs in the project area. MPCA is currently meeting with the permittees outside of the TMDL process and feel that the process to upgrade or eliminate the remaining CSOs is working very well.

Typical CSO concentrations for total coliforms are reported as 10^5 to 10^7 MPN/100 mL (Novotny et al., 1989), or about 1 order of magnitude greater than treatment plant effluent. Raw sewage entering a WWTF typically has a total coliform count of 10^7 to 10^9 most probable number[3] (MPN) per 100 mL (Novotny et al., 1989). Associated with raw sewage are proportionally high concentrations of pathogenic bacteria, viruses, and protozoans. A typical plant reduces the total coliform count by about three orders of magnitude, to the range of 10^4 to 10^6 MPN/100 mL. The magnitude of pathogen reduction, however, varies with the treatment process employed.

Sanitary Sewer Overflows

WWTF bypasses, also called sanitary sewer overflows (SSOs) are emergency discharges of partially treated or untreated sewage. They occur during periods of heavy precipitation, when WWTFs become overloaded due to illicit stormwater connections and/or inflow and infiltration (I&I). Inflow typically is from a structure or device that collects stormwater and drains to the sanitary sewer. Infiltration is the seepage of groundwater into sanitary pipes through cracks and joints. They occur during periods of heavy precipitation, when WWTFs become overloaded due to illicit stormwater connections and/or I&I. SSOs typically last from a few hours to a few days. Violations are recorded if a WWTF's effluent exceeds the 200 cfu/100 ml fecal coliform bacteria. Bypasses occur in separated and combined sewer systems. CSOs, in contrast to SSOs, are specific to combined sewer systems. Table 4-3 identifies the subwatersheds that have

[2] The 2010 events occurred after a breach between the downtown Minneapolis storm and sanitary sewer systems. The breach was identified during a routine July 2010 inspection. It had not been visible during a May 2010 inspection. Once identified, plans and special provisions were completed; construction started in September 2010 and was completed in January 2011.

[3] Laboratory analytical methods for bacteria typically entail one of two methods: membrane filtration or multiple-tube fermentation. Membrane filtration filters organism from the water sample onto a paper surface for incubation. Resultant visible colonies/growths are counted and reported as coliform forming units (CFUs) per 100 milliliters of sample. Multiple-tube fermentation uses test tubes and measures gas production during incubation. Results are reported as most probable number of organisms (MPN or organisms) per 100 milliliters of sample. Measurements of CFUs and MPN are often compared directly; however, there are inherent differences in analytical procedures that may or may not always produce comparable results.

experienced more than five SSO events of water that has not received secondary treatment during the period 2002-2011 (according to WWTF bypass reports submitted to MPCA).

According to *Future Wastewater Infrastructure Needs and Capital Costs: FY 2012 Biennial Survey of Wastewater Collection and Treatment*, sewers installed over 50 years ago are typically beyond their useful life due to materials used at the time of construction (e.g. vitrified clay tiles) and new and improved construction standards (MPCA 2012a). The report found that approximately 72% of sewers in Minneapolis and St. Paul were constructed over 50 years ago. Approximately 14% of sewers in suburban MCES Service Area communities are over 50 years old. In greater Minnesota, the percent of collection sewer systems older than 50 years is estimated to be 31%. The geographic extent of areas serviced by WWTFs in each subwatershed was approximated as the Metropolitan Urban Service Area and 2006 National Land Cover Dataset (NLCD) *Developed* land covers. This information was used in combination with results from the MPCA's Fiscal Year 2012 report to approximate the percent area of each TMDL and Protection Subwatershed having collection sewers over 50 years old (Table 4-3). It should be noted, however, that age of infrastructure is only one of the risk factors for sanitary sewers to leak. New and old sanitary sewer pipes could leak due to a number of factors including invasion from tree roots or poor construction practices.

Considering the age of some sanitary sewers and vulnerability of sewers to I&I, untreated sewage leaks from the sewers into the ground and can enter the stormsewer conveyance system. This phenomenon was identified as a likely cause of extensive human fecal contamination in separated storm drain systems in Santa Barbara, California (Sercu et al. 2009). A series of follow-up field studies concluded that *leaking sanitary sewers can directly contaminate nearby leaking storm drains with untreated sewage during dry weather* and that sanitary sewer leakage can be *chronic*, contaminating downstream surface waters (Sercu et al. 2011). Generally accepted engineering practices are to site sanitary sewers below water mains and stormsewers to minimize leakage. However, the number of sanitary sewers that are sited below stormsewers in our project area is unknown.

Most Cities have routine sanitary sewer operation and maintenance plans and ongoing rehabilitation efforts to address leaking or structurally unsound pipes. A common method used in rehabilitating leaking or structurally unsound sanitary sewer pipes is lining.

According to the Phase I water quality data analysis conducted as a part of this project (MPCA and MDH 2009), the following conclusions were reached with respect to water quality:

- Bacteria concentrations along the Mississippi River mainstem peak around the metropolitan area.
- Storm sewer data exhibit high *E. coli* concentrations and experience some of the greatest concentrations of all monitoring sites. Please note that data were available from only four sites out of hundreds of outfalls to the Mississippi River and tributaries in the Phase I Project Area and therefor may not be representative of concentrations in all storm sewer outfalls. However, these *E. coli* concentrations were within the range of data reported for storm sewers in other urban areas (e.g.: Wisconsin, Bannerman *et al*. 1993; Michigan, Gannon and Busse 1989; International BMP Database records, WWE and GC 2010).

Land Application of Biosolids

Application of biosolids from WWTFs follows Minnesota Rules Chapter 7041 *Sewage Sludge Management*. The application of biosolids from WWTFs is highly regulated, monitored, and tracked.

Biosolids disposal methods that inject or incorporate within 24-hours of land application result in minimal possibility for mobilization to downstream surface waters. Surface application presents a conceivable risk to surface waters. However, the restrictions in Table 4-5 apply. In order to meet pathogen reduction requirements, land applied biosolids have a 2,000,000 org/100 mL limit; typical counts range from 6,000 to 200,000 org/100 mL.

Table 4-3. WWTFs, CSO locations, SSO events, and infrastructure susceptible to failure in TMDL and Protection Subwatersheds.

Sub-watershed ID	Reach Name	TMDL or Protection Sub-watershed	Number of WWTFs	Number of Locations where CSOs Could Still Occur	Greater than 5 SSO events prior to secondary treatment during 2002-2011?	% Area Having Sanitary Sewers Over 50 Years Old[1]
07010201-501	Mississippi River	Protection	-	-	-	3%
07010201-502	Mississippi River	Protection	-	-	-	42%
07010201-513	Mississippi River	Protection	2	-	-	10%
07010201-516	Little Two River	TMDL	1	-	-	3%
07010201-523	Two River	TMDL	-	-	-	4%
07010201-525	Spunk Creek	TMDL	1	-	-	3%
07010201-528	Watab River	TMDL	-	-	-	12%
07010201-529	Watab River, North Fork	TMDL	1	-	-	5%
07010201-537	County Ditch 12	TMDL	-	-	-	2%
07010201-543	South Two River	TMDL	3	-	-	4%
07010201-545	Platte River	Protection	-	-	-	4%
07010201-554	Watab River, South Fork	TMDL	-	-	-	4%
07010201-564	County Ditch 13	TMDL	-	-	-	7%
07010201-577	Little Rock Creek	Protection	1	-	-	4%
07010201-607	Mississippi River	Protection	1	-	-	4%
07010201-615	Stony Creek	Protection	-	-	-	3%
07010202-501	Sauk River	Protection	-	-	-	23%
07010203-503	Mississippi River	Protection	2	-	-	30%
07010203-510	Mississippi River	Protection	4	-	Y	10%
07010203-511	Clearwater River	Protection	-	-	-	6%
07010203-525	Elk River	Protection	-	-	-	18%
07010203-528	Unnamed creek	TMDL	2	-	-	14%
07010203-557	Silver Creek	TMDL	-	-	-	4%
07010203-561	Unnamed creek (Luxemburg Creek)	TMDL	-	-	-	3%
07010203-572	Plum Creek	TMDL	-	-	-	4%
07010203-574	Mississippi River	Protection	-	-	-	56%

Sub-watershed ID	Reach Name	TMDL or Protection Sub-watershed	Number of WWTFs	Number of Locations where CSOs Could Still Occur	Greater than 5 SSO events prior to secondary treatment during 2002-2011?	% Area Having Sanitary Sewers Over 50 Years Old[1]
07010203-635	Johnson Creek (Meyer Creek)	TMDL	-	-	-	3%
07010203-639	Johnson Creek (Meyer Creek)	TMDL	-	-	-	6%
07010203-724	Unnamed creek (Robinson Hill Creek)	TMDL	-	-	-	6%
07010206-501	Mississippi River	Protection	1	-	-	10%
07010206-502	Mississippi River	Protection	1	-	-	8%
07010206-503	Mississippi River	Protection	-	6	Y	66%
07010206-504	Mississippi River	Protection	1	-	-	17%
07010206-505	Mississippi River	Protection	-	1	Y	57%
07010206-506	Shingle Creek (County Ditch 13)	TMDL	-	-	-	18%
07010206-509	Mississippi River	Protection	-	-	-	32%
07010206-512	Mississippi River	Protection	-	-	-	14%
07010206-513	Mississippi River	Protection	-	1	-	72%
07010206-514	Mississippi River	Protection	-	1	-	62%
07010206-517	Unnamed creek	Protection	1	-	-	14%
07010206-526	Unnamed creek (Plymouth Creek)	TMDL	-	-	-	14%
07010206-538	Bassett Creek	TMDL	-	-	-	21%
07010206-542	Unnamed creek (Interstate Valley Creek)	TMDL	-	-	-	16%
07010206-552	Unnamed creek (North Branch, Bassett Creek)	TMDL	-	-	-	14%
07010206-568	Mississippi River	Protection	-	-	-	14%
07010206-584	Rice Creek	TMDL	-	-	-	11%
07010206-592	Battle Creek	Protection	-	-	-	51%
07010206-606	Fish Creek	Protection	-	-	-	37%
07010206-727	Unnamed creek	Protection	-	-	-	13%
07010206-xxx	Unnamed, Unassessed	Protection	-	-	-	3%

[1] Infrastructure failure is the key issue. Age of sewer is used as an indicator of the potential for failure per *Future Wastewater Infrastructure Needs and Capital Costs: FY 2012 Biennial Survey of Wastewater Collection and Treatment* which states that sewers installed over 50 years ago are typically beyond their useful life due to the materials used at the time of construction. Note that some of the older sanitary sewer systems have been lined or rehabilitated which reduces the possibility of leaking. Also note that none of the TMDL subwatershed areas have >50% of sanitary sewers over 50 years old.

Illicit Discharges from Unsewered Communities

According to the 2007 American Housing Survey, twenty-two percent of households in the Midwest depend on onsite or small community cluster systems to treat wastewater. In many cases, these systems are installed and forgotten until problems arise. Residential lots in small communities throughout Minnesota cannot accommodate modern septic systems that meet the requirements of current codes due to small lot size and/or inadequate soils. Development pressures in lake communities add to the problem as well as cabins that occupy a large footprint on small lake lots. In addition, many small communities are characterized by outdated, malfunctioning septic systems serving older residences. Small lots, poor soils, and inadequate septic system designs and installations may be implicated in bacterial contamination of groundwater but the link to surface water contamination is tenuous. Community septic systems that discharge greater than 10,000 gallons per day are required to obtain an NPDES discharge permit.

"Failing" subsurface sewage treatment systems (SSTS) are specifically defined as systems that are failing to protect groundwater from contamination, while those systems which discharge partially treated sewage above-ground to road ditches, tile lines, and directly into streams, rivers and lakes are considered an imminent threat to public health and safety (ITPHS).

ITPHS systems also include illicit discharges from unsewered communities (sometimes called "straight-pipes"). The use of straight pipes to convey sewage away from homes was the first infrastructure step toward sewage treatment in individual, community, and municipal systems. In agricultural regions, where the land has been drained for crop production, drain tile lines were commonly used to convey sewage away from homes and businesses to the edge of town, combining sewage with ground and surface water. This resulted in the "community" straight pipes; some still occur in Minnesota. Straight pipes are illegal and pose an imminent threat to public health as they convey raw sewage from homes and businesses directly to surface water. Community straight pipes are more commonly found in small agricultural communities.

MPCA's 2011 report to the legislature, *Recommendations and Planning for Statewide Inventories, Inspections of Subsurface Sewage Treatment System*, identifies percent of systems in unsewered communities that are ITPHS for each county in Minnesota (MPCA 2011). Table 4-4 identifies the ITPHS rates for counties in the TMDL and Protection Subwatersheds; for example, 6% of systems in unsewered communities in Anoka County are estimated to be ITPHS. The percentages of ITPH systems may not apply at the same rate to areas in the Twin Cities served by the Metropolitan Council's WWTFs. Refer to the Metropolitan Council Environmental Services web page that specifies the communities served by each of their 7 WWTFs: (http://www.metrocouncil.org/Wastewater-Water/Services/Wastewater-Treatment-(1)/Communities-Served-by-7-MCES-Treatment-Plants.aspx).

The individual owner of a septic system is responsible for replacing or discontinuing the use of an Imminent Threat to Public Health (ITPH) system within ten months of a noncompliance notice being issued. Community problems often take much longer to fix, and often seek funding through the Public Facilities Authority or other state and federal sources. Although the owner of a system is responsible for paying to fix a noncompliant system, many counties or watersheds have low interest loans or grants to assist low-income homeowners.

Table 4-4. Rates of ITPHS septic systems, including illicit discharges from unsewered communities.

County	2000-2009 Average Estimate of % Imminent Threat to Public Health Septic Systems[1]
Anoka	6%
Benton	9%
Dakota	3%
Hennepin	4%
Morrison	13%
Ramsey	0%
Sherburne	1%
Stearns	1%
Todd	10%
Washington	1%
Wright	3%

Source: MPCA (2011)

[1] Imminent Threat to Public Health (ITPH) Septic System data are derived from surveys of County staff and County level Subsurface Sewage Treatment System (SSTS) status inventories. The specific location of ITPH septic systems is not known. The table is not intended to suggest that ITPH septic systems contribute excess bacteria to the specific waterbodies addressed in this report, rather it suggests that, in general, failing septic systems are believed controllable sources of bacteria in the project area.

Land Application of Septage

A state subsurface sewage treatment system (SSTS) license issued by the MPCA is required for any business that conducts work to design, install, repair, maintain, operate, or inspect all or part of an SSTS. Counties are responsible for regulating SSTS in all areas not covered by city or township SSTS ordinances. All Local Governmental Units (LGUs) that regulate SSTS must adopt ordinances that comply with revisions to the SSTS rules and LGUs may enforce ordinances. These local programs are responsible for permitting and inspection of new SSTS and for ensuring compliance of existing SSTS when problems are found. Land application of septage is regulated by the USEPA. Disposal contractors are required to properly treat and disinfect septage through processing or lime stabilization. Treated septage may then be disposed of onto agricultural and forest lands. EPA Standards Section 503 provides general requirements, pollutant limits, management practices, and operational standards for the final use or disposal of septage generated during the treatment of domestic sewage in a treatment works. The management practices require that septage application remain greater than 10 meters from waters of the United States, as defined in 40 CFR 122.2, unless otherwise permitted. To prevent septage from entering wetlands or other waters of the United States, septage may not be applied to sites that are flooded, frozen, or snow-covered. Standards for the density of fecal coliform in the septage are as follows: Fecal coliform shall be less than 1000 MPN (most probable number) per gram of total solids (dry weight basis), or the density of *Salmonella sp.* bacteria shall be less than three MPN per four grams of total solids (dry weight basis) at the time it is used or disposed, at the time it is prepared for sale or give away (in a bag or other container) for application to the land, or at the time the septage or material derived from septage is prepared to meet the requirements in 503.10 (b), (c), (e), or (f).

MPCA does not directly regulate the land application of septage from SSTS. Management guidelines entail site suitability requirements with respect to soil conditions, slope, and minimum separation distances (MPCA 2002). Notable requirements include 3 foot minimum depth to bedrock and seasonally saturated soils, restrictions on 6-12% slopes, no application on slopes greater than 12%, and horizontal separation distances as shown in Table 4-5. Dakota and Sherburne Counties have SSTS septage ordinances, but site suitability guidance does not appear to differ from MPCA guidance. Some cities and townships have SSTS septage ordinances (a list is available at http://www.pca.state.mn.us/index.php/view-document.html?gid=10139); these were not reviewed as a part of this study. According to MPCA, approximately five complaints a year are reported to MPCA with regard to land application of septage in the Phase I Project Area between St. Paul and Royalton (Pat Shelito, MPCA, Personal Communication, September 30, 2011). However, since MPCA does not directly regulate the land application of septage from SSTS, there is a lot of uncertainty as to the level of implementation of MPCA guidance and EPA standards.

Table 4-5. Minimum separation distances for septage land application

Table adapted from “Septage and Restaurant Grease Trap Waste Management Guidelines” (MPCA 2002).

<table>
<tr><th colspan="2">Feature</th><th>Surface Application</th><th>Incorporated within 48 hours</th><th>Injected</th></tr>
<tr><td colspan="2">Private drinking water supply wells</td><td colspan="3">200’</td></tr>
<tr><td colspan="2">Public drinking water supply wells[1]</td><td colspan="3">1000’</td></tr>
<tr><td colspan="2">Irrigation wells</td><td>50’</td><td>25’</td><td>25’</td></tr>
<tr><td colspan="2">Residences</td><td>200’</td><td>200’</td><td>100’</td></tr>
<tr><td colspan="2">Residential developments</td><td>600’</td><td>600’</td><td>300’</td></tr>
<tr><td colspan="2">Public contact sites</td><td>600’</td><td>600’</td><td>300’</td></tr>
<tr><td rowspan="3">Down gradient lakes, rivers, streams, wetlands, intermittent streams[2], or tile inlets connected to these surface water features, and sinkholes</td><td>0 to 6% slope</td><td>200’</td><td>50’</td><td>50’</td></tr>
<tr><td>6 to 12% slope</td><td>Not Allowed</td><td>100’</td><td>100’</td></tr>
<tr><td>Winter
(0 to 2% slope)</td><td>600’</td><td>Not Applicable</td><td>Not Applicable</td></tr>
<tr><td rowspan="2">Grassed Water Ways[3]</td><td>0 to 6% slope</td><td>100’</td><td>33’</td><td>33’</td></tr>
<tr><td>6 to 12% slope</td><td>Not Allowed</td><td>33’</td><td>33’</td></tr>
</table>

[1]There may be special requirements if the land application site is within the boundaries of a wetland protection area. Check with the Minnesota Department of Health or local unit of government.

[2] Intermittent stream means a drainage channel with definable banks that provides for runoff flow to any of the surface waters listed in the above table during snow melt or rainfall events.

[3] Grassed waterways are natural or constructed and seeded to grass as protection against erosion. Separation distances are from the centerline of grassed waterways. For a grassed waterway which is wider than the separation distances required, application is allowed to the edge of the grass strip.

4.1.2 Pets

Pets (dogs and cats) can contribute bacteria to a watershed when their waste is not properly managed. When this occurs, bacteria can be introduced to waterways from:

- Dog parks
- Residential yard and sidewalk runoff (spring runoff after winter accumulation)
- Rural areas where there are no pet cleanup ordinances
- Animal elimination of excrement directly into waterbodies

Dogs

Dog waste can be a significant source of pathogen contamination of water resources in urban settings. Dog waste in the immediate vicinity of a waterway could be a significant local source with local water quality impacts.

Cats

Outdoor and feral cats may contribute significantly to bacteria levels in urban streams and rivers (Ram et al. 2007).

4.1.3 Livestock

Animal Feeding Operations

Manure containing fecal bacteria can be transported in watershed runoff to surface waters. The MPCA regulates animal feedlots in Minnesota though counties may be delegated by the MPCA to administer the program for feedlots that are not under federal regulation. The primary goal of the state program for animal feeding operations is to ensure that surface waters are not contaminated by the runoff from feeding facilities, manure storage areas, and cropland with improperly applied manure.

An animal feeding operation (AFO) is a general term for an area intended for the confined holding of animals, where manure may accumulate, and where vegetative cover cannot be maintained within the enclosure due to the density of animals. Animal feeding operations that either (a) have a capacity of 1,000 animal units or more, or (b) meet or exceed the EPA's Concentrated Animal Feeding Operation (CAFO) threshold and discharge to Waters of the United States, are required to apply for permit coverage through the MPCA. One animal unit is defined as one 1,000-pound animal. One beef cow or horse, 3.3 market hogs, or 0.7 of a dairy cow is the equivalent of one animal unit. A turkey is 0.018 animal units, and a chicken is 0.01 animal units. If item (a) is triggered, the permit can be an SDS or NPDES/SDS permit; if item (b) is triggered, the permit must be an NPDES permit. These permits require that the feedlots have zero discharge to surface water.

Feedlots with greater than 50 animal units, or greater than 10 animal units in shoreland areas, are required to register with the State of Minnesota. Estimates of the numbers of animal units in registered feedlots are available from the MPCA. All NPDES-permitted feedlots (refer to previous paragraph) are also registered with the state. Feedlots with fewer than 1,000 animal units but greater than 50 animal units (or 10 animal units in shoreland areas) are registered with the state but not required to have a permit through the SDS or NPDES program. Figure 4-1 illustrates the triggers for registration and permitting based on number of animal units (AU). Figure 4-2 through Figure 4-4 identify the locations (and counts) of animal feeding operations (feedlots) based on the MPCA registration database. Registered operations not requiring NPDES coverage are grouped separately from those that are NPDES-permitted.

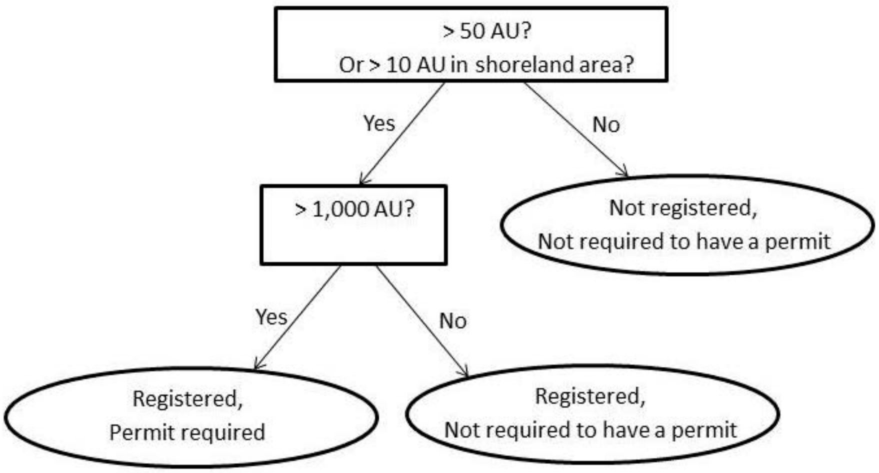


Figure 4-1. Animal feeding operation registration and permitting triggers based on number of animal units (AU).
Permit required refers to the SDS or NPDES/SDS permit program.

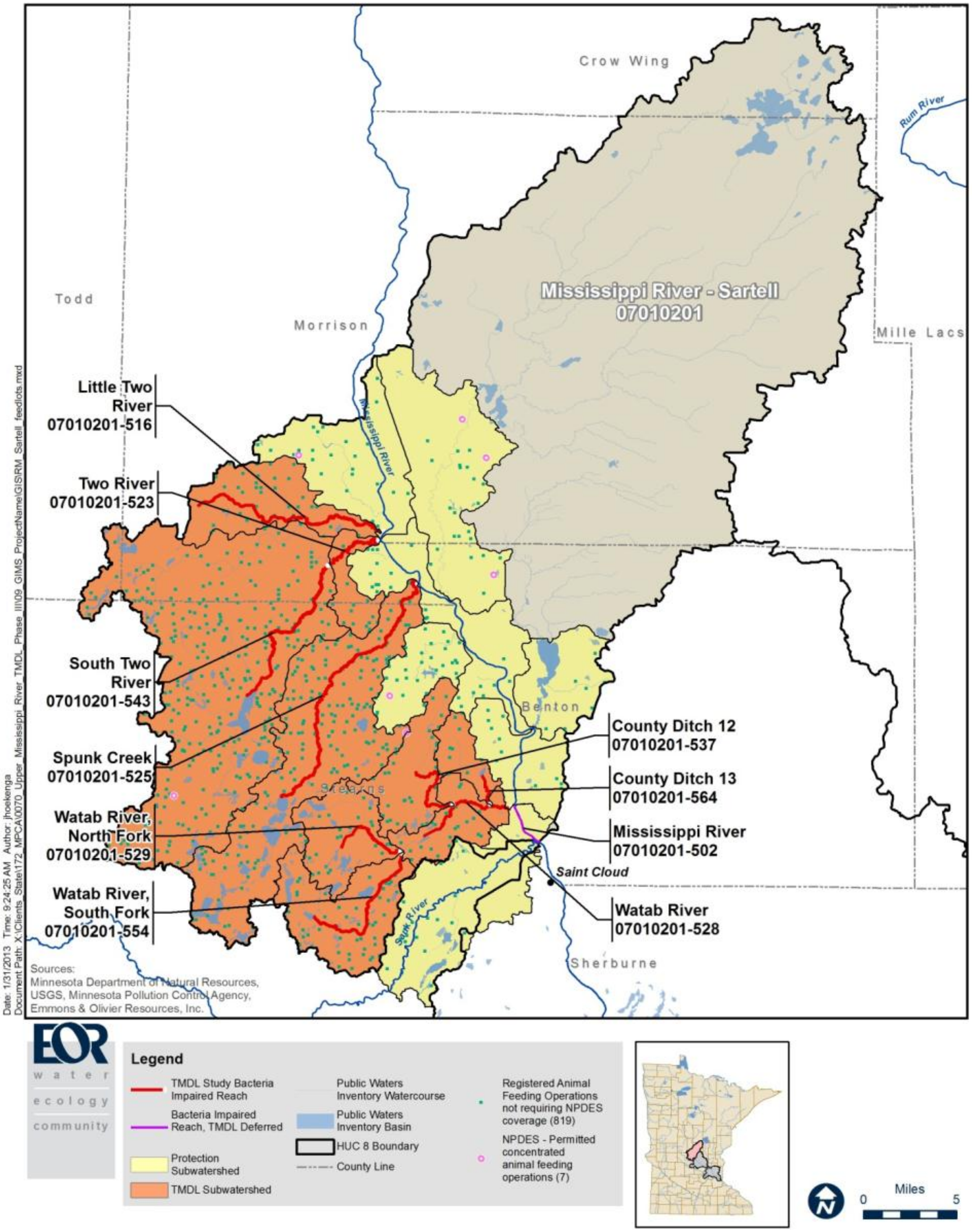


Figure 4-2. Mississippi River – Sartell Watershed (HUC 07010201) registered animal feeding operations in the TMDL and Protection Subwatersheds.
Data from MPCA Data Desk, April 2011

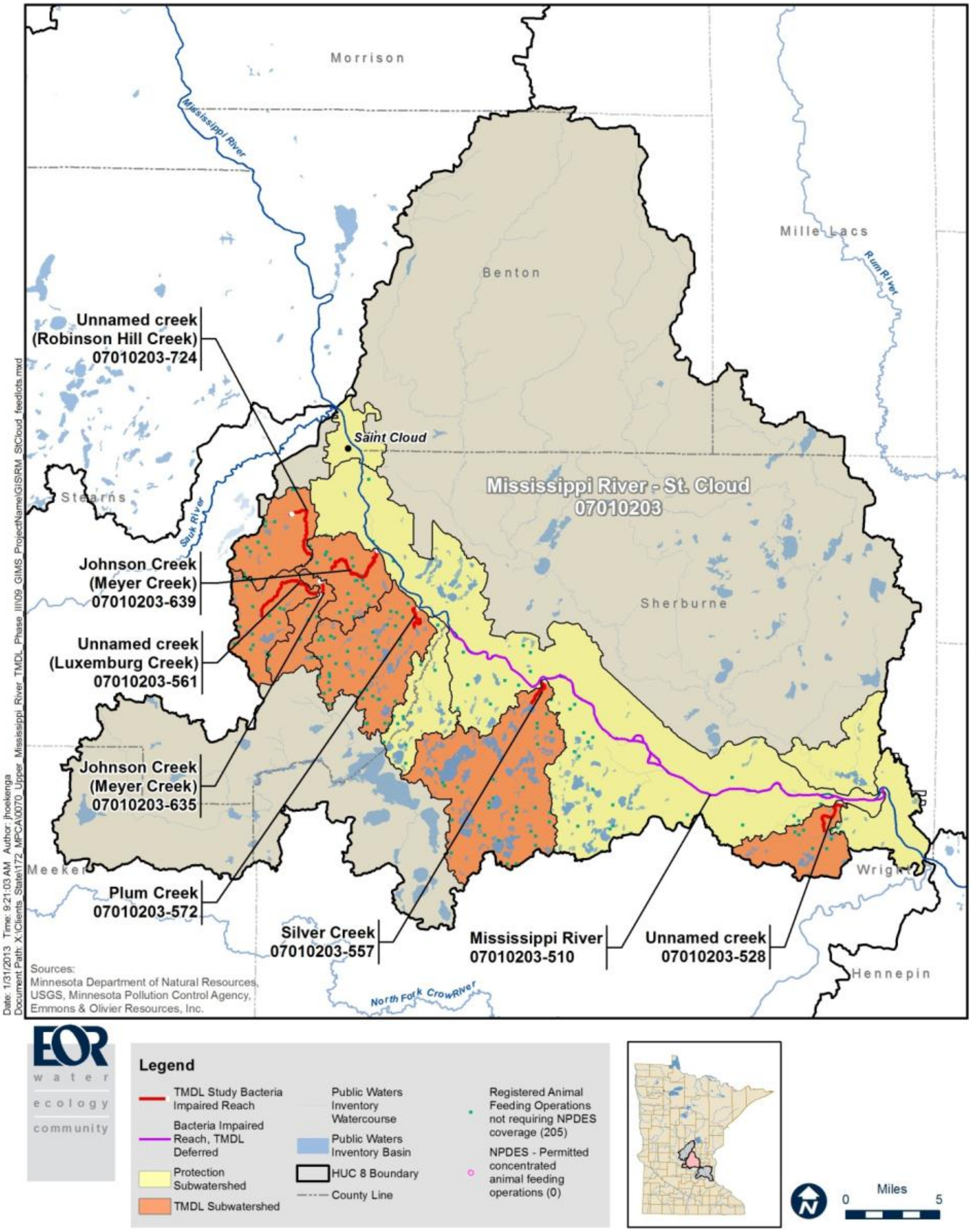


Figure 4-3. Mississippi River – St. Cloud Watershed (HUC 07010203) registered animal feeding operations in the TMDL and Protection Subwatersheds.
Data from MPCA Data Desk, April 2011

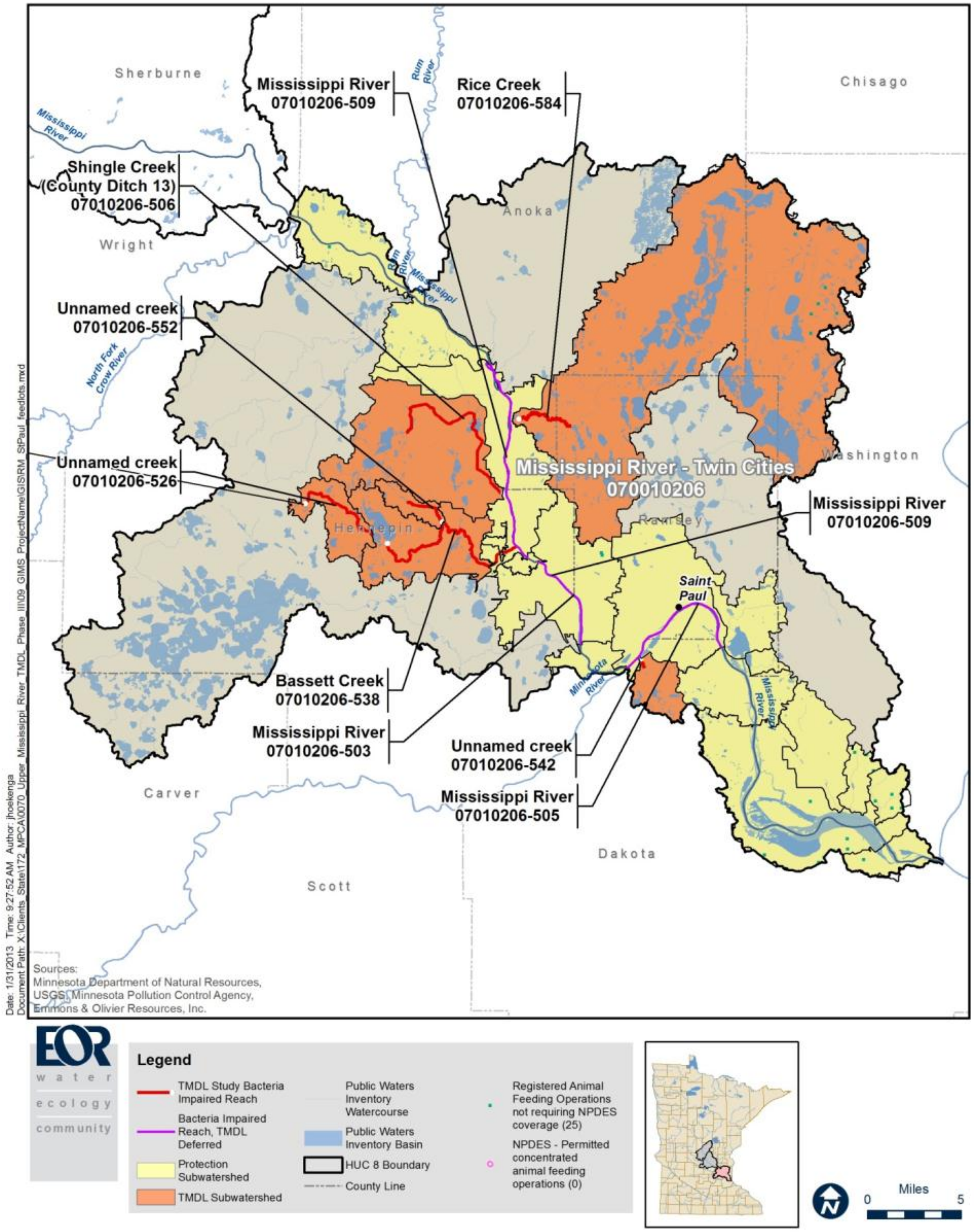


Figure 4-4. Mississippi River – Twin Cities Watershed (HUC 07010206) registered animal feeding operations in the TMDL and Protection Subwatersheds.
Data from MPCA Data Desk, April 2011

<u>Livestock Not Requiring Registration</u>

These facilities are small-scale farms that house less than 50 animal units outside of shoreland and less than 10 animal units in shoreland (Figure 4-1) but may have small-scale feeding operations and associated manure application or stockpiles. These facilities are still required to follow the MN state rule chapter 7020 for feedlots. For the purposes of this study, these facilities may include any livestock (e.g. sheep, goats, cows, horses), but exclude pets (dogs and cats).

<u>Land Application of Manure</u>

Livestock manure is often either surface applied or incorporated into farm fields as a fertilizer and soil amendment. This land application of manure if not properly applied has the potential to be a substantial source of fecal contamination, entering waterways from overland runoff and drain tile intakes. MN Rules Chapter 7020 contains manure application setback requirements (Table 4-6). These setback requirements are largely based on research related to phosphorus transport, and not bacterial transport, and the effectiveness of these current setbacks on bacterial transport to surface waters is not known.

A 2002 research study on the *Movement and persistence of fecal bacteria in agricultural soils and subsurface drainage water: A review* shows that subsurface draintile can be a major pathway for pathogens into surface water systems (Jamieson et al. 2002).

Table 4-6. Manure application setback distances for Minnesota
Minimum setbacks near waters (counties can be more restrictive than MN Rule 7020).
Table adapted from "Fecal Coliform TMDL Assessment for 21 Impaired Streams in the Blue Earth River Basin" (Minnesota State University, Mankato, Water Resources Center, June 2007).

Waterbody Type	Surface Application	Incorporation within 24 hrs.
Lake, stream	300'*	25'**
Wetlands (10+ ac.)	300'*	25'**
Ditches (without berms)	300'*	25'**
Open tile intakes	300'	0
Well, quarry	50'	50'
Sinkhole (w/o berms)		
Downslope	50'	50'
Upslope	300'	50'

*100' vegetated buffer can be used instead of 300' setback for non-winter applications (50' buffer for wetlands/ditches).
**No long-term phosphorus build-up within 300'

<u>Grazing</u>

Grazing occurs on pastured areas where the concentration of animals allows a vegetative cover to be maintained during the growing season. Pastures are neither permitted nor registered with the state.

The impact that grazing livestock have on surface water quality can be mitigated through the use of vegetative buffers along waterways and/or barriers that exclude the animals from entering or approaching surface waterbodies. Agricultural land uses adjacent to lakes, rivers, and streams require a buffer strip of permanent vegetation that is 50 feet wide unless the areas are part of a resource management system plan (MN Rule 6120.330 Subp. 7). Additionally, for any new ditches or ditch improvements, the land adjacent to public ditches must include a buffer strip of permanent vegetation that is usually 16.5 feet wide on each side (MN Statute 103E.021). Note that it is commonly believed that these rules have limited enforcement statewide.

4.1.4 Wildlife

Bacteria can be contributed to surface water by wildlife (e.g. raccoons, deer, ducks, and geese) from dwelling in waterbodies, within conveyances to waterbodies, or when their waste is carried to stormwater inlets, creeks, ditches, and lakes during stormwater runoff events. Areas such as DNR designated wildlife management areas, State Parks, National Parks, National Wildlife Refuges, golf courses, state forest, and other conservation areas and for some animals, urban areas including stormwater ponds provide wildlife habitat and could be potential sources of fecal coliform due to the high densities of animals. There are likely many other areas within the TMDL and Protection Subwatersheds where wildlife congregates. It has been suggested that surface water in areas near power plants may remain open throughout the winter, offering a gathering place for waterfowl and resulting in higher fecal contamination.

Bacteria fate and transport mechanisms differ between wildlife that live and dwell in surface water such as waterfowl and semi-aquatic mammals, where there is a daily source of bacteria input directly to waters, and wildlife that dwell in upland areas such as deer, where input of bacteria to waterbodies is primarily precipitation driven.

In urban areas, wildlife such as raccoons and rats often find adequate habitat within storm sewer systems where bacteria from scat can accumulate over time during dry periods. Runoff from storm events ultimately dislodges accumulated scat and flushes it into receiving waters.

4.1.5 Land Cover as Delivery Mechanism

The fate and transport of bacteria after it leaves the animal is widely variable. The landscape onto which the bacteria is excreted, applied, stored, or discharged affects the level of risk of contamination of downstream surface waters. In addition, watershed runoff from pervious and impervious landscapes contains bacteria from all source categories: humans, pets, livestock, and wildlife. Consider some example scenarios: manure applied to cultivated cropland, raccoon excrement in stormsewer pipe, horse droppings excreted in a pasture or pigeon droppings on pavement. The diversity of sources and of fate and transport mechanisms makes determination of bacteria sources a difficult task. Estimating actual loads to surface waters from each of the potential sources involves even more complexity and requires a weight-of-evidence approach. As part of the weight-of-evidence approach, we put together all that we know. It is clear that many of the mechanisms that drive the fate and transport of bacteria in pervious landscapes significantly differ from that of impervious landscapes. The fate and transport mechanisms that define the amount of bacteria ultimately delivered to surface waters are discussed independently for pervious and impervious landscapes. Section 4.1.6 contains land cover maps of the TMDL and Protection Subwatersheds based on the 2006 National Land Cover Dataset.

Pervious (Rural) Landscapes

Pervious (rural) landscapes often entail agricultural activities and septic systems. In addition, expansive pervious landscapes are characterized by natural and ditched drainage ways, agricultural draintile, and large tracts of natural landscapes. These factors affect the movement to surface waters of watershed runoff and its associated pollutants. Draintile and ditches can accelerate transport of pollutants, but pervious surfaces and natural landscapes can slow transport.

Impervious (Urban) Landscapes

Absent of stormwater BMPs, fecal bacteria and associated pathogen loads in urban stormwater runoff are directly conveyed to lakes, streams, and rivers via impervious surfaces, storm drains, and storm sewer system networks. In cases where there are failures of the sanitary sewer system, impervious landscapes can also be characterized by chronic contamination of stormsewer systems that convey raw sewage originating from chronic leakage and from underground breaches in sanitary sewers (Sauer et al. 2011; Sercu et al. 2009; Sercu et al. 2011). Chronic leakage from a sanitary sewer pipe would be characterized as being a smaller water volume and more continuous versus acute leakage (i.e. breach) that could be characterized as having a larger water volume and be more temporary a phenomena. Fecal bacteria concentrations in stormwater runoff from urban areas can be as great as or greater than those found in cropland runoff, grazed pasture runoff, and feedlot runoff (USEPA 2001).

Bacteria enters our waterways in impervious settings due to the following sources and delivery mechanisms:

- Animals
  - Pets
  - Wildlife
- Sanitary Sewer Bypasses/Overflows
  - Illicit Connections
  - Sewer Failure
  - Inflow and infiltration
  - Combined sewer overflows
- Inadequate Treatment Capacity of Some Stormwater Infrastructure

4.1.6 2006 NLCD Land Cover Maps

The 2006 USGS National Land Cover Dataset (NLCD) provides a valuable tool to identify the developed, agricultural, and natural landscapes throughout the TMDL and Protection Subwatersheds. Table 4-7 provides the 2006 NLCD description of the land covers in the TMDL and Protection Subwatersheds. Figure 4-5 through Figure 4-13 illustrate land cover of the TMDL and Protection Subwatersheds. In addition to these maps, a more detailed set of maps depicting the land cover as it relates to municipal boundaries can be found on the MPCA website for the project at http://www.pca.state.mn.us/ktqha48.

Table 4-7. 2006 USGS NLCD descriptions.

Land Cover	Description
Barren Land (Rock/Sand/ Clay)	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Cultivated Crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Developed, High Intensity	Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.
Developed, Medium Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
Developed, Low Intensity	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
Developed, Open Space	Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
Deciduous Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Grassland/Herbaceous	Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Open Water	All areas of open water, generally with less than 25% cover or vegetation or soil
Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Shrub/Scrub	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Woody Wetlands	Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Mississippi River – Sartell Watershed (HUC 07010201)

Land cover in the Mississippi River – Sartell Watershed (Figure 4-5 and Figure 4-6) is primarily agricultural and mostly under private ownership.

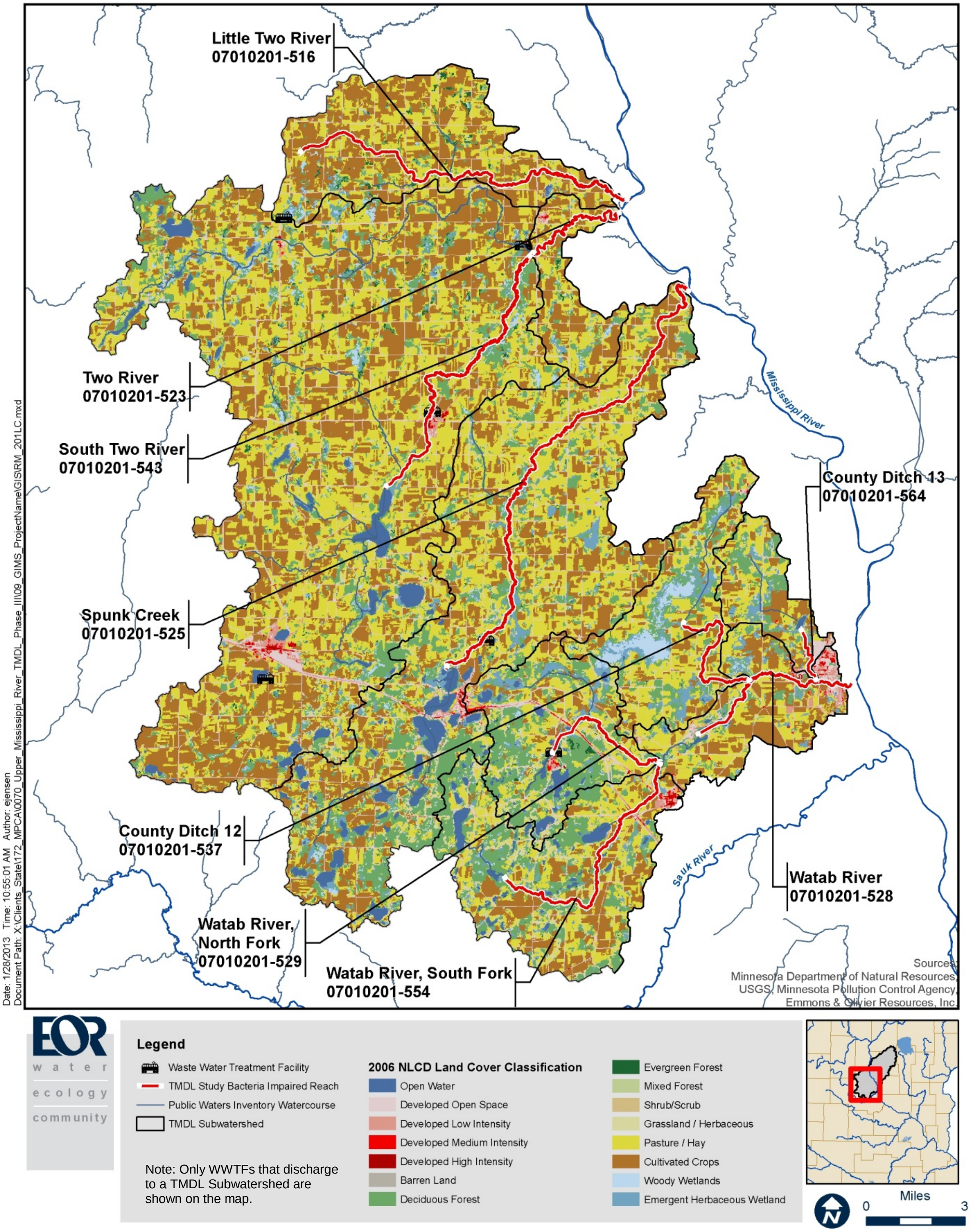


Figure 4-5. Mississippi River – Sartell Watershed (HUC 07010201) land cover and WWTF locations: TMDL Subwatersheds.
Impaired reaches outside of the TMDL Subwatersheds are not shown and are not part of this study.

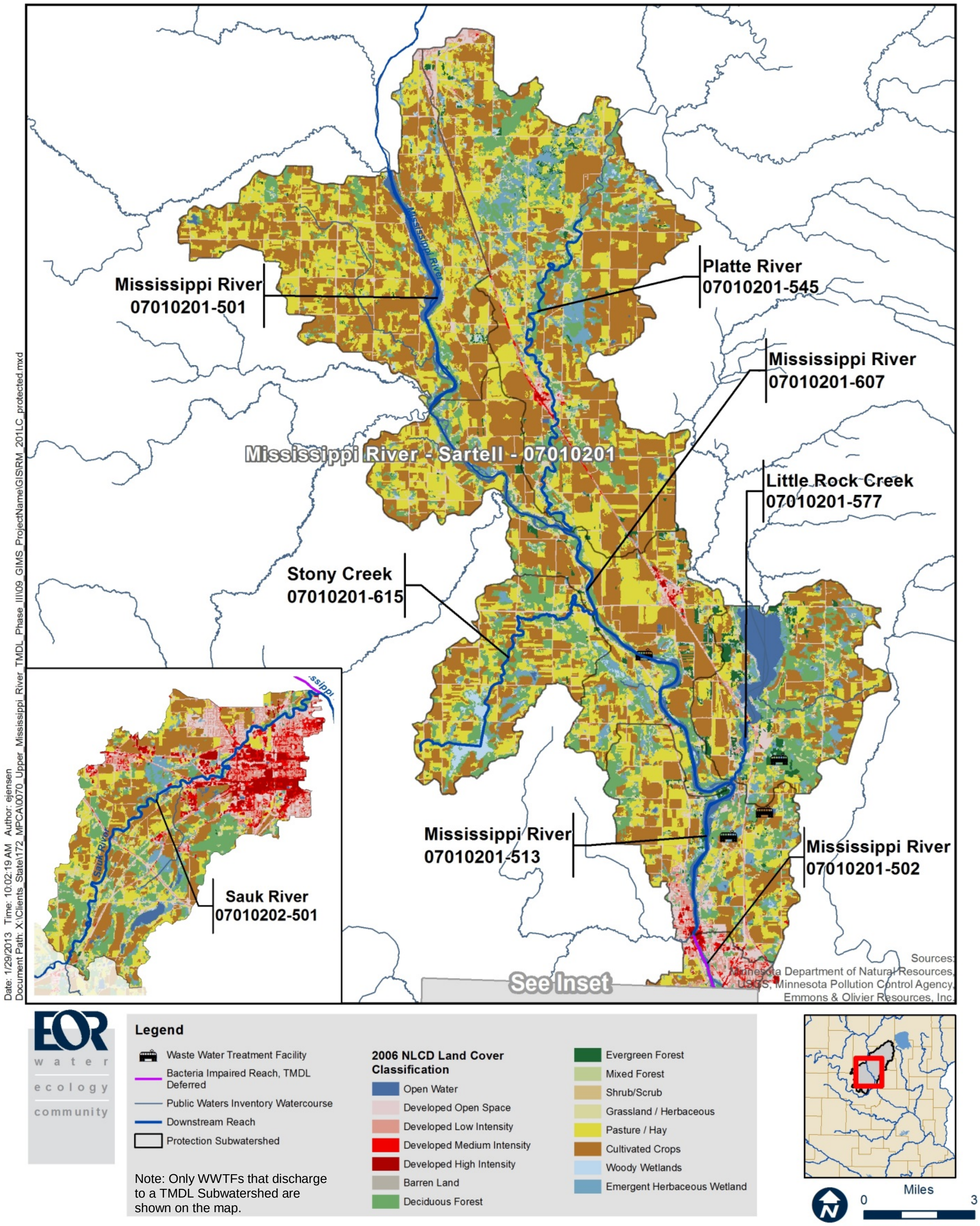


Figure 4-6. Mississippi River – Sartell Watershed (HUC 07010201) land cover and WWTF locations: Protection Subwatersheds.
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

Mississippi River – St. Cloud Watershed (HUC 07010203)

The Mississippi River – St. Cloud Watershed is on the fringe of the Twin Cities Metropolitan Area and underwent significant residential development during the height of the economic boom (Figure 4-7 through Figure 4-10).

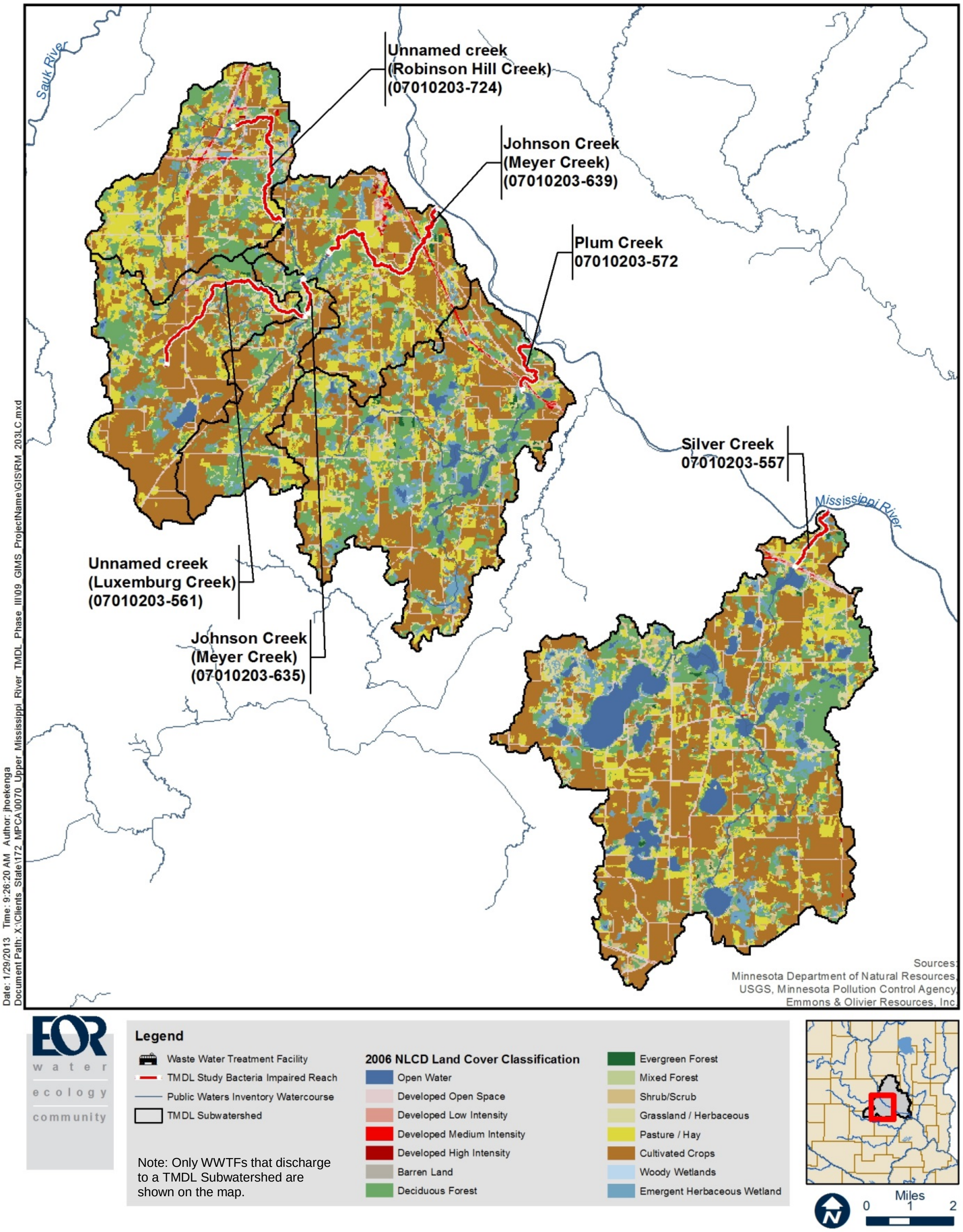


Figure 4-7. Mississippi River – St. Cloud Watershed (HUC 07010203) land cover and WWTF locations: TMDL Subwatersheds (West, Map 1 of 2).
Impaired reaches outside of the TMDL Subwatersheds are not shown and are not part of this study.

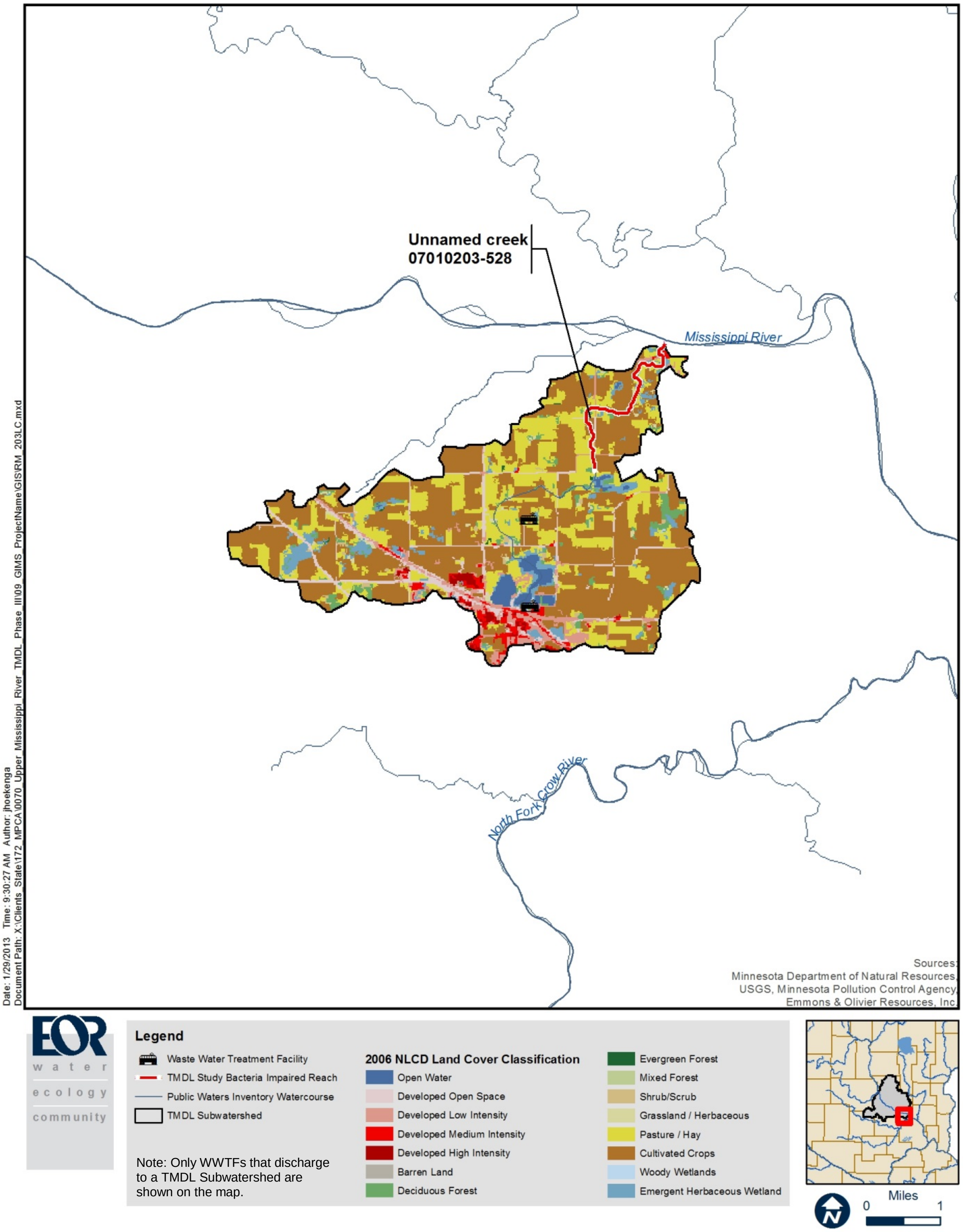


Figure 4-8. Mississippi River – St. Cloud Watershed (HUC 07010203) land cover and WWTF locations: TMDL Subwatersheds (East, Map 2 of 2).
Impaired reaches outside of the TMDL Subwatersheds are not shown and are not part of this study.

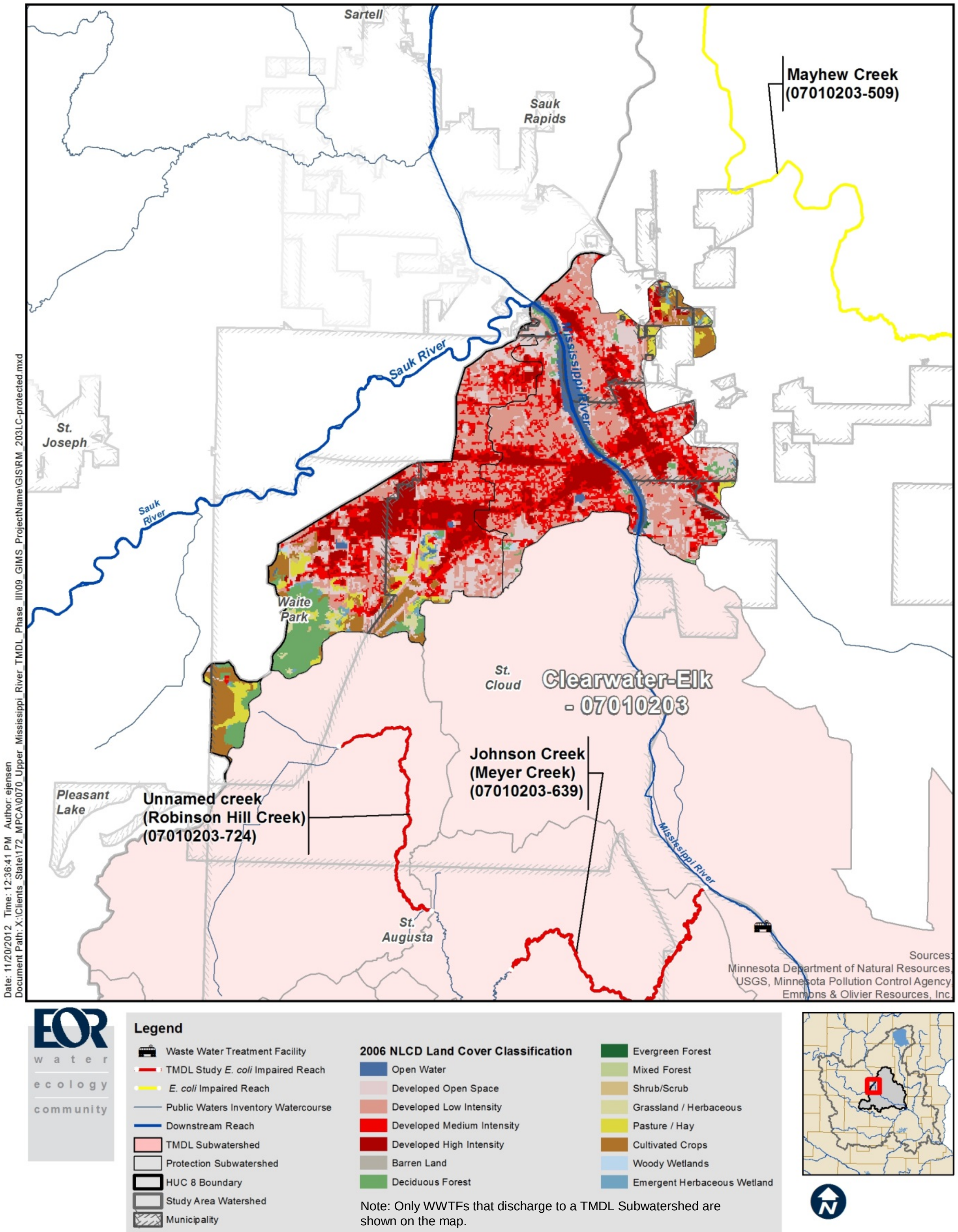


Figure 4-9. Mississippi River – St. Cloud Watershed (HUC 07010203) land cover: Protection Subwatersheds (North, Map 1 of 2).
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

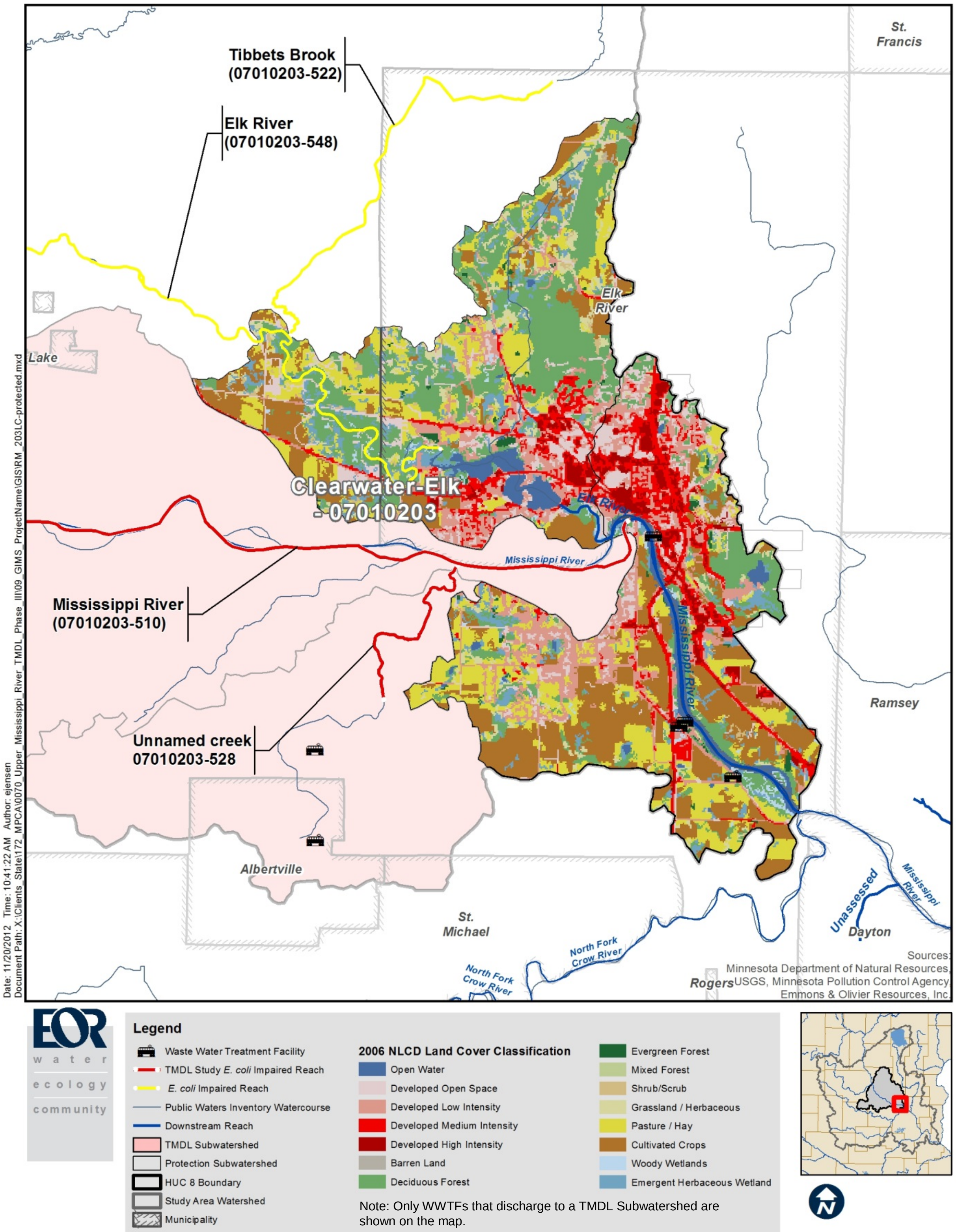


Figure 4-10. Mississippi River – St. Cloud Watershed (HUC 07010203) land cover and WWTF locations: Protection Subwatersheds (South, Map 2 of 2).
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

Mississippi River – Twin Cities Watershed (HUC 07010206)

Consistent with the high population of the Mississippi River – Twin Cities Watershed (Table 3-1) land cover in the watershed (Figure 4-11 through Figure 4-13) is characterized by medium- to high-intensity developed areas, especially along the river corridor.

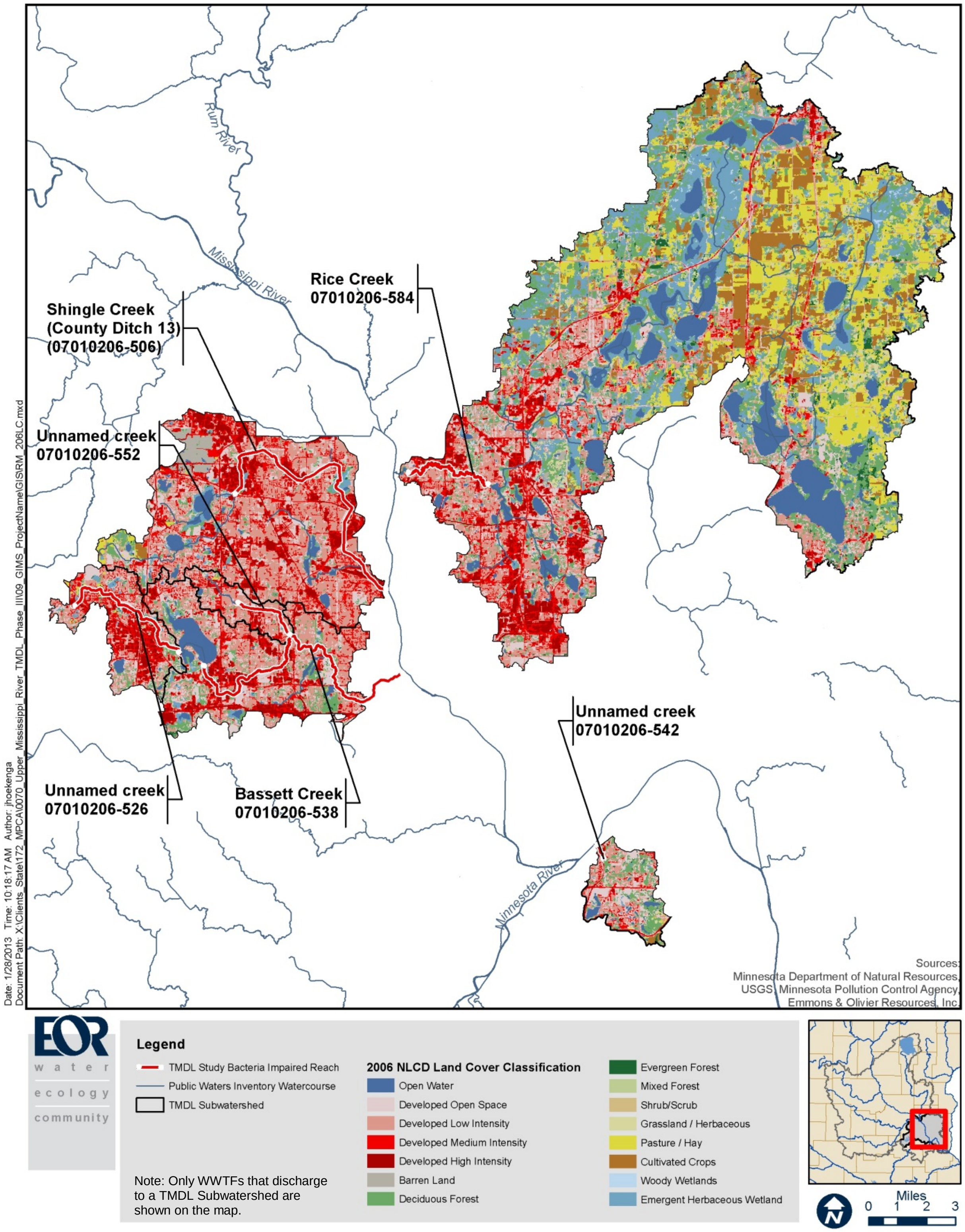


Figure 4-11. Mississippi River – Twin Cities Watershed (HUC 07010206) land cover and WWTF locations: TMDL Subwatersheds.

Impaired reaches outside of the TMDL Subwatersheds are not shown and are not part of this study.

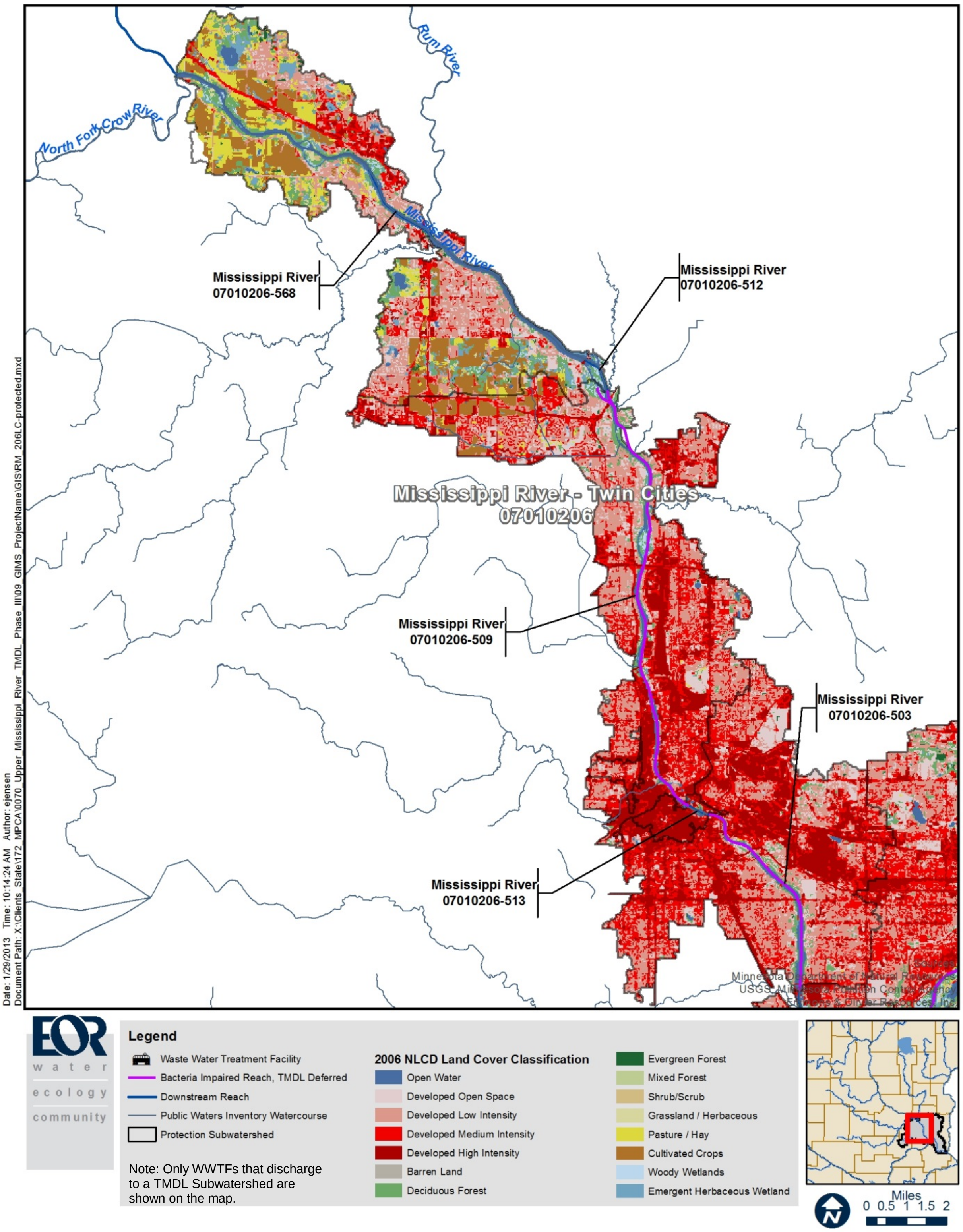


Figure 4-12. Mississippi River – Twin Cities Watershed (HUC 07010206) land cover: Protection Subwatersheds (North, Map 1 of 2).

Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

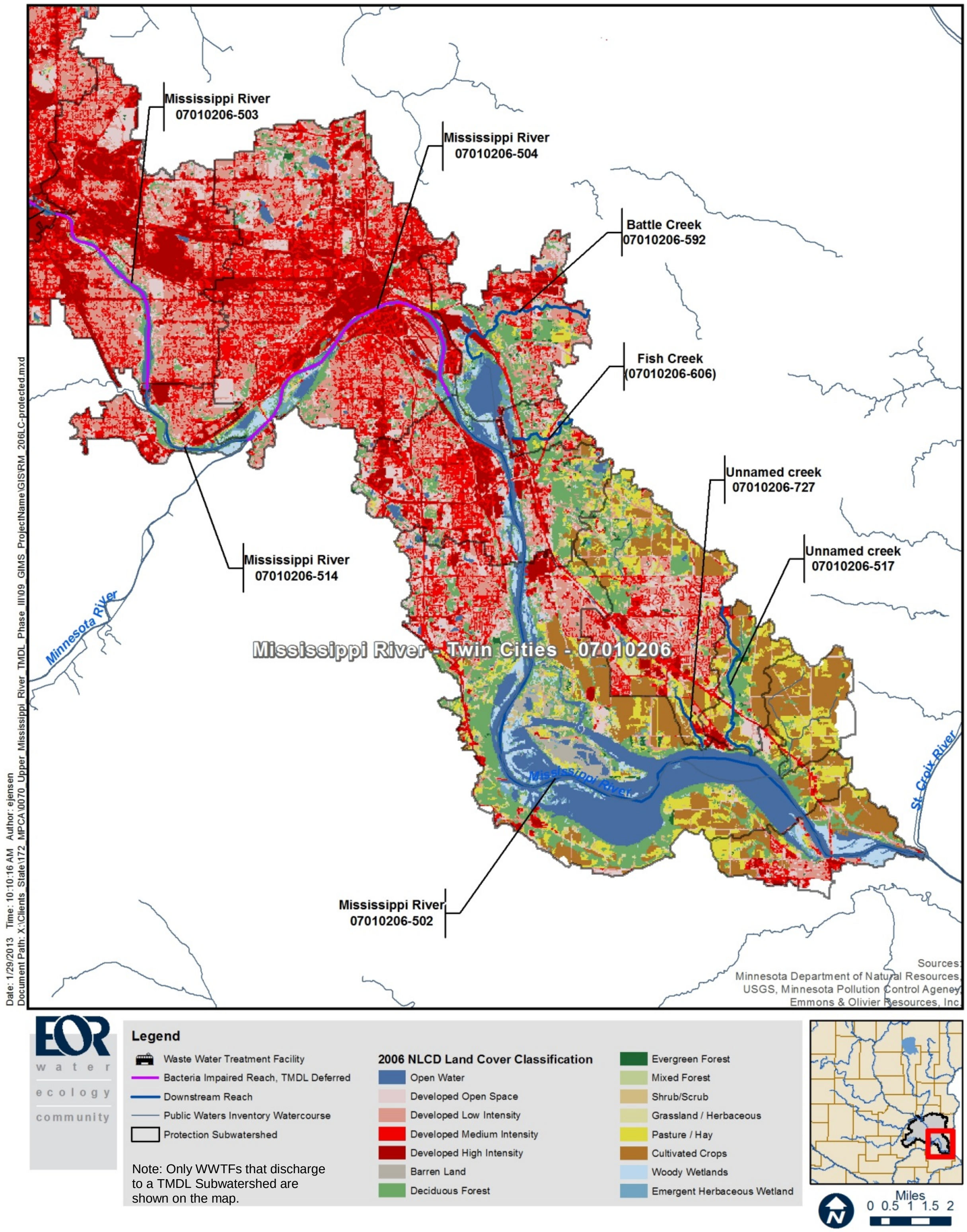


Figure 4-13. Mississippi River – Twin Cities Watershed (HUC 07010206) land cover and WWTF locations: Protection Subwatersheds (South, Map 2 of 2).
Impaired reaches outside of the project subwatersheds are not shown and are not part of this study.

4.2 Approach to Identifying Potential Bacteria Sources

The following series of tables describes the methodologies used to estimate the delivery of bacteria to surface waters in the TMDL and Protection Subwatersheds. Where applicable in this approach, bacteria production estimates are based on the bacteria content in feces and an average excretion rate (with units of cfu/day-head; where *head* implies an individual animal). Bacteria content and excretion rates vary by animal type. The EPA's *Protocol for Developing Pathogen TMDLs* provides estimates for bacteria production for most animals shown in Table 4-8 (USEPA 2001); values for deer and raccoons were obtained from other sources (Zeckoski et al. 2005; Yagow 1999). All production rates obtained from the literature are from fecal coliform rather than *E. coli* due to the availability of fecal coliform data. The production rate was multiplied by 0.5 to estimate the *E. coli* production rate, which is based on the assumption that 50% of fecal coliform are *E. coli* (Doyle and Erikson 2006).

The potential bacteria that is delivered to surface waters was calculated for each TMDL and Protection Subwatershed. However, potential bacteria sources are ultimately reported using relative rankings only. Due to the complexity of the fate and transport mechanisms of bacteria in the environment, expressing results through relative rankings as opposed to numeric results is one way to account for uncertainties in the estimates.

Table 4-8. Bacteria production by animal type.

Source Category	Producer	*E. coli* Production Rate [cfu/day-head]	Literature Source[1]
Humans	Humans	1×10^{9}	Metcalf and Eddy 1991
Companion Animals	Dogs and Cats	2.5×10^{9}	Horsley and Witten 1996
Livestock	Cattle	2.7×10^{9}	Metcalf and Eddy 1991
	Hogs	4.5×10^{9}	Metcalf and Eddy 1991
	Sheep and Goats	9×10^{9}	Metcalf and Eddy 1991
	Poultry	1.3×10^{8}	Metcalf and Eddy 1991
	Horses	2.1×10^{8}	ASAE 1998
Wildlife	Deer	1.8×10^{8}	Zeckoski et al. 2005
	Geese	1.0×10^{7}	Alderisio and DeLuca 1999 [assumes 3 lbs waste/goose per day (City of Eden Prairie 2008)]
	Breeding Ducks	5.5×10^{9}	Metcalf and Eddy 1991
	Raccoons	5.7×10^{7}	Yagow 1999
	Pigeons	8.0×10^{7}	Oshiro and Fujioka 1995

[1] Literature sources provide fecal coliform production rates, which were converted to *E. coli* by applying a conversion factor of 0.5 based on Doyle and Erikson (2006). Therefore, *E. coli* production rate = 0.5 x fecal coliform production rate.

4.2.1 Humans

Table 4-9. Data sources and assumptions for estimates of potential bacteria sources: humans.

<table>
<tr><th colspan="3">Bacteria Sources</th><th>Data Sources and Assumptions</th></tr>
<tr><td rowspan="3">Sewered Community</td><td rowspan="2">WWTF</td><td>WWTF Effluent</td><td>Based on WWTF design flow and NPDES permit limits; refer to Table 4-1 in Section 4.1.1</td></tr>
<tr><td>Land Application of Biosolids</td><td>Delivery assumed to be low based on regulations; refer to Land Application of Biosolids in Section 4.1.1.</td></tr>
<tr><td>Collection System</td><td>Illicit Connections or Leakage of Raw Sewage from Sanitary Sewer into Stormsewer[1]</td><td>Accounted for qualitatively based on the percent of the subwatershed having sewers over 50 years old (derived from MPCA 2012a; refer also to Footnote 1 and descriptions in Sanitary Sewer Overflows on Page 43 and Table 4-3)
<table>
<tr><td>% Area Having Sewers Over 50 Years Old</td><td>Relative Rank Among All Potential Bacteria Sources[1] (Table 4-15 and Table 4-16)</td></tr>
<tr><td>> 50%</td><td>Medium-Low</td></tr>
<tr><td>30% - 49%</td><td>Low</td></tr>
<tr><td>10% - 29%</td><td>Low</td></tr>
<tr><td>0% - 9%</td><td>Low</td></tr>
</table></td></tr>
<tr><td rowspan="3">Unsewered Community</td><td rowspan="2">Compliant SSTS</td><td>SSTS Discharge to Groundwater</td><td>Groundwater sources of E. coli were excluded from this analysis because there is not enough information available to adequately evaluate the magnitude of groundwater sources of E. coli to surface waters.</td></tr>
<tr><td>Land Application of Septage</td><td>There is a lot of uncertainty as to the level of implementation of MPCA guidance and EPA standards; however, delivery assumed to be low based on the guidance and standards as described in Land Application of Septage in Section 4.1.1.</td></tr>
<tr><td>Non-Compliant SSTS</td><td>ITPHS SSTS including Illicit Discharges</td><td>The population in unsewered communities was estimated based on 2010 Census block groups[2] (US Census Bureau 2011) for those areas outside of the WWTF service area. The WWTF service area was estimated as the area external to the Metropolitan Urban Service Area and 2006 NLCD Developed land covers. SSTS flow was estimated to be 265 L/person-day (Metcalf and Eddy 1991). The estimated fraction of flow from unsewered communities that is classified as ITPHS was applied based on MPCA (2011) (refer to Table 4-4). Raw sewage E. coli concentration was estimated at 3.15 x 10^6 org/100ml based on an approximate 2:1 relationship between fecal coliform and E. coli in waste [Doyle and Erikson (2006)] provided in Overcash and Davidson (1980) as referenced in USEPA (2011).</td></tr>
</table>

[1] Table 4-3 in *Wastewater Treatment Facilities (WWTFs) and Collection Systems*, Section 4.1.1, identifies, for each subwatershed, qualitative findings with respect to infrastructure susceptible to failure based on time period of construction. Based on the literature underground leakage of untreated sewage into stormsewers from SSOs and illicit connections (refer to *Sanitary Sewer Overflows* on Page 43) appears to be a potentially large bacteria source. In the absence of a quantitative tool to report bacteria loading from leakage of untreated sewage, the percent of the subwatershed having sewers over 50 years old (derived from MPCA 2012a, *Combined Sewer Overflows* estimated for each subwatershed in Table 4-3) is used as a surrogate. There are definite limitations to this approach. However, the literature regarding this issue is strong enough to warrant accounting for, even if using a limited approach, infrastructure susceptible to failure due to the time period of construction in the estimates of potential bacteria sources.

[2] A census block in an urban area typically corresponds to individual city blocks bounded by streets; blocks in rural areas may include many square miles and may have some boundaries that are not streets. A block group is a group

of census blocks. A block group is smaller than a census tract, which is a small statistical subdivision of a county (e.g. a municipality or a portion of a large city). There could be hundreds of census tracts in large cities like Chicago.

4.2.2 Livestock Requiring Registration

The Census of Agriculture is a complete count of U.S. farms and ranches. The Census definition of a farm is *any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year* (USDA 2009). The Census looks at data in many areas, including animal ownership and sales. The authority for the Census comes from federal law under the *Census of Agriculture Act of 1997* (Public Law 105-113, Title 7, United States Code, Section 2204g). The Census is taken every fifth year, covering the prior year. The most recent Census was completed for the year 2007. The USDA National Agricultural Statistics Service (NASS) conducts the survey. Livestock numbers, by county, are available for cattle, hogs, sheep, goats, and poultry. Data for counties that overlap TMDL and Protection Subwatershed boundaries were distributed between each applicable subwatershed on an area-weighted basis. For example, County A with 100 square miles and 100 head of cattle would be treated as having 1 head of cattle per square mile; the TMDL Subwatershed that includes 50 square miles of County A would be estimated to have 50 head of cattle. MPCA's geographic feedlot database developed for registration and NPDES permitting provides location data and related accounting. However, the numbers of animal units recorded in the database are the *allowable* numbers under the permit/registration and not the *actual* numbers on site; actual animal units are often lower and could be significantly lower. Therefore, USDA NASS data was used to approximate livestock requiring registration. Horses are accounted for as livestock not requiring registration (refer to Section 4.2.3).

Table 4-10. Data sources and assumptions for estimates of potential bacteria sources: livestock. NOTE: This table is read from left-to-right, demonstrating the progressive breakdown into increasing numbers of categories of fate and transport mechanisms. For example, first livestock populations were categorized into grazing and AFO populations. The fate of bacteria from AFOs was further categorized into 'Partially Housed or Open Log without Runoff Controls' or 'Land Application of Manure'. In all cases, bacteria production by animal type was used based on references cited by USEPA (2001), refer to Table 4-8.

<table>
<tr><th colspan="3">Bacteria Sources[1]
Data Sources and Assumptions</th><th>Delivery Factor</th></tr>
<tr><td colspan="3">Grazing
Grazing populations were estimated for cattle, goats, and sheep based on the USDA 2007 Census of Agriculture (USDA NASS 2009).</td><td>Ultimately, a delivery factor (refer to Section 4.2.6) was applied to estimate the amount of bacteria delivered to downstream surface waters. The applicable geographic area for grazing animals is based on 2006 NLCD Pasture/Hay and Grassland/Herbaceous land covers (refer to Table 4-7).</td></tr>
<tr><td rowspan="3">Animal Feeding Operations (AFO)
AFO populations were estimated for cattle, poultry, goats, sheep and hogs based on the USDA 2007 Census of Agriculture (USDA NASS 2009).</td><td colspan="2">Partially Housed or Open Lot without Runoff Controls
The proportion of AFO animals that are partially housed or in open lots without runoff controls was based on Mulla et al. (2001):
- Cattle 50%
- Poultry 8%
- Goats 42%
- Sheep 42%
- Hogs 15%</td><td>Ultimately, a delivery factor (refer to Section 4.2.6) was applied to estimate the amount of bacteria delivered to downstream surface waters. The applicable geographic area for AFOs is based on 2006 NLCD Barren, Pasture/Hay, Grassland/Herbaceous, and Scrub/Shrub land covers (refer to Table 4-7).</td></tr>
<tr><td rowspan="2">Land Application of Manure
Mulla et al. (2001):
- Cattle 50%
- Poultry 92%
- Goats 58%
- Sheep 58%
- Hogs 85%</td><td>Surface Application without Incorporation
Mulla et al. (2001):
- Cattle 86%
- Poultry 91%
- Goats 89%
- Sheep 89%
- Hogs 65%</td><td>Ultimately, a delivery factor (refer to Section 4.2.6) was applied to estimate the amount of bacteria delivered to downstream surface waters. The applicable geographic area for land application of manure is based on 2006 NLCD Cultivated Crops land cover (refer to Table 4-7).</td></tr>
<tr><td>Incorporated or Injected
Mulla et al. (2001):
- Cattle 14%
- Poultry 9%
- Goats 11%
- Sheep 11%
- Hogs 35%</td><td>Delivery was assumed to be low based on regulations; refer to Land Application of Manure in Section 4.1.3.</td></tr>
</table>

[1] MPCA's geographic feedlot database developed for registration and NPDES permitting provides the *allowable* numbers under the permit/registration and not the *actual* numbers on site; actual animal units are often lower and could be significantly lower. Therefore, USDA NASS data was used for livestock population estimates.

4.2.3 Livestock Not Requiring Registration

Animal populations typical of small scale facilities were estimated based on windshield surveys (including only facilities with fewer than 50 animal units) conducted by the Chisago County Soil and Water Conservation District (SWCD) in lower portions of the Sunrise River Watershed and the Three Rivers Park District in the watershed of Lake Independence in west-central Hennepin County. Based on these surveys, aerial rates of cattle, goats, sheep, horses and poultry were identified and applied to geographic areas having 2006 NLCD *Pasture/Hay* and *Grassland/Herbaceous* land covers.

All cattle, goats, sheep, poultry, and horses were treated as partially housed or open lot operations without runoff controls. Ultimately, a delivery factor (refer to Section 4.2.6) was applied to estimate the amount of bacteria delivered to downstream surface waters. The applicable geographic area for stockpiling or spreading of manure from these small scale facilities is based on 2006 NLCD *Mixed Forest*, *Pasture/Hay*, and *Grassland/Herbaceous* land covers (refer to Table 4-7). In all cases, bacteria production by animal type was estimated based on literature values cited Table 4-8.

4.2.4 Pets

Populations of pets (dogs and cats) were estimated as described in Table 4-11.

Table 4-11. Data sources and assumptions for estimates of pet populations.

Animal	Basis for Estimates of Animal Population
Dogs	American Veterinary Medical Association's (AVMA) 2006 data for % of Minnesota households that own dogs (34.2%) and mean number of dogs in each household (1.4 dogs) (AVMA 2007); 2010 Census block group data[1] for number of households (US Census Bureau 2011) in the applicable geographic areas as described in Table 4-12.
Cats	AVMA's 2006 data for % of Minnesota households that own cats (31.9%) and mean number of cats in each household (2.3 cats) (AVMA 2007); 2010 Census block group data[1] for number of households (US Census Bureau 2011) in the applicable geographic areas as described in Table 4-12.

[1] A census block in an urban area typically corresponds to individual city blocks bounded by streets; blocks in rural areas may include many square miles and may have some boundaries that are not streets. A block group is a group of census blocks. A block group is smaller than a census tract, which is a small statistical subdivision of a county (e.g. a municipality or a portion of a large city). There could be hundreds of census tracts in large cities like Chicago.

Table 4-12. Data sources and assumptions for estimates of potential bacteria sources: pets.
NOTE: In all cases, bacteria production by animal type was used based on references cited by USEPA (2011), refer to Table 4-8.

Bacteria Source Categories Data Sources and Assumptions		**Delivery Factor**
Waste Not Collected by Owners - Dogs 38% (TBEP 2012)	**Pervious Areas** Cats and dogs belonging to households within all 2006 NLCD land covers *except Open Water* and *Developed* (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters.
	Impervious Areas Cats and dogs belonging to households within 2006 NLCD *Developed* land covers (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters.
Waste Collected by Owners - Dogs 62% - Cats 100%		Zero delivery to downstream surface waters.

4.2.5 Wildlife

Populations of wildlife (breeding ducks, deer, geese, pigeons, and raccoons) were estimated as described in Table 4-13.

Table 4-13. Data sources and assumptions for estimates of wildlife populations.

Animal	Basis for Estimates of Animal Population
Breeding Ducks	State-wide annual population estimate of 550,000 between the years 2005-2009 provided in a presentation by the Minnesota DNR Wetland Wildlife Population and Research Group at the 2010 Minnesota DNR Roundtable (http://files.dnr.state.mn.us/fish_wildlife/roundtable/2010/wildlife/wf_pop-harvest.pdf), distributed equally among areas of open water; annual *E. coli* production estimates include only the seven-month residence period (April through October)
Deer	DNR report Status of Wildlife Populations, Fall 2009, which entails pre-fawn densities by DNR deer permit area based on field surveys and modeling as reported in Population Trends of White-Tailed Deer in Minnesota's Farmland/Transition Zone, 2009 by Marrett Grund and Population Trends Of White-Tailed Deer In The Forest Zone, 2009 by Mark Lenarz (see Dexter 2009); missing data for the metro area (Permit Area 601) and three additional small permit areas were estimated based on the average density of surrounding permit areas.
Geese	DNR report Status of Wildlife Populations, Fall 2009, estimates by Minnesota ecoregion based on a spring helicopter survey and modeling and reported in the Minnesota Spring Canada Goose Survey, 2009 by David Rave (see Dexter 2009). The seven-county metro area was excluded from the ecoregion-based estimates, but Rave's study uses estimates for the metro area from *Canada Goose Program Report* 2004 (Cooper 2004). Population estimates were converted to densities with respect to acres of *Open Water* 2006 NLCD land cover; densities were doubled as a conservative method to account for the fact that the goose survey focuses on breeding adults and does not account for goslings. The resulting density was then applied to the *Open Water* acreage of each subwatershed. For the Transition Ecoregion, the density came to 0.28 geese per acre of *Open Water*; for the metro region, the density came to 0.20 geese per acre of *Open Water*.
Pigeons	New York City population estimate (Innolytics 2012), applied as an aerial rate (5 pigeons per acre) to applicable geographic areas (only *Developed, High Intensity* 2006 NLCD land cover, areas with imperviousness of greater than 80%) as described in Table 4-14.
Raccoons	The DNR estimates 800,000 to one million state-wide (DNR 2011); a value of 900,000 was used.

Table 4-14. Data sources and assumptions for estimates of potential bacteria sources: wildlife.
NOTE: In all cases, bacteria production by animal type was used based on literature values in Table 4-8.

Bacteria Source Categories Data Sources and Assumptions	**Delivery Factor**
Open Water Areas All geese and ducks were considered to reside on and within a 100 foot buffer of 2006 NLCD *Open Water* and wetland land covers (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters.
Impervious Areas Deer and raccoons within 2006 NLCD *Developed* land covers (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters .
Pervious Areas Deer and raccoons within all 2006 NLCD land covers *except Open Water* and *Developed* (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters.
High Intensity Development Pigeons within 2006 NLCD *Developed, High Intensity* land covers (refer to Table 4-7).	Ultimately, a delivery factor (refer to Section 4.2.6) from the applicable geographic area was applied to estimate the amount of bacteria delivered to downstream surface waters.

4.2.6 Bacteria Delivery Factor to Surface Waters

Bacteria delivery factors (the estimated percent of *E. coli* that is delivered from the landscape to rivers and streams) were applied to bacteria sources that end up on the land surface prior to discharge to surface waters (e.g. land application of manure or wildlife excrement) but do not have overriding assumptions as to the relative delivery potential (e.g. land application of biosolids having low delivery potential). The bacteria delivery factors account for fate and transport factors such as proximity to surface waters, slope, imperviousness, and discharge to lakes prior to discharge to stream networks. A unique delivery factor was calculated for each bacteria source category in each subwatershed (e.g. the delivery factor for grazing animals in TMDL Subwatershed 07010201-516, Little Two River, differed from the delivery factor for grazing animals in TMDL Subwatershed 07010201-523, Two River).

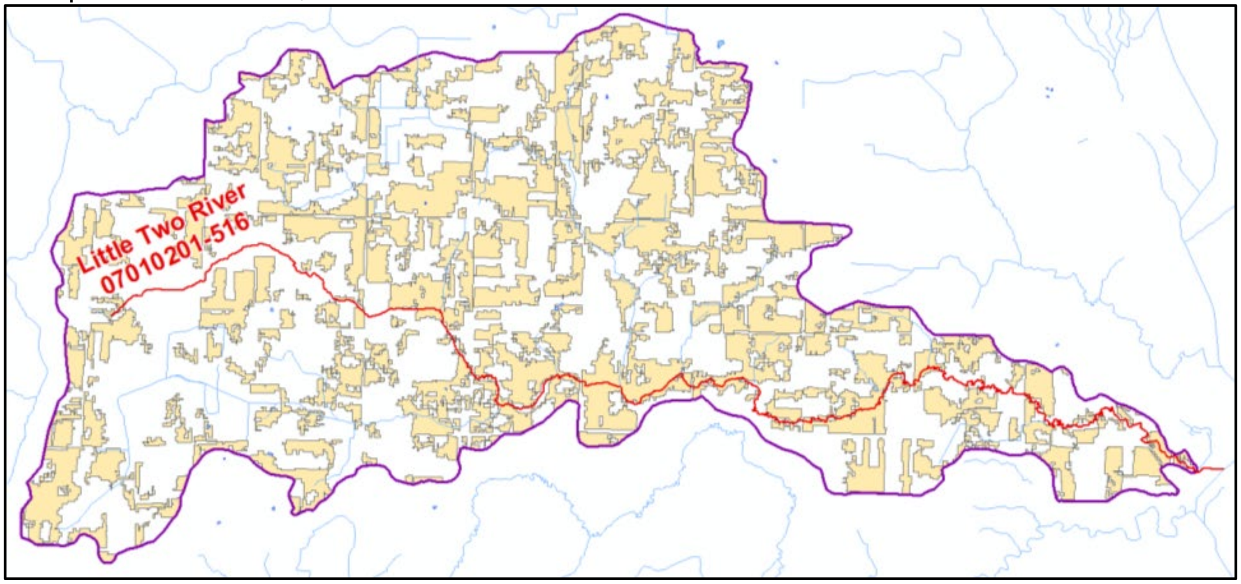
The basis for the delivery factors was the state-wide GIS layers of Water Quality Risk, as recently developed by a Minnesota multi-Agency effort and published under the name Conservation Targeting Tools (www.bwsr.state.mn.us/ecological_ranking/, *Maps & GIS Data*). The original Water Quality Risk GIS layer is a 30 meter gridded dataset. Each grid cell has a risk score on a 0-100 basis for its potential contribution to surface water quality degradation, 100 being the highest risk. Half (50 points) of the risk score was determined by Stream Power Index (SPI) values, which account for the likelihood of overland erosion based on slope and soil type. Half of the risk score was determined based on the proximity to the nearest surface water feature; the highest risk score was given to the grid cells closest to water features.

The original Water Quality Risk layer does not account for imperviousness. In addition lakes that are not part of a stream network (i.e. not flow-through lakes), are weighed equally with streams and flow-through lakes in the proximity scoring. Since imperviousness increases risk of surface water contamination of bacteria and since streams are the impaired surface waters of interest (not lakes), the 0-100 water quality risk layer was revised to account for these elements. The water quality risk score of non-flow-through-lakes (including a quarter mile buffer) was reduced by 50 points, to a minimum possible value of zero. In addition, a third 50-point scale for imperviousness was added to the water quality risk score. Areas having imperviousness of 50% or more (2006 NLCD *Developed, Medium Intensity* and *Developed, High Intensity* land covers) were given an additional 50 points. Areas having imperviousness of 25 to 49% (2006 NLCD *Developed, Low Intensity* land cover) were given an additional 25 points. Finally, the project-wide GIS layer was re-scaled to a range of 0-100, resulting in the *delivery factor GIS layer* for use in the estimates of potential bacteria sources. The factor, 0-100, was interpreted to mean the percent of *E. coli* that is delivered from the landscape to rivers and streams. Although the presence of subsurface drain-tiles can increase the delivery of bacteria to surface water systems, it was not included in the delivery factor.

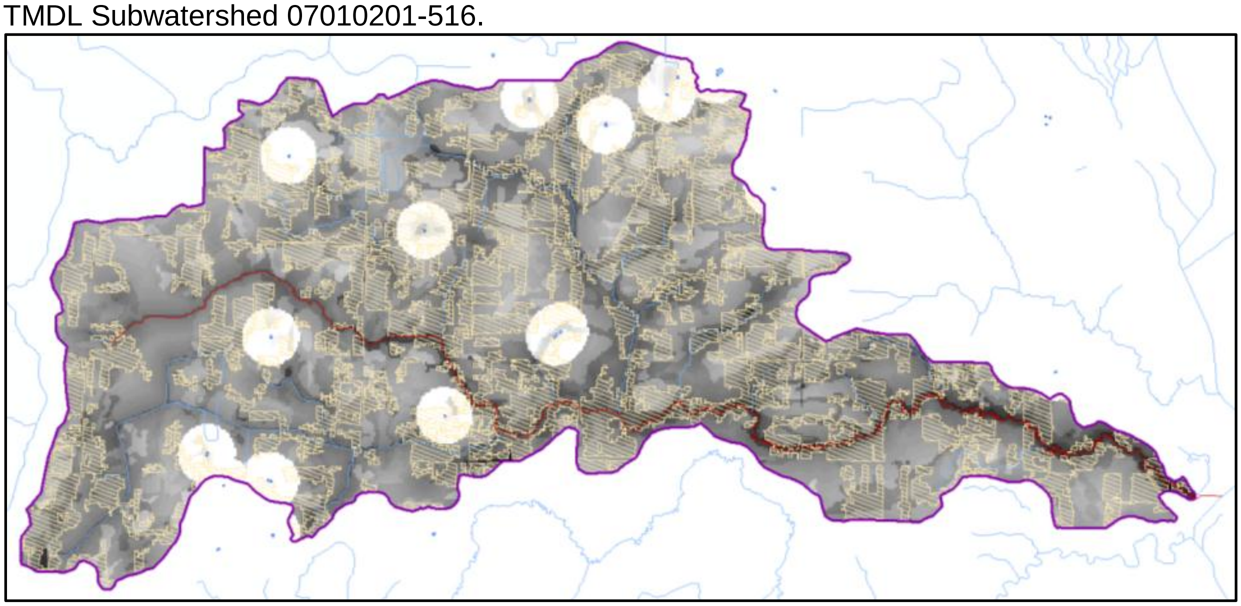
The delivery factor GIS layer was used wherever described in the tables in Section 4.2, which define bacteria source estimation approaches. Using the gridded delivery factor GIS layer, the mean delivery factor was calculated for each bacteria source category for each TMDL and Protection Subwatershed across the applicable geographic areas described in the approach summary tables in Section 4.2 (e.g. grazing animals were assumed to occur in NLCD 2006 land covers of *Pasture/Hay* and *Grassland/Herbaceous*). The delivery factors were interpreted and applied as the percent of the *E. coli* that is delivered from the landscape to rivers and streams. The delivery factor accounts for delivery to *all* stream reaches in each of the subwatersheds; it is not specific to the individual TMDL Reach or Protection Reach.

The following three steps in Figure 4-14 illustrate the delivery factor calculations and how the delivery factors are used for the determination of the percent of *E. coli* that is delivered from the landscape to rivers and streams. The example is for grazing livestock in TMDL Subwatershed 07010201-516 Little Two River. Again, delivery factors were applied only where described in the approach summary tables in Section 4.2.

Step 1. Grazing livestock are assumed to graze on *Pasture/Hay* or *Grassland/Herbaceous* 2006 NLCD land covers, as described in Table 4-10 and illustrated below with peach polygons for the example subwatershed, TMDL Subwatershed 07010201-516 Little Two River.



Step 2. The delivery factor GIS layer (as described in the preceding paragraphs) is illustrated below; it is a gridded dataset that ranges in value from 100 (black) to 0 (white). Note that the darker the color, the higher the risk for *E. coli* to be delivered from the grazing areas to rivers and streams; the regions near stream channels have the highest water quality risk (highest delivery factors). Large white (or nearly white) circles illustrate the revision that was performed to reduce the water quality risk (the delivery factor) for non-flow-through lakes (as previously described). The geographic areas where livestock graze are shown below with hatching (the same as the peach areas in Step 1). The average value of the grid cells within the hatched area is calculated, resulting in the delivery factor of 32 (on a scale of 0 to 100 with 100 being the highest risk for *E. coli* to be delivered to rivers and streams) to be applied to grazing livestock in TMDL Subwatershed 07010201-516.



Go to next page for Step 3.

Step 3. The calculated delivery factor for grazing livestock in TMDL Subwatershed 07010201-516 (32) is interpreted to be the percent of *E. coli* from grazing livestock that is actually delivered to surface waters. Therefore, the *E. coli* loading from grazing horses, cattle, goats, and sheep is equal to 0.32 multiplied by the count of these animals (estimated using methods described in Section 4.2.2 and Section 4.2.3) and multiplied by the respective *E. coli* production rate of these animals (Table 4-8, in units of *E.coli* cfu/day-head).

Figure 4-14. Example of the delivery factor calculation for grazing livestock in TMDL Subwatershed 07010201-516 Little Two River.
This figure begins on the previous page.

4.2.7 Strengths and Limitations

The results of the estimates of potential bacteria sources inform stakeholders as to the types and relative magnitude of bacteria delivered to surface waters in the respective TMDL or Protection Subwatershed. The estimates of potential bacteria sources were not used to determine the TMDL equation, but they provide a valuable tool for the planning and management of waterbodies with respect to bacteria contamination.

The estimates of potential bacteria sources use a GIS-based approach. However, available data sources are at different scales and have different boundaries than that of the TMDL and Protection Subwatersheds. A limitation to the estimation process is that populations must be distributed geographically (e.g. county to subwatersheds) using assumptions related to population density. There is a probable minimum scale at which bacteria source estimates are useful.

A significant portion of animal types were accounted for in the potential bacteria sources. However, several animals were not included: birds other than geese and ducks (e.g. song birds and wading birds) and many wild animals (e.g. bear and wild turkey). Data, resource limitations, and consideration for the major animals in the TMDL and Protection Subwatersheds led to the selected set of animal types accounted for in these estimates.

The estimates of potential bacteria sources are also limited by the fact that bacteria delivery mechanisms are complex. Fate and transport mechanisms at the microbiological scale are difficult to quantify. In addition, there is insufficient data to determine with great certainty for our particular subwatersheds the actual distribution of the fecal matter throughout the environment (e.g. the actual portion of manure that is land applied with incorporation, or the actual amount of human waste that is produced and the proportion that is treated via septic systems as opposed to municipal wastewater treatment facilities).

The delivery factor is a well-designed water quality risk matrix developed and reviewed through a multi-agency effort. This water quality risk matrix (and the adjustment that was made as a part of this study) provides for the consideration of a variety of factors related to the fate and transport of *E. coli* (e.g. proximity to rivers and streams, imperviousness, and soil erosion potential). Although it certainly provides a tool for relative risk of *E. coli* delivery to surface waters, it may or may not be accurate to interpret the resultant numeric risk values as the actual percent of *E. coli* that is delivered from the landscape to surface waters.

The estimates of potential bacteria sources also do not account for the relative risk among different types of bacteria. Instead, *E. coli* production is estimated as an indicator of the likelihood of pathogen contamination of our waterbodies.

4.3 Potential Bacteria Sources: Results

Table 4-15 and Table 4-16 identify the potential bacteria sources of the TMDL and Protection Subwatersheds. Results are presented by source categories: first by fate and transport mechanism (Table 4-15), and subsequently by animal type (Table 4-16). The bacteria load from any single source is reported relative to the bacteria loads from the other sources in the same subwatershed. Note that the two different summary tables are provided in order to give a fuller picture of the potential bacteria sources, since different categorizations (e.g. by fate and transport mechanism versus animal type) may highlight different potential sources. Refer to Section 4.2.7 for a discussion of strengths and limitations of these results. Also recall that different animals produce different levels of *E. coli* in their excrement (refer to Table 4-8).

Table 4-15. Potential bacteria sources of the TMDL and Protection Subwatersheds, grouped by mechanism of delivery to surface waters. Comparison across source categories of relative amounts of each subwatershed. For example, the “07010201-501” row presents a comparison of the *E. coli* delivered to surface waters by one source category vs. another source category (within the same 07010201-501 Subwatershed). (Symbols are viewed relative to other symbols within the same row and represent the percentile of the range of values within the subwatershed.)
• - low (0-25th percentile), ž - medium-low (26th-50th percentile), œ - medium-high (51st-75th percentile), ˜ - high (76th-100th percentile), blank –no bacteria

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protec-tion	Humans					Livestock Requiring Registration				Livestock Not Requiring Registration	Pets		Wildlife		
			WWTF Effluent	Illicit Connections or Leakage of Raw Sewage from Sanitary to Storm Sewer[1]	ITPHS Septics	Land Application of Biosolids[3]	Land Application of Septage	Grazing	Partially Housed or OL w/o Runoff Controls	Land Application w/o Incorporation	Land Application w/ Incorporation or Injection	Partially Housed or OL w/o Runoff Controls	Impervious	Pervious	Impervious	Pervious	Water and Wetlands
Mississippi River	07010201-501	Protec-tion		•	•		•	•	•	˜	•	•	•	•	•	•	•
Mississippi River	07010201-502	Protect ion		•	ž		•	•	•	›	•	•	˜	ž	•	•	•
Mississippi River	07010201-513	Protec-tion	•	•	›	•	•	•	•	˜	•	•	•	•	•	•	•
Little Two River	07010201-516	TMDL	•	•	•	•	•	•	•	˜	•	•	•	•	•	•	•
Two River	07010201-523	TMDL		•	•		•	•	•	˜	•	•	•	•	•	•	•
Spunk Creek	07010201-525	TMDL	•	•	•	•	•	•	•	˜	•	•	•	•	•	•	•
Watab River	07010201-528	TMDL		•	•		•	•	•	˜	•	•	•	•	•	•	•
Watab River, North Fork	07010201-529	TMDL	•	•	•	•	•	•	•	˜	•	•	•	•	•	•	•
County Ditch 12	07010201-537	TMDL		•	•		•	•	•	˜	•	•	•	•	•	•	•
South Two River	07010201-543	TMDL	•	•	•	•	•	•	•	˜	•	•	•	•	•	•	•
Platte River	07010201-545	Protec-tion		•	•		•	•	•	˜	•	•	•	•	•	•	•

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protec-tion	Humans					Livestock Requiring Registration				Livestock Not Requiring Registration	Pets		Wildlife		
			WWTF Effluent	Illicit Connections or Leakage of Raw Sewage from Sanitary to Storm Sewer[1]	ITPHS Septics	Land Application of Biosolids[3]	Land Application of Septage	Grazing	Partially Housed or OL w/o Runoff Controls	Land Application w/o Incorporation	Land Application w/ Incorporation or Injection	Partially Housed or OL w/o Runoff Controls	Impervious	Pervious	Impervious	Pervious	Water and Wetlands
Watab River, South Fork	07010201-554	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
County Ditch 13	07010201-564	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Little Rock Creek	07010201-577	Protec-tion	•	•	ž	•	•	•	•	~	•	•	•	•	•	•	•
Mississippi River	07010201-607	Protec-tion	•	•	•	•	•	•	•	~	•	•	•	•	•	•	•
Stony Creek	07010201-615	Protec-tion		•	•		•	•	•	~	•	•	•	•	•	•	•
Sauk River	07010202-501	Protec-tion		•	•		•	•	•	~	•	•	ž	•	•	•	•
Mississippi River	07010203-503	Protec-tion	•	•	›	•	•	•	•	›	•	•	~	›	ž	•	ž
Mississippi River	07010203-510	Protect ion	•	•	›	•	•	•	ž	~	•	•	ž	›	•	•	›
Clearwater River	07010203-511	Protec-tion		•	ž		•	•	•	~	•	•	•	•	•	•	ž
Elk River	07010203-525	Protec-tion		•	~		•	•	•	•	•	•	›	~	•	•	›
Unnamed creek	07010203-528	TMDL	•	•	~	•	•	•	•	~	•	•	•	ž	•	•	•
Silver Creek	07010203-557	TMDL		•	ž		•	•	•	~	•	•	•	•	•	•	ž

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protec-tion	Humans					Livestock Requiring Registration				Livestock Not Requiring Registration	Pets		Wildlife		
			WWTF Effluent	Illicit Connections or Leakage of Raw Sewage from Sanitary to Storm Sewer[1]	ITPHS Septics	Land Application of Biosolids[3]	Land Application of Septage	Grazing	Partially Housed or OL w/o Runoff Controls	Land Application w/o Incorporation	Land Application w/ Incorporation or Injection	Partially Housed or OL w/o Runoff Controls	Impervious	Pervious	Impervious	Pervious	Water and Wetlands
Unnamed creek (Luxemburg Creek)	07010203-561	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Plum Creek	07010203-572	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Mississippi River	07010203-574	Protec-tion		ž	›		•	•	•	•	•	•	~	•	•	•	•
Johnson Creek (Meyer Creek)	07010203-635	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Johnson Creek (Meyer Creek)	07010203-639	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Unnamed creek (Robinson Hill Creek)	07010203-724	TMDL		•	•		•	•	•	~	•	•	•	•	•	•	•
Mississippi River	07010206-501	Protec-tion	•	•	•	•	•	•	•	•	•	•	~	ž	•	•	ž
Mississippi River	07010206-502	Protec-tion	•	•	ž	•	•	•	•	•	•	•	~	ž	•	•	~
Mississippi River	07010206-503	Protect ion		ž			•	•	•		•		~	•	•	•	•
Mississippi River	07010206-504	Protec-tion	ž	•	•	•	•	•	•	•	•	•	~	•	•	•	•

			Humans					Livestock Requiring Registration				Livestock Not Requiring Registration	Pets		Wildlife		
Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protec-tion	WWTF Effluent	Illicit Connections or Leakage of Raw Sewage from Sanitary to Storm Sewer[1]	ITPHS Septics	Land Application of Biosolids[3]	Land Application of Septage	Grazing	Partially Housed or OL w/o Runoff Controls	Land Application w/o Incorporation	Land Application w/ Incorporation or Injection	Partially Housed or OL w/o Runoff Controls	Impervious	Pervious	Impervious	Pervious	Water and Wetlands
Mississippi River	07010206-505	Protection		ž			•	•	•	•	•	•	~	•	•	•	•
Shingle Creek (County Ditch 13) [2]	07010206-506	TMDL		•	•		•	•	•	•	•	•	~	•	•	•	•
Mississippi River	07010206-509	Protection		•			•	•	•	•	•	•	~	•	•	•	•
Mississippi River	07010206-512	Protec-tion		•			•	•	•	•	•	•	~	•	•	•	•
Mississippi River	07010206-513	Protec-tion		ž			•						~	•	•	•	•
Mississippi River	07010206-514	Protec-tion		ž			•	•	•		•		~	•	•	•	•
Unnamed creek	07010206-517	Protec-tion	•	•	•	•	•	•	•	•	•	•	ž	~	•	•	ž
Unnamed creek (Plymouth Creek) [2]	07010206-526	TMDL		•			•	•	•	•	•	•	~	ž	•	•	•
Bassett Creek[2]	07010206-538	TMDL		•			•	•	•		•		~	•	•	•	•
Unnamed creek (Interstate Valley Creek)	07010206-542	TMDL		•	•		•	•	•	•	•	•	~	›	•	•	•

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protec-tion	Humans					Livestock Requiring Registration				Livestock Not Requiring Registration	Pets		Wildlife		
			WWTF Effluent	Illicit Connections or Leakage of Raw Sewage from Sanitary to Storm Sewer[1]	ITPHS Septics	Land Application of Biosolids[3]	Land Application of Septage	Grazing	Partially Housed or OL w/o Runoff Controls	Land Application w/o Incorporation	Land Application w/ Incorporation or Injection	Partially Housed or OL w/o Runoff Controls	Impervious	Pervious	Impervious	Pervious	Water and Wetlands
Unnamed creek (North Branch, Bassett Creek)[2]	07010206-552	TMDL		•			•	•	•		•		~	•	•	•	•
Mississippi River	07010206-568	Protec-tion		•	~		•	•	•	•	•	•	›	ž	•	•	ž
Rice Creek	07010206-584	TMDL		•	~		•	•	•	•	•	•	~	ž	•	•	›
Battle Creek	07010206-592	Protec-tion		ž			•	•	•	•	•	•	~	ž	•	•	•
Fish Creek	07010206-606	Protec-tion		•			•	•	•	•	•	•	~	~	ž	•	ž
Unnamed creek	07010206-727	Protec-tion		•	•		•	•	•	•	•	•	~	ž	•	•	•
Unnamed, Unassessed	07010206-xxx	Protec-tion		•	~		•	›	ž	ž	•	~	•	~	•	ž	ž

[1]Table 4-3 in *Wastewater Treatment Facilities (WWTFs) and Collection Systems*, Section 4.1.1, identifies, for each subwatershed, qualitative findings with respect to failing infrastructure. Based on the literature, chronic underground leakage of untreated sewage into stormsewers (refer to Combined Sewer Overflows on Page 42) is a bacteria source. In the absence of a quantitative tool to report bacteria loading from leakage of untreated sewage, the percent of the subwatershed having sewers over 50 years old (derived from MPCA 2012a, estimated for each subwatershed in Table 4-3) is used as a surrogate for estimating relative bacteria loads from raw sewage leaking into stormsewers. The relative loads are ranked according to Table 4-9: > 50% area having sewers over 50 years old results in a ranking of Medium-Low, 30-49% is Low, 10-29% is Low, 0-9% is Low. There are definite limitations to this approach. However, the literature regarding this issue is strong enough to warrant accounting for, even if using a limited approach, infrastructure susceptible to failure due to time period of construction in these estimates of potential bacteria sources. [2]Local sources note that grazing animals are not present in this subwatershed. [3]Note that we lack the specific locations where biosolids are land-applied.

Table 4-16. Potential bacteria sources of the TMDL and Protection Subwatersheds, grouped by animal type.
Comparison across source categories of relative amounts of each subwatershed. For example, the “07010201-501” row presents a comparison of the *E. coli* delivered to surface waters by one animal type vs. another animal type (within the same 07010201-501 Subwatershed). (Symbols are viewed relative to other symbols within the same row.) Results represent bacteria delivered to streams and rivers (not merely the bacteria produced by these animals).
• - low (0-25th percentile), ž - medium-low (26th-50th percentile), œ - medium-high (51st-75th percentile), ˜ - high (76th-100th percentile), blank - no bacteria

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protection	Humans[1]	Livestock						Pets	Wildlife				
				Horses	Cattle	Goats	Sheep	Hogs	Poultry	Dogs	Raccoons	Deer	Pigeons	Ducks	Geese
Mississippi River	07010201-501	Protection	•	•	•	•	•	•	˜	•	•	•		•	•
Mississippi River	07010201-502	Protection	›	•	•	•	•	•	ž	˜	•	•	•	•	•
Mississippi River	07010201-513	Protection	˜	•	•	•	•	ž	˜	•	•	•	•	•	•
Little Two River	07010201-516	TMDL	•	•	•	•	•	•	˜	•	•	•		•	•
Two River	07010201-523	TMDL	•	•	•	•	•	ž	˜	•	•	•	•	•	
Spunk Creek	07010201-525	TMDL	•	•	ž	•	•	ž	˜	•	•	•	•	•	•
Watab River	07010201-528	TMDL	ž	•	ž	•	•	ž	˜	•	•	•	•	•	•
Watab River, North Fork	07010201-529	TMDL	•	•	ž	•	•	ž	˜	•	•	•	•	•	•
County Ditch 12	07010201-537	TMDL	•	•	ž	•	•	ž	˜	•	•	•	•	•	•
South Two River	07010201-543	TMDL	•	•	•	•	•	ž	˜	•	•	•	•	•	•
Platte River	07010201-545	Protection	•	•	•	•	•	•	˜	•	•	•	•	•	•
Watab River, South Fork	07010201-554	TMDL	•	•	ž	•	•	ž	˜	•	•	•	•	•	•
County Ditch 13	07010201-564	TMDL	•	•	ž	•	•	ž	˜	•	•	•	•	•	•
Little Rock Creek	07010201-577	Protection	ž	•	•	•	•	•	˜	•	•	•	•	•	•
Mississippi River	07010201-607	Protection	ž	•	•	•	•	ž	˜	•	•	•	•	•	•
Stony Creek	07010201-615	Protection	•	•	ž	•	•	ž	˜	•	•	•		•	•
Sauk River	07010202-501	Protection	ž	•	ž	•	•	ž	˜	›	•	•	•	•	•
Mississippi River	07010203-503	Protection	›	•	•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010203-510	Protection	›	•	ž	•	•	ž	˜	˜	•	•	•	›	•

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protection	Humans[1]	Livestock						Pets	Wildlife				
				Horses	Cattle	Goats	Sheep	Hogs	Poultry	Dogs	Raccoons	Deer	Pigeons	Ducks	Geese
Clearwater River	07010203-511	Protection	Ž	•	Ž	•	•	Ž	˜	•	•	•	•	Ž	•
Elk River	07010203-525	Protection	›	•	•	•	•	•	•	˜	•	•	•	Ž	•
Unnamed creek	07010203-528	TMDL	˜	•	Ž	•	•	Ž	›	›	•	•	•	•	•
Silver Creek	07010203-557	TMDL	Ž	•	›	•	•	›	˜	Ž	•	•	•	›	•
Unnamed creek (Luxemburg Creek)	07010203-561	TMDL	•	•	Ž	•	•	Ž	˜	•	•	•		•	•
Plum Creek	07010203-572	TMDL	•	•	Ž	•	•	Ž	˜	•	•	•	•	•	•
Mississippi River	07010203-574	Protection	˜	•	•	•	•	•	•	˜	•	•	•	•	
Johnson Creek (Meyer Creek)	07010203-635	TMDL	•	•	Ž	•	•	Ž	˜	•	•	•		•	•
Johnson Creek (Meyer Creek)	07010203-639	TMDL	•	•	Ž	•	•	Ž	˜	•	•	•	•	•	•
Unnamed creek (Robinson Hill Creek)	07010203-724	TMDL	•	•	Ž	•	•	Ž	˜	•	•	•	•	•	•
Mississippi River	07010206-501	Protection	•	•	•	•	•	•	•	˜	•	•	•	Ž	•
Mississippi River	07010206-502	Protection	•	•	•	•	•	•	•	˜	•	•	•	›	•
Mississippi River	07010206-503	Protection	˜		•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010206-504	Protection	Ž	•	•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010206-505	Protection	˜	•	•	•	•	•	•	˜	•	•	•	•	•
Shingle Creek (County Ditch 13)	07010206-506	TMDL	Ž	•	•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010206-509	Protection	›	•	•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010206-512	Protection	Ž	•	•	•	•	•	•	˜	•	•	•	•	•
Mississippi River	07010206-513	Protection	˜							˜	•	•	•	•	•
Mississippi River	07010206-514	Protection	˜		•	•	•	•	•	˜	•	•	•	•	•
Unnamed creek	07010206-517	Protection	Ž	•	•	•	•	•	•	˜	•	•	•	•	•

Downstream-most Reach Name of Sub-watershed	Subwatershed ID (If TMDL Subwatershed, Impaired AUID)	TMDL or Protection	Humans[1]	Livestock						Pets	Wildlife				
				Horses	Cattle	Goats	Sheep	Hogs	Poultry	Dogs	Raccoons	Deer	Pigeons	Ducks	Geese
Unnamed creek (Plymouth Creek)	07010206-526	TMDL	ž	•	•	•	•	•	•	~	•	•	•	•	•
Bassett Creek	07010206-538	TMDL	ž		•	•	•	•	•	~	•	•	•	•	•
Unnamed creek (Interstate Valley Creek)	07010206-542	TMDL	ž	•	•	•	•	•	•	~	•	•	•	•	•
Unnamed creek (North Branch, Bassett Creek)	07010206-552	TMDL	ž		•	•	•	•	•	~	•	•	•	•	•
Mississippi River	07010206-568	Protection	~	•	•	•	•	•	•	~	•	•	•	ž	•
Rice Creek	07010206-584	TMDL	›	•	•	•	•	•	•	~	•	•	•	ž	•
Battle Creek	07010206-592	Protection	~	•	•	•	•	•	•	~	•	•	•	•	•
Fish Creek	07010206-606	Protection	›	•	•	•	•	•	•	~	•	•	•	•	•
Unnamed creek	07010206-727	Protection	ž	•	•	•	•	•	•	~	•	•	•	•	•
Unnamed, Unassessed	07010206-xxx	Protection	~	•	~	ž	~	•	•	~	•	ž	•	ž	

[1]The relative amount of bacteria loading from humans is the greater of the two reported results for human sources in Table 4-15. Refer to Footnote 1 of Table 4-15 for how bacteria loads from leaking of sanitary sewers into storm sewers were estimated.

5 APPROACH: WATER QUALITY ANALYSIS AND TMDLS

The water quality data analysis presented in this report was conducted in addition to the Phase I analysis and for development of the TMDLs; this analysis includes the use of additional monitoring data collected per the recommendations of the Phase I report. This first phase of the overall TMDL study and protection project included data analysis, preliminary investigation of potential bacteria sources, and monitoring recommendations. The Phase I report, *Upper Mississippi River Bacteria TMDL: Data Analysis, Source Assessment, and Monitoring Recommendations*, entailed water quality trends analysis and a concise summary of findings (MPCA and MDH 2009).

5.1 Monitoring

Extensive monitoring has been done in support of this TMDL (Refer to *Section 6 Water Quality Analysis Results* and Appendix C, D, and E). In Phase I of this project, water quality and flow data from the Mississippi River mainstem and tributaries collected between 1999 to 2008 was compiled and assessed. The findings of this assessment are described in the Phase I Report *Upper Mississippi River Bacteria TMDL: Data Analysis, Source Assessment, and Monitoring Recommendations* (MPCA and MDH 2009) which can be found on the project website at http://www.pca.state.mn.us/ktqha48. Key findings from the assessment of monitoring data were as follows:

- Data at individual sites often show increasing bacteria concentrations into the fall. In several cases, this trend appears only after 2004.
- High winter concentrations are not uncommon among sites having winter data. In particular, River Mile (RM) 863.0 and 815.6 experience high winter concentrations. Data from a downstream site on the Minnesota River also experiences high winter concentrations. Several water quality monitoring sites do not have winter data. Even though the aquatic recreation standard does not apply during the winter months, winter bacteria sources are relevant due to the potential survival of bacteria in sediments of downstream waterbodies. Winter bacteria sources are also relevant to source water protection efforts.
- Bacteria concentrations along the Mississippi River mainstem peak around the metropolitan area.
- Increases in bacteria concentrations between adjacent monitoring sites along the Mississippi River mainstem mainly occur in late summer and fall and never occur in the spring. Mississippi RMs 858.5, 839.1, and 831.0 experience increases in bacteria concentrations between adjacent monitoring sites only during winter months.
- Tributary sites tend to experience more exceedances above the *E. coli* standard than Mississippi River mainstem sites.
- Storm sewer data exhibit high *E. coli* concentrations and experience some of the greatest concentrations of all monitoring sites. Please note that data were available from only four sites out of hundreds of outfalls to the Mississippi River and tributaries in the Phase I Project Area so may not be representative of concentrations in all storm sewer outfalls. However, these *E. coli* concentrations were within the range of data reported for storm sewers in other urban areas (e.g.: Wisconsin, Bannerman *et al*. 1993; Michigan, Gannon and Busse 1989; International BMP Database records, WWE and GC 2010).
- Exceedances in *E. coli* concentrations above the standard (126 org/100mL) are experienced under all flow regimes demonstrating no clear pattern and suggesting a possible mix of

bacteria sources. The lack of trends is especially apparent, and expected, on mainstem, large river data; it is a function of the inherent convergence of a variety of bacteria sources and flow regimes from both local and regional watersheds.

- Mainstem data indicate that neither temperature, total suspended solids nor turbidity alone is a surrogate for *E. coli*.
- Annual trends in geometric mean bacteria concentrations of AUIDs indicate a relatively common decrease in *E. coli* and fecal coliform concentrations in the years 2006 and 2008 as compared to the year before. Increases are less common.

An additional aspect of the report was to develop an approach for monitoring to be conducted in 2010 and 2011 to fill data gaps. *E. coli* monitoring was conducted by EOR and MPCA at the locations and frequency indicated in Table 5-1. The Mississippi WMO also added a monitoring location on the Mississippi River, between Upper and Lower Saint Anthony Falls, AUID 07010206-513.

A separate pilot study was undertaken to investigate the use of microbial source tracking (MST) of fecal contamination for TMDL studies in Minnesota. The MPCA and MDH collaborated with the University of Minnesota and undertook a sampling effort at 19 sites, which entailed laboratory analyses of surface water quality samples for *Bacteroides* primers and fluoride. *E. coli* in these samples were also analyzed. Eleven of the 19 MST study sites were among the sites monitored in 2010 and 2011 to fill data gaps for *E. coli*; as such, they are marked in Table 5-1. The MST report *Microbial Source Tracking Pilot Study: Developed for the Upper Mississippi River Bacteria TMDL*, will be posted to the project website at http://www.pca.state.mn.us/ktqha48. *Enterococcus* was also monitored at four sites in 2011; they are also marked in Table 5-1.

Table 5-1. Monitoring sites and numbers of samples in 2010 and 2011.

Station	Reach Name	AUID	Reach Name	Number of Samples		
				2010	2011	Total
S000-025[1]	MISSISSIPPI RIVER AT US-169 BRIDGE AT ANOKA	07010206-568	Mississippi River	20	26	46
S000-052	MISSISSIPPI R. SH-101 ELK RIVER	07010203-503	Mississippi River	15	18	33
S000-068[2]	MISSISSIPPI RIVER AT LOCK AND DAM #2 AT HASTINGS	07010206-502	Mississippi River	21	17	38
S000-150	MISSISSIPPI R CSAH-26 BRIDGE, 3 MI W OF ROYALTON	07010201-501	Mississippi River	15	18	33
S001-946[1]	SHINGLE CR AT 45TH AVE & RR TRACK, MPLS, MN	07010206-506	Shingle Creek (County Ditch 13)	21	22	43
S002-011	MISSISSIPPI R, BOAT LANDING AT HIDDEN FALLS PARK IN ST. PAUL	07010206-514	Mississippi River	18	16	34
S002-947[1]	WATAB R. AT CSAH 1 IN SARTELL, MN	07010201-528	Watab River	9	21	30
S002-948[1]	SPUNK CK AT CSAH 21, 3.5 MI SW OF ROYALTON, MN.	07010201-525	Spunk Creek	15	19	34
S002-949[1]	TWO RIVERS AT CSAH 25, 2 MI. E. OF BACKUS, MN	07010201-523	Two River	15	20	35

Station	Reach Name	AUID	Reach Name	Number of Samples		
				2010	2011	Total
S003-370[1, 2]	JOHNSON CK BTWN CR-75 AND I-94, 5 MI S OF ST CLOUD, MN	07010203-639	Johnson Creek (Meyer Creek)	9	28	37
S003-993	COON CR AT VALE ST BRG IN COON HOLLOW AREA IN COON RAPIDS	07010206-530	Coon Creek	17	15	32
S005-052	MISSISSIPPI RIVER: ST. PAUL, 494 BRIDGE BELOW WWTP	07010206-504	Mississippi River	19	22	41
S005-540	SILVER CK AT CURTIS AVE NW, 3.5 MI SW OF BECKER, MN	07010203-557	Silver Creek	7	24	31
S006-139[1, 2]	UNN STR JUST OFF LILYDALE RD IN LILYDALE	07010206-542	Unnamed creek (Interstate Valley Creek)	21	18	39
S006-140[1]	CD-17 AT 79TH WAY NE DWNSTR CLVRT IN FRIDLEY	07010206-557	Unnamed creek	20	20	40
S006-141	RICE CK BTWN LOCK LK & MISSISSIPPI R IN MANOMIN CTY PK	07010206-586	Rice creek	25	20	45
S006-142	RUM R AT PED. BRG JUST ABOVE CONFLUENCE WITH MISS. R.	07010207-555	Rum River	20	25	45
S006-143	TROUT BK STORM SEWER OUTFALL TO THE MISS. R OFF WARNER RD	NA	Stormsewer	20	20	40
S006-144	MISSISSIPPI R AT US-61 BRG IN HASTINGS	07010206-501	Mississippi River	19	16	35
S006-145	MISSISSIPPI R DWNSTR OF COON RPDS DAM IN COON RPDS REG PK	07010206-512	Mississippi River	19	23	42
S006-146	MISSISSIPPI R UPSTR OF COON RPDS DAM IN COON RPDS REG PK	07010206-511	Mississippi River	21	18	39
S006-147	MISSISSIPPI R ALONG RIVERSIDE AVE., .25 MI N OF SARTELL DAM	07010201-513	Mississippi River	14	23	37
S006-148[1,2]	UNN STR AT CSAH-39 IN OSTEGO	07010203-528	Unnamed creek	15	26	41
S006-162[1]	LITTLE TWO R AT CSAH-52 (GREAT R RD), 3.3 MI W OF ROYALTON	07010201-516	Little Two River	15	26	41
S006-163[1]	MISSISSIPPI R DWNSTR OF MN-15 BRG IN SAUK RAPIDS	07010201-502	Mississippi River	13	27	40

[1] Monitoring station was also part of the *Microbial Source Tracking Pilot Study*, which will be posted to the project website at http://www.pca.state.mn.us/ktqha48. A total of 19 sites were monitored; only 11 were among the sites monitored in 2010 and 2011 to fill *E. coli* data gaps. MST Pilot Study samples were analyzed for *Bacteroides* primers, fluoride, and *E. coli*.

[2] Water quality sampling was also done at this site for *Enterococcus* in 2011.

5.2 Database

5.2.1 Water Quality

Existing *E. coli* data (2002-2011) within the TMDL and Protection Subwatersheds (and from the downstream-most monitoring stations of impaired tributaries that directly discharge to the Mississippi River) were gathered and compiled from the following sources:

- Environmental Quality Information System (EQuIS) – download from MPCA
- Metropolitan Council Environmental Services – download through Environmental Information Management System website
- Data submitted directly from St. Paul Regional Water Services, St. Cloud Water Treatment Facility, Minnesota Department of Health, Mississippi Watershed Management Organization, Capital Region Watershed District (data were requested individually from these sources because these entities do not submit their data to EQuIS, or had only submitted some of their data to EQuIS, with respect to the 10-year period of interest)

Water quality samples that were found to have *E. coli* concentrations below the reporting limit (as defined by the laboratory analytical methods) were used at a concentration of half of that of the reporting limit. Samples that were found to be greater than the upper limit concentration of the analytical test were requested to be diluted (ten-times dilution) for subsequent samples. Data that were still found to be greater than the upper limit concentration of the analytical test were not diluted again; they were used in the data analysis at the same concentration as the upper limit.

5.2.2 Flow

In-stream flow (discharge) data (2002-2011) from within the TMDL and Protection Subwatersheds (and from downstream monitoring stations of impaired tributaries that directly discharge to the Mississippi River) were compiled from website downloads from the following sources: USGS, MCES, and DNR/MPCA Cooperative Stream Gaging.

5.2.3 Precipitation

Precipitation data (2002-2011) from within and near the TMDL and Protection Subwatersheds were compiled from website downloads from MCES and the National Weather Service.

5.3 Water Quality Data Analysis

Water quality data from each Mississippi River reach and from each reach that directly outlets to this portion of the Mississippi River were evaluated. These reaches were included in the water quality evaluation whether or not they are impaired for aquatic recreation due to *E. coli*. For each of these reaches, the following analyses were completed.

5.3.1 Load duration curves

Load duration curves (LDCs) illustrate *E. coli* concentrations with respect to flow on the same day providing information as to the timing and source of high levels of *E. coli* in the water body. The y-axis of a LDC represents *E. coli* load, and the x-axis represents flow in terms of the probability of exceedance: low flows have a high probability of exceedance and high flows have a low probability of exceedance. A given mass of *E. coli* at low flows would have a much lower concentration if occurring during high flows; this input would also likely have a different source in each case (e.g. septic field leaching versus stormwater runoff). LDC analyses on large rivers may have a different meaning than those on small rivers. On small rivers, high flows are the result of runoff within the immediate drainage area. On a large river system, high flows may be the result of a rain event away from the vicinity of the monitoring point at a far upstream location where precipitation patterns differ than that experienced locally. In that case, high *E. coli* loading at high flows may actually be a dry weather input from adjacent land that did not receive precipitation. Alternatively, the adjacent land may be the source of the precipitation, but the *E. coli* may be from dry (or wet) weather input upstream. In order to better address the source of flows, local precipitation data from the National Weather Service were plotted against gauged flow as part of this analysis. In addition, monitoring data on adjacent tributaries helped provide information for the mainstem LDCs.

For LDCs on Mississippi River reaches, flow data from the nearest flow monitoring site on the Mississippi River (from 2002-2011) were used to develop the LDC for each reach. Data were weighted by watershed area to approximate flow at the downstream end of each reach. For LDCs on the tributaries, flow data from the nearest monitoring site (also from 2002-2011) on the tributary were used, and weighted by watershed area to approximate flow at the downstream end of the reach. If flow data were not available on the tributary, then flow data from the nearest site on the Mississippi River were used and area-weighted. Where mainstem flow data were used to approximate tributary flow data, values for *E. coli* loading are less reliable than where tributary flow data are used. However, the relationship between monitored *E. coli* data and the standard remain valid. A list of which flow and water quality monitoring sites were used for each reach's LDC is in Table C-1 in Appendix C.

E. coli monitoring data (individual samples) from all monitoring sites along a reach are displayed in the reach's LDC.

E. coli loads that exceed the *E. coli* loading at the numeric standard of 126 org/100mL are individual load observations, which are not used to determine whether the waterbody is impaired. In addition, the state standard applies only from April to October, but this analysis evaluates exceedances throughout the calendar year.

5.3.2 Monthly summary figures

Figures showing relationships among precipitation, flow, and *E. coli* are also included. Monthly *E. coli* geometric mean, monthly mean flow, and total monthly precipitation are graphed together. For Mississippi River reaches, the flow data weighted by watershed area were used. For tributaries, area weighted flow data from the tributary were used. If flow data were not available from the tributary, then this monthly summary figure is not included for that reach. Table C-1 in Appendix C summarizes the pairing of precipitation, flow and *E. coli* monitoring stations used for each reach.

5.3.3 Tabular summaries

The following summary tables are provided in Appendix D.

- Monthly *E. coli* geometric mean concentrations for each reach; data are combined across all years (e.g. all May data are combined into one geometric mean for 2002-2011).
- Monthly *E. coli* geometric mean concentrations for each reach; monthly geometric means are presented individually for each year of monitoring data (e.g. May 2002, May 2003, and etc.).

Note that MPCA's water quality data assessment for listing stream reaches as impaired for bacteria entails analysis of the data by month by year, if data allow, else the assessment is conducted by month across all years. Therefore, data presented in these summary tables may not be consistent with the approach used for listing stream reaches as impaired for bacteria.

5.4 Loading Capacity

Equation 1 illustrates the calculation procedures for the TMDL. The TMDLs are calculated based on the geometric mean standard (126 org/100 ml). It is assumed that practices implemented to meet the geometric mean standard will also address the "maximum" standard (1,260 org/100 ml) and that the maximum standard will also be met.

The loading capacity and allocations apply only to the TMDL Subwatershed of each TMDL Reach (TMDL study impairments), as described in Section 2.5 *TMDL Study Impairments and Subwatersheds*. The TMDL Subwatershed includes the direct drainage area of the TMDL Reach, the direct drainage area of reaches directly upstream that are unassessed, and the drainage area of unassessed tributaries. It does not include tributaries that are meeting *E. coli* standards, tributaries for which there is a current or planned TMDL study in the near future, or upstream tributaries that are also impaired and part of a TMDL Subwatershed for a separate impairment.

The loading capacity of each TMDL Reach was calculated using the load duration curve developed for the TMDL Reach and the reach directly upstream (see *Load duration curves* under Section 5.3: *Water Quality Data Analysis*). Each load duration curve was used to identify five flow intervals: high, moist, mid-range, dry, and low flow. The midpoint of each interval was selected as the representative flow for that interval, and the loading capacity of the reach at that point was calculated by multiplying the flow by the water quality standard (126 org/100 L *E. coli*).

The TMDL for each TMDL Subwatershed was calculated by subtracting the loading capacity of the upstream reach and the loading capacity of any tributary that is not in the TMDL Subwatershed from the loading capacity of the TMDL Reach, such that the TMDL reflects the allowable load of the TMDL Subwatershed only. If the upstream reach meets water quality standards, then the existing load is used instead of the loading capacity. The existing load is based on the midpoint of each flow duration interval and the *E. coli* geometric mean concentration of all observations (all monitoring sites along the reach are combined) in that flow interval. The lower of the two *E. coli* concentrations of the upstream reach (existing vs. loading capacity) is used so that, if a stream has better water quality than the standard, it is assumed that the stream will not degrade. Three significant digits were used when reporting all flows, concentrations, and loads throughout the report.

TMDL = LCTR – LCUR

LCTR = **L**oading **C**apacity of **T**MDL **R**each = Flow x *E. coli* standard (126 org/100ml)

LCUR = **L**oading **C**apacity [or **E**xisting **L**oad] of **U**pstream **R**eaches not in the TMDL Subwatershed = Flow x [*E. coli* standard (126 org/100ml) OR monitored *E. coli* geometric mean, whichever is lower]

In all cases, flow is from the hydrologically-nearest flow station, area-weighted to represent flow at the downstream end of the respective reach; and flow is from the midpoint of each of five flow regimes.

Equation 1. TMDL Development

Loading capacities (and associated allocations) were not calculated for Protection Reaches. Although Protection Subwatersheds do not, therefore, receive a numeric goal, potential bacteria sources (Section 4) and applicable implementation strategies were identified (Section 9) (as was done for the TMDL Subwatersheds).

Equation 3 represents the calculation of percent reductions required to meet the TMDL. Figure 5-1 is an illustration of the TMDL and percent reduction calculations for a hypothetical TMDL Subwatershed, for demonstration purposes only.

5.5 Wasteload Allocations

Wasteload allocations (WLA) were established for regulated municipal separate storm sewer systems (MS4s) and for NPDES-permitted wastewater treatment facilities (WWTFs). Three significant digits were used when reporting all loads throughout the report.

5.5.1 MS4

Community storm sewer systems within the TMDL Subwatersheds that serve a population of at least 10,000 and systems with a population of at least 5,000 and discharging to valuable or polluted waters may be required to obtain a Municipal Separate Storm Sewer System (MS4) permit. This permit requires a range of actions to reduce the impact of stormwater from these communities on downstream waterbodies. Since there are likely to be multiple sources of bacteria contributing to the impairment, reductions may be needed from all contributing sources (both regulated and non-regulated entities).

For each TMDL Reach, a categorical WLA was developed for state, county, city, township, watershed district, and other regulated MS4s. The area that falls under MS4 regulation was approximated by the following:

- City and township: The 2006 USGS National Land Cover Dataset (NLCD), a 30-meter grid that characterizes land cover, was used to approximate the areas within cities and townships that are regulated by the MS4 permit. The following “developed” categories were used to approximate the regulated area:
  - Developed, open space
  - Developed, low intensity
  - Developed, medium intensity
  - Developed, high intensity

The remaining land cover categories are natural land covers and were used to approximate the areas *not* regulated by the MS4 permit (associated with the load allocation).

- MnDOT: An average right of way (ROW) width of 90 feet was assumed on all MnDOT roads (MnDOT BaseMap 2011 Roads GIS shapefile: Interstate, US Highway, or MN Highway) within MnDOT's Metro District and Outstate District within the US Census Bureau-defined Urbanized Areas. A ROW width of 90 feet on both sides of the centerline of each road was used to approximate MnDOT's regulated area.
- County: A 90-foot ROW was also assumed for county roads (including CSAHs) within the US Census Bureau-defined Urbanized Areas.
- Watershed District: Areas regulated through watershed district MS4 permits were assumed to overlap with city, township, county and/or state MS4 areas.
- Additional MS4 areas (e.g. colleges and universities): The boundary of the property was used to approximate the regulated area. These areas often overlapped with other regulated MS4 boundaries such as cities.

The categorical WLA for regulated municipal stormwater was determined on an area basis. It is the TMDL minus the Margin of Safety (MOS) and WWTF WLAs, which is then multiplied by the areal proportion of the TMDL watershed that is considered to be regulated through the MS4 permit. Overlapping areas that are regulated through the MS4 permit (e.g. areas of a city that overlap with university property) were not double-counted in the determination of the regulated acreage applicable to the categorical WLA calculation.

For low flows for TMDL Reach 07010203-528 Unnamed Creek (T121 R23W S19, south line to Mississippi R), the MS4 WLA is expressed as an equation. Refer to Section 5.5.2, Subsection *WLAs and LA for TMDL Reach 07010203-528 Unnamed Creek* and Equation 2 on Page 104.

5.5.2 Wastewater treatment facilities (WWTFs)

WLAs were provided for all NPDES-permitted WWTFs that have fecal coliform discharge limits (200 org/100mL, April 1 through October 31) and whose surface discharge stations fall within the TMDL watersheds. On March 17, 2008, Minnesota Rules Chapter 7050 water quality standards for bacteria were changed from fecal coliform concentration to *E. coli* concentration supported by an EPA guidance document on bacteriological criteria (USEPA 1986). In conjunction with the change of indicator organisms for bacterial water quality, a decision was made to retain existing fecal coliform effluent limitations for wastewater treatment facilities. This decision is extensively documented in the regulation's Statement of Need and Reasonableness, Book III, Section VII.G. If a discharger is meeting the fecal coliform limits of their permit, it is assumed that they are also meeting the *E. coli* WLA in these TMDLs. The WLA was therefore calculated using the assumption that the *E. coli* standard of 126 org/100mL provides equivalent protection from illness due to primary contact recreation as 200 org/100mL fecal coliform multiplied by the permitted facility design flow. Continuously discharging municipal WWTF WLAs were calculated based on the average wet weather design flow, equivalent to the wettest 30-days of influent flow expected over the course of a year. Municipal controlled discharge WWTF (pond) WLAs were calculated based on the maximum daily volume that may be discharged in a 24-hour period. Unlike the TMDL and the WLAs for permitted MS4 dischargers, the WLAs for the WWTFs do not vary based on instream flow. Expanding and new dischargers permitted at the fecal coliform limit will be added to the *E. coli* WLA via the NPDES permit public notice process (see Section 5.8: *Reserve Capacity and Future Growth* for a discussion regarding new or expanded WWTFs).

Since all allocations apply only to the TMDL Subwatersheds and not upstream watersheds (see Section 2.5 *TMDL Study Impairments and Subwatersheds*), WWTF WLAs were developed only for those facilities located in the TMDL Subwatersheds. NPDES-permitted WWTFs that are located in the hydrologic watershed of an impaired reach but upstream of the TMDL Subwatershed were not provided WLAs, based on the following assumptions:

1) If the WWTF is located in a watershed of an upstream impaired reach, then the WWTF will receive a WLA for the TMDL of the upstream impaired reach (i.e. the reach to which the WWTF discharges more directly). For example, all of the WWTFs in the Crow River watershed have received or will receive WLAs as part of separate TMDL reports.
2) If the reach directly upstream of the impaired reach is meeting water quality standards, the unimpaired reach is successfully assimilating existing bacteria loads. Dischargers in this area upstream of the TMDL watershed do not contribute to the downstream impairment as demonstrated by the fact that the upstream reach is not impaired due to high *E. coli* concentrations. All WWTFs are permitted to discharge fecal coliform at a concentration of 200 org/mL, which provides an equivalent protection from illness due to primary contact recreation to the *E. coli* standard of 126 org/mL, and therefore serves to attain and maintain the *E. coli* water quality standard.

<u>WLAs and LA for TMDL Reach 07010203-528 Unnamed Creek</u>

The total daily loading capacities in the low flow zone are very small due to the occurrence of very low flows in the long-term flow records. Consequently, for one of the impaired reaches (07010203-528, Unnamed Creek, T121 R23W S19, south line to Mississippi R), the permitted WWTF design flows exceed the stream flow at the low flow zone. Of course actual treatment facility flow can never exceed stream flow as it is a component of stream flow. To account for this singular unique situation, the low flow WLAs and LA for TMDL Reach 07010203-528 are expressed as Equation 2 rather than an absolute number.

(Wasteload) Allocation = (flow from *E. coli* source) x 126 org *E. coli*/100mL

Equation 2. TMDL Reach 07010203-528 low flow WWTF WLAs and LA.

In essence, this amounts to assigning a concentration-based limit to MS4 communities and nonpoint source LA sources for the low flow zone for TMDL Reach 07010203-528. The WLA for straight pipe wastewater discharges remains zero. This is the same procedure employed for four reaches with similar situations in the *Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota* (MPCA 2006) and the *Pipestone Creek Bacteria and Turbidity TMDL Report (MPCA 2008).*

5.5.3 Other

WLAs for regulated construction stormwater (permit #MN R100001) were not developed, since *E. coli* is not a typical pollutant from construction sites. To clarify, this means construction stormwater was not assigned a 0.0, but instead a WLA was not assigned which is an important distinction.

WLAs for regulated industrial stormwater were also not developed. Industrial stormwater must receive a WLA only if the pollutant is part of benchmark monitoring for an industrial site in the watershed of an impaired water body (as detailed in MPCA's June 8, 2001 memo cited in previous paragraph). There are no *E. coli* benchmarks associated with the industrial stormwater permit (permit #MN R050000).

Straight pipes are illegal conveyances of raw sewage from homes and businesses directly to surface water. Straight pipes receive a WLA of zero for all impaired water bodies because discharges from straight pipes are not authorized under any NPDES/SDS permits.

5.6 Load Allocations

Load allocations (LAs) represent the portion of the loading capacity that is designated for non-regulated sources of *E. coli*. Like the WLA for regulated stormwater runoff, the LA for each TMDL Reach was determined on an area basis. It is the TMDL minus the MOS and WWTF WLAs, which is then multiplied by the areal proportion of the TMDL watershed that is *not* considered to be regulated through the MS4 permit (see Section 5.5 for a discussion on how the regulated watershed areas are those areas designated as *Developed* according to NLCD land cover data). Three significant digits were used when reporting all loads throughout the report.

For low flows for TMDL Reach 07010203-528 Unnamed Creek (T121 R23W S19, south line to Mississippi R), the LA is expressed as an equation. Refer to Section 5.5.2, Subsection *WLAs and LA for TMDL Reach 07010203-528 Unnamed Creek* and Equation 2 on Page 104. For many reaches the allocations are based, in part, upon monitoring data that was collected during 2010, 2011. Refer to Table 5-1 for the specific reaches.

5.7 Margin of Safety

The margin of safety (MOS) accounts for uncertainties in both characterizing current conditions and the relationship between the load, wasteload, monitored flows, and in-stream water quality. Ultimately, the MOS accounts for uncertainty that the allocations will result in attainment of water quality standards.

An explicit MOS equal to 10% of the loading capacity was used for this TMDL report based on the following considerations:

- Since the TMDL is developed for each of five flow regimes, most of the uncertainty in flow is a result of extrapolating (area-weighting) flows from the hydrologically-nearest stream gage. The explicit MOS, in part, accounts for this.
- Allocations are a function of flow, which varies from high to low flows. This variability is accounted for through the development of a TMDL for each of five flow regimes.
- The load duration analysis does not address bacteria re-growth in sediments, die-off, and natural background levels. The MOS helps to account for the variability associated with these conditions.

5.8 Reserve Capacity and Future Growth

An explicit reserve capacity was not included in these TMDLs. The LAs (for non-regulated sources) are for all current and future sources.

A process for incorporating future MS4 regulated areas into the WLAs was established. Future transfer of loads in this TMDL may be necessary if any of the following scenarios occur within a TMDL Subwatershed:

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

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

A process for incorporating future WWTF discharges into the WLAs was established. All WLAs (and LAs) are based on 2002-2011 stream flow data, and the allocations assume that the flow regime will not change in the future. However, increases in population density in the watersheds are likely to lead to new and/or expanded WWTFs, which will increase flows from WWTFs to surface waters. Increased flows from WWTFs will also increase the overall loading capacity by increasing river flows. Since the fecal coliform discharge limits are consistent with *E. coli* water quality standards, the discharge limits of the new and expanded WWTFs will serve to attain and maintain water quality standards. Therefore, new and expanded WWTFs are not likely to have an impact on the *E. coli* concentrations in the stream reaches provided the discharge limits are met.

A streamlined WLA modification procedure will be used to update WLAs for new and expanding WWTFs. This process will apply to the WWTFs that received a WLA in this report and to any new NPDES-permitted wastewater discharge in the TMDL watersheds.

1) A new or expanding discharger will file with the MPCA permit program a permit modification request or an application for a permit reissuance. The permit application information will include documentation of the current and proposed future flow volumes and fecal coliform loads.
2) The MPCA permit program will notify the MPCA TMDL program upon receipt of the request or application and will provide the appropriate information, including the proposed discharge volumes and the fecal coliform loads.

3) MPCA Watershed program staff will provide the permit program with information on the TMDL WLA to be published with the permit's public notice.
4) The supporting documentation (fact sheet, statement of basis, effluent limits summary sheet) for the proposed permit will include information about the fecal coliform discharge requirements, noting that for fecal coliform the effluent limit is consistent with the in-stream *E. coli* standard and the increased discharge will maintain the *E. coli* water quality standard. The public will have the opportunity to provide comments on the new proposed permit, including the fecal coliform discharge and its relationship to the TMDL.
5) The MPCA TMDL program will notify the EPA TMDL program of the proposed action at the start of the public comment period. The MPCA permit program will provide the permit language with the attached fact sheet (or other appropriate supporting documentation) and new fecal coliform information to the MPCA TMDL program and the USEPA TMDL program.
6) EPA will transmit any comments to the MPCA Permits and TMDL programs during the public comment period, typically via e-mail. MPCA will consider any comments provided by EPA and by the public on the proposed permit action and WLA and will respond accordingly, conferring with EPA if necessary.
7) If, following the review of comments, MPCA determines that the new or expanded fecal coliform discharge is consistent with applicable water quality standards, MPCA will issue the permit with these conditions and send a copy of the final fecal coliform information to the USEPA TMDL program. MPCA's final permit action, which has been through a public notice period, will constitute an update of the WLA.
8) EPA will document the update to the WLA in the administrative record for the TMDL. Through this process EPA will maintain an up-to-date record of the applicable WLAs for permitted facilities in the watershed.

5.9 Reductions Needed to Meet TMDL

In all cases, WWTFs are required to meet their permitted bacteria loading limits and are not required to make any further reductions in bacteria loading as a part of this TMDL study. All other bacteria loads do require reductions in order to meet the TMDL. Bacteria sources requiring reduction will be termed *watershed runoff* for the purposes of this TMDL, which includes stormwater and watershed runoff from urban and rural landscapes, including regulated (MS4 stormwater) and non-regulated sources. The percent reductions needed to meet the allocations for watershed runoff (i.e. sources other than WWTFs) were estimated according to the following steps (illustrated in Equation 3).

The existing load of each TMDL Reach was calculated using the load duration curve developed for the TMDL Reach and the reach directly upstream (see *Load duration curves* under Section 5.3: *Water Quality Data Analysis*). Each load duration curve was used to identify five flow intervals: high, moist, mid-range, dry, and low flow. The midpoint of each interval was selected as the representative flow for that interval. The existing load of the reach for that interval was calculated by multiplying the flow by the *E. coli* geometric mean of all observations (all monitoring sites along the reach were combined) in that flow interval.

The existing load for each TMDL Subwatershed was calculated by subtracting the existing load of upstream reaches that are not in the TMDL Subwatershed from the existing load of the TMDL Reach, such that *the existing load reflects the load of the TMDL Subwatershed only*. The existing load of upstream reaches was calculated in the same way as that of the TMDL Reach. Three significant digits were used when reporting all flows, concentrations, and loads throughout the report.

The WWTF WLAs were then subtracted from the existing load of the TMDL Reach so that the existing load reflects the load from watershed runoff only (and from the TMDL Subwatershed only).

The existing *watershed runoff* load from the TMDL Subwatershed ('ELTR – ELUR – WWTF WLAs' in Equation 3) was then compared to the loading capacity from watershed sources in order to obtain the percent reduction required to meet the TMDL. The loading capacity from watershed sources is the TMDL minus the MOS and the WWTF WLAs. The required percent reduction was calculated for every flow regime as long as data was available from the TMDL Reach and upstream reaches.

Based on the selection process for the TMDL Reaches in this project (refer to Section 2.5.1), all impaired reaches upstream of TMDL Reaches are also being addressed as a part of this TMDL study, and a TMDL has been calculated for them. Therefore, if the TMDL Reach is not meeting the water quality standard because of the load from an upstream impaired reach (in other words, if the TMDL Reach will meet the water quality standard once the upstream impaired reach reduces its *E. coli* concentration to the water quality standard), the TMDL Subwatershed received a 0% reduction for the applicable flow regime.

$$\text{\% Reduction} = \left[\frac{\text{ELTR} - \text{ELUR} - \text{WWTF WLAs} - (\text{TMDL} - \text{MOS} - \text{WWTF WLAs})}{(\text{ELTR} - \text{ELUR} - \text{WWTF WLAs})}\right] \times 100$$

ELTR = **E**xisting **L**oad of **T**MDL **R**each = Flow x *E. coli* geometric mean concentration

ELUR = **E**xisting **L**oad of **U**pstream **R**eaches not in the TMDL Subwatershed = Flow x *E. coli* geometric mean concentration

TMDL = Loading Capacity of TMDL Reach – Loading Capacity of Upstream Reach as described in Section 5.4 *Loading Capacit*y, Equation 1

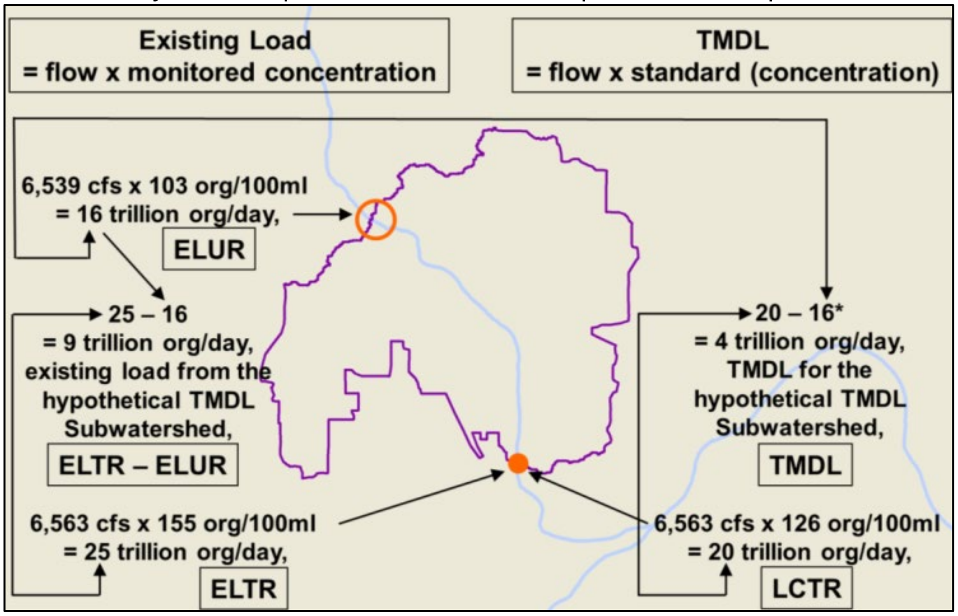
WWTF WLAs = The sum of the **W**aste**W**ater **T**reatment **F**acility **W**asteload **A**llocation**s**.

In all cases, flow is from the hydrologically-nearest flow station, area-weighted to represent flow at the downstream end of the respective reach; and flow is from the midpoint of each of five flow regimes.

Equation 3. Percent reductions.

Note that the *E. coli* standard is applied by month (April through October in coordination with the recreational season), but the TMDL and percent reductions are calculated by flow regime in order to accommodate variability in *E. coli* concentrations at different flows.

Step 1. Calculate the TMDL for the TMDL Subwatershed.
Acronyms correspond to those found in Equation 1 and Equation 3.



* If the monitored concentration of the upstream reach (in this example, 103 org/100ml) exceeded the standard of 126 org/100ml (in this example it does not), the upstream reach is impaired, a TMDL was written for the upstream reach, and the standard of 126 org/100ml was used for the upstream reach load calculation. Refer to LCUR in Equation 1. Note that the alternative use of 126 org/100ml is not applicable to the calculation of the existing load of the TMDL Subwatershed [(ELTR – ELUR) in this figure and Equation 3].

Step 2. Calculate percent reduction for the TMDL Subwatershed.
Acronyms correspond to those found in Equation 1 and Equation 3.

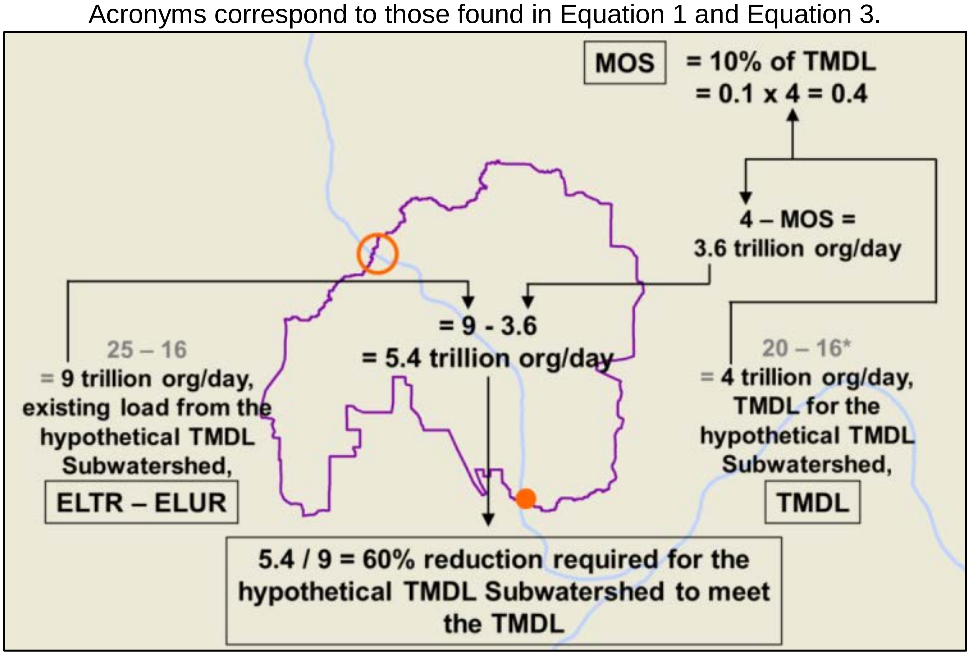


Figure 5-1. Calculations of the TMDL and required percent reduction for a hypothetical TMDL Subwatershed for demonstration purposes.
These calculations are provided for demonstration purposes only; the watershed is not an actual TMDL Subwatershed and the data and calculations are not actual results. Note that Equation 3 assumes WWTFs receive a 0% reduction (in Equation 3, WWTF loads are subtracted from existing loads and the TMDL); for simplicity, WWTFs are not accounted for in this illustration.

5.10 Critical Conditions and Seasonal Variations

Use of these water bodies for aquatic recreation occurs from April through October, which includes all or portions of the spring, summer and fall seasons. *E. coli* loading varies with the flow regime and season. Spring is associated with large flows from snowmelt, the summer is associated with the growing season as well as periodic storm events and receding streamflows, and the fall brings increasing precipitation and rapidly changing agricultural landscapes.

The following list represents a compilation of trends and findings with respect to critical conditions and seasonal variations based on the water quality analysis [some of these findings are based on the Phase I analysis (MPCA and MDH 2009)]:

- Data at individual sites often show increasing bacteria concentrations into the fall. In several cases, this trend appears only after 2004.
- Increases in bacteria concentrations between adjacent monitoring sites along the Mississippi River mainstem mainly occur in late summer and fall and never occur in the spring.
- High winter concentrations are not uncommon among sites having winter data. Several water quality monitoring sites do not have winter data. Even though the aquatic recreation standard does not apply during the winter months, winter bacteria sources are relevant due to the potential survival of bacteria in sediments of downstream waterbodies. Winter bacteria sources are also relevant to source water protection efforts.
- Tributary sites tend to experience more exceedances above the *E. coli* standard than Mississippi River mainstem sites.
- Bacteria concentrations along the Mississippi River mainstem peak around the metropolitan area.
- Storm sewer data exhibit high *E. coli* concentrations and experience some of the greatest concentrations of all monitoring sites. Please note that data were available from only four sites out of hundreds of outfalls to the Mississippi River and tributaries in the Phase I Project Area so may not be representative of concentrations in all storm sewer outfalls. However, these *E. coli* concentrations were within the range of data reported for storm sewers in other urban areas (e.g.: Wisconsin, Bannerman *et al*. 1993; Michigan, Gannon and Busse 1989; International BMP Database records, WWE and GC 2010).
- Exceedances in *E. coli* concentrations above the standard (126 org/100mL) are experienced under all flow regimes demonstrating no clear pattern and suggesting a possible mix of bacteria sources. The lack of trends is especially apparent, and expected, on mainstem, large river data; it is a function of the inherent convergence of a variety of bacteria sources and flow regimes from both local and regional watersheds.

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

6 WATER QUALITY ANALYSIS RESULTS

The three Major Watersheds on which the TMDL and Protection Study is focused are Mississippi River – Sartell Watershed (HUC 07010201), Mississippi River – St. Cloud Watershed (HUC 07010203), and Mississippi River – Twin Cities Watershed (HUC 07010206). These watersheds provide the framework for presentation of the water quality analysis results.

For each Mississippi River reach and adjacent (directly discharging) tributary, the following analyses were conducted on data from 2002-2011:

- Load duration curves
    - TMDL and Protection Reaches (here in Section 6)
    - Reaches outside of the TMDL and Protection Subwatersheds (Appendix E)
- Monthly data summary figures with precipitation, flow, and *E. coli* data (if data allow)
    - TMDL and Protection Reaches (here in Section 6)
    - Reaches outside of the TMDL and Protection Subwatersheds (Appendix E)
- Geometric means in tabular form (Table D-1 and Table D-2 in Appendix D)

Table C-1 in Appendix C summarizes the pairing of precipitation, flow and *E. coli* monitoring stations used for each reach. If no water quality data were available for any single reach, no data analyses were conducted for that reach.

The load durations curves presented in the following section plot the *E. coli* load using the standard of 126 org/100ml across the range of flows for each reach. Observed (monitored) values of *E. coli* that are plotted come from throughout the period of record. In calculating the TMDL, as well as determining allocations and percent reduction, the geometric mean of the monthly values in each flow regime was used rather than simply using the occurrence of exceedances. In viewing the load duration curves there will be situations where a high level of *E. coli* can be seen in a given flow regime yet there is not an exceedance of the standard when the geometric mean is calculated. Refer to Appendix D for the geometric means that were used for the TMDL calculation.

6.1 Mississippi River – Sartell Watershed (HUC 07010201)

6.1.1 Protection Reach 07010201-501 Mississippi River (End HUC 07010104 (below Swan R) to Two R) US ACE River Mile 954-961

This reach of the Mississippi River (AUID 07010201-501) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

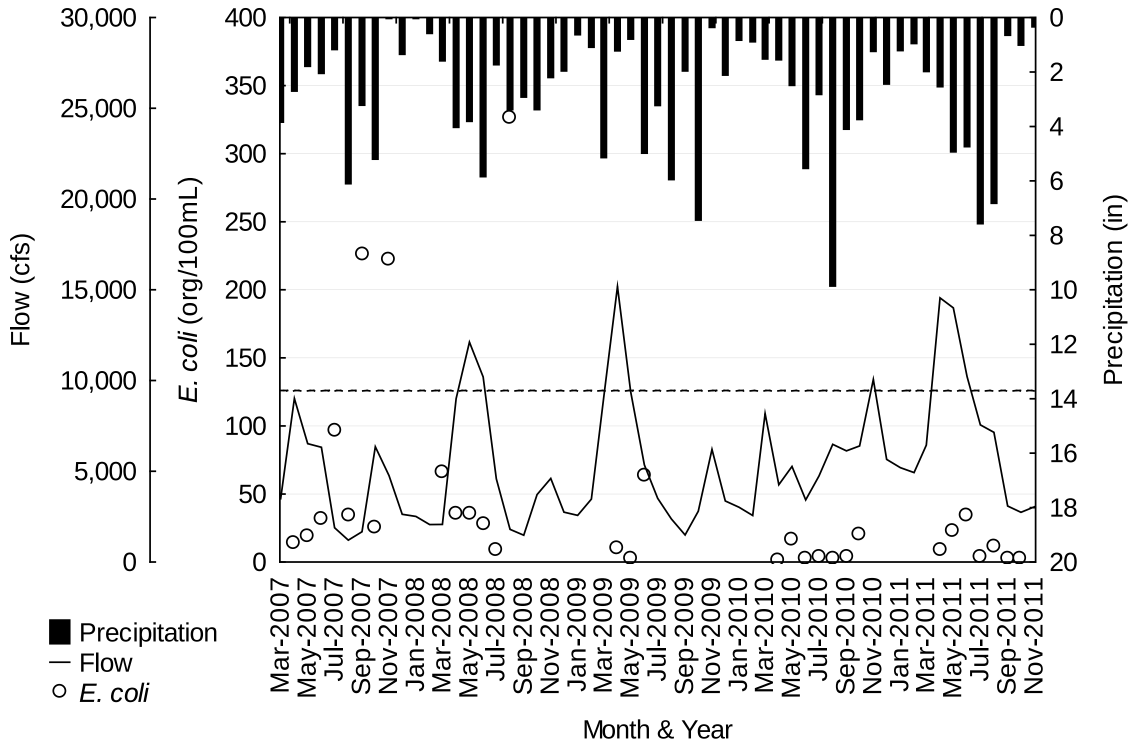


Figure 6-1. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010201-501) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

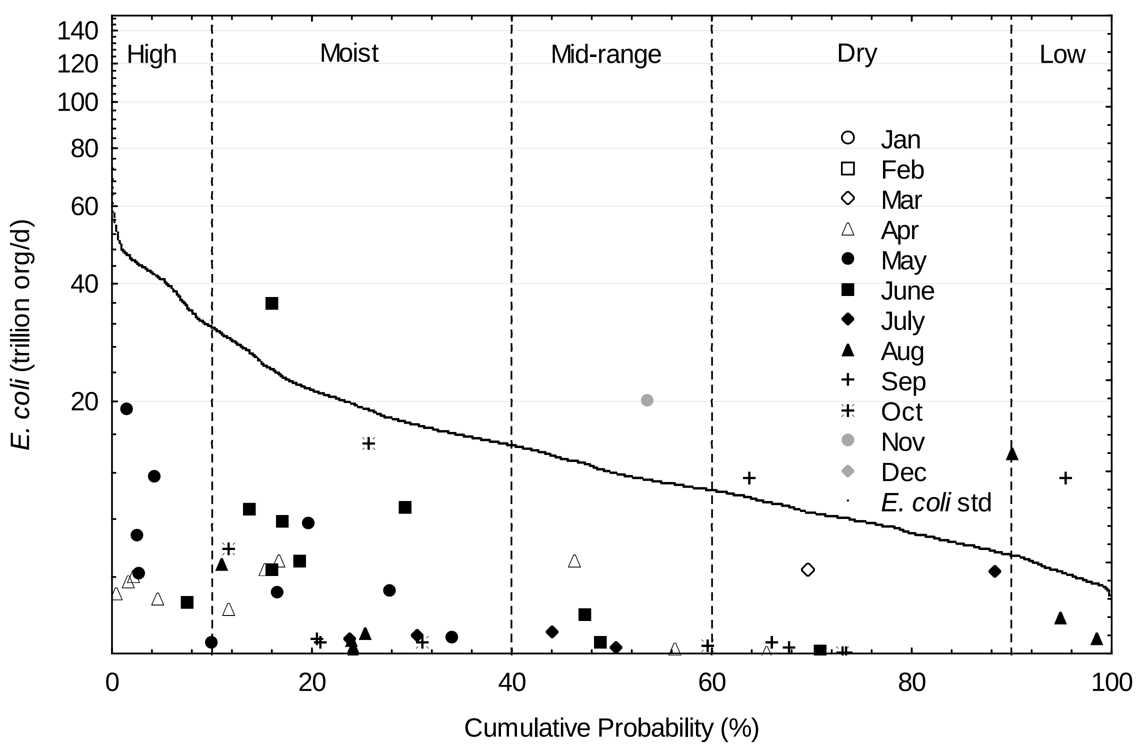


Figure 6-2. Load duration curve for *E. coli* at Mississippi River (07010201-501).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.2 Protection Reach 07010201-502: Mississippi River (Watab R to Sauk R) US ACE River Mile 930-932.5

This reach of the Mississippi River (AUID 07010201-502) is impaired for aquatic recreation due to *E. coli*. The TMDL for this reach is being deferred (refer to Section 2.6.1).

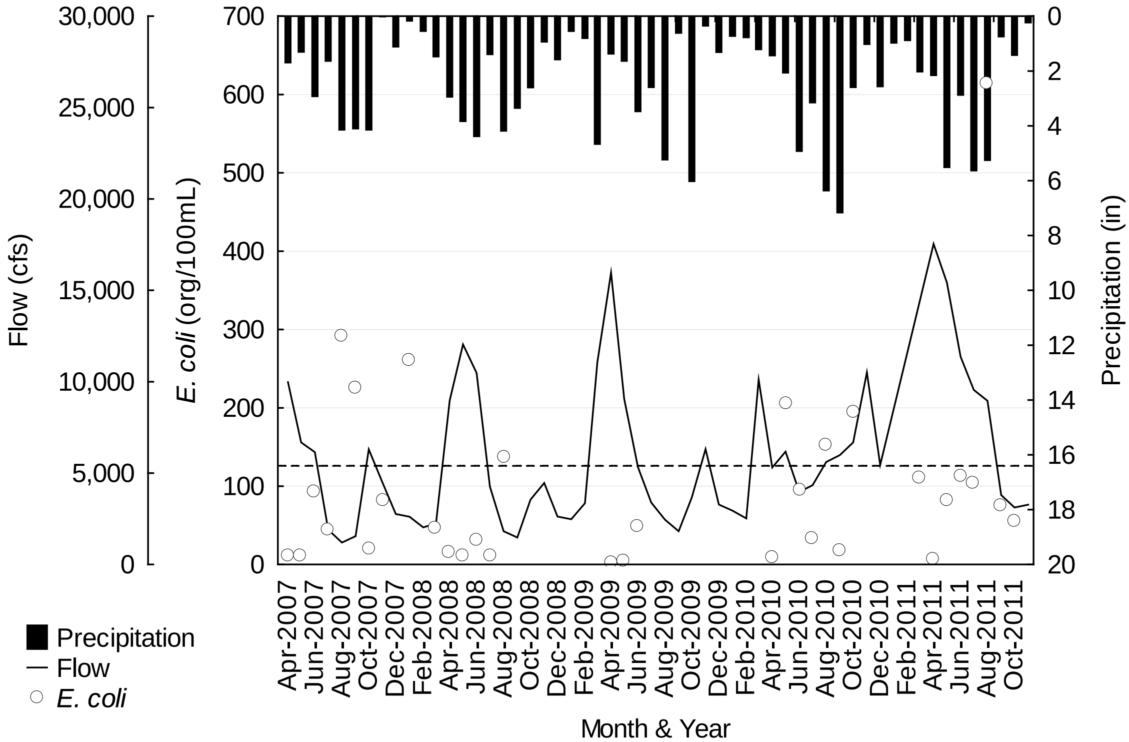


Figure 6-3. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010201-502) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

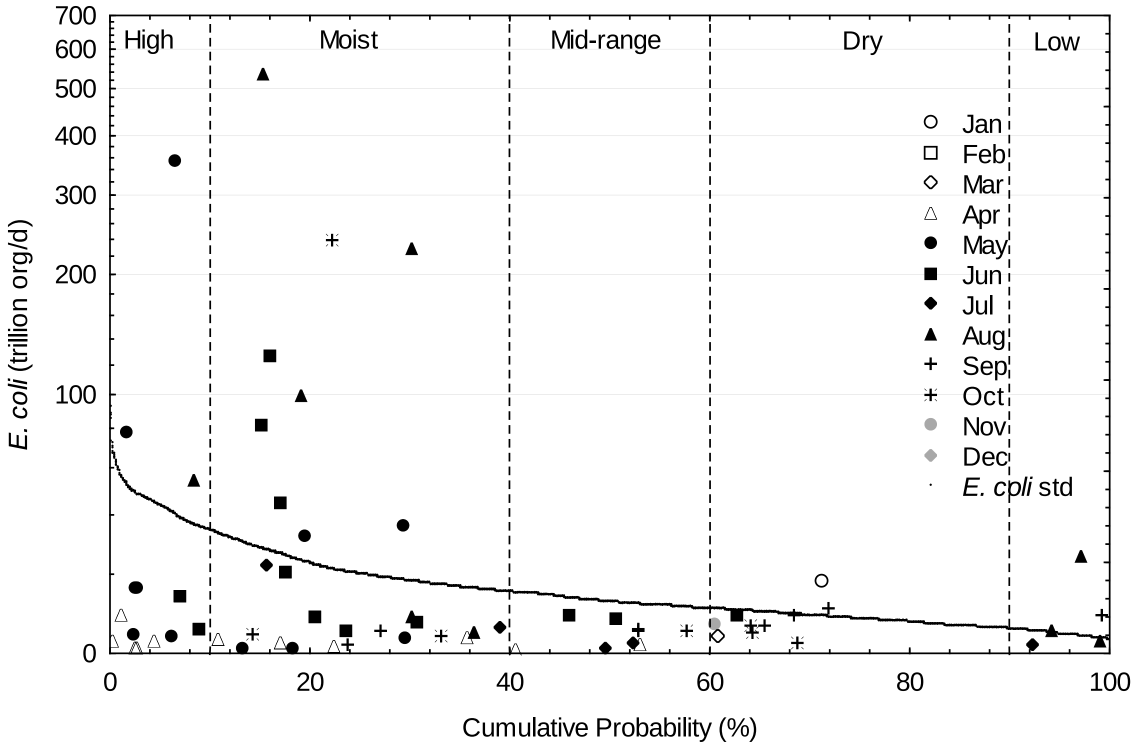


Figure 6-4. Load duration curve for *E. coli* at Mississippi River (07010201-502).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.3 Protection Reach 07010201-513: Mississippi River (Little Rock Cr to Sartell Dam) US ACE River Mile 932.5-937

This reach of the Mississippi River (AUID 07010201-513) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

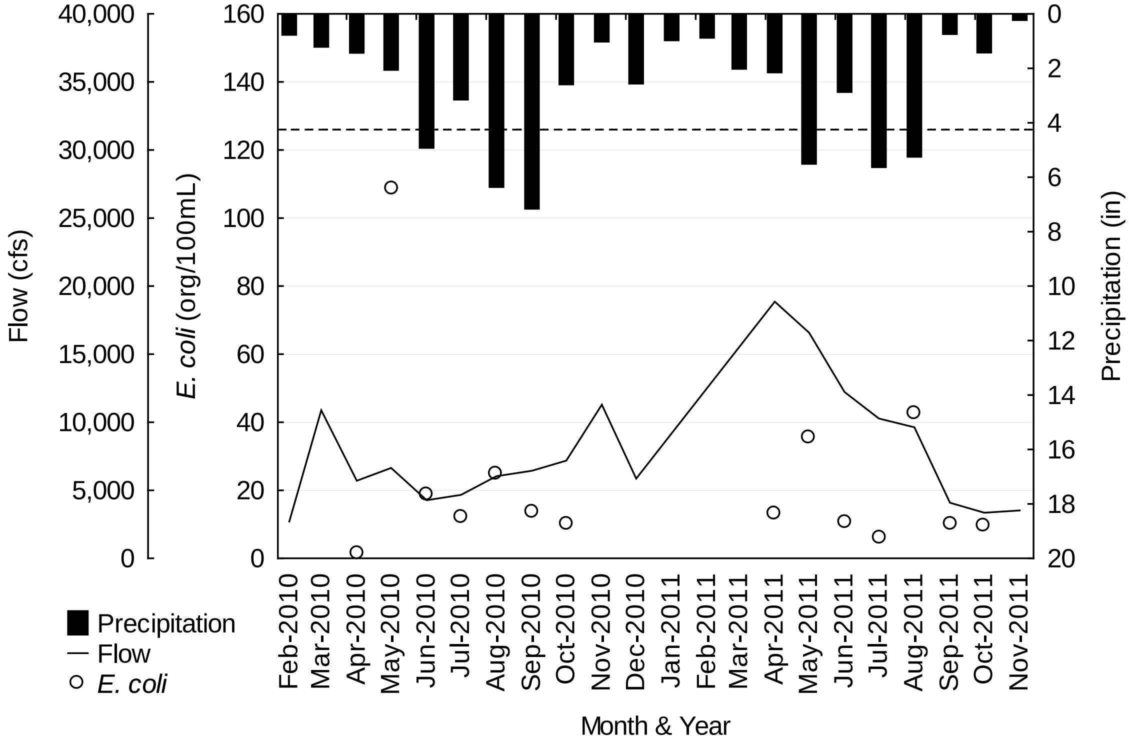


Figure 6-5. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010201-513) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

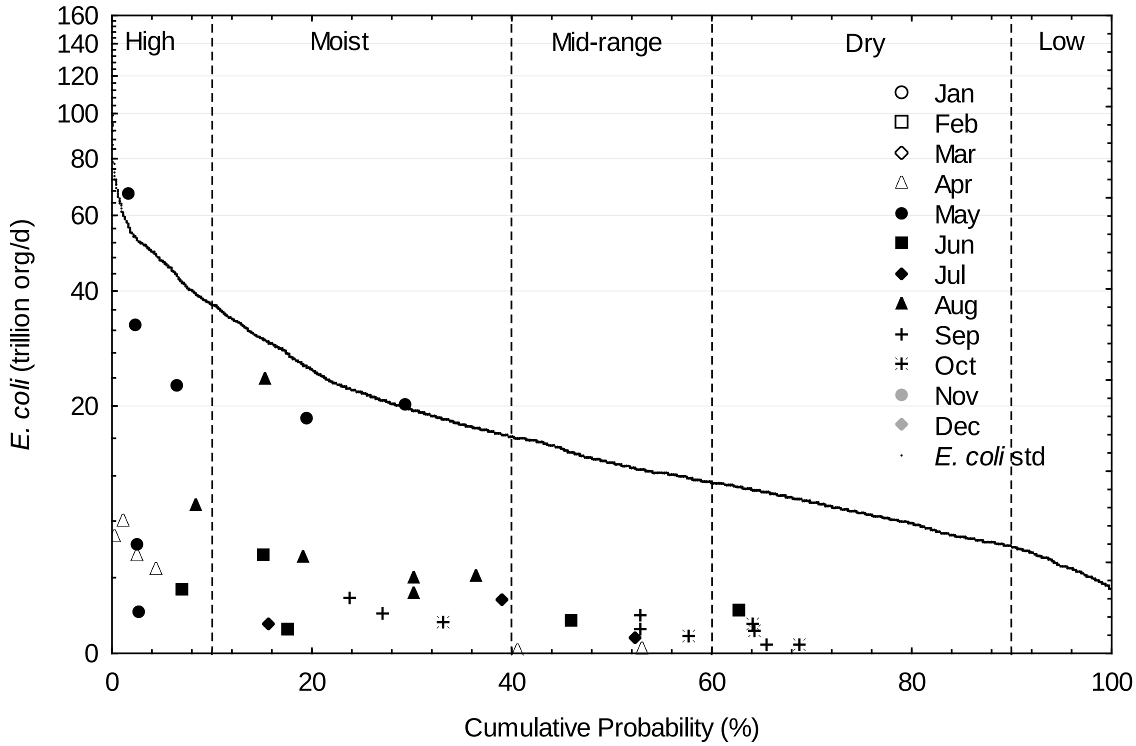


Figure 6-6. Load duration curve for *E. coli* at Mississippi River (07010201-513).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.4 TMDL Reach 07010201-516: Little Two River (Headwaters to Mississippi R)

Little Two River (AUID 07010201-516) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

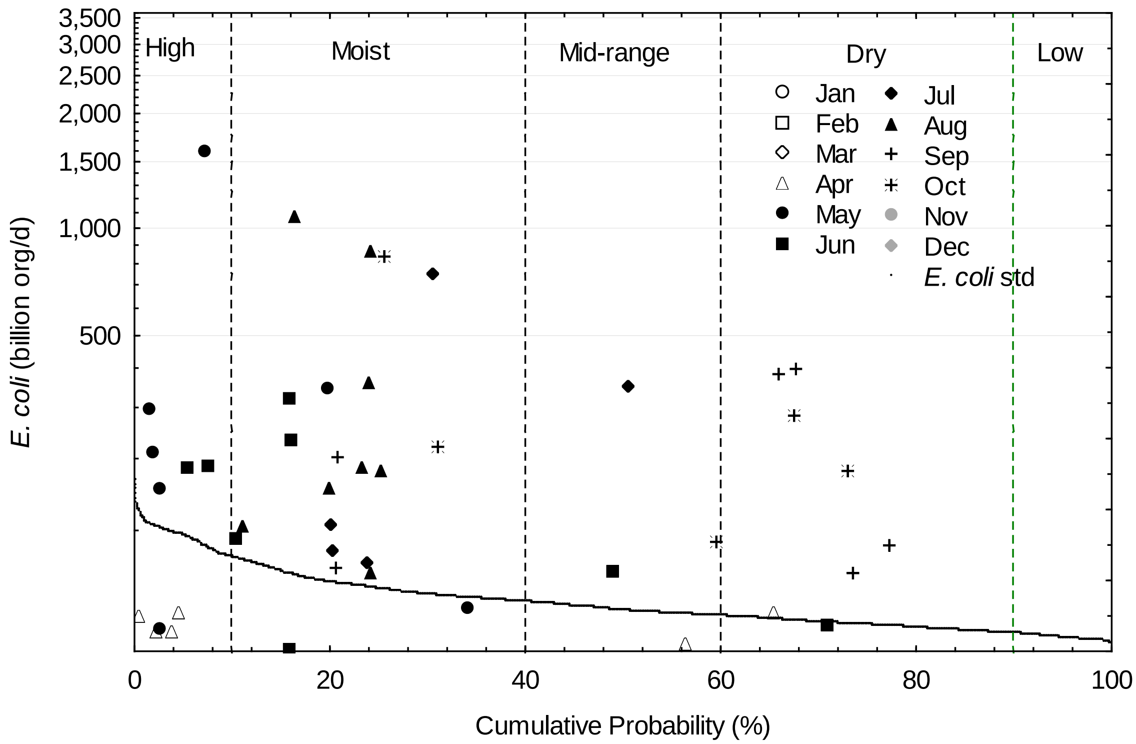


Figure 6-7. Load duration curve for *E. coli* at Little Two River (07010201-516).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.5 TMDL Reach 07010201-523: Two River (North & South Two R to Mississippi R)

Two River (AUID 07010201-513) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

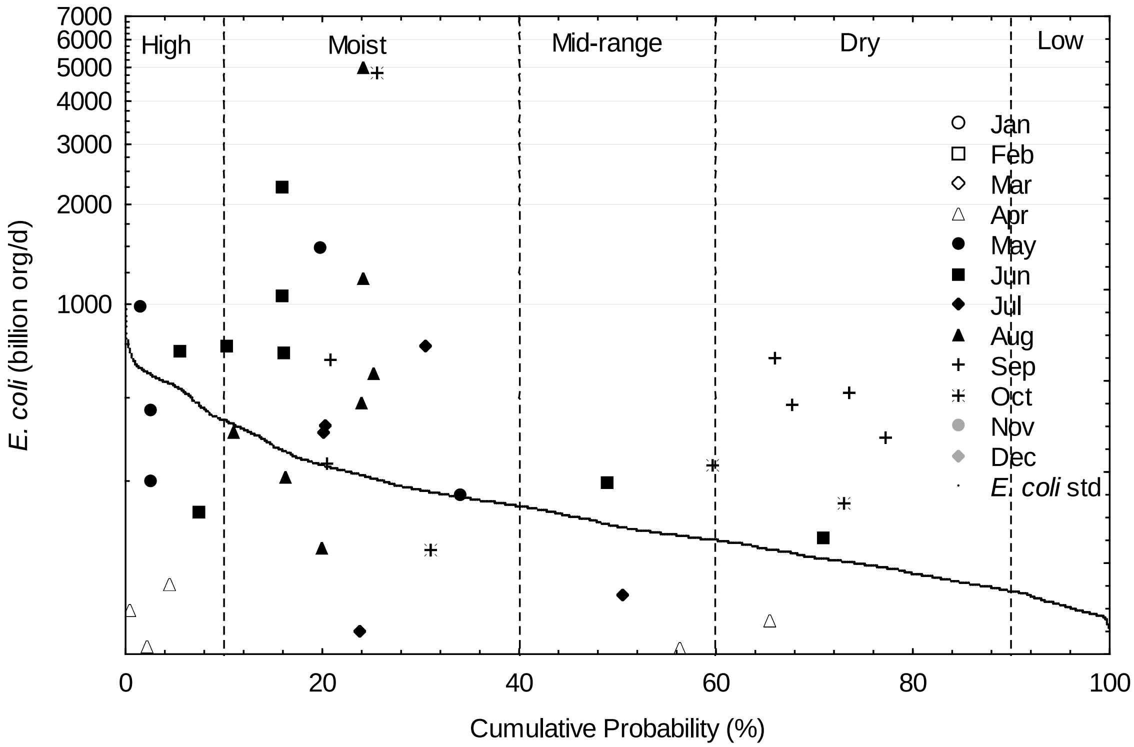


Figure 6-8. Load duration curve for *E. coli* at Two River (07010201-523).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.6 TMDL Reach 07010201-525: Spunk Creek (Lower Spunk Lk to Mississippi R)

Spunk Creek (AUID 07010201-525) is a tributary of the Mississippi River and is impaired for aquatic recreation due to fecal coliform. This reach received an *E. coli* TMDL as a part of this study (Table 7-1 in Section 7).

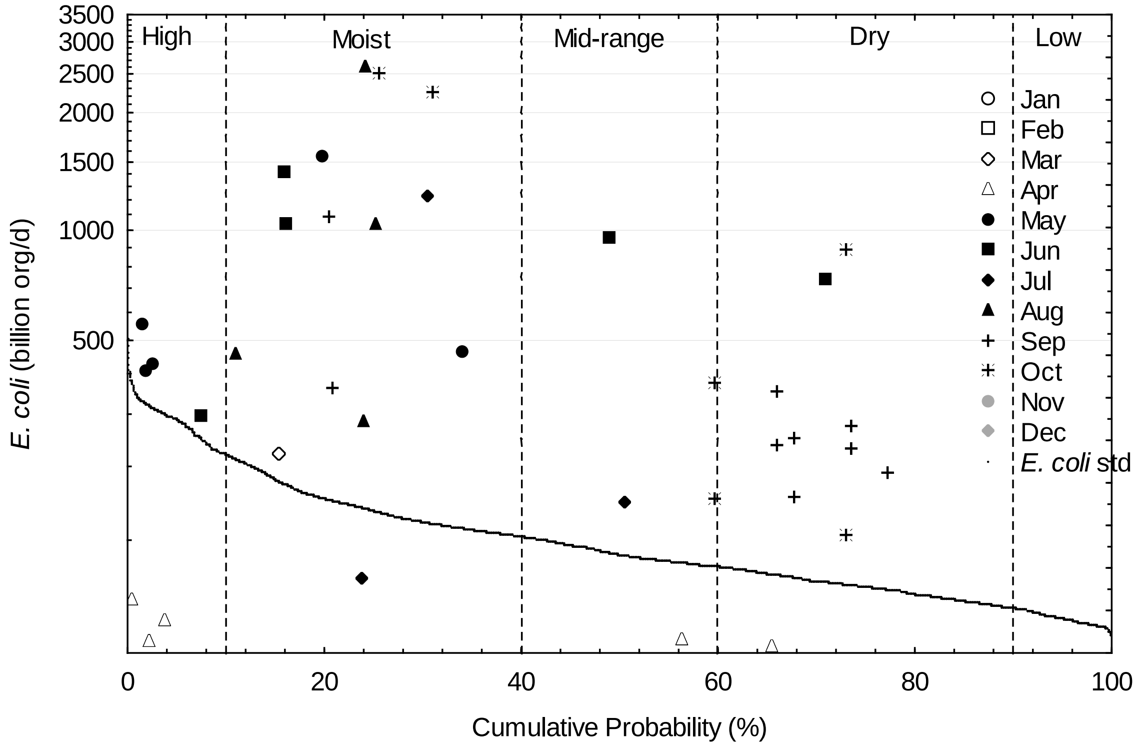


Figure 6-9. Load duration curve for *E. coli* at Spunk Creek (07010201-525).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.7 TMDL Reach 07010201-528: Watab River (Rossier Lk to Mississippi R)

Watab River (AUID 07010201-528) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

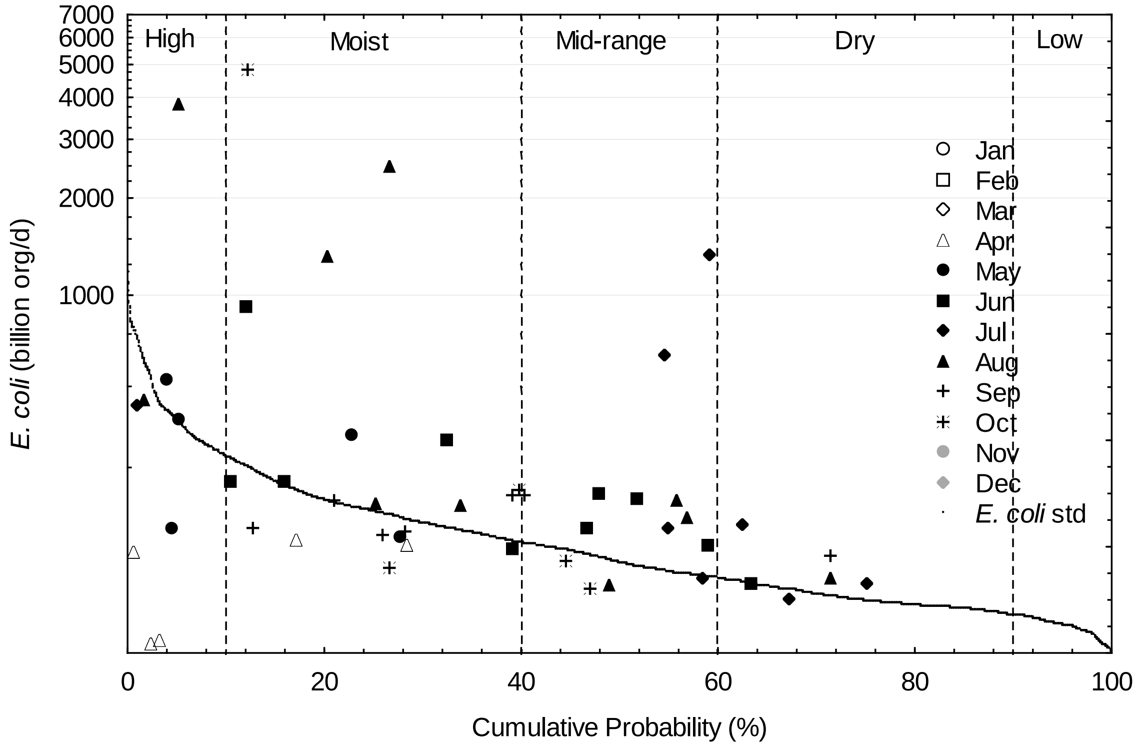


Figure 6-10. Load duration curve for *E. coli* at Watab River (07010201-528).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.8 TMDL Reach 07010201-529: Watab River, North Fork (Headwaters (Stump Lk 73-0091-00) to S Fk Watab R)

Watab River, North Fork (AUID 07010201-528) is a tributary of the Watab River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

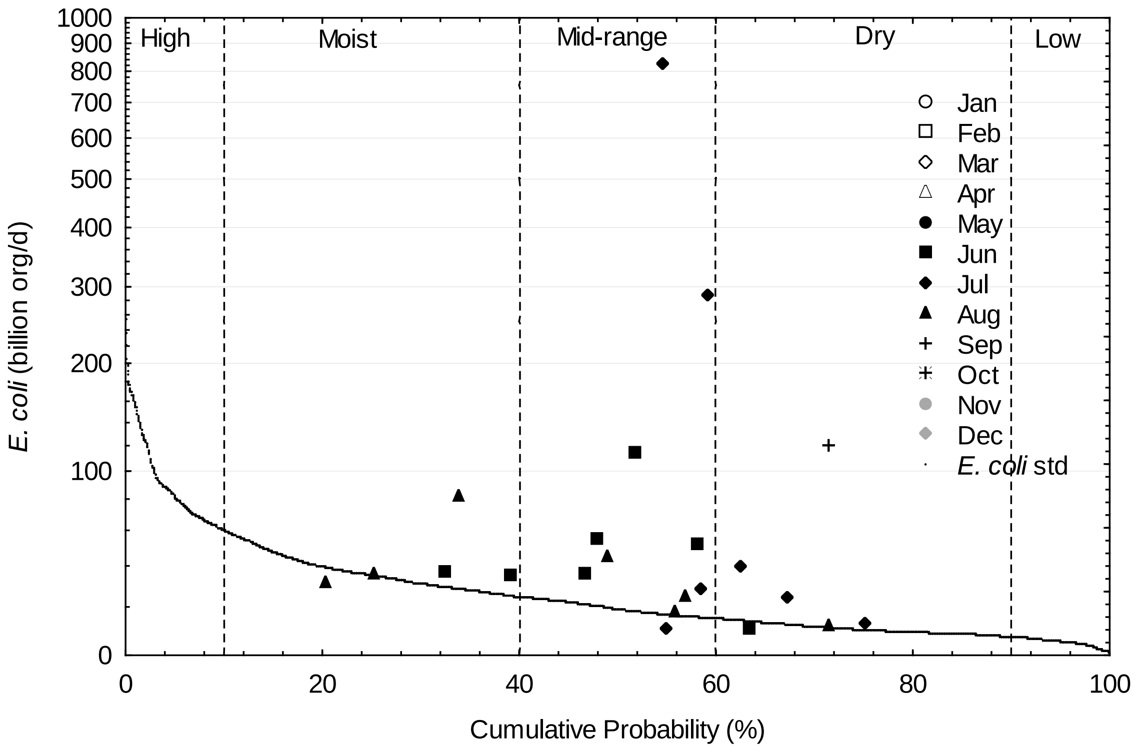


Figure 6-11. Load duration curve for *E. coli* at Watab River, North Fork (07010201-529). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.9 TMDL Reach 07010201-537: County Ditch 12 (Unnamed cr to Watab R)

County Ditch 12 (AUID 07010201-537) is a tributary of the Watab River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

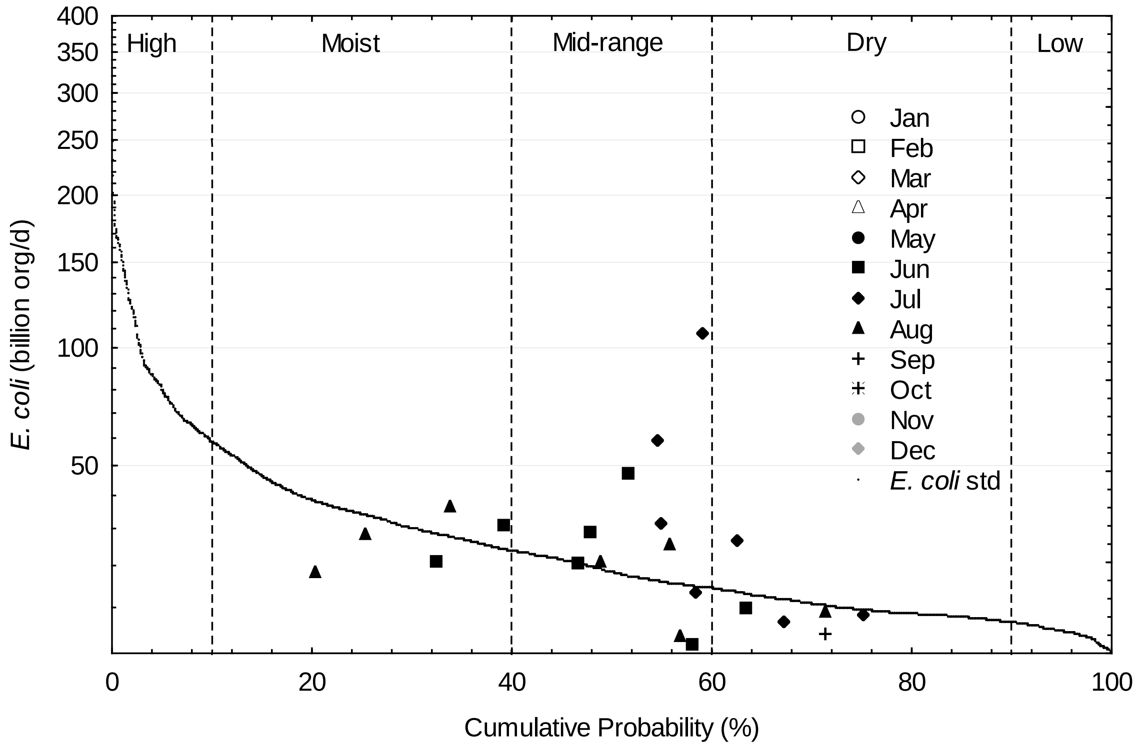


Figure 6-12. Load duration curve for *E. coli* at County Ditch 12 (07010201-537).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.10 TMDL Reach 07010201-543: South Two River (Two River Lk to Two R)

South Two River (AUID 07010201-543) is a tributary of Two River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

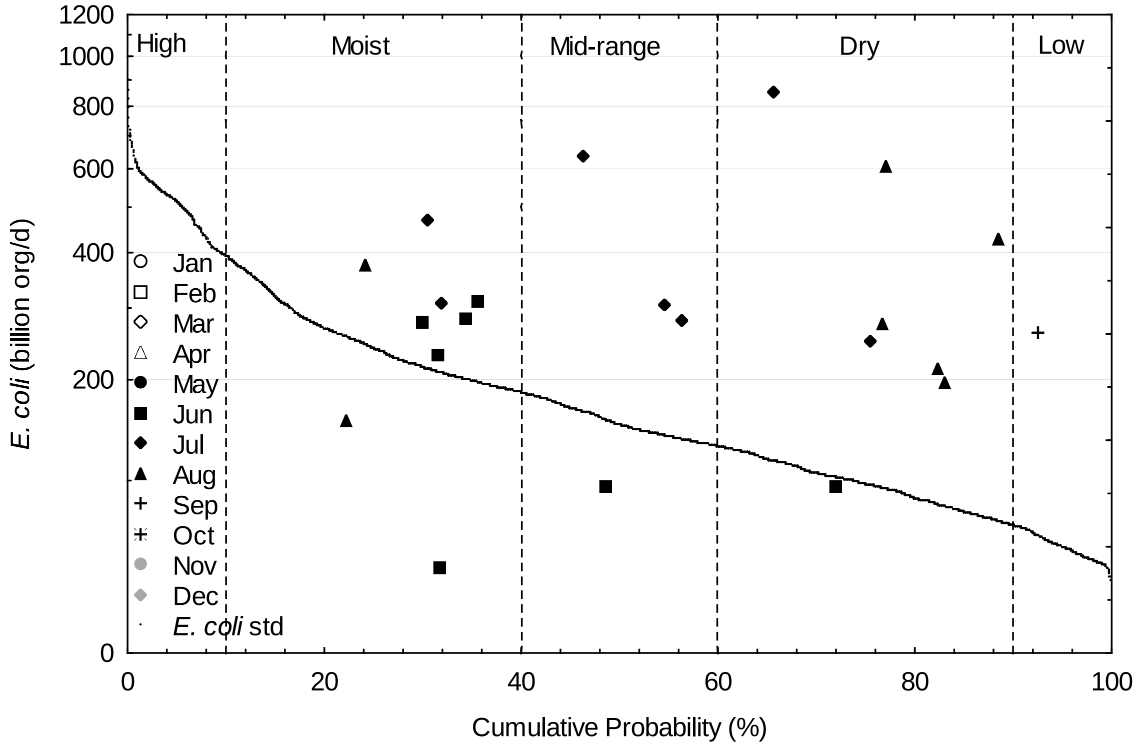


Figure 6-13. Load duration curve for *E. coli* at South Two River (07010201-543).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.11 Protection Reach 07010201-545: Platte River (Unnamed cr (above RR bridge) to Mississippi R)

The Platte River (AUID 07010201-545) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*.

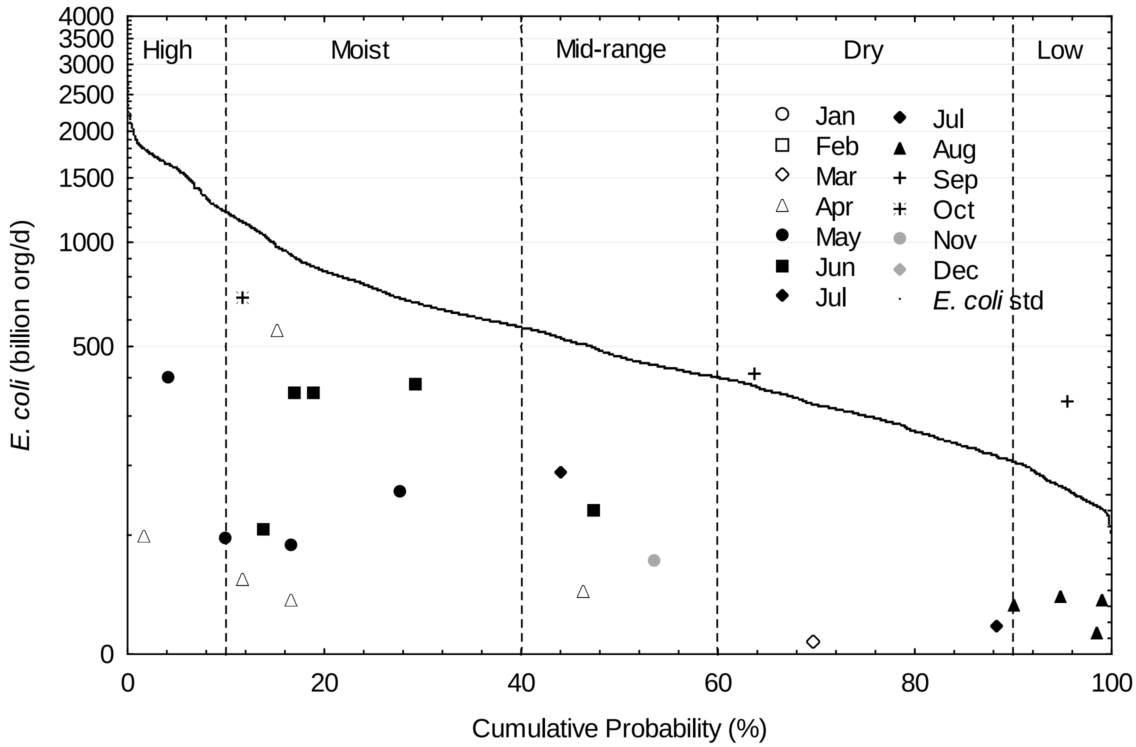


Figure 6-14. Load duration curve for *E. coli* at Platte River (07010201-545).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.12 TMDL Reach 07010201-554: Watab River, South Fork (Little Watab Lk to Watab R)

Watab River, South Fork (AUID 07010201-554) is a tributary of the Watab River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

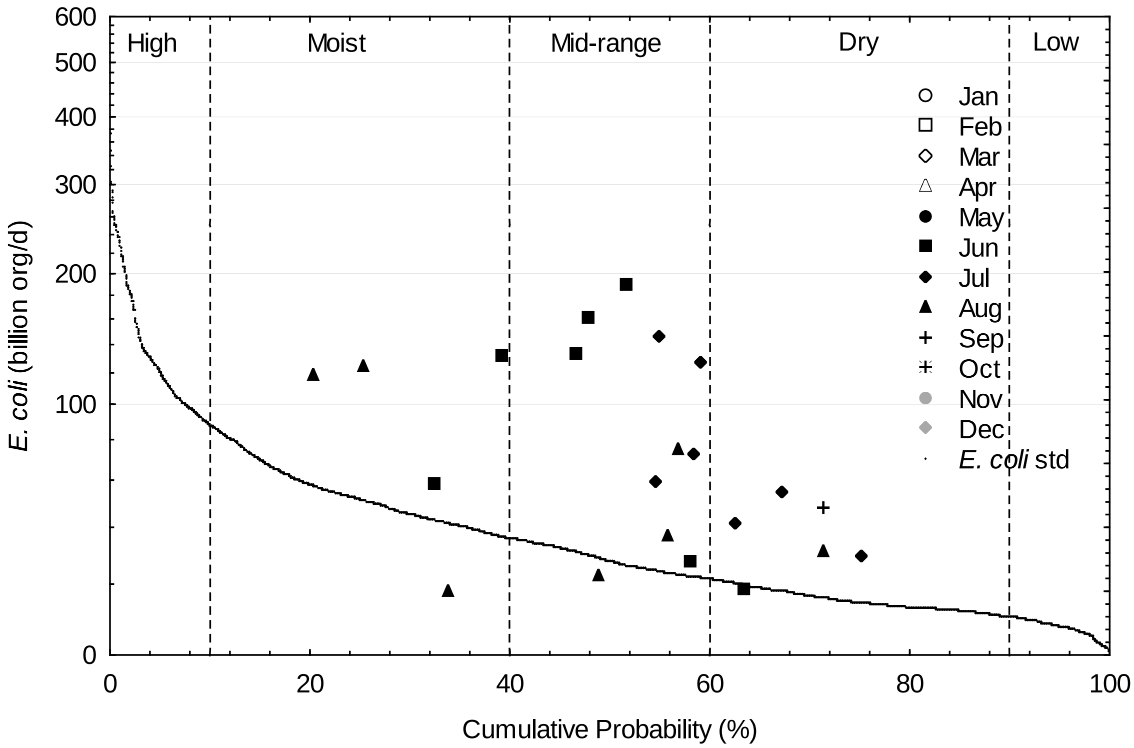


Figure 6-15. Load duration curve for *E. coli* at Watab River, South Fork (07010201-554). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.13 TMDL Reach 07010201-564: County Ditch 13 (Bakers Lk to Watab R)

County Ditch 13 (AUID 07010201-564) is a tributary of the Watab River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

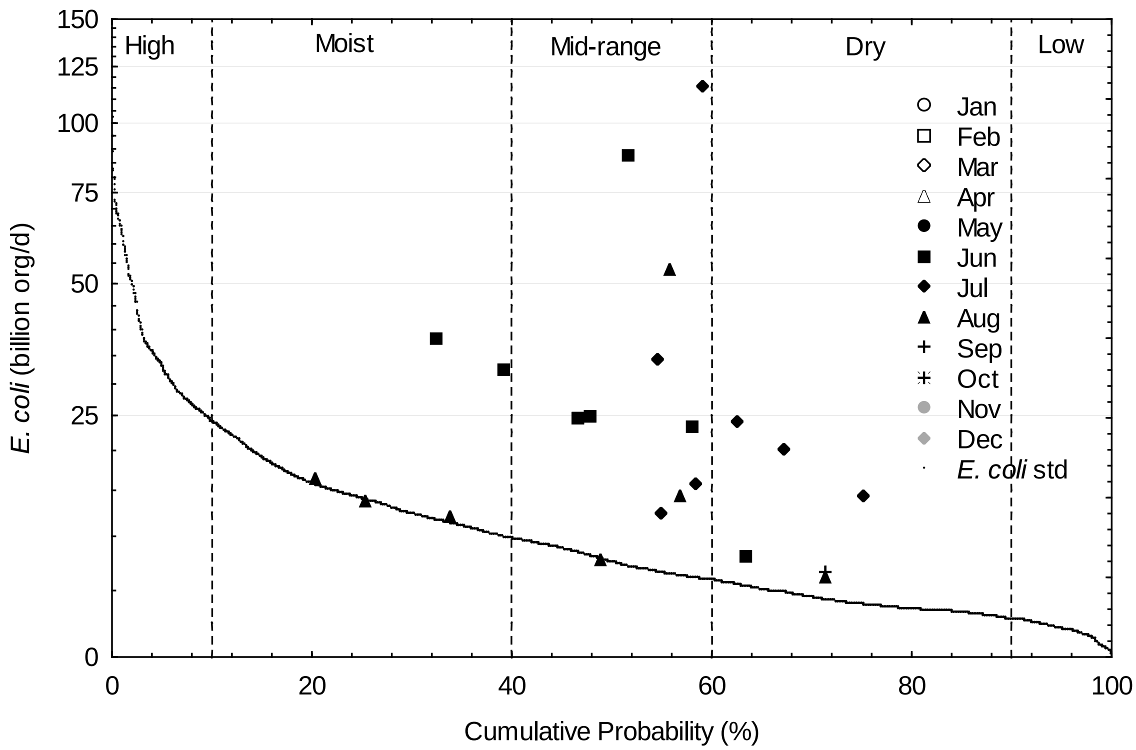


Figure 6-16. Load duration curve for *E. coli* at County Ditch 13 (07010201-564).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.14 Protection Reach 07010201-577: Little Rock Creek (Little Rock Lk to Mississippi R)

This reach of Little Rock Creek (AUID 07010201-577) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

6.1.15 Protection Reach 07010201-607: Mississippi River (Morrison/Stearns County border to Little Rock Cr) US ACE River Mile 937-947

This reach of the Mississippi River (AUID 07010201-607) is the downstream reach of the Protection Subwatershed with the same identification number. However, this reach does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

6.1.16 Protection Reach 07010201-615: Stony Creek (Headwaters to Mississippi R)

Stony Creek (AUID 07010201-615) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Refer to Section 2.2.1 for an explanation of water quality standards and associated data requirements for assessment.

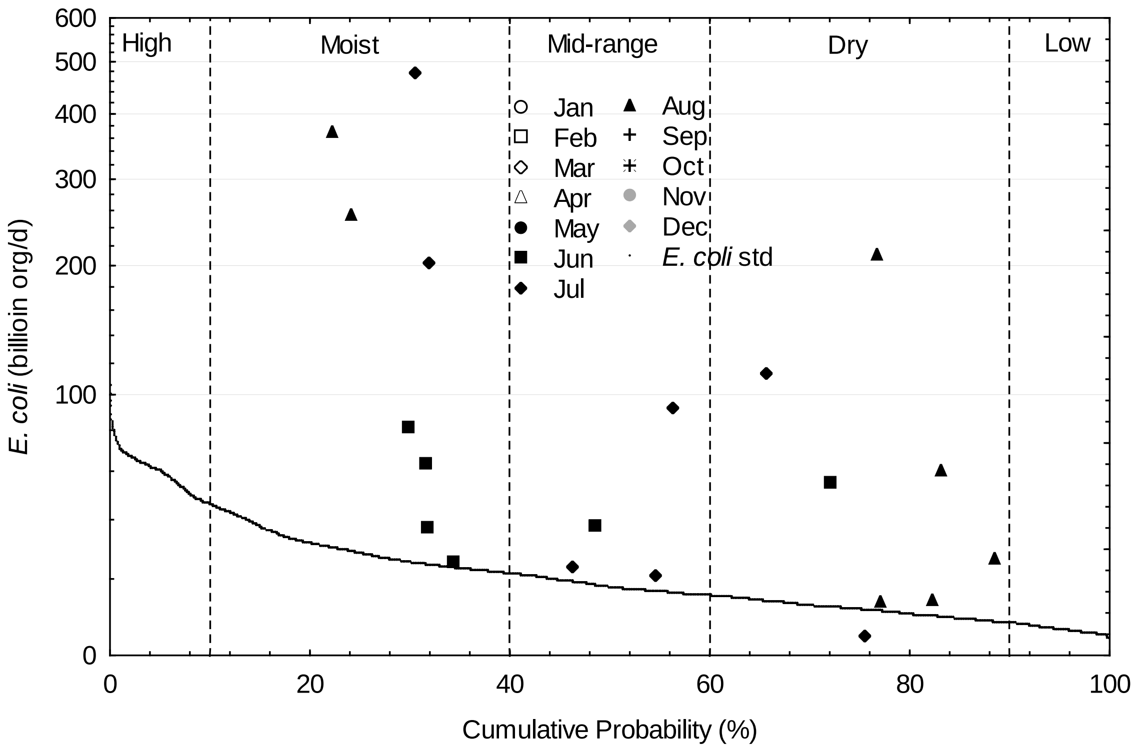


Figure 6-17. Load duration curve for *E. coli* at Stony Creek (07010201-615).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.1.17 Protection Reach 07010202-501: Sauk River (Mill Cr to Mississippi R)

The Sauk River (AUID 07010202-501) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

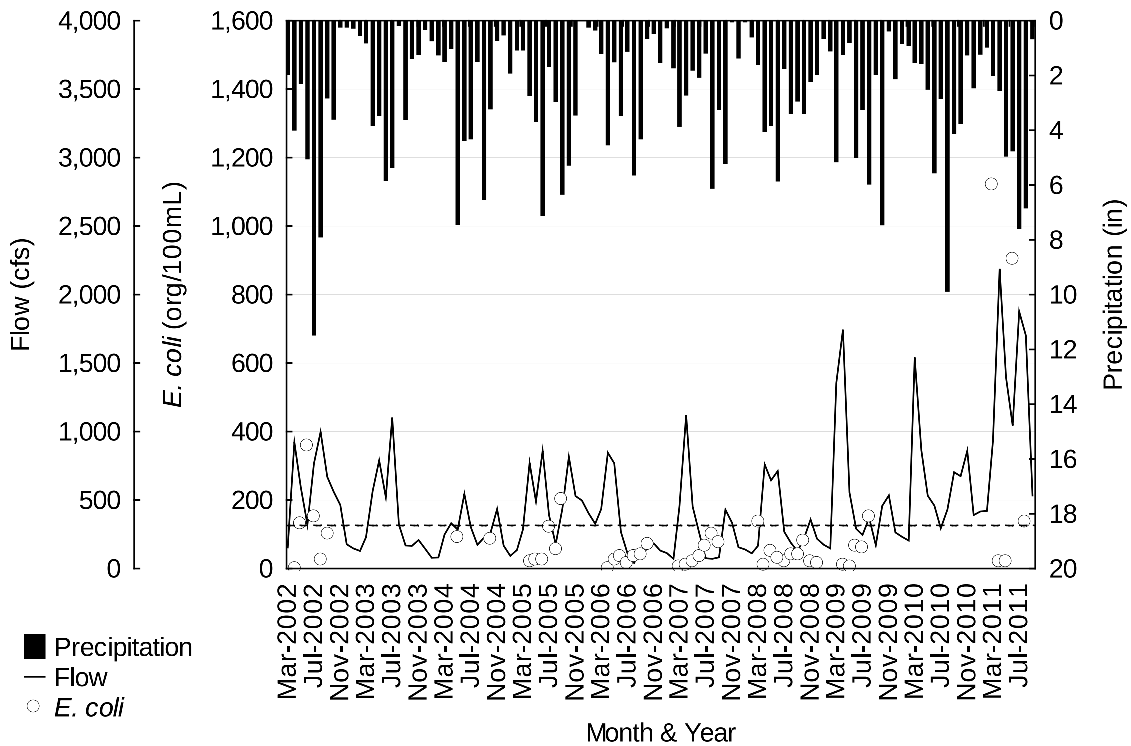


Figure 6-18. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Sauk River (07010202-501) from 2002-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

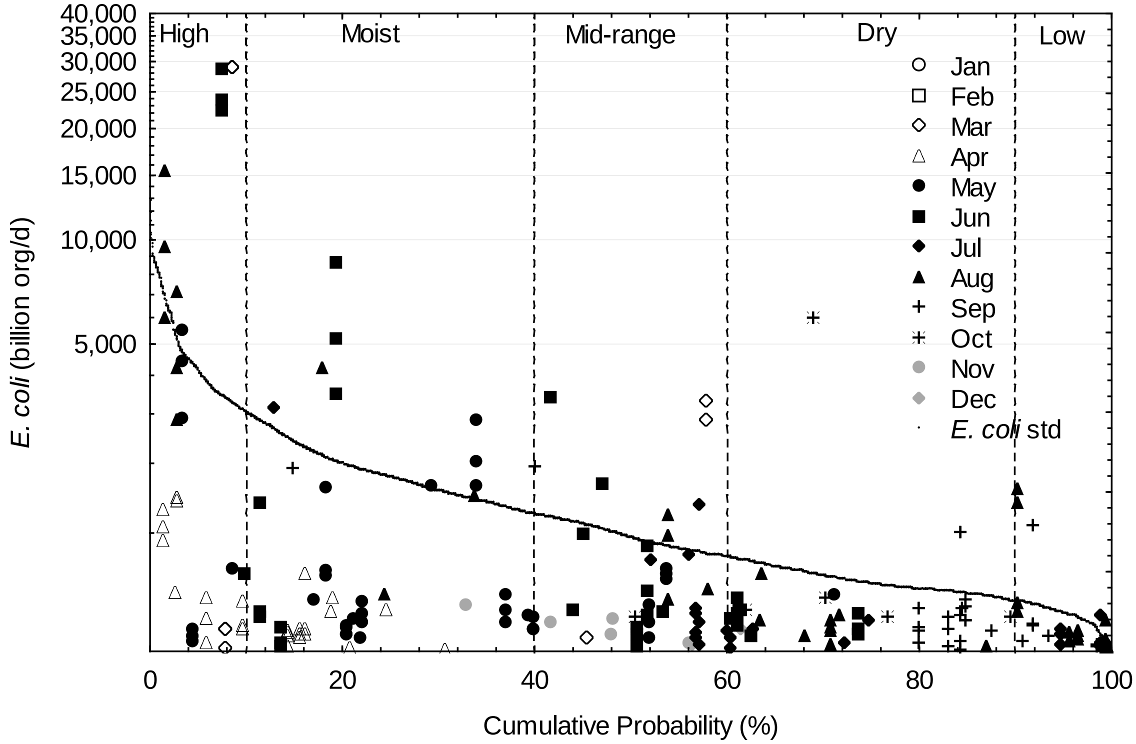


Figure 6-19. Load duration curve for *E. coli* at Sauk River (07010202-501).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2 Mississippi River – St. Cloud Watershed (HUC 07010203)

6.2.1 Protection Reach 07010203-503: Mississippi River (Elk R to Crow R) US ACE River Mile 879.5-884.5

This reach of the Mississippi River (AUID 07010203-503) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

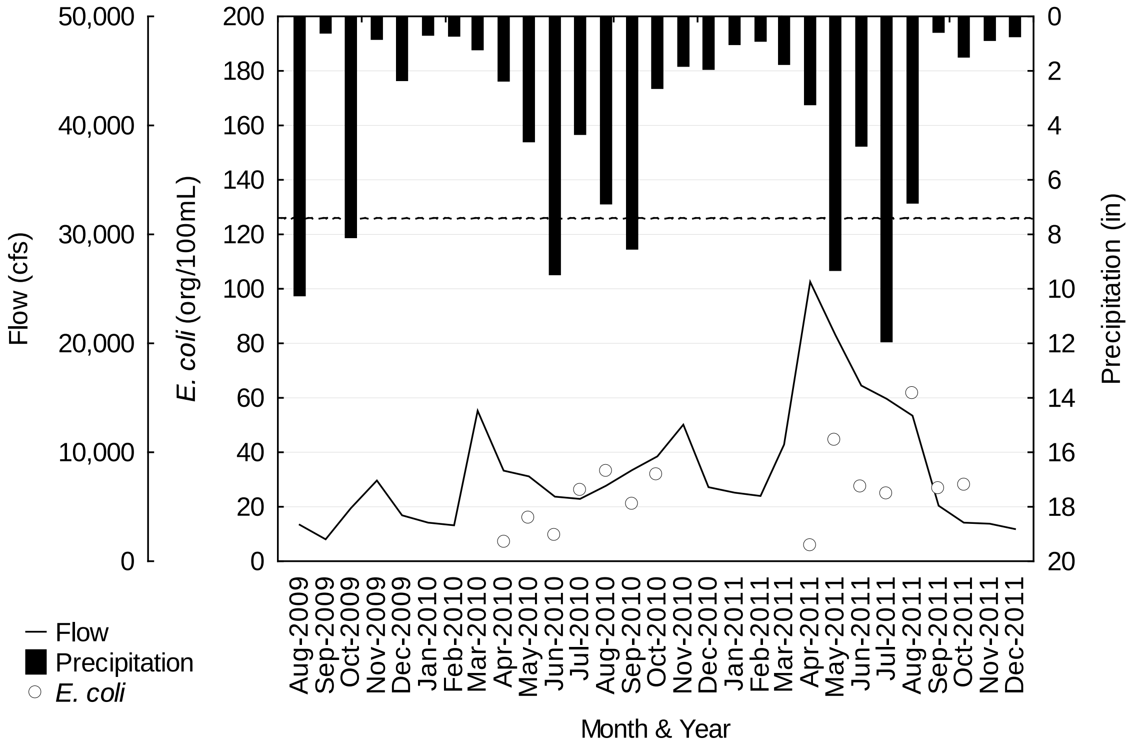


Figure 6-20. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010203-503) from 2009-2011.
Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

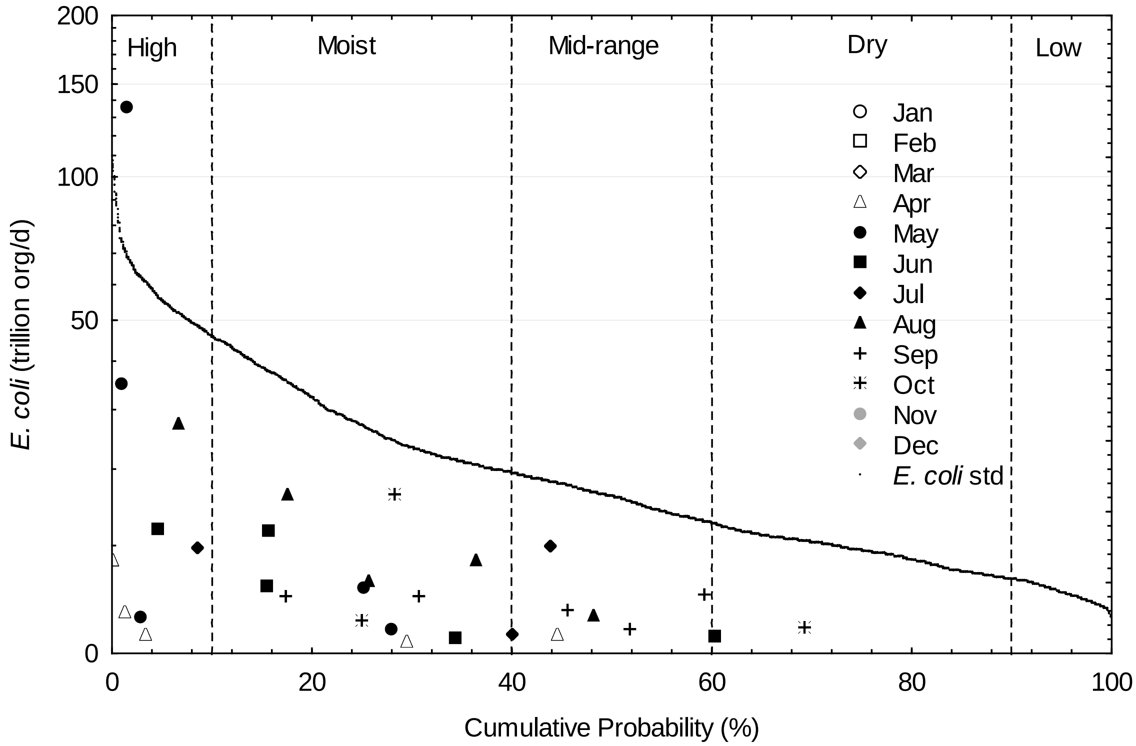


Figure 6-21. Load duration curve for *E. coli* at Mississippi River (07010203-503).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.2 Protection Reach 07010203-510: Mississippi River (Clearwater R to Elk R) US ACE River Mile 884-914

This reach of the Mississippi River (AUID 07010203-510) is impaired for aquatic recreation due to fecal coliform. Only *E. coli* data were analyzed. The TMDL for this reach is being deferred (refer to Section 2.6.1).

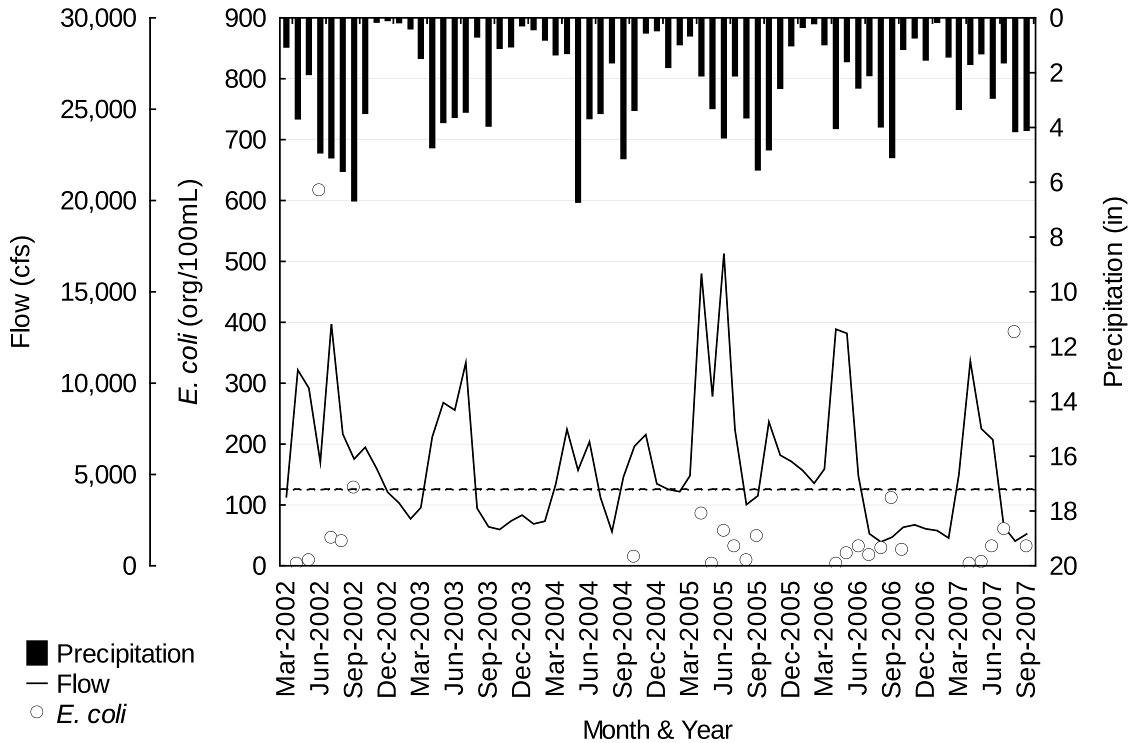


Figure 6-22. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010203-510) from 2002-2007.
Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

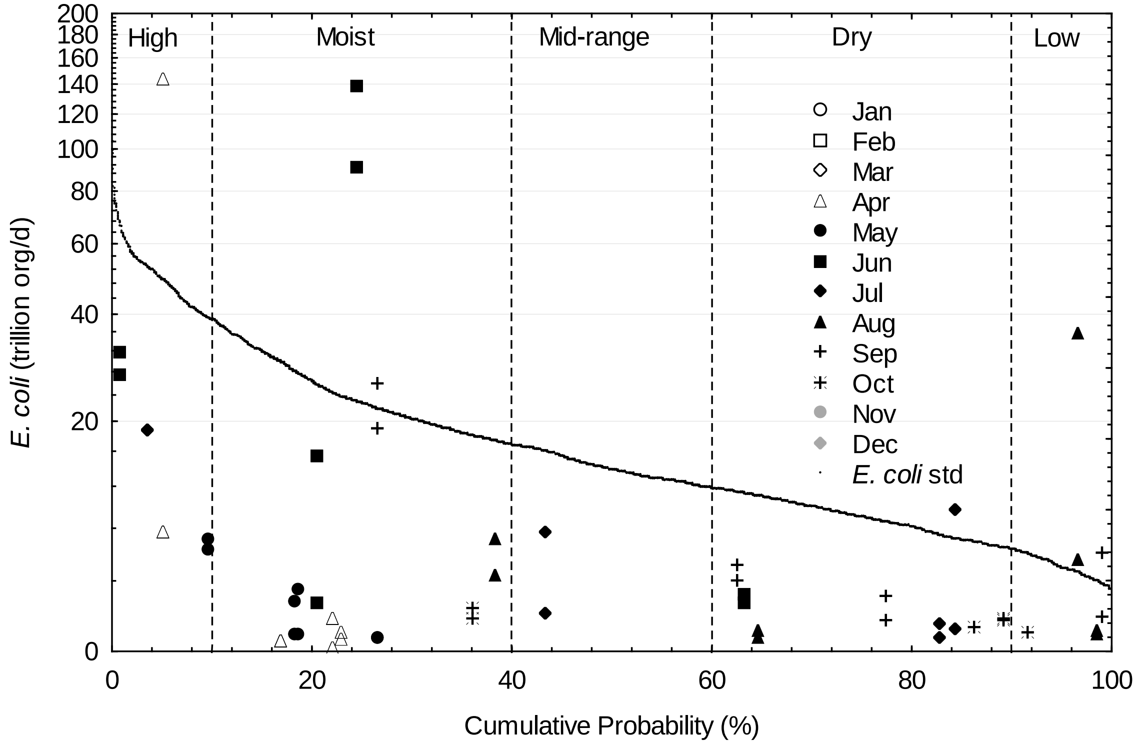


Figure 6-23. Load duration curve for *E. coli* at Mississippi River (07010203-510).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.3 Protection Reach 07010203-511: Clearwater River (Clearwater Lk to Mississippi R)

The Clearwater River (AUID 07010203-511) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

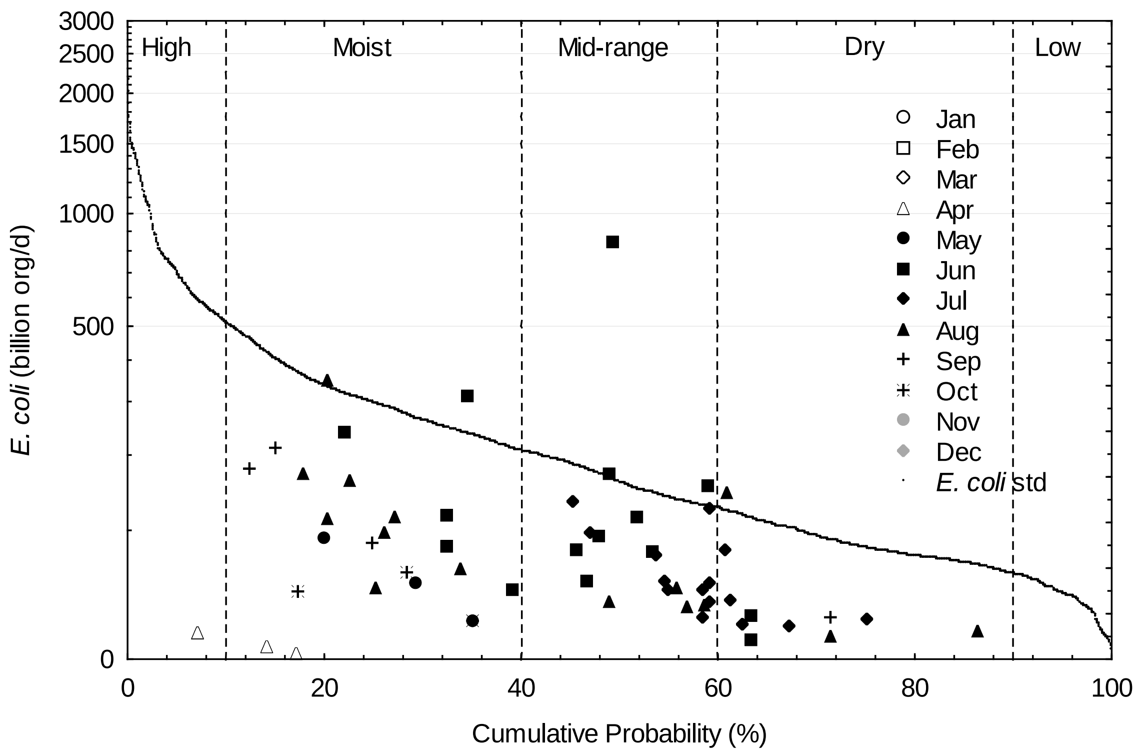


Figure 6-24. Load duration curve for *E. coli* at Clearwater River (07010203-511).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.4 Protection Reach 07010203-525: Elk River (Orono Lk to Mississippi R)

This reach of Elk River (AUID 07010203-525) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

6.2.5 TMDL Reach 07010203-528: Unnamed creek (T121 R23W S19, south line to Mississippi R)

Unnamed creek (AUID 07010203-528) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

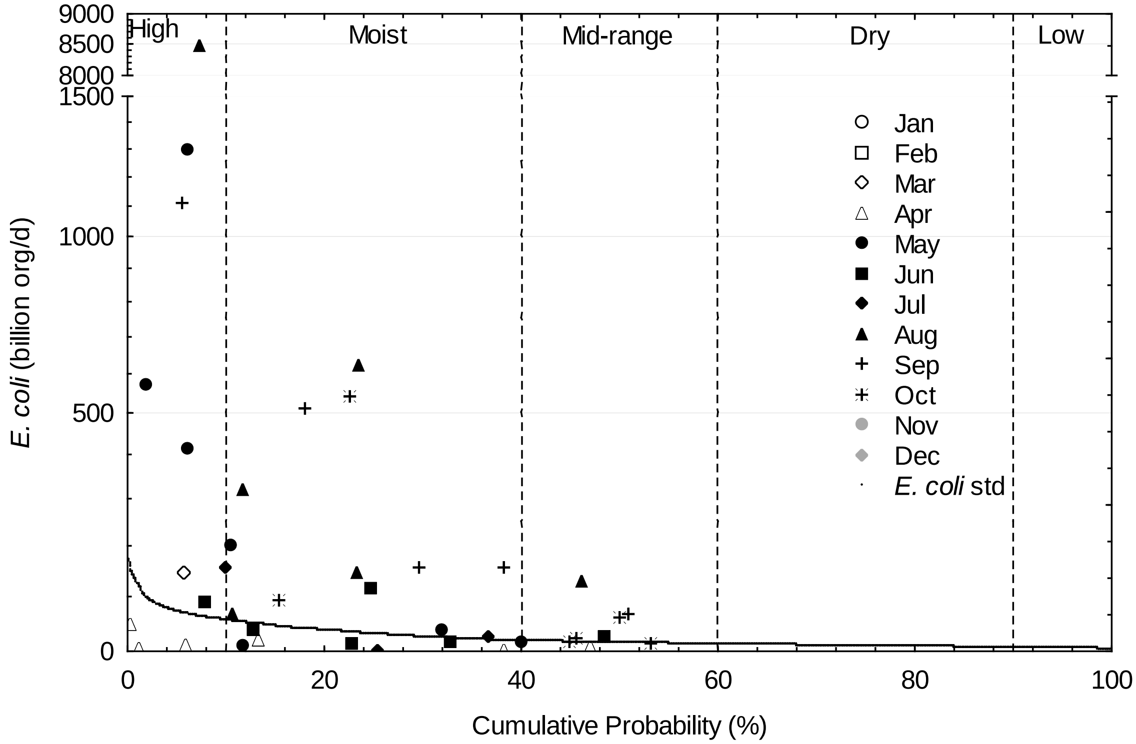


Figure 6-25. Load duration curve for *E. coli* at Unnamed creek (07010203-528).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.6 TMDL Reach 07010203-557: Silver Creek (Locke Lk to Mississippi R)

Silver Creek (AUID 07010203-557) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

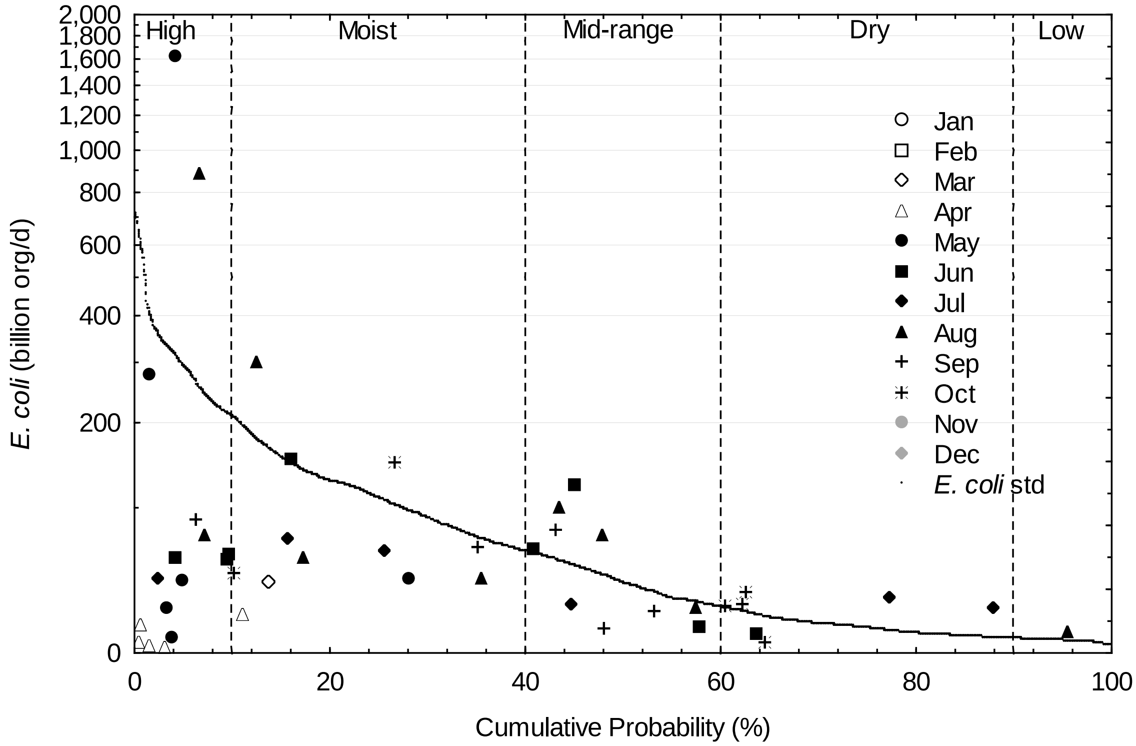


Figure 6-26. Load duration curve for *E. coli* at Silver Creek (07010203-557).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.7 TMDL Reach 07010203-561: Unnamed creek (Luxemburg Creek) (T123 R28W S30, south line to Johnson Cr)

Unnamed creek (Luxemburg Creek) (AUID 07010203-561) is a tributary of Johnson Creek and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

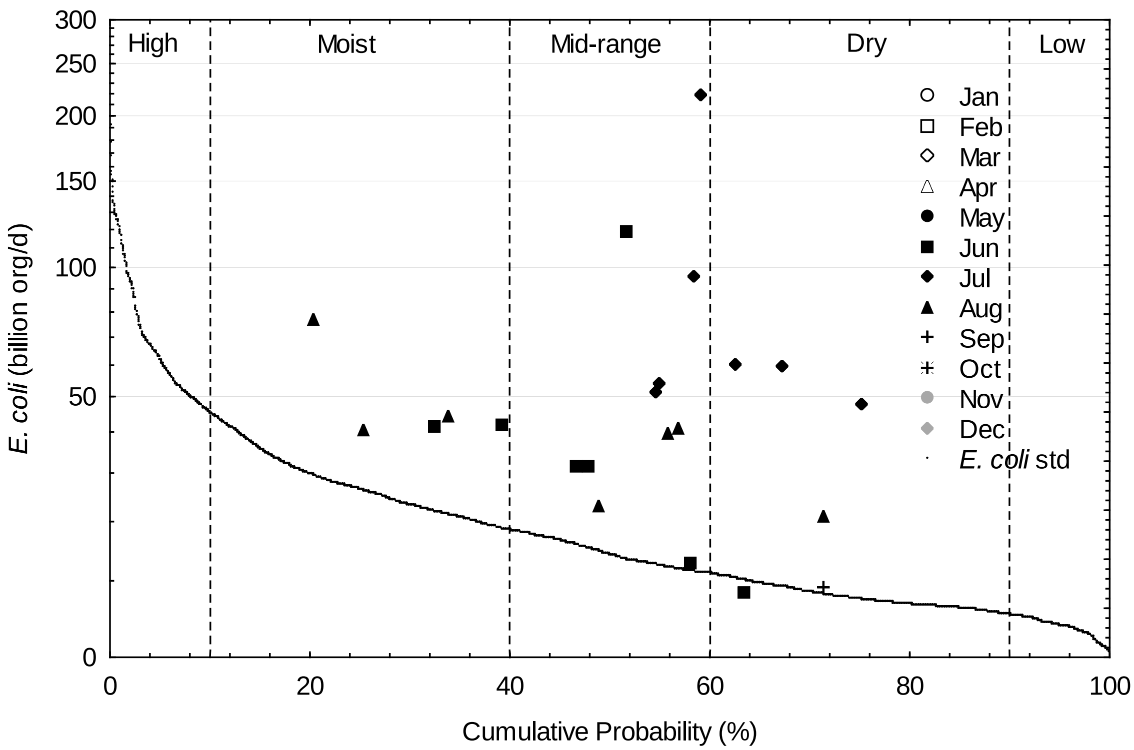


Figure 6-27. Load duration curve for *E. coli* at Unnamed creek (Luxemburg Creek) (07010203-561). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.8 TMDL Reach 07010203-572: Plum Creek (Warner Lk to Mississippi R)

Plum Creek (AUID 07010203-572) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

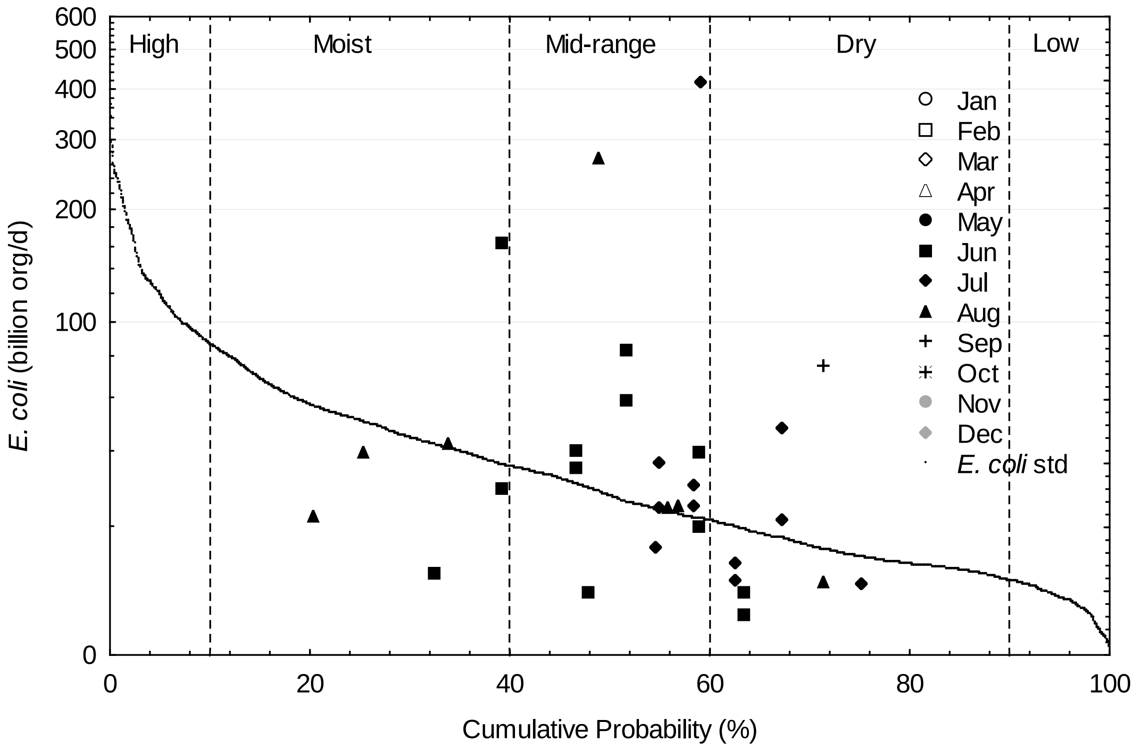


Figure 6-28. Load duration curve for *E. coli* at Plum Creek (07010203-572).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.9 Protection Reach 07010203-574: Mississippi River (Sauk River to University Dr S bridge in St. Cloud) US ACE River Mile 926.5-930

This reach of the Mississippi River (AUID 07010203-574) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

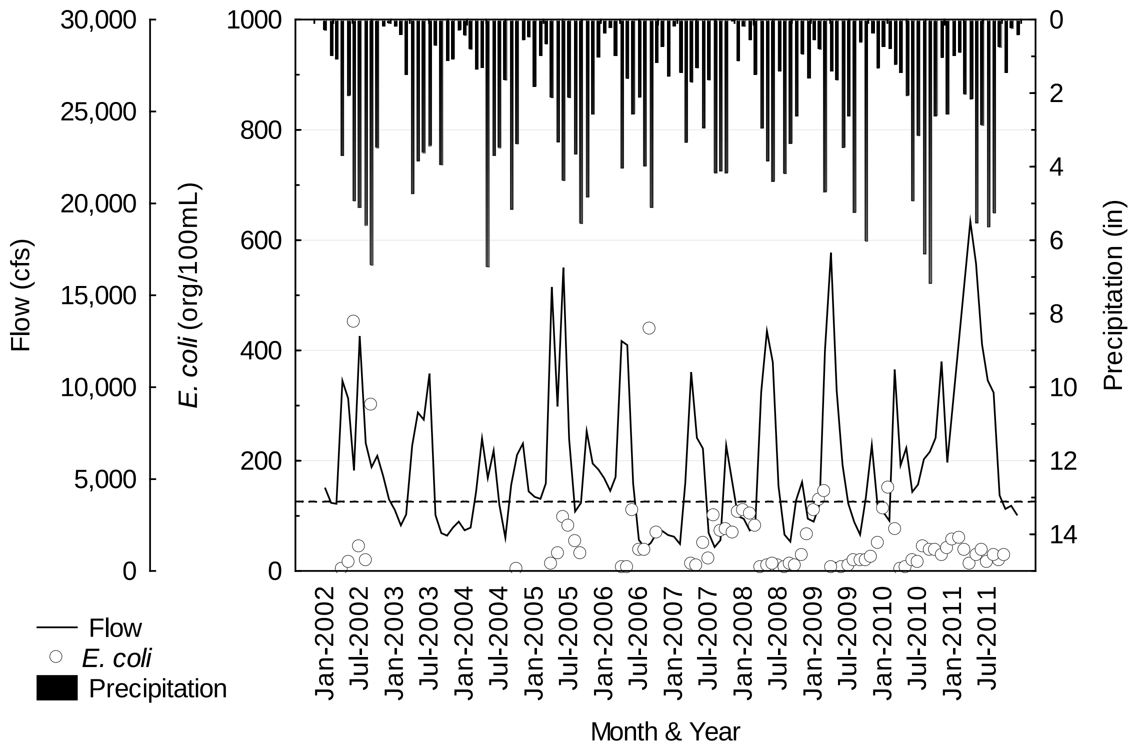


Figure 6-29. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010203-574) from 2002-2011.
Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

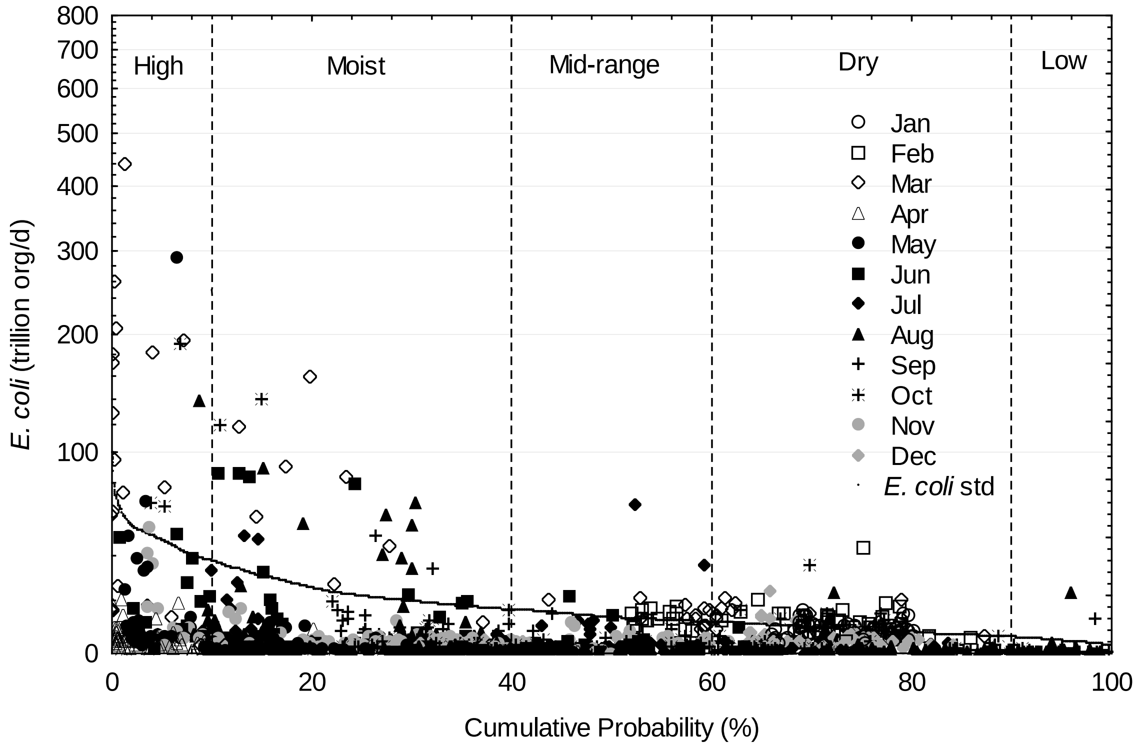


Figure 6-30. Load duration curve for *E. coli* at Mississippi River (07010203-574).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.10 TMDL Reach 07010203-635: Johnson Creek (Meyer Creek) (Unnamed cr to Unnamed cr)

Johnson Creek (AUID 07010203-635) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

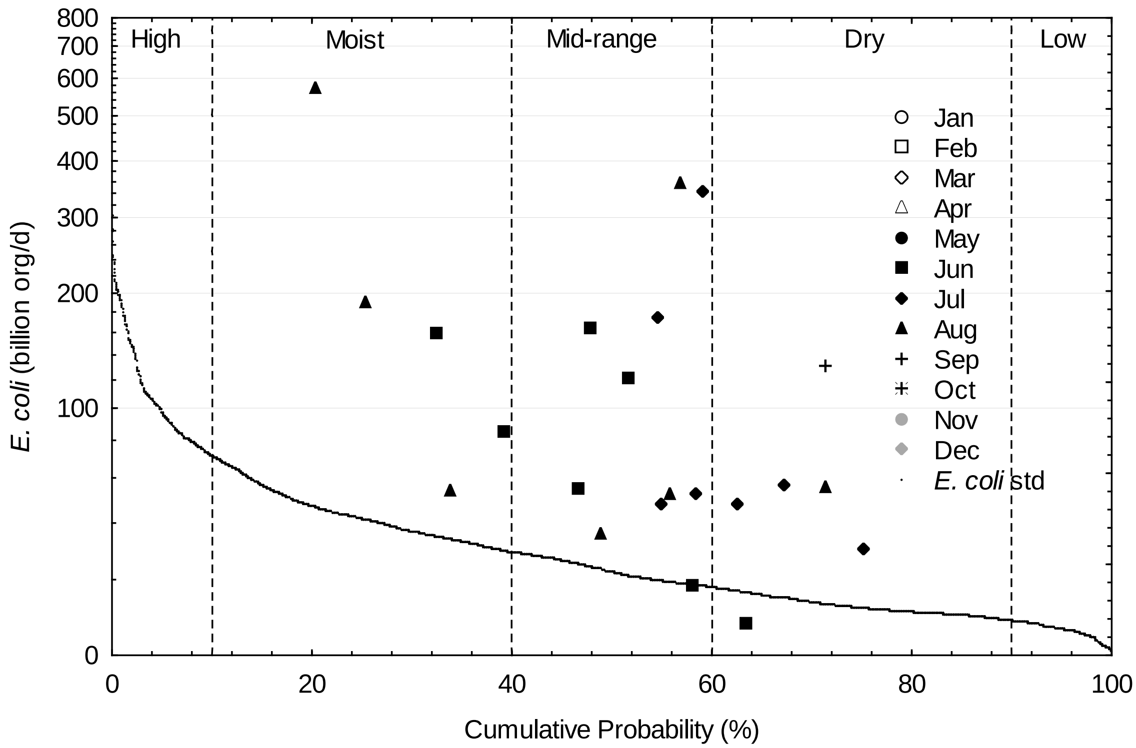


Figure 6-31. Load duration curve for *E. coli* at Johnson Creek (07010203-635).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.11 TMDL Reach 07010203-639: Johnson Creek (Meyer Creek) (T123 R28W S14, west line to Mississippi R)

Johnson Creek (AUID 07010203-639) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

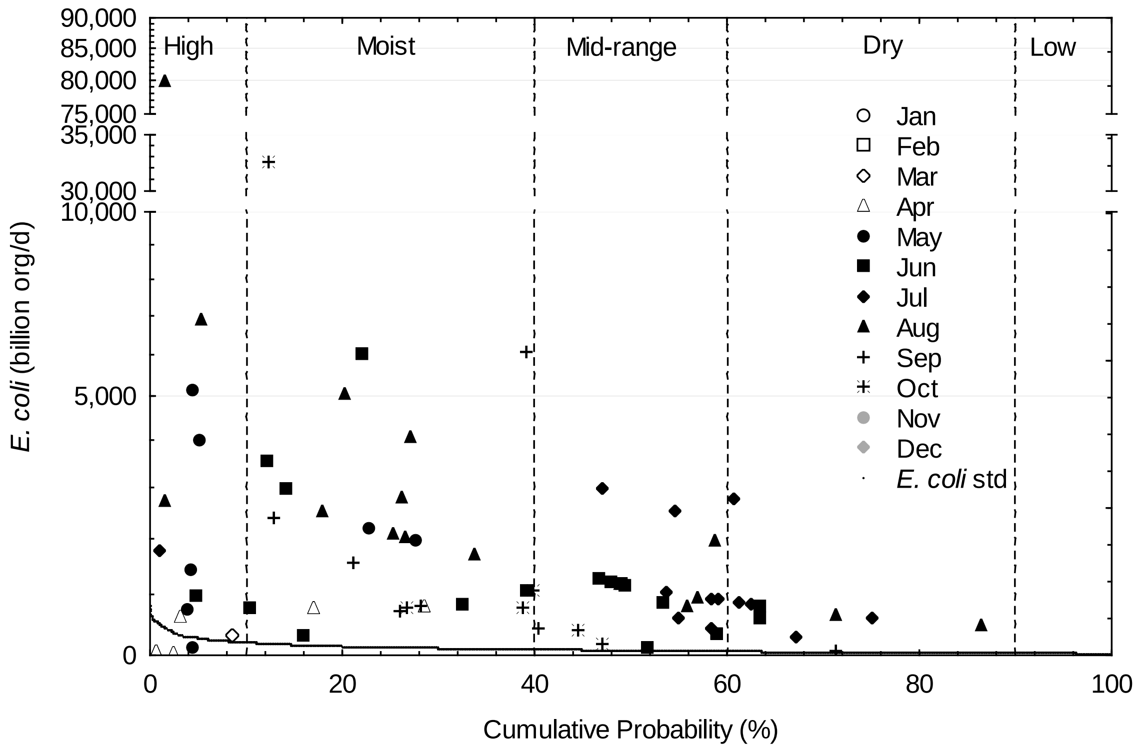


Figure 6-32. Load duration curve for *E. coli* at Johnson Creek (07010203-639).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.2.12 TMDL Reach 07010203-724: Unnamed creek (Robinson Hill Creek) (CD 14 to CSAH 136)

Unnamed creek (AUID 07010203-724) is a tributary of Johnson Creek and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

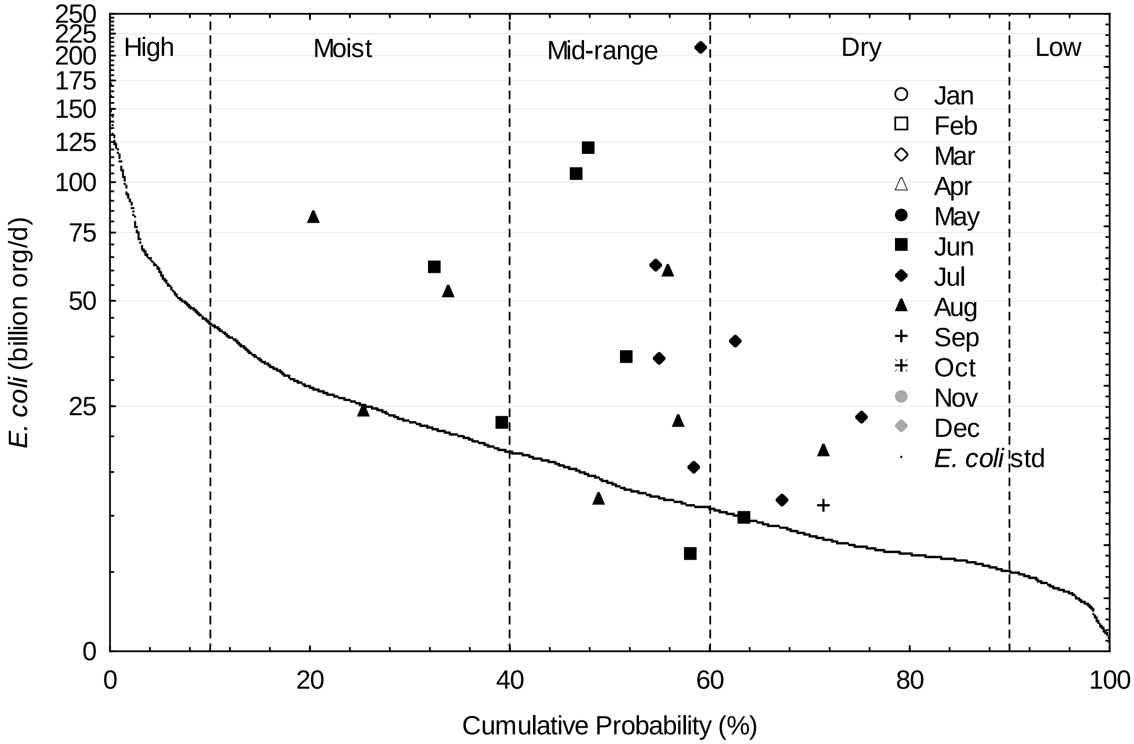


Figure 6-33. Load duration curve for *E. coli* at Unnamed creek (Robinson Hill Creek) (07010203-724).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3 Mississippi River – Twin Cities Watershed (HUC 07010206)

6.3.1 Protection Reach 07010206-501: Mississippi River (L & D #2 to St Croix R (RM 815.2 to 811.3))

This reach of the Mississippi River (AUID 07010206-501) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

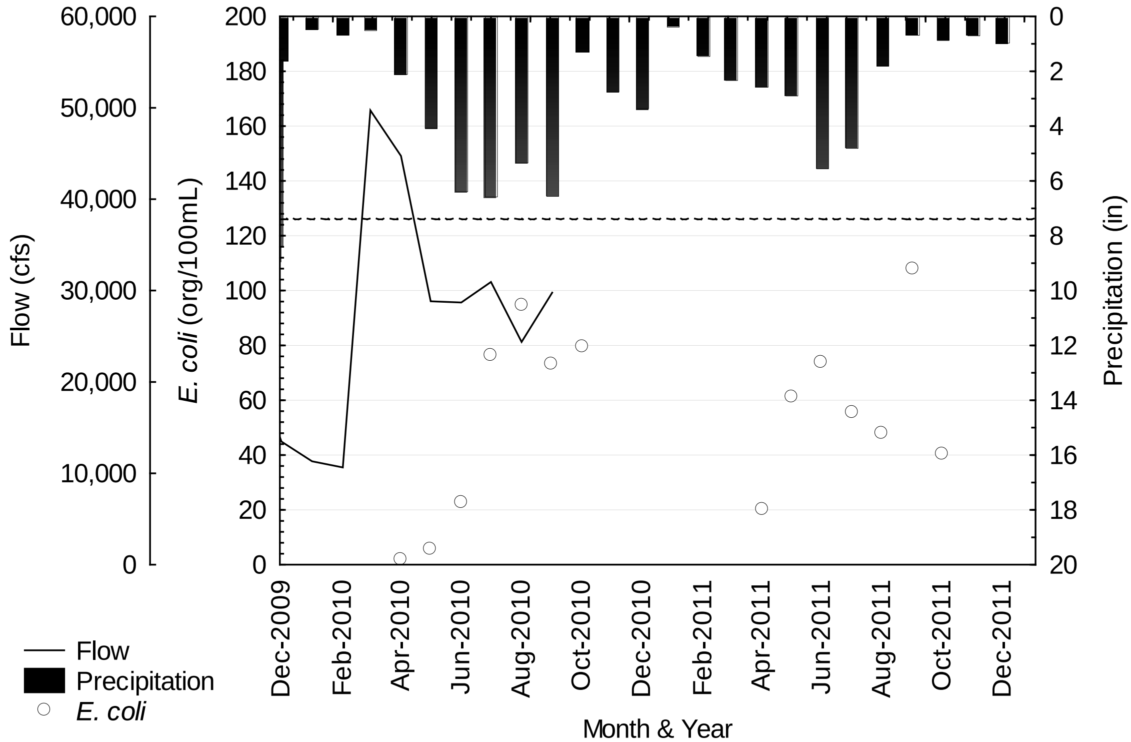


Figure 6-34. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-501) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

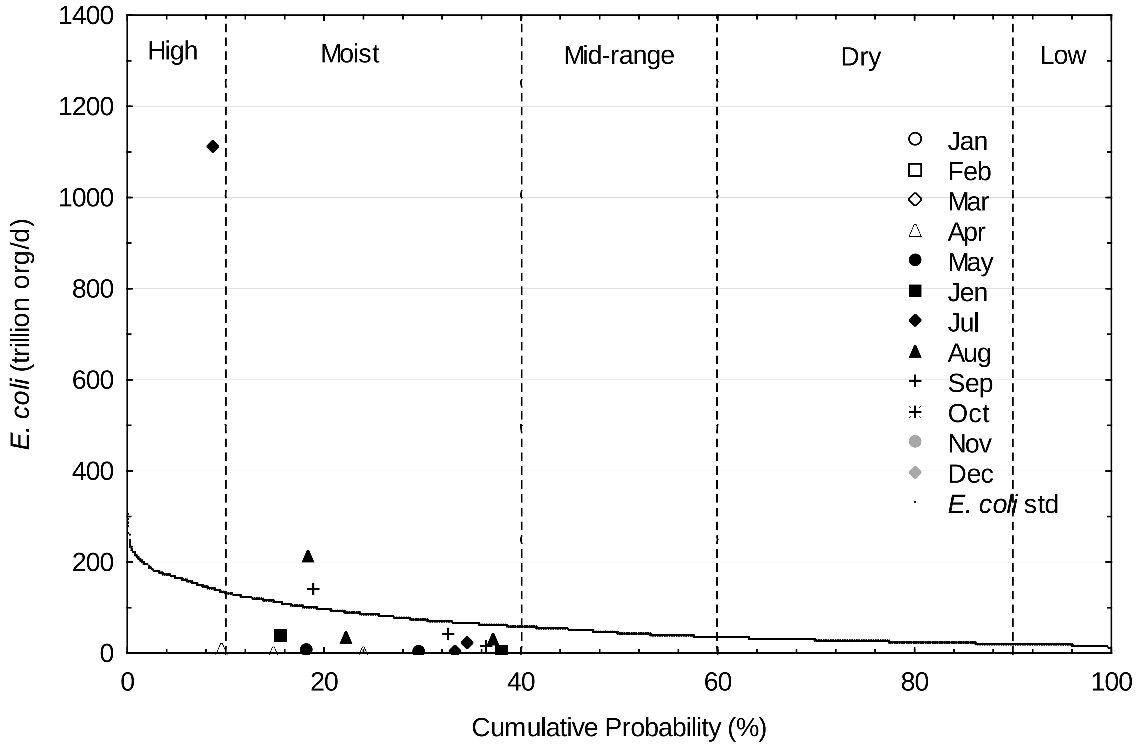


Figure 6-35. Load duration curve for *E. coli* at Mississippi River (07010206-501).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.2 Protection Reach 07010206-502: Mississippi River (Rock Island RR bridge to L & D #2 (RM 830 to 815.2))

This reach of the Mississippi River (AUID 07010206-502) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

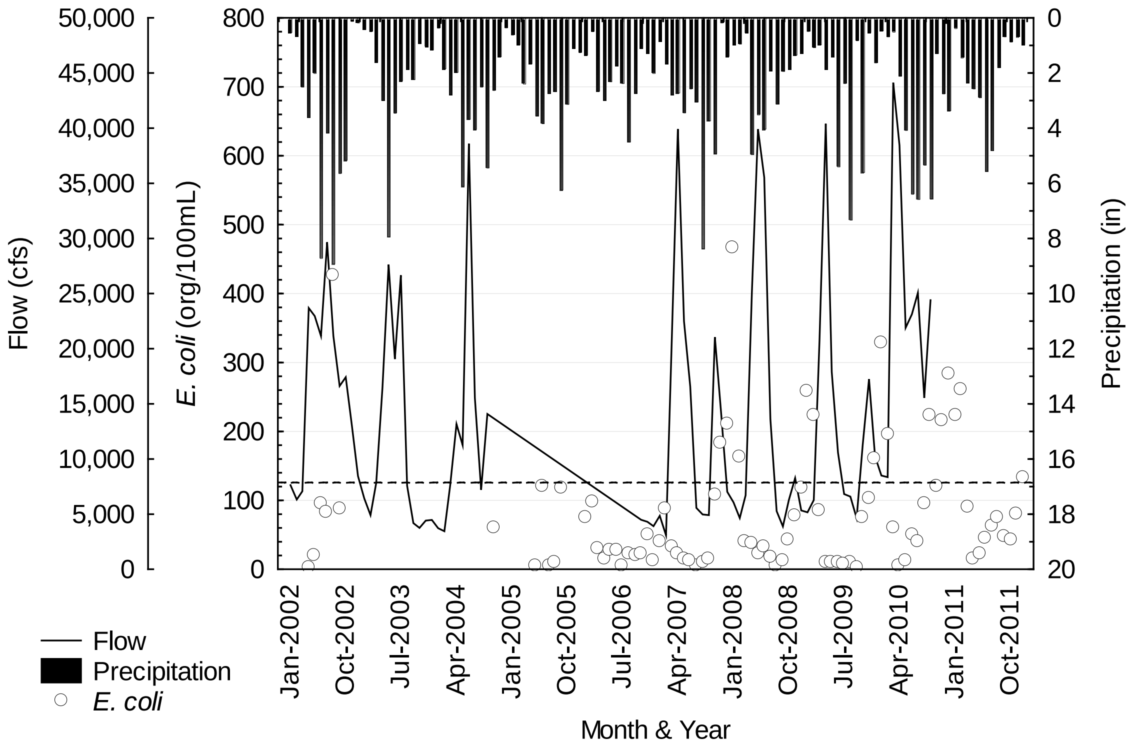


Figure 6-36. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-502) from 2002-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

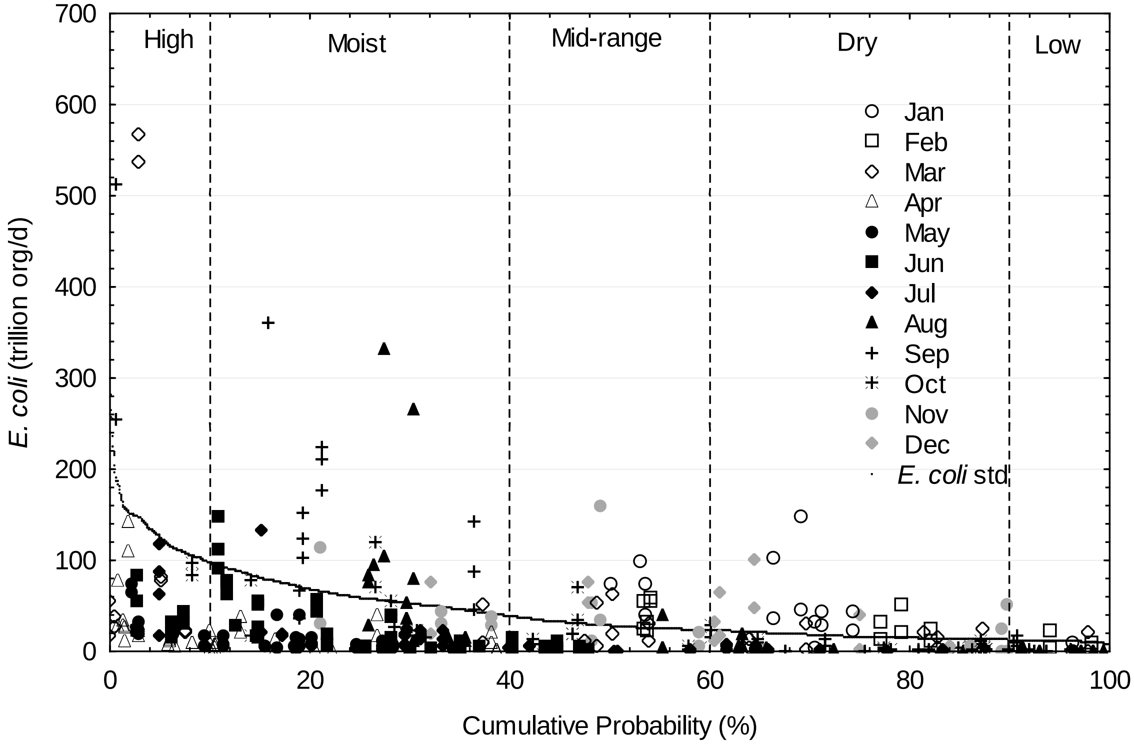


Figure 6-37. Load duration curve for *E. coli* at Mississippi River (07010206-502).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.3 Protection Reach 07010206-503: Mississippi River (Lower St Anthony Falls to L & D #1 (RM 853.3 to RM 847.6))

This reach of the Mississippi River (AUID 07010206-503) is impaired for aquatic recreation due to *E. coli*. The TMDL for this reach is being deferred (refer to Section 2.6.1).

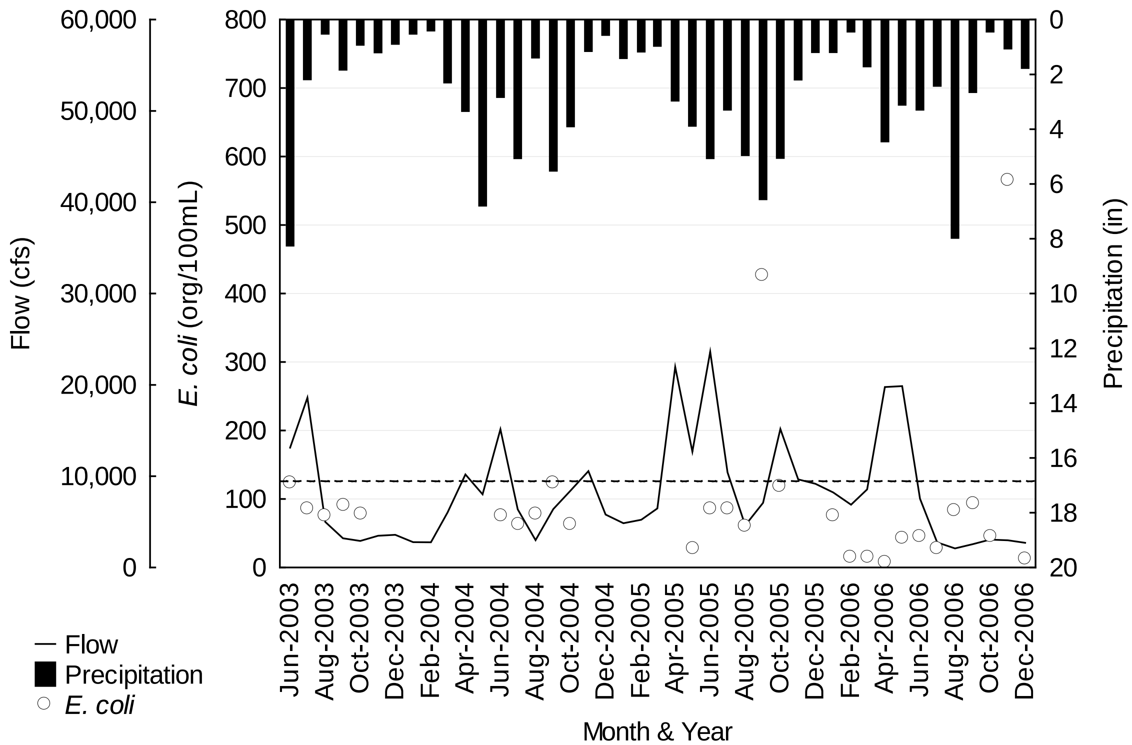


Figure 6-38. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-503) from 2003-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

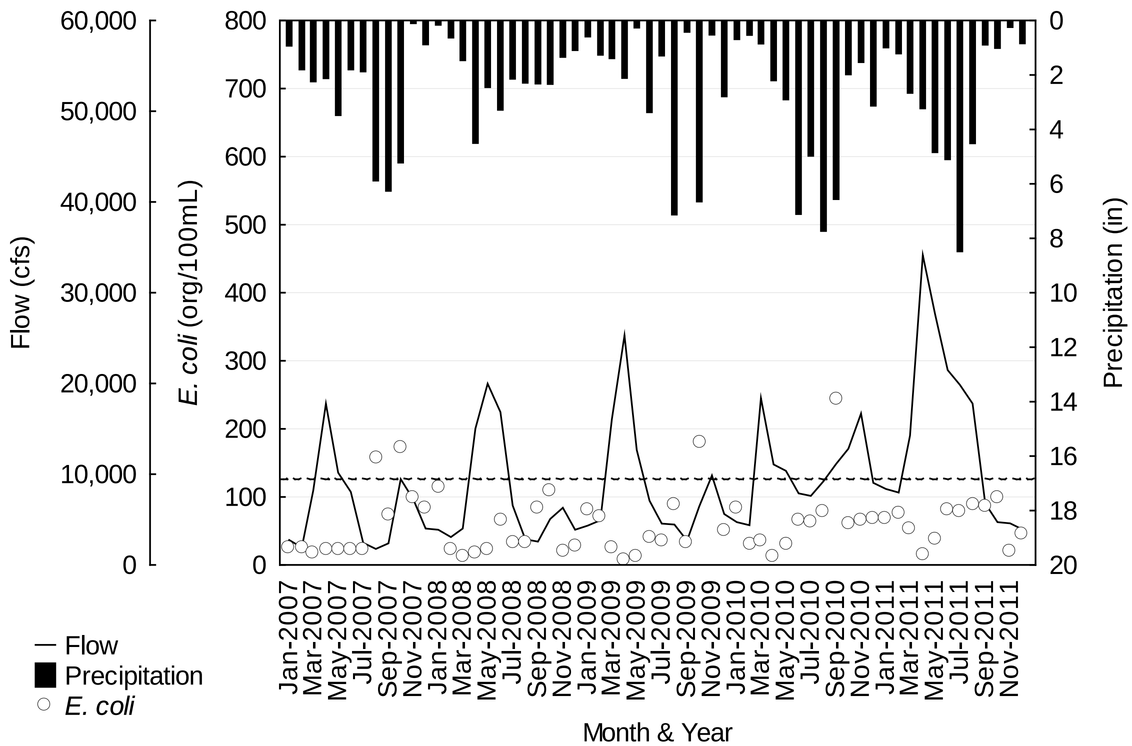


Figure 6-39. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-503) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

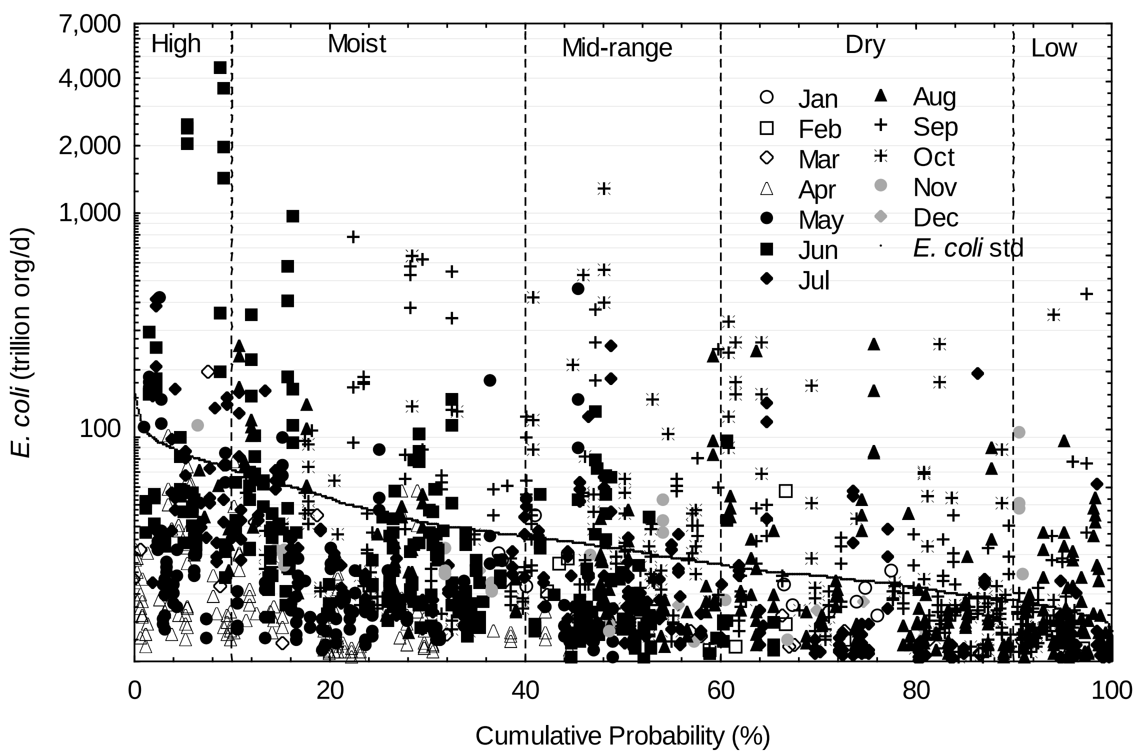


Figure 6-40. Load duration curve for *E. coli* at Mississippi River (07010206-503). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.4 Protection Reach 07010206-504: Mississippi River (Metro WWTP to Rock Island RR bridge (RM 835 to 830))

This reach of the Mississippi River (AUID 07010206-504) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

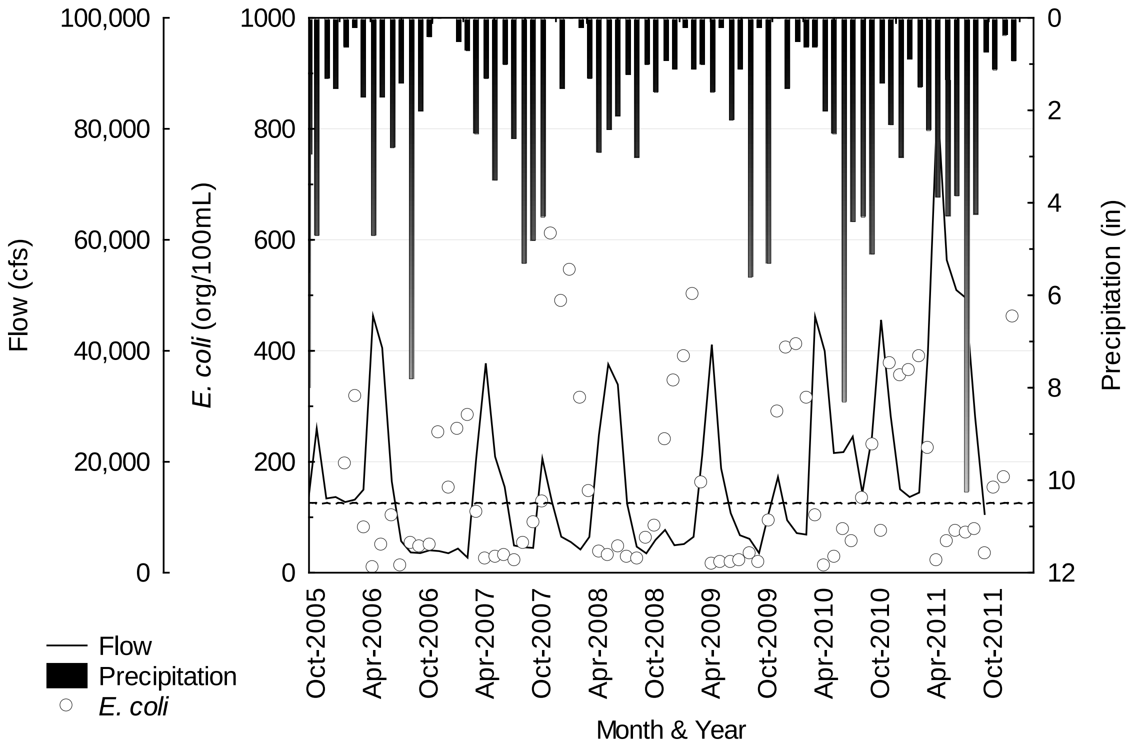


Figure 6-41. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-504) from 2006-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

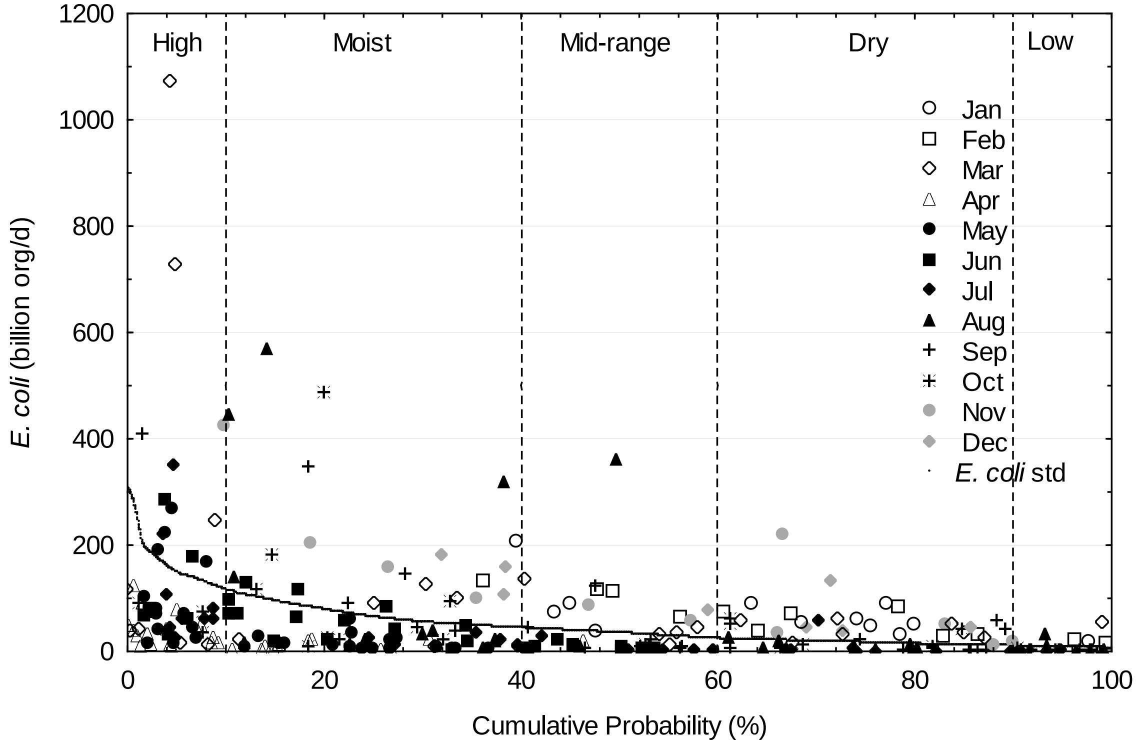


Figure 6-42. Load duration curve for *E. coli* at Mississippi River (07010206-504).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.5 Protection Reach 07010206-505: Mississippi River (Minnesota R to Metro WWTP (RM 844 to 835))

This reach of the Mississippi River (AUID 07010206-505) is impaired for aquatic recreation due to *E. coli*. The TMDL for this reach is being deferred (refer to Section 2.6.1).

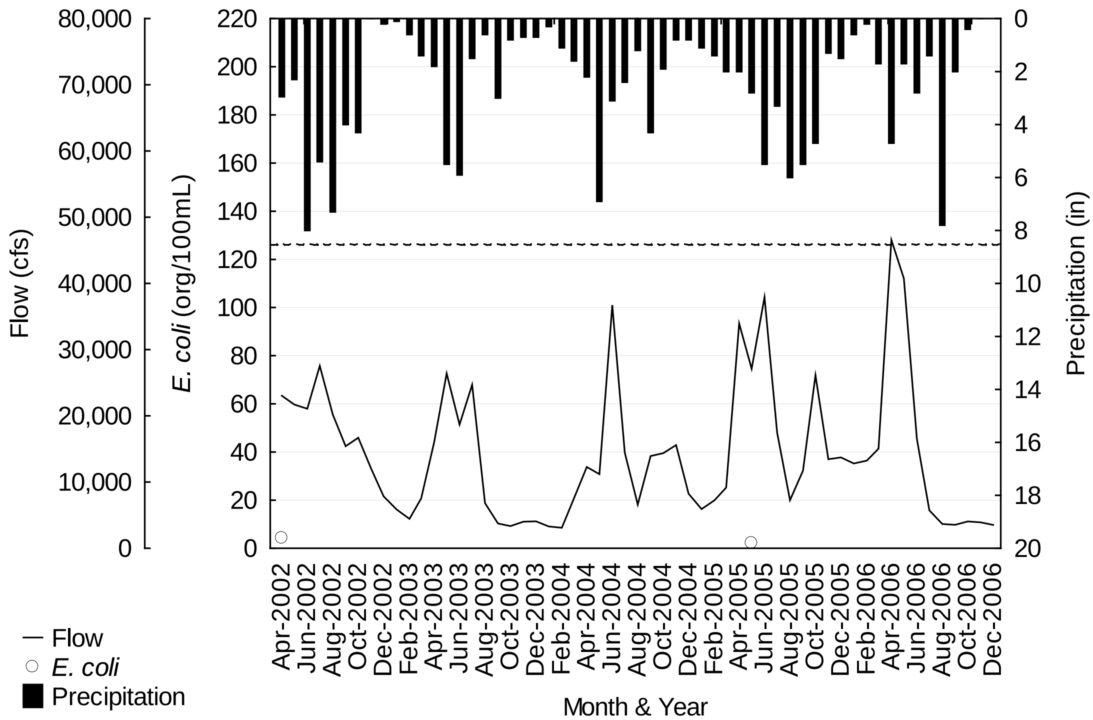


Figure 6-43. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-505) from 2002-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL). Some data is available from 2002 and 2005; however, the majority of the monthly data appear in Figure 6-44.

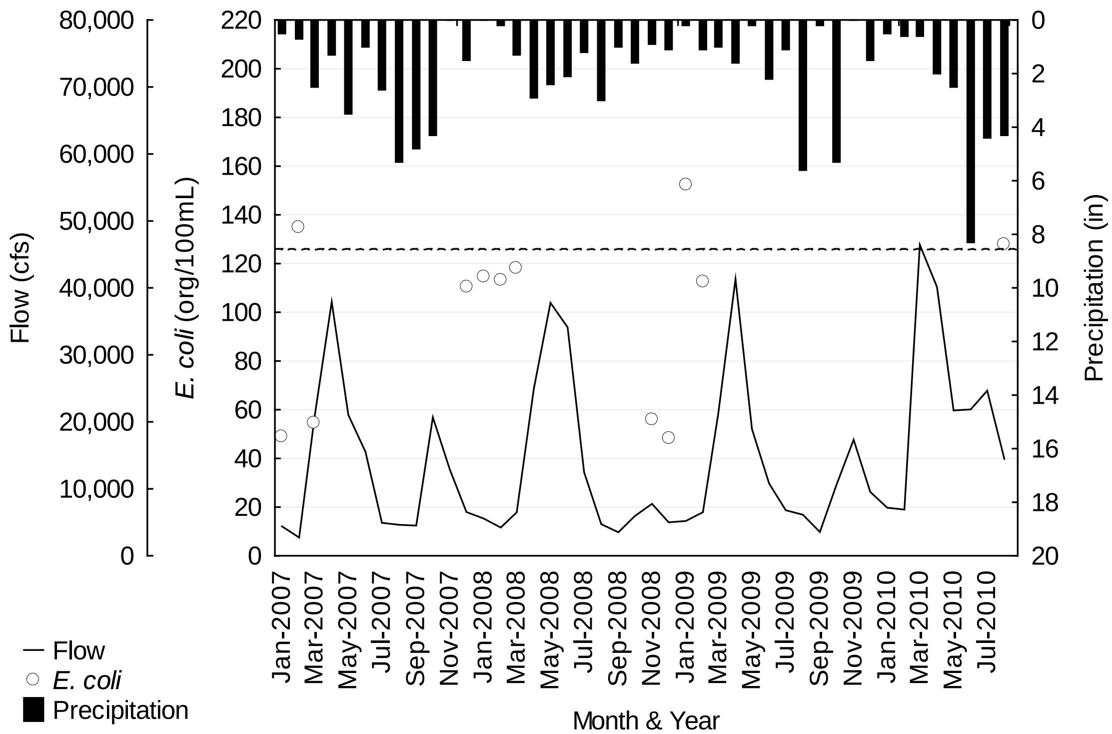


Figure 6-44. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-505) from 2007-2010. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

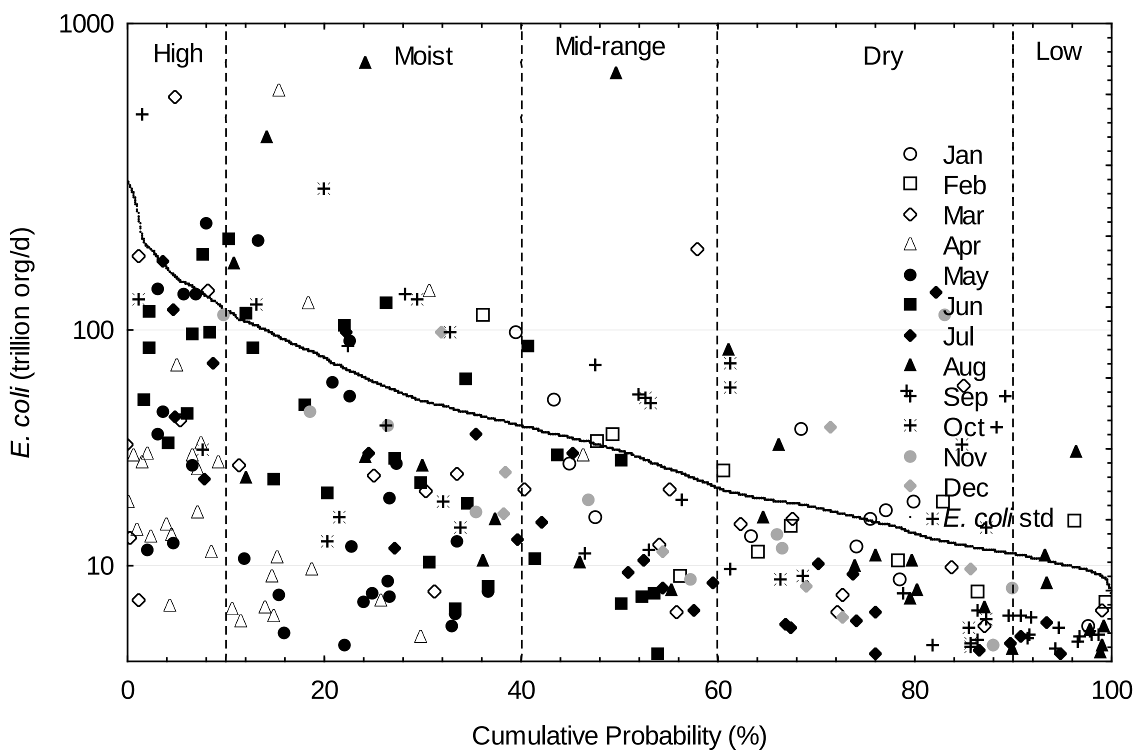


Figure 6-45. Load duration curve for *E. coli* at Mississippi River (07010206-505). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.6 TMDL Reach 07010206-506: Shingle Creek (County Ditch 13) (Headwaters (Eagle Cr/Bass Cr) to Mississippi R)

Shingle Creek (AUID 07010206-506) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

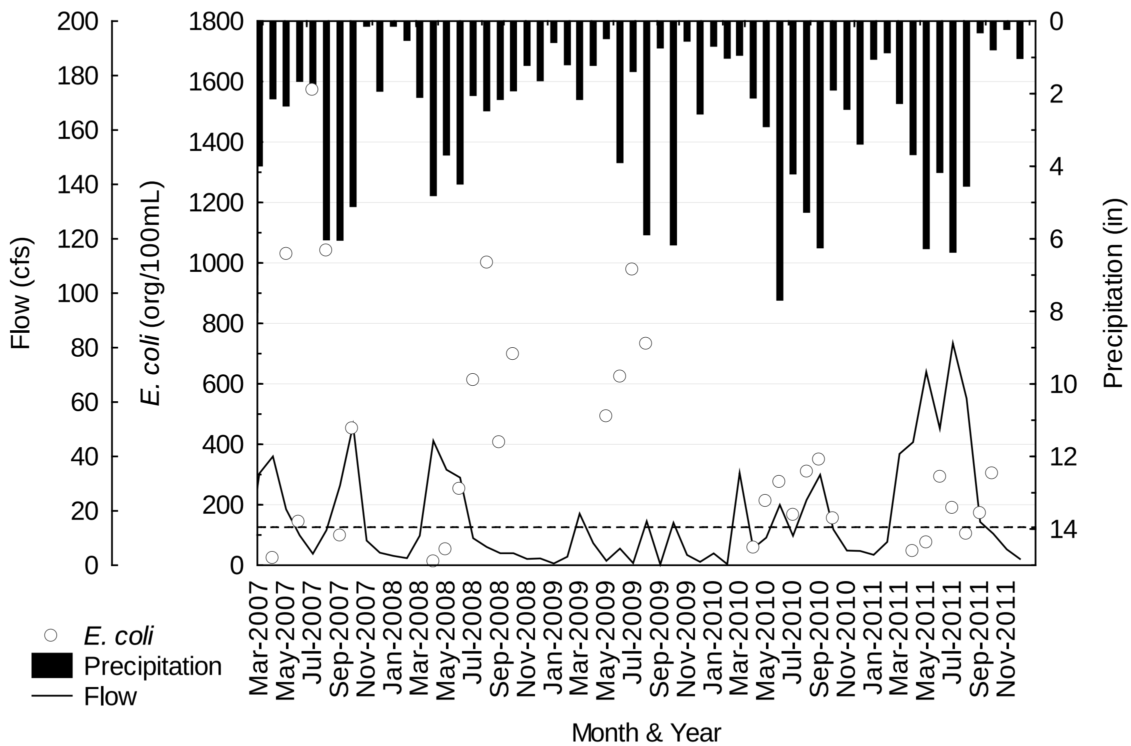


Figure 6-46. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Shingle Creek (07010206-506) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

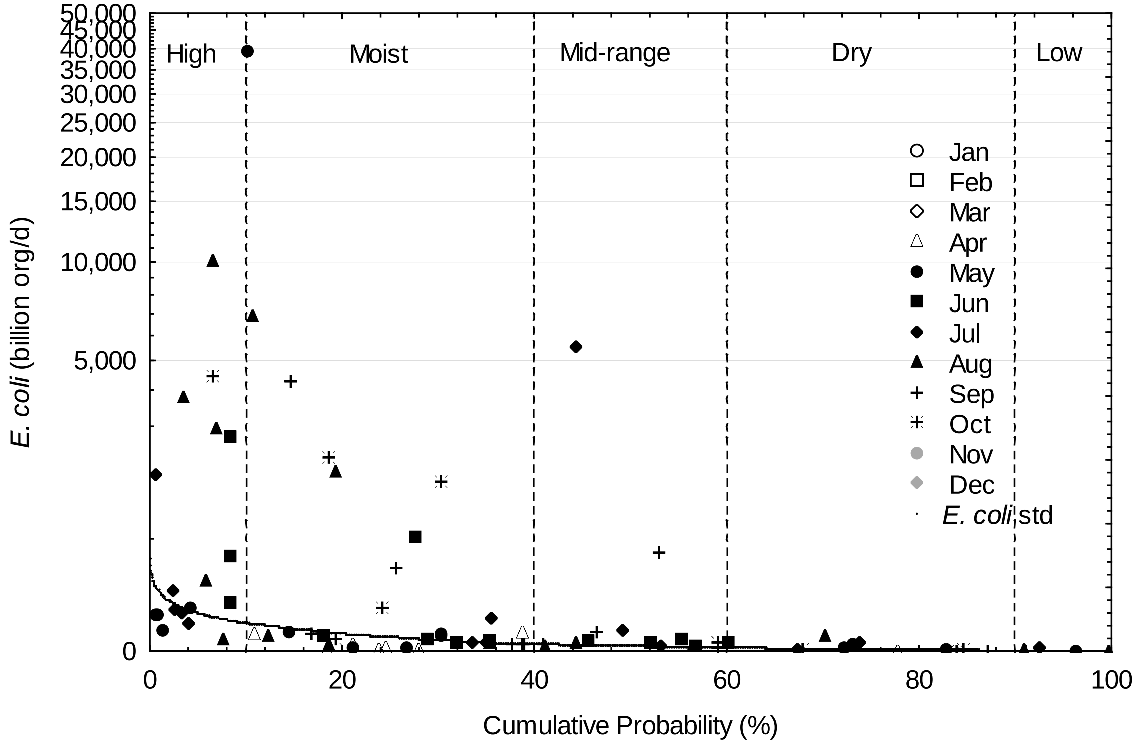


Figure 6-47. Load duration curve for *E. coli* at Shingle Creek (07010206-506).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.7 Protection Reach 07010206-509: Mississippi River (Coon Creek to Upper St. Anthony Falls) US ACE River Mile 854-865

This reach of the Mississippi River (AUID 07010203-509) is impaired for aquatic recreation due to *E. coli*. The TMDL for this reach is being deferred (refer to Section 2.6.1).

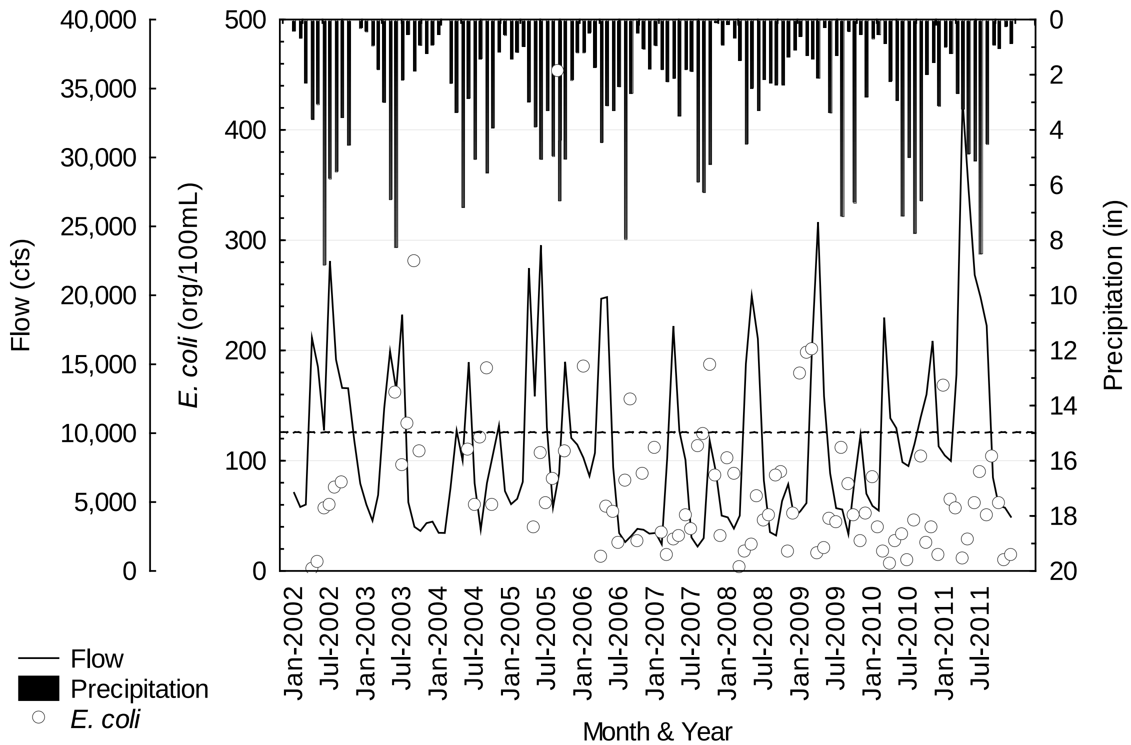


Figure 6-48. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-509) from 2002-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

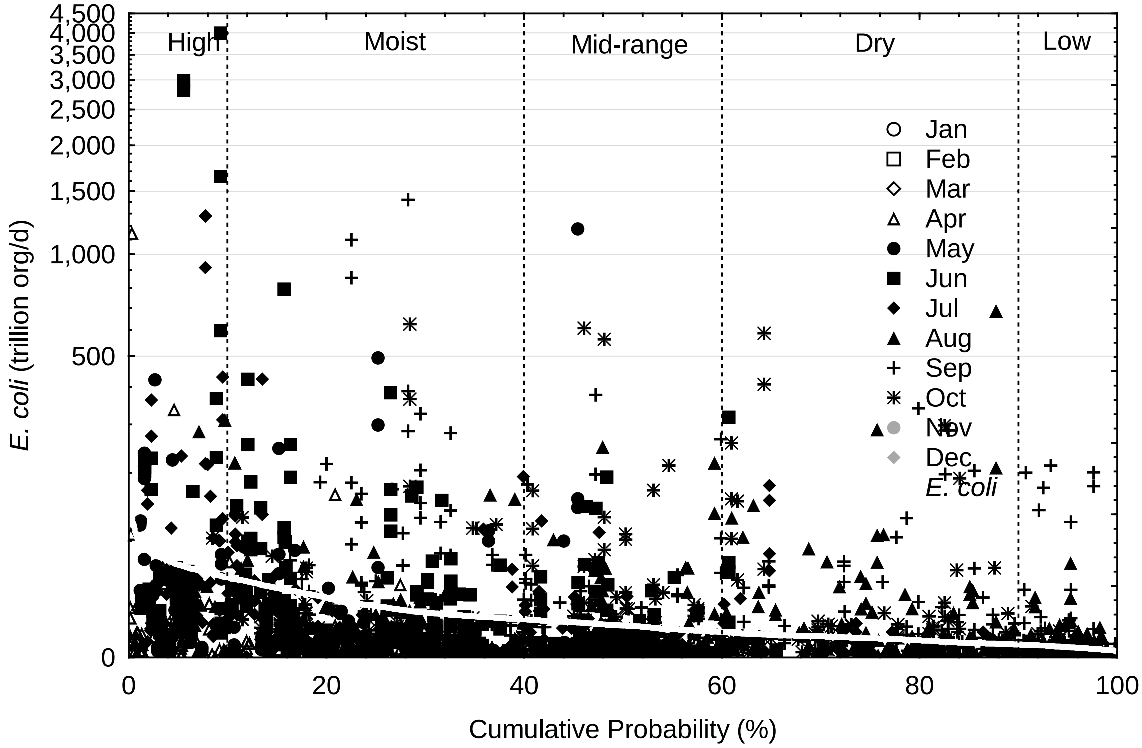


Figure 6-49. Load duration curve for *E. coli* at Mississippi River (07010206-509).
The *E. coli* standard is plotted in white.
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.8 Protection Reach 07010206-511: Mississippi River (Elm Cr to Coon Rapids Dam) US ACE River Mile 866-871

This reach of the Mississippi River (AUID 07010206-511) has been assessed as fully supporting aquatic recreation with respect to *E. coli*. This reach discharges to Protection Reach 07010206-512: Mississippi River (Coon Rapids Dam to Coon Cr).

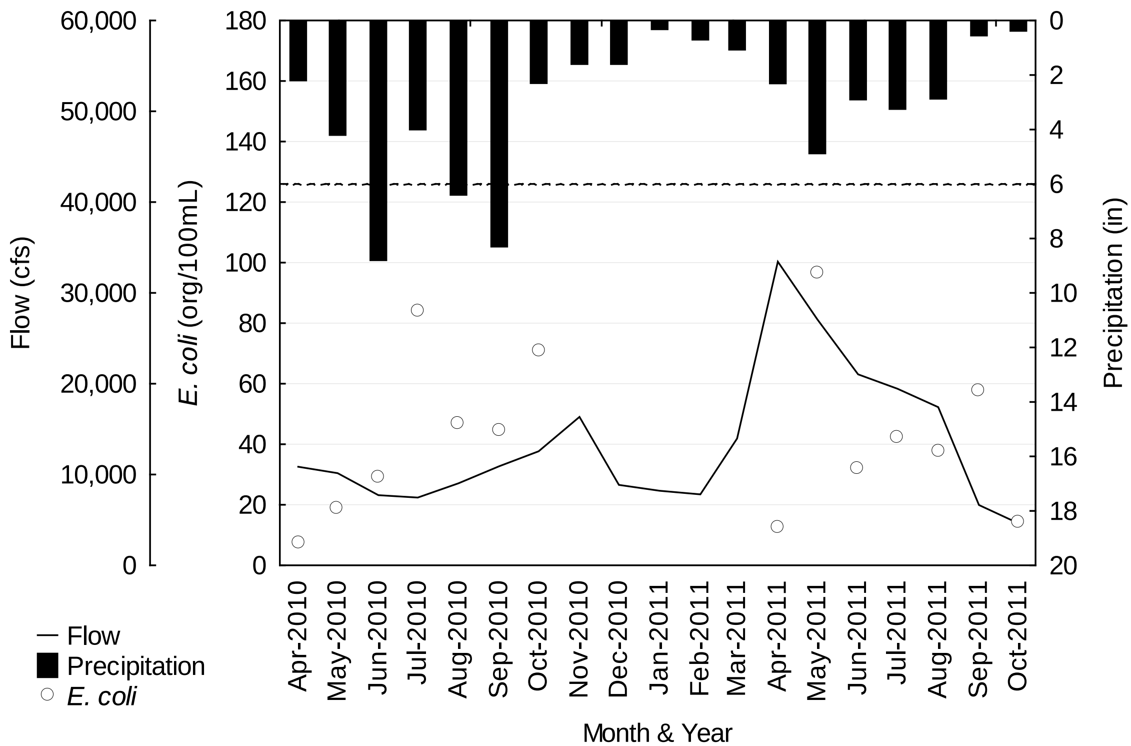


Figure 6-50. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-511) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

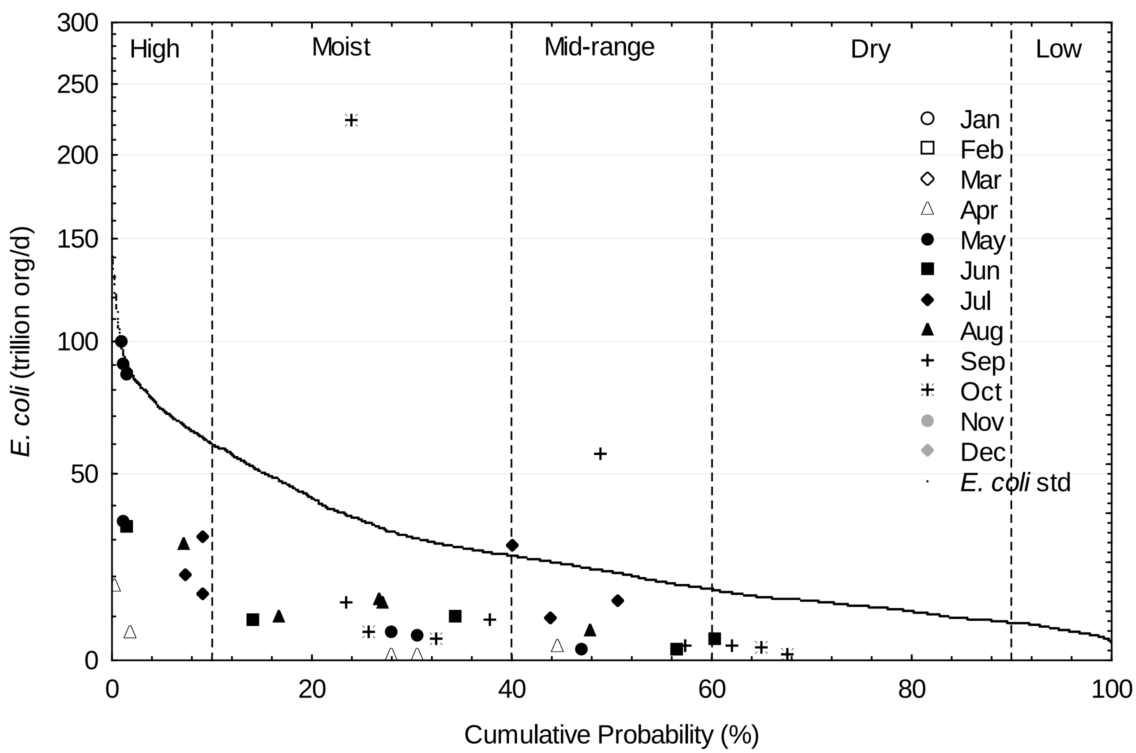


Figure 6-51. Load duration curve for *E. coli* at Mississippi River (07010206-511).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

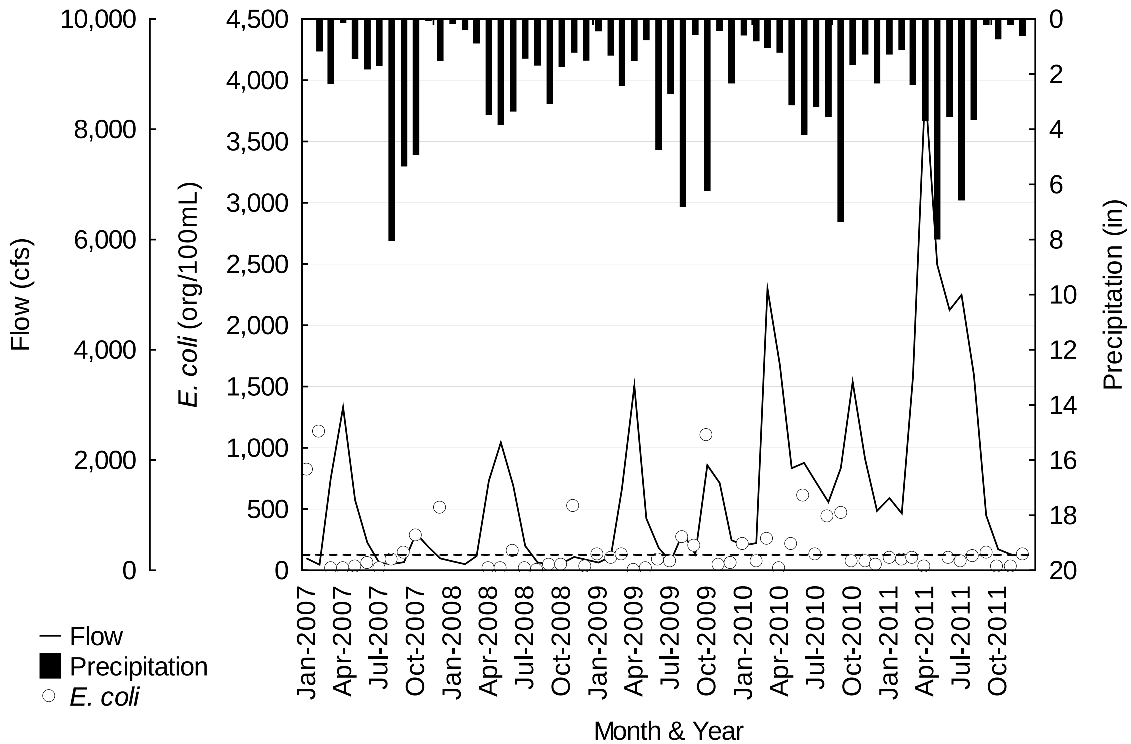


Figure 6-52. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Crow River (07010204-502) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

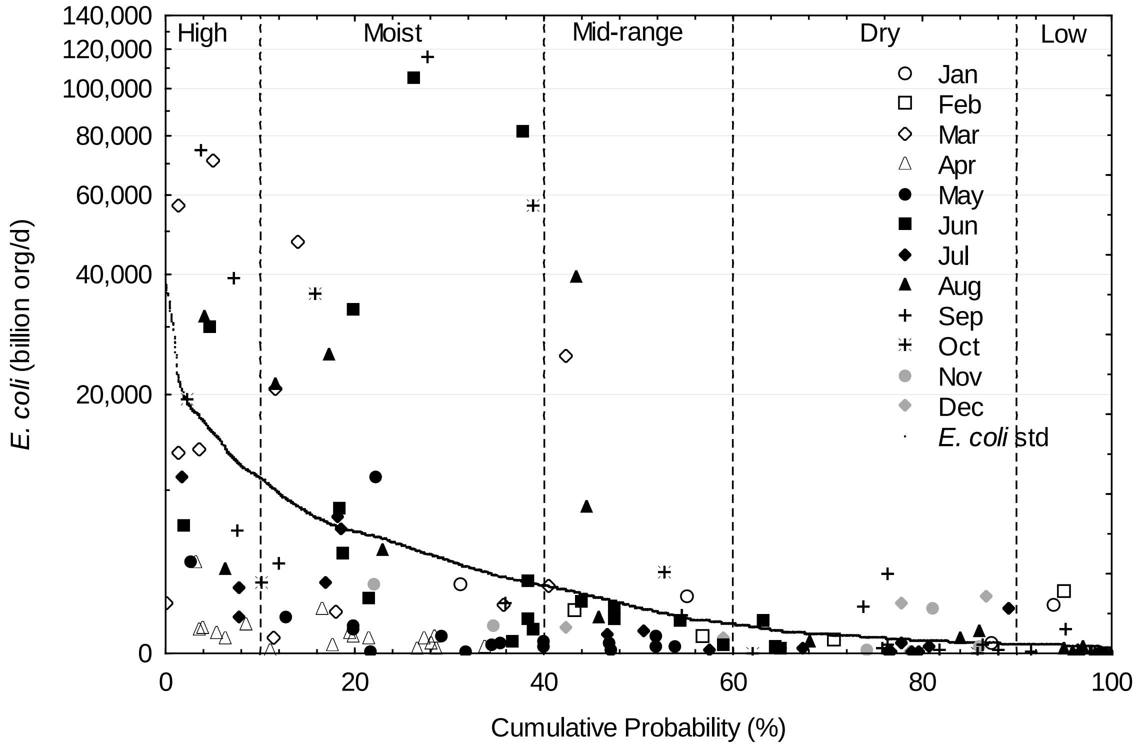


Figure 6-53. Load duration curve for *E. coli* at Crow River (07010204-502).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.9 Protection Reach 07010206-512: Mississippi River (Coon Rapids Dam to Coon Cr) US ACE River Mile 865-866

This reach of the Mississippi River (AUID 07010206-512) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

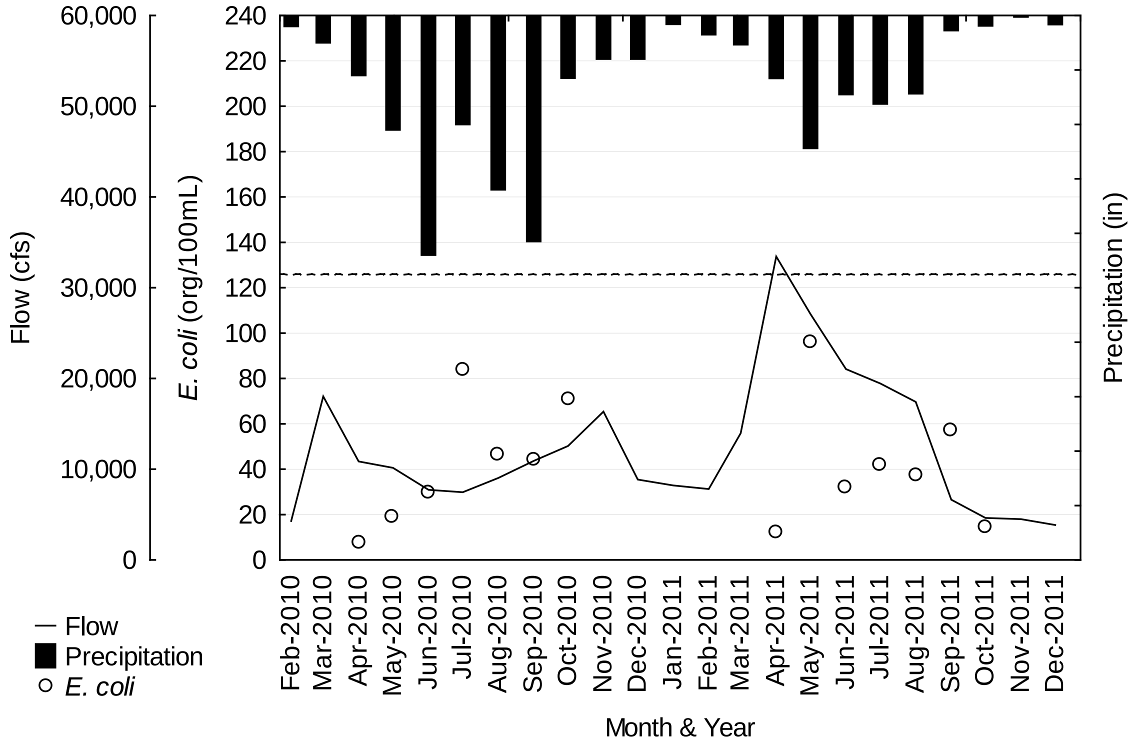


Figure 6-54. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-512) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

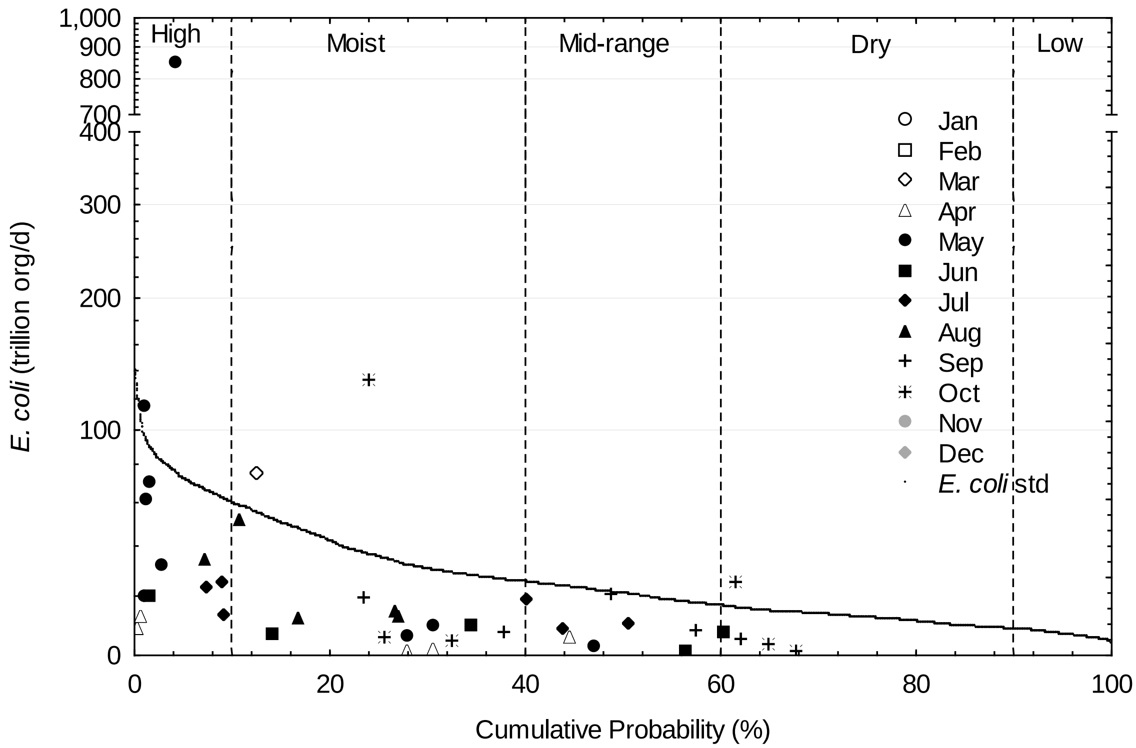


Figure 6-55. Load duration curve for *E. coli* at Mississippi River (07010206-512).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.10 Protection Reach 07010206-513: Mississippi River (Upper St Anthony Falls to Lower St Anthony Falls) US ACE River Mile 853.5-854

This reach of the Mississippi River (AUID 07010206-513) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

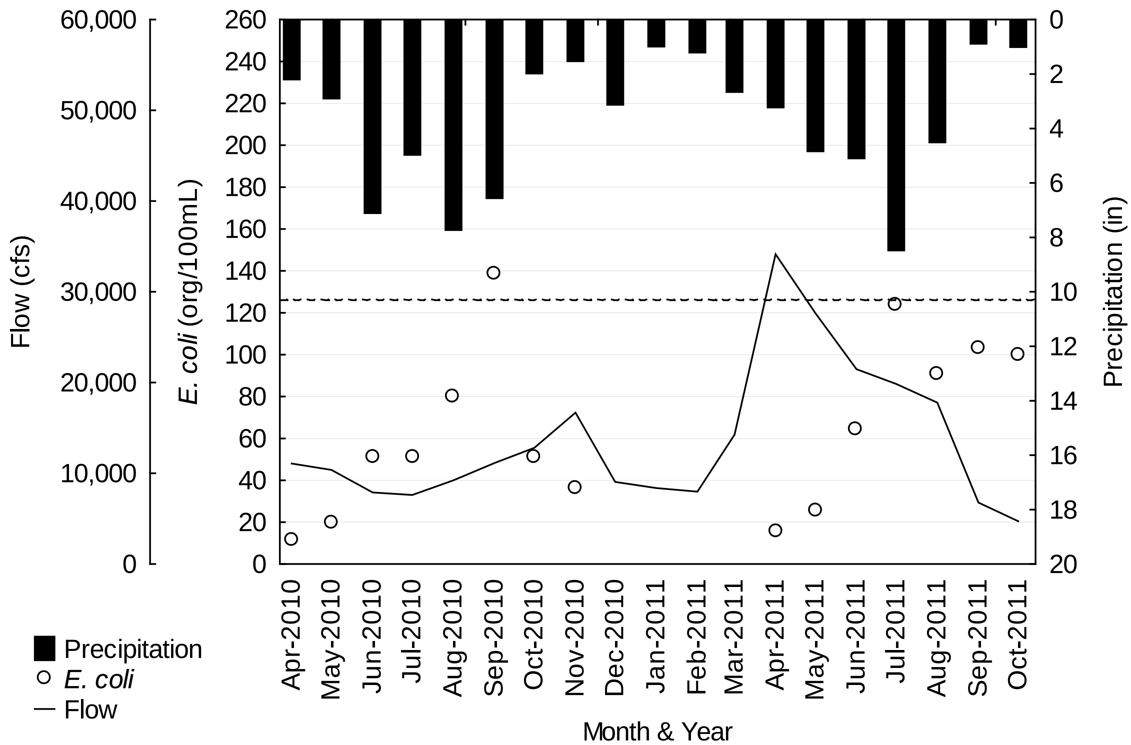


Figure 6-56. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-513) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

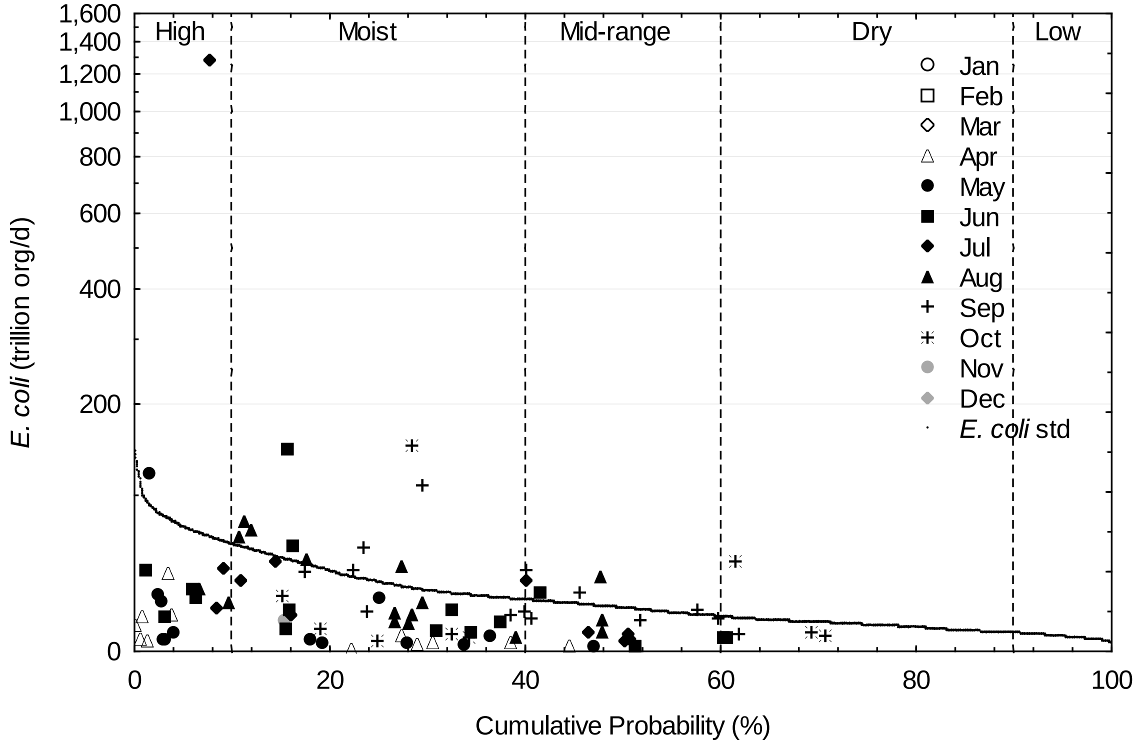


Figure 6-57. Load duration curve for *E. coli* at Mississippi River (07010206-513).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.11 Protection Reach 07010206-514: Mississippi River (L & D #1 to Minnesota R) US ACE River Mile 844-847.5

This reach of the Mississippi River (AUID 07010206-514) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

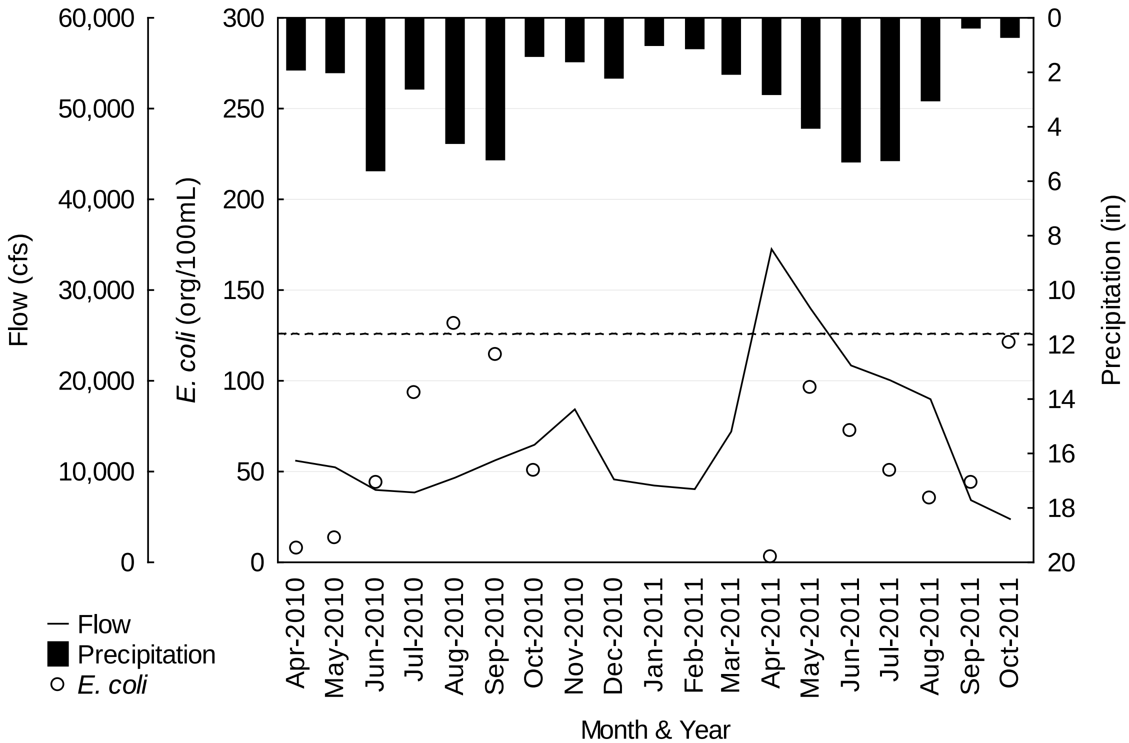


Figure 6-58. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-514) from 2010-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

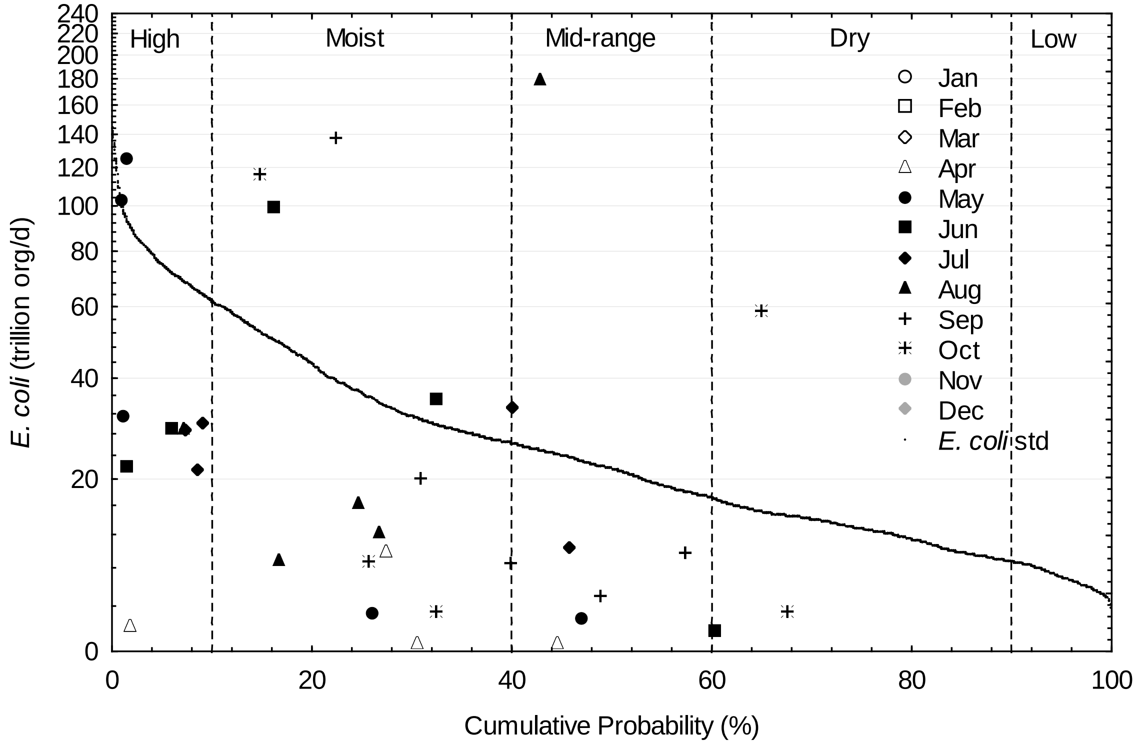


Figure 6-59. Load duration curve for *E. coli* at Mississippi River (07010206-514).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.12 Protection Reach 07010206-517: Unnamed creek (Headwaters to Mississippi R)

This unnamed creek (AUID 07010206-517) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

6.3.13 TMDL Reach 07010206-526: Unnamed Creek (Plymouth Creek) (Headwaters to Medicine Lk)

Unnamed Creek (Plymouth Creek) (AUID 07010206-526) is the headwaters of Bassett Creek and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

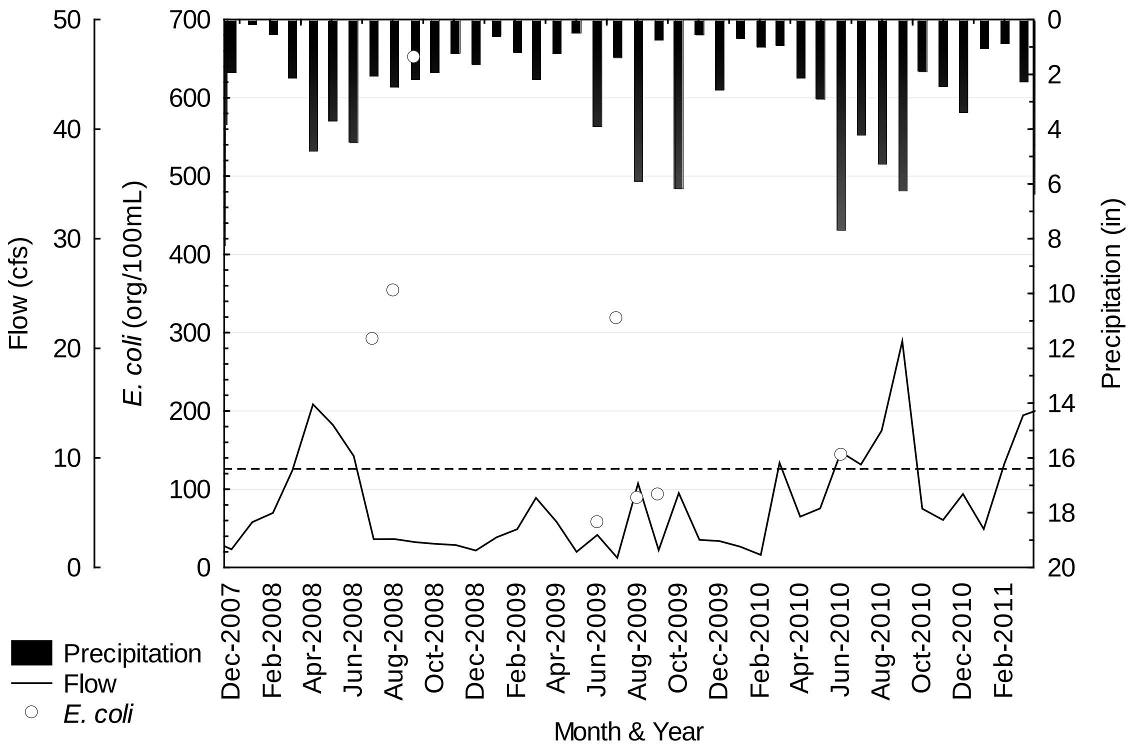


Figure 6-60. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Unnamed Creek (Plymouth Creek) (07010206-526) from 2008-2010. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

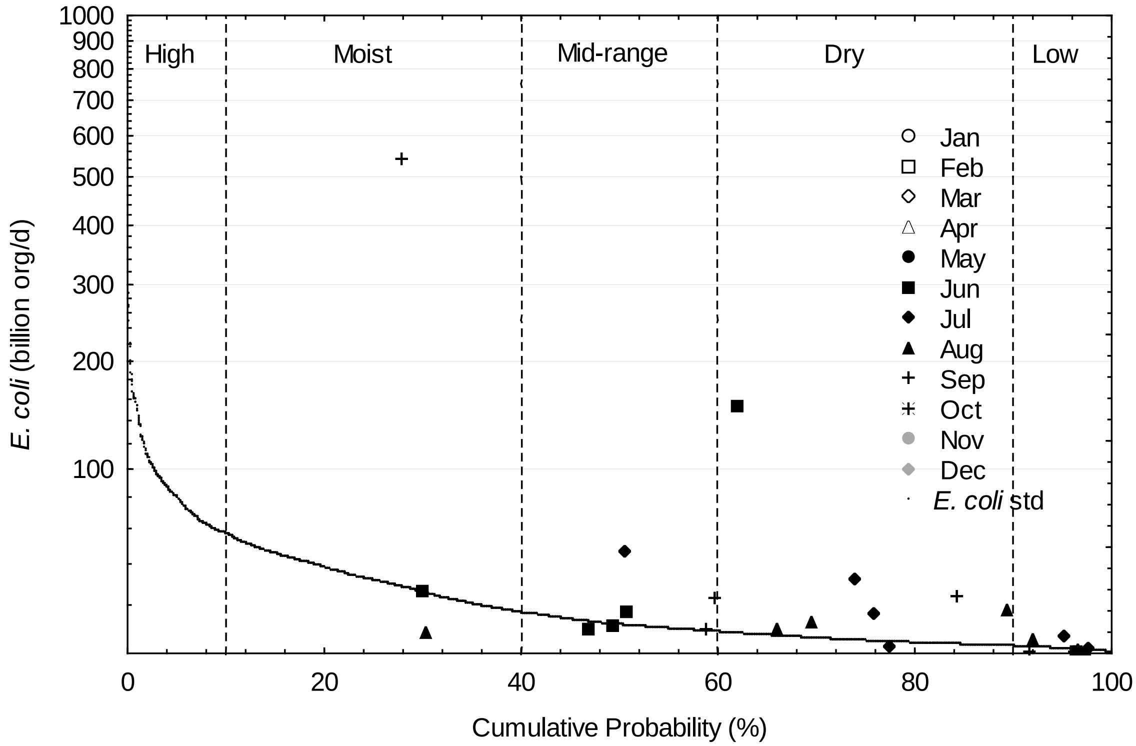


Figure 6-61. Load duration curve for *E. coli* at Unnamed Creek (Plymouth Creek) (07010206-526). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.14 TMDL Reach 07010206-538: Bassett Creek (Medicine Lk to Mississippi R)

Bassett Creek (AUID 07010206-538) is a tributary of the Mississippi River and is impaired for aquatic recreation due to fecal coliform. This reach received an *E. coli* TMDL as a part of this study (Table 7-1 in Section 7).

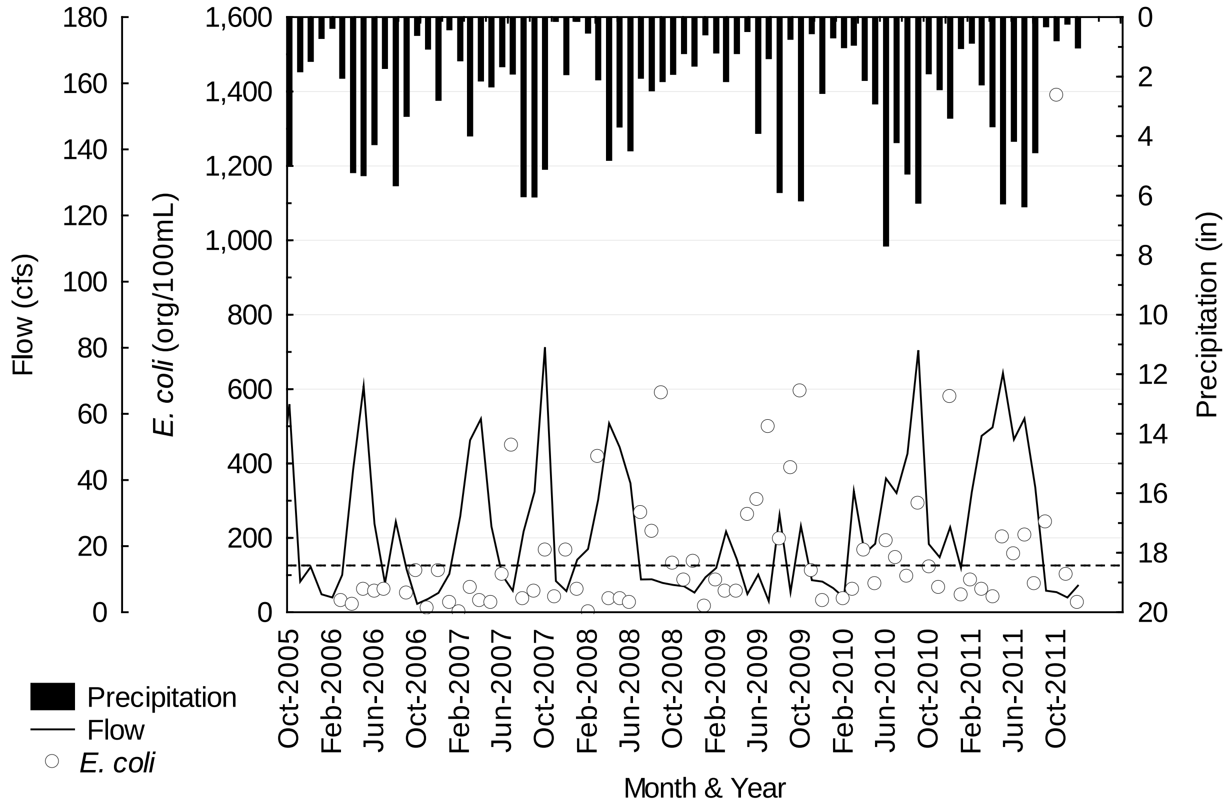


Figure 6-62. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Bassett Creek (07010206-538) from 2006-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

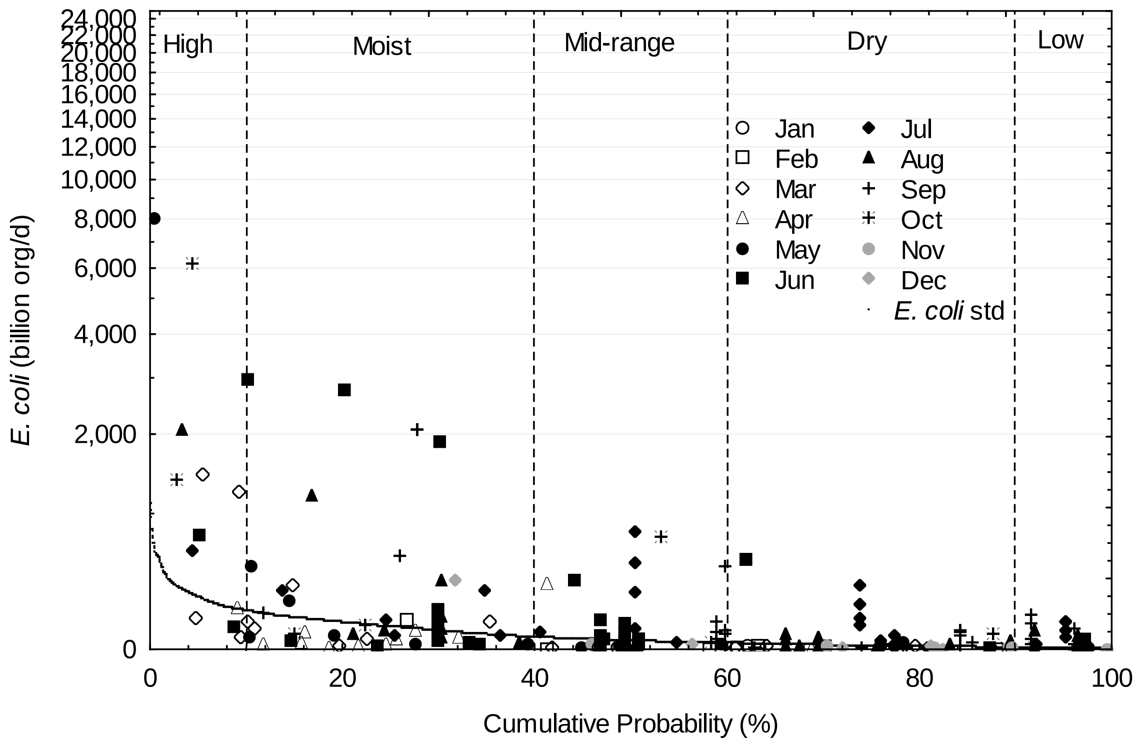


Figure 6-63. Load duration curve for *E. coli* at Bassett Creek (07010206-538).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.15 TMDL Reach 07010206-542: Unnamed creek (Interstate Valley Creek) (Unnamed cr to Mississippi R)

Unnamed Creek (Interstate Valley Creek) (AUID 07010206-542) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

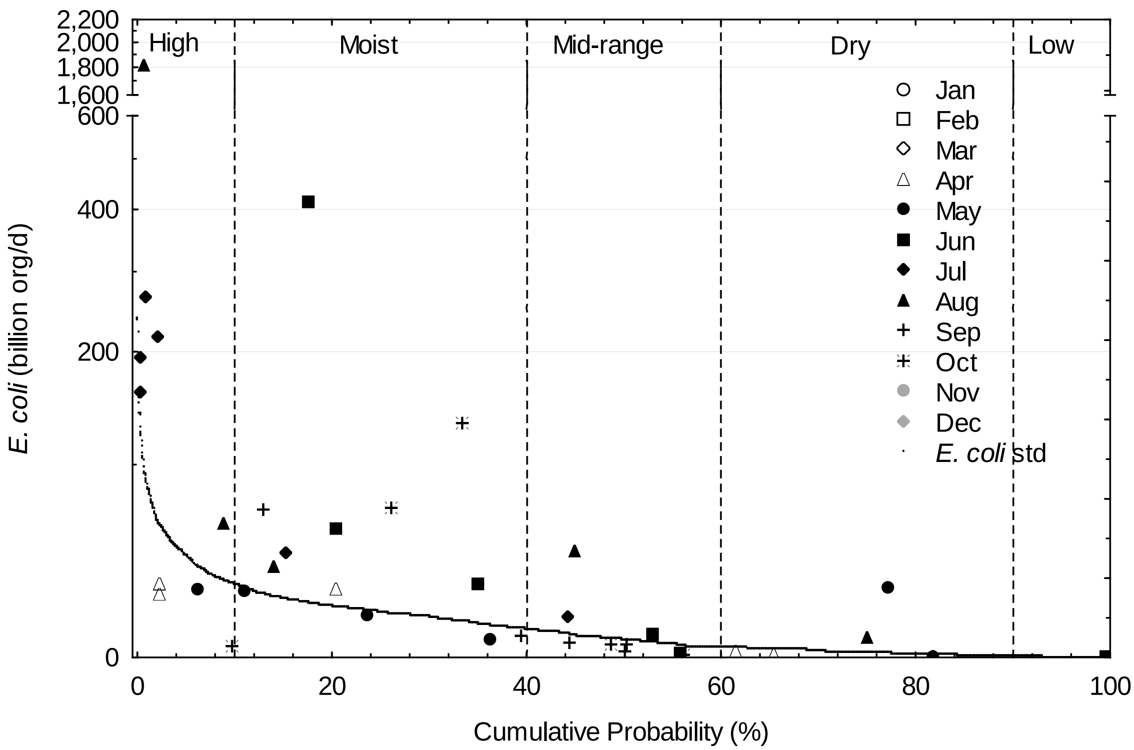


Figure 6-64. Load duration curve for *E. coli* at Unnamed Creek (Interstate Valley Creek) (07010206-542).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.16 TMDL Reach 07010206-552: Unnamed creek (North Branch, Bassett Creek) (Unnamed lk to Bassett Cr)

Unnamed Creek (North Branch, Bassett Creek) (AUID 07010206-552) is a tributary of Bassett Creek and is impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7).

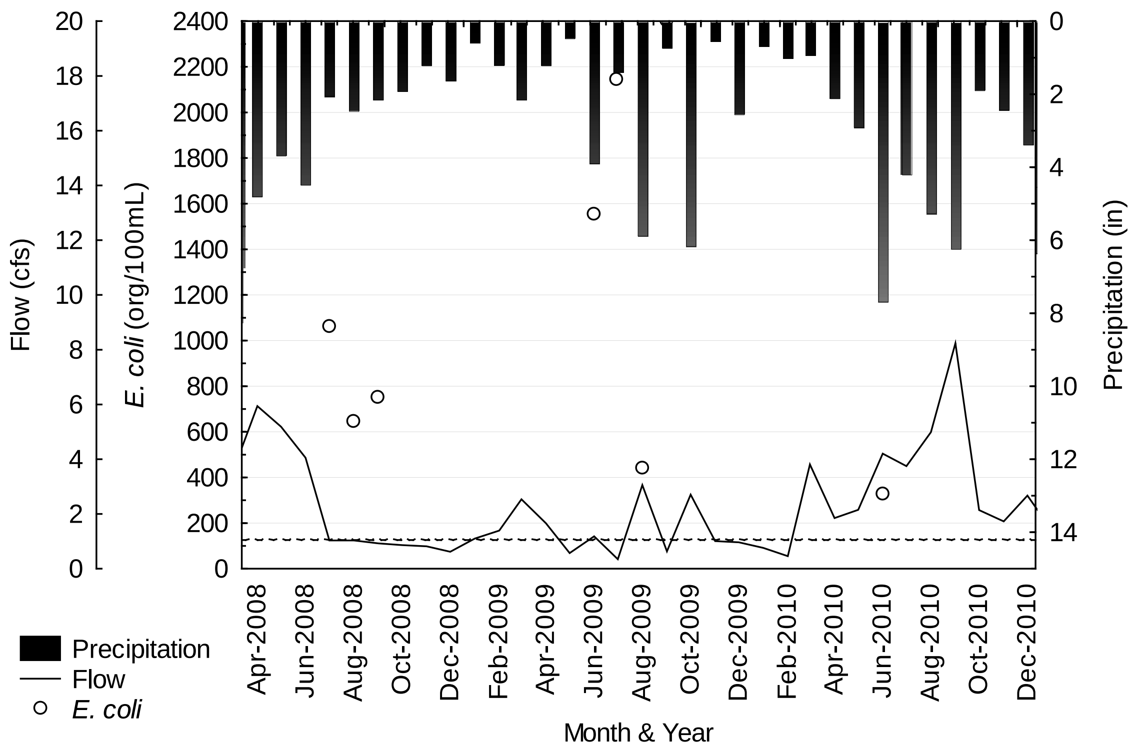


Figure 6-65. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Unnamed Creek (North Branch, Bassett Creek) (07010206-552) from 2008-2010. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

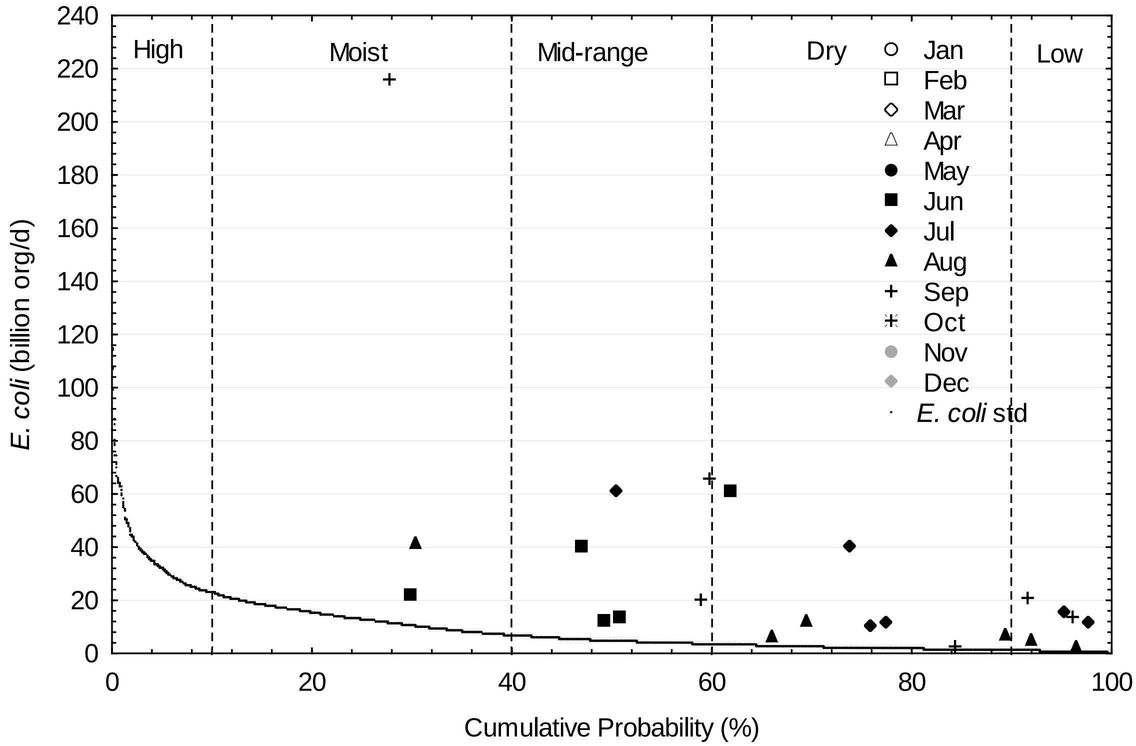


Figure 6-66. Load duration curve for *E. coli* at Unnamed Creek (North Branch, Bassett Creek) (07010206-552).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.17 Protection Reach 07010206-568: Mississippi River (NW city limits of Anoka to Rum R) US ACE River Mile 871.5-874

This reach of the Mississippi River (AUID 07010206-568) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

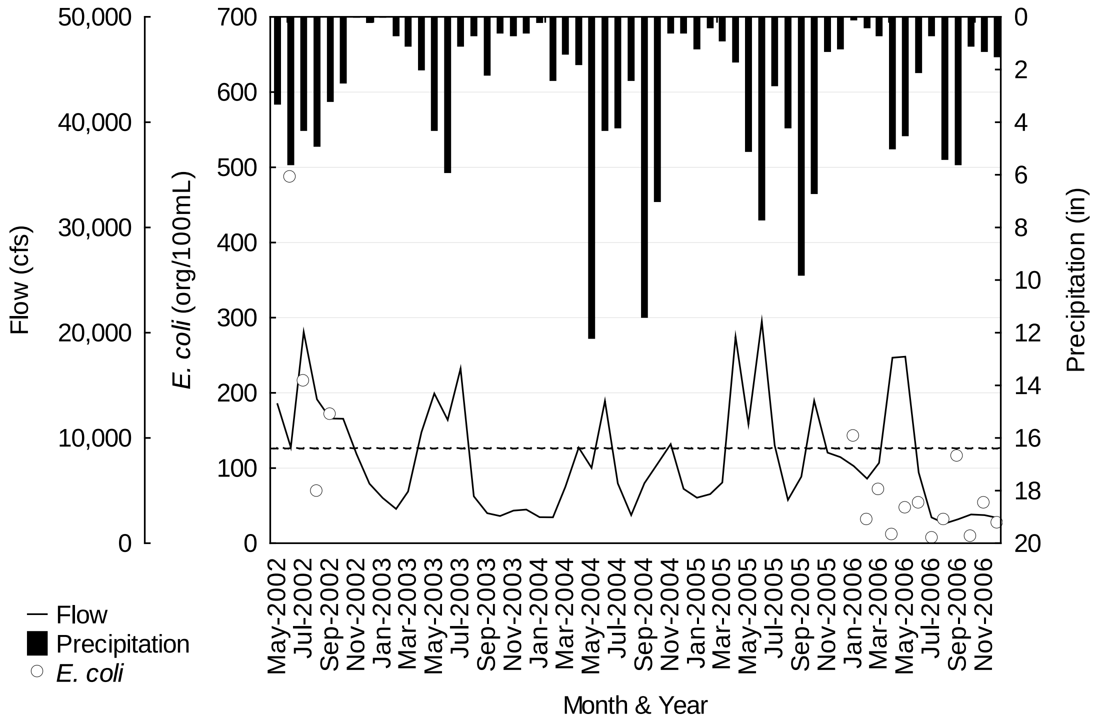


Figure 6-67. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-568) from 2002-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

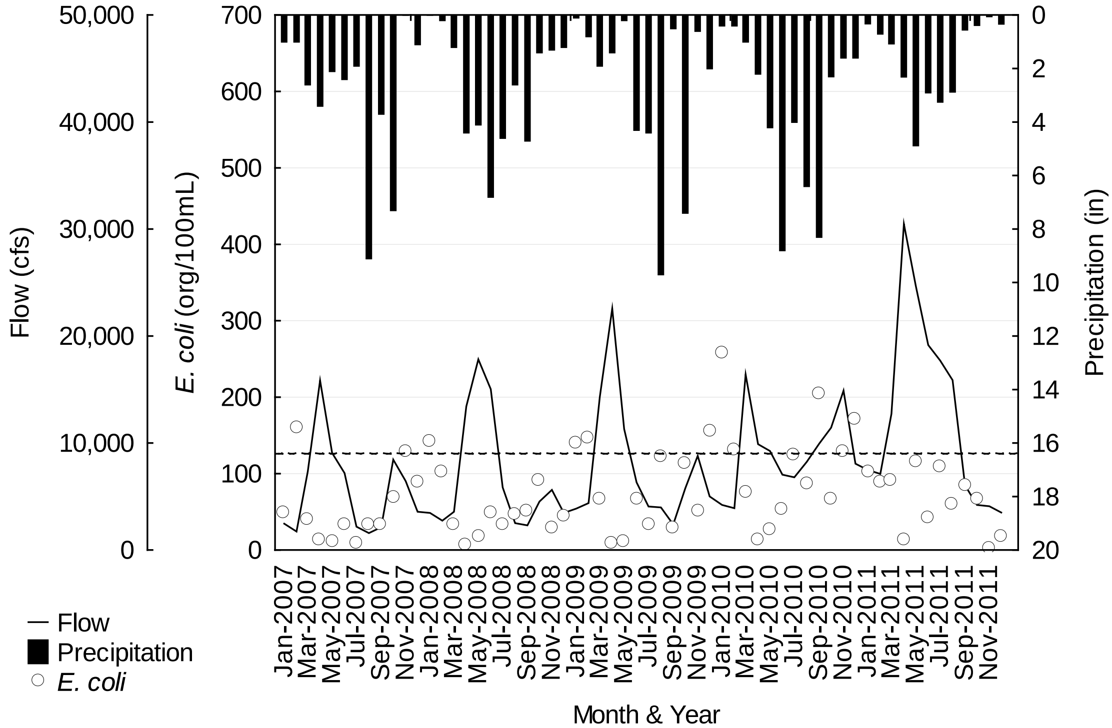


Figure 6-68. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Mississippi River (07010206-568) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

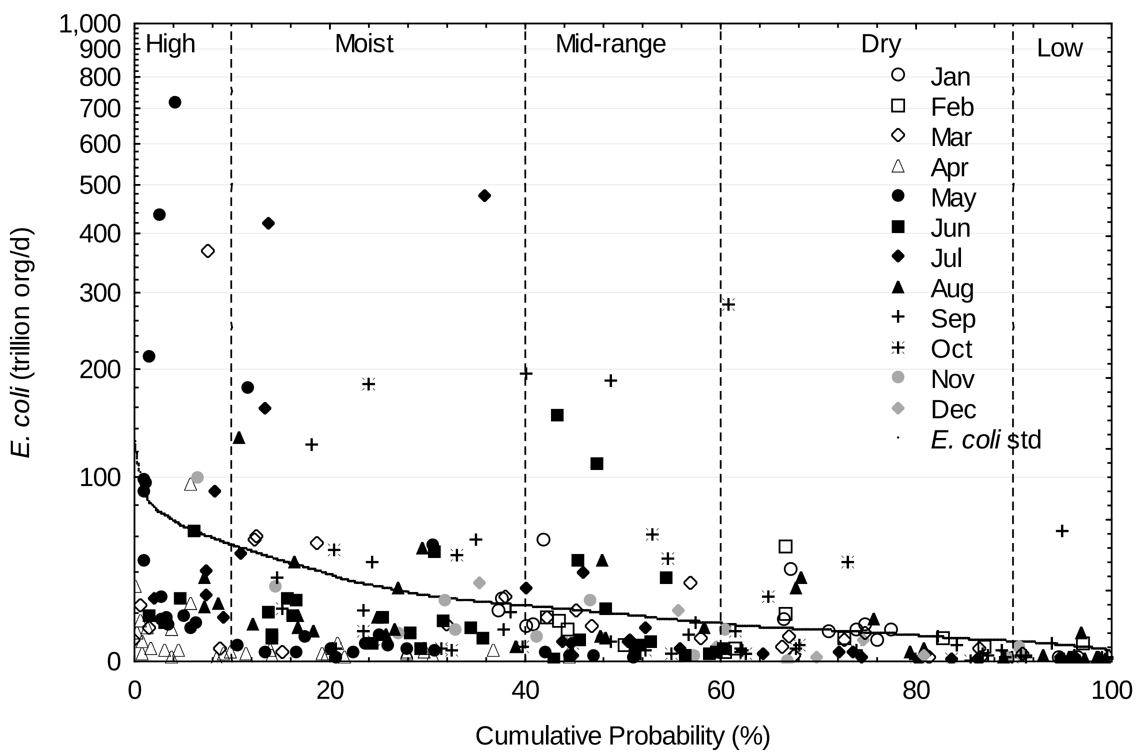


Figure 6-69. Load duration curve for *E. coli* at Mississippi River (07010206-568). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.18 TMDL Reach 07010206-584: Rice Creek (Long Lk to Locke Lk)

Rice Creek (AUID 07010206-584) is a tributary of the Mississippi River impaired for aquatic recreation due to *E. coli*. This reach received a TMDL as a part of this study (Table 7-1 in Section 7). The TMDL Reach flows through Locke Lake prior to discharge to the Mississippi River.

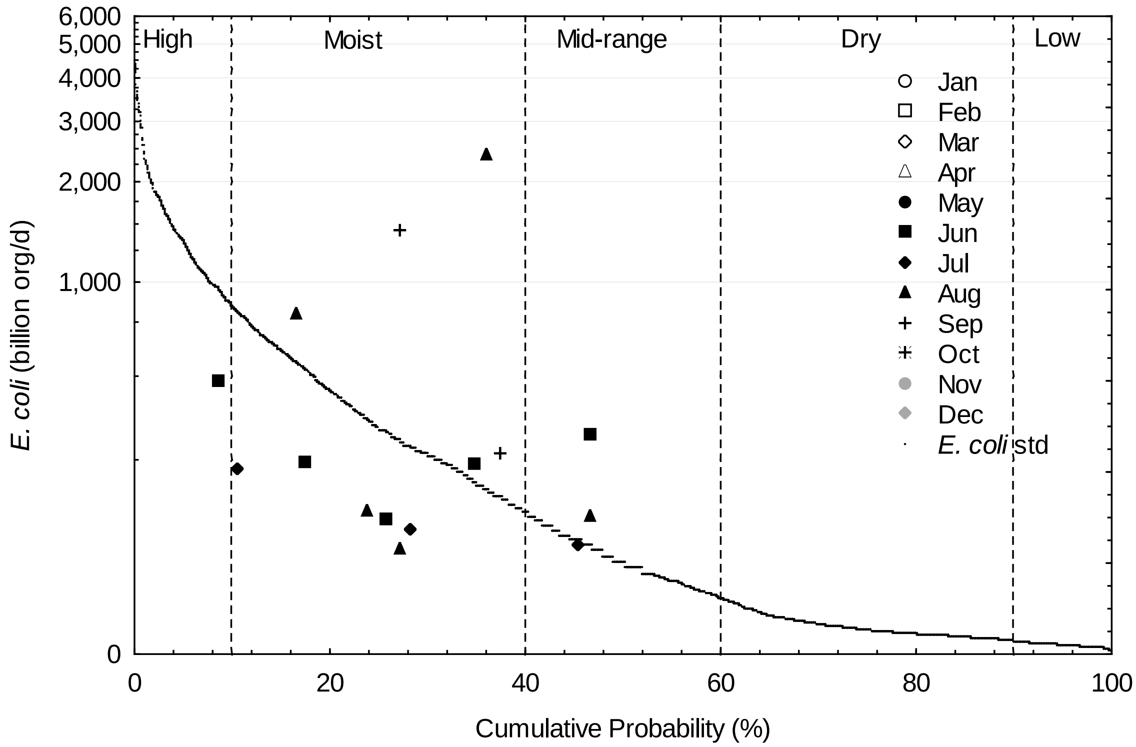


Figure 6-70. Load duration curve for *E. coli* at Rice Creek (07010206-584).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.19 Protection Reach 07010206-592: Battle Creek (Battle Creek Lk to Pigs Eye Lk)

Battle Creek (AUID 07010206-592) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*.

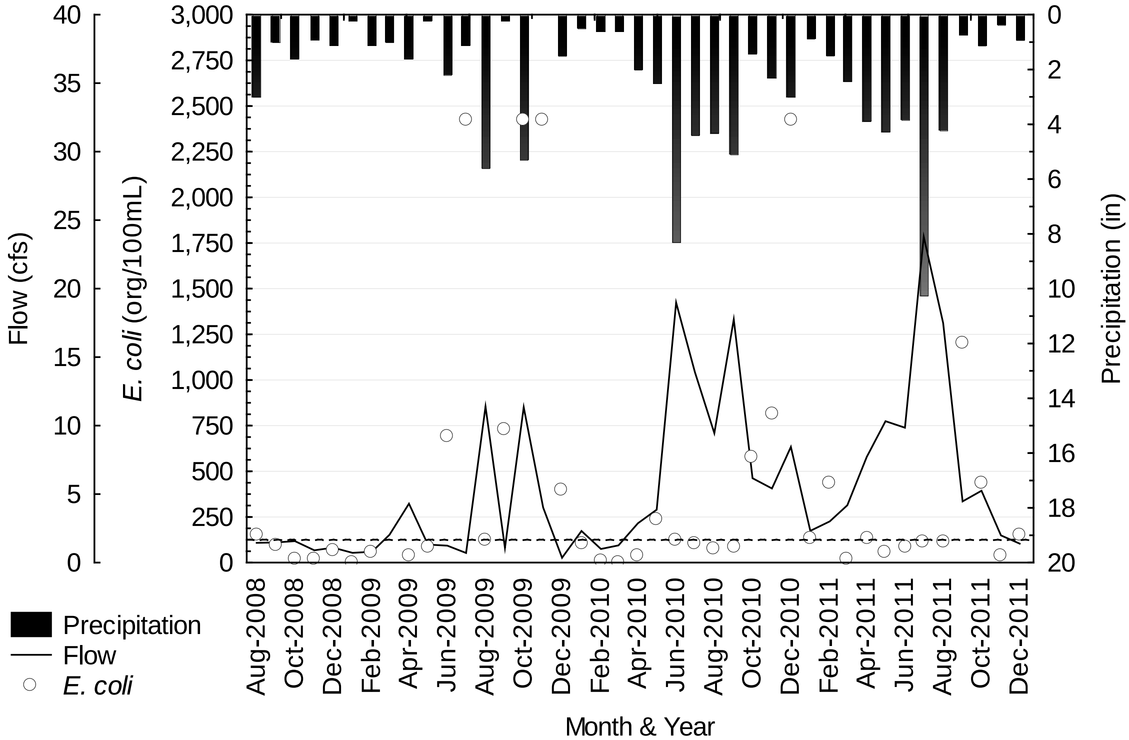


Figure 6-71. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Battle Creek (07010206-592) from 2008-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

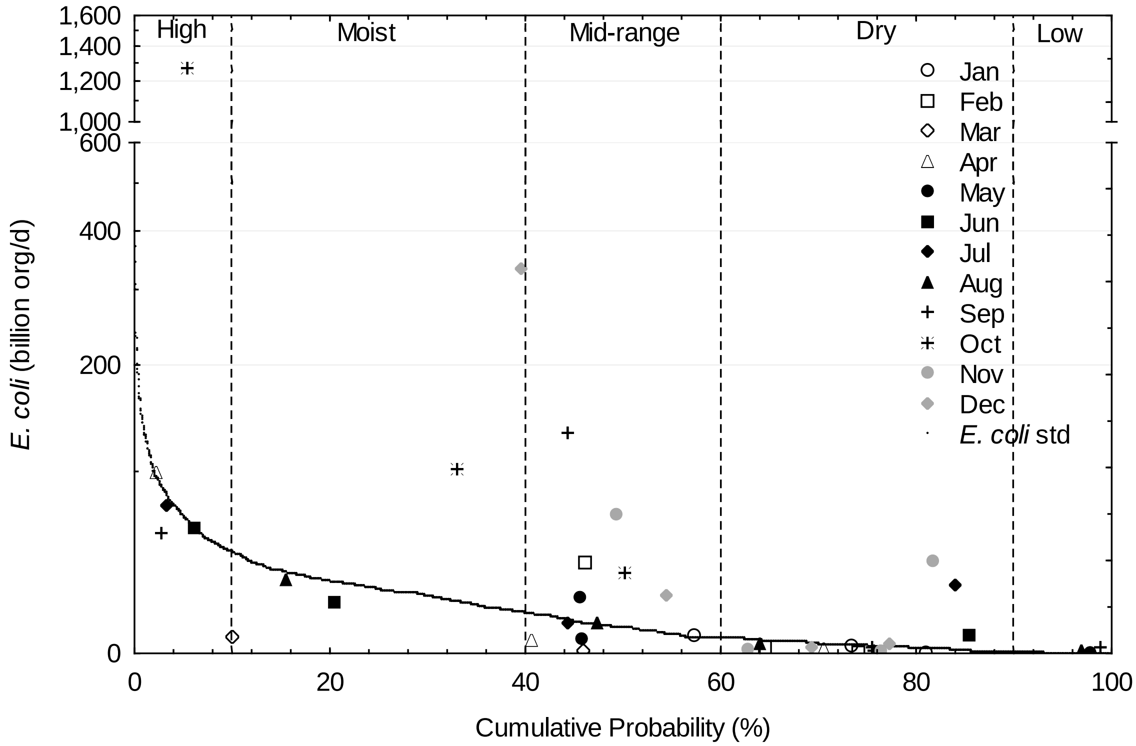


Figure 6-72. Load duration curve for *E. coli* at Battle Creek (07010206-592).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.20 Protection Reach 07010206-606: Fish Creek (Carver Lk to Unnamed (North Star) lk)

Fish Creek (AUID 07010206-606) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

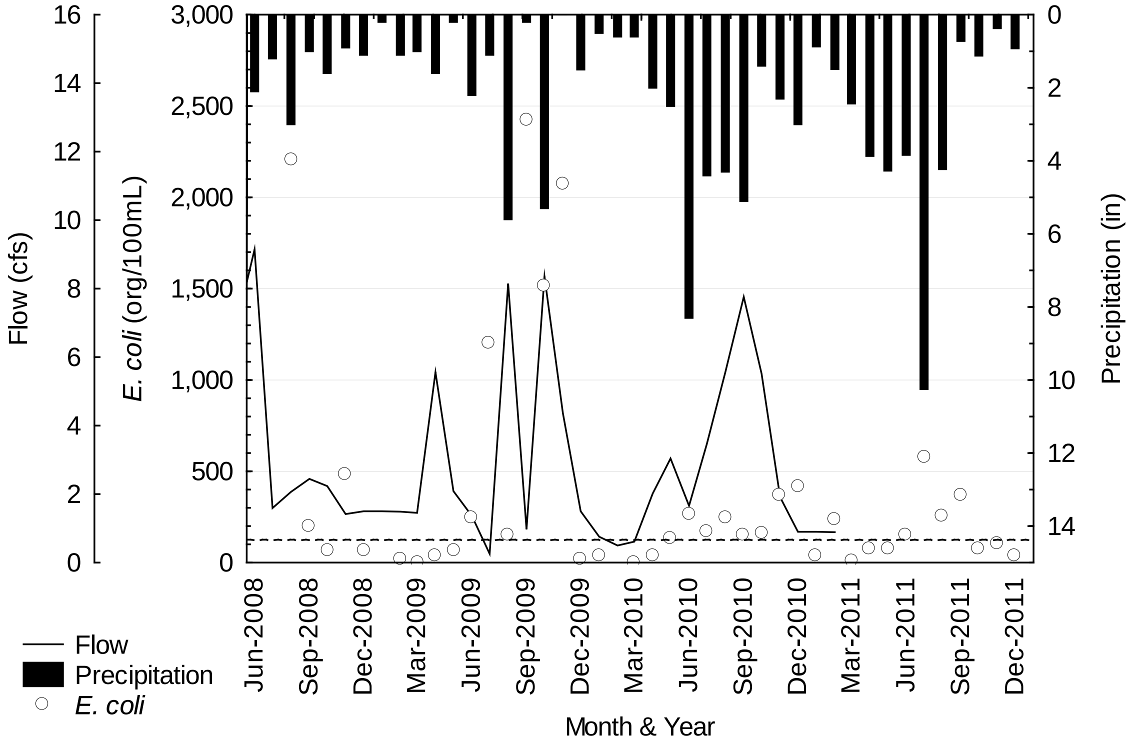


Figure 6-73. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Fish Creek (07010206-606) from 2008-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

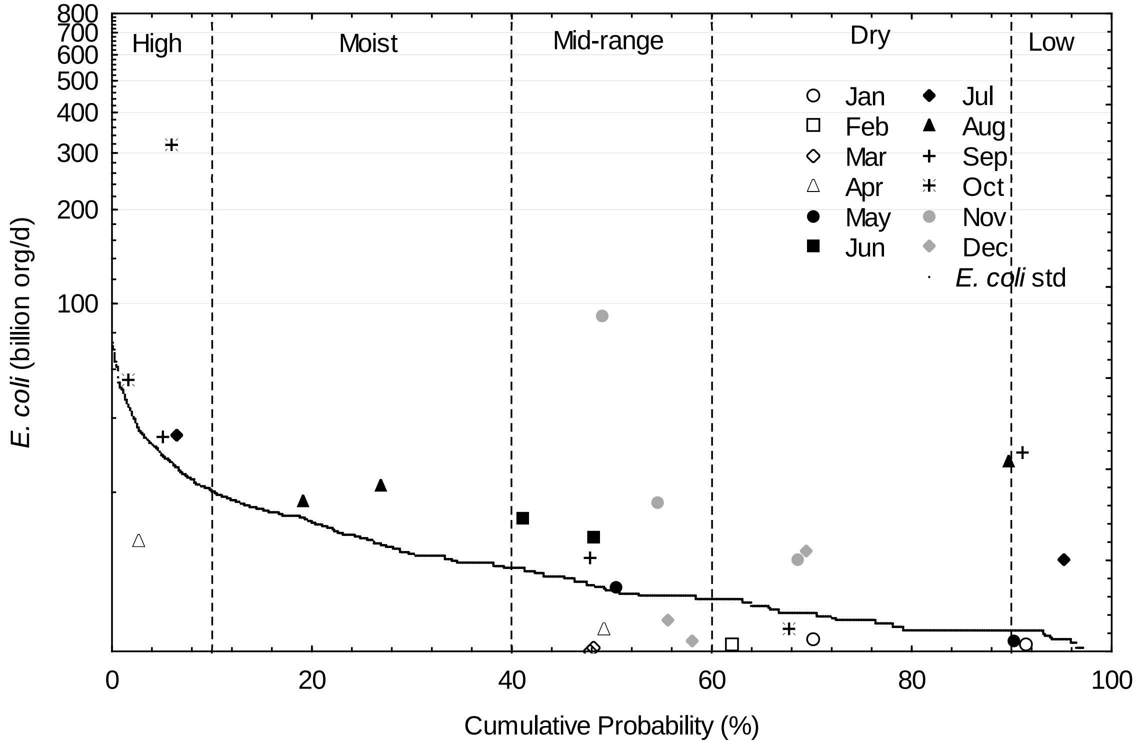


Figure 6-74. Load duration curve for *E. coli* at Fish Creek (07010206-606).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

6.3.21 Protection Reach 07010206-727: Unnamed creek (Unnamed lk (82-0086-00) to Mississippi R)

This unnamed creek (AUID 07010206-727) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

6.3.22 Protection Reach 07010206-xxx: Unnamed/unassessed creek (to Mississippi R)

This unnamed, unassessed creek (AUID 07010206-xxx) discharges to Mississippi River Reach 07010206-502; it does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

7 TMDLS AND PERCENT REDUCTIONS

The TMDL for each TMDL Reach is provided in Table 7-1. For each TMDL Reach, the percent reduction required in order to meet the TMDL is also provided. In all cases, WWTFs are required to meet their permitted bacteria loading limits and receive a 0% reduction as a part of these TMDLs. Bacteria sources requiring reduction consists of *watershed runoff*, which includes stormwater and watershed runoff from urban and rural landscapes, including regulated (MS4 stormwater) and non-regulated sources. Table 7-2 lists the individual WLAs for each WWTF for each TMDL Subwatershed. Table 7-3 lists the MS4s in each TMDL Subwatershed.

Table 7-1. TMDLs and % reduction of watershed load.
All loads are expressed using three significant digits.

Listed Reach Name	Reach Description	AUID	Flow Regime	WLA WWTFs (Total) (billion org/d)	WLA Straight Pipes (billion org/d)	WLA MS4 (billion org/d)	Load Allocation (billion org/d)	MOS (billion org/d)	TMDL (billion org/d)	Existing Load from Watershed Runoff (rural and urban runoff, regulated and non-regulated) (billion org/d)	LA + MS4 WLA (max-imum allowable water-shed runoff) (billion org/d)	Estimated Reduc-tion in Watershed Runoff (%)
Little Two River	Headwaters to Mississippi R	07010201-516	High	3.03	-	-	82.5	9.5	95	72.3	82.5	0%
			Moist	3.03	-	-	36.9	4.44	44.4	136	36.9	73%
			Mid-Range	3.03	-	-	22	2.78	27.8	55	22	60%
			Dry	3.03	-	-	13.2	1.8	18	93.5	13.2	86%
			Low	3.03	-	-	5.91	0.993	9.93	ID	5.91	ID
Two River	North & South Two R to Mississippi R	07010201-523	High	-	-	0.274	29.4	3.3	33	169	29.7	82%
			Moist	-	-	0.133	14.3	1.6	16	239	14.4	94%
			Mid-Range	-	-	0.0832	8.92	1	10	IDUL	9	0%
			Dry	-	-	0.0549	5.89	0.66	6.6	IDUL	5.94	0%
			Low	-	-	0.0291	3.12	0.35	3.5	ID	3.15	ID
Spunk Creek	Lower Spunk Lk to Mississippi R	07010201-525	High	2.01	-	2.05	254	28.7	287	116	256	0%
			Moist	2.01	-	0.948	118	13.4	134	756	119	84%
			Mid-Range	2.01	-	0.588	73	8.4	84	176	73.6	58%
			Dry	2.01	-	0.375	46.6	5.44	54.4	189	47.0	75%
			Low	2.01	-	0.2	24.8	3	30	ID	25	ID
Watab River	Rossier Lk to Mississippi R	07010201-528	High	-	-	9.46	49.7	6.57	65.7	137	59.2	57%
			Moist	-	-	4.59	24.1	3.19	31.9	65.4	28.7	56%
			Mid-Range	-	-	2.12	11.1	1.47	14.7	IDUL	13.2	0%
			Dry	-	-	1.4	7.32	0.969	9.69	IDUL	8.72	0%
			Low	-	-	0.582	3.05	0.404	4.04	ID	3.63	ID
Watab River, North Fork	Headwaters (Stump Lk 73-0091-00) to S Fk Watab R	07010201-529	High	1.15	-	0.655	73	8.31	83.1	ID	73.7	ID
			Moist	1.15	-	0.269	29.9	3.48	34.8	45.7	30.2	34%
			Mid-Range	1.15	-	0.139	15.5	1.86	18.6	60.2	15.6	74%
			Dry	1.15	-	0.067	7.46	0.964	9.64	18.5	7.53	59%
			Low	1.15	-	0.0305	3.4	0.509	5.09	ID	3.43	ID
County Ditch 12	Unnamed cr to Watab R	07010201-537	High	-	-	0.268	73.2	8.16	81.6	ID	73.5	ID
			Moist	-	-	0.112	30.7	3.42	34.2	29.9	30.8	0%
			Mid-Range	-	-	0.0601	16.4	1.83	18.3	23.1	16.5	29%

Listed Reach Name	Reach Description	AUID	Flow Regime	WLA WWTFs (Total) (billion org/d)	WLA Straight Pipes (billion org/d)	WLA MS4 (billion org/d)	Load Allocation (billion org/d)	MOS (billion org/d)	TMDL (billion org/d)	Existing Load from Watershed Runoff (rural and urban runoff, regulated and non-regulated) (billion org/d)	LA + MS4 WLA (max-imum allowable water-shed runoff) (billion org/d)	Estimated Reduc-tion in Watershed Runoff (%)
			Dry	-	-	0.0311	8.49	0.947	9.47	7.47	8.52	0%
			Low	-	-	0.0164	4.48	0.5	5	ID	4.5	ID
South Two River	Two River Lk to Two R	07010201-543	High	27.3	-	-	435	51.4	514	ID	435	ID
			Moist	27.3	-	-	189	24	240	230	189	18%
			Mid-Range	27.3	-	-	108	15	150	245	108	56%
			Dry	27.3	-	-	60.4	9.74	97.4	291	60.4	79%
			Low	27.3	-	-	21	5.37	53.7	206	21	90%
Watab River, South Fork	Little Watab Lk to Watab R	07010201-554	High	-	-	4.55	106	12.3	123	ID	111	ID
			Moist	-	-	1.9	44.3	5.13	51.3	82.9	46.2	44%
			Mid-Range	-	-	1.02	23.7	2.75	27.5	84.7	24.7	71%
			Dry	-	-	0.525	12.3	1.42	14.2	29.1	12.8	56%
			Low	-	-	0.278	6.48	0.751	7.51	ID	6.76	ID
County Ditch 13	Bakers Lk to Watab R	07010201-564	High	-	-	2.91	27.3	3.36	33.6	ID	30.2	ID
			Moist	-	-	1.22	11.5	1.41	14.1	23	12.7	45%
			Mid-Range	-	-	0.653	6.12	0.753	7.53	29.7	6.77	77%
			Dry	-	-	0.338	3.17	0.39	3.9	9.52	3.51	63%
			Low	-	-	0.179	1.68	0.206	2.06	ID	1.86	ID
Unnamed creek	T121 R23W S19, south line to Mississippi R	07010203-528	High	7.86	-	6.83	50.6	7.25	72.5	169	57.4	66%
			Moist	7.86	-	2.38	17.7	3.1	31	43.3	20.1	54%
			Mid-Range	7.86	-	0.671	4.97	1.5	15	15.6	5.64	64%
			Dry	7.86	-	0.0982	0.727	0.965	9.65	ID	0.825	ID
			Low	EQN	-	EQN	EQN	0.622	6.22	ID	EQN	ID
Silver Creek	Locke Lk to Mississippi R	07010203-557	High	-	-	-	266	29.5	295	38.1	266	0%
			Moist	-	-	-	99	11	110	61.1	99	0%
			Mid-Range	-	-	-	36	4	40	36.6	36	1.6%
			Dry	-	-	-	11.6	1.29	12.9	14.2	11.6	18%
			Low	-	-	-	5.81	0.646	6.46	10.8	5.81	46%
Unnamed creek (Luxembur	T123 R28W S30, south	07010203-561	High	-	-	-	56.9	6.32	63.2	ID	56.9	ID
			Moist	-	-	-	23.9	2.65	26.5	53.7	23.9	56%
			Mid-Range	-	-	-	12.8	1.42	14.2	52.8	12.8	76%

Listed Reach Name	Reach Description	AUID	Flow Regime	WLA WWTFs (Total) (billion org/d)	WLA Straight Pipes (billion org/d)	WLA MS4 (billion org/d)	Load Allocation (billion org/d)	MOS (billion org/d)	TMDL (billion org/d)	Existing Load from Watershed Runoff (rural and urban runoff, regulated and non-regulated) (billion org/d)	LA + MS4 WLA (maximum allowable watershed runoff) (billion org/d)	Estimated Reduction in Watershed Runoff (%)
g Creek)	line to Johnson Cr		Dry	-	-	-	6.6	0.733	7.33	21	6.6	69%
			Low	-	-	-	3.48	0.387	3.87	ID	3.48	ID
Plum Creek	Warner Lk to Mississippi R	070102 03-572	High	-	-	0.024	109	12.1	121	ID	109	ID
			Moist	-	-	0.01	45.5	5.06	50.6	41.5	45.5	0%
			Mid-Range	-	-	0.00537	24.4	2.71	27.1	43.1	24.4	43%
			Dry	-	-	0.00277	12.6	1.4	14	11.8	12.6	0%
			Low	-	-	0.00147	6.67	0.741	7.41	ID	6.67	ID
Johnson Creek (Meyer Creek)	Unnamed cr to Unnamed cr	070102 03-635	High	-	-	-	32.4	3.6	36	ID	32.4	ID
			Moist	-	-	-	13.6	1.51	15.1	118	13.6	89%
			Mid-Range	-	-	-	7.2	0.8	8	41.9	7.2	83%
			Dry	-	-	-	3.75	0.417	4.17	12.4	3.75	70%
			Low	-	-	-	1.99	0.221	2.21	ID	1.99	ID
Johnson Creek (Meyer Creek)	T123 R28W S14, west line to Mississippi R	070102 03-639	High	-	-	3.12	88.7	10.2	102	720	91.8	87%
			Moist	-	-	1.32	37.5	4.31	43.1	1520	38.8	97%
			Mid-Range	-	-	0.701	19.9	2.29	22.9	678	20.6	97%
			Dry	-	-	0.364	10.3	1.19	11.9	399	10.7	97%
			Low	-	-	0.193	5.49	0.631	6.31	ID	5.68	ID
Unnamed creek (Robinson Hill Creek)	CD 14 to CSAH 136	070102 03-724	High	-	-	4.06	50.4	6.05	60.5	ID	54.5	ID
			Moist	-	-	1.69	21.1	2.53	25.3	48.6	22.8	53%
			Mid-Range	-	-	0.911	11.3	1.36	13.6	42.8	12.2	71%
			Dry	-	-	0.47	5.85	0.702	7.02	13.7	6.32	54%
			Low	-	-	0.249	3.09	0.371	3.71	ID	3.34	ID
Shingle Creek (County Ditch 13)	Headwaters (Eagle Cr/ Bass Cr) to Mississippi R	070102 06-506	High	-	-	202	34.9	26.3	263	602	237	61%
			Moist	-	-	68.4	12	8.93	89.3	142	80.4	43%
			Mid-Range	-	-	22.9	4.05	2.99	29.9	87.9	27.0	69%
			Dry	-	-	8.19	1.44	1.07	10.7	11.1	9.63	13%
			Low	-	-	1.33	0.238	0.174	1.74	4.91	1.57	68%
Unnamed creek (Plymouth	Headwaters to Medicine Lk	070102 06-526	High	-	-	61.1	11.2	8.03	80.3	149	72.3	51%
			Moist	-	-	24.3	4.4	3.19	31.9	48.6	28.7	41%
			Mid-Range	-	-	8.83	1.61	1.16	11.6	40.7	10.4	74%

Listed Reach Name	Reach Description	AUID	Flow Regime	WLA WWTFs (Total) (billion org/d)	WLA Straight Pipes (billion org/d)	WLA MS4 (billion org/d)	Load Allocation (billion org/d)	MOS (billion org/d)	TMDL (billion org/d)	Existing Load from Watershed Runoff (rural and urban runoff, regulated and non-regulated) (billion org/d)	LA + MS4 WLA (max-imum allowable water-shed runoff) (billion org/d)	Estimated Reduc-tion in Watershed Runoff (%)
Creek)			Dry	-	-	3.89	0.707	0.511	5.11	2.45	4.6	0%
			Low	-	-	1.59	0.295	0.209	2.09	ID	1.89	ID
Bassett Creek	Medicine Lk to Mississippi R	07010206-538	High	-	-	138	39.8	19.7	197	861	178	79%
			Moist	-	-	54.1	15.6	7.74	77.4	23.1	69.7	0%
			Mid-Range	-	-	19.9	5.67	2.84	28.4	4.4	25.6	0%
			Dry	-	-	10.6	3.03	1.51	15.1	19.4	13.6	30%
			Low	-	-	3.56	1.03	0.509	5.10	7.3	4.59	37%
Unnamed creek (Interstate Valley Creek)	Unnamed cr to Mississippi R	07010206-542	High	-	-	26.9	13	4.43	44.3	57.7	39.9	31%
			Moist	-	-	10.8	5.23	1.78	17.8	37.6	16	57%
			Mid-Range	-	-	4.08	1.97	0.672	6.72	4.7	6.05	0%
			Dry	-	-	1.2	0.578	0.198	1.98	1.43	1.78	0%
			Low	-	-	0.12	0.0578	0.0198	0.198	0.267	0.178	33%
Unnamed ck (North Branch, Bassett Creek)	Unnamed lk to Bassett Cr	07010206-552	High	-	-	26.7	2.21	3.21	32.1	ID	28.9	ID
			Moist	-	-	10.6	0.839	1.27	12.7	70.3	11.4	84%
			Mid-Range	-	-	3.85	0.317	0.463	4.63	31.3	4.17	87%
			Dry	-	-	1.69	0.145	0.204	2.04	12.2	1.84	85%
			Low	-	-	0.692	0.0582	0.0833	0.833	9.7	0.75	92%
Rice Creek	Long Lk to Locke Lk	07010206-584	High	-	-	396	819	135	1350	684	1220	0%
			Moist	-	-	96.8	200	33	330	312	297	4.8%
			Mid-Range	-	-	23.6	49.1	8.08	80.8	130	72.7	44%
			Dry	-	-	4.93	10.2	1.68	16.8	ID	15.1	ID
			Low	-	-	1.75	3.64	0.599	5.99	ID	5.39	ID

ID – Insufficient Data; one or more reaches (the TMDL Reach or upstream reaches) lack monitoring data for calculation of the TMDL and/or the existing load attributable to the TMDL Subwatershed. **IDUL** – Impairment Due to Upstream Load; the existing load from the TMDL Subwatershed appears to be insignificant. **N/A** – Not applicable. **EQN** – Equation; for this singular situation, the WLAs and LA are expressed as Equation 2 on Page 104. Refer to Section 5.5.2, Subsection *WLAs and LA for TMDL Reach 07010203-528 Unnamed Creek*.

Table 7-2. Wastewater treatment facility (WWTF) wasteload allocations (WLA).

WWTF Name	WWTF Permit No.	WWTF WLA (billion org/d)	AUID	Reach Name	Reach Description
Upsala	MNG580053	3.03	07010201-516	Little Two River	Headwaters to Mississippi R
Avon	MN0047325	2.01	07010201-525	Spunk Creek	Lower Spunk Lk to Mississippi R
Order of St Benedict	MN0022411	1.15	07010201-529	Watab River, North Fork	Headwaters (Stump Lk 73-0091-00) to S Fk Watab R
Albany	MN0020575	23.8	07010201-543	South Two River	Two River Lk to Two R
Bowlus	MN0020923	2.38	07010201-543	South Two River	Two River Lk to Two R
Holdingford	MN0023710	1.07	07010201-543	South Two River	Two River Lk to Two R
Albertville	MN0050954	4.43*	07010203-528	Unnamed creek	T121 R23W S19, south line to Mississippi R
Otsego West	MN0066257	3.43*	07010203-528	Unnamed creek	T121 R23W S19, south line to Mississippi R

* For low flows, the WWTF WLA is expressed as Equation 2 on Page 104. Refer to Section 5.5.2, Subsection *WLAs and LA for TMDL Reach 07010203-528 Unnamed Creek*.

Table 7-3. MS4s within each TMDL Subwatershed.

AUID of TMDL Reach	Reach Name	Reach Description	MS4s in TMDL Subwatershed (MS4 Permit ID)
07010201-523	Two River	North & South Two R to Mississippi R	Brockway Township (MS400068)
07010201-525	Spunk Creek	Lower Spunk Lk to Mississippi R	Brockway Township (MS400068)
07010201-528	Watab River	Rossier Lk to Mississippi R	Le Sauk Township (MS400143) Sartell City (MS400048) St Cloud City (MS400052) St Joseph City (MS400125) St Joseph Township (MS400157) Stearns County (MS400159)
07010201-529	Watab River, North Fork	Headwaters (Stump Lk 73-0091-00) to S Fk Watab R	St Joseph Township (MS400157)
07010201-537	County Ditch 12	Unnamed cr to Watab R	Brockway Township (MS400068)
07010201-554	Watab River, South Fork	Little Watab Lk to Watab R	St Joseph City (MS400125) St Joseph Township (MS400157) Stearns County (MS400159)
07010201-564	County Ditch 13	Bakers Lk to Watab R	Brockway Township (MS400068) Le Sauk Township (MS400143) Sartell City (MS400048)
07010203-528	Unnamed creek	T121 R23W S19, south line to Mississippi R	Otsego City (MS400243) St Michael City (MS400246)
07010203-572	Plum Creek	Warner Lk to Mississippi R	St Cloud City (MS400052)
07010203-639	Johnson Creek (Meyer Creek)	T123 R28W S14, west line Mississippi R	St Cloud City (MS400052)
07010203-724	Unnamed creek (Robinson Hill Creek)	CD 14 to CSAH 136	MnDOT Outstate District (MS400180) St Cloud City (MS400052) Stearns County (MS400159) Waite Park City (MS400127)

AUID of TMDL Reach	**Reach Name**	**Reach Description**	**MS4s in TMDL Subwatershed (MS4 Permit ID)**
07010206-506	Shingle Creek (County Ditch 13)	Headwaters (Eagle Cr/Bass Cr) to Mississippi R	Brooklyn Center City (MS400006) Brooklyn Park City (MS400007) Crystal City (MS400012) Hennepin County (MS400138) Hennepin Technical College Brooklyn Park (MS400198) Maple Grove City (MS400102) Minneapolis Municipal Storm Water (MN0061018) MnDOT Metro District (MS400170) New Hope City (MS400039) North Hennepin Community College (MS400205) Osseo City (MS400043) Plymouth City (MS400112) Robbinsdale City (MS400046)
07010206-526	Unnamed creek (Plymouth Creek)	Headwaters to Medicine Lk	Hennepin County (MS400138) MnDOT Metro District (MS400170) Minnetonka City (MS400035) Plymouth City (MS400112)
07010206-538	Bassett Creek	Medicine Lk to Mississippi R	Crystal City (MS400012) Golden Valley City (MS400021) Hennepin County (MS400138) Medicine Lake City (MS400104) Minneapolis Municipal Storm Water (MN0061018) Minnetonka City (MS400035) MnDOT Metro District (MS400170) New Hope City (MS400039) Plymouth City (MS400112) Robbinsdale City (MS400046) St Louis Park City (MS400053)
07010206-542	Unnamed creek (Interstate Valley Creek)	Unnamed cr to Mississippi R	Dakota County (MS400132) Inver Grove Heights City (MS400096) Lilydale City (MS400028) Mendota Heights City (MS400034) MnDOT Metro District (MS400170) Sunfish Lake City (MS400055) West St Paul City (MS400059)
07010206-552	Unnamed creek (North Branch, Bassett Creek)	Unnamed lk to Bassett Cr	Crystal City (MS400012) Golden Valley City (MS400021) Hennepin County (MS400138) MnDOT Metro District (MS400170) New Hope City (MS400039) Plymouth City (MS400112)

AUID of TMDL Reach	Reach Name	Reach Description	MS4s in TMDL Subwatershed (MS4 Permit ID)
07010206-584	Rice Creek	Long Lk to Locke Lk	Anoka County (MS400066) Arden Hills City (MS400002) Birchwood Village City (MS400004) Blaine City (MS400075) Centerville City (MS400078) Century College (MS400171) Circle Pines City (MS400009) Columbia Heights City (MS400010) Dellwood City (MS400084) Falcon Heights City (MS400018) Forest Lake City (MS400262) Fridley City (MS400019) Grant City (MS400091) Hennepin County (MS400138) Hugo City (MS400094) Lauderdale City (MS400026) Lexington City (MS400027) Lino Lakes City (MS400100) Mahtomedi City (MS400031) Minneapolis Municipal Storm Water (MN0061018) Minnesota Correctional-Lino Lakes (MS400177) MnDOT Metro District (MS400170) Mounds View City (MS400037) New Brighton City (MS400038) North Oaks City (MS400109) Ramsey County Public Works (MS400191) Roseville City (MS400047) Shoreview City (MS400121) Spring Lake Park City (MS400050) St Anthony Village City (MS400051) University of Minnesota – Twin Cities Campus (MS400212) White Bear Lake City (MS400060) White Bear Township (MS400163) Willernie City (MS400061) Washington County (MS400160)

8 STAKEHOLDER PARTICIPATION

During development of the TMDL, eight large stakeholder meetings were held. The purpose of these meetings was to inform the groups about the findings of the TMDL project and to solicit their input. A list of the many organizations represented at the meetings can be found in Appendix A. Meeting dates, topics, and presentations can be found at http://www.pca.state.mn.us/ktqha48.

A formal public notice period for this Upper Mississippi River Bacteria TMDL Study and Protection Plan was held from April 7, 2014 through May 6, 2014. Nine comment letters were received during the official public notice period.

9 IMPLEMENTATION STRATEGIES

Various approaches to implementation are needed to address the variety of bacteria sources in this Upper Mississippi River Bacteria TMDL Study and Protection Plan. Implementation strategies include source controls, education, maintenance, and treatment best management practices (BMPs).

TMDL Subwatersheds have numeric *E. coli* targets that need to be met through implementation of BMPs that reduce the transport of bacteria into watercourses. The major bacteria sources in each subwatershed are a key initial focus for implementation. Protection Subwatersheds do not have a numeric *E. coli* target, but the major sources have been identified and can be used to target the types of BMPs that will prevent exceedance of the standard. Potential bacteria sources are outlined for each of the TMDL and Protection Subwatersheds in Table 4-15. Implementation should be targeted to the identified likely sources.

Adaptive management will be used to refine strategies during the implementation process. As implementation activities are conducted, management strategies may be revised to reflect observed impacts in the watershed (the Monitoring Plan is described in Section 11). Source reduction and pollution prevention are the initial focus for implementation efforts. Limiting bacteria sources is expected to lower the concentration of bacteria entering a BMP and increase the likelihood that the outflow from the BMP will support surface water quality standards. Treatment BMPs should be implemented to provide bacteria reduction in support of source control efforts.

Municipal, watershed, wastewater treatment system and other local and regional plans may already include implementation of best management practices that will provide bacteria control and treatment. The implementation strategies listed here should be supported by and integrated with these planned and ongoing efforts. In addition, bacteria reduction should be considered when designing BMPs for other purposes. For example, if a BMP is planned for nutrient reduction, design factors should be considered that would also provide bacteria reduction. BMPs that address multiple contaminants are preferred and will be encouraged.

All BMPs have a range of effectiveness. BMPs that treat stormwater and bacteria in runoff are particularly susceptible to variation in treatment efficiency because the runoff volume that the practice receives depends on variable rainfall and runoff conditions. Discussion of specific BMPs for each of several BMP categories is included in Section 9.1. The BMP descriptions and effectiveness summaries will be outlined further through the more detailed Implementation Plan when it is developed.

9.1 Implementation Strategy Descriptions

Many BMPs provide treatment through filtration or settling of sediment. Since bacteria can be associated with sediment, sedimentation and filtration may help limit bacteria pollution. Bacteria also is known to be removed or deactivated through exposure to sunlight, and through drying. Of course, avoiding the need for treatment by eliminating sources that allow the transport of bacteria into waterways is another best management practice. Details on most of these implementation strategies (e.g., bacteria removal efficiencies and design parameters that improve system performance) can be found in the report *Effectiveness of Best Management Practices for*

Bacteria Removal, developed by EOR for the Upper Mississippi River Bacteria TMDL, June 2011 (http://www.pca.mn.gov/index.php/view-document.html?gid=16328). More recent data on practice effectiveness may also be found through the International Stormwater BMP Database and its *International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary Statistical Addendum: TSS, Bacteria, Nutrients, and Metals, July 2012* (http://www.bmpdatabase.org/). *The Agricultural BMP Handbook for Minnesota* developed by EOR for the Minnesota Department of Agriculture (http://www.mda.state.mn.us/protecting/cleanwaterfund/research/agbmphandbook.aspx) provides additional guidance for many of the agricultural implementation strategies.

Several TMDLs have been completed in this project area to address other pollutants (e.g. total phosphorus (TP) and total suspended solids (TSS)). It is recognized that as implementation activities are undertaken to address these pollutants the potential exists that bacteria concentrations may be reduced as well. Many of the Best Management Practices (BMPs) that will be used to address these pollutants, particularly those that rely on infiltrating stormwater, may also be beneficial in reducing bacteria concentrations.

9.1.1 Pollution Prevention and Source Controls

Source controls and pollution prevention focus on limiting the introduction of bacteria to the landscape where bacteria could be transported to waterbodies. Source controls and pollution prevention are recommended as the first step when implementing bacteria controls because reducing the introduction of bacteria into landscapes where bacteria could be transported to waterbodies also limits the need for and size of structural controls. Source controls include efforts such as control of pet waste, street sweeping, septic system maintenance (see Section 9.1.10), wildlife management, livestock exclusion from riparian access (see Section 9.1.7), manure management (see Section 9.1.8), clean runoff water diversion and animal husbandry as well as education on these topics. Source controls such as education may not directly target a specific source area, but can provide valuable benefits toward bacteria reduction. Municipal separate storm sewer system (MS4) Minimum Control Measures (MCMs) required as a part of the MS4 permit include pollution prevention practices and maintenance requirements that can address source areas. Information on clean runoff water diversion practices is included in MDA (2012).

9.1.2 Wetland Treatment Systems

Wetland treatment systems are wetlands constructed with the purpose of treating wastewater or stormwater inputs. The wetlands may be vegetated, open water, or a combination of these. A range of removal efficiencies were found for different wetland treatment system designs. More effective wetland designs have a large treatment volume in proportion to the contributing drainage area, have open water areas between vegetated areas, have long flow paths and a resulting longer detention time, and are designed to allow few overflow events.

9.1.3 Detention and Retention Ponds

Sedimentation ponds, also called detention, retention, or stormwater ponds, are open water ponds constructed to allow the settling of particles in stormwater and watershed runoff and the storage of water to limit flooding. Sedimentation ponds typically contain ponded open water, but an alternate design, a dry detention pond, holds water for a brief period and drains dry. Bacteria removal efficiencies vary depending on design factors and setting. Designs that limit the washout of accumulated sediment, limit overflows, provide a longer detention time, and discourage congregations of wildlife and waterfowl have been shown to have higher removal efficiencies. The International Stormwater BMP Database's *International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary Statistical Addendum: TSS, Bacteria, Nutrients, and Metals, July 2012* (http://www.bmpdatabase.org/) found retention ponds to be the most effective practice of those evaluated as far as reductions in *E. coli* concentrations from the inlet to the outlet.

Ponds used in wastewater treatment and storage are addressed in Sections 9.1.8 and 9.1.11.

9.1.4 Biofiltration/Filtration

Biofiltration and filtration practices rely on the transport of stormwater and watershed runoff through a medium such as sand, compost, soil, or a combination of these in order to filter out sediment and therefore sediment-associated bacteria. Biofiltration systems, also called bioretention systems, are vegetated while filtration systems are not. Filtration and biofiltration practices are expected to be most effective when sized to limit overflows and designed to provide the longest flow path from inlet to outlet.

A related practice is the woodchip bioreactor, typically used to reduce nitrogen from agricultural tile drainage. The practice has potential to also provide bacteria reductions. Additional information on the practice can be found in *The Agricultural BMP Handbook for Minnesota* (MDA 2012).

9.1.5 Hydrodynamic and Manufactured Devices

Hydrodynamic devices capture sediment from stormwater by encouraging more rapid sedimentation through the swirling action of water moving through the device. Other manufactured devices may include filtration or settling of stormwater. Bacteria removal efficiency can vary widely depending on the type and configuration of the manufactured system.

9.1.6 Vegetated Buffers/Filter Strips/Swales

Vegetated buffers and filter strips are vegetated sections of land next to an area of runoff. The runoff is allowed to flow evenly over the buffer or filter strip, allowing capture of sediment by vegetation and allowing water to filter into the soil. Buffers and filter strips are used in numerous urban, rural, and agricultural applications such as adjacent to streams and wetlands, along agricultural field boundaries, and around feedlots. Swales are similar to buffers but allow a more directed flow pattern in a shallow, vegetated ditch. *The Agricultural BMP Handbook for Minnesota* includes information on filter strips and field borders and feedlot/wastewater filter strips specific to agricultural applications (MDA 2012). There are a range of reported bacteria removal efficiencies for buffers. Buffers and filter strips are expected to be most effective when infiltration into the soil is high and when a long flow path is provided over the buffer or filter strip. Swales are typically more effective for bacteria removal if filtration is included (e.g. permeable compost rolls across the swale).

9.1.7 Livestock Riparian Access Control

Livestock with access to streams, lakes, and other riparian areas directly introduce fecal matter and bacteria into the waterway or waterbody. Access control may include fencing, rotational grazing, stream crossing, and protection in heavy use areas. Installing watering systems away from the pond or stream can also reduce the amount of time animals spend in the waterbody or waterway. MDA (2012) provides information specific to agricultural applications for livestock exclusion fencing, rotational grazing, riparian and channel vegetation, and streambank and shoreline protection, though bacteria reductions associated with these practices are not discussed.

9.1.8 Manure Management

Manure management includes a variety of practices intended to store, treat, and use manure in a manner that limits the potential for the bacteria in manure to be transported to water bodies or waterways. Examples of manure management include land application methods that incorporate manure into the soil, storage of manure in areas where offsite transport is limited, and timing of manure application to avoid runoff-producing rainfall shortly after application. Information on manure management is available in the University of Minnesota Extension's 2007 publication *Best Management Practices for Pathogen Control in Manure Management Systems* (http://www.extension.umn.edu/distribution/livestocksystems/DI8544.html) (Spiehs and Goyal 2007).

9.1.9 Wastewater System Maintenance

Wastewater treatment systems require regular maintenance to maintain effective capture of bacteria. On-site subsurface sewage treatment systems require maintenance such as septic tank pumping. Larger community or regional wastewater treatment facilities require ongoing maintenance and replacement of infrastructure as the plant ages. Minimization or elimination of inflow and infiltration through repairing damaged, sewers also reduces the potential for exfiltration from sanitary sewers.

9.1.10 Wastewater System Structural Improvements

Wastewater treatment system infrastructure can be updated to increase bacteria capture and reduce or eliminate problem areas. For example, sanitary sewer and combined sewer overflows can be eliminated with changes to infrastructure. In unsewered areas, nonconforming and straight pipe systems need to be updated to current standards. In agricultural applications, manure and agricultural waste storage may need upgraded infrastructure to limit seepage into underlying soils and groundwater or storage facility covers to avoid overflow after rainfall events.

9.1.11 Education

Education efforts focus on bringing greater awareness to the issues surrounding bacteria contamination and methods to reduce loading and transport of bacteria. Education efforts targeted to the general public are commonly used to provide information on the status of impacted waterways as well as to address pet waste and wildlife issues. Education efforts may emphasize aspects such as cleaning up pet waste or managing the landscape to discourage nuisance congregations of wildlife and waterfowl. Education can also be targeted to municipalities, wastewater system operators, land managers and other groups who play a key role in the management of bacteria sources.

9.1.12 Ordinances

Ordinances are a tool used to set standards that must be followed in prescribed situations. Ordinances relevant to BMPs for bacteria treatment commonly include pet waste ordinances, septic system or SSTS ordinances, and buffer and stormwater management ordinances.

9.2 Costs

The Clean Water Legacy Act requires that a TMDL include an overall approximation of the cost to implement a TMDL (MN Statutes 2007, section 114D.25). The implementation cost estimate is based on treating the leading sources of bacteria identified for each TMDL Subwatershed in Table 4-15. Although implementation strategies may not only target the sources of bacteria ranked as *high* or *medium-high* (Table 4-15), it is assumed that the cost of treating these leading bacteria sources provides a reasonable basis for the costs required to meet the TMDL under a range of actual implementation scenarios. Implementation scenarios will be investigated in greater detail as a part of the Implementation Plan and will entail adaptive management principles.

The cost estimate entails a unit cost for decreasing the bacteria loads. The sources of bacteria can be lumped into three generalized categories: rural animals (livestock, wildlife, and pets), imminent threat to public health septic systems, and bacteria sources in urban stormwater (urban wildlife, pets, and humans[4]). A unit cost for each of these generalized categories was developed. The unit cost for bringing animal units (AU) under manure management plans and feedlot lot runoff controls is $350/AU. This value is based on USDA Environmental Quality Incentives Program (EQIP) payment history and includes buffers, livestock access control, manure management plans, waste storage structures, and clean water diversions.

Repair or replacement of imminent threat to public health septic systems was estimated at $7,500/system (USEPA 2011).

Reductions in bacteria loads from urban stormwater is estimated to be $190,000/square mile of urban area. This estimate is based on the base costs of typical structural stormwater BMPs as identified in Table 6-2 of *Costs and Benefits of Storm Water BMPs* (USEPA 1999). Although the best available cost estimate is based on structural stormwater BMPs, the cost is assumed to be more-than-adequate to account for educational campaigns that might be undertaken in place of structural BMPs. It is important to note that the urban stormwater cost estimate does not account for large-scale capital projects such as replacing existing wastewater and stormwater collection systems due to age and/or failure. Note that resolving underground breaches in sanitary sewer that results in the leakage of raw sewage into stormsewer would likely require these large-scale efforts. Note that none of TMDL subwatersheds ranked high for failing infrastructure. Refer to Table 4-3 and Table 4-15. For reference the TMDL subwatersheds combined are 738 square miles of which 163 acres are developed area using the NLCD dataset.

The cost of slip lining sanitary sewer pipes depends upon the size of pipe and the extent of the project. Based on recent projects in the City of Minneapolis and the City of Blaine the range of

[4] Note that human sources of bacteria in urban stormwater is discussed in Section 4.1.1.

costs to slip line one mile of 12” pipe is $152,000 to $227,000 and the cost to slip line one mile of 30” pipe ranges from $544,000 to $1,262,000.

The preliminary cost estimate is expressed as a range. The low end of the range is half of the raw calculated cost, and the high end of the range is twice the raw calculated cost. The initial estimate for implementing the Upper Mississippi River Bacteria TMDL in the TMDL Subwatersheds is approximately $36 million to $144 million. Note that these cost estimates do not reflect BMP maintenance costs over time which can be substantial.

The preliminary cost estimate does not account for the fact that implementation measures addressing bacteria also (and typically) treat other surface water pollutants. For example, education campaigns for dog owners to pick-up their dog’s waste reduces *E. coli* loading to surface waters as well as phosphorus loading. In addition, as in this example, implementation efforts that meet the needs of this bacteria TMDL may also help meet the needs of other planned stakeholder initiatives and/or permit requirements such as the MS4 permit’s Minimum Control Measures (MCMs). Ultimately, the costs incurred that are exclusive to meeting this bacteria TMDL is expected to be less than half of the preliminary cost estimate; half of the preliminary estimate is equal to $18 million to $72 million.

10 REASONABLE ASSURANCES

As part of an implementation strategy, reasonable assurances provide a level of confidence that the TMDL allocations will be implemented by federal, state, or local authorities. Implementation of the Upper Mississippi River Bacteria TMDL will be accomplished by both state and local action on many fronts, both regulatory and non-regulatory. Multiple entities in the watershed already work towards improving water quality. Water quality restoration efforts will be undertaken by Watershed Districts, County SWCDs, Counties, Municipalities, and local groups with assistance from the MPCA. Bacteria reductions from point sources will be made through permit compliance.

10.1 Non-Regulatory

The implementation strategies described in this TMDL have demonstrated to be effective in reducing bacteria loadings. Participation of landowners will be essential to reducing nonpoint sources of pollution and improving water quality. Educational efforts and cost share programs can increase participation to levels needed to protect water quality. Monitoring will continue and adaptive management will be in place to evaluate progress made towards achieving the beneficial use of each stream reach.

At the local level, most of the watershed districts, counties, SWCDs and local units of government currently implement programs targeted at water quality improvement and have been actively involved in projects to improve water quality in the past. It is anticipated that their involvement will continue. Potential state funding of TMDL implementation projects includes Clean Water Fund grants and Section 319 funding. At the federal level, funding can be provided through Section 319 grants that provide cost share dollars to implement activities in the watershed.

10.2 Regulatory

10.2.1 Municipal Separate Storm Sewer System (MS4) Permits

Stormwater discharges associated with MS4s are regulated through National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) permits. The Stormwater Program for MS4s is designed to reduce the amount of sediment and pollution that enters surface and ground water from storm sewer systems to the maximum extent practicable. MS4 Permits require the implementation of Best Management Practices (BMPs) to address WLAs. In addition, the owner or operator is required to develop a stormwater pollution prevention program (SWPPP) that incorporates BMPs applicable to their MS4. The SWPPP must cover six minimum control measures:

- Public education and outreach;
- Public participation/involvement;
- Illicit discharge, detection and elimination;
- Construction site runoff control;
- Post-construction site runoff control; and
- Pollution prevention/good housekeeping.

Many of the MS4s included in this TMDL have had considerable experience in managing non-point source pollution. Most MS4s have been included in other TMDLs or have addressed non-point source pollution through coordination with Watershed Districts (MN Statute 103D) or Watershed Management Organizations (MN Statute 103B) which have complete coverage throughout the Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington Counties as well as partial coverage throughout the rest of the TMDL area. MS4s also have a history of working together to manage stormwater runoff through Capital Improvement Projects that cross jurisdictional boundaries. Watershed Districts and Watershed Management Organizations have also taken an active leadership role in developing regional stormwater management solutions that involve multiple MS4s entities. The MPCA developed Minimal Impact Design Standards (MIDS) which represent the next generation of stormwater management. MIDS defines water performance goals for new development and redevelopment that will provide enhanced protection for Minnesota's water resources. MIDS is being incorporated into the State Stormwater Manual and more information can be found at http://www.pca.state.mn.us/veiza8e.

10.2.2 Wastewater & State Disposal System (SDS) Permits

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

10.2.3 Subsurface Sewage Treatment Systems Program (SSTS)

Subsurface Sewage Treatment Systems (SSTS), commonly known as septic systems, are regulated by Minnesota Statutes 115.55 and 115.56.
These regulations detail:

- Minimum technical standards for individual and mid-size SSTS;
- A framework for local administration of SSTS programs and;
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee.

10.2.4 Feedlot Rules

The Minnesota Pollution Control Agency (MPCA) regulates the collection, transportation, storage, processing and disposal of animal manure and other livestock operation wastes. The MPCA Feedlot Program implements rules governing these activities, and provides assistance to counties and the livestock industry. The feedlot rules apply to most aspects of livestock waste management including the location, design, construction, operation and management of feedlots and manure handling facilities.

There are two primary concerns about feedlots in protecting water:

- Ensuring that manure on a feedlot or manure storage area does not run into water;
- Ensuring that manure is applied to cropland at a rate, time and method that prevents bacteria and other possible contaminants from entering streams, lakes and ground water.

11 MONITORING PLAN

Monitoring the effectiveness of this TMDL will be accomplished through the MPCA intensive watershed monitoring approach which consists of a ten year cycle for assessing the waters of Minnesota. The steps of the approach include; monitoring and gathering of data, assessment of the data, establishing implementation strategies to meet standards and implementing water quality improvement activities. The monitoring is done to identify environmental status by examining the condition of a water body and is done through a combination of MPCA monitoring; monitoring by other local, state and federal agencies; citizen monitoring; and remote sensing. The entire process will be repeated 10 years following initiation of the monitoring. Specifically as it relates to monitoring effectiveness of this TMDL the following major watersheds will be monitored in the year indicated; the Mississippi River–Twin Cities Watershed, 2020, the Mississippi River–St. Cloud Watershed, 2019, and the Mississippi River–Sartell Watershed, 2016. During the 2013-14 monitoring seasons, the MPCA has been and is currently monitoring the Mississippi River from its headwaters in Itasca State Park down to St. Anthony Falls in Minneapolis.

In addition to the monitoring done in conjunction with the MPCA intensive watershed monitoring approach it is anticipated that a significant amount of monitoring will be done by the local partners that have been heavily involved in this TMDL development. Many of the partners have conducted water quality and flow monitoring in the past and are expected to continue to monitor the resources that are of local importance. Some of the state and local entities listed in Appendix A have collected *E. coli* data in the past and are likely to continue monitoring in the future. Some of these partners may also monitor for pathogens.

As water quality improvement practices are constructed in the implementation phase of the TMDL it can be expected that a monitoring effort will follow. The MPCA will encourage local partners to actively monitor the performance of the implementation projects and programs they undertake in order to account for their effectiveness in meeting the goals of the TMDL.

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APPENDIX A. STAKEHOLDER ORGANIZATIONS

Table A-1. Stakeholder organizations

Continues onto additional pages

- Albany Wastewater Treatment Facility (WWTF)
- Albertville WWTF
- Anoka Soil and Water Conservation District
- Anoka County
- Anoka Technical College
- Anoka-Ramsey Community College
- Avon WWTF
- Bassett Creek Watershed Management Organization (WMO)
- Benton County
- Benton County Soil and Water Conservation District (SWCD)
- Benton Utilities WWTF
- Big Lake Township
- Big Lake WWTF
- Bowlus WWTF
- Brockway Township
- Capitol Region Watershed District (WD)
- Carver County
- Centra Sota Cooperative
- Century College
- City of Andover
- City of Anoka
- City of Becker
- City of Blaine
- City of Big Lake
- City of Brooklyn Center
- City of Brooklyn Park
- City of Champlin
- City of Columbia Heights
- City of Coon Rapids
- City of Cottage Grove
- City of Crystal
- City of Dayton
- City of East Bethel
- City of Elk River
- City of Falcon Heights
- City of Fridley
- City of Golden Valley
- City of Grant
- City of Ham Lake
- City of Hastings
- City of Hilltop
- City of Hugo
- City of Inver Grove Heights
- City of Lake Elmo
- City of Landfall
- City of Lauderdale
- City of Lexington
- City of Lilydale
- City of Lino Lakes
- City of Little Canada
- City of Little Falls
- City of Mahtomedi
- City of Maple Grove
- City of Maplewood
- City of Medicine Lake
- City of Melrose
- City of Minneapolis Public Works Surface Water & Sewers Division
- City of Minneapolis Public Works Water Treatment & Distribution Division
- City of Minnetonka
- City of Monticello
- City of Mounds View
- City of New Brighton
- City of New Hope
- City of Newport
- City of North Oaks
- City of North St. Paul
- City of Oakdale
- City of Osseo
- City of Otsego
- City of Pine Springs
- City of Plymouth
- City of Ramsey
- City of Robbinsdale
- City of Rosemount
- City of Roseville
- City of Sartell
- City of Sauk Rapids
- City of Shoreview
- City of South St. Paul
- City of Spring Lake Park
- City of St. Anthony
- City of St. Cloud
- City of St. Cloud WWTF
- City of St. Joseph
- City of St. Louis Park
- City of St. Michael
- City of St. Paul
- City of St. Paul Park
- City of St. Paul Public Works
- City of St. Paul Regional Water Services
- City of Sunfish Lake
- City of Vadnais Heights
- City of Waite Park
- City of West St. Paul

- City of White Bear Lake
- City of Willernie
- City of Woodbury
- Clear Lake/Clearwater WWTF
- Clearwater River WD
- Coon Creek WD
- Crow River Organization of Water
- Dairy Producers
- Dakota County
- Dakota County SWCD
- Elk River WWTF
- Elk River Watershed Association
- Elm Creek WMO
- Friends of the Mississippi River
- Great River Greening
- Haven Township
- Hennepin County Environmental Services
- Hennepin County Public Health Protection
- Hennepin County Public Works
- Hennepin County-Environmental Health
- Hennepin Technical College
- Holdingford WWTF
- Inver Hills Community College
- Lake Andrew WWTF
- Le Sauk Township
- League of MN Cities
- Lower Minnesota River WD
- Lower Mississippi River WMO
- Lower Rum River WMO
- Metropolitan Council – Eagles Point, Hastings, Metropolitan WWTFs
- Metropolitan Council
- Metropolitan State University
- Middle Fork Crow River WD
- Minden Township
- Minneapolis Community/Technical College
- Minneapolis Park & Recreation Board
- Minneapolis Water Works
- Minnehaha Creek WD
- Mississippi River WMO
- MN Agriculture Water Resources Coalition (MAWRC)
- MN Board of Water and Soil Resources
- MN Center for Environmental Advocacy
- MN Cities Stormwater Coalition
- MN Correctional, Lino Lakes
- MN Department of Agriculture
- MN Department of Health
- MN Department of Natural Resources
- MN Department of Transportation
- MN Milk Producers Association
- MN Pollution Control Agency
- MN Rural Water Association
- Monticello WWTF
- Morrison County Courthouse
- Morrison SWCD
- New Pirates Cove WWTF
- North Fork Crow River WD
- North Hennepin Community College
- NPS Mississippi National River and Recreation Area
- Order of St. Benedict WWTF
- Otsego WWTF West
- Ramsey County
- Ramsey County Public Works
- Ramsey Washington Metro WD
- Rice Creek WD
- Rice WWTF
- Riverbend Mobile Home Park WWTF
- Saint Paul College
- Sauk Rapids Township
- Sauk River Watershed
- Sauk River WD
- Sherburne County
- Sherburne County SWCD
- Shingle Creek WMC
- South Washington WD
- St. Cloud State University
- St. Cloud Technical College
- St. Joseph Township
- Stearns County
- Stearns County SWCD
- Stearns County Water Planning
- Three Rivers Park District
- Todd County SWCD
- US Army Corps of Engineers
- US Geological Survey
- University of Minnesota
- University of Minnesota-Water Resources Center
- Upper Mississippi River Basin Association
- Upper Mississippi River Source Water Protection Project
- Upsala WWTF
- USDA Natural Resources Conservation Service
- Valley Branch WD
- Washington County
- Watab Township
- West Mississippi Watershed Management Commission
- White Bear Township

- Wright County Commissioner
- Wright County Farm Bureau
- Wright County Soil and Water Conservation District
- Xcel Energy

APPENDIX B. CLASSIFICATION OF IMPAIRED REACHES EXCLUDED FROM THE UPPER MISSISSIPPI RIVER BACTERIA TMDL STUDY AND PROTECTION PLAN

Table B-1. Impaired reaches excluded from the TMDL Study and Protection Plan.

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Skunk River	Hillman Cr to Platte R	07010201-521	Fecal Coliform	Aquatic Recreation	2008	2015/2019	2B, 3C	not adjacent	Mississippi River (Sartell) WRAPS – Future cycle (2016)
Ashley Creek	Headwaters to Sauk Lk	07010202-503	*Escherichia coli*	Aquatic Recreation	2010	2008/2012	2B, 3C	not adjacent / separate project	Sauk River Watershed Restoration & Protection Strategy (WRAPS) – Current Cycle
Sauk River	Adley Cr to Getchell Cr	07010202-505	*Escherichia coli*	Aquatic Recreation	2012	2018/2022	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Sauk River	Getchell Cr to State Hwy 23	07010202-508	*Escherichia coli*	Aquatic Recreation	2010	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Adley Creek	Sylvia Lk to Sauk R	07010202-527	*Escherichia coli*	Aquatic Recreation	2010	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Stony Creek	Headwaters (Unnamed lk 73-0261-00) to Sauk R	07010202-541	*Escherichia coli*	Aquatic Recreation	2010	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Unnamed creek	Unnamed cr to Sauk R	07010202-542	*Escherichia coli*	Aquatic Recreation	2012	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Eden Lake Outlet	Headwaters (Eden Lk 73-0150-00) to Browns Lk	07010202-545	*Escherichia coli*	Aquatic Recreation	2012	2018/2022	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Crooked Lake Ditch	Unnamed cr to Lk Osakis	07010202-552	*Escherichia coli*	Aquatic Recreation	2012	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Getchell Creek (County Ditch 2)	Unnamed cr to Sauk R	07010202-562	*Escherichia coli*	Aquatic Recreation	2012	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Unnamed creek (Cold Spring Creek)	T123 R30W S15, west line to Sauk R	07010202-567	*Escherichia coli*	Aquatic Recreation	2012	2008/2012	1B, 2A, 3B	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Unnamed creek	Unnamed cr to Getchell Cr	07010202-615	*Escherichia coli*	Aquatic Recreation	2012	2018/2022	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Unnamed ditch	Headwaters to Pearl Lk	07010202-665	*Escherichia coli*	Aquatic Recreation	2012	2008/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Mill Creek	Headwaters (Goodners Lk 73-0076-00) to Pearl Lk	07010202-674	*Escherichia coli*	Aquatic Recreation	2012	2018/2022	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Mill Creek	Pearl Lk to Sauk R	07010202-676	Fecal Coliform	Aquatic Recreation	2006	2006/2012	2B, 3C	not adjacent / separate project	Sauk River WRAPS – Current Cycle
Elk River	Mayhew Cr to Rice Cr	07010203-507	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Elk River	Headwaters to Mayhew Cr	07010203-508	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Mayhew Creek	Mayhew Lk 05-0007-00 to Elk R	07010203-509	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Rice Creek	Rice Lk to Elk R	07010203-512	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Tibbets Brook	Rice Lk to Elk R	07010203-522	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Snake River	Unnamed cr to Eagle Lk outlet	07010203-529	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	1B, 2A, 3B	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Battle Brook	CD 18 to Elk Lk	07010203-535	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Elk River	St Francis R to Orono Lk	07010203-548	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Clearwater River	CD 44 to Lk Betsy	07010203-549	Fecal Coliform	Aquatic Recreation	1996	TMDL plan approved	2B, 3C	not adjacent	Clearwater River – CD#44 to Lake Betsy Bacteria and Lake Nutrients (Clear, Louisa, Scott, Betsy, Union & Marie Lakes) – TMDL approved 11/2009

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Unnamed creek (Fairhaven Creek)	Headwaters to Lk Louisa	07010203-565	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	1B, 2A, 3B	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Elk River	Elk Lk (71-0141-00) to St Francis R	07010203-579	Fecal Coliform	Aquatic Recreation	2008	TMDL plan approved	2B, 3C	not adjacent	Elk River Multiple Impairments TMDL – TMDL Approved 6/14/2012
St Francis River	Headwaters to Unnamed lk (71-0371-00)	07010203-700	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	not adjacent	Mississippi River (St. Cloud) WRAPS – Future cycle (2019)
Crow River	S Fk Crow R to Mississippi R	07010204-502	Fecal Coliform	Aquatic Recreation	2004	2006/2012	2B, 3C	separate project	North Fork Crow & Lower Crow Bacteria, Turbidity & Low DO – (Completed – TMDL approved 8/20/13)
Crow River, North Fork	Mill Cr to S Fk Crow R	07010204-503	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Crow River, North Fork	M Fk Crow R to Jewitts Cr	07010204-507	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Crow River, Middle Fork	Green Lk to N Fk Crow R	07010204-511	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Grove Creek	Unnamed cr to N Fk Crow R	07010204-514	*Escherichia coli*	Aquatic Recreation	2010	2010/2013	2B, 3C	separate project	North Fork Crow River WRAPS – Current Cycle
Mill Creek	Buffalo Lk to N Fk Crow R	07010204-515	*Escherichia coli*	Aquatic Recreation	2012	2018/2022	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Washington Creek (County Ditch 9)	Washington Lk to N Fk Crow R	07010204-518	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Unnamed creek	Unnamed cr to Crow R	07010204-542	*Escherichia coli*	Aquatic Recreation	2010	2010/2013	2B, 3C	separate project	North Fork Crow River WRAPS – Current Cycle

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Crow River, North Fork	Meeker/Wright County line to Mill Cr	07010204-556	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Jewitts Creek (County Ditch 19, 18, 17)	Headwaters (Lk Ripley 47-0134-00) to N Fk Crow R	07010204-585	*Escherichia coli*	Aquatic Recreation	2010	2010/2013	2C	separate project	North Fork Crow River WRAPS – Current Cycle
Collinwood Creek	Unnamed cr (Unnamed lk 47-0031-00 outlet) to Big Swan Lk	07010204-604	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Sarah Creek	Lk Sarah to Crow R	07010204-628	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Unnamed creek	Unnamed ditch to Woodland WMA wetland (86-0085-00)	07010204-667	*Escherichia coli*	Aquatic Recreation	2010	2010/2013	2B, 3C	separate project	North Fork Crow River WRAPS – Current Cycle
Unnamed creek	Unnamed cr to Woodland WMA wetland (86-0085-00)	07010204-668	*Escherichia coli*	Aquatic Recreation	2012	2017/2021	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Twelvemile Creek	Little Waverly Lk to N Fk Crow R	07010204-681	*Escherichia coli*	Aquatic Recreation	2012	2019/2023	2B, 3C	separate project	North Fork Crow River WRAPS – Future Cycle (2017)
Buffalo Creek	JD 15 to S Fk Crow R	07010205-501	Fecal Coliform	Aquatic Recreation	2008	2010/2013	2B, 3C	separate project	Buffalo Creek South Fork Crow River Bacteria TMDL – Sent to EPA 10/28/13
Buffalo Creek	Headwaters to JD 15	07010205-502	Fecal Coliform	Aquatic Recreation	2008	2006/2013	2B, 3C	separate project	Buffalo Creek South Fork Crow River Bacteria TMDL – Sent to EPA 10/28/13
Crow River, South Fork	Buffalo Cr to N Fk Crow R	07010205-508	Fecal Coliform	Aquatic Recreation	2006	2010/2016	2B, 3C	separate project	North Fork Crow River WRAPS – Current Cycle
Elm Creek	Headwaters (Lk Medina 27-0146-00) to Mississippi R	07010206-508	*Escherichia coli*	Aquatic Recreation	2010	2009/2014	2B, 3C	separate project	Elm Creek WRAPS – Current Cycle

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Diamond Creek	Headwaters (French Lk 27-0127-00) to Unnamed lk	07010206-525	*Escherichia coli*	Aquatic Recreation	2010	2009/2014	2B, 3C	separate project	Elm Creek WRAPS – Current Cycle
Rush Creek	Headwaters to Elm Cr	07010206-528	*Escherichia coli*	Aquatic Recreation	2010	2009/2014	2B, 3C	separate project	Elm Creek WRAPS – Current Cycle
Coon Creek	Unnamed cr to Mississippi R	07010206-530	*Escherichia coli*	Aquatic Recreation	2014	TBD	2B, 3C	separate project	Coon Creek WRAPS – Current Cycle
Minnehaha Creek	Lk Minnetonka to Mississippi R	07010206-539	*Fecal Coliform*	Aquatic Recreation	2008	2009/2013	2B, 3C	separate project	Minnehaha Creek TMDL – Current Cycle
Unnamed creek	Headwaters to Mississippi R	07010206-557	*Escherichia coli*	Aquatic Recreation	2014	TBD	2B, 3C	separate project	Coon Creek WRAPS – Current Cycle
Unnamed ditch	Headwaters to Mississippi R	07010206-594	*Escherichia coli*	Aquatic Recreation	2014	TBD	2B, 3C	separate project	Coon Creek WRAPS – Current Cycle
Fish Creek	Carver Lk to Unnamed (North Star) lk	07010206-606	*Escherichia coli*	Aquatic Recreation	2014	TBD	2C	not adjacent	Ramsey-Washington Metro Watershed District WRAPS – Current Cycle
Unnamed creek (Lambert Creek)	Unnamed ditch to Vadnais Lake	07010206-637	Fecal Coliform	Aquatic Recreation	2008	2010/2014	2B, 3C	separate project	Vadnais Lake Area WMO TMDL – Current Cycle
Unnamed creek (Lambert Creek)	Highway 96 to Unnamed ditch	07010206-639	*Escherichia coli*	Aquatic Recreation	2014	TBD	2B, 3C	separate project	Vadnais Lake Area WMO TMDL – Current Cycle
Painter Creek	Unnamed cr to Lk Minnetonka	07010206-700	*Escherichia coli*	Aquatic Recreation	2010	2011/2016	2B, 3C	separate project	Minnehaha Creek TMDL – Current Cycle
Rush Creek, South Fork	Unnamed lk (27-0439-00) to Rush Cr	07010206-732	*Escherichia coli*	Aquatic Recreation	2010	2009/2014	2B, 3C	separate project	Elm Creek WRAPS – Current Cycle
Chaska Creek	Headwaters to Minnesota R	07020012-512	Fecal Coliform	Aquatic Recreation	2006	2013/2016	2B, 3C	not adjacent	Lower Minnesota River Watershed WRAPS – Future Cycle (2014)
Carver Creek	Headwaters to Minnesota R	07020012-516	Fecal Coliform	Aquatic Recreation	2002	TMDL plan approved	2B, 3C	not adjacent	Carver County Bacteria TMDL – TMDL approved 03/14/2007
Unnamed creek	Headwaters to Minnesota R	07020012-528	Fecal Coliform	Aquatic Recreation	2006	2013/2018	2B, 3C	not adjacent	Lower Minnesota River Watershed WRAPS – Future Cycle (2014)

Listed Reach Name	Reach Description	AUID	Listed Pollutant	Impaired Use	Year Listed	TMDL Start/ Completion	Beneficial Use Class[1]	Why Excluded from TMDL Study	Separate Project Description
Unnamed creek (East Creek)	Unnamed cr to Minnesota R	07020012-581	Fecal Coliform	Aquatic Recreation	2006	2013/2018	2B, 3C	not adjacent	Lower Minnesota River Watershed WRAPS – Future Cycle (2014)

[1] All waters, whether designated with a specific beneficial use classification or not, are also classified as 3C, 4A, 4B, 5, and 6 waters. For waters with multiple classifications, the more restrictive standards apply.

APPENDIX C. MONITORING STATIONS FOR DATA ANALYSES

Table C-1. Flow, water quality, and precipitation monitoring stations used for the load duration curve and monthly summary figure of each reach.

E. coli			Flow		Precipitation
Waterbody	AUID	Monitoring Site(s)	Waterbody	Monitoring Site	NWS Station
Mississippi River	07010201-501	S000-150	Mississippi River	5267000	211691
	07010201-502	S006-163 S005-782	Mississippi River	5270700	217294
	07010201-509	None	Mississippi River	5267000	211691
	07010201-513	S006-147	Mississippi River	5270700	217294
	07010203-503	S000-052	Mississippi River	5288500	217309
	07010203-510	S000-148 S000-221	Mississippi River	5270700	217294
	07010203-574	S000-026 S005-913 S006-875	Mississippi River	5270700	217294
	07010206-501	S006-144	Mississippi River	5344500	213567
	07010206-502	MCES-094 MCES-100 MCES-104 S000-068 S000-339	Mississippi River	5331580	213567
	07010206-503	S001-303 S004-655 S004-656 MCES-119 S004-657	Mississippi River	5288500	214884
	07010206-504	MCES-107 S005-052	Mississippi River	5331000	MCES-052
	07010206-505	MCES-115 S000-266 S006-735	Mississippi River	5331000	MCES-006
	07010206-509	MCES-120 S000-024 S004-652 S004-653 S004-654 SPWU-1	Mississippi River	5288500	214884
	07010206-511	S006-146	Mississippi River	5288500	MCES-037 MCES-138
	07010206-512	S006-145	Mississippi River	5288500	MCES-037 MCES-138
	07010206-513	S006-164	Mississippi River	5288500	214884 MCES-002
	07010206-514	S002-011	Mississippi River	5288500	MCES-061
	07010206-568	S000-025 MCES-122	Mississippi River	5288500	MCES-037 MCES-138
Sauk River	07010202-501	S000-360 S004-621 S000-503 S000-017 SCWU-002	Sauk River	5270500	211691
Little Two River	07010201-516	S006-162	Mississippi River	5267000	211691
Two River	07010201-543	S000-424	Mississippi River	5267000	211691
	07010201-523	S002-949	Mississippi River	5267000	211691
Lower Spunk Lake	07010201-525	S002-948	Mississippi River	5267000	211691

E. coli			Flow		Precipitation
Waterbody	**AUID**	**Monitoring Site(s)**	**Waterbody**	**Monitoring Site**	**NWS Station**
Watab River	07010201-528	S002-947	Sauk River	5270500	211691
	07010201-554	S005-715	Sauk River	5270500	211691
	07010201-529	S005-714	Sauk River	5270500	211691
County Ditch 12	07010201-537	S005-713	Sauk River	5270500	211691
County Ditch 13	07010201-564	S003-363	Sauk River	5270500	211691
County Ditch 17	07010206-557	S006-140	Elm Creek	5287890	217309 MCES-138
Platte River	07010201-545	S001-930	Mississippi River	5267000	211691
Stony Creek	07010201-615	S005-719	Mississippi River	5267000	211691
Clearwater River	07010203-511	S004-508 S004-504	Sauk River	5270500	217294
Unnamed Creek	07010203-528	S006-148	Elk River	5275000	211107
Elk River	07010203-548	S000-278	Elk River	5275000	217294
Silver Creek	07010203-557	S005-540	Crow River	5280000	211107
Unnamed Creek (Luxemburg Creek)	07010203-561	S003-366	Sauk River	5270500	211691
Plum Creek	07010203-572	S003-369 S005-721	Sauk River	5270500	217294
Johnson (Meyer) Creek	07010203-635	S005-711	Sauk River	5270500	211691
	07010203-639	S003-370 S003-765	Sauk River	5270500	217294
Unnamed (Robinson or Neenah) Creek	07010203-724	S003-365	Sauk River	5270500	211691
Crow River	07010204-502	MCES-037 S000-050 S001-257 S004-796 S004-433 S004-433 S000-004	Crow River	5280000	211107
Shingle Creek	07010206-506	S001-946	Shingle Creek	5288705	215838
Elm Creek	07010206-508	S003-441 S004-221 S004-222 S004-543 S004-544 S004-545 S005-338 S005-818 S005-819	Elm Creek	5287890	MCES-138 MCES-037
Unnamed (Headwaters to Medicine Lk)	07010206-526	S005-012 S005-346 S005-351	Bassett Creek	MCES-002	215838
Coon Creek	07010206-530	S003-993	Elm Creek	5287890	217309 MCES-138
Bassett Creek	07010206-538	MCES-002 S005-013 S005-015 S005-016 S005-017 S005-348	Bassett Creek	MCES-002	215838

E. coli			**Flow**		**Precipitation**
Waterbody	**AUID**	**Monitoring Site(s)**	**Waterbody**	**Monitoring Site**	**NWS Station**
Minnehaha Creek	07010206-539	MCES-061 S000-078 S001-334 S003-731 S003-732 S003-733 S003-734 S003-735 S003-739 S003-740 S003-742 S003-743 S004-370 S004-371 S004-372 S004-525	Minnehaha Creek	MCES-061	MCES-061
Unnamed Creek (Interstate Valley Creek)	07010206-542	S006-139	Battle Creek	MCES-006	MCES-061
Unnamed Lake (North Branch, Bassett Creek)	07010206-552	S005-014	Bassett Creek	MCES-002	215838
Rice Creek	07010206-584	S003-049	Elm Creek	5287890	MCES-138 218450
Battle Creek	07010206-592	MCES-006	Battle Creek	MCES-006	MCES-006
Unnamed (Pleasure)	07010206-594	S005-636 S005-637 S005-263 S003-995	Elm Creek	5287890	217309 MCES-138
Fish Creek	07010206-606	MCES-052	Fish Creek	MCES-052	MCES-052
Rum River	07010207-555	S000-016 MCES-138 S006-142	Rum River	MCES-139	MCES-138 217309
Minnesota River	07020012-505	MCES-069 MCES-068 MCES-066	Minnesota River	5330920	215435

APPENDIX D. *E. COLI* DATA SUMMARY

Table D-1. Summary of monthly *E. coli* geometric mean concentrations across all years.
All *E. coli* units in org / 100 ml

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010201-501	Protection	3	1	66	66	66	66	66	66
		4	10	1	48	8.88	7	9.5	22
		5	9	2	51	16.2	12	19	35
		6	10	2	185	21.5	9	25.5	42
		7	5	3	96	9.09	4	6	9
		8	8	1	326	11.8	3	13	36.5
		9	7	1	345	10.8	3	4	148
		10	6	1	99	7.63	4	4.5	25
		11	1	222	222	222	222	222	222
07010201-502	TMDL	1	1	260	260	260	260	260	260
		3	2	47	110	71.9	47	78.5	110
		4	11	3	26	8.55	5	9	20
		5	11	5	1100	44.5	11	41	186
		6	12	19	580	87.2	45.5	81	162
		7	5	12	104	36.3	23	44	50
		8	9	38	2400	277	104	186	816
		9	8	11	326	70.2	44	71	137.5
		10	7	19	1400	67.2	27	58	80
		11	1	82	82	82	82	82	82
07010201-513	Protection	4	6	1	17	6.32	2	12	13
		5	7	5	150	49.1	15	78	130
		6	5	5	25	13.2	10	14	23
		7	3	6	21	9.59	6	7	21
		8	6	20	100	32.7	26	28	30
		9	5	5	18	11.4	11	12	16
		10	5	5	17	9.83	9	10	12
07010201-516	TMDL	3	1	220	220	220	220	220	220
		4	6	15	150	29.8	16	24	34
		5	7	19	2400	251	100	250	870
		6	8	4	710	163	135.35	254.75	404
		7	5	185	2400	523	201.4	272.3	1600
		8	8	160	2419.6	604	288.65	508.5	1700
		9	6	160	2420	689	388	565	2240
		10	6	210	2400	834	461	956.5	1700
07010201-523	TMDL	4	5	4	41	13.4	9	16	18
		5	5	53	650	154	96	130	199
		6	8	50	870	220	163.2	207.35	341.5
		7	5	15	410	99.4	53	167	178.5
		8	7	55.6	2400	252	101.4	230	580
		9	6	130	687	395	300	480.5	613
		10	5	69	2400	261	119	236	261

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010201-525	TMDL	3	1	160	160	160	160	160	160
		4	5	6	26	14.5	12	15	23
		5	5	160	1300	331	172	214	520
		6	5	152	1600	772	770	1046	1400
		7	3	56	1300	252	56	220	1300
		8	5	260	2400	835	276	980	2400
		9	5	308	920	462	310	461	517
		10	5	411	2400	1250	649	1986	2400
07010201-528	TMDL	4	5	2	93	14.5	3	16	72
		5	5	42	250	117	100	130	162
		6	10	101	461	191	123.6	183.9	285.1
		7	8	74	2419.6	266	112.85	198.45	660.85
		8	10	84.2	2000	300	137.6	216.75	920.8
		9	7	69	240	139	98	129	214
		10	5	64	2400	194	73	108	225
07010201-529	TMDL	6	7	96	816.4	256	159.7	214.3	435.2
		7	7	81.6	6310	459	161.6	248.1	2419.6
		8	7	101.9	365.4	177	131.4	139.6	290.9
		9	1	1413.6	1413.6	1410	1413.6	1413.6	1413.6
07010201-537	TMDL	6	7	18.9	344.8	111	93.3	125.9	185
		7	7	70.6	920.8	217	108.6	248.1	461.1
		8	7	32.7	206.4	101	60.2	108.1	166.4
		9	1	50.4	50.4	50.4	50.4	50.4	50.4
07010201-543	TMDL	6	7	24.3	198.9	108	76.8	139.6	178.2
		7	7	186	920.8	342	260.3	277.8	488.4
		8	7	75.9	816.4	319	191.8	328.2	770.1
		9	1	547.5	547.5	548	547.5	547.5	547.5
07010201-545	Protection	3	1	3	3	3	3	3	3
		4	5	5	73	11.1	6	7	11
		5	4	10	31	18.1	11	20.5	30
		6	5	13	72	38.2	33	50	53
		7	2	10	45	21.2	10	27.5	45
		8	4	12	35	22.4	16	25	32.5
		9	2	138	261	190	138	199.5	261
		10	1	77	77	77	77	77	77
		11	1	21	21	21	21	21	21
07010201-554	TMDL	6	7	117.2	920.8	338	155.3	461.1	686.7
		7	7	259.5	770.1	407	260.3	387.1	727
		8	7	53.8	410.6	189	99	248.9	307.6
		9	1	387.3	387.3	387	387.3	387.3	387.3
07010201-564	TMDL	6	7	186	1553.1	442	365.4	410.6	478.8
		7	7	238.2	2419.6	553	325.5	517.2	648.8
		8	7	123.4	1046.2	203	123.6	133.3	285.1
		9	1	191.8	191.8	192	191.8	191.8	191.8

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010201-615	Protection	6	6	135.4	579.4	284	191.8	293.4	410.6
		7	7	51.2	2419.6	425	156.5	727	1046.2
		8	7	155.3	2419.6	633	186	816.4	1553.1
07010202-501	Protection	3	9	1	1119.9	77.1	5.2	468	1119.9
		4	28	1	35	9.07	6	8	19.45
		5	38	2	252	27.8	13	24	85
		6	33	2	1046.2	50.4	21	39	121
		7	24	4	288	37.8	17.5	40.5	72
		8	36	10	576	75.8	36.65	70.15	137.7
		9	27	6	432	54.5	38	62	90.9
		10	7	19.9	1300	78	31.5	62	84
		11	5	9.7	27.5	18.1	13.5	20.1	26.5
		12	2	7.4	24.9	13.6	7.4	16.15	24.9
07010203-503	Protection	4	5	3	10	6.18	5	6	10
		5	5	6	248	29.7	10	26	60
		6	5	7	39	17.9	13	19	27
		7	3	10	69	25.8	10	25	69
		8	5	23	66	42.4	30	52	58
		9	5	16	49	24.4	17	25	26
		10	5	12	84	29.4	22	24	41
07010203-510	TMDL	4	8	1	370	6.69	2	4	14.5
		5	8	4	23	8.3	4	8	18
		6	8	13	760	76.5	32	56	287.5
		7	8	12	170	34.3	18	34.5	52.5
		8	8	8	980	46.1	19.5	32	101
		9	8	24	200	69	44	58	130
		10	6	12	33	21.3	16	21.5	32
07010203-511	Protection	4	3	1	3.1	1.84	1	2	3.1
		5	3	12.4	34.4	21.7	12.4	23.8	34.4
		6	15	12.2	650	69.6	36.4	68	130
		7	15	21.8	122.9	46.7	35.5	44	70
		8	15	17.3	149.1	42.6	30.5	42	60
		9	4	34.5	65.9	45	35.7	42.8	57.3
		10	3	12.4	27.1	17.1	12.4	15	27.1
07010203-528	TMDL	3	1	260	260	260	260	260	260
		4	6	5	47	20.2	10	27	47
		5	7	25	2400	313	100	460	770
		6	6	50	461	138	91	137.5	190
		7	3	4	345	59.2	4	150	345
		8	6	150	17000	1170	550	875	2400
		9	5	575	2000	1080	770	1046	1600
		10	6	104	2000	279	105	215	488
07010203-548	Not Adjacent	4	3	5	21	8.57	5	6	21
		5	3	15	42	24.4	15	23	42

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		6	9	14	1400	75.4	47	63	100
		7	6	23	110	56.7	36	60.5	100
		8	7	45	980	176	67	133	387
		9	2	291	866	502	291	578.5	866
07010203-557	TMDL	3	1	31	31	31	31	31	31
		4	5	1	13	2.08	1	1	3
		5	6	3	650	33.9	9	36.5	88
		6	8	23	300	68.9	34.5	60.5	130
		7	6	15	370	89.5	61	68	330
		8	9	39	440	136	73	210	214
		9	5	35	178	75.2	42	83	111
		10	6	28	194	93.6	36	138.5	180
07010203-561	TMDL	6	7	101.2	1119.9	253	137.6	248.9	280.9
		7	7	517.2	2419.6	860	547.5	816.4	1046.2
		8	7	193.5	435.2	293	195.6	325.5	410.6
		9	1	137.4	137.4	137	137.4	137.4	137.4
07010203-572	TMDL	6	12	31.6	574.8	119	42.85	129.6	259.55
		7	11	62.7	2419.6	166	82.3	141.4	193.5
		8	7	49.6	1203.3	140	78	129.6	137.4
		9	1	613.1	613.1	613	613.1	613.1	613.1
07010203-574	Protection	1	92	16.1	920.8	89.4	61.9	95.9	134.3
		2	88	20.8	648.8	106	82	116.1	156.45
		3	97	2	928	75.7	26.2	105.6	186
		4	98	0.5	55	6.85	4.1	7.45	13.4
		5	101	0.5	833	7.87	4	10	17.2
		6	99	0.5	450	18.9	8	20	42.5
		7	114	0.5	663	13.7	5.2	15	33.6
		8	135	0.5	650	19.6	10	20.5	41
		9	130	0.5	440	21.9	13.5	22	39.4
		10	125	0.5	573	21.6	10.4	20	37
		11	94	3	136	27.1	19.4	26.95	36.4
		12	94	15.8	1299.7	53.1	34.5	49.75	74.9
07010203-635	TMDL	6	7	57.6	866.4	309	125.9	365.4	727
		7	7	307.6	2419.6	562	325.5	365.4	1119.9
		8	7	193.5	2419.6	554	201.4	547.5	1553.1
		9	1	1299.7	1299.7	1300	1299.7	1299.7	1299.7
07010203-639	TMDL	3	1	190	190	190	190	190	190
		4	6	11	1000	82.6	12	137	710
		5	7	56	2400	852	326	1986	2400
		6	17	266	6500	1410	920.8	2000	2400
		7	13	450	7700	2230	1413.6	2400	2419.6
		8	16	822	24000	3090	2400	2419.6	4183
		9	7	206.4	9800	1190	690	976	1800
		10	6	345	24000	1490	690	1055	1732

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010203-724	TMDL	6	7	72.7	1046.2	288	127.4	344.8	866.4
		7	7	167	2419.6	444	178.2	410.6	648.8
		8	7	105	648.8	255	121.1	290.9	365.4
		9	1	178.9	178.9	179	178.9	178.9	178.9
07010204-502	Separate Project	1	4	93	818	217	112.5	175.5	518.5
		2	4	66	1125	156	75.5	90	610
		3	12	8	1046	117	55	113.5	452.5
		4	18	2	35	10.5	7	11	17
		5	17	2	219	17.5	12	20	23
		6	20	17	2900	113	42.5	102.5	160
		7	20	5	650	38.9	17.5	37.5	74
		8	17	5	1700	89.9	40	110	270
		9	18	9	2800	120	50	80	390
		10	10	3	2076	53.5	7	42	284
		11	5	24	518	76.7	39	66	83
		12	6	25	816	126	49	96.5	503
07010206-501	Protection	4	4	0.5	20	3.66	1.25	5.5	14.5
		5	5	4	77	23.6	8	50	60
		6	5	12	200	46.3	44	44	46
		7	6	10	1000	65.2	33	56.5	76
		8	5	25	270	72.2	49	64	93
		9	5	28	190	85.5	61	78	180
		10	5	28	230	60.9	44	50	59
07010206-502	Protection	1	24	5	1010	173	124	218.5	355
		2	24	24	435	159	110	189	276
		3	49	2	488	54.1	24	55	152
		4	64	1	118	13.7	8.5	14.5	26
		5	63	3	152	17.5	9	16	26
		6	76	1	199	28.5	13.5	32	75
		7	82	0.5	387	14.8	6	16	34
		8	80	0.5	1308	24.4	6.5	25.5	86
		9	76	0.5	580	26.8	9.5	28	95
		10	65	9	650	56.2	30	55	102
		11	28	6	707	96.6	54	113	249
		12	19	3	613	132	63	228	308
07010206-503	TMDL	1	14	11	172	64.2	56	74.5	104
		2	12	9	411	37.3	19	32.5	70.5
		3	24	5	345	24.1	11.5	23.5	42
		4	138	1	185	13.6	7	12	26
		5	142	2	2400	26.7	12	21.5	46
		6	252	0.8	8700	67	32	52.5	117.5
		7	253	1	2420	51.1	25	52	110
		8	254	4	2500	76.1	36	64	135
		9	228	6	9100	111	52	90	216.5

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		10	219	5	7200	96.9	35	82	167
		11	26	15	1414	79.6	41	58.5	184
		12	8	14	83	39.9	24.5	49	65.5
07010206-504	Protection	1	12	131	687	342	260	335.5	477.5
		2	12	225	649	346	288	345	390
		3	26	14	866	137	46	221	347
		4	30	5	66	17.8	8	17	34
		5	30	11	220	35.5	19	27	62
		6	30	11	219	53.6	27	52	99
		7	32	8	365	32.8	12.5	29.5	63.5
		8	29	4	1267	62.3	22	56	108
		9	29	12	613	64.7	32	37	151
		10	30	13	2400	93.7	46	74	170
		11	14	37	1300	283	228	298	411
		12	10	153	866	365	276	404.5	461
07010206-505	TMDL	1	12	39	272	113	71.5	114.5	174
		2	12	37	291	112	73.5	114	175
		3	25	3	866	56.2	29	55	96
		4	29	4	816	19.2	9	14	31
		5	28	2	246	27.2	10.5	25.5	101
		6	31	2	249	56	30	60	116
		7	30	4	1203	38.6	21	37	66
		8	28	10	2420	83.7	34.5	65.5	161
		9	29	11	613	60.9	29	42	154
		10	27	11	461	77.6	31	51	219
		11	14	13	1023	63	36	72	86
		12	10	13	285	63.5	43	57	93
07010206-506	TMDL	4	9	10	370	36.2	20	31	53
		5	14	24	27000	170	64	125	240
		6	13	100	1700	287	150	230	410
		7	14	82	19000	301	110	155	532
		8	15	41	5500	439	86	520	1628
		9	12	41	4000	253	106.5	120	720
		10	12	28	3500	298	112	249	1405
07010206-508	Separate Project	4	58	2	326	22.3	10	19.5	58
		5	114	1	411	46.6	24	44	104
		6	119	2	2419	119	51	120	249
		7	118	1	2420	103	40	108	260
		8	134	1	2420	102	46	102.5	238
		9	116	1	2420	119	59.5	120.5	345
		10	120	1	2420	85.1	29.5	68	268.5
		11	13	4	579	42.1	18	36	93
07010206-509	TMDL	1	81	20	2280	130	85	130	197
		2	64	0.5	1300	71.4	40.5	63.5	130

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		3	69	0.5	1100	36.3	17	41	200
		4	187	0.5	1100	12.3	7	13	30
		5	204	0.5	6300	28.3	13	25	45
		6	319	0.5	8000	64.5	35	68	140
		7	321	0.5	2420	42.8	23	48	101
		8	337	0.5	9500	78.6	45	90	172
		9	304	0.5	5500	140	77.5	130	300
		10	316	0.5	4900	59.6	24	72	160
		11	107	0.5	1046	30.2	20	41	72
		12	81	0.5	200	24.6	20	42	75
07010206-511	Protection	4	5	5	17	9.18	5	9	17
		5	7	13	130	48	22	46	120
		6	5	16	47	30.5	22	36	44
		7	6	31	140	59.5	39	56.5	83
		8	5	26	54	42.8	38	51	53
		9	5	23	330	51.9	25	44	45
		10	5	9	770	37.4	20	23	23
07010206-512	Protection	3	1	170	170	170	170	170	170
		4	5	4	31	10.1	7	8	15
		5	9	16	1400	68.2	26	49	99
		6	5	7	54	23.7	16	28	44
		7	6	27	91	49.2	44	47	60
		8	5	31	110	56.2	47	54	65
		9	5	36	120	57.4	41	54	65
		10	6	12	460	47.7	19	24	200
07010206-513	Protection	4	12	2	64	13.7	8.5	15	24
		5	13	9	166	22.5	11	15	38
		6	16	15	365	57.6	40	50	75.5
		7	11	26	2420	82.8	41	50	119
		8	16	30	219	85.3	51.5	77	147.5
		9	14	63	435	122	82	113	161
		10	12	16	579	71.7	31.5	65.5	103
		11	1	36	36	36	36	36	36
07010206-514	Protection	4	4	3	37	6.04	3	3.5	20.5
		5	5	12	170	44.3	16	40	130
		6	5	13	250	59.5	30	51	150
		7	5	41	160	64.6	53	55	59
		8	5	23	910	77.5	45	53	56
		9	5	28	440	77.6	41	68	82
		10	5	15	490	71.8	30	31	280
07010206-526	TMDL	6	8	3	2400	81.7	32.5	105.5	160
		7	6	78	770	304	140	425	520
		8	6	41	710	177	99	210	250
		9	6	38	2400	244	60	240	820

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010206-530	Separate Project	3	1	190	190	190	190	190	190
		4	7	6	190	33.1	12	34	67
		5	9	63	2400	178	120	130	160
		6	6	130	550	212	130	180	310
		7	6	48	1000	201	110	190	390
		8	9	82	980	347	130	490	610
		9	2	820	2400	1400	820	1610	2400
		10	6	56	550	138	77	87	390
07010206-538	TMDL	1	4	14	60	31	19.5	34.5	52
		2	6	1	179	18.6	2	36.5	86
		3	16	9	692	73.5	35.5	68.5	188
		4	13	9	816	51	24	61	90
		5	12	24	1426	90.4	37	53.5	230.5
		6	40	1	2420	191	63	155	495
		7	35	17	2400	305	120	280	980
		8	33	23	1400	182	93	220	370
		9	32	32	2400	386	130.5	365	1310
		10	9	59	2420	317	121	147	797
		11	6	12	112	55.9	40	76	100
		12	6	23	580	101	32	123	166
07010206-539	Separate Project	1	3	55	201	116	55	141	201
		2	4	9	177	68.2	46	123.5	170.5
		3	13	7	727	37.8	17	28	86
		4	12	6	219	32.1	14.5	22.5	90.5
		5	80	0.5	2420	40.7	22	42	90.5
		6	222	0.5	1986	84.8	43	96	190
		7	237	1	8500	111	72	130	238
		8	256	1	19000	241	97	265.5	616.5
		9	240	1	38000	319	133	310	805
		10	147	2	44000	193	60	150	517
		11	15	22	387	91.6	48	84	226
		12	5	12	2420	249	130	411	613
07010206-542	TMDL	4	6	23	170	50.9	27	52	61
		5	6	19	2000	120	67	100.5	120
		6	6	37	2400	258	170	235	370
		7	6	160	440	255	200	230	370
		8	5	200	2400	516	240	460	690
		9	5	38	340	93.1	75	84	86
		10	5	16	1200	106	17	78	520
07010206-552	TMDL	6	5	270	2400	612	340	390	1000
		7	6	650	2400	1510	770	2050	2400
		8	6	310	710	531	520	550	650
		9	6	250	2400	1340	710	2400	2400
07010206-	Separate	4	6	4	150	37.4	16	54	150

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
557	Project	5	5	75	170	97.4	80	86	100
		6	7	72	2000	304	140	310	710
		7	6	160	980	345	210	325	550
		8	5	82	1000	214	160	170	200
		9	6	160	1100	503	280	580	980
		10	5	35	1700	146	68	91	180
07010206-568	Protection	1	14	32	399	117	82	129	160
		2	12	26	517	93.2	58	93	141.5
		3	26	8	770	59.1	22	74	126
		4	31	2	185	11.2	7	10	21
		5	33	5	1300	39	15	27	66
		6	33	4	880	55.2	27	49	75
		7	32	3	2420	40.1	13.5	38	88
		8	33	11	365	63.9	36	53	130
		9	31	14	1300	77.9	33	62	130
		10	31	5	2420	54.3	18	41	172
		11	13	3	201	54.1	45	59	105
		12	7	12	172	50.8	26	45	156
07010206-584	TMDL	6	5	54	390	103	58	64	150
		7	3	36	120	61.9	36	55	120
		8	5	41	1600	163	54	180	180
		9	2	190	610	340	190	400	610
07010206-592	Protection	1	3	0.5	129	18.7	0.5	102	129
		2	3	13	435	67.3	13	54	435
		3	2	5	17	9.22	5	11	17
		4	3	36	131	56.4	36	38	131
		5	3	59	238	106	59	86	238
07010206-586	Adjacent, Insufficient Data for Assessme nt	4	7	6	66	16.4	10	13	27
		5	7	6	690	73.6	39	86	120
		6	6	34	220	95.9	60	105.5	190
		7	6	54	410	126	86	98	220
		8	8	23	610	191	110	260	400
		9	2	370	460	413	370	415	460
		10	6	21	1100	174	96	140	650
		3	1	180	180	180	180	180	180
07010206-592	Protection	6	3	84	687	193	84	125	687
		7	3	109	2420	309	109	112	2420
		8	4	76	148	112	93.5	118.5	137
		9	4	82	1203	284	86.5	409	965
		10	4	19	2420	328	227	507	1499.5
		11	4	24	2420	206	31	427	1618
		12	4	63	2420	311	108	276	1409.5
07010206-594	Separate Project	3	3	3	435.2	35.3	3	33.6	435.2
		4	2	8	116.2	30.5	8	62.1	116.2

AUID	Reach Categor-ization	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		5	8	210	2420	576	235.65	300	2203.15
		6	12	120	2419.6	523	271.3	613.5	800
		7	2	160	238.2	195	160	199.1	238.2
		8	12	5	2419.6	148	56.35	114.3	748.7
		9	3	137.4	579.4	275	137.4	261.3	579.4
		10	2	248.1	387.3	310	248.1	317.7	387.3
07010206-606	Protection	1	2	39	40	39.5	39	39.5	40
		2	2	15	238	59.7	15	126.5	238
		3	3	1	10	3.68	1	5	10
		4	3	38	78	49.5	38	41	78
		5	3	63	135	87.2	63	78	135
		6	3	155	261	216	155	248	261
		7	3	172	1203	493	172	579	1203
		8	4	152	2203	383	200	254	1231.5
		9	4	150	2420	402	174	281.5	1392.5
		10	4	69	1516	189	73	117.5	837
		11	4	105	2076	444	235	426.5	1282
		12	4	21	413	68.3	29	52.5	240.5
07010207-555	Separate Project	1	13	6	387	26.6	17	22	34
		2	12	2	239	18.5	7	20.5	29.5
		3	25	3	435	24.1	10	21	40
		4	35	2	62	11.5	9	12	16
		5	37	10	225	35.6	20	34	54
		6	34	11	613	46	27	37	70
		7	35	13	613	53.5	26	45	98
		8	34	12	1700	72	40	65	105
		9	32	29	517	114	76.5	99.5	165.5
		10	35	4	2420	48.4	26	44	86
		11	13	19	233	45.9	26	48	66
		12	8	9	144	17.2	10.5	14	17
07020012-505	Adjacent, Not Impaired	1	35	30	532	112	64	105	199
		2	36	34	1035	163	65.5	148	349.5
		3	66	4	2420	77.9	37	101.5	189
		4	75	0.5	83	8.16	4	8	16
		5	71	1	139	12.8	7	10	23
		6	75	0.5	1300	66.9	29	81	141
		7	79	0.5	179	28.2	16	34	56
		8	72	2	688	26.4	10.5	21	62.5
		9	72	7	2420	40.9	15.5	28	66
		10	74	2	1046	57	22	50	153
		11	38	6	326	56.8	32	55	101
		12	35	15	770	91.4	42	110	162

Table D-2. Summary of monthly *E. coli* geometric mean concentrations for each year of monitoring data.

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010201-501	Protection	2007	4	2	9	22	14.1	9	15.5	22
			5	2	16	22	18.8	16	19	22
			6	3	18	42	31.4	18	41	42
			7	1	96	96	96	96	96	96
			8	2	24	49	34.3	24	36.5	49
			9	2	148	345	226	148	246.5	345
			10	1	25	25	25	25	25	25
			11	1	222	222	222	222	222	222
		2008	3	1	66	66	66	66	66	66
			4	2	26	48	35.3	26	37	48
			5	1	35	35	35	35	35	35
			6	1	28	28	28	28	28	28
			7	1	9	9	9	9	9	9
			8	1	326	326	326	326	326	326
		2009	4	1	10	10	10	10	10	10
			5	1	2	2	2	2	2	2
			6	1	64	64	64	64	64	64
		2010	4	2	1	2	1.41	1	1.5	2
			5	2	6	45	16.4	6	25.5	45
			6	2	2	5	3.16	2	3.5	5
			7	2	3	6	4.24	3	4.5	6
			8	3	1	4	2	1	2	4
			9	2	3	4	3.46	3	3.5	4
			10	2	4	99	19.9	4	51.5	99
		2011	4	3	7	11	8.51	7	8	11
			5	3	12	51	22.7	12	19	51
			6	3	9	185	33.7	9	23	185
			7	1	4	4	4	4	4	4
			8	2	6	20	11	6	13	20
			9	3	1	7	3.04	1	4	7
			10	3	1	5	2.71	1	4	5
07010201-502	TMDL	2007	4	2	11	11	11	11	11	11
			5	2	6	23	11.7	6	14.5	23
			6	3	46	214	92.3	46	80	214
			7	1	44	44	44	44	44	44
			8	2	104	816	291	104	460	816
			9	2	155	326	225	155	240.5	326
			10	1	19	19	19	19	19	19

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			11	1	82	82	82	82	82	82
		2008	1	1	260	260	260	260	260	260
			3	1	47	47	47	47	47	47
			4	2	9	26	15.3	9	17.5	26
			5	1	12	12	12	12	12	12
			6	1	31	31	31	31	31	31
			7	1	12	12	12	12	12	12
			8	1	138	138	138	138	138	138
		2009	4	1	3	3	3	3	3	3
			5	1	5	5	5	5	5	5
			6	1	49	49	49	49	49	49
		2010	4	2	5	20	10	5	12.5	20
			5	2	170	250	206	170	210	250
			6	2	82	110	95	82	96	110
			7	2	23	50	33.9	23	36.5	50
			8	3	38	1600	152	38	58	1600
			9	2	11	32	18.8	11	21.5	32
			10	2	27	1400	194	27	713.5	1400
		2011	3	1	110	110	110	110	110	110
			4	4	3	20	6.77	4	6	13.5
			5	5	11	1100	82.7	41	42	186
			6	5	19	580	112	45	99	365
			7	1	104	104	104	104	104	104
			8	3	186	2400	613	186	517	2400
			9	4	56	120	75.8	58	71	101
			10	4	31	80	54.2	44.5	59	70
07010201-513	Protection	2010	4	2	1	2	1.41	1	1.5	2
			5	2	91	130	109	91	110.5	130
			6	2	14	25	18.7	14	19.5	25
			7	2	7	21	12.1	7	14	21
			8	3	20	30	25	20	26	30
			9	2	12	16	13.9	12	14	16
			10	1	10	10	10	10	10	10
		2011	4	4	12	17	13.4	12	12.5	15
			5	5	5	150	35.7	15	66	78
			6	3	5	23	10.5	5	10	23
			7	1	6	6	6	6	6	6
			8	3	26	100	42.7	26	30	100
			9	3	5	18	9.97	5	11	18
			10	4	5	17	9.79	7	10.5	14.5

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010201-516	TMDL	2010	4	2	25	150	61.2	25	87.5	150
			5	2	100	870	295	100	485	870
			6	2	110	260	169	110	185	260
			7	2	1600	2400	1960	1600	2000	2400
			8	3	160	2400	727	160	1000	2400
			9	2	160	520	288	160	340	520
			10	2	710	2400	1310	710	1555	2400
		2011	3	1	220	220	220	220	220	220
			4	4	15	34	20.8	15.5	19.5	28.5
			5	5	19	2400	236	186	250	345
			6	6	4	710	161	160.7	270.25	517
			7	3	185	272.3	216	185	201.4	272.3
			8	5	190	2419.6	540	387.3	500	517
			9	4	388	2420	1060	499	1425	2330
			10	4	210	1700	667	335.5	832	1451.5
07010201-523	TMDL	2010	4	2	16	41	25.6	16	28.5	41
			5	2	130	650	291	130	390	650
			6	2	160	190	174	160	175	190
			7	2	53	410	147	53	231.5	410
			8	3	230	2400	684	230	580	2400
			9	2	130	300	197	130	215	300
			10	2	69	2400	407	69	1234.5	2400
		2011	4	3	4	18	8.65	4	9	18
			5	3	53	199	100	53	96	199
			6	6	50	870	238	166.4	248.35	411
			7	3	15	178.5	76.5	15	167	178.5
			8	4	55.6	299	119	78.5	110.2	209
			9	4	460	687	558	480.5	557	650
			10	3	119	261	194	119	236	261
07010201-525	TMDL	2010	4	2	23	26	24.5	23	24.5	26
			5	2	520	1300	822	520	910	1300
			6	2	1400	1600	1500	1400	1500	1600
			7	2	220	1300	535	220	760	1300
			8	3	260	2400	1140	260	2400	2400
			9	2	310	920	534	310	615	920
			10	2	2400	2400	2400	2400	2400	2400
		2011	3	1	160	160	160	160	160	160
			4	3	6	15	10.3	6	12	15
			5	3	160	214	181	160	172	214
			6	3	152	1046	497	152	770	1046

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	1	56	56	56	56	56	56
			8	2	276	980	520	276	628	980
			9	3	308	517	419	308	461	517
			10	3	411	1986	809	411	649	1986
07010201-528	TMDL	2009	6	5	115.3	285.1	169	123.6	172.2	195.6
			7	5	104.6	275.5	168	121.1	172.2	224.7
			8	5	84.2	261.3	154	137.6	166.4	172.2
			9	1	240	240	240	240	240	240
		2010	4	2	72	93	81.8	72	82.5	93
			5	2	100	250	158	100	175	250
			6	2	261.3	298.7	279	261.3	280	298.7
			7	2	1046.2	2419.6	1590	1046.2	1732.9	2419.6
			8	3	307.6	2000	827	307.6	920.8	2000
			9	2	69	98	82.2	69	83.5	98
			10	2	64	2400	392	64	1232	2400
		2011	4	3	2	16	4.58	2	3	16
			5	3	42	162	96	42	130	162
			6	3	101	461	183	101	131	461
			7	1	74	74	74	74	74	74
			8	2	91	1300	344	91	695.5	1300
			9	4	108	214	158	118.5	169.5	212
			10	3	73	225	121	73	108	225
07010201-529	TMDL	2009	6	5	96	816.4	265	178.9	214.3	435.2
			7	5	81.6	365.4	195	161.6	235.9	248.1
			8	5	131.4	365.4	208	139.6	198.9	290.9
			9	1	1413.6	1413.6	1410	1413.6	1413.6	1413.6
		2010	6	2	159.7	344.8	235	159.7	252.25	344.8
			7	2	2419.6	6310	3910	2419.6	4364.8	6310
			8	2	101.9	139.6	119	101.9	120.75	139.6
07010201-537	TMDL	2009	6	5	18.9	344.8	104	93.3	125.9	161.6
			7	5	70.6	248.1	140	108.6	112.6	248.1
			8	5	32.7	166.4	97.1	106.7	108.1	137.6
			9	1	50.4	50.4	50.4	50.4	50.4	50.4
		2010	6	2	93.3	185	131	93.3	139.15	185
			7	2	461.1	920.8	652	461.1	690.95	920.8
			8	2	60.2	206.4	111	60.2	133.3	206.4
07010201-543	TMDL	2009	6	5	24.3	198.9	114	139.6	161.6	178.2
			7	5	260.3	920.8	402	275.5	325.5	488.4
			8	5	307.6	816.4	471	328.2	365.4	770.1
			9	1	547.5	547.5	548	547.5	547.5	547.5

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		2010	6	2	76.8	116.6	94.6	76.8	96.7	116.6
			7	2	186	277.8	227	186	231.9	277.8
			8	2	75.9	191.8	121	75.9	133.85	191.8
07010201-545	Protection	2007	4	2	6	73	20.9	6	39.5	73
			5	2	12	29	18.7	12	20.5	29
			6	3	13	50	27.8	13	33	50
			7	1	10	10	10	10	10	10
			8	3	12	35	23.3	12	30	35
			9	2	138	261	190	138	199.5	261
			10	1	77	77	77	77	77	77
			11	1	21	21	21	21	21	21
		2008	3	1	3	3	3	3	3	3
			4	2	5	11	7.42	5	8	11
			5	1	31	31	31	31	31	31
			6	1	53	53	53	53	53	53
			7	1	45	45	45	45	45	45
			8	1	20	20	20	20	20	20
		2009	4	1	7	7	7	7	7	7
			5	1	10	10	10	10	10	10
			6	1	72	72	72	72	72	72
07010201-554	TMDL	2009	6	5	117.2	920.8	335	155.3	461.1	547.5
			7	5	259.5	770.1	383	260.3	387.1	410.6
			8	5	53.8	410.6	176	99	248.9	307.6
			9	1	387.3	387.3	387	387.3	387.3	387.3
		2010	6	2	172.2	686.7	344	172.2	429.45	686.7
			7	2	307.6	727	473	307.6	517.3	727
			8	2	196.8	261.3	227	196.8	229.05	261.3
07010201-564	TMDL	2009	6	5	186	1553.1	461	365.4	410.6	478.8
			7	5	238.2	547.5	399	325.5	461.1	517.2
			8	5	123.4	285.1	160	123.6	133.3	178.2
			9	1	191.8	191.8	192	191.8	191.8	191.8
		2010	6	2	387.3	410.6	399	387.3	398.95	410.6
			7	2	648.8	2419.6	1250	648.8	1534.2	2419.6
			8	2	131.4	1046.2	371	131.4	588.8	1046.2
07010201-615	Protection	2009	6	4	135.4	410.6	243	163.6	258.65	368.05
			7	5	51.2	1046.2	250	156.5	161.6	727
			8	5	155.3	2419.6	472	186	410.6	816.4
		2010	6	2	261.3	579.4	389	261.3	420.35	579.4
			7	2	1046.2	2419.6	1590	1046.2	1732.9	2419.6
			8	2	1119.9	1553.1	1320	1119.9	1336.5	1553.1

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010202-501	Protection	2002	4	1	2	2	2	2	2	2
			5	1	130	130	130	130	130	130
			6	1	360	360	360	360	360	360
			7	1	150	150	150	150	150	150
			8	1	28	28	28	28	28	28
			9	1	100	100	100	100	100	100
		2004	5	1	93	93	93	93	93	93
			10	1	84	84	84	84	84	84
		2005	4	1	20	20	20	20	20	20
			5	1	24	24	24	24	24	24
			6	1	24	24	24	24	24	24
			7	1	120	120	120	120	120	120
			8	1	56	56	56	56	56	56
			9	1	200	200	200	200	200	200
		2006	4	1	1	1	1	1	1	1
			5	1	24	24	24	24	24	24
			6	1	36	36	36	36	36	36
			7	1	13	13	13	13	13	13
			8	1	35	35	35	35	35	35
			9	1	42	42	42	42	42	42
			10	2	62	84	72.2	62	73	84
		2007	3	3	1	5.2	3	1	5.2	5.2
			4	13	2	35	8.15	5	7	12
			5	17	7	92	21.9	12	18	38
			6	13	5	121	34.1	29	36	60
			7	7	23	288	63.5	41	55	72
			8	13	33	576	98.7	44	73	120
			9	10	37	432	74.1	44	63.5	93
		2008	3	3	10	540	136	10	468	540
			4	8	6	32	11.6	6.5	11	19.5
			5	10	15	252	49.4	20	35.5	144
			6	10	2	540	28.9	8	21.5	216
			7	11	4	215	20.8	14	19	31
			8	11	10	180	40.1	21.1	37.3	71.4
			9	14	6	307.6	38.9	19	44.45	73
			10	4	19.9	1300	79.6	25.7	40.35	674.6
			11	5	9.7	27.5	18.1	13.5	20.1	26.5
			12	2	7.4	24.9	13.6	7.4	16.15	24.9
		2009	4	1	10	10	10	10	10	10
			5	1	6	6	6	6	6	6
			6	4	17.3	201	66.4	33.45	81.1	156.8

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	3	45.5	101.4	61.8	45.5	51.2	101.4
			8	3	108.1	248.1	152	108.1	131.4	248.1
		2011	3	3	1119.9	1119.9	1120	1119.9	1119.9	1119.9
			4	3	16	22.8	19	16	18.9	22.8
			5	6	2	148.3	18	3	40.85	118.7
			6	3	816.4	1046.2	905	816.4	866.4	1046.2
			8	6	68.9	288	138	101.9	141	178
07010203-503	Protection	2010	4	2	5	10	7.07	5	7.5	10
			5	2	10	26	16.1	10	18	26
			6	2	7	13	9.54	7	10	13
			7	2	10	69	26.3	10	39.5	69
			8	3	23	52	33	23	30	52
			9	2	17	26	21	17	21.5	26
			10	2	12	84	31.7	12	48	84
		2011	4	3	3	10	5.65	3	6	10
			5	3	6	248	44.7	6	60	248
			6	3	19	39	27.1	19	27	39
			7	1	25	25	25	25	25	25
			8	2	58	66	61.9	58	62	66
			9	3	16	49	27	16	25	49
			10	3	22	41	27.9	22	24	41
07010203-510	TMDL	2002	4	2	2	2	2	2	2	2
			5	2	4	16	8	4	10	16
			6	2	500	760	616	500	630	760
			7	2	45	45	45	45	45	45
			8	2	32	52	40.8	32	42	52
			9	2	110	150	128	110	130	150
		2004	10	2	12	16	13.9	12	14	16
		2005	4	2	20	370	86	20	195	370
			5	2	4	4	4	4	4	4
			6	2	52	60	55.9	52	56	60
			7	2	16	60	31	16	38	60
			8	2	8	12	9.8	8	10	12
			9	2	44	56	49.6	44	50	56
		2006	4	2	1	9	3	1	5	9
			5	2	20	23	21.4	20	21.5	23
			6	2	29	35	31.9	29	32	35
			7	2	12	24	17	12	18	24
			8	2	27	32	29.4	27	29.5	32
			9	2	60	200	110	60	130	200

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			10	4	20	33	26.4	21.5	27.5	32.5
		2007	4	2	3	5	3.87	3	4	5
			5	2	4	12	6.93	4	8	12
			6	2	13	75	31.2	13	44	75
			7	2	20	170	58.3	20	95	170
			8	2	150	980	383	150	565	980
			9	2	24	44	32.5	24	34	44
07010203-511	Protection	2009	6	7	12.2	151.5	44.5	27.2	36.4	95.9
			7	7	21.8	65	34.1	23.1	36.4	44
			8	7	17.3	60	28.9	19.5	30.5	32.4
			9	1	34.5	34.5	34.5	34.5	34.5	34.5
		2010	4	3	1	3.1	1.84	1	2	3.1
			5	3	12.4	34.4	21.7	12.4	23.8	34.4
			6	8	42.2	650	103	57.2	82.05	147.6
			7	8	35.5	122.9	61.6	42.6	60.25	86.4
			8	8	33	149.1	59.8	42.1	47.1	97.7
			9	3	36.9	65.9	49.1	36.9	48.7	65.9
			10	3	12.4	27.1	17.1	12.4	15	27.1
07010203-528	TMDL	2010	4	2	10	47	21.7	10	28.5	47
			5	2	100	190	138	100	145	190
			6	2	91	190	131	91	140.5	190
			7	2	4	150	24.5	4	77	150
			8	3	550	2400	1090	550	980	2400
			9	2	1600	2000	1790	1600	1800	2000
			10	2	260	2000	721	260	1130	2000
		2011	3	1	260	260	260	260	260	260
			4	4	5	47	19.4	10.5	27	42.5
			5	5	25	2400	434	460	727	770
			6	4	50	461	141	73	137.5	320
			7	1	345	345	345	345	345	345
			8	3	150	17000	1250	150	770	17000
			9	3	575	1046	774	575	770	1046
			10	4	104	488	173	104.5	137.5	329
07010203-548	Not Adjacent	2007	4	2	5	21	10.2	5	13	21
			5	2	15	42	25.1	15	28.5	42
			6	3	57	109	73.1	57	63	109
			7	1	55	55	55	55	55	55
			8	2	133	387	227	133	260	387
			9	2	291	866	502	291	578.5	866
		2009	4	1	6	6	6	6	6	6

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			5	1	23	23	23	23	23	23
			6	3	22	99	46.8	22	47	99
			7	2	36	100	60	36	68	100
			8	2	45	980	210	45	512.5	980
		2010	6	3	14	1400	125	14	100	1400
			7	3	23	110	55.1	23	66	110
			8	3	67	290	133	67	120	290
07010203-557	TMDL	2009	6	2	59	62	60.5	59	60.5	62
			7	2	330	370	349	330	350	370
			8	2	210	230	220	210	220	230
		2010	4	1	13	13	13	13	13	13
			5	1	55	55	55	55	55	55
			6	3	130	300	172	130	130	300
			7	3	61	74	65.4	61	62	74
			8	4	52	210	96.8	62.5	91.5	160
			9	2	35	42	38.3	35	38.5	42
			10	2	28	180	71	28	104	180
		2011	3	1	31	31	31	31	31	31
			4	4	1	3	1.32	1	1	2
			5	5	3	650	30.8	9	18	88
			6	3	23	36	30.1	23	33	36
			7	1	15	15	15	15	15	15
			8	3	39	440	154	39	214	440
			9	3	83	178	118	83	111	178
			10	4	36	194	107	83	138.5	170.5
07010203-561	TMDL	2009	6	5	101.2	1119.9	256	137.6	248.9	280.9
			7	5	547.5	1046.2	774	727	816.4	816.4
			8	5	193.5	435.2	269	195.6	261.3	325.5
			9	1	137.4	137.4	137	137.4	137.4	137.4
		2010	6	2	235.9	260.3	248	235.9	248.1	260.3
			7	2	517.2	2419.6	1120	517.2	1468.4	2419.6
			8	2	325.5	410.6	366	325.5	368.05	410.6
07010203-572	TMDL	2009	6	10	31.6	574.8	153	101.9	154.7	290.9
			7	9	62.7	343.6	133	83.3	141.4	172.2
			8	5	78	1203.3	175	98.7	129.6	137.4
			9	1	613.1	613.1	613	613.1	613.1	613.1
		2010	6	2	33.2	34.5	33.8	33.2	33.85	34.5
			7	2	82.3	2419.6	446	82.3	1250.95	2419.6
			8	2	49.6	131.4	80.7	49.6	90.5	131.4
07010203-	Protectio	2002	4	1	2	2	2	2	2	2

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
574	n		5	1	16	16	16	16	16	16
			6	1	450	450	450	450	450	450
			7	1	45	45	45	45	45	45
			8	1	20	20	20	20	20	20
			9	1	300	300	300	300	300	300
		2004	10	1	2	2	2	2	2	2
		2005	4	1	12	12	12	12	12	12
			5	1	32	32	32	32	32	32
			6	1	96	96	96	96	96	96
			7	1	80	80	80	80	80	80
			8	1	52	52	52	52	52	52
			9	1	30	30	30	30	30	30
		2006	4	1	6	6	6	6	6	6
			5	1	6	6	6	6	6	6
			6	1	110	110	110	110	110	110
			7	1	38	38	38	38	38	38
			8	1	37	37	37	37	37	37
			9	1	440	440	440	440	440	440
			10	2	39	120	68.4	39	79.5	120
		2007	4	3	1	55	13.4	1	44	55
			5	3	8	11	9.58	8	10	11
			6	3	19	140	50	19	47	140
			7	3	2	91	23	2	67	91
			8	3	30	650	100	30	52	650
			9	3	31	220	70.8	31	52	220
			10	1	74	74	74	74	74	74
			11	2	63	75	68.7	63	69	75
			12	2	74	150	105	74	112	150
		2008	1	2	93	130	110	93	111.5	130
			2	2	100	110	105	100	105	110
			3	2	54	120	80.5	54	87	120
			4	2	2	13	5.1	2	7.5	13
			5	2	8	14	10.6	8	11	14
			6	2	7	28	14	7	17.5	28
			7	14	0.5	99	9.4	3.1	5.1	61
			8	33	0.5	91.5	5.21	3	6	16.4
			9	32	0.5	67.6	12.3	7.7	12.6	20.05
			10	32	0.5	161.5	10.3	7.7	10.6	18.3
			11	32	3	99.5	28.4	22	30.75	48.75
			12	33	30.9	133.4	65.6	51.2	67.7	82
		2009	1	33	53.7	238.2	111	93.3	105.4	139.6

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			2	30	77.6	240.4	129	104.6	129.2	161.6
			3	33	20	786	145	109.2	172	214.2
			4	30	2	28.5	7.9	5.2	7.85	12.4
			5	31	0.5	41	2.82	1	3.1	8
			6	31	0.5	146	7.36	4	6	16.4
			7	33	0.5	663	10.9	3.1	12.6	30
			8	34	0.5	320	19.3	10	20.4	31.5
			9	32	2	61.8	19.2	12.5	20.6	26.6
			10	31	4.1	204.8	20.5	8.6	17.9	34.4
			11	30	12.2	45	24.3	19.5	24.45	32.7
			12	28	15.8	290.9	51.3	30.25	48.4	82.65
		2010	1	27	47.9	209.8	113	86	122.3	145
			2	28	60.1	648.8	150	119.9	139.65	178.65
			3	31	2	928	76.2	16.4	135.4	198.9
			4	30	0.5	13.4	3.24	2	3.1	6.2
			5	31	0.5	49	5.8	4	8	14.8
			6	30	0.5	192	18	10	20	29.2
			7	31	0.5	52.8	14.6	10.4	16.4	26
			8	31	0.5	443	44.9	20.4	43.2	82
			9	30	0.5	231	37.6	24.2	43.8	70.8
			10	31	4	573	37.4	14.8	29	80
			11	30	8	136	27.1	16.4	25.55	42.5
			12	31	15.8	1299.7	41.9	29.2	35.9	41.9
		2011	1	30	16.1	920.8	56.1	40.2	52.1	76.8
			2	28	20.8	172.3	60.9	44	57.85	90
			3	31	6.2	439	37.5	18.5	29.9	66.2
			4	30	2	40.2	12.3	8.6	13.4	17.3
			5	31	8.6	833	27	13.4	17.3	41
			6	30	4	327	39	19.6	31.25	86
			7	30	0.5	194	16.6	8	16.2	33.6
			8	31	8	448	29.2	15	20.5	41
			9	30	0.5	48.5	19.9	16.4	23.2	31
			10	27	4	464	28.3	20	24.2	48.8
07010203-635	TMDL	2009	6	5	57.6	727	221	125.9	275.5	365.4
			7	5	307.6	488.4	366	325.5	365.4	365.4
			8	5	193.5	2419.6	496	201.4	547.5	579.4
			9	1	1299.7	1299.7	1300	1299.7	1299.7	1299.7
		2010	6	2	579.4	866.4	709	579.4	722.9	866.4
			7	2	1119.9	2419.6	1650	1119.9	1769.75	2419.6
			8	2	344.8	1553.1	732	344.8	948.95	1553.1

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010203-639	TMDL	2009	6	7	275.5	2419.6	1370	920.8	1732.9	2400
			7	7	866.4	2419.6	1730	1119.9	2400	2419.6
			8	7	2400	2419.6	2410	2400	2419.6	2419.6
			9	1	206.4	206.4	206	206.4	206.4	206.4
		2010	4	2	710	1000	843	710	855	1000
			5	2	2400	2400	2400	2400	2400	2400
			6	5	1119.9	6500	2520	2400	2400	2419.6
			7	5	2400	7700	4370	2419.6	5800	6131
			8	6	1986.3	5200	3570	2400	4100	5172
			9	2	840	1800	1230	840	1320	1800
			10	2	910	24000	4670	910	12455	24000
		2011	3	1	190	190	190	190	190	190
			4	4	11	261	25.9	11.5	12.5	137
			5	5	56	2400	563	326	650	1986
			6	5	266	2600	832	460	522	2400
			7	1	450	450	450	450	450	450
			8	3	822	24000	4090	822	3466	24000
			9	4	690	9800	1810	833	1303	5715
			10	4	345	1732	839	517.5	945	1466
07010203-724	TMDL	2009	6	5	72.7	866.4	212	127.4	156.5	344.8
			7	5	167	488.4	294	178.2	365.4	410.6
			8	5	105	325.5	197	121.1	248.1	290.9
			9	1	178.9	178.9	179	178.9	178.9	178.9
		2010	6	2	365.4	1046.2	618	365.4	705.8	1046.2
			7	2	648.8	2419.6	1250	648.8	1534.2	2419.6
			8	2	365.4	648.8	487	365.4	507.1	648.8
07010204-502	Separate Project	2002	4	1	19	19	19	19	19	19
			5	1	20	20	20	20	20	20
			6	4	40	2900	170	48	93	1515
			7	4	17	140	46.6	25	46.5	100
			8	3	40	270	137	40	240	270
			9	3	60	80	68.9	60	68	80
		2004	10	1	4	4	4	4	4	4
		2005	4	1	10	10	10	10	10	10
			5	1	2	2	2	2	2	2
			6	1	52	52	52	52	52	52
			7	1	60	60	60	60	60	60
			8	1	72	72	72	72	72	72
			9	1	2800	2800	2800	2800	2800	2800
		2006	3	1	34	34	34	34	34	34

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			4	2	7	8	7.48	7	7.5	8
			5	1	33	33	33	33	33	33
			6	1	110	110	110	110	110	110
			7	2	22	101	47.1	22	61.5	101
			8	1	21	21	21	21	21	21
			9	2	9	110	31.5	9	59.5	110
			10	2	3	7	4.58	3	5	7
			11	1	83	83	83	83	83	83
			12	1	816	816	816	816	816	816
		2007	1	1	818	818	818	818	818	818
			2	1	1125	1125	1130	1125	1125	1125
			3	1	9	9	9	9	9	9
			4	3	14	14	14	14	14	14
			5	4	15	48	24.5	18	22.5	36
			6	4	30	110	55.3	32.5	58	95.5
			7	4	5	47	13.7	7.5	12.5	31
			8	4	12	285	84.3	47	131	232.5
			9	4	38	410	148	59	235	400
			10	1	284	284	284	284	284	284
			12	1	503	503	503	503	503	503
		2008	4	4	5	35	13.7	8.5	14.5	26
			5	4	12	23	18.9	16	21.5	23
			6	4	17	2400	155	56	122.5	1275
			7	3	13	42	21.4	13	18	42
			8	2	5	6	5.48	5	5.5	6
			9	3	20	55	37	20	46	55
			10	1	44	44	44	44	44	44
			11	1	518	518	518	518	518	518
			12	1	25	25	25	25	25	25
		2009	1	1	132	132	132	132	132	132
			2	1	95	95	95	95	95	95
			3	3	76	260	126	76	101	260
			4	5	2	9	5.33	5	6	8
			5	5	3	21	10.1	7	12	20
			6	3	36	170	88.2	36	112	170
			7	4	23	650	76.7	26	54.5	365
			8	4	78	1700	274	94	248.5	1043.5
			9	2	50	777	197	50	413.5	777
			10	2	579	2076	1100	579	1327.5	2076
			11	1	39	39	39	39	39	39
			12	1	62	62	62	62	62	62

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
		2010	1	1	219	219	219	219	219	219
			2	1	66	66	66	66	66	66
			3	5	8	1046	255	326	579	687
			4	1	17	17	17	17	17	17
			5	1	219	219	219	219	219	219
			6	1	613	613	613	613	613	613
			7	1	125	125	125	125	125	125
			8	1	438	438	438	438	438	438
			9	2	387	549	461	387	468	549
			10	2	40	126	71	40	83	126
			11	1	66	66	66	66	66	66
			12	1	49	49	49	49	49	49
		2011	1	1	93	93	93	93	93	93
			2	1	85	85	85	85	85	85
			3	2	77	126	98.5	77	101.5	126
			4	1	34	34	34	34	34	34
			6	2	45	238	103	45	141.5	238
			7	1	68	68	68	68	68	68
			8	1	112	112	112	112	112	112
			9	1	140	140	140	140	140	140
			10	1	30	30	30	30	30	30
			11	1	24	24	24	24	24	24
			12	1	131	131	131	131	131	131
07010206-501	Protection	2010	4	3	0.5	9	2.08	0.5	2	9
			5	2	4	8	5.66	4	6	8
			6	2	12	44	23	12	28	44
			7	3	10	1000	76.6	10	45	1000
			8	3	49	270	94.6	49	64	270
			9	3	28	180	73.3	28	78	180
			10	3	44	230	79.7	44	50	230
		2011	4	1	20	20	20	20	20	20
			5	3	50	77	61.4	50	60	77
			6	3	44	200	74	44	46	200
			7	3	33	76	55.5	33	68	76
			8	2	25	93	48.2	25	59	93
			9	2	61	190	108	61	125.5	190
			10	2	28	59	40.6	28	43.5	59
07010206-502	Protection	2002	4	2	2	4	2.83	2	3	4
			5	2	16	28	21.2	16	22	28
			6	2	84	110	96.1	84	97	110

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	2	32	210	82	32	121	210
			8	2	240	760	427	240	500	760
			9	2	64	120	87.6	64	92	120
		2004	10	2	32	110	59.3	32	71	110
		2005	5	2	4	8	5.66	4	6	8
			6	1	120	120	120	120	120	120
			7	2	4	8	5.66	4	6	8
			8	2	4	20	8.94	4	12	20
			9	2	72	190	117	72	131	190
		2006	1	4	24	158	74.2	40.5	98.5	149
			2	4	24	276	99	51	132	231
			3	6	6	128	30.9	16	25.5	110
			4	12	4	80	16.1	11	12.5	26.5
			5	12	7	152	27.4	13.5	24	62.5
			6	8	8	147	26.8	9.5	28	71
			7	10	0.5	15	3.96	1	8.5	10
			8	10	3	411	21.9	10	11.5	52
			9	10	5	36	19.9	17	22	29
			10	12	10	55	22	17	22.5	29
			11	6	6	518	49.1	8	48	249
			12	2	3	58	13.2	3	30.5	58
		2007	1	4	5	227	41	14	65.5	167.5
			2	4	40	249	87.8	43	88	189.5
			3	8	7	270	32.2	14	23.5	131.5
			4	10	9	118	22.2	11	17	26
			5	10	7	66	15.8	8	16	23
			6	12	3	52	13.9	8	15	25
			7	13	0.5	30	4.34	3	5	6
			8	13	0.5	117	10.2	4	10	38
			9	12	1	104	14	7	11.5	36.5
			10	10	25	266	108	91	118	155
			11	4	88	707	182	101.5	135	431
			12	4	63	613	211	120.5	234.5	452
		2008	1	4	236	1010	467	272	478.5	829.5
			2	4	108	276	163	108	163.5	247.5
			3	7	2	192	39.5	27	45	141
			4	8	12	88	37.5	30	35	58.5
			5	8	8	62	21.7	12	23	40.5
			6	10	18	71	32.6	23	31.5	47
			7	12	11	62	18.7	13.5	17.5	20
			8	11	0.5	32	5.28	3	6	12

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			9	12	2	172	12.9	6.5	11	18.5
			10	10	13	115	43.7	30	45	65
			11	4	29	233	77.5	37.5	81	174.5
			12	4	17	365	118	56.5	210.5	345
		2009	1	4	187	345	257	198.5	267	334.5
			2	4	122	435	224	147.5	222.5	353.5
			3	8	18	287	85.9	54.5	87	181
			4	10	2	53	11.2	8	10.5	21
			5	6	3	26	9.26	5	9.5	18
			6	11	1	47	9.38	5	12	23
			7	14	1	41	7.22	4	6.5	11
			8	12	0.5	201	9.54	5	12.5	16
			9	11	0.5	10	3.46	1	6	10
			10	8	30	291	74.7	47.5	67	111
			11	4	58	222	103	68.5	95.5	167
			12	4	47	326	161	120.5	211	277
		2010	1	4	198	488	330	267	350.5	426.5
			2	4	112	291	195	136.5	218.5	283.5
			3	10	7	488	60.1	22	39.5	232
			4	11	1	26	4.88	2	4	15
			5	13	3	71	13.4	11	12	23
			6	17	5	199	49.9	34	86	105
			7	15	15	120	39.6	29	43	59
			8	14	28	649	94.8	44	86	184
			9	14	36	580	223	172	263.5	411
			10	11	48	650	120	57	93	331
			11	4	108	291	215	184.5	261	276
			12	3	254	308	283	254	291	308
		2011	1	4	96	411	223	134	268.5	388
			2	4	192	365	262	193	269.5	355
			3	10	18	228	89.2	52	104	160
			4	11	5	48	15.8	9	16	26
			5	10	6	91	23.6	10	20.5	86
			6	15	13	162	44.1	21	54	86
			7	14	24	387	62.3	33	49	64
			8	16	11	1308	74.4	35.5	43.5	101.5
			9	13	20	169	46.8	31	42	62
			10	12	9	110	41.8	26.5	44.5	73
			11	6	6	345	80.8	54	101	249
			12	2	64	278	133	64	171	278

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010206-503	TMDL	2003	6	50	18	7100	123	38	92	270
			7	57	17	580	85.7	52	72	140
			8	43	14	2500	74.7	35	60	100
			9	48	15	440	90.8	59	91	131
			10	39	16	680	79.3	50	80	102
		2004	6	27	18	740	76.9	35	80	130
			7	27	7	460	63.1	27	62	140
			8	27	10	1100	78.5	27	55	150
			9	27	40	450	124	66	82	270
			10	13	25	390	63.6	40	60	98
		2005	5	3	27	30	28.3	27	28	30
			6	15	27	350	85.7	46	68	122
			7	21	15	1400	86.5	32	70	210
			8	30	9	1900	61.5	28	56	90
			9	21	110	2300	426	170	240	1400
			10	18	25	7200	120	45	82	120
		2006	1	3	26	172	74.6	26	93	172
			2	2	9	28	15.9	9	18.5	28
			3	2	13	20	16.1	13	16.5	20
			4	22	2	27	8.56	5	11	13
			5	22	8	220	44.2	23	35	130
			6	25	12	210	45.8	26	46	68
			7	26	2	1200	28.1	12	26.5	82
			8	27	10	850	82.6	40	80	140
			9	18	16	435	94.1	52	81	210
			10	21	5	1100	45	17	30	73
			11	4	214	1414	565	387	580	1007
			12	1	14	14	14	14	14	14
		2007	1	3	11	59	25.3	11	25	59
			2	1	26	26	26	26	26	26
			3	4	5	59	17.8	7.5	22	46.5
			4	23	3	110	22.5	8	23	50
			5	27	2	2400	23.1	13	17	28
			6	19	0.8	121	23.3	15	27	44
			7	29	1	2420	22.6	10	16	46
			8	21	16	1600	157	44	170	410
			9	22	16	9100	74.5	23	45	160
			10	29	5	2800	174	100	170	270
			11	8	48	280	100	53	86.5	195
			12	1	83	83	83	83	83	83
		2008	1	2	81	160	114	81	120.5	160

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			2	2	15	37	23.6	15	26	37
			3	5	9	28	13.5	10	12	15
			4	27	2	140	17.2	8	22	40
			5	22	5	64	23.1	13	25	46
			6	29	13	8700	66.6	40	60	82
			7	26	8	320	34	17	26.5	56
			8	25	4	770	33.2	14	36	78
			9	28	26	1300	83	45	75	109.5
			10	30	10	3000	110	40	85	160
			11	5	15	26	20.7	20	22	22
			12	2	17	46	28	17	31.5	46
		2009	1	2	61	111	82.3	61	86	111
			2	2	12	411	70.2	12	211.5	411
			3	5	11	70	26.6	14	24	51
			4	22	2	18	8.82	7	10	14
			5	21	6	50	13.2	8	12	20
			6	28	2	345	41.1	19	36	86
			7	28	5	1100	36.4	10	32	115
			8	24	20	1600	89.9	35	61	230
			9	15	6	170	33.6	14	46	76
			10	24	30	5900	180	85.5	140	285
			12	1	52	52	52	52	52	52
		2010	1	2	68	104	84.1	68	86	104
			2	2	23	39	29.9	23	31	39
			3	5	10	345	36.7	23	24	35
			4	25	1	185	12.6	6	8	19
			5	25	3	770	29.9	14	20	55
			6	29	8	649	67	32	66	172
			7	17	11	613	64.2	30	73	105
			8	28	31	186	78	52.5	75	122
			9	27	68	2480	243	93	225	540
			10	22	16	2420	60.1	25	31.5	72
			11	8	41	184	65.5	49	57	77.5
			12	1	69	69	69	69	69	69
		2011	1	2	56	86	69.4	56	71	86
			2	3	53	96	76.5	53	88	96
			3	3	31	96	52.6	31	49	96
			4	19	3	140	16.4	8	16	27
			5	22	6	613	37.8	15	25.5	157
			6	30	19	2400	80.6	39	51.5	82
			7	22	34	345	78	49	72	118

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			8	29	13	517	90.1	46	86	199
			9	22	27	1733	87.2	44	65.5	128
			10	23	21	1986	98.6	32	65	167
			11	1	20	20	20	20	20	20
			12	2	32	62	44.5	32	47	62
07010206-504	Protection	2006	1	2	131	291	195	131	211	291
			2	2	291	345	317	291	318	345
			3	3	24	157	80.2	24	137	157
			4	4	5	45	11	6.5	8	26.5
			5	4	13	166	48.8	27	52.5	115
			6	3	48	172	102	48	127	172
			7	5	8	16	12	11	12	15
			8	3	15	105	53.3	15	96	105
			9	4	36	73	46.5	36.5	42.5	60.5
			10	4	38	88	50.5	38.5	44.5	69
			11	3	147	479	252	147	228	479
			12	1	153	153	153	153	153	153
		2007	1	2	248	272	260	248	260	272
			2	2	261	308	284	261	284.5	308
			3	4	14	818	110	20	257	653
			4	4	13	66	26.3	14	26	51.5
			5	4	12	111	28	16	21.5	67
			6	4	12	88	30.2	19.5	28	58.5
			7	4	12	54	21.2	12.5	18.5	39
			8	4	4	397	53.9	22.5	85.5	263.5
			9	4	21	613	89.5	27	92	382
			10	5	38	272	129	105	144	228
			11	2	288	1300	612	288	794	1300
			12	2	276	866	489	276	571	866
		2008	1	2	435	687	547	435	561	687
			2	2	285	345	314	285	315	345
			3	4	50	347	147	74	187	311.5
			4	4	18	61	36.5	24.5	41.5	56.5
			5	4	16	62	30.5	19.5	30.5	50
			6	4	27	83	46.5	32.5	46.5	69
			7	4	13	91	27.9	15	23.5	60.5
			8	4	11	57	24.8	13.5	27	47.5
			9	4	31	461	63.7	31.5	34	248.5
			10	4	30	411	84.7	42.5	65.5	243.5
			11	2	210	276	241	210	243	276

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			12	2	261	461	347	261	361	461
		2009	1	2	345	438	389	345	391.5	438
			2	2	387	649	501	387	518	649
			3	4	14	399	163	170	356.5	393
			4	5	10	34	16.7	11	16	22
			5	3	15	21	18.2	15	19	21
			6	4	11	33	19	13	19.5	28.5
			7	5	10	365	22.1	11	11	12
			8	4	14	108	35.1	21	32	72
			9	4	12	32	18.9	13.5	18.5	27
			10	4	50	326	93.3	52	70	206
			11	2	260	326	291	260	293	326
			12	2	378	435	405	378	406.5	435
		2010	1	2	326	517	411	326	421.5	517
			2	2	225	436	313	225	330.5	436
			3	5	17	613	104	24	214	228
			4	7	6	33	11.2	6	7	26
			5	6	13	57	26.9	20	23	48
			6	7	23	170	76.8	40	93	156
			7	7	29	89	56.1	41	63	84
			8	7	33	1267	134	56	71	870
			9	7	100	520	231	130	248	411
			10	7	13	770	74.4	34	50	240
			11	2	308	461	377	308	384.5	461
			12	2	291	431	354	291	361	431
		2011	1	2	228	579	363	228	403.5	579
			2	2	387	393	390	387	390	393
			3	6	46	866	225	179	249.5	291
			4	6	6	58	21.5	15	18.5	55
			5	9	11	220	55	31	59	140
			6	8	26	219	73.8	46.5	66	133.5
			7	7	23	291	73.2	37	61	167
			8	7	18	727	79.1	21	42	490
			9	6	21	40	33.8	35	36	39
			10	6	46	2400	152	57	114	170
			11	3	37	411	171	37	327	411
			12	1	461	461	461	461	461	461
07010206-505	TMDL	2002	4	1	4.5	4.5	4.5	4.5	4.5	4.5
			5	1	16	16	16	16	16	16
			6	1	60	60	60	60	60	60

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	1	170	170	170	170	170	170
			8	1	1400	1400	1400	1400	1400	1400
			9	1	91	91	91	91	91	91
		2004	10	1	40	40	40	40	40	40
		2005	5	1	2	2	2	2	2	2
			6	2	96	170	128	96	133	170
			7	1	110	110	110	110	110	110
			8	1	28	28	28	28	28	28
			9	1	220	220	220	220	220	220
		2006	1	2	61	99	77.7	61	80	99
			2	2	37	291	104	37	164	291
			3	3	15	53	24.3	15	18	53
			4	6	4	36	11.8	5	11	31
			5	6	10	219	29.8	13	25.5	38
			6	4	19	249	80.4	36	110	208
			7	6	4	1203	36.4	20	26	37
			8	4	36	90	52.3	41.5	48	69.5
			9	5	11	41	24.4	20	29	33
			10	6	11	166	39.3	13	31.5	160
			11	3	13	1023	99.5	13	74	1023
			12	1	13	13	13	13	13	13
		2007	1	2	39	62	49.2	39	50.5	62
			2	2	80	228	135	80	154	228
			3	4	36	91	54.8	38.5	54	79
			4	5	11	63	22.1	15	18	28
			5	5	3	161	20.2	12	17	34
			6	5	11	69	26.4	22	24	32
			7	5	7	60	17.7	8	14	37
			8	5	10	448	54.5	18	44	135
			9	5	16	488	92.2	42	44	461
			10	5	31	326	158	148	236	283
			11	2	71	73	72	71	72	73
			12	2	43	285	111	43	164	285
		2008	1	2	89	147	114	89	118	147
			2	2	65	198	113	65	131.5	198
			3	4	29	613	118	66.5	105	359.5
			4	4	111	816	269	148	249	564.5
			5	4	102	246	137	108.5	118	183.5
			6	4	36	105	50.1	37	41	74.5
			7	4	26	51	36.3	29	36.5	46
			8	4	10	462	65.1	33.5	62.5	265

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			9	5	24	613	55.2	26	32	42
			10	3	47	366	95.7	47	51	366
			11	2	36	86	55.6	36	61	86
			12	2	25	93	48.2	25	59	93
		2009	1	2	130	178	152	130	154	178
			2	2	83	152	112	83	117.5	152
			3	4	28	133	69.8	49	80.5	112
			4	5	4	23	9.85	6	12	14
			5	3	7	108	20.9	7	12	108
			6	4	2	116	18	10	21.5	70.5
			7	5	16	63	25.9	18	23	28
			8	4	84	219	114	86	96	161.5
			9	4	11	50	24.2	15.5	25.5	40.5
			10	4	51	399	176	132.5	216.5	309
			11	2	49	91	66.8	49	70	91
			12	2	50	79	62.8	50	64.5	79
		2010	1	2	81	261	145	81	171	261
			2	2	67	98	81	67	82.5	98
			3	5	3	866	49.7	6	40	488
			4	4	5	33	12.4	8	12	23
			5	4	8	66	22.2	9	28	56
			6	5	79	248	138	105	135	178
			7	4	39	105	67.3	52.5	71	90.5
			8	4	33	2420	128	40.5	59	1245
			9	4	154	308	241	201	266.5	296.5
			10	4	22	461	69.6	28	51	264.5
			11	2	76	121	95.9	76	98.5	121
			12	2	51	228	108	51	139.5	228
		2011	1	2	170	272	215	170	221	272
			2	2	130	144	137	130	137	144
			3	5	15	96	49.6	54	55	70
			4	4	8	20	12.1	8.5	12	17.5
			5	4	8	100	22.7	9.5	20.5	65
			6	6	30	219	66.9	36	67	86
			7	4	26	127	59.7	33	68	111.5
			8	5	28	548	90.2	33	63	187
			9	4	38	96	54.1	43	48.5	72.5
			10	4	12	205	43.7	20.5	40	128
			11	3	25	38	28.7	25	25	38
			12	1	63	63	63	63	63	63

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010206-506	TMDL	2007	4	2	20	31	24.9	20	25.5	31
			5	2	39	27000	1030	39	13519.5	27000
			6	2	130	160	144	130	145	160
			7	2	130	19000	1570	130	9565	19000
			8	4	210	4900	1040	365	1360	3550
			9	1	98	98	98	98	98	98
			10	2	84	2419	451	84	1251.5	2419
		2008	4	1	10	10	10	10	10	10
			5	2	24	110	51.4	24	67	110
			6	1	250	250	250	250	250	250
			7	1	610	610	610	610	610	610
			8	1	1000	1000	1000	1000	1000	1000
			9	2	41	4000	405	41	2020.5	4000
			10	2	140	3500	700	140	1820	3500
		2009	5	1	490	490	490	490	490	490
			6	2	230	1700	625	230	965	1700
			7	1	980	980	980	980	980	980
			8	3	130	5500	733	130	550	5500
		2010	4	3	12	370	57.6	12	43	370
			5	5	100	435	214	200	214	240
			6	3	150	410	275	150	340	410
			7	4	82	532	165	101	130	336
			8	4	41	1628	310	63.5	843	1614
			9	5	106	3635	348	110	120	1000
			10	4	28	2400	157	46	102	1270
		2011	4	3	22	78	45	22	53	78
			5	4	44	140	72.5	54	67	105
			6	5	100	1700	292	120	210	494
			7	6	84	521	189	110	140	510
			8	3	46	278	100	46	79	278
			9	4	107	440	171	113.5	135	295
			10	4	168	410	302	249	347.5	387.5
07010206-508	Separate Project	2007	7	4	44	201	135	119	194	197.5
			8	5	28	579	152	126	152	261
			9	6	43	2419	354	276	366	517
			10	8	36	1732	309	146.5	360	875
			11	4	12	579	56.7	19.5	41	317
		2008	4	3	5	261	48.2	5	86	261
			5	14	5	161	36.5	16	48	93
			6	12	44	548	141	85	134	248.5

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	12	117	921	374	233	479.5	596
			8	9	9	921	91.7	24	117	365
			9	14	50	2419	276	107	343	488
			10	12	5	866	121	40.5	230	387
			11	9	4	205	36.9	18	36	93
		2009	5	28	19	411	73	33.5	65	179.5
			6	35	23	2419	256	125	248	461
			7	38	1	2419	83.6	39	104	236
			8	40	1	2419	88.2	47.5	95	155
			9	40	1	579	54.8	33	78	129.5
			10	40	1	2419	59.6	20	37.5	294.5
		2010	4	40	2	326	22.2	10	19.5	52.5
			5	32	1	345	36.9	22.5	40	102.5
			6	40	2	921	97.6	52	117.5	242
			7	32	12	1733	90.5	32.5	106	225
			8	40	11	1046	102	53.5	92	198
			9	24	46	2420	175	72.5	105.5	282
			10	32	17	2420	111	51	68	171
		2011	4	15	4	133	19.3	8	15	38
			5	40	11	411	44.7	23	40	71
			6	32	4	261	60.9	37	55	115.5
			7	32	9	2420	88	30	73	177.5
			8	40	6	2420	115	41	108	265
			9	32	4	1414	131	58.5	135	399
			10	28	2	921	62.5	34.5	71	137.5
07010206-509	TMDL	2002	4	1	2	2	2	2	2	2
			5	1	8	8	8	8	8	8
			6	1	56	56	56	56	56	56
			7	1	60	60	60	60	60	60
			8	1	76	76	76	76	76	76
			9	1	80	80	80	80	80	80
		2003	6	50	18	8000	161	60	121.5	280
			7	57	14	940	95.6	52	90	190
			8	45	20	2900	133	62	94	370
			9	48	44	3800	281	125	190	510
			10	39	30	2440	109	62	96	160
		2004	6	27	27	1400	110	52	92	200
			7	27	10	260	60.2	27	68	160
			8	27	23	9500	121	44	73	280
			9	26	50	650	184	90	245	340

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			10	17	20	520	59.6	37	50	80
		2005	5	3	16	100	39.3	16	38	100
			6	16	32	330	107	68	85	230
			7	22	18	230	61.3	30	58	110
			8	31	18	550	82.8	45	74	130
			9	20	78	5500	454	175	440	1100
			10	18	18	3200	109	46	62	250
		2006	1	1	185	185	185	185	185	185
			4	22	3	73	12.4	7	12.5	18
			5	24	13	610	58.5	23.5	51	155
			6	25	16	649	53.2	32	48	82
			7	28	5	84	24.5	16	30	38
			8	28	25	440	81	41	91	140
			9	27	25	461	155	109	150	310
			10	33	2	866	27.4	10	22	82
			11	5	5	330	87.7	93	154	220
		2007	1	3	79	162	111	79	106	162
			2	1	34	34	34	34	34	34
			3	3	8	37	14.4	8	10	37
			4	25	2	560	27.9	8	37	75
			5	28	3	6300	31.9	15.5	25	40
			6	20	8	630	50.1	26.5	39	64
			7	31	5	370	37.2	21	35	74
			8	23	20	1400	113	37	120	320
			9	23	9	4300	124	45	73	540
			10	29	5	3300	187	96	190	390
			11	8	46	200	87.1	60	77.5	130
			12	2	7	135	30.7	7	71	135
		2008	1	2	67	157	103	67	112	157
			2	2	68	113	87.7	68	90.5	113
			3	2	1	6	2.45	1	3.5	6
			4	26	2	160	16.9	8	13.5	42
			5	21	7	150	23.9	12	25	33
			6	29	13	720	67.3	40	54	120
			7	26	8	280	45.2	30	43	80
			8	26	10	370	50.5	20	54	110
			9	30	21	400	86.2	50	99	140
			10	31	5	3600	89.4	24	86	240
			11	6	10	25	17.5	12	20	24
			12	3	39	84	51.6	39	42	84
		2009	1	33	45	840	179	130	170	230

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			2	19	20	1300	198	130	200	490
			3	17	78	1100	201	110	200	310
			4	30	2	1100	15.5	10	16	20
			5	36	8	230	20.6	12	20	26
			6	48	11	1100	47.1	22	45	72
			7	44	6	1500	43.2	20	25.5	77
			8	53	18	1600	111	46	78	230
			9	37	20	3500	78.5	44	76	96
			10	60	0.5	4900	50	26	99	200
			11	36	0.5	620	26.9	20	30.5	51
			12	31	0.5	155	51.9	41	52	98
		2010	1	30	20	272	84.8	63	91	148
			2	29	0.5	121	38.9	31	52	72
			3	35	0.5	710	17.2	2	23	75
			4	53	0.5	206	6.62	1	10	20
			5	60	0.5	1733	26.1	13.5	20.5	37
			6	62	0.5	2420	32.8	9	88	200
			7	49	0.5	630	10	0.5	33	100
			8	60	0.5	1414	44.8	51.5	100	200
			9	57	0.5	3540	104	100	131	310
			10	53	0.5	2420	25.9	19	25	56
			11	39	0.5	1046	38.5	30	52	73
			12	31	0.5	90	14.1	0.5	41	74
		2011	1	12	41	2280	167	84.5	110.5	198.5
			2	13	20	310	64	41	52	85
			3	12	20	300	56	40	41	62.5
			4	30	0.5	111	11.8	9	13.5	31
			5	31	0.5	630	27.8	10	37	109
			6	41	0.5	1986	60.9	40	66	100
			7	36	0.5	2420	88.8	44.5	100	200
			8	43	0.5	630	50.2	43	91	135
			9	35	0.5	1986	103	100	102	190
			10	36	0.5	1203	60.7	28	100	139
			11	13	0.5	41	8.94	10	20	30
			12	14	0.5	200	13.5	10	21.3	32
07010206-511	Protection	2010	4	3	5	17	7.52	5	5	17
			5	3	13	24	19	13	22	24
			6	3	16	44	29.4	16	36	44
			7	3	51	140	84	51	83	140
			8	3	38	53	46.8	38	51	53

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			9	2	44	45	44.5	44	44.5	45
			10	3	20	770	70.8	20	23	770
		2011	4	2	9	17	12.4	9	13	17
			5	4	46	130	96.3	83	120	125
			6	2	22	47	32.2	22	34.5	47
			7	3	31	62	42.2	31	39	62
			8	2	26	54	37.5	26	40	54
			9	3	23	330	57.5	23	25	330
			10	2	9	23	14.4	9	16	23
07010206-512	Protection	2010	4	3	4	31	9.54	4	7	31
			5	3	16	40	24.5	16	23	40
			6	3	7	54	25.5	7	44	54
			7	3	44	91	62.2	44	60	91
			8	2	47	54	50.4	47	50.5	54
			9	2	36	65	48.4	36	50.5	65
			10	3	19	460	55.9	19	20	460
		2011	3	1	170	170	170	170	170	170
			4	2	8	15	11	8	11.5	15
			5	6	26	1400	114	49	90.5	150
			6	2	16	28	21.2	16	22	28
			7	3	27	50	39	27	44	50
			8	3	31	110	60.5	31	65	110
			9	3	41	120	64.3	41	54	120
			10	3	12	200	40.7	12	28	200
07010206-513	Protection	2010	4	6	2	28	12	12	15	20
			5	7	11	93	19.9	11	15	33
			6	8	15	150	51.5	40	49.5	75.5
			7	5	26	179	51	31	48	50
			8	8	30	219	80.1	51.5	77	134
			9	8	66	435	139	87	125.5	202
			10	6	16	579	51.2	29	31.5	68
			11	1	36	36	36	36	36	36
		2011	4	6	6	64	15.6	6	15.5	28
			5	6	9	166	26	9	26	43
			6	8	25	365	64.5	38	53	105
			7	6	41	2420	124	44	83.5	119
			8	8	49	166	90.9	54.5	100	147.5
			9	6	63	161	103	82	103	141
			10	6	49	387	100	63	90.5	105
07010206-	Protection	2010	4	3	3	37	7.63	3	4	37

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
514	n		5	2	12	16	13.9	12	14	16
			6	2	13	150	44.2	13	81.5	150
			7	2	55	160	93.8	55	107.5	160
			8	3	45	910	132	45	56	910
			9	3	41	440	114	41	82	440
			10	3	15	280	50.7	15	31	280
		2011	4	1	3	3	3	3	3	3
			5	3	40	170	96	40	130	170
			6	3	30	250	72.6	30	51	250
			7	3	41	59	50.4	41	53	59
			8	2	23	53	34.9	23	38	53
			9	2	28	68	43.6	28	48	68
			10	2	30	490	121	30	260	490
07010206-526	TMDL	2008	7	3	78	770	291	78	410	770
			8	3	250	710	354	250	250	710
			9	3	140	2400	651	140	820	2400
		2009	6	5	3	2400	58.3	27	38	91
			7	3	140	520	318	140	440	520
			8	3	41	170	88.4	41	99	170
			9	3	38	340	91.9	38	60	340
		2010	6	3	120	190	144	120	130	190
07010206-530	Separate Project	2010	4	3	34	190	75.6	34	67	190
			5	3	120	220	151	120	130	220
			6	3	210	550	330	210	310	550
			7	5	48	1000	220	110	250	390
			8	5	130	980	448	400	580	610
			9	2	820	2400	1400	820	1610	2400
			10	3	56	390	119	56	77	390
		2011	3	1	190	190	190	190	190	190
			4	4	6	61	17.8	9	17.5	42
			5	6	63	2400	193	110	140	160
			6	3	130	150	136	130	130	150
			7	1	130	130	130	130	130	130
			8	4	82	920	253	96	300	705
			10	3	86	550	161	86	88	550
07010206-538	TMDL	2006	3	1	32	32	32	32	32	32
			4	1	18	18	18	18	18	18
			5	1	61	61	61	61	61	61
			6	1	55	55	55	55	55	55
			7	1	59	59	59	59	59	59

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			9	1	49	49	49	49	49	49
			10	1	110	110	110	110	110	110
			11	1	12	12	12	12	12	12
			12	1	109	109	109	109	109	109
		2007	1	1	25	25	25	25	25	25
			2	1	2	2	2	2	2	2
			3	1	67	67	67	67	67	67
			4	1	28	28	28	28	28	28
			5	1	24	24	24	24	24	24
			6	1	99	99	99	99	99	99
			7	2	365	548	447	365	456.5	548
			8	1	33	33	33	33	33	33
			9	1	57	57	57	57	57	57
			10	2	59	461	165	59	260	461
			11	1	40	40	40	40	40	40
			12	1	166	166	166	166	166	166
		2008	1	1	60	60	60	60	60	60
			2	1	1	1	1	1	1	1
			3	2	254	692	419	254	473	692
			4	3	9	73	34.2	9	61	73
			5	1	36	36	36	36	36	36
			6	2	15	42	25.1	15	28.5	42
			7	13	35	2400	268	120	190	820
			8	14	23	1300	217	100	290	370
			9	13	85	2400	589	210	650	2400
			10	1	129	129	129	129	129	129
			11	1	86	86	86	86	86	86
			12	1	137	137	137	137	137	137
		2009	1	1	14	14	14	14	14	14
			2	1	86	86	86	86	86	86
			3	3	9	276	56.1	9	71	276
			4	2	24	121	53.9	24	72.5	121
			5	1	260	260	260	260	260	260
			6	15	1	2420	300	110	410	2400
			7	13	17	2400	497	280	980	1700
			8	15	31	1400	198	89	240	550
			9	13	32	2400	386	220	370	1700
			10	2	147	2420	596	147	1283.5	2420
			11	1	112	112	112	112	112	112
			12	1	32	32	32	32	32	32
		2010	2	1	34	34	34	34	34	34

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			3	5	10	613	62.3	19	66	122
			4	3	62	816	166	62	90	816
			5	5	38	308	76.5	45	46	108
			6	18	50	2420	189	96	160	290
			7	4	77	240	144	99.5	157	216
			8	2	93	102	97.4	93	97.5	102
			9	2	131	649	292	131	390	649
			10	1	121	121	121	121	121	121
			11	1	66	66	66	66	66	66
			12	1	580	580	580	580	580	580
		2011	1	1	44	44	44	44	44	44
			2	2	39	179	83.6	39	109	179
			3	4	39	86	58.5	44.5	60	78
			4	3	16	133	39.1	16	28	133
			5	3	29	1426	203	29	201	1426
			6	3	33	1700	154	33	65	1700
			7	2	166	261	208	166	213.5	261
			8	1	78	78	78	78	78	78
			9	2	190	310	243	190	250	310
			10	2	797	2420	1390	797	1608.5	2420
			11	1	100	100	100	100	100	100
			12	1	23	23	23	23	23	23
07010206-539	Separate Project	2005	6	36	3	1100	113	76	113	195
			7	36	1	480	84	73	112	170
			8	36	1	7600	333	165	460	805
			9	45	1	38000	358	300	400	710
			10	36	4.5	28000	223	59	150	350
			11	9	22	226	71.4	48	74	86
		2006	3	1	9	9	9	9	9	9
			4	1	12	12	12	12	12	12
			5	1	13	13	13	13	13	13
			6	28	5	550	99.9	53	116	235
			7	19	8	430	126	82	160	210
			8	9	10	730	326	460	540	570
			9	1	214	214	214	214	214	214
			10	1	114	114	114	114	114	114
			11	1	64	64	64	64	64	64
			12	1	2420	2420	2420	2420	2420	2420
		2007	1	1	141	141	141	141	141	141
			4	1	13	13	13	13	13	13

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			5	1	29	29	29	29	29	29
			6	21	1	450	69.8	41	100	150
			7	22	1	990	153	88	230	420
			8	49	18	2300	372	160	520	880
			9	41	2	8100	410	87	370	2300
			10	31	9	2000	125	27	120	530
			11	1	27	27	27	27	27	27
			12	1	12	12	12	12	12	12
		2008	1	1	201	201	201	201	201	201
			3	2	7	58	20.1	7	32.5	58
			4	2	16	22	18.8	16	19	22
			5	11	7	120	38.6	22	40	78
			6	22	3	1400	136	27	185	600
			7	41	4	500	72.6	40	80	130
			8	42	10	13000	280	42	285	1300
			9	41	8	12000	354	120	300	780
			10	21	2	5000	106	60	110	160
			11	1	387	387	387	387	387	387
		2009	2	2	164	177	170	164	170.5	177
			3	2	20	53	32.6	20	36.5	53
			4	2	23	109	50.1	23	66	109
			5	1	12	12	12	12	12	12
			6	20	12	816	115	67	130	210
			7	27	30	8500	289	130	220	440
			8	39	4	19000	312	90	350	750
			9	13	18	860	147	96	190	240
			10	10	100	44000	1210	330	1035	3400
			11	1	249	249	249	249	249	249
			12	1	411	411	411	411	411	411
		2010	3	4	10	727	57.1	13.5	51.5	406.5
			4	2	201	219	210	201	210	219
			5	33	0.5	2420	71.1	39	79	194
			6	43	0.5	1986	77.8	59	93	192
			7	50	1	1553	92.4	72	121	236
			8	41	3	1300	159	76	199	387
			9	52	3	2420	321	119.5	321.5	1439
			10	19	3	199	52.9	39	59	109
			11	1	86	86	86	86	86	86
			12	1	613	613	613	613	613	613
		2011	1	1	55	55	55	55	55	55
			2	2	9	83	27.3	9	46	83

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			3	4	22	150	53.1	25	57	118
			4	4	6	72	21.1	13	21.5	47.5
			5	33	1	458	25.8	16	38	63
			6	52	1	387	53.9	34	62.5	117.5
			7	42	1	2420	113	54	147	228
			8	40	1	980	100	69.5	120.5	232
			9	47	2	2420	262	140	249	649
			10	29	40	2420	499	186	461	2420
			11	1	387	387	387	387	387	387
			12	1	130	130	130	130	130	130
07010206-542	TMDL	2010	4	3	23	170	47.3	23	27	170
			5	3	19	2000	137	19	67	2000
			6	3	170	290	207	170	180	290
			7	3	220	440	285	220	240	440
			8	3	460	2400	913	460	690	2400
			9	3	38	340	104	38	86	340
			10	3	17	520	88.3	17	78	520
		2011	4	3	52	61	54.8	52	52	61
			5	3	91	120	106	91	110	120
			6	3	37	2400	320	37	370	2400
			7	3	160	370	228	160	200	370
			8	2	200	240	219	200	220	240
			9	2	75	84	79.4	75	79.5	84
			10	2	16	1200	139	16	608	1200
		2008	7	3	650	2400	1060	650	770	2400
			8	3	580	710	644	580	650	710
			9	3	250	2400	752	250	710	2400
		2009	6	2	1000	2400	1550	1000	1700	2400
			7	3	1700	2400	2140	1700	2400	2400
			8	3	310	520	438	310	520	520
			9	3	2400	2400	2400	2400	2400	2400
		2010	6	3	270	390	330	270	340	390
07010206-557	Separate Project	2010	4	3	86	150	125	86	150	150
			5	3	75	170	101	75	80	170
			6	3	72	710	193	72	140	710
			7	3	160	210	192	160	210	210
			8	3	82	1000	241	82	170	1000
			9	2	580	1100	799	580	840	1100
			10	3	35	1700	176	35	91	1700
		2011	4	3	4	22	11.2	4	16	22

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			5	2	86	100	92.7	86	93	100
			6	4	160	2000	429	235	325	1170
			7	3	440	980	619	440	550	980
			8	2	160	200	179	160	180	200
			9	4	160	980	399	220	430	780
			10	2	68	180	111	68	124	180
07010206-568	Protection	2002	6	2	270	880	487	270	575	880
			7	2	42	1100	215	42	571	1100
			8	2	36	130	68.4	36	83	130
			9	2	100	290	170	100	195	290
		2006	1	3	82	326	142	82	108	326
			2	2	26	38	31.4	26	32	38
			3	2	70	73	71.5	70	71.5	73
			4	4	2	48	10.4	5	11.5	31.5
			5	5	15	435	47.6	26	36	40
			6	3	40	77	53.2	40	49	77
			7	5	3	14	6.99	3	11	12
			8	3	11	260	31.6	11	11	260
			9	4	27	1300	115	32.5	84	715
			10	5	5	19	9.74	7	11	12
			11	2	31	89	52.5	31	60	89
			12	1	26	26	26	26	26	26
		2007	1	3	32	96	48.4	32	37	96
			2	1	161	161	161	161	161	161
			3	4	10	146	39.2	21.5	41	97.5
			4	5	2	185	13.3	6	8	23
			5	3	10	17	12.3	10	11	17
			6	4	21	70	33.8	22.5	30.5	53.5
			7	5	3	24	9.44	5	13	16
			8	3	26	40	32.5	26	33	40
			9	4	14	83	33.3	23	32.5	58
			10	5	16	347	69.7	41	42	172
			11	2	105	159	129	105	132	159
			12	1	89	89	89	89	89	89
		2008	1	2	137	146	141	137	141.5	146
			2	2	85	122	102	85	103.5	122
			3	5	17	88	33.8	18	22	75
			4	3	4	16	7.27	4	6	16
			5	4	9	31	19	12	23	31
			6	5	27	75	47.9	47	50	53

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			7	3	11	92	33.2	11	36	92
			8	4	23	196	46.7	27	32.5	115
			9	5	27	130	50.1	33	44	62
			10	3	17	2420	90.5	17	18	2420
			11	2	14	58	28.5	14	36	58
			12	1	45	45	45	45	45	45
		2009	1	2	121	160	139	121	140.5	160
			2	2	42	517	147	42	279.5	517
			3	5	8	268	67.3	49	91	144
			4	4	6	11	8.52	7	9	10.5
			5	3	5	26	10.9	5	10	26
			6	4	4	687	66.9	28	96	413.5
			7	4	28	37	33.1	30.5	34	36
			8	5	40	365	121	56	105	308
			9	3	20	40	28.8	20	30	40
			10	4	26	488	113	28	232.5	461.5
			11	3	45	59	52	45	53	59
			12	1	156	156	156	156	156	156
		2010	1	2	166	399	257	166	282.5	399
			2	2	93	186	132	93	139.5	186
			3	5	10	770	75.4	30	84	126
			4	7	9	22	12.8	9	12	22
			5	7	10	250	26.4	14	20	28
			6	8	16	276	52.7	23.5	41.5	150
			7	7	41	2420	124	44	53	238
			8	8	30	290	87.3	55.5	64.5	182.5
			9	5	66	1062	205	79	172	380
			10	7	18	690	66.8	23	45	237
			11	3	88	201	129	88	121	201
			12	1	172	172	172	172	172	172
		2011	1	2	75	138	102	75	106.5	138
			2	3	74	101	88.6	74	93	101
			3	5	20	173	91.1	99	122	150
			4	8	4	32	12.7	7	16	21.5
			5	11	26	1300	115	28	127	330
			6	7	23	126	41.7	26	28	74
			7	6	39	411	110	58	101	192
			8	8	36	310	60.3	39.5	49.5	65
			9	8	28	1200	84.3	38.5	66	112.5
			10	7	26	260	66.2	36	63	100
			11	1	3	3	3	3	3	3

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			12	2	12	26	17.7	12	19	26
07010206-584	TMDL	2010	6	2	150	390	242	150	270	390
			7	2	55	120	81.2	55	87.5	120
			8	2	180	1600	537	180	890	1600
			9	2	190	610	340	190	400	610
		2011	6	3	54	64	58.5	54	58	64
			7	1	36	36	36	36	36	36
			8	3	41	180	73.6	41	54	180
07010206-592	Protection	2008	8	1	148	148	148	148	148	148
			9	1	91	91	91	91	91	91
			10	1	19	19	19	19	19	19
			11	1	24	24	24	24	24	24
			12	1	63	63	63	63	63	63
		2009	1	1	0.5	0.5	0.5	0.5	0.5	0.5
			2	1	54	54	54	54	54	54
			4	1	36	36	36	36	36	36
			5	1	86	86	86	86	86	86
			6	1	687	687	687	687	687	687
			7	1	2420	2420	2420	2420	2420	2420
			8	1	126	126	126	126	126	126
			9	1	727	727	727	727	727	727
			10	1	2420	2420	2420	2420	2420	2420
			11	1	2420	2420	2420	2420	2420	2420
			12	1	399	399	399	399	399	399
		2010	1	1	102	102	102	102	102	102
			2	1	13	13	13	13	13	13
			3	1	5	5	5	5	5	5
			4	1	38	38	38	38	38	38
			5	1	238	238	238	238	238	238
			6	1	125	125	125	125	125	125
			7	1	109	109	109	109	109	109
			8	1	76	76	76	76	76	76
			9	1	82	82	82	82	82	82
			10	1	579	579	579	579	579	579
			11	1	816	816	816	816	816	816
			12	1	2420	2420	2420	2420	2420	2420
		2011	1	1	129	129	129	129	129	129
			2	1	435	435	435	435	435	435
			3	1	17	17	17	17	17	17
			4	1	131	131	131	131	131	131

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			5	1	59	59	59	59	59	59
			6	1	84	84	84	84	84	84
			7	1	112	112	112	112	112	112
			8	1	111	111	111	111	111	111
			9	1	1203	1203	1200	1203	1203	1203
			10	1	435	435	435	435	435	435
			11	1	38	38	38	38	38	38
			12	1	153	153	153	153	153	153
07010206-594	Separate Project	2006	5	4	210	300	251	210	255	300
			6	4	130	800	452	315	650	800
			7	1	160	160	160	160	160	160
			8	2	5	5	5	5	5	5
		2007	3	1	3	3	3	3	3	3
			4	1	8	8	8	8	8	8
			5	4	261.3	2420	1320	1123.8	2203.15	2420
			6	1	235.9	235.9	236	235.9	235.9	235.9
			9	1	579.4	579.4	579	579.4	579.4	579.4
		2008	4	1	116.2	116.2	116	116.2	116.2	116.2
			6	2	435.2	770.1	579	435.2	602.65	770.1
			7	1	238.2	238.2	238	238.2	238.2	238.2
			8	2	106.3	2419.6	507	106.3	1262.95	2419.6
			9	2	137.4	261.3	189	137.4	199.35	261.3
		2009	3	2	33.6	435.2	121	33.6	234.4	435.2
			6	4	306.7	2419.6	1020	516.85	1356.65	2202.95
			8	8	54.6	2419.6	253	81.35	214.95	748.7
			10	2	248.1	387.3	310	248.1	317.7	387.3
		2011	6	1	120	120	120	120	120	120
07010206-606	Protection	2008	8	1	2203	2203	2200	2203	2203	2203
			9	1	198	198	198	198	198	198
			10	1	69	69	69	69	69	69
			11	1	488	488	488	488	488	488
			12	1	68	68	68	68	68	68
		2009	2	1	15	15	15	15	15	15
			3	1	1	1	1	1	1	1
			4	1	41	41	41	41	41	41
			5	1	63	63	63	63	63	63
			6	1	248	248	248	248	248	248
			7	1	1203	1203	1200	1203	1203	1203
			8	1	152	152	152	152	152	152
			9	1	2420	2420	2420	2420	2420	2420

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			10	1	1516	1516	1520	1516	1516	1516
			11	1	2076	2076	2080	2076	2076	2076
			12	1	21	21	21	21	21	21
		2010	1	1	40	40	40	40	40	40
			3	1	5	5	5	5	5	5
			4	1	38	38	38	38	38	38
			5	1	135	135	135	135	135	135
			6	1	261	261	261	261	261	261
			7	1	172	172	172	172	172	172
			8	1	248	248	248	248	248	248
			9	1	150	150	150	150	150	150
			10	1	158	158	158	158	158	158
			11	1	365	365	365	365	365	365
			12	1	413	413	413	413	413	413
		2011	1	1	39	39	39	39	39	39
			2	1	238	238	238	238	238	238
			3	1	10	10	10	10	10	10
			4	1	78	78	78	78	78	78
			5	1	78	78	78	78	78	78
			6	1	155	155	155	155	155	155
			7	1	579	579	579	579	579	579
			8	1	260	260	260	260	260	260
			9	1	365	365	365	365	365	365
			10	1	77	77	77	77	77	77
			11	1	105	105	105	105	105	105
			12	1	37	37	37	37	37	37
07010206-586	Adjacent, Insufficient Data for Assessment	2010	4	3	19	66	32.4	19	27	66
			5	3	6	120	39.6	6	86	120
			6	3	150	220	184	150	190	220
			7	5	54	220	99.6	86	96	100
			8	4	23	610	114	66.5	110	360
			9	2	370	460	413	370	415	460
			10	3	21	1100	130	21	96	1100
		2011	3	1	180	180	180	180	180	180
			4	4	6	13	9.84	8	11	12.5
			5	4	39	690	117	58.5	84	390
			6	3	34	61	49.9	34	60	61
			7	1	410	410	410	410	410	410
			8	4	210	410	319	260	350	400
			10	3	130	650	233	130	150	650

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
07010207-555	Separate Project	2002	4	1	2	2	2	2	2	2
			5	1	16	16	16	16	16	16
			6	1	18	18	18	18	18	18
			7	1	36	36	36	36	36	36
			8	1	40	40	40	40	40	40
			9	1	170	170	170	170	170	170
		2004	10	1	4	4	4	4	4	4
		2005	4	1	2	2	2	2	2	2
			5	1	16	16	16	16	16	16
			6	1	26	26	26	26	26	26
			7	1	96	96	96	96	96	96
			8	1	32	32	32	32	32	32
			9	1	420	420	420	420	420	420
		2006	1	2	6	17	10.1	6	11.5	17
			2	2	2	5	3.16	2	3.5	5
			3	2	4	9	6	4	6.5	9
			4	5	6	23	11	9	10	13
			5	6	28	152	58.7	36	47	123
			6	4	28	68	35.9	28.5	29.5	49
			7	6	16	36	24.1	19	24.5	31
			8	4	13	59	31.1	23.5	35	47.5
			9	5	58	517	143	66	91	330
			10	7	6	2420	27.1	8	11	36
			11	2	26	80	45.6	26	53	80
			12	1	14	14	14	14	14	14
		2007	1	3	11	387	49.2	11	28	387
			2	1	239	239	239	239	239	239
			3	3	6	343	35.1	6	21	343
			4	6	3	17	10.2	9	12.5	16
			5	4	14	30	20.8	15	22	29
			6	5	15	47	25	16	27	32
			7	6	13	117	30.2	19	25	42
			8	4	12	45	30.2	23.5	39.5	44.5
			9	5	29	88	55.7	32	79	83
			10	5	28	411	73.5	44	64	66
			11	2	25	49	35	25	37	49
			12	1	11	11	11	11	11	11
		2008	1	2	22	62	36.9	22	42	62
			2	2	8	18	12	8	13	18
			3	5	3	24	13.1	12	21	21
			4	3	12	18	15.1	12	16	18

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			5	4	10	117	33.4	19	33	77.5
			6	5	23	55	38.6	30	42	54
			7	3	24	34	28.4	24	28	34
			8	4	26	43	34.5	28.5	36	42
			9	5	39	157	86.6	74	81	133
			10	3	25	147	50.5	25	35	147
			11	2	26	46	34.6	26	36	46
			12	2	10	144	37.9	10	77	144
		2009	1	2	34	47	40	34	40.5	47
			2	2	6	128	27.7	6	67	128
			3	5	10	435	38.6	12	14	117
			4	4	4	49	13.3	7	13	32.5
			5	3	10	17	12.7	10	12	17
			6	4	11	613	73.9	19	95.5	388.5
			7	4	41	79	52	43	47.5	64.5
			8	5	67	291	108	70	72	148
			9	3	60	96	82.1	60	96	96
			10	4	13	99	41.1	23.5	49.5	82
			11	3	19	48	27.6	19	23	48
			12	1	9	9	9	9	9	9
		2010	1	2	14	19	16.3	14	16.5	19
			2	2	14	23	17.9	14	18.5	23
			3	5	7	144	23	10	16	40
			4	7	8	62	16.2	8	10	36
			5	7	20	60	31.8	20	30	44
			6	8	34	387	92.7	57.5	88.5	135
			7	7	20	613	113	68	101	201
			8	8	64	1700	179	66	117	417
			9	5	55	308	155	130	161	251
			10	7	23	310	57.7	31	44	93
			11	3	66	233	109	66	84	233
			12	1	14	14	14	14	14	14
		2011	1	2	20	24	21.9	20	22	24
			2	3	23	36	26.7	23	23	36
			3	5	12	93	40.7	33	39	78
			4	8	9	30	12.3	10	11.5	12
			5	11	17	225	55.7	34	47	110
			6	6	16	116	38.6	26	35	57
			7	7	50	308	107	74	98	150
			8	7	44	340	94	56	93	124
			9	7	96	370	144	103	122	190

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			10	8	34	410	77.6	54	61.5	93
			11	1	49	49	49	49	49	49
			12	2	14	20	16.7	14	17	20
07020012-505	Adjacent, Not Impaired	2006	1	6	48	144	73.7	50	62	125
			2	6	46	269	109	50	135.5	222
			3	10	11	73	29.5	17	32	53
			4	11	2	65	12.2	6	10	34
			5	11	4	86	16.3	8	14	59
			6	15	5	715	83.8	14	107	517
			7	11	4	44	15.8	10	16	38
			8	12	4	50	13	6.5	9	28
			9	12	8	53	18	12	16.5	27
			10	12	2	96	17.4	8.5	18.5	41
			11	6	6	326	27.2	10	13.5	117
			12	6	15	133	43	18	38.5	120
		2007	1	6	45	215	92	56	91	157
			2	6	55	1035	225	56	286	517
			3	12	6	2420	70.3	11.5	31.5	1296
			4	11	2	83	9.52	4	6	64
			5	12	2	86	13.9	6	12.5	41
			6	12	18	99	49.8	38	46	87
			7	12	0.5	91	9.16	4.5	9.5	16
			8	12	2	688	27.2	6	16	248
			9	12	12	1046	74.1	23	70.5	185.5
			10	12	92	1046	214	141.5	207.5	275.5
			11	9	26	252	65.3	44	54	70
			12	5	61	110	88.9	86	89	108
		2008	1	6	135	532	282	206	268.5	488
			2	6	84	649	271	86	408	517
			3	10	19	308	110	44	166.5	225
			4	11	4	45	14.5	9	16	19
			5	12	5	50	16.5	11	15.5	28
			6	12	29	276	85.4	46	71.5	169
			7	12	21	161	49.2	31.5	50	74.5
			8	12	3	378	33.3	8.5	37	138
			9	12	7	161	29.4	18	27	52
			10	12	4	51	26	19	36	41
			11	6	19	286	68.8	31	55	210
			12	6	62	326	169	117	180	308
		2009	1	6	84	365	166	89	191.5	206

AUID	Reach Categor-ization	Year	Month	N	Minimum	Maximum	Geometric Mean	25th Percentile	Median (50th Percentile)	75th Percentile
			2	6	34	770	125	53	130	167
			3	12	37	217	90	62.5	98.5	121.5
			4	12	0.5	15	3.06	1.5	3	8.5
			5	12	3	10	6.12	4.5	6.5	8.5
			6	12	0.5	461	25.1	21.5	32.5	64
			7	15	5	92	21.3	8	23	36
			8	12	6	299	35.2	20	27	73.5
			9	12	8	50	19.7	12	15.5	38
			10	12	20	770	103	47.5	79.5	287.5
			11	6	21	64	38.4	25	42.5	56
			12	6	23	42	32.5	26	33.5	42
		2010	1	6	30	176	63.5	34	69	77
			2	6	56	219	112	58	135	155
			3	11	4	328	74.1	8	156	214
			4	15	2	45	8.57	4	8	28
			5	12	7	139	20.1	9	17	45.5
			6	12	55	219	114	88.5	119.5	141.5
			7	15	25	179	62	34	55	121
			8	12	9	248	43.5	14	54.5	94.5
			9	9	71	2420	484	211	260	2420
			10	14	8.5	435	58.9	36	51.5	131
			11	6	41	112	71.2	47	79.5	100
			12	6	114	192	148	120	153	174
		2011	1	5	64	121	96.7	99	105	105
			2	6	73	921	201	93	125	692
			3	11	91	270	138	105	120	216
			4	15	1	22	7.43	4	9	12
			5	12	1	75	9.78	5	9.5	36
			6	12	11	1300	83	18	108	303.5
			7	14	17	86	41.9	34	44	56
			8	12	13	28	18.9	16	19	23
			9	15	7	142	26	20	28	38
			10	12	11	816	57.7	15.5	45.5	195.5
			11	5	39	228	104	61	101	222
			12	6	103	770	186	107	153.5	210

APPENDIX E. WATER QUALITY ANALYSIS FOR REACHES OUTSIDE OF TMDL AND PROTECTION SUBWATERSHEDS

E.1 Mississippi River – Sartell Watershed (HUC 07010201)

E.1.1 AUID 07010201-508: Mississippi River (Spunk Cr to Platte R)

This reach of the Mississippi River (AUID 07010201-508) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

E.1.2 AUID 07010201-509: Mississippi River (Two R to Spunk Cr)

This reach of the Mississippi River (AUID 07010201-509) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

E.1.3 AUID 07010201-606: Mississippi River (Platte R to Morrison/Stearns County border)

This reach of the Mississippi River (AUID 07010201-606) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

E.2 Mississippi River – St. Cloud Watershed (HUC 07010203)

E.2.1 AUID 07010203-513: Mississippi River (St Cloud Dam to Clearwater R)

This reach of the Mississippi River (AUID 07010203-513) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

E.2.2 AUID 07010203-548: Elk River (St Francis R to Orono Lk)

Elk River (AUID 07010203-548) discharges to Orono Lake, which ultimately drains to the Mississippi River). This reach is impaired for aquatic recreation due to *E. coli*.

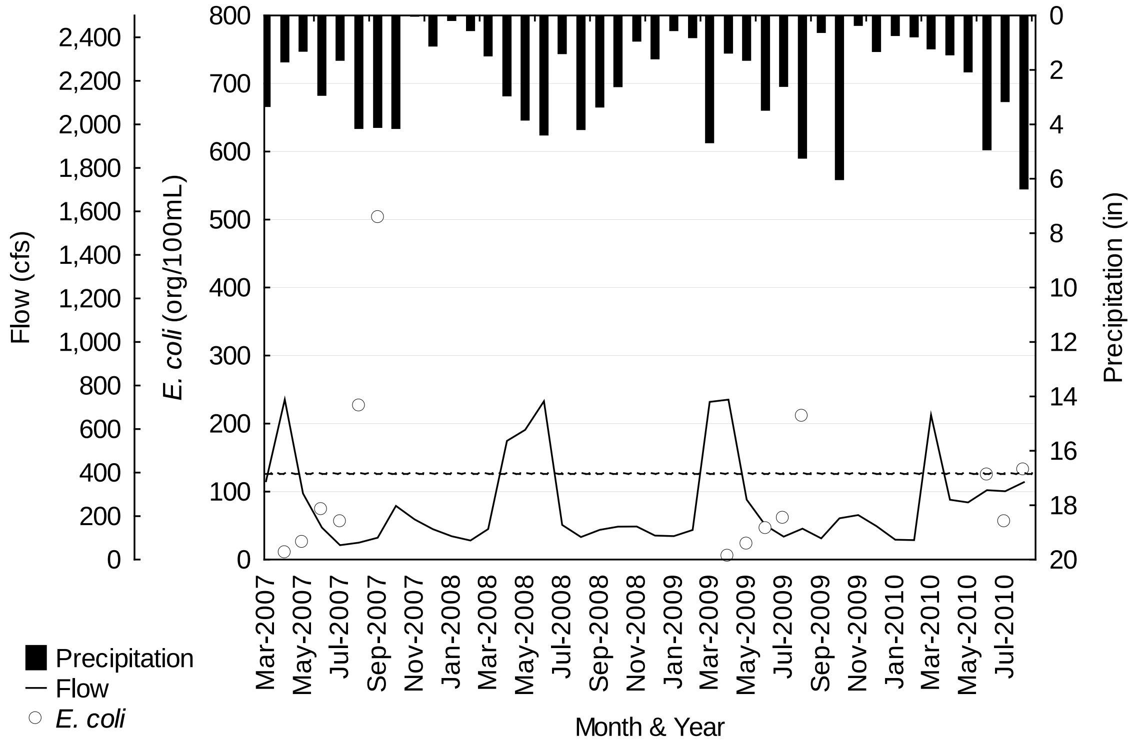

Figure E-1. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Elk River (07010203-548) from 2007-2010.
Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

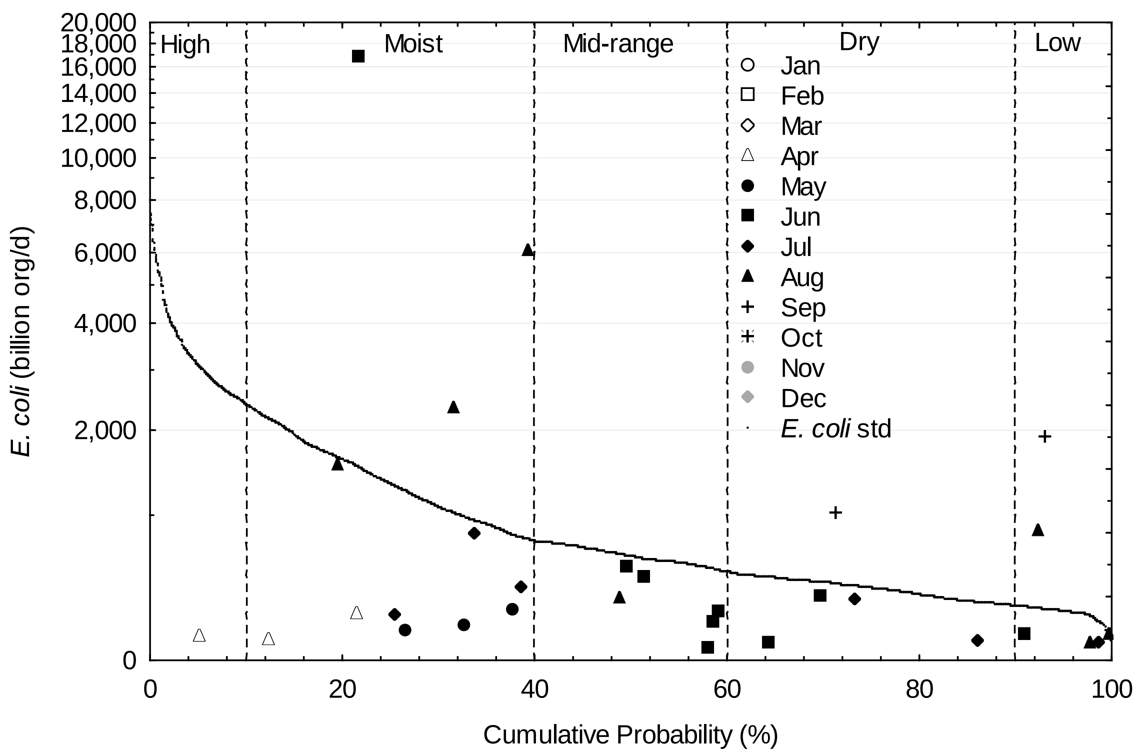

Figure E-2. Load duration curve for *E. coli* at Elk River (07010203-548).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.2.3 AUID 07010204-502: Crow River (S Fk Crow R to Mississippi R)

The Crow River (AUID 07010204-502) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

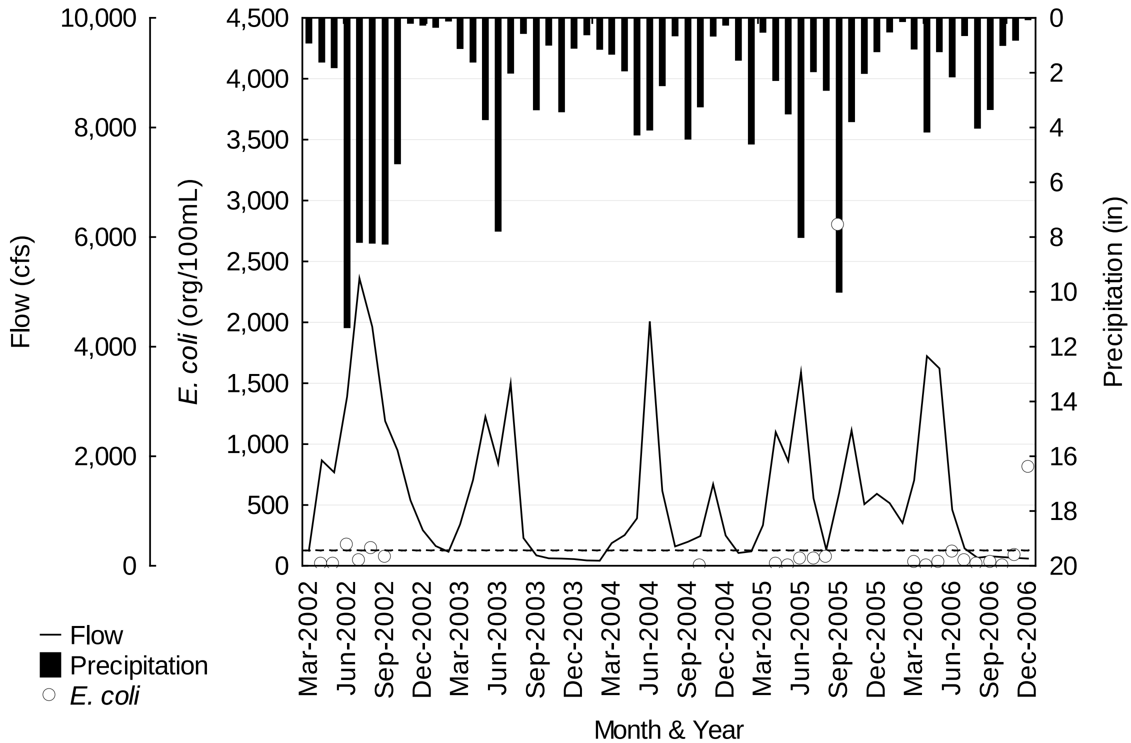

Figure E-3. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Crow River (07010204-502) from 2002-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

E.3 Mississippi River – Twin Cities Watershed (HUC 07010206)

E.3.1 AUID 07010206-508: Elm Creek (Headwaters (Lk Medina 27-0146-00) to Mississippi R)

Elm Creek (AUID 07010206-508) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

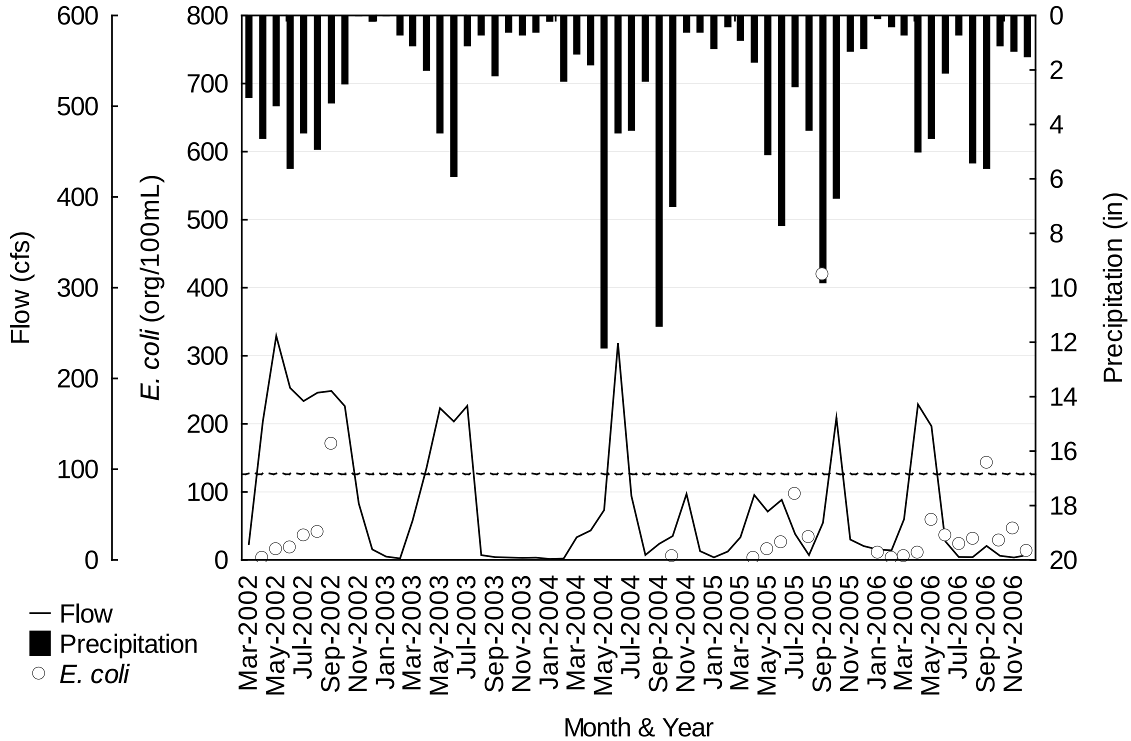

Figure E-4. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Elm Creek (07010206-508) from 2002-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

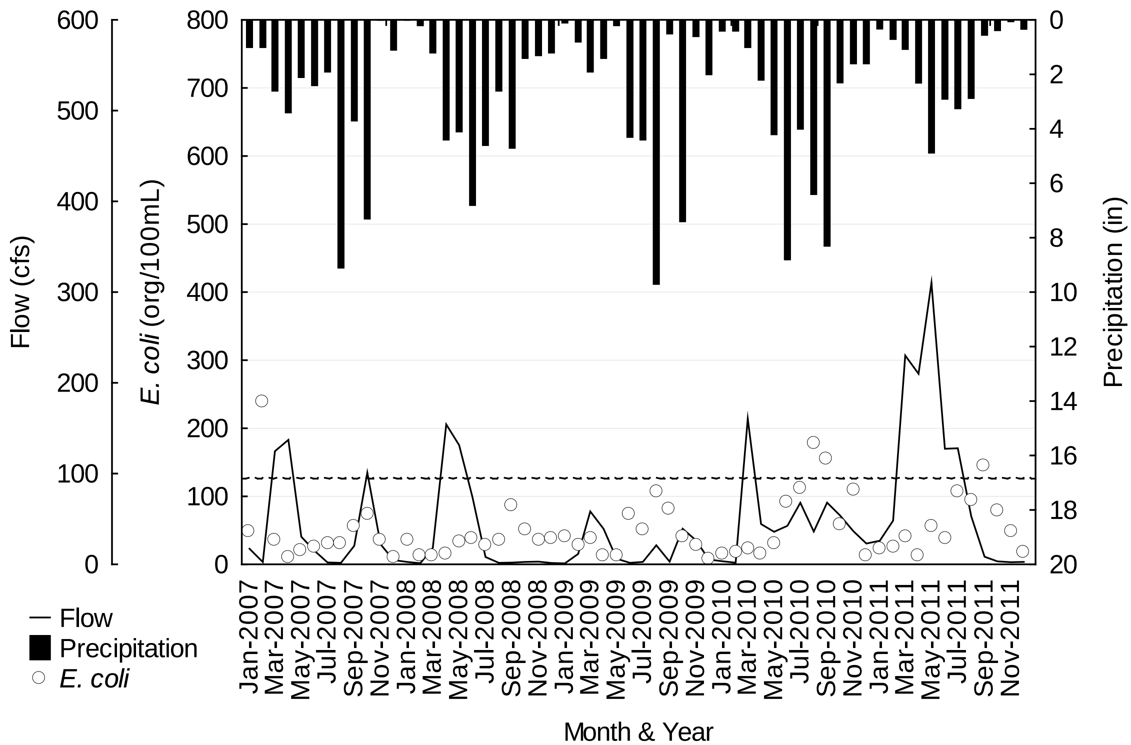

Figure E-5. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Elm Creek (07010206-508) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

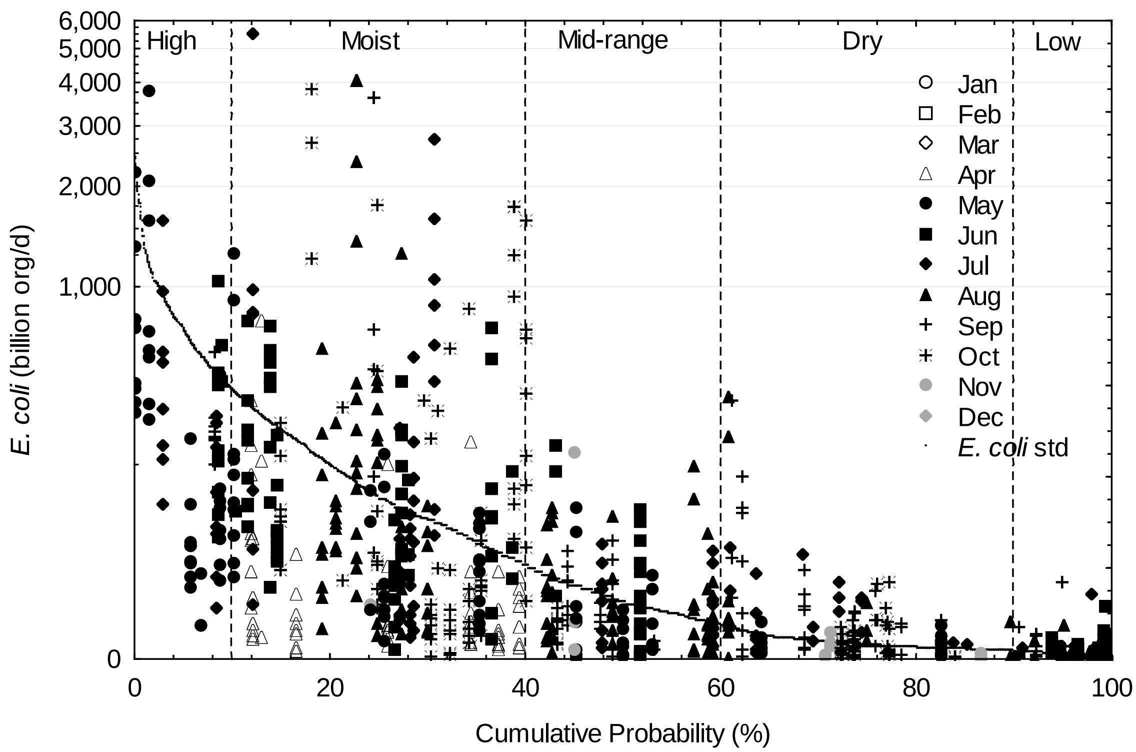

Figure E-6. Load duration curve for *E. coli* at Elm Creek (07010206-508).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.2 AUID 07010206-530: Coon Creek (Unnamed cr to Mississippi R)

Coon Creek (AUID 07010206-530) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

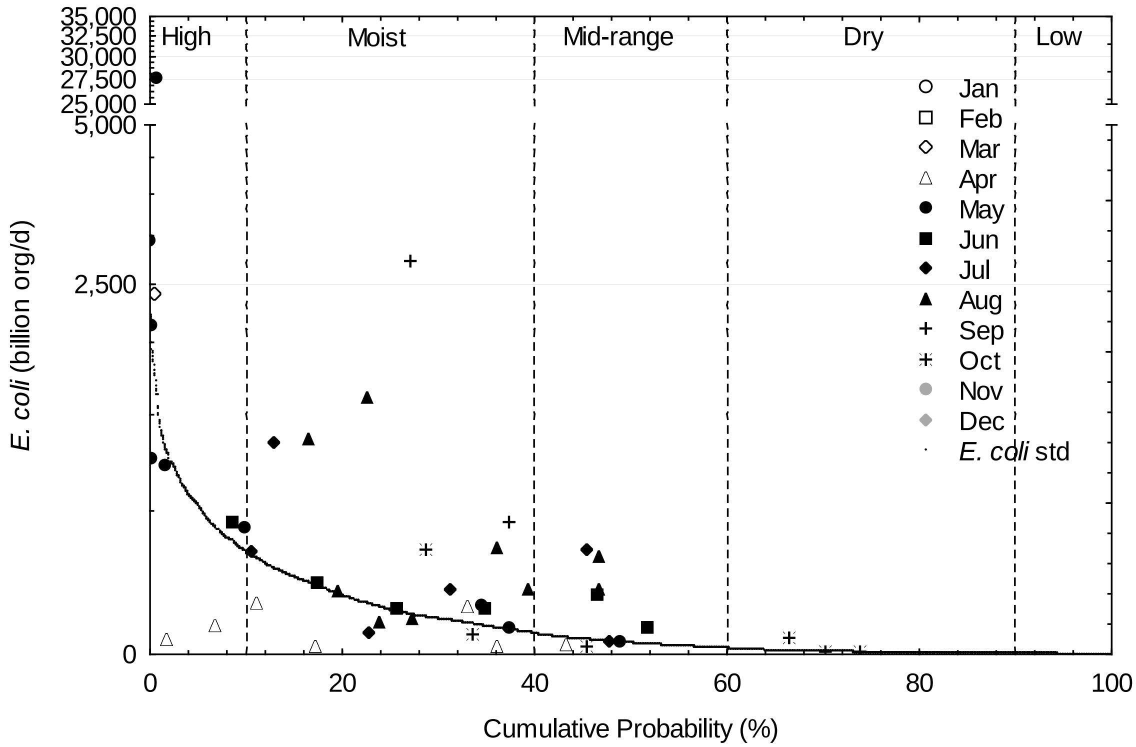

Figure E-7. Load duration curve for *E. coli* at Coon Creek (07010206-530).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.3 AUID 07010206-539: Minnehaha Creek (Lk Minnetonka to Mississippi R)

Minnehaha Creek (AUID 07010206-539) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

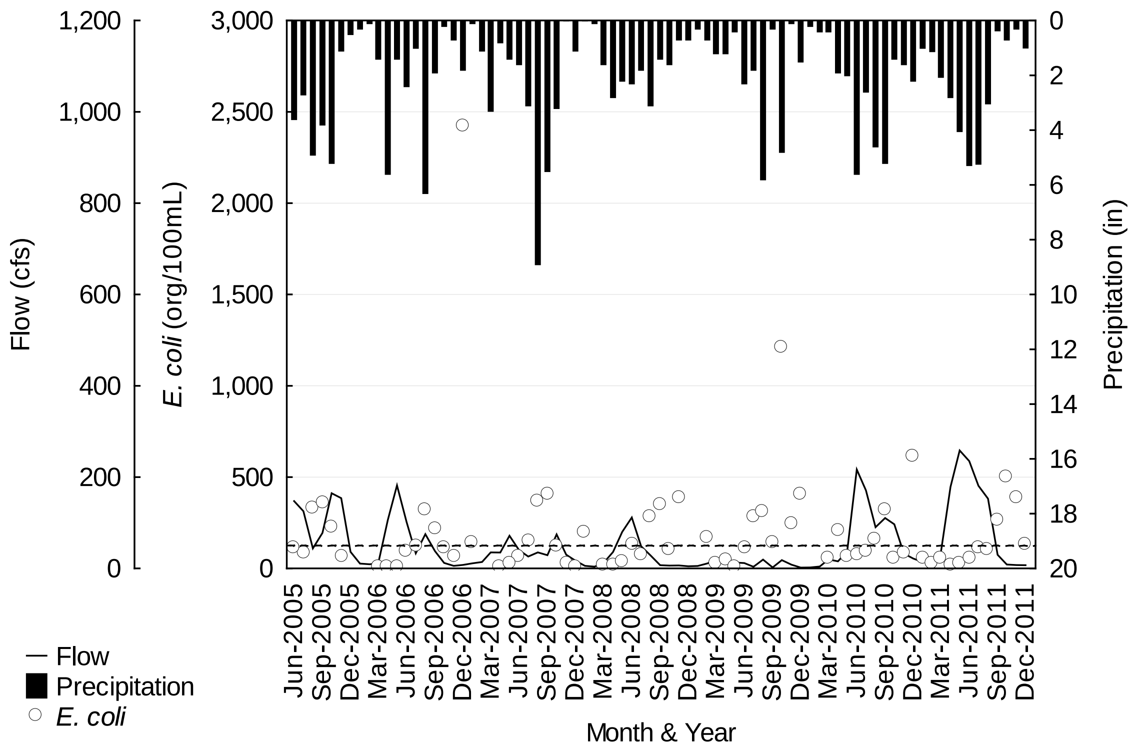

Figure E-8. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Minnehaha Creek (07010206-539) from 2005-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

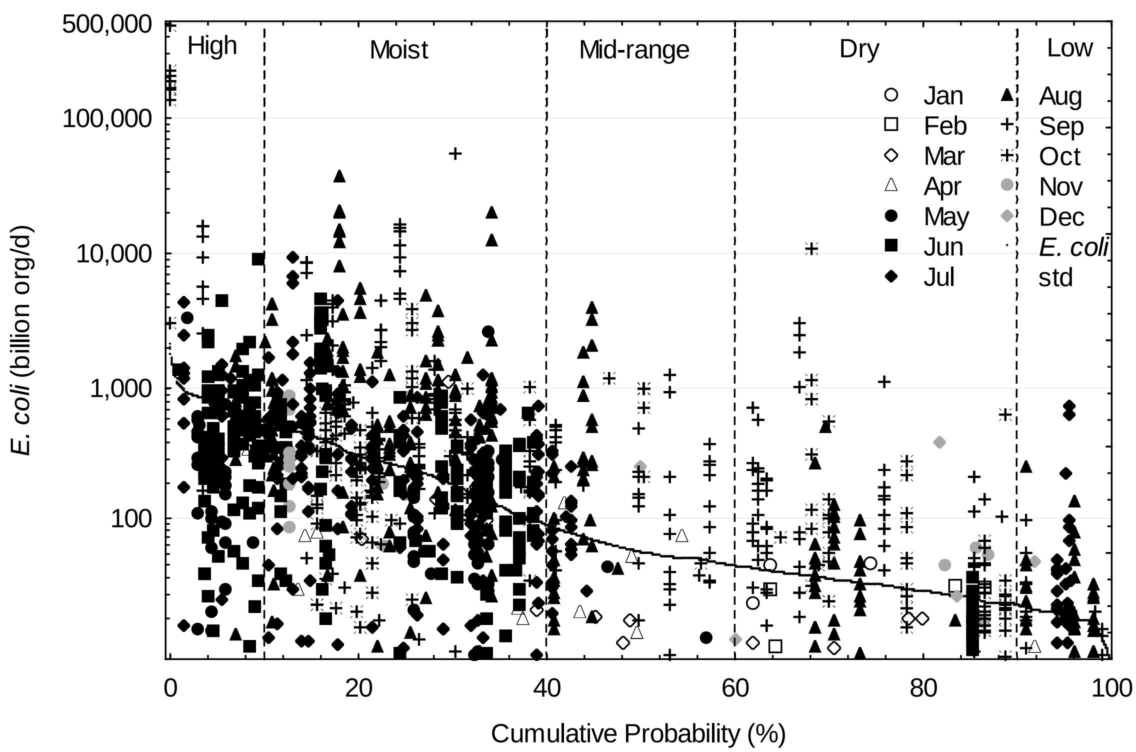

Figure E-9. Load duration curve for *E. coli* at Minnehaha Creek (07010206-539). The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.4 AUID 07010206-557: County Ditch 17 (Headwaters to Mississippi R)

County Ditch 17 (AUID 07010206-557) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

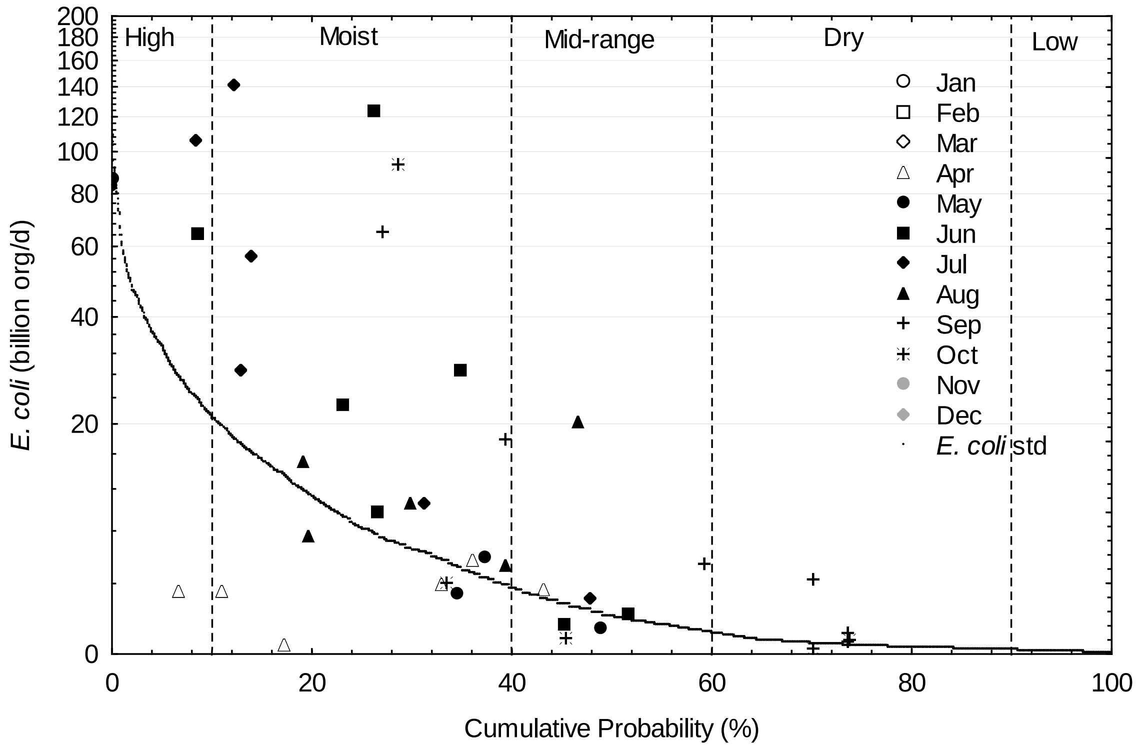

Figure E-10. Load duration curve for *E. coli* at County Ditch 17 (07010206-557).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.5 AUID 07010206-567: Mississippi River (Crow R to NW city limits of Anoka)

This reach of the Mississippi River (AUID 07010206-567) does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Water quality data are not available.

E.3.6 AUID 07010206-594: Unnamed ditch (Headwaters to Mississippi R)

Unnamed ditch (AUID 07010206-594) is a tributary of the Mississippi River and is impaired for aquatic recreation due to *E. coli*.

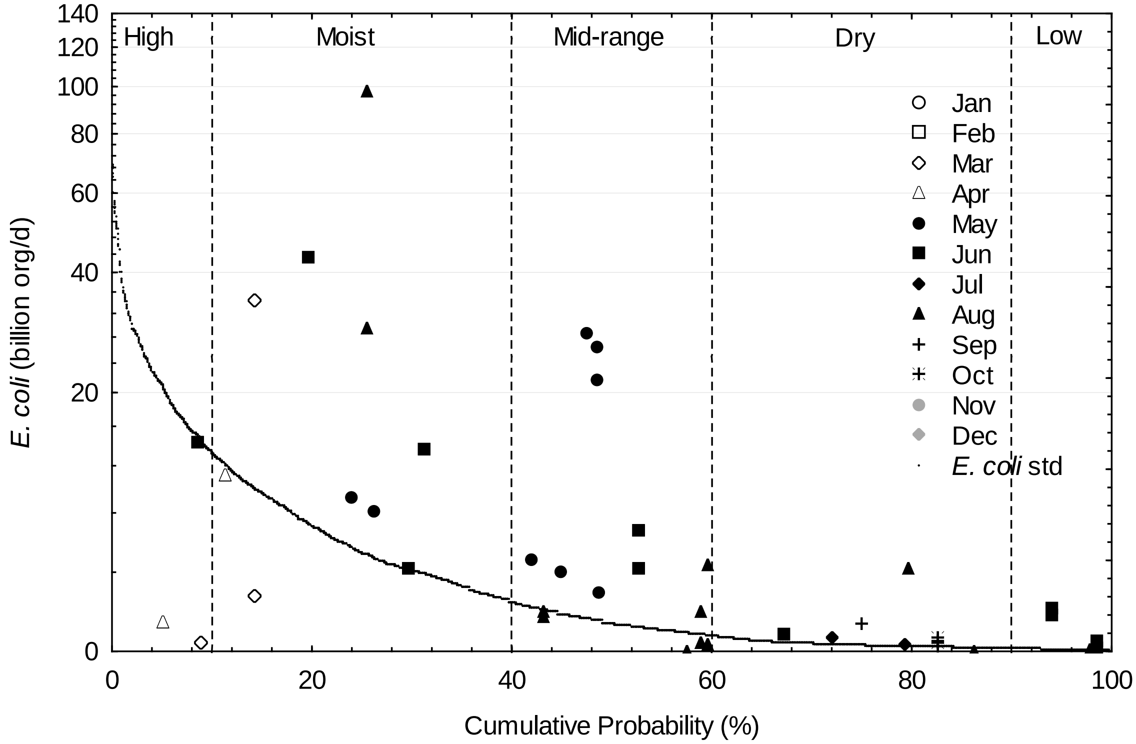

Figure E-11. Load duration curve for *E. coli* at Unnamed ditch (07010206-594).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.7 AUID 07010207-555: Rum River (Trott Bk to Madison/Rice St in Anoka)

Rum River (AUID 07010207-555) discharges to Rum River (AUID 07010207-556, Madison/Rice St in Anoka to Mississippi R) prior to discharge to the Mississippi River. AUID 07010207-555 is impaired for aquatic recreation due to *E. coli*. AUID 07010207-556 does not have sufficient data to assess whether it is full support or non support with respect to *E. coli*. Monthly summary data are shown on two figures (Figure E-12 and Figure E-13) for improved visibility.

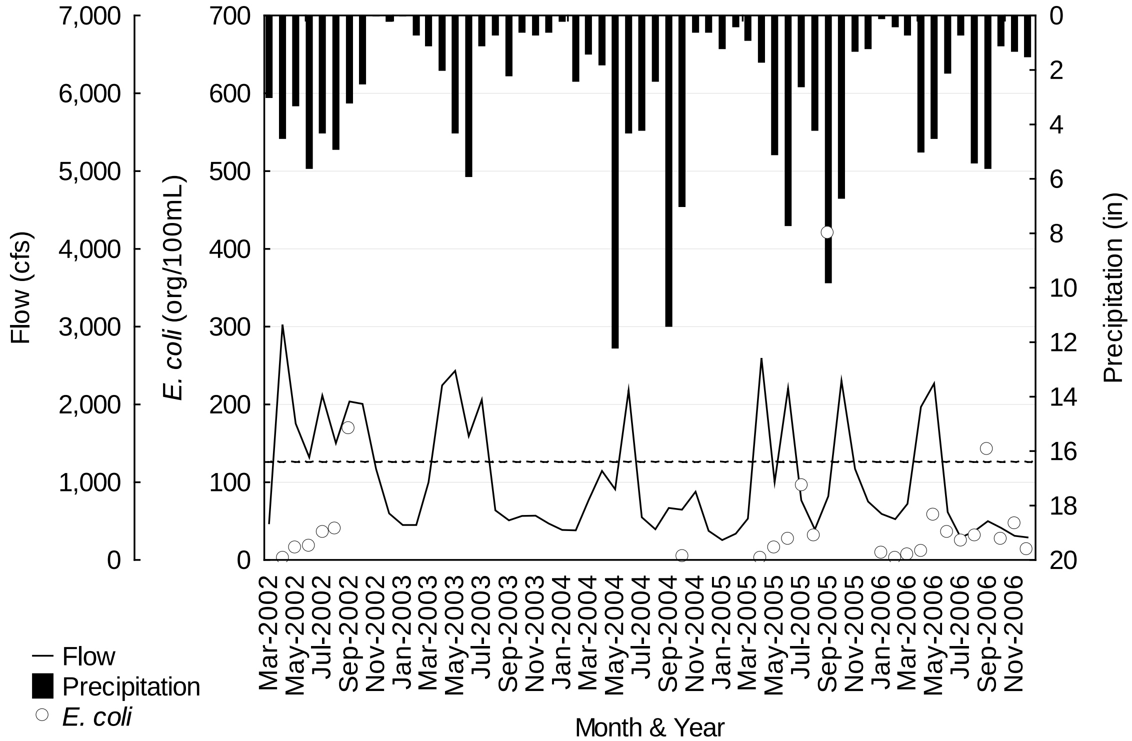

Figure E-12. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Rum River (07010207-555) from 2002-2006. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

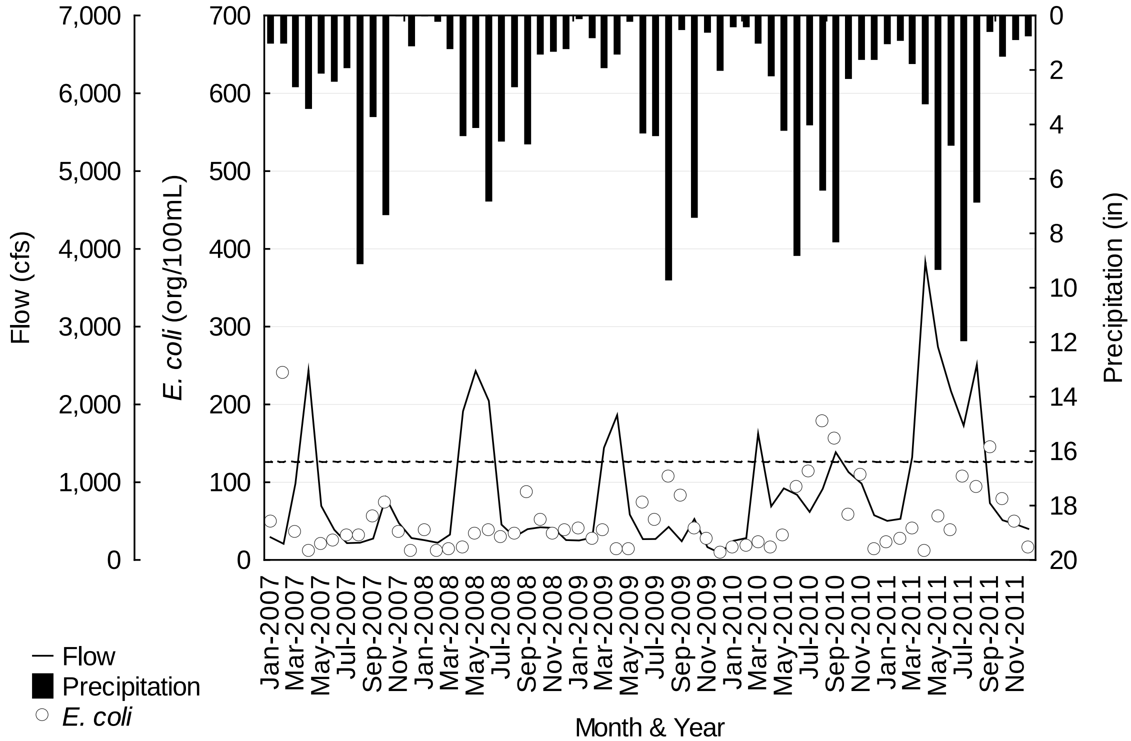

Figure E-13. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Rum River (07010207-555) from 2007-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

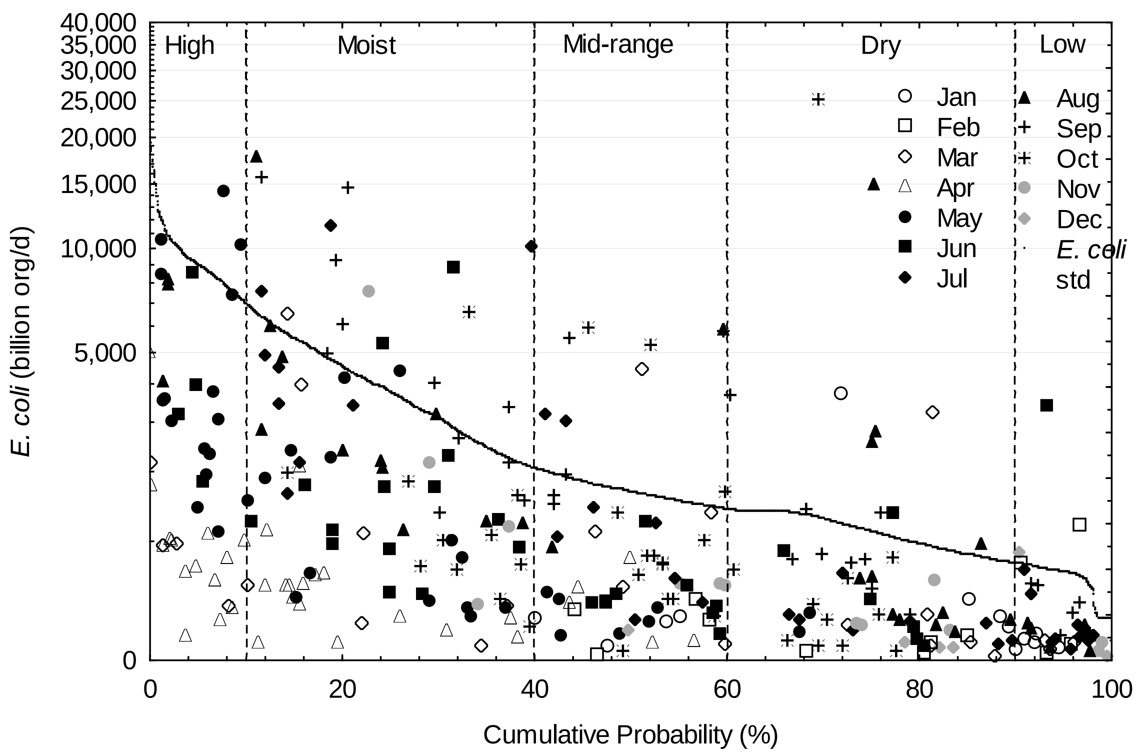

Figure E-14. Load duration curve for *E. coli* at Rum River (07010207-555).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.

E.3.8 AUID 07020012-505: Minnesota River (RM 22 to Mississippi R)

This reach of the Minnesota River (AUID 07020012-505) has been assessed as fully supporting aquatic recreation with respect to *E. coli*.

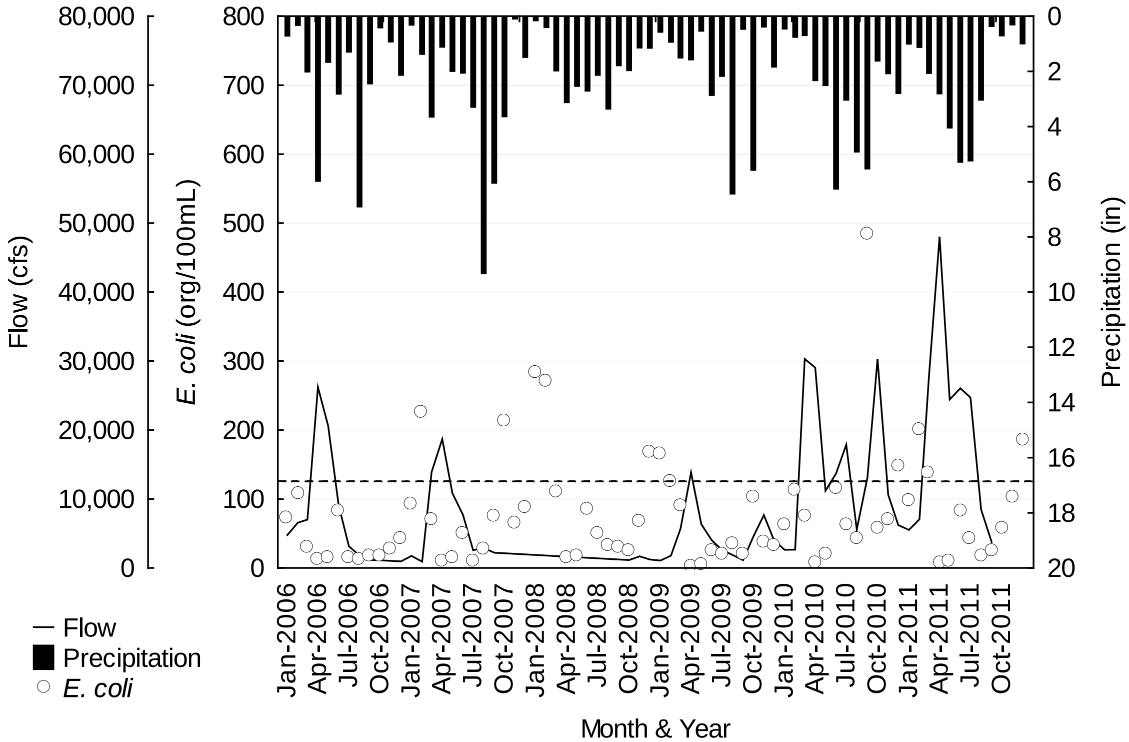

Figure E-15. *E. coli* geometric means, monthly mean flow, and total monthly precipitation at Minnesota River (07020012-505) from 2006-2011. Dashed line represents the *E. coli* geometric mean standard (126 org/100 mL).

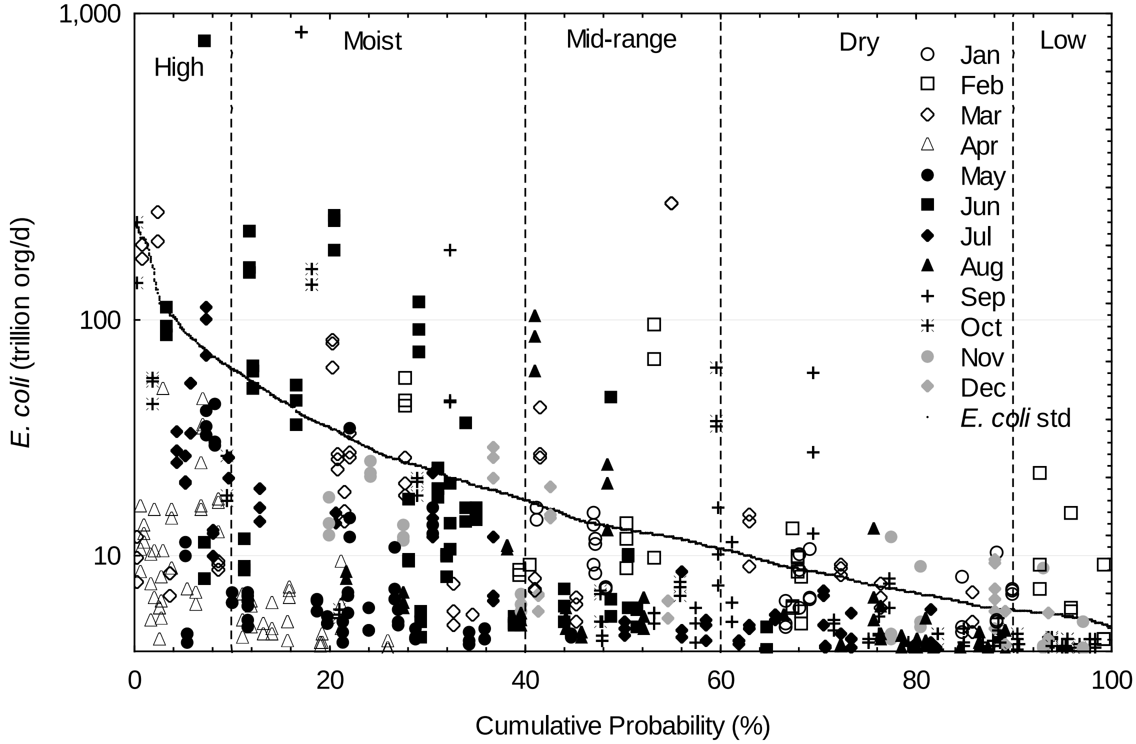

Figure E-16. Load duration curve for *E. coli* at Minnesota River (07020012-505).
The curve represents the *E. coli* load at the standard of 126 org/100 ml.