Watershed

February 2020

Upper Wapsipinicon River Watershed Total Maximum Daily Load

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Acronyms

1W1P	One Watershed, One Plan
AFO	Animal Feeding Operation
AU	Animal Unit
AUID	Assessment Unit ID
BMP	best management practice
BWSR	Board of Water and Soil Resources
CAFO	Concentrated Animal Feeding Operation
CWA	Clean Water Act
CWLA	Minnesota's Clean Water Legacy Act
DNR	Minnesota Department of Natural Resources
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
GHOST	Generic Hydrologic Overland-Subsurface Toolkit
IADNR	Iowa Department of Natural Resources
IFC	Iowa Flood Center
IIHR	IIHR—Hydroscience and Engineering
IWM	Intensive Water Monitoring
ISTS	Individual Septic Treatment System
IPHT	Imminent Public Health Threat
LA	load allocation
m	meter
mL	milliliter
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
SID	Stressor Identification Report
SSTS	Subsurface Sewage Treatment Systems
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load

TP	total phosphorus
UWRW	Upper Wapsipinicon River Watershed
WLA	wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy

Executive summary

The Clean Water Act (CWA; 1972) requires that each state develop a report to identify and restore any waterbody that is deemed impaired by state regulations, known as a Total Maximum Daily Load (TMDL) Study. A TMDL identifies the pollutant that is causing the impairment and how much of that pollutant can enter the waterbody and still meet water quality standards, and apportions pollutant loads to sources in the watershed. This TMDL study includes calculations for one stream reach with a bacteria impairment located in the Upper Wapsipinicon River Watershed (UWRW) of southcentral Minnesota.

Information from multiple sources was used to evaluate the ecological health of this watershed:

- All available water quality data over the past 10 years
- UWRW Monitoring and Assessment Report (https://www.pca.state.mn.us/sites/default/files/wq-ws3-07080203b.pdf)
- Published studies
- UWRW Stressor Identification (SID) Report (https://www.pca.state.mn.us/sites/default/files/wq-ws5-07080102a.pdf)
- Upper Wapsipinicon Watershed Hydrologic Assessment Report (Iowa Flood Center[IFC]/IIHR—Hydroscience and Engineering [IIHR] 2019)
- Stakeholder input

Nonpoint sources such as agricultural runoff, individual septic treatment systems (ISTS) and animal feedlots are all important pollutant sources in the UWRW. An inventory of these and other pollutant sources were used to inform the stream load duration curves. This tool was then used to determine the loads for the stream that corresponds to state water quality standard attainment.

The findings from this TMDL study will be used in conjunction with the UWRW Restoration and Protection Strategy (WRAPS) Report. The purpose of the WRAPS report is to support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for implementation planning (Cedar River One Watershed, One Plan [1W1P]). The WRAPS provides additional discussion of pollutant sources, implementation strategies, and tools for prioritization. Following completion, the WRAPS and TMDL documents will be publically available on the Minnesota Pollution Control Agency (MPCA) UWRW website: https://www.pca.state.mn.us/water/watersheds/upper-wapsipinicon-river.

Priorities and plans for the Upper Wapsipinicon Watershed are captured in the Cedar River 1W1P, accessible through the Cedar River Watershed District website: https://www.cedarriverwd.org/1w1p/.

1. Project overview

1.1 Purpose

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and resources to state and local governments to accelerate efforts to monitor, assess and restore impaired waters and to protect unimpaired waters. The result has been a comprehensive watershed approach that integrates water resource management efforts with local government and local stakeholders and develops restoration and protection studies for Minnesota's 80 major watersheds.

For the UWRW, this approach began with intensive watershed monitoring in 2015, focusing on chemical and biological monitoring (fish and macroinvertebrates) to assess overall stream health. This assessment was completed in 2016 and used to develop this TMDL report, as well as the WRAPS report.

This TMDL study addresses an aquatic recreation impairment due to bacteria on one stream Assessment Unit ID (AUID) in the UWRW.

Completed studies for this watershed that are referenced in this TMDL report include:

- UWRW Monitoring and Assessment Report (MPCA 2018)
- UWRW SID Report (MPCA 2018a)

More related information is summarized in the WRAPS report; those works listed above can be reviewed at the MPCA's UWRW website: https://www.pca.state.mn.us/water/watersheds/upper-wapsipinicon-river.

Given the accumulation of data and conclusions achieved throughout these component processes, the documents cross-reference frequently and should thus be considered a "package" of information that comprehensively addresses condition monitoring, restoration, and protection in the UWRW.

The findings from this TMDL study can be used in conjunction with the WRAPS report and supporting information to guide management in the UWRW. Together, these reports will support local projects in developing scientifically-supported restoration and protection strategies to be used for subsequent implementation planning.

The goal of this TMDL study was to quantify, as best as possible, *E. coli* reductions needed to meet state water quality standards for the impaired stream section, Wapsipinicon River (07080102-507), in the UWRW. This UWRW TMDL study was established in accordance with Section 303(d) of the CWA and provides wasteload allocations (WLAs) and load allocations (LAs) for *E. coli* contributors within the watershed. Due to the complex nature of *E. coli*, these allocations represent where the most likely significant source of *E. coli* originates. In addition, flow duration curves help identify under which flow conditions *E. coli* exceedances most likely occur; providing supporting evidence for *E. coli* sources.

The impaired stream within the UWRW flows across the Minnesota state border into Iowa. The TMDL is being calculated to Minnesota state water quality standards. The MPCA's TMDL process calculates TMDL endpoints to attain water quality standards at the most downstream endpoint of the impaired reach. For a segment that crosses a state border, this is typically the state border. One should assume that compliance with a TMDL means that Minnesota water quality standards are being met at the state border, and that waters originating within its boundaries will not cause or contribute to impairments downstream.

1.2 Identification of waterbodies

This TMDL report addresses one stream AUID throughout the UWRW (Figure 1). In the case of the aquatic life impairment, the use support decisions drew heavily on biota data, which required further examination (herein referred to as SID) to determine whether or not pollutants are causing the impairments. Pollutant stressors are addressed via TMDLs; non-pollutant stressors are addressed though the WRAPS report.

Data and assessment indicate the following impairments for the Upper Wapsipinicon River (-507):

- Not supporting aquatic life use with identified stressors including nitrate (pollutant, but no water quality standard exists, so no TMDL), habitat and altered hydrology (non-pollutant, so no TMDL).
- Not supporting aquatic recreation with the pollutant being bacteria (indicator bacteria is *E. coli*).

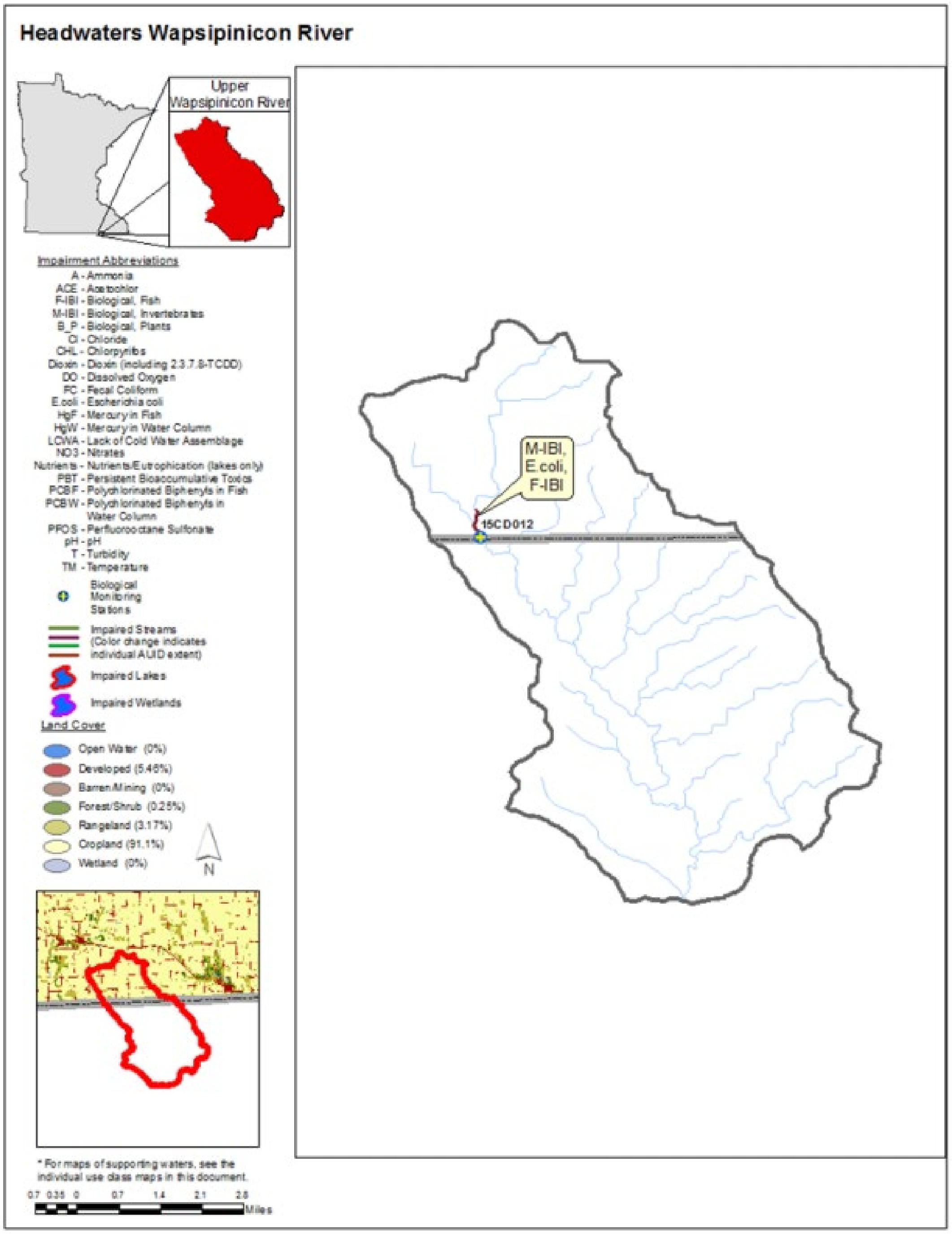

Figure 1. Water quality impairments in the Upper Wapsipinicon River Watershed.

Through SID investigation, altered hydrology and habitat stressors were confirmed for AUID 07080102-507. Neither altered hydrology nor habitat are pollutant stressors and therefore are not addressed in this TMDL.

Nitrogen has been identified as a pollutant stressor impacting the aquatic life within the UWRW. Because the reach assessed is designated as a Class 2Bg water, there is no applicable nitrogen water quality standard. Refer to Section 2.1 for a description of surface water designated uses. All aquatic life use impairments – not just those with associated TMDLs –are addressed in the WRAPS report.

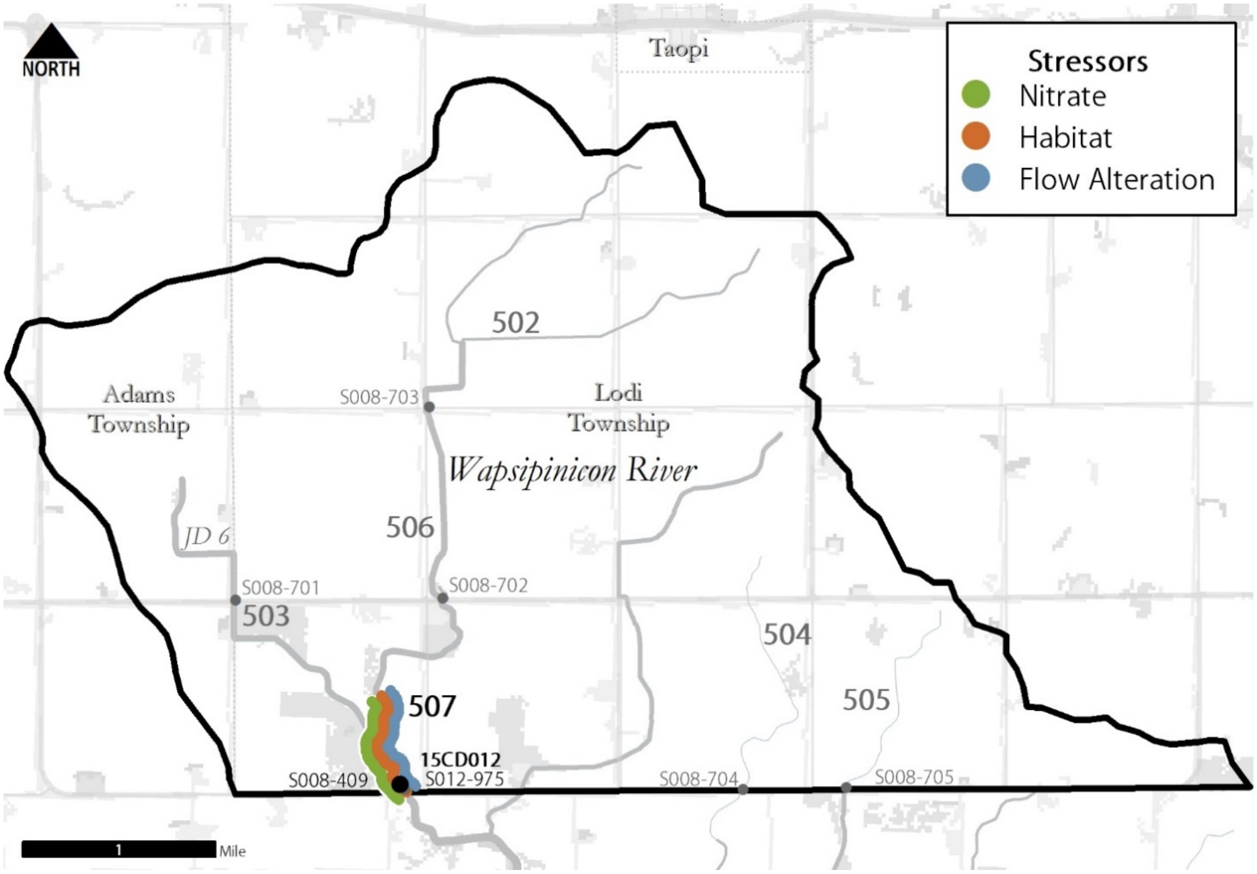

Figure 2. Stressors to biota identified in the Upper Wapsipinicon River Watershed.

Table 1. Water quality impairments of Upper Wapsipinicon River addressed in this TMDL.

HUC8	Waterbody Name	Reach Description	AUID (HUC-8)	Use Class	Year Added to List	Affected Use	Proposed Category	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in This Report
Upper Wapsipinicon River (07080102)	Wapsipinicon River	-92.6732, 43.5073 to MN/IA border	507	2Bg	2018	Aquatic Life	5	Aquatic macroinvertebrate bioassessment Fish bioassessment	Flow Alteration Habitat Nitrate	**No:** non-pollutant stressor **No:** non-pollutant stressor **No**: WQ standard not established
						Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*

The proposed categories will be reflected on the 2022 impaired waters list.

1.3 Priority ranking

The MPCA's schedule for TMDL completions, as indicated on Minnesota's Section 303(d) impaired waters list, reflects the State's priority ranking of this TMDL. The MPCA has aligned our TMDL priorities with the watershed approach and our WRAPS cycle. The schedule for TMDL completion corresponds to the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan Minnesota's TMDL Priority Framework Report to meet the needs of U.S. Environmental Protection Agency (EPA's) national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the CWA Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments that will be addressed by TMDLs by 2022. The UWRW impairment addressed by this TMDL are part of that MPCA prioritization plan to meet EPA's national measure.

2. Applicable water quality standards and numeric water quality targets

2.1 State of Minnesota Designated Uses

Each lake and stream reach has a Designated Use Classification defined by Minn. R. 7050.0140, which sets the optimal purpose for that waterbody. The stream addressed by this TMDL falls into the 2Bg designated use classifications: *"Warm water Stream protected for aquatic life and recreation, capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms that meet or exceed the General Use biological criteria."*

Class 2 waters are protected for aquatic life, aquatic consumption, and aquatic recreation. The Minnesota narrative water quality standards for all Class 2Bg waters (Minn. R. 7050.0222, subp. 4c.) states that:

> *"General cool and warm water aquatic life and habitat" or "class 2Bg" is a beneficial use that means waters capable of supporting and maintaining a balanced, integrated, adaptive community of warm or cool water aquatic organisms having a species composition, diversity, and functional organization comparable to the median of biological condition gradient level 4 as established in Calibration of the Biological Condition Gradient for Streams of Minnesota, Gerritsen et al. (2012)."*

2.1.1 Bacteria (*E. coli* and Fecal Coliform)

E. coli standards for Class 2 waters are defined in Minn. R. 7050.0222 and presented in Table 2. There are two *E. coli* standards for Class 2 waters – one applied to monthly geometric mean concentrations, and the other applied to individual samples. The Class 2 standard is in effect from April through October.

Table 2. Water quality standard of *E. coli* impairment addressed in this TMDL.

Pollutant	Water Quality Standard	Description of standard	Time standard applies
E. coli	126 org/100 mL	geometric mean of ≥ 5 samples per calendar month	April 1 - October 31
	1,260 org/100 mL	≤ 10% of all samples exceed standard per calendar month	

Because the impaired section of Upper Wapsipinicon River crosses into the State of Iowa, Iowa water quality criteria was examined to verify whether the downstream *E. coli* standard was more restrictive than the upstream Minnesota standard. Approximately three miles downstream from the Minnesota/Iowa border, the Upper Wapsipinicon River ("01-WPS-354") is impaired by *E. coli*. The listing of "01-WPS-354" is a State of Iowa impairment. It is important to point out that there is not a continuous *E. coli* impairment on the Upper Wapsipinicon River from Minnesota into Iowa. This gap in the *E. coli* impairment is due to a lack of data for assessment, rather than available data supporting *E. coli* meeting designated use standards.

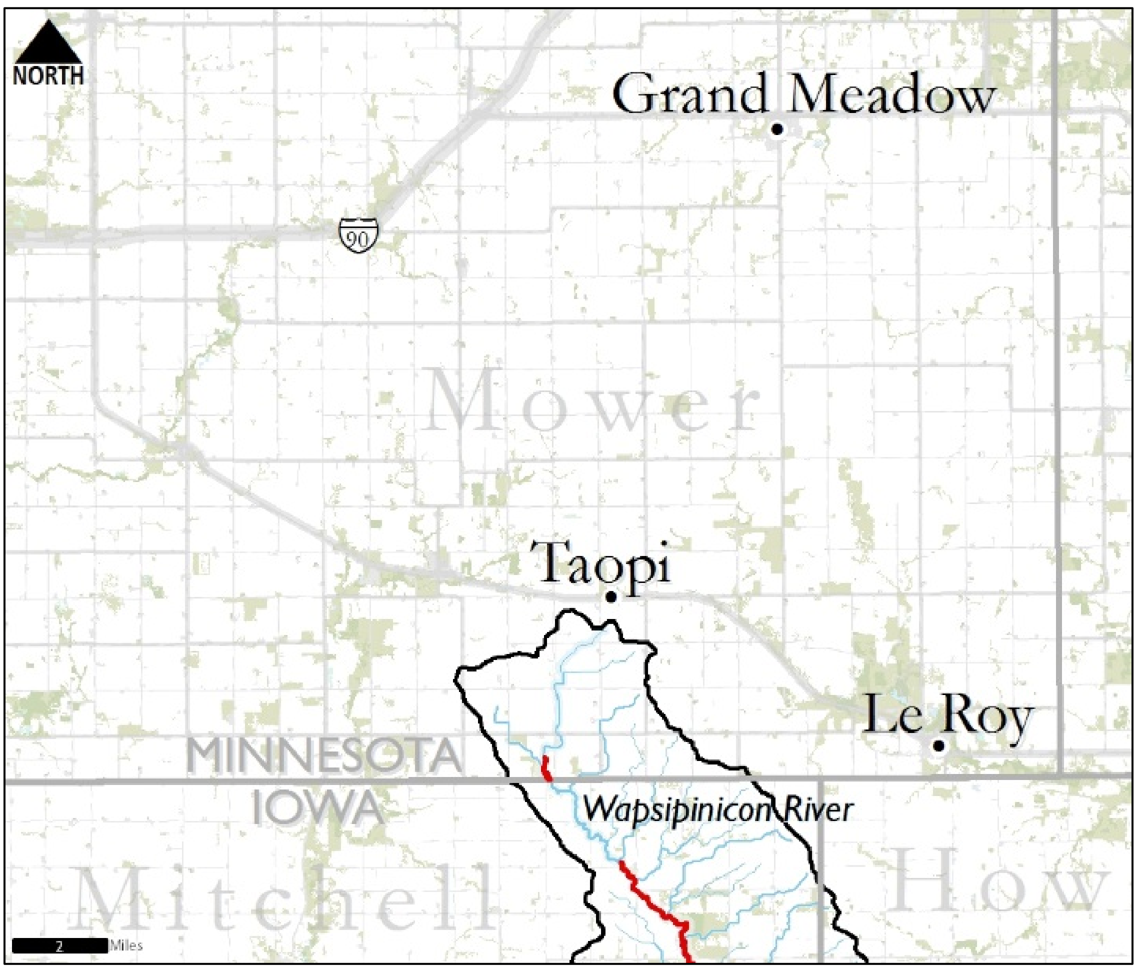

Figure 3. *E. coli* impairment on the Upper Wapsipinicon River.

Section 01-WPS-354 is designated, according to State of Iowa water quality criteria, for Recreation Primary contact (A1), Recreation Secondary contact (A2) and Aquatic Life Cold Water Type 1 (B(CW1)). Corresponding *E. coli* standards for Iowa's designated uses are outlined in Table 3.

Table 3. State of Iowa water quality criteria for *E. coli* in surface waters designated for primary and secondary contact; IADNR 2017.

Standard Type	Class A1: Primary Contact Recreational Use *	Class A2: Secondary Contact Recreational Use *
Geometric Mean (organisms/100 mL)	126	630
Sample Maximum (organisms/100 mL)	235	2,880
** Criteria apply from March 15–November 15 except year-round for Class A2 waters that are also designated for class B(CW1) [coldwater aquatic life] uses.*		

Since both Minnesota and Iowa *E. coli* monthly geometric standards are 126 org/100 milliliter (mL), the TMDL targets the most restrictive standard. This includes protecting for the single *E. coli* sample standard of 1,260 org/100 mL (Minnesota) and 235 org/100 mL (Iowa).

3. Watershed and waterbody characterization

The UWRW is a headwater of the greater Cedar River Watershed located entirely within Mower County in south central Minnesota. This watershed spans 13 square miles in Minnesota and makes up approximately 0.81% of the entire Wapsipinicon River Watershed (NRCS 2007a). The entire Wapsipinicon River Watershed drains 1,568 square miles of land across Minnesota and Iowa before flowing into the Mississippi River at the Illinois/Iowa border. As of January 1, 2018, no part of the UWRW is located within the boundary of an American Indian/Alaska Native/Native Hawaiian area (AIANNH). The Iowa portion of the watershed includes an active organization, known as the UWRW Management Authority, dedicated to reducing flooding, improving water quality, and reducing in-stream sedimentation

3.1 Streams

The mainstem of the Upper Wapsipinicon River originates in Minnesota as a series of modified surface waters; mainly drainage ditches. The watershed has one small section of natural channel in the lower portion of the UWRW above the Minnesota/Iowa border. Due to the size of this watershed, no subwatersheds are established.

Table 4. Watershed area of impaired water.

AUID	Name	Length (mi)	Direct Drainage (ac)	Total Watershed Area	Upstream Impaired Reach
07080102-507	**Wapsipinicon River**	**0.61**	**5,495**	**13 sq. mi.**	**None**

3.2 Land use

Historically, the UWRW was covered by native prairie. Today, 91% of the Minnesota portion of the watershed has been converted to row crop agriculture (DNR 2013). Rangeland (pasture) makes up 3.2% of the land use and 5.5% for general development. All other land use categories (forest and wetland) are less than 1% of the total watershed. Primary land covers for the greater Wapsipinicon watershed are

Row Crops (75.3%), Grass/Pasture/Hay (9.8%), Residential/Commercial Development (7.5%), Forest (3.6%), and Wetlands (3.4%). (NRCS 2016). For the remainder of this report, the Upper Wapsipinicon River will refer to parts of the watershed in Minnesota.

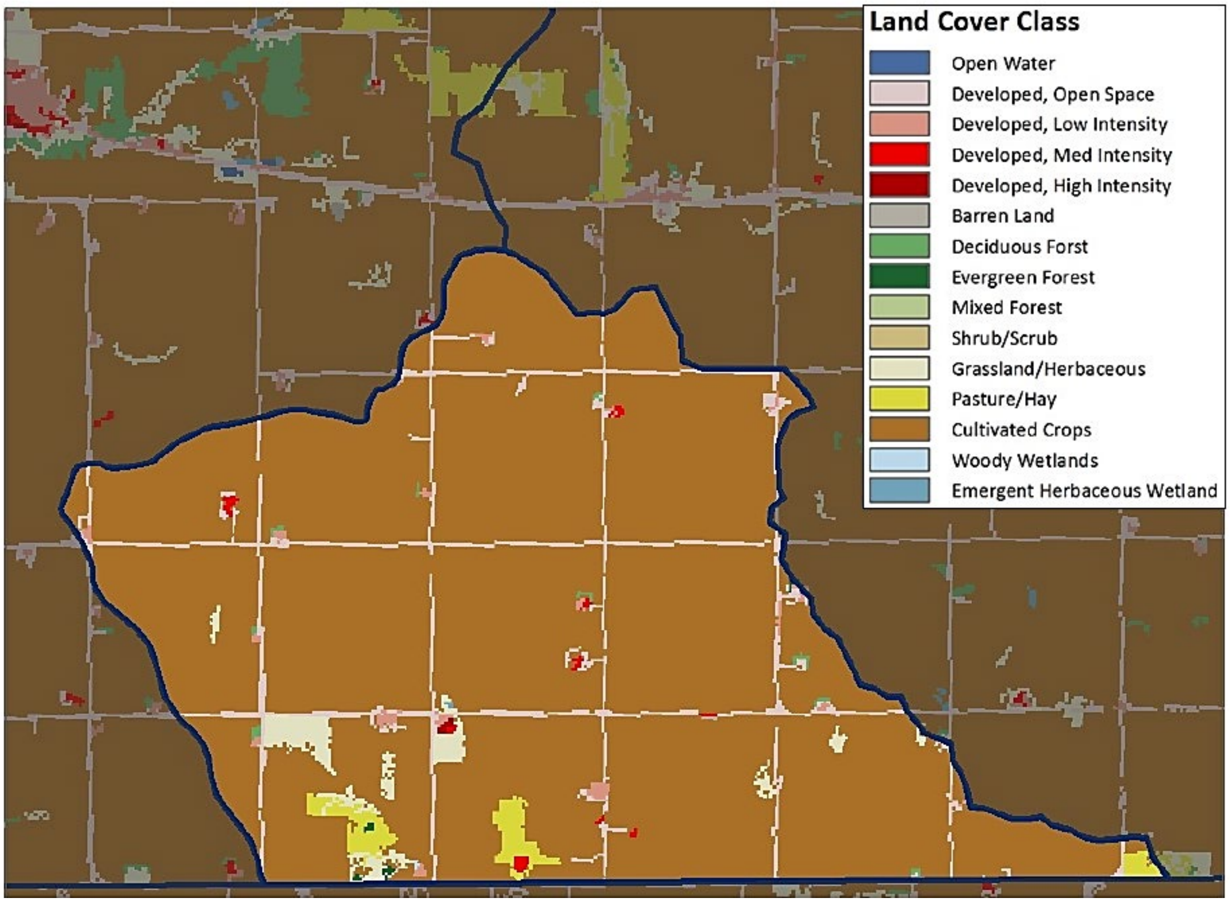

Figure 4. Land cover classes of the Upper Wapsipinicon River Watershed; USGS 2011.

3.3 Current/historical water quality

The UWRW contains a single AUID with a sufficient amount of water quality data to make a complete water quality assessment. Existing stream water quality conditions were quantified using data downloaded from the MPCA Environmental Quality Information System (EQuIS) database from a 10-year period (2006 through 2016). Data were summarized by year and month to evaluate any major differences; including seasonal variation. The summary of data by year only consider data taken during the time period that the standard is in effect (April through October). The frequency of exceedances represents the percentage of samples that exceed the water quality standard.

Because there are no stream flow gages established in this watershed, simulated flows were requested to and obtained from the IFC. Simulated flows for the Upper Wapsipinicon River were created for use in a hydrologic assessment report of the greater Wapsipinicon River Watershed. The hydrologic assessment report predicted stream flows on a three-hour time step using Generic Hydrologic Overland-Subsurface Toolkit (GHOST) model outputs and Steve IV radar-based hourly precipitation data. For additional information on the hydrologic report and GHOST model, see IFC's Iowa Watershed Approach website.

A load duration curve is provided for the impaired AUID in Section 4.2.4. Load duration curves are used to evaluate the relationship between hydrology (stream flow) and water quality. For example, sediment concentrations often increase with higher stream flows; a result of stream channel scouring from higher velocities. The load duration curve provides a visual display of this flow to water quality relationship.

Load duration curves were developed as follows:

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

Flow duration curves were developed using daily average flows (2002 through 2016) made available by the IFC's GHOST Model. Model calibration was carried out for a nine-year period (2002 through 2010). Validation of the model's performance was evaluated using measurements taken between 2011 and 2016. Simulated flows were compared against observed flows at two USGS stream-gage stations: Wapsipinicon River at Independence (USGS 05421000) and Wapsipinicon River near Tripoli (USGS 05420680). For this TMDL report, simulated flows from all months (even those outside of the time period that the standard is in effect) were used to develop the flow duration curve.

Develop load duration curves: To develop load duration curves, all mean daily flows were multiplied by the *E. coli* water quality standard (i.e. 126 org/100 mL) and converted to a daily load. This allows a "continuous" load duration curve to be created representing the load in the stream when the stream meets its water quality standard under all flow conditions. Loads calculated from water quality monitoring data from 2015 and 2016 are also plotted on the load duration curve, based on the concentration of the sample multiplied by the GHOST-simulated flows on the day that the sample was taken.

Fifteen sampling events at station S008-409 of Upper Wapsipinicon River (07080102-507) occurred June through August of 2015 and 2016 (Figure 5). *E. coli* geometric means were established for June, July, and August and assessed for meeting the monthly and individual *E. coli* water quality standards. The geometric mean concentrations increased from June to July and dropped to the lowest concentration in August. Geometric mean *E. coli* concentrations exceeded the water quality standard of 126 org/100 mL in every month sampled. Two samples collected in June and August 2015, respectively, exceeded the individual standard of 1,260 org/100 mL. This exceedance in the individual standard represents 13% of the samples collected.

In the TMDL equation table of this report (Table 7), only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, it should be understood that the entire curve represents the TMDL and it is what the EPA ultimately approves.

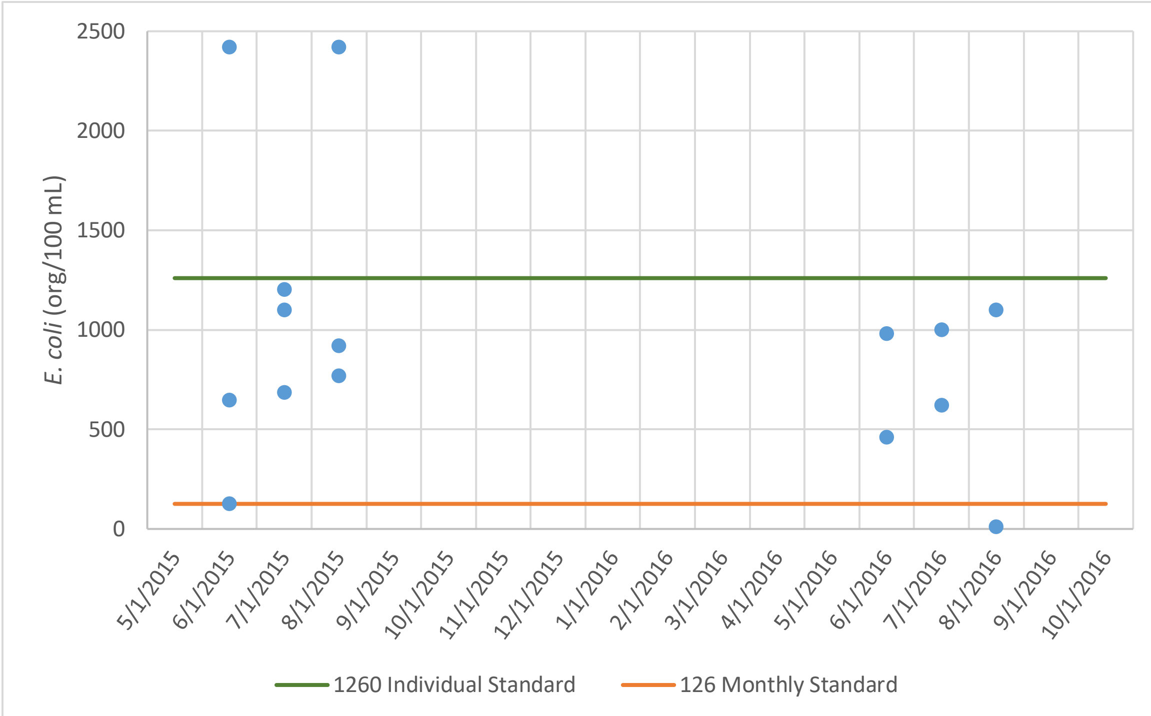

Figure 5. *E. coli* (org/100 mL) collected in the UWRW 2015 and 2016.

Table 5. 10-year geometric mean *E. coli* (org/100 mL) concentrations in Upper Wapsipinicon River (07080102-507), 2015-2016.

Site	Range of Data (org/100 mL)	Geometric mean (org/100 mL) [n]	Individual Standard Exceedances (1,260 org/100 mL) [%]	Monthly Standard Exceedances (126 org/100 mL) [%]	Geometric mean (org/100 mL) [n]		
					June	July	Aug
WAPSIPINICON RIVER: "07080102-507"	10 - 2419.6*	629.4 [15]	2 [13%]	14 [93%]	618.7 [5]	891.6 [5]	452.0 [5]

* When high levels of *E. coli* are detected during laboratory analysis, dilution occurs. Because of this dilution, the maximum reported *E. coli* concentration is often 2,420 org/100 mL. In this table, concentrations > 2,420 org/100 mL were lowered to 2,420 org/100 mL to remove the influence that the diluted samples have on the overall statistics of each group.

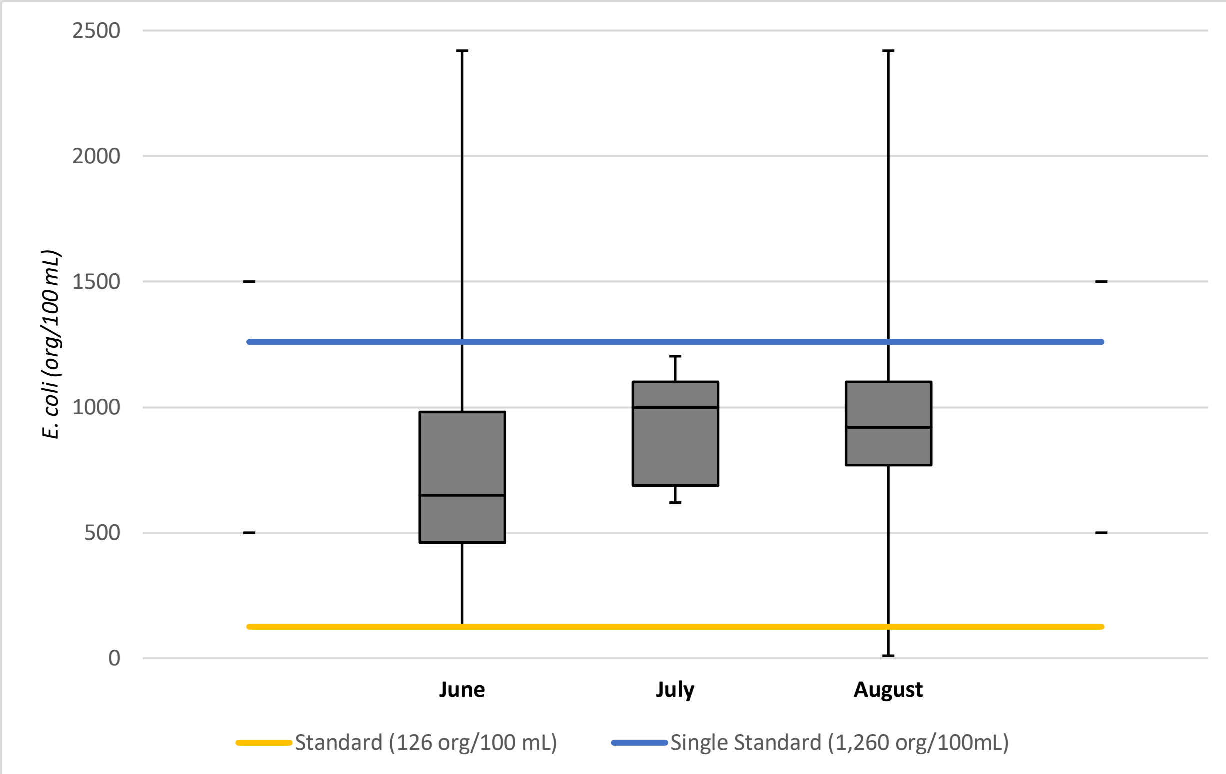

Figure 6. *E. coli* concentrations sampled in the UWRW.

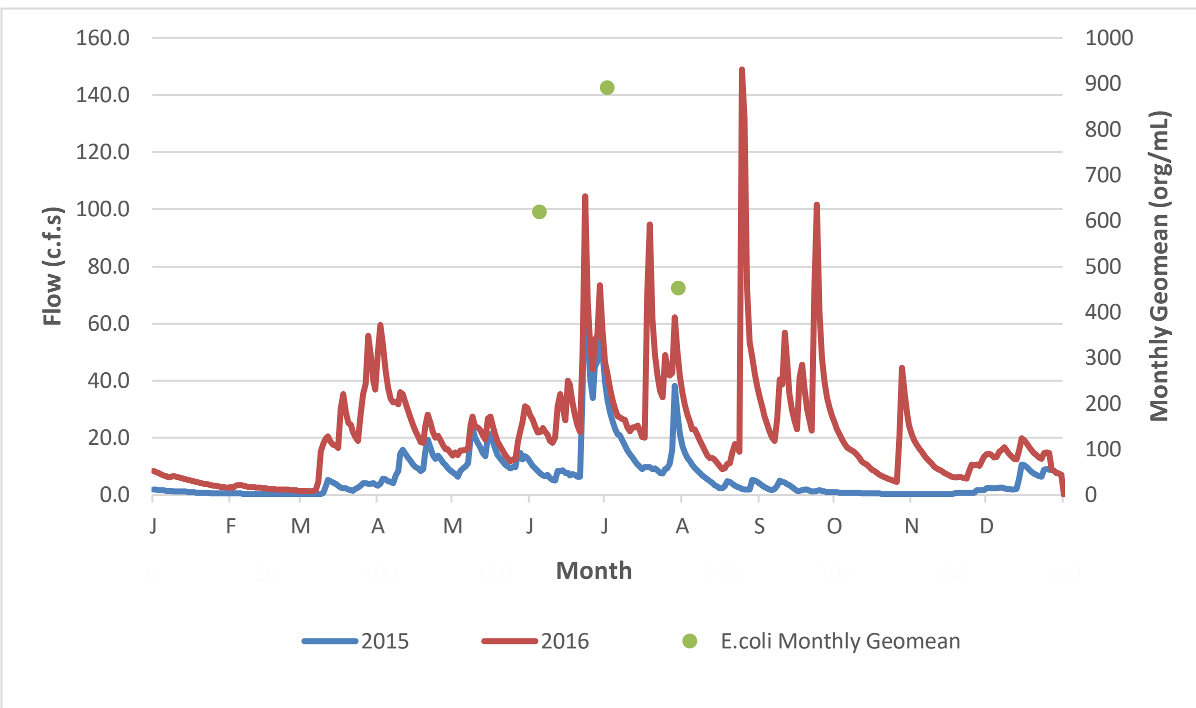

Figure 7. UWRW GHOST simulated flows and associated *E. coli* monthly geometric means.

3.4 Pollutant source summary

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

Non-permitted and permitted pollutant sources to the impaired waterbody are evaluated in this report. Some non-permitted pollutant loading is from natural background, which is the landscape condition that occurs outside of human influence. Minn. R. 7050.0150, subp. 4, defines the term natural causes as "the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a water body in the absence of measurable impacts from human activity or influence." Non-permitted natural background sources of *E. coli* can include runoff from undisturbed land, wildlife waste, and natural stream development. See subsequent Section 4.1.1 for further discussion on natural background considerations.

3.4.1 *E. coli* sources

E. coli sources evaluated in this study are animal feedlot operations (AFOs), subsurface sewage treatment systems (SSTS), natural growth of *E. coli*, and non-permitted stormwater runoff. *E. coli* is unlike other pollutants in that it is a living organism that can multiply and persist in soil and water environments (Ishii et al. 2006, Chandrasekaran et al. 2015, Sadowsky et al. and Burns and McDonnell 2017). Use of watershed models for estimating relative contributions of *E. coli* sources delivered to streams is difficult and generally has high uncertainty. Thus, a weight of evidence approach was used to determine the likely primary sources of *E. coli*, with a focus on the most likely sources that can be effectively reduced using management practices. The following sources have been evaluated as potential *E. coli* sources in the UWRW.

3.4.1.1 NPDES Permitted sources

Due to the small area of the UWRW, there are a limited number of facilities and point sources permitted by the MPCA for discharging wastewater. No wastewater treatment facilities or Municipal Separate Storm Sewer Systems (MS4s) are located in this watershed.

Permitted animal feeding operations (NPDES and SDS)

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

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

CAFOs are inspected by the MPCA in accordance with the MPCA NPDES Compliance Monitoring Strategy approved by the EPA. All CAFOs (NPDES- permitted, SDS- permitted and not required to be permitted) are inspected by the MPCA on a routine basis with an appropriate mix of field inspections, offsite monitoring and compliance assistance.

In the UWRW, all NPDES and SDS permitted feedlots are designed to have zero discharge. Because of this design requirement, NPDES/SDS permitted feedlot facilities have a “zero” WLA. One NPDES-permitted feedlot currently operates within the watershed.

Table 6. NPDES-permitted feedlots in the UWRW.

Facility Name	Permit Number	Majority Animal Type	AUs
Mark Schaefer Farm 2	MNG440070	Swine	1440

3.4.1.2 Non-permitted/Nonpoint sources

Non-NPDES/SDS Permitted Feedlots

All animal feedlots in Minnesota are regulated by Minn. R. ch. 7020. The MPCA has regulatory authority of feedlots but Counties may choose to participate in a delegation agreement transferring partial feedlot regulatory authority to the local unit of government. Delegated Counties are then able to enforce Minn. R. ch. 7020 (along with any other local rules and regulations) within their respective jurisdiction for facilities that are not permitted under a NPDES/SDS feedlot permit. In the UWRW, Mower County is delegated the feedlot regulatory authority.

The primary goal of the state program for AFOs is to ensure that surface waters are not contaminated by the runoff from feeding facilities, manure storage or stockpiles, and cropland with improperly applied manure. Livestock are also present at hobby farms and small-scale farms not large enough to require registration, but may have small-scale feeding operations and associated manure application or stockpiles.

Livestock manure is either surface applied or incorporated onto farm fields as a fertilizer and soil amendment. This land application of manure has the potential to be a substantial source of fecal contamination, entering waterways from overland runoff and drain tile intakes. Minn. R. ch. 7020 contains manure application setback requirements based on research related to phosphorus transport, not bacterial transport. The effectiveness of these current application setbacks on bacterial transport to surface waters is not known.

At the writing of this report, there are 20 registered and active animal feedlots (Figure 8) within the UWRW. Nine are swine facilities, seven beef and four dairy. As mentioned previously, one of the 20 feedlots is a CAFO operating under a NPDES permit (Table 6). Facilities raising livestock vary in management styles depending on the types of animals housed. Outside, unroofed areas (open lots) are typically used for dairy and beef operations while total confinement is traditionally used for swine and poultry facilities. Because open lots are exposed to rain and snow melt, they have an increased risk of discharging *E. coli*-contaminated runoff.

All animal feedlots are subject to state feedlot rules, which include provisions for registration, manure management, facility inspection, permitting, and discharge standards. On-site feedlot inspections are conducted by compliance staff to verify feedlot facility discharge compliance. This includes the inspection of facility components including open lots, manure and wastewater storage areas and mortality storage structures. Feedlot facilities with open lots have increased risk for bacterial runoff. Feedlot facilities with open lots located in shoreland and/or floodplain are considered highest risk areas for bacterial runoff. Of the 20 feedlots in the watershed, half are documented as having open lots. Two feedlot facilities are located within shoreland areas of the UWRW, one dairy facility (with open lots), the other swine (total confinement).

Thirteen of the 20 (65%) active feedlots within the UWRW have been inspected in the past five years. Of those inspected, all facilities were found to be meeting facility discharge requirements; four had non-compliant manure application records. While a majority of feedlots in this watershed were compliant at the time of inspection, seven facilities have yet to be inspected.

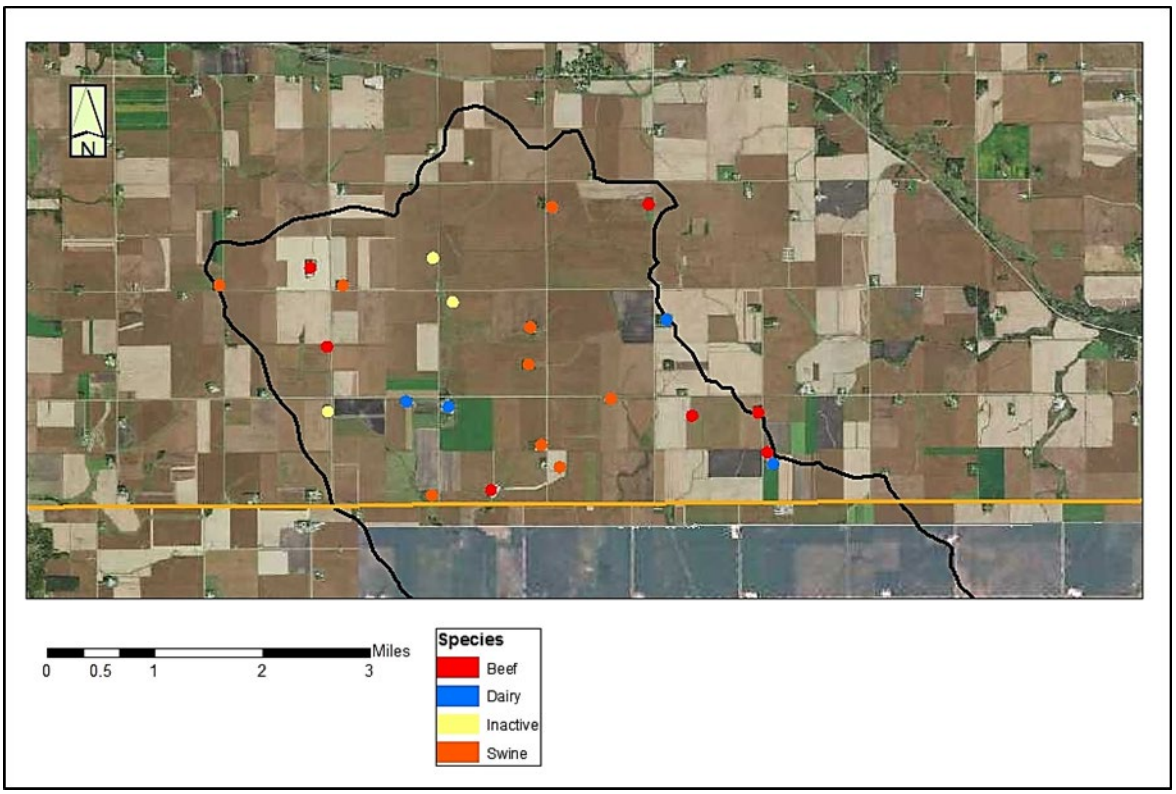

Figure 8. Registered animal feedlots in the Upper Wapsipinicon River Watershed.

Individual Septic Treatment Systems

Mower County is responsible for administering the SSTS program within this watershed to ensure compliance of existing septic systems as well as proper design and installation of new septic systems. The UWRW includes an estimated 26 locations where septic systems are likely present (Mower County, December 21, 2018 communication). Of these 26, Mower County has issued a Certificate of Compliance for 8 systems since 1996. This means that 8 systems have been confirmed as meeting SSTS requirements and 18 remain with an unknown compliance status. Based on a recent in depth review of another watershed and statistics, Mower County expects at least 50% (9 of the remaining 18) may not pass a compliance inspection if one was completed. The 2016 MPCA SSTS Tableau reports find approximately

50% of SSTSs in Mower County are failing to protect groundwater, 5% are an Imminent Public Health Threat (IPHT) and 45% of SSTSs are assumed compliant.

Natural growth of *E. coli*

When evaluating sources of *E. coli* in the UWRW, it is important to recognize the natural growth of *E. coli* in soil and sediment. Research in the last 15 years has found the persistence of *E. coli* in soil, beach sand, and sediments throughout the year in the north central United States without the continuous presence of sewage or mammalian sources. An Alaskan study (Adhikari et al. 2007) found that total coliform bacteria in soil were able to survive for six months in subfreezing conditions. A study of cold water streams in southeastern Minnesota, completed by the MPCA staff, found the resuspension of *E. coli* in the stream water column due to stream sediment disturbance. A recent study near Duluth, Minnesota (Ishii et al. 2010) found that *E. coli* were able to grow in agricultural field soil. A study by Chandrasekaran et al. (2015) of ditch sediment in the Seven Mile Creek Watershed in southern Minnesota found that strains of *E. coli* had become naturalized to the water−sediment ecosystem. They concluded that roughly 63.5% were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. The study indicates that between the four sites sampled during the study period, an average of 12% of all *E. coli* isolated were a “persistent strain”. However, for each impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment, and therefore natural background is accounted for and addressed through the MPCA’s waterbody assessment process.

Non-permitted stormwater runoff

Stormwater runoff acts as a delivery mechanism of multiple *E. coli* sources including wildlife, domestic pets, and humans. Impervious surfaces such as roads, driveways, and rooftops can exacerbate stormwater flows increasing the likelihood of *E. coli* contaminated runoff entering surface waters. Frequency and intensity of storm events can also increase *E. coli* inputs from the landscape because of the already saturated surfaces such as farm fields. In the UWRW, a likely stormwater runoff scenario is *E. coli* contaminated runoff from farm fields reaches surface waters either directly or via field tile intakes. The land application of manure can also present an increased risk of *E. coli* runoff into surface and ground waters. Minn. R. ch. 7020, requires manure application rates, application setback distances, winter application restrictions and incorporation requirements for spreading manure in close proximity to sensitive features.

Wildlife

Deer, waterfowl, and other animals are not exempt from contributing to *E. coli* impairments. In the UWRW, there are no managed public lands (including wildlife management areas) that would promote the congregation of wildlife large enough to make a substantial contribution to *E. coli* loads. In addition, only 1% of the watershed is forest and/or wetland; land most conducive to the residence of wildlife populations. A 2017 Minnesota Department of Natural Resources (DNR) deer survey, found an average of 7 deer per square mile in the area of UWRW, while non-NPDES- permitted livestock animal densities are approximately 1,752 animals per square mile. It is likely any *E. coli* contribution from wildlife in the UWRW is negligible.

3.4.1.3 Summary of *E. coli* Sources

The behavior of bacteria and pathogens in the environment is complex. Concentrations of bacteria depend on environmental conditions such as weather, water temperature and flow, in addition to sources. Potential *E. coli* sources within the UWRW were considered to identify which are likely a major or minor source. Based on the density of source types in the watershed, the following *E. coli* sources have a likely impact:

- Livestock waste from AFOs is likely a source of major concern when feedlots lack runoff treatment (solid settling areas and filter strips) and/or are located close to surface waterbodies. Non-NPDES permitted feedlots are typically more of a concern than CAFOs or NPDES-permitted AFOs because non-NPDES feedlots are not required to completely contain runoff.
- Waste from wildlife is not considered a major source. Available habitat for wildlife is a small fraction of the watershed area and is minor compared to other potential sources.
- Non-permitted stormwater runoff is considered a likely major source of *E. coli* for the UWRW. Areas of highest impact would be agricultural fields that received animal manure. Priority areas of concern are manured acres within 300 feet of surface waters and/or field intake tiles. Watershed monitoring data indicate that *E. coli* concentrations increase with flow (Figure 7), suggesting that runoff driven sources are of most concern.
- Effluent from wastewater treatment plants and MS4 discharge are not a source of *E. coli* for this watershed because none exist within the watershed. Should future development occur, these sources may become a potential *E. coli* source.
- At this time, little is known regarding the concentration of persistent (“resident”) bacteria in the Upper Wapsipinicon River. While unknown, there is the possibility a notable concentration could be resuspended in the water column through disturbance. Future studying of this potential source may be warranted, especially if impairment remains following the correction of identified sources.
- According to Mower County, IPHTs in the watershed may exist in the 35% of SSTSs that have unverified compliance. Verification by inspection is needed to assess whether they pose a threat to human and environmental health. Without information on their location relative to the impaired stream, SSTSs should be considered a moderate source of *E. coli*.

4. TMDL development

4.1 Loading allocation methodology/Natural background

The approach used in calculating the TMDL for the impaired reach was consistent with the methods used in previous TMDLs published by the MPCA. The TMDL, which is represented as the total loading capacity (TLC), is calculated using the following equation:

$$TLC=WLA+LA+MOS+RC$$

Total Loading Capacity (TLC): the maximum allowed pollutant load calculated at the downstream end of a waterbody such that it does not exceed water quality standards

Wasteload Allocation (WLA): the sum of all point source pollutant loads within the waterbody's drainage area, which includes NPDES permitted industrial and municipal WWTFs, regulated construction and industrial stormwater, and MS4 communities (both present and future)

Load Allocation (LA): remaining pollutant load that is allocated to nonpoint source loads that do not require a NPDES permit

Margin of Safety (MOS): expressed as a percent of the TLC and accounts for any uncertainty in the calculations of WLA and LA components

Reserve Capacity (RC): accounts for any potential future loading sources that need to be included in the TMDL.

4.1.1 Margin of safety

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

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

The MOS can either be implicitly incorporated into conservative assumptions used to develop the TMDL or be added as a separate explicit component of the TMDL (EPA 1991). An explicit MOS of 10% was included in this TMDL. The use of an explicit MOS accounts for environmental variability in pollutant loading, variability in water quality monitoring data, calibration and validation processes of modeling efforts, uncertainty in modeling outputs, conservative assumptions made during the modeling efforts, and limitations associated with the drainage area-ratio method used to extrapolate flow data.

The GHOST model outputs used for this TMDL combines land surface data, hydrographic boundaries, meteorological inputs, and water quality and quantity data to simulate watershed processes. The UWRW GHOST model was calibrated and validated using two USGS stream flow gaging stations: Wapsipinicon River near Tripoli (#05420680) and Wapsipinicon River at Independence (#0542100). Calibration results indicate that the GHOST model is a valid representation of hydrologic and water quality conditions in the modeled watersheds and an adequate tool to use for LDC development. Flow data used to develop the stream TMDL is derived from GHOST-simulated daily flow data. For more information on the development of the Wapsipinicon GHOST model, reference the Upper Wapsipinicon River Hydrologic Assessment Report (IFC/IIHR 2019).

4.1.2 Seasonal variation and critical conditions

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

4.1.3 Baseline year

Baseline year for the TMDL is defined as the midpoint of the water quality datasets. The *E. coli* data for the UWRW are from 2015 through 2016. The midpoint for this dataset is August 13, 2015 making the baseline year 2015. Any activities implemented during or after the baseline year that led to a reduction in *E. coli* load to the watershed may be considered as progress towards meeting the LA.

4.1.4 Construction and industrial stormwater WLAs

Construction stormwater is permitted through the Construction Stormwater General Permit MNR100001. Permitted construction stormwater sources are not expected to be sources of *E. coli* and are not provided WLAs.

Industrial stormwater is permitted through the General Permit MNR050000 for Industrial Stormwater Multi-Sector. Permitted industrial stormwater sources are not expected to be sources of *E. coli* and are not provided WLAs. MPCA's industrial stormwater permit does not regulate discharges of *E. coli*. The permit does not contain *E. coli* benchmarks; industrial stormwater permittees are required to sample their stormwater for parameters that more closely match the potential contribution of pollutants for their industry sector or subsector.

4.1.5 Reserve capacity

No reserve capacities for *E. coli* indicator bacteria are anticipated to be necessary for this watershed; therefore, none are included in this TMDL.

4.1.6 Natural background consideration

"Natural background" is defined in both Minnesota rule and statute: Minn. R. 7050.0150, subp. 4, "Natural causes' means the multiplicity of factors that determine the physical, chemical or biological conditions that would exist in the absence of measurable impacts from human activity or influence." The CWLA (Minn. Stat. § 114D.10, subd. 10) defines natural background as "characteristics of the water body resulting from the multiplicity of factors in nature, including climate and ecosystem dynamics that affect the physical, chemical or biological conditions in a water body, but does not include measurable and distinguishable pollution that is attributable to human activity or influence."

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

4.2 *E. coli* TMDL approach

4.2.1 Loading capacity and percent reductions

Loading capacities were created using a load duration curve developed from simulated flows (reference Section 3.3 for a description of load duration curve development). The loading capacity was calculated as flow multiplied by the *E. coli* geometric mean standard (126 org/100 mL). It is assumed that practices implemented to meet the geometric mean standard will also address the individual sample standard (1,260 org/100 mL).

The estimated percent reduction needed to meet the *E. coli* TMDL was calculated by comparing the highest observed (monitored) monthly geometric mean from the months that the standard applies to the geometric mean standard (monitored – standard / monitored).

As mentioned in Section 3, *E. coli* is complex. Calculating percent reduction is not an exact science as there are many factors impacting *E. coli* concentrations which may or may not be captured in the water quality data. The percent reduction should be interpreted as a means to capture the level of effort needed to reduce *E. coli* concentrations in the watershed. Calculations come from the best available data and support the conclusion that *E. coli* sources need to be addressed.

4.2.2 Load allocation methodology

The LA represents the portion of the loading capacity that is allocated to pollutant loads that are not permitted through an NPDES permit (e.g., non-permitted watershed runoff, IPHT, and natural background [see Section 3.4]). The LA for this *E. coli* TMDL was calculated as the LC minus the MOS minus the WLAs.

4.2.3 Wasteload allocation methodology

There are no permitted municipal WWTPs or MS4s in the UWRW, so there are no WLAs from these facilities in this TMDL. NPDES-permitted feedlot facilities are required to completely contain runoff and therefore are not allowed to discharge *E. coli* to surface waters. WLAs are not provided for these facilities; this is equivalent to a WLA of zero.

4.2.4 TMDL summary

This section provides the water quality summary table for the *E. coli* impairment addressed in this report. The estimated percent reduction needed to meet the *E. coli* TMDL was calculated by comparing the highest observed (monitored) monthly geometric mean from the months that the standard applies to the geometric mean standard (monitored – standard / monitored). Monthly geometric means were used to estimate percent reduction only if they are based on five or more samples. The estimated percent reductions provide a rough approximation of the overall reduction needed for the waterbody to meet the TMDL. As mentioned previously, the percent reductions should not be interpreted as definitive *E. coli* concentration goals, but rather as a weight of evidence to be referenced for targeting areas for watershed restoration.

When taken as a whole, the water quality data indicates that the majority of *E. coli* exceedances occur under very high flows. This further illustrates the conclusion that runoff-driven sources such as stormwater runoff and runoff from AFOs are the primary sources of concern. Load reductions are needed to address multiple source types (see Section 3.4: Stream *E. coli* source summary).

Table 7. *E. coli* TMDL summary, Upper Wapsipinicon River (07080102-507).

- **303(d) listing year or proposed year: 2019**
- **Baseline year: 2015**

TMDL parameter		Flow zones				
		Very high	**High**	**Mid-range**	**Low**	**Very low***
Sources		***E. coli* load (billion orgs/day)**				
Wasteload	Construction/Industrial SW	0.00	0.00	0.00	0.00	0.00
	Total WLA	0.00	0.00	0.00	0.00	0.00
Load	**Total LA**	266.21	70.91	14.50	3.43	0.00**
	MOS	29.57	7.87	1.61	0.38	0.00**
	Total load	295.78	78.78	16.11	3.81	0.00
Maximum Monthly Geomean (org/100 mL)		891.6				
Overall estimated percent reduction		86%				

* Very low flow is equivalent to no flow.

** Load calculated as zero.

Table 8. Percent of total daily *E. coli* loading capacity, Upper Wapsipinicon River (07080102-507).

	Flow Zones				
	Very High	**High**	**Mid - range**	**Low**	**Very Low**
	Percent of total daily loading capacity				
TOTAL DAILY L0ADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0%	0%	0%	0%	0%
Livestock Facilities Requiring NPDES Permits	0%	0%	0%	0%	0%
"Straight Pipe" Septic Systems	0%	0%	0%	0%	0%
Load Allocation	90%	90%	90%	90%	0%
Margin of Safety	10%	10%	10%	10%	0%

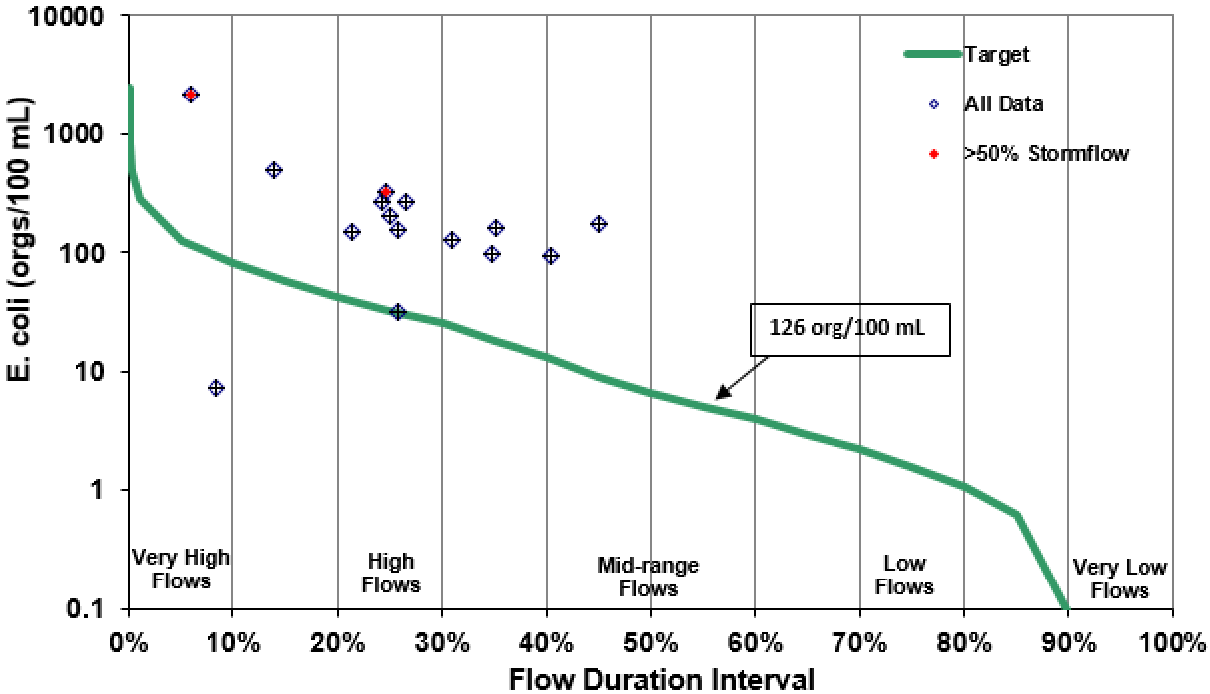

Figure 9. Load duration curve for *E. coli*, Upper Wapsipinicon River (07080102-507).

5. Future growth considerations

5.1 New or expanding permitted MS4 WLA transfer process

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

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

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

5.2 New or expanding wastewater

The MPCA, in coordination with the EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to waterbodies with an EPA approved TMDL (MPCA 2012). This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target and will ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA to comment on the permit changes based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that the new or expanded wastewater discharge is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

For more information on the overall process, visit the MPCA's TMDL Policy and Guidance webpage.

6. Reasonable assurance

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

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

There are no permitted point sources in the UWRW. Because of this, WLAs and reasonable assurance for point source reductions are not included as part of this TMDL.

Reasonable assurance for non-permitted sources discussed in Section 3.4 includes supporting evidence that there:

- are reliable means for addressing pollutant loads (i.e., best management practice [BMPs] and pollution reduction programs) (see TMDL Section 6.1 *Non-permitted source reduction programs* and 6.2 *Example non-permitted source reduction projects and partners*);
- are reliable means for prioritizing and focusing management (see Section 4.0 *draft Cedar River* 1W1P);
- is a strategy for implementation (see Section 8 *Implementation strategy summary* and the UWRW WRAPS);
- are available funds to execute projects (see Section 6.3 *Funding availability*)
- is a system of tracking progress and monitoring water quality response (see Sections 7 *Monitoring plan* and 8.4 *Adaptive management*); and,

- are nonpoint source reduction projects at multiple scales (see Section 6.2 *Example non-permitted source reduction projects and partners*).

Reasonable assurance of these six components is provided by the numerous nonpoint source reduction programs, local planning efforts, funding sources, and the project implementation efforts of partners and participating organizations that continue to work towards improving water quality in the UWRW as described in the following sections. The goals and objectives for the UWRW TMDL are consistent with state-wide source reduction programs and the draft Cedar River 1W1P, and are incorporated into the MPCA's WRAPS Report for the watersheds.

6.1 Examples of non-permitted source reduction programs and plans

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

6.1.1 SSTS Implementation and Enforcement

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

- Minimum technical standards for individual and mid-size SSTS;
- A framework for local units of government to administer SSTS programs;
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee;
- Various ordinances for septic installation, maintenance, and inspection.

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

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

Currently, a system is in place in the state such that when a straight pipe system or other IPHT location is confirmed, county health departments send notices of non-compliance. Upon doing so, a 10-month deadline is set for the system to be brought into compliance. All known IPHT are recorded in a statewide database by the MPCA. From 2006 to 2017, 742 straight pipes were tracked by the MPCA statewide and 701 of those were abandoned, fixed, or were found not to be a straight pipe system. There have been 17 Administrative Penalty Orders issued and docketed in court. The remaining straight pipe systems received a notification of non-compliance and are currently within the 10-month deadline. The MPCA, through the Clean Water Partnership Loan Program, awarded $2.45 million to local partners to provide low interest loans for SSTS upgrades in 2016. More information on SSTS financial assistance can be found on the MPCA's website.

Southeast Minnesota has proven to be a leader in addressing unsewered communities, which can be sources of nutrients and pathogens to surface waters. Mower County has been developing a proposal to require septic inspections upon property transfer, fund a watershed – based septic inventory project, and require shoreland properties to show septic compliance. These initiatives are yet to be approved by Mower County Board of Commissioners, but is an example of dedication to addressing *E. coli* issues of the area.

6.1.2 MPCA feedlot program

The MPCA Feedlot Program implements rules governing the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes. Minn. R. ch. 7020 regulates feedlots in the state of Minnesota. All feedlots capable of holding 50 or more AUs, or 10 in shoreland areas, are subject to this rule. A feedlot holding 1,000 or more AUs is required to have coverage under an NPDES/SDS permit. The focus of the rule is to prevent and reduce water quality impacts from animal feedlots and their land application activities.

The Feedlot Program is implemented through a delegation agreement between MPCA and county governments. The MPCA works with county representatives to provide training, program oversight, policy and technical support, and formal enforcement support when needed. The Mower County feedlot officer administers the feedlot program in the UWRW. MPCA is responsible for the CAFOs and feedlot facilities with over 1,000 AUs in this County.

6.1.3 Buffer program

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

For all public waters, the more restrictive of:

- a 50-foot average width, 30-foot minimum width, continuous buffer of perennially rooted vegetation, or
- the state shoreland standards and criteria

For public drainage systems established under Minn. Stat. ch. 103E, a 16.5-foot minimum width continuous buffer.

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

Board of Water and Soil Resources (BWSR) provides oversight of the buffer program, which is primarily administered at the local level; compliance with the Buffer Law in the state is displayed on the state's Minnesota Buffer Law website. As of July 2019, Mower County reported an approximate 95% to 100% compliance with the Buffer Law.

6.1.4 Agricultural Water Quality Certification Program

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

Through this program, certified producers receive:

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

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

6.1.5 Minnesota Nutrient Reduction Strategy

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

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

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

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

- Intensive watershed monitoring
- Assessment of watershed health
- Development of WRAPS reports to inform local water planning and implementation (Cedar River 1W1P)
- Management of NPDES and other regulatory and assistance programs

This framework will result in nutrient reduction for the basin as a whole and the major watersheds in the basin. Water Quality Trends for Minnesota Rivers and Streams at Milestone Sites notes that sites across Minnesota, including those on the Cannon River and Straight River, show significant reductions over the period of record for TSS, phosphorus, ammonia and biochemical oxygen demand (MPCA 2014c). The Minnesota NRS documented a 33% reduction of the phosphorus load leaving the state via the Mississippi River from the pre-2000 baseline to current (MPCA 2014d). These reports generally agree that while further reductions are needed (e.g. for UWRW reduction goals), municipal and industrial phosphorus loads as well as loads of runoff-driven pollutants (i.e. TSS and total phosphorus) are decreasing; a conclusion that lends assurance that the UWRW WRAPS and TMDL nitrate goals and strategies are reasonable and that long-term, enduring efforts to decrease erosion and nutrient loading to surface waters have the potential for positive impacts.

6.1.6 Conservation Easements and Reinvest in Minnesota Reserve

The Reinvest in Minnesota (RIM) Reserve was created in 1986 through the enactment of the RIM Resources Act. RIM Reserve is the primary land acquisition program for state-held conservation easements, wetland restoration, and native grassland restoration on private land in Minnesota and aims to restore marginal and environmentally sensitive agricultural land to protect soil, water quality, and fish and wildlife habitat. The program partners with public and private landowners; state, federal, and local government entities; non-profit organizations; and the citizens of Minnesota. When private landowners participate, the land is acquired through BWSR on behalf of the state and placed under permanent easement. The RIM Reserve provides the funds to compensate participating landowners. Statewide participation in the RIM Reserve program through February 2019, is provided in Figure 10.

In addition, BWSR regularly tracks conservation easements throughout the state. Table 9 provides a summary of the acres within Mower County that are currently in easements.

Table 9. Acres of land enrolled in conservation easements in Mower County (BWSR 2018).

County	Conservation Lands Summary (acres)						Cropland Acres	Percent Enrolled
	CRP	CREP	RIM	RIM WRP	WRP	Total		
Mower	8,666	726	1,325	601	658	11,976	384,388	3.1%

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

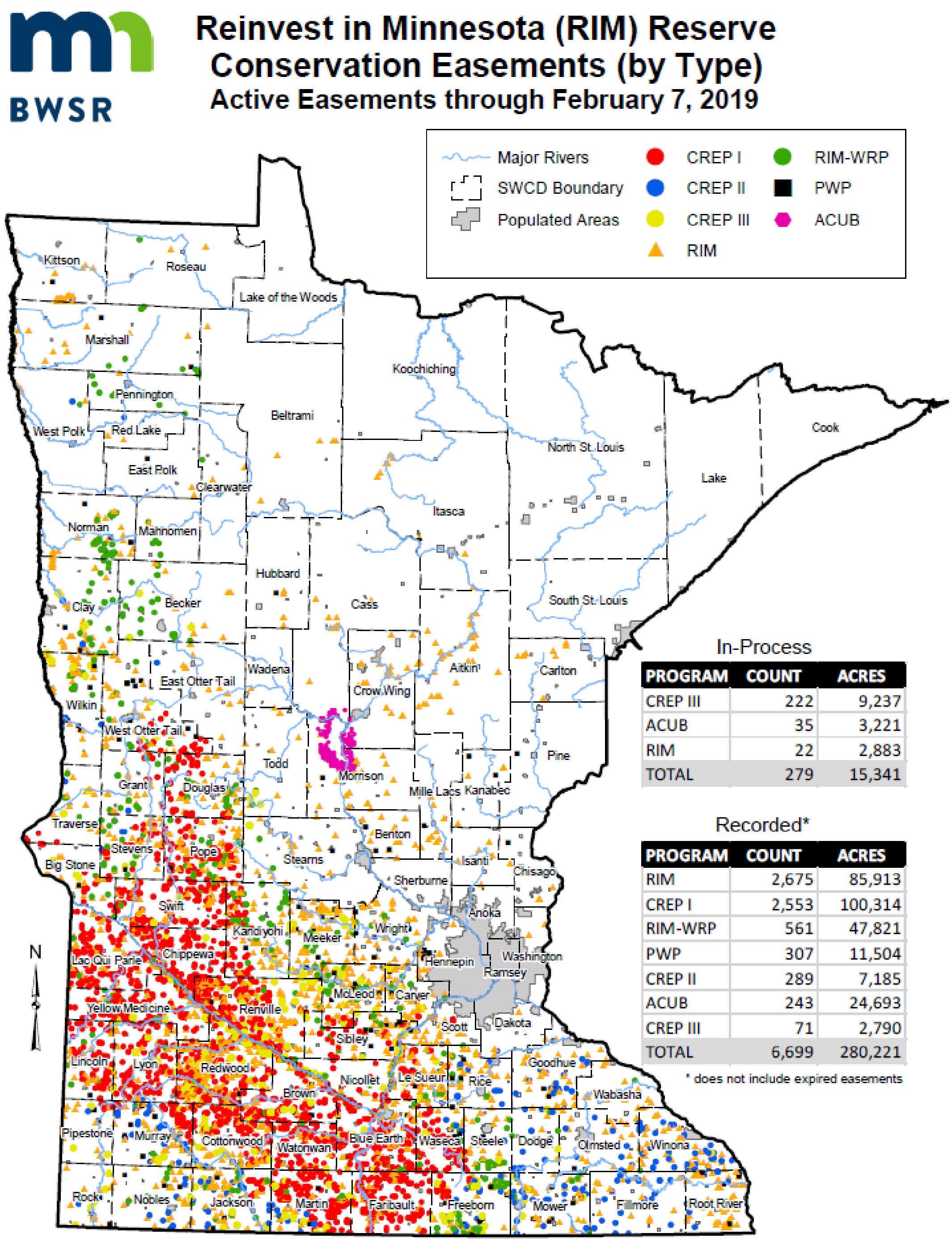

Figure 10. Reinvest in Minnesota conservation easements statewide.

6.2 Example non-permitted source reduction projects and partners

Several partners are active in this watershed administering projects and plans aiming to reduce nonpoint source pollution. The following are examples by participating organization.

6.2.1 Cedar River One Watershed, One Plan

The Cedar River 1W1P committees created for the development of the plan (Advisory, Policy, and Planning Committees) meet on a regular basis to implement recommendations from the 1W1P. The committees are made up of county and SWCD representatives, BWSR representatives, community members, and several others. Numerous projects were identified by these committees for the UWRW. Top priorities outlined in the draft Cedar 1W1P include addressing:

1. Accelerated erosion and sedimentation;
2. Surface water quality degradation;
3. Excessive flooding;
4. Degraded soil health;
5. Threatened groundwater supply;
6. Threats to fish, wildlife and habitat; and
7. Reduced livability and recreation.

The UWRW TMDL and complimentary WRAPS reports provide a foundation for future planning in the UWRW. For the purposes of reasonable assurance, the WRAPS document is sufficient in that it provides strategies that in combination show examples of pollutant reduction goal attainment.

6.2.2 Mower Soil and Water Conservation District

Mower SWCD is an active partner in the UWRW. Some examples of their recent work include but are not limited to:

- Hosting a "Cover Crops 101" workshop in January 2019, and a field day focused on cover crops in November 2018, for local producers;
- Hosting annual rain barrel and/or tree sales; and
- Sponsoring the Envirothon educational competition event for local junior high and high school students.

More information on their work can be found on the Mower SWCD website.

6.3 Funding availability

On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the constitution to:

- protect drinking water sources;
- protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat;
- preserve arts and cultural heritage;
- support parks and trails; and
- protect, enhance, and restore lakes, rivers, streams, and groundwater.

This is a secure funding mechanism with the explicit purpose of supporting water quality improvement projects. Local sources of funding for counties and other organizations may include county taxes, levies, and fees. In some cases, these local financial resources provide funding for significant water quality and quantity improvement projects, local grants, staff, monitoring, and engineering costs. Through implementation of the Draft Cedar 1W1P, the UWRW has a 10-year budget of $105,207.00 to address degraded water quality and erosion/sedimentation issues. Upon completion of the 1W1P, the watershed partnership will receive additional automatic watershed based funding for implementation of the plan. Additional federal funds available to the various watershed entities include grants from EPA's 319 Grant Program for States and Territories and various Natural Resources Conservation Service programs.

6.4 Summary

In summary, significant time and resources have been devoted to identifying the best BMPs, providing means of focusing them in the Upper Wapsipinicon Watershed, and supporting their implementation via state initiatives and dedicated funding. The UWRW WRAPS and TMDLs, and the Cedar River 1W1P processes engaged partners to arrive at reasonable examples of BMP combinations that attain pollutant reduction goals. Minnesota is a leader in watershed planning as well as monitoring and tracking progress toward water quality goals and pollutant load reductions. Finally, examples cited herein confirm that BMPs and restoration projects have proven to be effective over time and as stated by the State of Minnesota Court of Appeals in A15-1622 MCEA vs MPCA and MCES:

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

7. Monitoring plan

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

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

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

Baseline monitoring—identifies the environmental condition of the water body to determine if water quality standards are being met and identify temporal trends in water quality.

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

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

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

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

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

Continued monitoring of water quality conditions in the UWRW will occur primarily through the intensive water monitoring (IWM) program as part of Minnesota's Water Quality Monitoring Strategy (MPCA 2011). Data needs are considered by each program and additional monitoring is implemented when deemed necessary and feasible. Further monitoring of the UWRW will aim to create a long-term data set to track progress towards water quality goals.

The second intensive watershed monitoring effort (Cycle II) began in the UWRW in 2019. Wapsipinicon River AUID 15CD012 (S008-409) will be the only sample site assessed during this next assessment round.

On-site monitoring of implementation practices is also planned to take place in order to better assess BMP effectiveness. This monitoring effort can come through direction of comprehensive watershed (1W1P) planning. Data will be collected as part of existing, new, and expanded monitoring and will be used to support implementation tasks such as filling data gaps for modeling and/or or establishing nitrate concentration trends.

Currently, the MPCA maintains a system of tracking BMPs that have been implemented from 2004 through 2018 (Table 10) via Clean Water Accountability reporting. Thirty-three practices have been reported as implemented in the watershed. Tracking implementation will continue in the future as information is reported. For more information about MPCA's BMP tracking, visit the Healthier Watersheds webpage: https://www.pca.state.mn.us/water/healthier-watersheds.

Table 10. Implemented BMPs reported in the Upper Wapsipinicon River Watershed.

Strategy	Practice Description	Total BMPs	Number of BMPs (by unit)	Installed Amount (by unit)	Units
Designed erosion control	Grassed Waterway	7	7	28	Acres
Tillage/residue management	Residue and Tillage Management, No-Till	3	3	294	Acres
Tillage/residue management	Residue and Tillage Management, Reduced Till	3	3	294	Acres
Nutrient management (cropland)	Nutrient Management	5	2	167	Acres
Converting land to perennials	Critical Area Planting	3	3	11	Acres
Living cover to crops in fall/spring	Cover Crop	1	1	83	Acres
Tile inlet improvements	Subsurface Drain	1	1	16,080	Feet
Septic System Improvements	Septic System Improvement	1	1	1	Count
Other	Mulching	6	6	14	Acres
Other	Composting Facility	2	2	2	Count
Other	Underground Outlet	1	1	3,201	Feet

8. Implementation strategy summary

Minnesota's watershed approach to restoring and protecting water quality is based on a major watershed, or HUC-8, scale. This watershed-level planning begins with intensive watershed monitoring (on a 10-year cycle) and culminates in local implementation (Figure 9). A WRAPS report is produced as part of this approach and addresses restoration of impaired watersheds and protection of unimpaired waters in each HUC8 watershed. The WRAPS for each HUC8 watershed includes elements such as implementation strategies and timelines for achieving the needed pollutant reductions. These high-level reports are then used to inform watershed management plans that focus on local priorities and knowledge to identify prioritized, targeted, and measurable actions and locally based strategies. These plans further define specific actions, measures, roles, and financing for accomplishing water resource goals. Implementation strategies in the Upper Wapsipinicon River WRAPS Report will heavily influence and support implementation of this TMDL. The following sections provide an overview of potential implementation strategies to address the high priority pollutant sources including IPHTs and septic systems, AFOs and agricultural runoff. Additional implementation activities are provided in the Upper Wapsipinicon River WRAPS Report and the future Cedar River 1W1P.

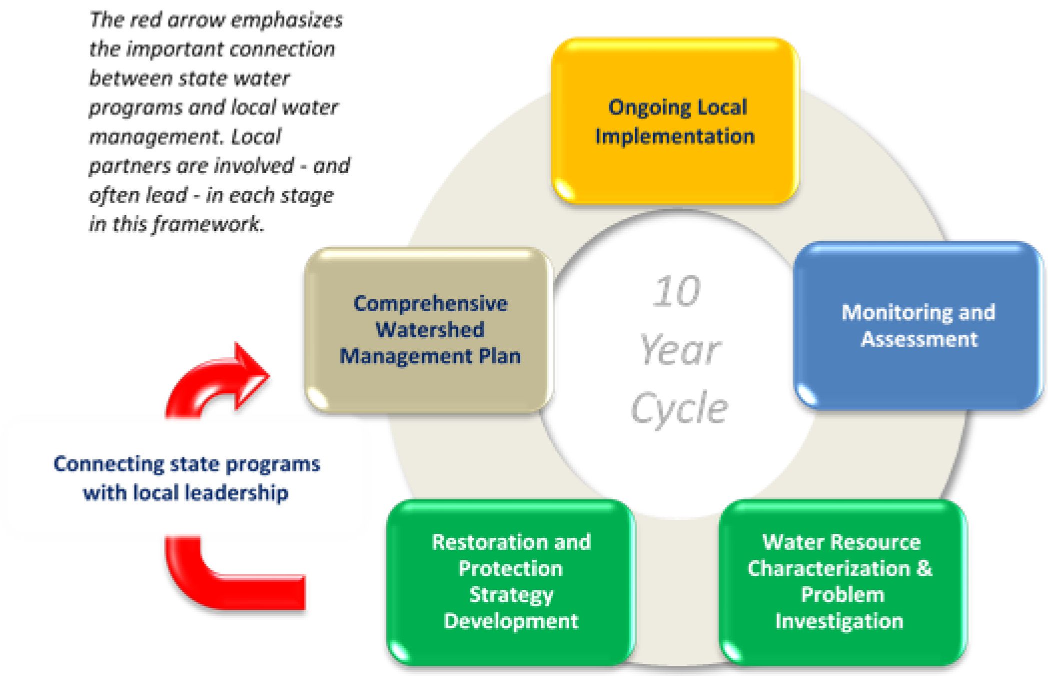

Figure 11. Minnesota's watershed approach

8.1 Non-permitted sources

Implementation of the UWRW TMDL will require several BMPs that address non-permitted (nonpoint) sources of *E. coli*. The partnered WRAPS report expands the discussion of *E. coli* sources, implementation strategies, and tools for prioritization. Prioritization and implementation plans for the UWRW can be found in the Cedar River 1W1P. This section provides an overview of example BMPs that may be used for implementation. The BMPs included in this section are not exhaustive, and the list may be amended. Priority sources of *E. coli* to target for implementation are livestock in AFOs, agricultural runoff and IPHT.

Table 11. Example BMPs for the Upper Wapsipinicon River Watershed.

Strategy	BMP Examples
Agricultural runoff control and soil improvements	Inject or incorporate manure within 24 hours of application
	Avoid winter application of manure and field slopes greater than 6%.
Feedlot runoff control and manure management	Feedlot runoff reduction and treatment
	Feedlot manure/storage addition
Pasture management	Livestock access control
Septic system improvements	Septic system improvement (maintenance and replacement)
Buffers and filters	Riparian buffers and field borders

8.2 Coordination with Iowa

The impaired stream addressed in this TMDL is upstream of an impaired stream section in Iowa. Consideration of Iowa water quality standards was incorporated into this TMDL to ensure that standards were consistent and/or provided the most protection (see Section 2.2 for more information). IFC/IIHR was instrumental in the construction of this TMDL by providing GHOST model flow projections.

In 2016, the U.S. Department of Housing and Urban Development awarded $97 million to the State of Iowa for their project, "The Iowa Watershed Approach for Urban and Rural Resilience." A partnership known as the UWRW Management Authority, made of 30 cities, counties and SWCDs, work together to reduce flooding and improve water quality in the watershed.

Continued coordination between MPCA and the Iowa Agencies will support successful implementation of this TMDL and the State of Iowa's project goals. For more information on Iowa's watershed work, search Iowa's Watershed Approach or the UWRW Management Authority website.

8.3 Cost

TMDLs are required to include an overall approximation of implementation costs (Minn. Stat. § 114D.25). The cost to implement the activities outlined in this TMDL are approximately $1 million over the next 10 years. The cost represents the amount of funding needed for implementation and activities related to implementation including feedlot program administration, septic program administration and SWCD support. Costs for implementing the TMDL and achieving *E. coli* reduction goals are based off practical implementation scenarios supported by local comprehensive watershed plan (Cedar River 1W1P). Actual implementation will likely differ.

8.3.1 *E. coli* reduction cost methodology

Costs to achieve the required *E. coli* reductions were calculated using the most likely sources (Section 3.4) and the estimated number of practices needed to meet the 86% reduction described in the Upper Wapsipinicon River TMDL summary (Table 7). The draft Cedar River 1W1P was referenced for the cost of most of the practices included in this report. BMPs used in the *E. coli* scenario calculation include:

- Feedlot BMPs
- SSTS maintenance and IPHT replacement
- Agricultural stormwater management (managing land application of manure)

Feedlot BMPs include filter strips around feedlots and runoff control practices. A feedlot BMP cost of $390 per AU was calculated for the impaired watersheds based on AUs provided by the MPCA (Root River TMDL and NRS) and the 2019 EQIP payments for Minnesota. This cost differs slightly from what is in the Cedar 1W1P Implementation Schedule since it is not specific to animal waste management systems, which may include large liquid manure storage areas not necessarily needed for facilities identified in this report. It was assumed that approximately 65% of existing feedlots were already implementing feedlot BMPs and did not need improvements. A basic nutrient management cost of $5.78 per acre (MDA 2017) was applied to all row cropped acres in the watershed.

8.4 Adaptive management

This list of implementation elements and the more detailed WRAPS report that will be prepared following this TMDL assessment focuses on adaptive management. Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired water bodies.

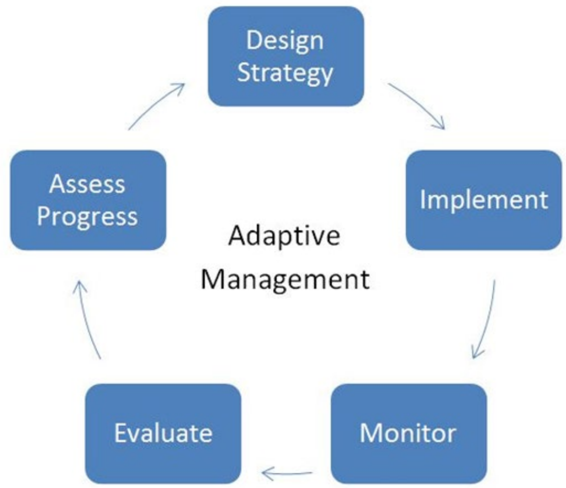

Figure 10. Adaptive management

Natural resource management involves a series of actions and associated feedback loops that help to inform next steps to achieve overarching goals. In the simplest of terms, adaptive management is a cyclical process or loop in which actions are implemented, monitored, evaluated, compared to anticipated progress, and redesigned if needed (Figure 10). In actuality, adaptive management in natural resource management consists of many of these feedback loops, all of which can occur at different speeds and durations. These loops or cycles can be large and programmatic in nature such as Minnesota's watershed approach, while others can be small and on a scale such as an individual field (Nelson et al. 2017). As a structured iterative implementation process, adaptive management offers the flexibility for responsible parties to monitor implementation actions, determine the success of such actions, and ultimately base management decisions on the measured results of completed implementation actions and the current state of the system. This process enhances the understanding and estimation of predicted outcomes and ensures refinement of necessary activities to better guarantee desirable results. In this way, understanding of the resource can be enhanced over time and management can be improved (Williams's et al. 2009).

9. Public participation

Over the course of this project, multiple outreach efforts have been conducted:

- January 3, 2019: Online WRAPS/TMDL kick-off meeting with Mower SWCD.
- February 11, 2019: Austin, Mower SWCD, WRAPS/TMDL development meeting.
- March 18, 2019: Online meeting with Mower SWCD – WRAPS/TMDL development update.
- April 16, 2019: Austin, JC Hormel Nature Center, Cedar River 1W1P Advisory Committee WRAPS/TMDL update.
- June 19, 2019: Postcard mailings to 64 residents and landowners within the Wapsipinicon watershed informing them of water quality conditions and invitation to submit concerns or comments during WRAPS/TMDL review.

9.1. Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from December 16, 2019 through January 15, 2020. There was one comment letter received and responded to as a result of the public comment period.

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