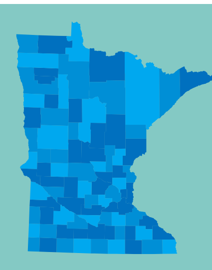
Grant

March 2020

Plum Creek Section 319 Nine-Element Plan

MINNESOTA POLLUTION CONTROL AGENCY



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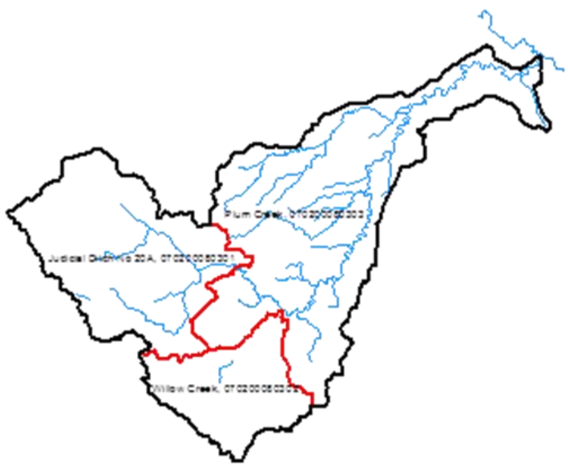
Contents

Executive summary

> "The tall willows fluttered slender leaves up against the sky, and little willows grew around them in clumps. They shaded all the ground, and it was cool and bare. The path went across it to a little spring, where cold, clear water fell into a tiny pool and then ran trickling to the creek." (Wilder, 1937, p. 13).

The Plum Creek Watershed (Figure 1) is historically significant, both to Minnesota and nationally. *On the Banks of Plum Creek* was written by Laura Ingalls Wilder, as a fictional account of her life. Later, *The Little House on the Prairie* television series adapted these books, setting the life of Wilder (nee Ingalls) along Plum Creek and outside the city of Walnut Grove, Minnesota. Walnut Grove attracts visitors from around the world to the annual pageant and museum (https://walnutgrove.org/index.html). The watershed is both historically and economically valued.

Figure 1. Plum Creek Watershed



The Plum Creek Watershed is 90.1 square miles (57,695.6 acres), located within the Cottonwood River Watershed (hydrological unit code (HUC)-8 07020008). It is comprised of three HUC-12 watersheds (070200080301, 07020008302, and 07020008303). The stream (AUID 07020008-516) is listed on the 303(d) list of impairments by turbidity and fecal coliform bacteria. For the purposes of this plan, these pollutants will be discussed as total suspended solids (TSS) and *Escherichia coli (E. coli)* as Minnesota water quality standards changed after the listing of these impairments. Sediment loading is a critical factor in southwestern Minnesota and ultimately, Plum Creek is a contributor to the Minnesota River Basin.

Almost the entire watershed (86%) is used for cultivated crops, mostly corn and soybeans. This area is also heavily tile drained to facilitate farming. This contributes to sediment and nutrient loading. Land application of manure and failing subsurface sewage treatment systems (SSTS) are the primary sources of *E. coli*. The suite of BMPs and activities included in Section 7 will address these concerns. The Redwood County Soil and Water Conservation District (SWCD) has been successfully working with landowners in the county to promote soil health and other agricultural BMPs. This focus area will allow the watershed partners to obtain a measurable change in water quality.

Implementation practices in this plan will achieve water quality standards for both TSS and *E. coli*. The tasks, activities, milestones, assessment criteria, and costs are outlined in Table 11, with long-term goals, estimated reductions per practice (Table 12). The success and trajectory of progress will be evaluated every two years, with additional milestones added. The plan is intended to be adapted as information the effectiveness of the strategy is evaluated.

Introduction

The Plum Creek Section 319 Small Watershed Focus Program Grant Nine Element (NKE) Plan was developed by compiling and synthesizing information from previous studies and planning documents including:

- Redwood County Comprehensive Local Water Management Plan, 2016
- Redwood County Comprehensive Plan, 2007
- Murray County Local Water Management Plan, 2017
- Lyon County Comprehensive Water Plan, 2011
- Cottonwood River Fecal Coliform 2013 TMDL, 2013
- Draft Cottonwood River Watershed TMDLs, 2020

The Plum Creek NKE Plan is a living, working document that serves as a guide and starting point for local stakeholders within the Plum Creek Watershed to achieve water quality goals through implementation of nonpoint source pollution control measures. An adaptive management approach is taken to allow for change, reaction, and course correction throughout implementation.

1.1 EPA nine elements

The intent of the Plum Creek NKE Plan is to concisely address the nine elements identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters* (EPA 2008) that are critical to preparing effective watershed plans to address nonpoint source pollution. EPA emphasizes the use of watershed-based plans containing the nine elements in Section 319 watershed projects in its guidelines for the Clean Water Act Section 319 program and grants (EPA 2013). The nine elements are listed in Table 1 along with the section of this report in which each element can be found.

Table 1. Nine elements and applicable report section

Section 319 Nine Elements	Applicable Report Section
a. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.	Section 4
b. An estimate of the load reductions expected from management measures.	Section 7.2
c. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element b, and a description of the critical areas in which those measures will be needed to implement this plan.	Section 7.0
d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	Sections 7.1 and 10
e. An information and education component used to enhance public understanding of the project and encourage the public's early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Section 8.0
f. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Section 7.0

Section 319 Nine Elements	Applicable Report Section
g. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 7.0
h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.	Section 7.0
i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item h immediately above.	Section 9.0

1.2 Nonpoint source (NPS) pollution management

Previous nonpoint pollution management activities and planning efforts have been and are being conducted in the Plum Creek NKE Plan project area at the statewide and local levels:

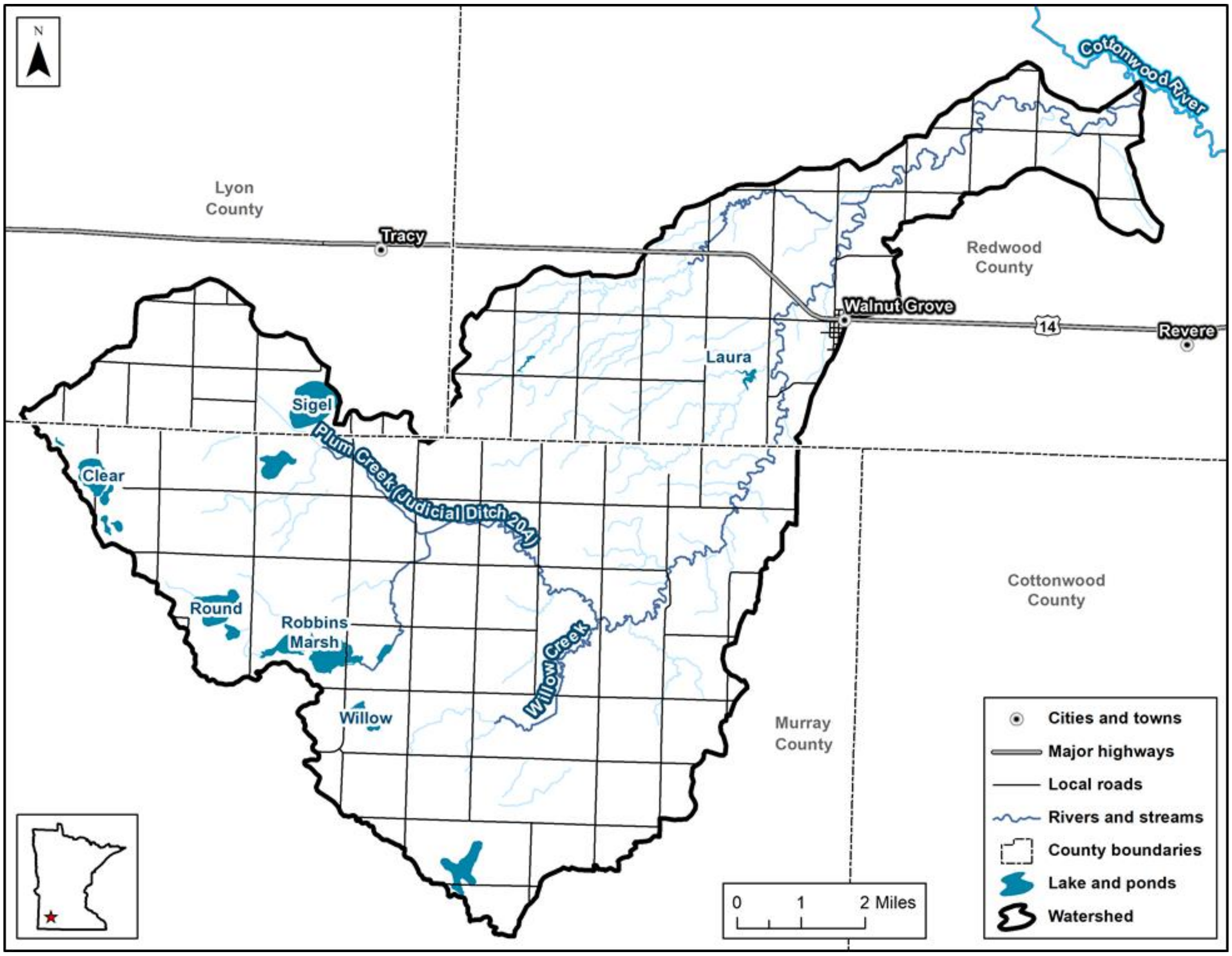
- Minnesota's Watershed Approach. Minnesota has adopted a watershed approach to address the state's major watersheds. The approach incorporates water quality assessment, watershed analysis, public participation, planning, implementation, and measurement of results into a 10-year cycle that addresses both restoration and protection needs. A key aspect of this effort is to develop and use watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. A monitoring and assessment report and watershed restoration and protection strategy report are currently under development for the Cottonwood River.

  These plans, strategies, and analysis studies have provided the foundational information on which this plan is built.
- **Total Maximum Daily Load (TMDL) development.** Prior to initiation of the Watershed Approach, the Cottonwood Fecal Coliform TMDL was developed by the Redwood Cottonwood Rivers Control Area (RCRCA) in 2013 and require an 88% reduction. The Cottonwood River Watershed TMDLs for total suspended solids (TSS) for Plum Creek currently being developed identify a 63% reduction in TSS. The TSS reduction goals for the Plum Creek Watershed were developed with the draft TMDLs.

2. Watershed description

The Plum Creek Watershed is located in portions of Lyon, Redwood, and Murray counties in Minnesota. Plum Creek (AUID 07020008-516) is approximately 34 miles in length and flows northeast from its headwaters through the community of Walnut Grove before it discharges to the Cottonwood River Figure 2. The Cottonwood River is a tributary to the Minnesota River.

Figure 2. Plum Creek Watershed

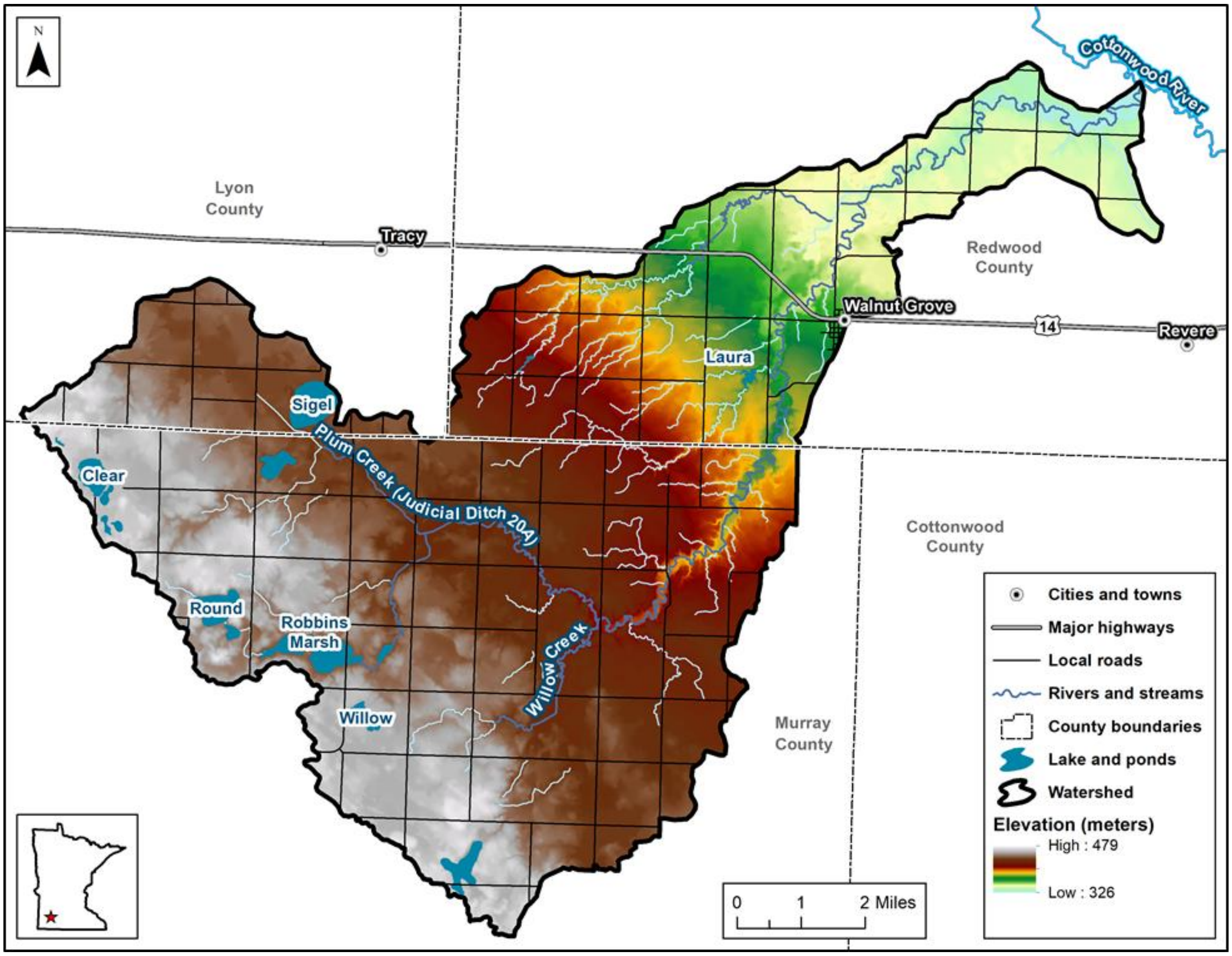


2.1 Topography and drainage

The Plum Creek Watershed is 90.1 square miles (57,695.6 acres). Plum Creek flows eastward then northward until it discharges to the Cottonwood River. There are several small lakes in the headwater area and a few small tributaries of which only one is named, Willow Creek, which flows northeast to Plum Creek.

Many tributaries of the Cottonwood River originate in the Coteau des Prairies region which is characterized by steep slopes and deep ravines (Biko Associates Inc. 2007). Because of the rapid decrease in elevation from the Coteau to lowland areas, lowlands are prone to serious annual flooding during times of snowmelt and heavy rainfall (Biko Associates Inc. 2007). Elevations across the Plum Creek Watershed range from 326 to 479 meters (1,070 – 1,572 feet) (Figure 3).

Figure 3. Plum Creek Watershed digital elevation map (DEM)



2.2 Geology and soils

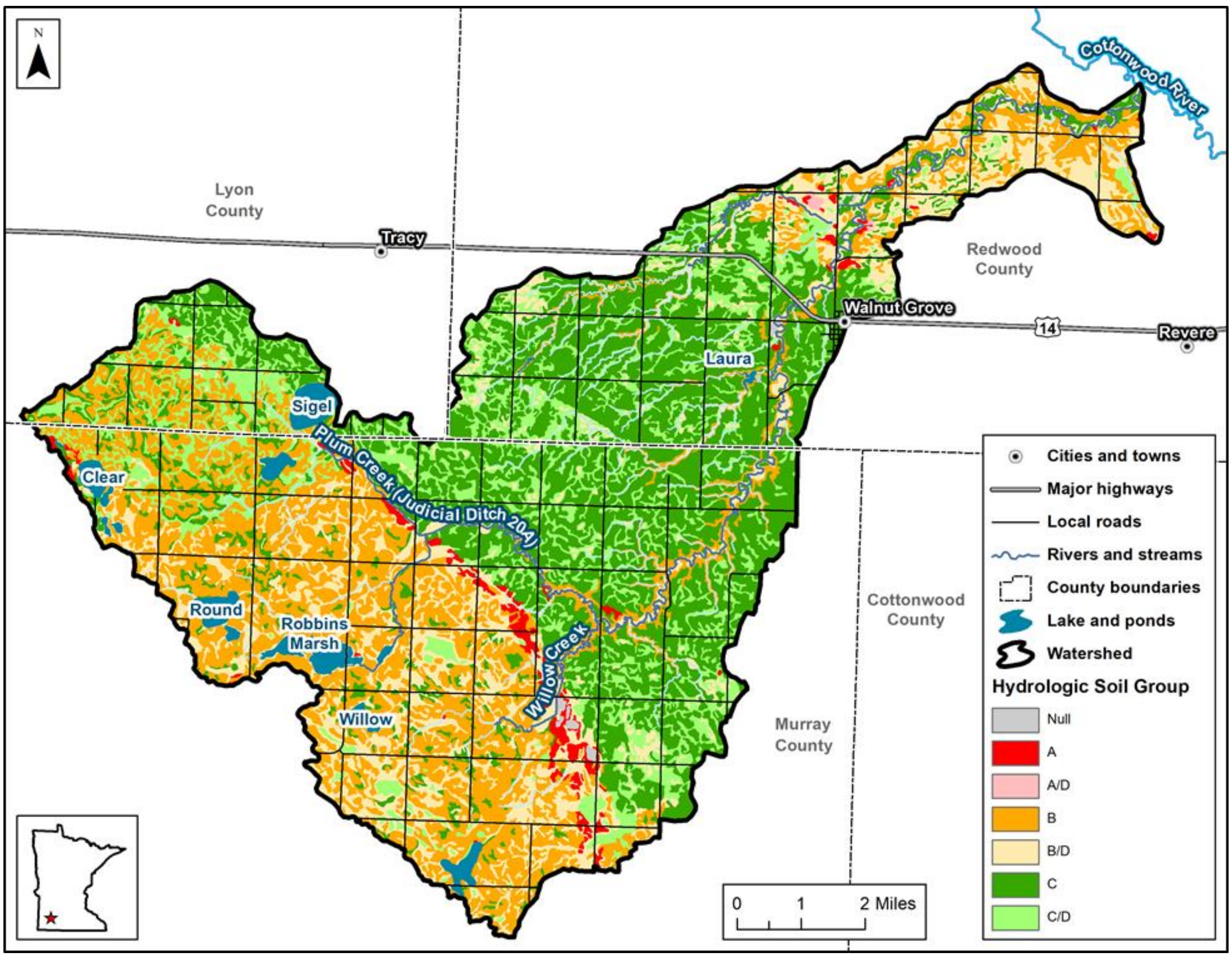
The upstream portion of the Plum Creek Watershed is largely located within Murray County, with a small amount of land in Lyon County, while the downstream portion of the watershed is located in Redwood County. Murray County is largely prairie land with no exposed bedrock. The Buffalo Ridge, a thick glacial deposit that was bypassed in the last glaciation, runs through the middle of the county. (Murray County Local Water Management Plan Task Force 2017). Redwood County is predominantly covered in a thick layer of glacial drift, except for the portions of the county that run along the Minnesota River Valley where rock formations are exposed. Cretaceous bedrock and sandstone lie beneath the glacial drift. In the southwest portion of Redwood County, where the Plum Creek Watershed lies, the cretaceous formation ranges between 10 – 400 feet thick (Biko Associates Inc. 2007).

Soils can be classified according to the hydrologic soil group (HSG) that describes in part the runoff potential and infiltration properties of the soil. HSG classifications vary from A that have low runoff potential and high infiltration rates to D which have high runoff potential and low infiltration rates. HSGs across the Plum Creek Watershed have distinct differences from the headwaters to the watershed outlet. The headwaters and outlet regions are largely B and B/D soils, and the central portion of the watershed is largely C and C/D soils (Table 2 and Figure 4). Dual classified soils (e.g., B/D, C/D) indicate the HSG in a drained condition/undrained conditions. These soils typically have a high water table, and when farmed are typically drained.

Table 2. Plum Creek Watershed hydrologic soil groups

HSG	Percent of watershed
Null/Water	1.1%
A	1.5%
A/D	0.1%
B	27.5%
B/D	19.5%
C	33.3%
C/D	17.0%

Figure 4. Plum Creek Watershed hydrologic soil groups

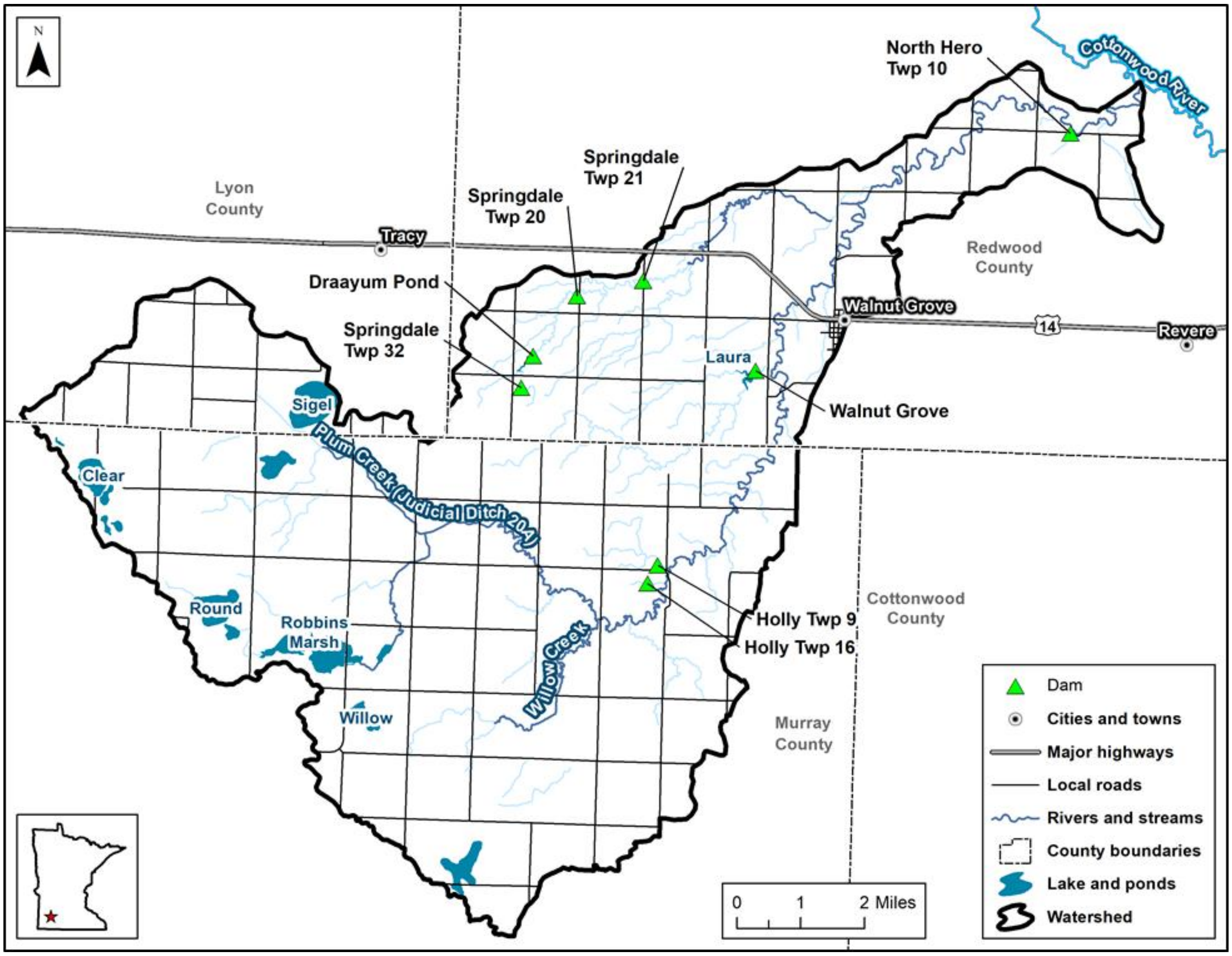


2.3 Waterbodies

Plum Creek is the main stream through this watershed and is 34.1 miles (54.9 kilometers) long. The only named tributary to Plum Creek is Willow Creek, which is approximately 4.4 miles (7.1 kilometers) in length. There are also two small unnamed tributaries to Plum Creek. Redwood County has constructed and maintained approximately 520 miles of open drainage ditches and 1,150 miles of county and judicial drainage tile across the county (Biko Associates Inc. 2007). Nearly all cropland that would benefit from artificial drainage has been tiled which accelerates drained water leading to higher peak flows and lower drought flows (Murray County Local Water Management Plan Task Force 2017).

There are a number of small lakes in the Plum Creek Watershed: Sigel Lake, Clear Lake, Round Lake, Willow Lake, as well as the Robbins Marsh. There is also a small waterbody called Lake Laura (sometimes referred to as Plum Creek Lake) located within Plum Creek County Park on a tributary to Plum Creek near Walnut Grove. Lake Laura is formed by the Walnut Grove Dam (MN00728) impoundment which is a class 2 dam. In total, there are 8 small dams located across the Plum Creek Watershed (Figure 5).

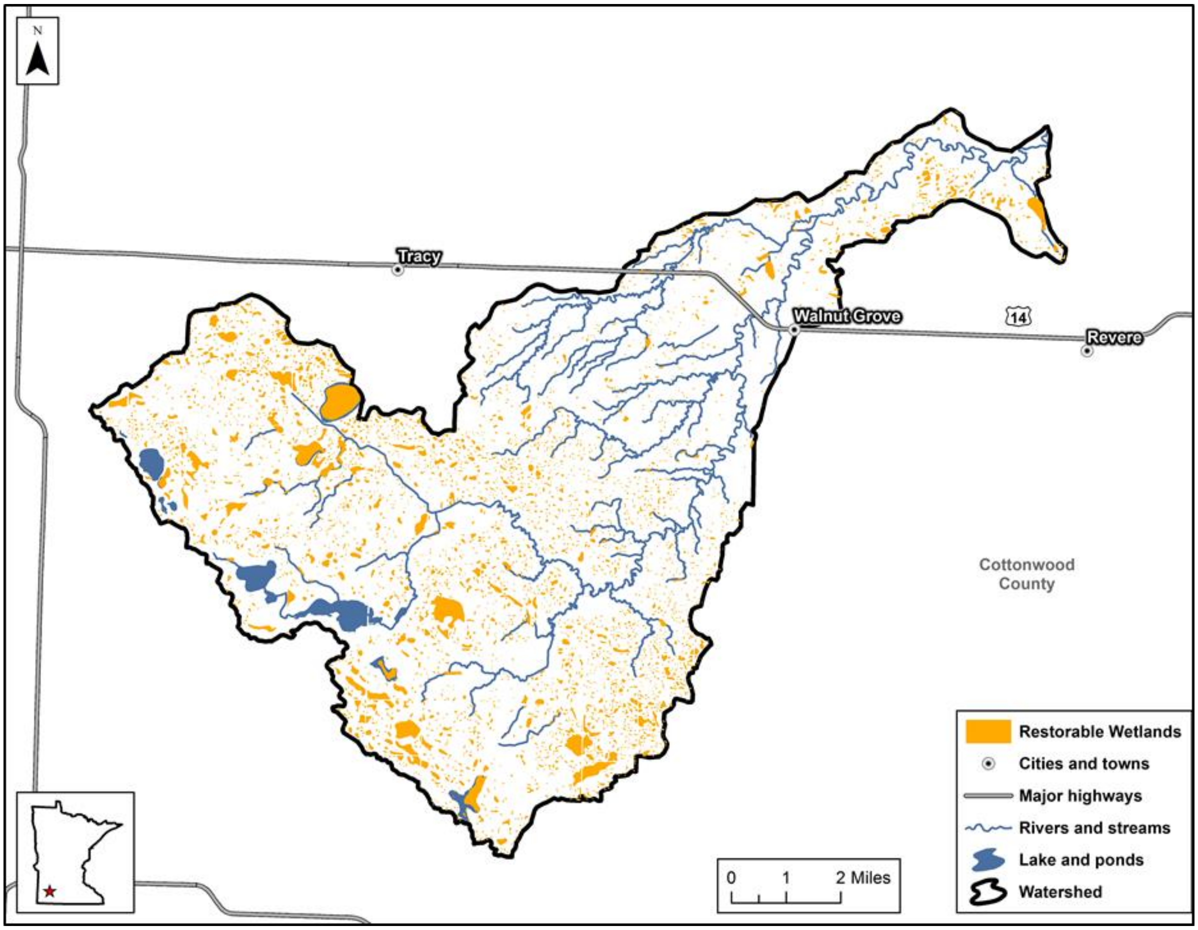
Figure 5. Plum Creek Watershed dams



2.4 Aquatic habitat and wetlands

The spatial coverages of open water and wetlands across the Plum Creek Watershed are 1% and 2% respectively (NLCD 2011). In general, many historic wetlands in the Cottonwood River Watershed have been drained and converted to cultivated fields. In addition, a large proportion of small creeks and streams have been ditched and straightened, permitting earlier planting and allowing more acres to be placed into production (MPCA n.d). The total amount of wetlands drained in Redwood County since the days of early European settlement is unknown, but it is estimated that about 90% of the county's original wetlands have been drained and those lands are now used for agricultural purposes (Southwest Regional Development Commission and Redwood County Emergency Management 2019). The Murray County Local Water Management Plan identified that wetland restoration would help restore local flow patterns as improved drainage for agricultural lands has resulted in changing the hydrology and sediment erosion across the county (Murray County Local Water Management Plan Task Force 2017). Restorable wetlands are provided by Ducks Unlimited (Figure 6) for the Plum Creek Watershed.

Figure 6. Ducks Unlimited restorable wetlands



2.5 Groundwater

The following description details groundwater resources across the entire Cottonwood River Watershed of which Plum Creek is a part (MPCA n.d.):

> "Aquifers throughout the watershed serve two major functions in the hydraulic system; they are sources of water supplies, and they furnish a perennial base of streamflow by ground water discharge.
>
> Water supplies are obtained from wells tapping Pleistocene glacial deposits, Cretaceous sandstone, Cambrian sandstone, and Precambrian crystalline rocks. The most accessible and widely used aquifers are beds of sand and gravel buried in the glacial deposits. Dominant regional ground water flow is northeastward from the topographic high in the southwest toward the Minnesota River. Local flow patterns indicate ground water discharging into rivers and creeks. Most of the Cottonwood River Watershed is an area of ground water recharge, indicated by a decreased in hydraulic potential as depth below land surface increases.
>
> The dissolved solids and water type in surficial aquifers (less than 100 feet deep) depend on mineral composition of the glacial sediment and the solubility of these minerals, ground water movement, and agricultural pollutants. End moraines having good surface drainage generally contain water having the largest concentration of dissolved solids (>1,000 mg/l) which is of the calcium magnesium type. Water from wells completed in sand and gravel and ground moraine deposits are generally of calcium magnesium bicarbonate type, with concentrations of dissolved

solids less than 1,000 mg/l. Nitrate concentrations greater than 45 mg/l are more frequent in shallow wells affected by infiltration of water through barnyard or feedlot wastes."

Murray County has 30 regulated public water supplies that use well water, eight of which are municipal water supplies (Murray County Local Water Management Plan Task Force 2017). Improving and protecting groundwater quality and quantity has been identified as an important element of the Murray County Local Water Management Plan.

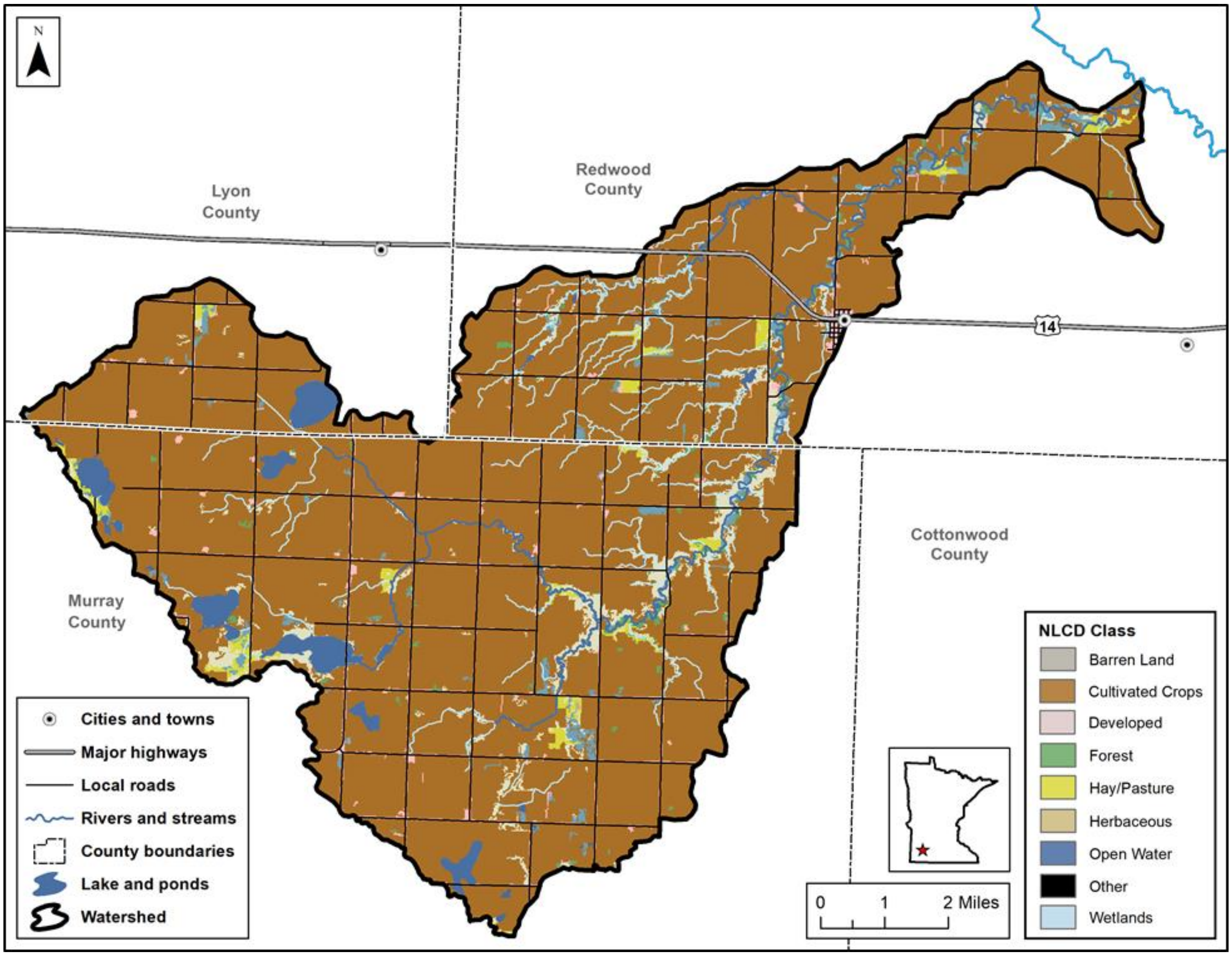
2.6 Land use

Within the 57,697-acre Plum Creek Watershed, 49,690 acres (86%) are classified as cultivated cropland, dominated by corn and soybean. The next two dominant land use types include development (5%) and herbaceous cover (3%). Table 3 displays the 2011 NLCD classification cover acreage and percent with the watershed as displayed in Figure 7. Cropland in the overall Cottonwood River Watershed is classified as moderately productive (94%) (MPCA n.d.).

Table 3. Land use breakdown for the Plum Creek Watershed (NLCD 2011)

Land use classification	Acres	Percent
Barren land	11	0%
Cultivated crops	49,690	86%
Developed	2,630	5%
Forest	650	1%
Hay/pasture	768	1%
Herbaceous	1,980	3%
Open water	580	1%
Wetlands	1,388	2%
Total	**57,697**	**100%**

Figure 7. Land use and land cover for Plum Creek Watershed (NLCD 2011)



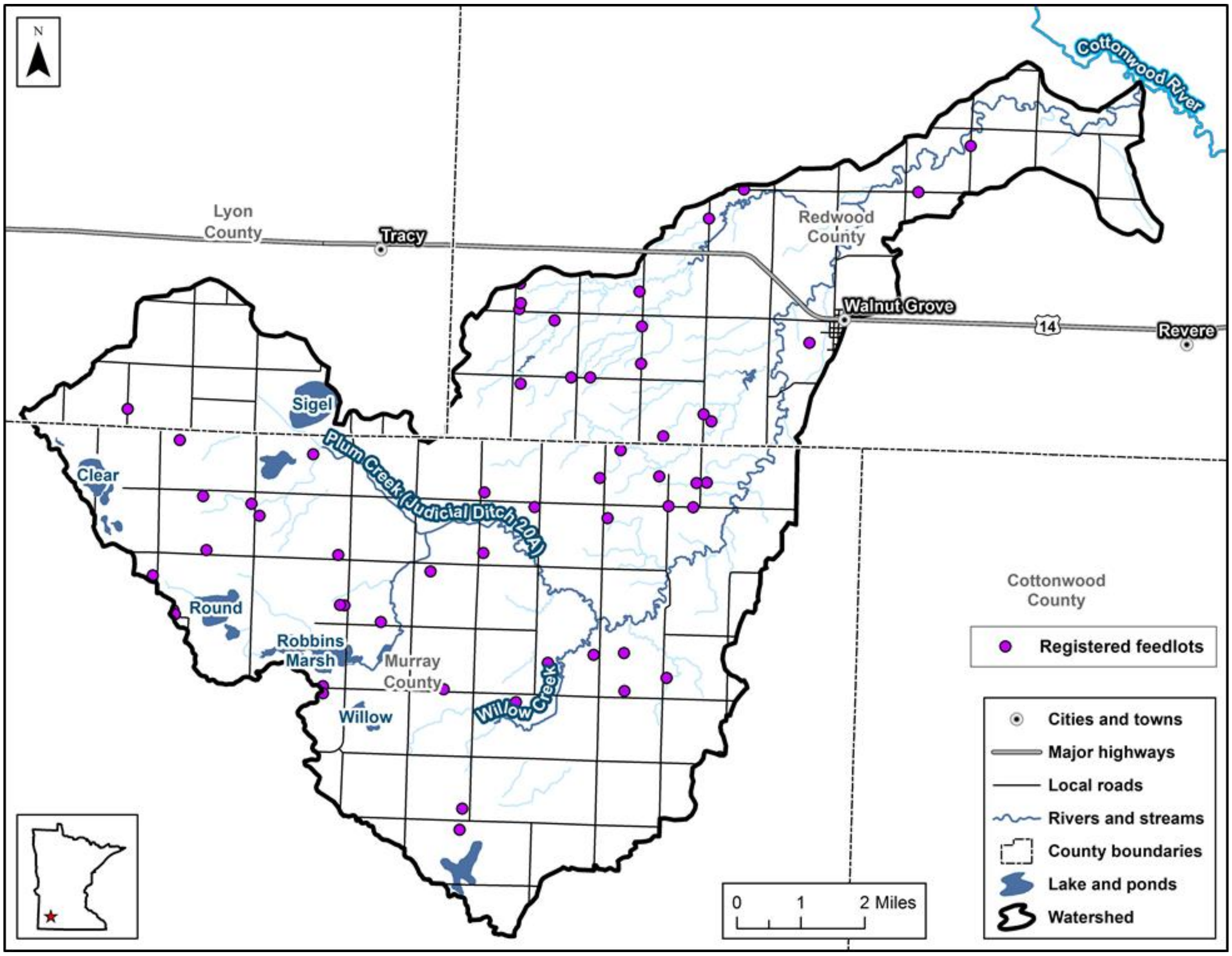
2.7 Wastewater

There are no WWTPs in this watershed, however the Cottonwood Fecal Coliform TMDL (2013) states that there are 239 subsurface sewage treatment systems (SSTS) in the Plum Creek Watershed of which 73 are failing. Note that there are no MS4 permittees in this watershed.

2.8 Feedlots

There is one NPDES permitted livestock facility for up to 8,400 swine. The other animal operations in the watershed do not require federal permits (NPDES), but are registered with the state. Locations of registered feedlots within the Plum Creek NKE Plan project area are provided in Figure 8.

Figure 8. Registered feedlots in the Plum Creek Watershed (MPCA 2016)



2.9 Climate and precipitation

The climate of the Plum Creek Watershed is typical of Southwestern Minnesota. The long-term average annual precipitation is 26 inches per year based on records from the Minnesota State Climatology Office for the Cottonwood River HUC-8 watershed. Most of the precipitation (79%) occurs between March and October with the remainder (21%) falling between November and February as mostly snow. The average annual snowfall is about 40 inches. The normal average annual temperature in the watershed is 44°F with the winter and summer normal average temperatures being 15°F and 70°F, respectively. The average minimum and maximum temperatures are 3°F and 82°F, respectively.

Detailed weather data are available at http://climate.umn.edu. In general, the watershed is continental, with cool dry winters and warm wet summers. Over 85% of the precipitation, falling within the watershed is returned to the atmosphere through the processes of evaporation and transpiration.

3. Water quality and quantity

3.1 Water quality standards and beneficial uses

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

- Beneficial uses — Identify how people, aquatic communities, and wildlife use our waters
- Numeric criteria — Amounts of specific pollutants allowed in a body of water and still protects it for the beneficial uses
- Narrative criteria — Statements of unacceptable conditions in and on the water
- Antidegradation protections — Extra protection for high-quality or unique waters and existing uses

Together, the beneficial uses, numeric and narrative criteria, and antidegradation protections provide the framework for achieving Clean Water Act goals.

Minnesota's water quality standards are provided in Minnesota Rules chapters 7050. All current state water rules administered by the MPCA are available on the Minnesota water rules page (https://www.pca.state.mn.us/water/water-quality-rules).

3.2 Beneficial uses

The beneficial uses for public waters in Minnesota are grouped into one or more classes as defined in Minnesota Rule (Minn. R.) ch. 7050.0140. The classes and beneficial uses are:

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

The aquatic life use class now includes a tiered aquatic life uses (TALU) framework for rivers and streams. The framework contains three tiers—exceptional, general, and modified uses.

All surface waters are protected for multiple beneficial uses.

3.3 Numeric criteria and state standards

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

- cold water aquatic life and habitat, also protected for drinking water: classes 1B; 2A, 2Ae, or 2Ag; 3A or 3B; 4A and 4B; and 5;
- cool and warm water aquatic life and habitat, also protected for drinking water: classes 1B or 1C; 2Bd, 2Bde, 2Bdg, or 2Bdm; 3A or 3B; 4A and 4B; and 5;

- cool and warm water aquatic life and habitat and wetlands: classes 2B, 2Be, 2Bg, 2Bm, or 2D; 3A, 3B, 3C, or 3D; 4A and 4B or 4C; and 5; and
- limited resource value waters: classes 3C; 4A and 4B; 5; and 7.

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

The MPCA assesses individual water bodies for impairment for class 2 uses—aquatic life and recreation. Class 2A waters are protected for the propagation and maintenance of a healthy community of cold water sport or commercial fish and associated aquatic life and their habitats. Class 2B waters are protected for the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish, and associated aquatic life and their habitats. Both class 2A and 2B waters are also protected for aquatic recreation activities including bathing and swimming.

Protection for aquatic recreation entails the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of *Escherichia coli* (*E. coli*) in the water, which is used as an indicator species of potential waterborne pathogens. To determine if a lake supports aquatic recreational activities, its trophic status is evaluated using total phosphorus, Secchi depth, and chlorophyll-*a* as indicators. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of aquatic life entails the maintenance of a healthy aquatic community as measured by fish and macroinvertebrate IBIs. Fish and invertebrate IBI scores are evaluated against criteria established for individual monitoring sites by water body type and use subclass (exceptional, general, and modified).

General use waters harbor “good” assemblages of fish and macroinvertebrates that can be characterized as having an overall balanced distribution of the assemblages and with the ecosystem functions largely maintained through redundant attributes. Modified use waters have been extensively altered through legacy physical modifications, which limit the ability of the biological communities to attain the general use. Currently the modified use is only applied to streams with channels that have been directly altered by humans (e.g., maintained for drainage, riprapped).

The ecoregion standard for aquatic recreation protects lake users from nuisance algal bloom conditions fueled by elevated phosphorus concentrations that degrade recreational use potential.

3.4 Antidegradation policies and procedures

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

A. Existing uses and the level of water quality necessary to protect existing uses shall be maintained and protected.
B. Degradation of high water quality shall be minimized and allowed only to the extent necessary to accommodate important economic or social development.
C. Water quality necessary to preserve the exceptional characteristics of outstanding resource value waters shall be maintained and protected.
D. Proposed activities with the potential for water quality impairments associated with thermal discharges shall be consistent with section 316 of the Clean Water Act, United States Code, title 33, section 1326.

3.5 Standards and criteria

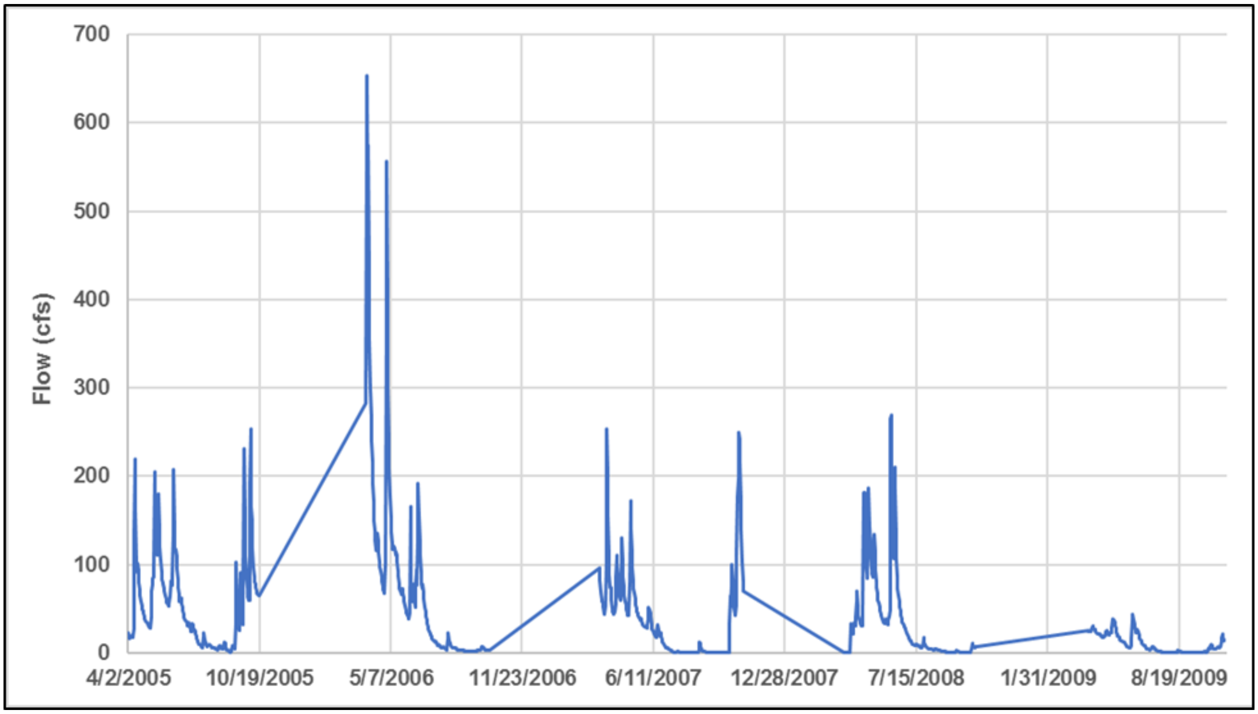
The stream and lake in the watershed are designated as class 2B waters. The water quality standards and criteria used in assessing the streams and lakes in the planning area include the following parameters:

- *E. coli* – not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies between April 1 and October 31.
- Dissolved oxygen – daily minimum of 5 milligrams per liter (mg/L).
- pH – to be between 6.5 and 9.0 pH units.
- Total suspended solids (TSS) – 65 mg/L not to be exceeded more than 10% of the time between April 1 and October 31.
- Chloride
  - Chronic: 230 mg/L
  - Maximum standard: 860 mg/L
  - Final acute value: 1,720 mg/L
- Stream eutrophication – based on summer average concentrations for the South River Nutrient Region
  - Total phosphorus (TP) concentration less than or equal to 150 micrograms per liter (µg/L) and
  - Chlorophyll-*a* (seston) concentration less than or equal to 35 µg/L or
  - Diel dissolved oxygen (DO) flux less than or equal to 4.5 mg/L or
  - Five-day biochemical oxygen demand (BOD) concentration less than or equal to 3.0 mg/L.
  - If the TP criterion is exceeded and no other variable is exceeded, the eutrophication standard is met.
- Lake eutrophication – based on summer average values for shallow lakes in the western corn belt plains ecoregion
  - Total phosphorus concentration less than or equal to 90 µg/L and
  - Chlorophyll-*a* concentration less than or equal to 30 µg/L or
  - Secchi disk transparency not less than 0.7 meter.
- Biological indicators – The basis for assessing the biological community are the narrative water quality standards and assessment factors in Minn. R. 7050.0150. Attainment of these standards is measured through sampling of the aquatic biota and is based on impairment thresholds for indices of biological integrity (IBI) that vary by use class. Appendix 4.1 in the Cedar River Watershed Monitoring and Assessment Report (MPCA 2012) provides the IBI numeric thresholds.

3.6 Streamflow

Streamflow was monitored by the MPCA for the period of 2005 to 2009 at Plum Creek near Walnut Grove, CSAH10 (29048001). Peak flow in this period was 653 in April of 2006, with base flow averaging 42 cfs (Figure 9). Limited streamflow data exists for the period of 1983 to 1984 at the Lake Laura Inlet (2904402), South Inlet (29044003) and Outlet (2904401) stream gages near Walnut Grove, MN.

Figure 9. Streamflow at Plum Creek near Walnut Grove, 2005-2009



3.7 Water quality data summaries

The fecal bacteria (e.g., *E. coli*) and TSS summaries associated with this section are sourced from the MPCA's online surface water data.

Samples collected from Plum Creek (S001-913) in 2005-2010 and 2017-2018 are summarized for *E. coli*. In most years, a few results exceeded the 1,260 MPN/100 mL standard (**Error! Reference source not f ound.**). When evaluated on a monthly basis between May through October, the 126 MPN/100 mL standard was often exceeded (Table 5). Data are summarized graphically in Figure 10. During the past 10 years only (2010-present), most of the data were collected during June, July, and August. Monthly geometric means applicable to the last 10 years only (2010-present) are:

- June – 701.7 MPN/100 mL
- July – 1,032.4 MPN/100 mL
- August – 946.9 MPN/100 mL

Table 4. Annual summary of E. coli data for Plum Creek (AUID 516 site S001-913, Apr-Oct)

Year	Sample count	Minimum (MPN/ 100mL)	Maximum (MPN/ 100mL)	Samples >1,260 MPN/100mL	Frequency of exceedances
2005	1	840	840	0	0%
2006	8	4	1,400	1	13%
2007	35	58	2,420	3	9%
2008	4	31	2,420	1	25%
2009	7	10	1,414	1	14%
2010	6	26	2,420	1	17%
2017	9	530	4,352	5	56%
2018	6	275	1,187	0	0%

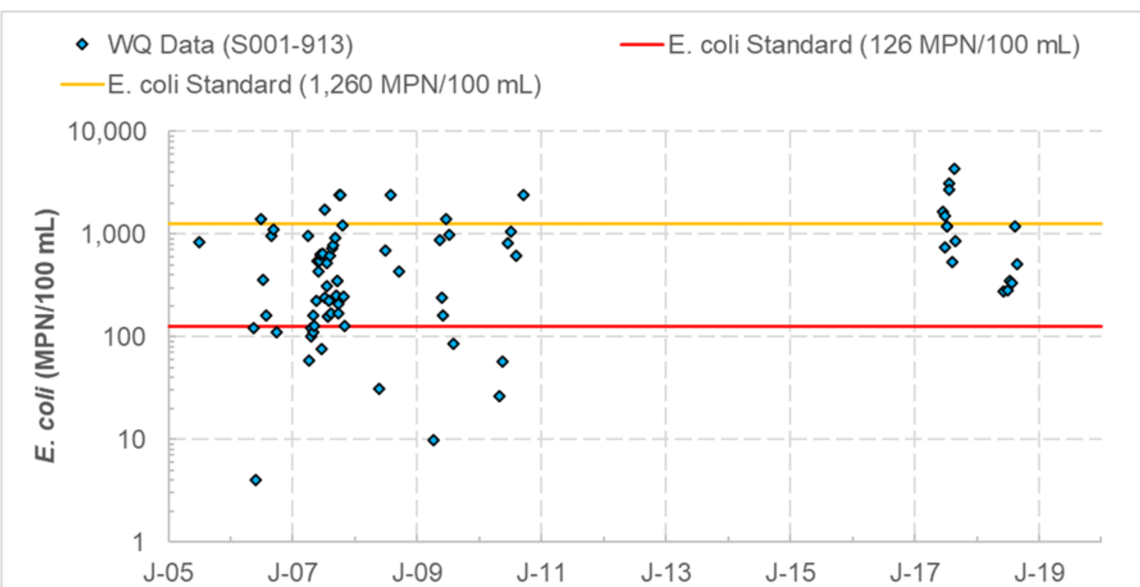
Values in red indicate years in which the numeric criteria was exceeded.

Table 5. Monthly summary of *E. coli* data for Plum Creek (AUID 516, site S001-913, 2005-2018)

Month	Sample count	Geomean (MPN/ 100mL)	Minimum (MPN/ 100mL)	Maximum (MPN/ 100mL)	Samples >1,260 MPN/100mL
April	7	83	10	960	0
May	11	126	4	866	0
June	16	588	76	1,664	4
July	15	655	159	3,076	4
August	13	576	86	4,352	1
September	9	413	110	2,420	1
October	5	741	127	2,420	2

Values in red indicate months in which the monthly geomean numeric criteria was exceeded.

Figure 10. *E. coli* data for Plum Creek (AUID 516, site S001-913, 2005-2018)



Total suspended solids

Samples collected from Plum Creek (S001-913) between 1997 and 2017 were evaluated for TSS. Except for 2009, one-third or more of the samples per year exceeded the 65 mg/L standard (Table 6). In April through September, the 65 mg/L standard was exceeded frequently (Table 7). These data are summarized graphically in Figure 11.

Table 6. Annual summary of TSS data for Plum Creek (AUID 516, site S001-913, Apr-Sep)

Year	Sample count	Mean (mg/L)	Minimum (mg/L)	Maximum (mg/L)	No. of exceedances	Frequency of exceedances
1997	7	133	11	528	4	57%
1998	6	166	9	450	2	33%
1999	10	374	5	2,153	6	60%
2000	12	860	6	2,390	7	58%
2001	11	458	1	1,130	6	55%
2002	12	394	5	1,300	8	67%
2003	8	590	12	2,510	4	50%
2004	16	221	1	1,500	8	50%
2005	16	133	8	496	9	56%
2006	15	91	7	516	6	40%
2007	12	57	7	179	4	33%
2008	16	73	5	308	7	44%
2009	12	28	1	152	1	8%
2010	21	72	4	366	9	43%
2011	13	69	6	296	5	38%
2012	10	401	1	2,670	5	50%
2017	10	64	6	185	4	40%

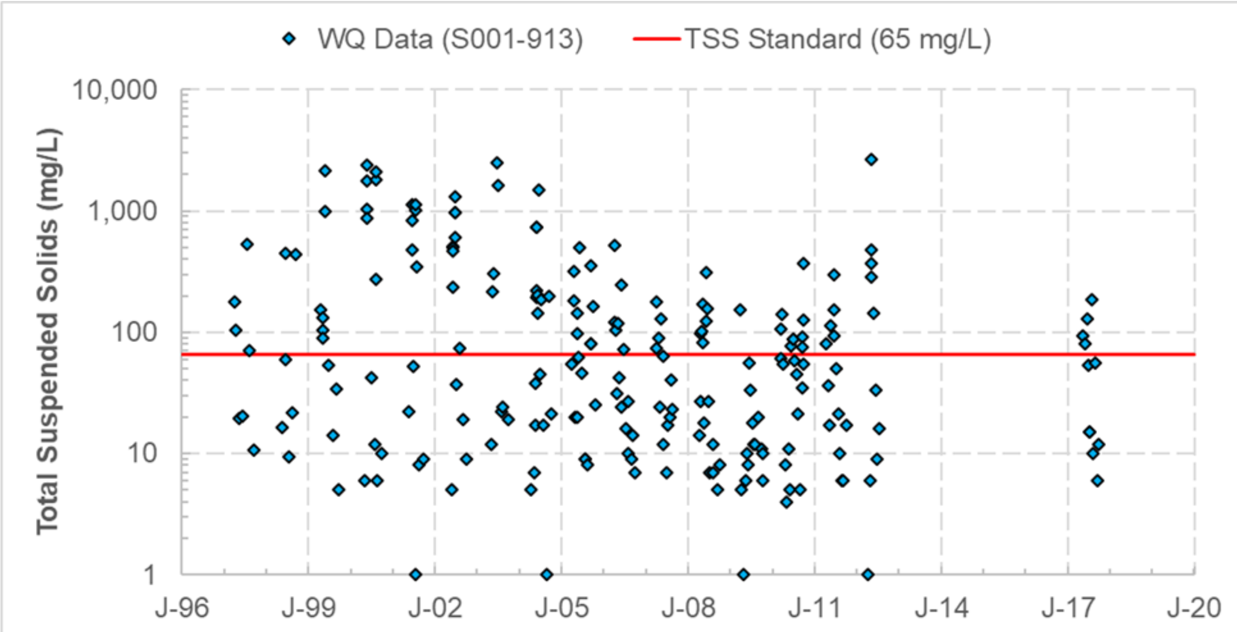
Values in red indicate years in which the numeric criteria (65 mg/L) was exceeded.

Table 7. Monthly summary of TSS data for Plum Creek (AUID 516, site S001-913, 1997-2017)

Values in red indicate months in which the numeric criteria (65 mg/L) was exceeded.

Year	Sample count	Mean (mg/L)	Minimum (mg/L)	Maximum (mg/L)	No. of exceedances	Frequency of exceedances
April	25	79	1	316	13	52%
May	47	344	4	2,670	26	55%
June	48	350	5	2,510	31	65%
July	28	137	1	1,130	6	21%
August	25	188	1	2,100	5	20%
September	28	80	5	437	10	36%
October	4	13	6	25	0	NA

Figure 11. TSS data for Plum Creek (AUID 516, site S001-913, 1997-2017).



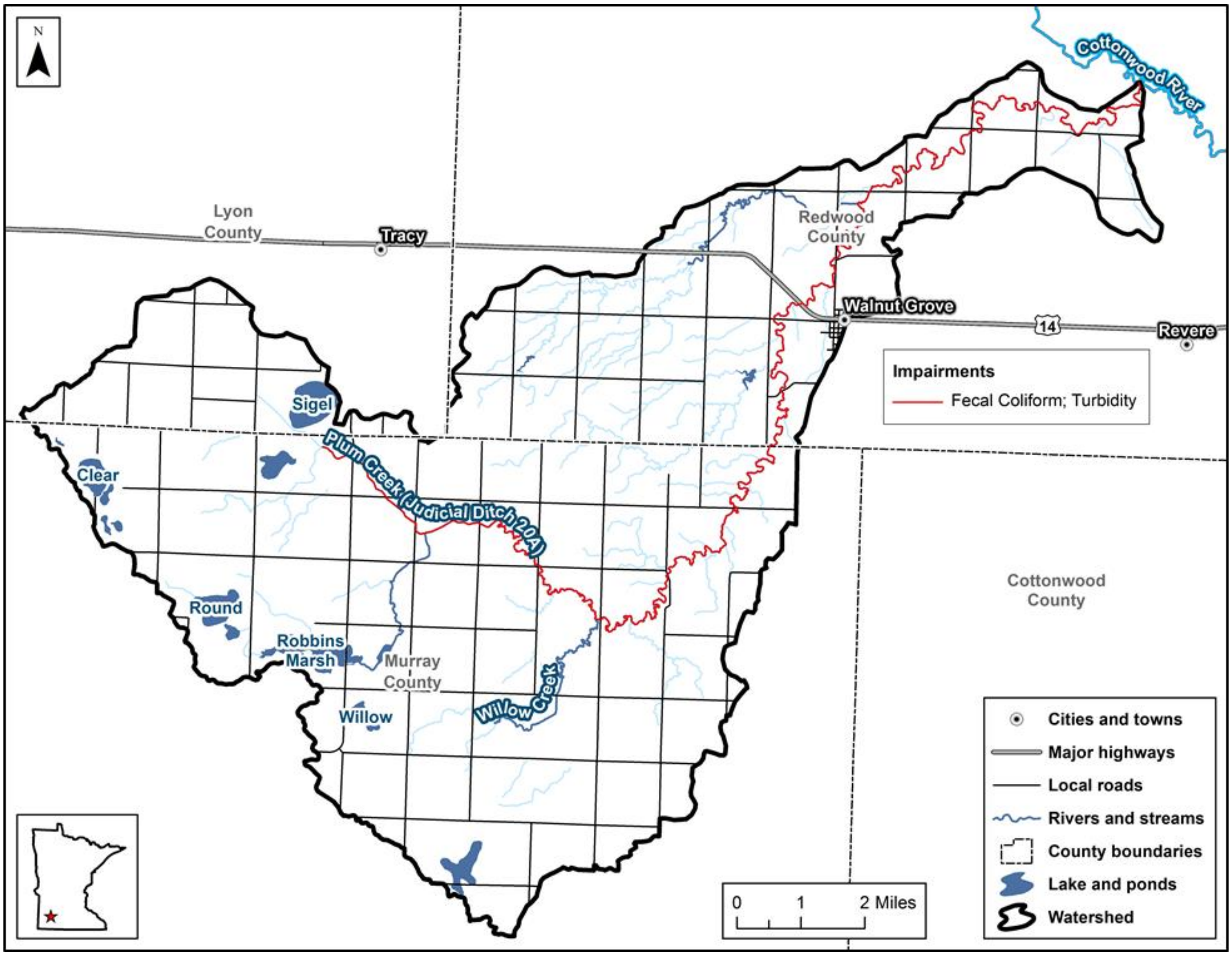
3.8 Impairments 303(d) listings

Water quality impairments are identified in the Minnesota's 303(d) list (Figure 12 and Table 8).

Table 8. Impaired streams in the Plum Creek Watershed (2018)

Reach name	Reach description	Class	Year listed	Affected designated use	Pollutant or stressor	Status of TMDL
Plum Creek (Judicial Ditch 20A) -516	Headwaters to Cottonwood R	2B, 3C	2006	Aquatic Life	Turbidity	2021 Target Completion
				Aquatic Recreation	Fecal Coliform	Approved 2014

Figure 12. Impairments in the Plum Creek Watershed



3.9 Watershed TMDLs

The fecal coliform impairment for Plum Creek (Judicial Ditch 20A) (07020008-516) was addressed in the Cottonwood River Fecal Coliform TMDL report (RCRCA 2013). Daily fecal coliform loading capacities and allocations for Plum Creek are provided in Table 9. The USGS gauging station for the Cottonwood River location in New Ulm, Minnesota was used to develop loading capacities for five flow regimes. The flow duration curve, displaying the target load against the existing load for each flow condition is shown in Figure 13.

Bacterial fecal coliform exceedances were observed in June, July, August, and September. Inadequate data were available for April and October, and no required reduction was observed for the month of May. Standard exceedances were most often observed during “moist”, “average”, and “dry” flow conditions.

A TMDL was completed for fecal coliform prior to the bacteria water quality standard changing to *E. coli*. This plan will use the *E. coli* standard for evaluation.

A TMDL for the turbidity listing is underway and will be completed as a TSS TMDL in 2021.

3,675 t/yr

Figure 13. Plum Creek fecal coliform load duration curve (RCRCA 2013).

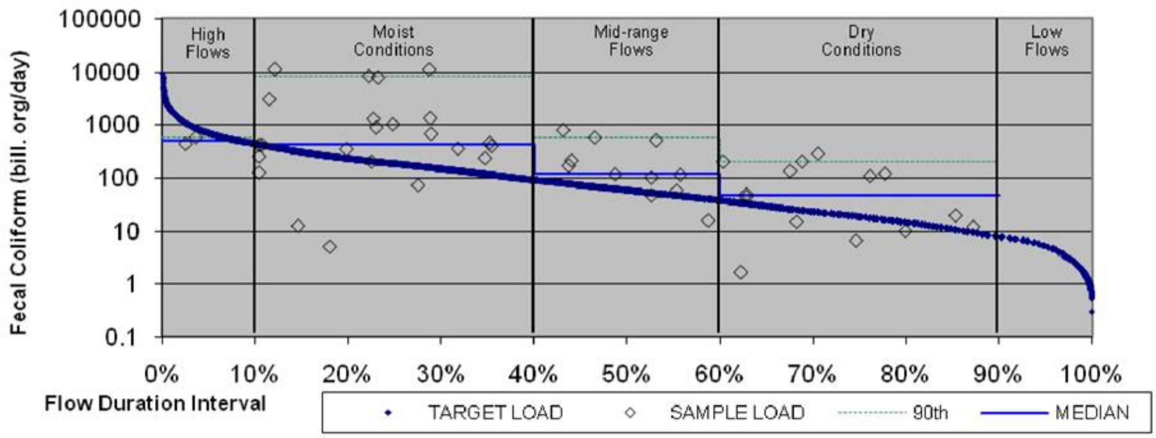


Table 9. Plum Creek daily fecal coliform loading capacities and allocations (RCRCA 2013)

	Flow Zone				
	High	**Moist**	**Mid**	**Dry**	**Low**
	Billion organisms per day				
TOTAL DAILY LOADING CAPACITY	687.0	183.1	57.9	18.2	5.0
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0	0	0	0	0
Communities Subject to MS4 NPDES Requirements	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	430.0	90.0	37.0	7.6	0.3
Margin of Safety	257.0	93.1	20.8	10.6	4.7
	Percent of total daily loading capacity				
TOTAL DAILY LOADING CAPACITY	100%	100%	100%	100%	100%
Wasteload Allocation					
Permitted Wastewater Treatment Facilities	0.0%	0.0%	0.0%	0.0%	0.0%
Communities Subject to MS4 NPDES Requirements	0.0%	0.0%	0.0%	0.0%	0.0%
Livestock Facilities Requiring NPDES Permits	0.0%	0.0%	0.0%	0.0%	0.0%
"Straight Pipe" Septic Systems	0.0%	0.0%	0.0%	0.0%	0.0%
Load Allocation	62.6%	49.1%	64.0%	41.8%	6.0%
Margin of Safety	37.4%	50.9%	36.0%	58.2%	94.0%

4. Pollutant source assessments

Pollutants of concern in the watershed include fecal coliform (*E. coli*) bacteria and TSS.

4.1 *E. coli*

Sources of bacteria to Plum Creek are identified in the fecal coliform TMDL for the Cottonwood River Watershed (Redwood Cottonwood Rivers Control Area 2013) and are summarized below:

- At the time of the study, there were 118 animal units/square mile in the Plum Creek Watershed. The TMDL found that manure from livestock represents more than 98% of the fecal matter produced in the Cottonwood River Watershed. Land application of this manure may reach surface waters via three different pathways: overland runoff, open tile intakes, and preferential flow.
- There are 239 subsurface sewage treatment systems (SSTS) in the Plum Creek Watershed of which 73 are failing. Failing SSTSs and those with inadequate treatment are a source of bacteria to waterways.
- Waste from humans, pets and wildlife can be directly deposited in streams and rivers or from runoff via impervious surfaces to storm sewer systems and overland flow.

All feedlots are either NPDES permitted or registered with state and subject to Minnesota feedlot rules. These are not considered to be a source of *E. coli* loading in the watershed. As noted above, the source contributions have been identified as land application of manure. Using the suite of BMPs included in the Plan, this source will be addressed.

A portion of the city of Walnut Grove is located in the Plum Creek Watershed, but the WWTF does not discharge to Plum Creek. The city is also not an MS4. Therefore, regulated human sources of *E. coli* are not sources to the stream.

4.2 TSS

Near channel sources account for over 70% of the total fine sediment load with cropland runoff the second highest source at 19% (Table 10). The high level of near channel sources of sediment align with observations from the Murray County Local Water Management Plan (2017) which states that due to its steep gradient, “much of the highly erodible land in Murray County is located on the banks of Plum Creek.”

Table 10. Sediment sources in the Plum Creek Watershed

Source	Percentage
Upland	20%
Cropland	19%
Feedlot	<1 %
Pasture	<1 %
Natural (forest, grassland, open water, wetlands)	<1 %
Urban	1%
Near Channel	72%
Wastewater	0.1%

5. Watershed critical areas

The critical areas in the watershed include:

Critical Area #1: Plum Creek high runoff risk area. ACPF was used to determine high runoff risk areas within the watershed (**Error! Reference source not found.**). These areas are identified as a c ritical area. These critical areas will also address near channel sources, which are identified as the likely predominant source of sediment to the Cottonwood River (MPCA 2019). This critical area can be further prioritized with stakeholder input or as part of a streambank assessment, which identifies the least stable banks along the creek.

Critical Area #2: High sediment loading areas. Areas of the watershed with disproportionately high sediment loading rates are targeted for management practice implementation using PTMApp (Figure 15).

Critical Area #3. Feedlots. The Cottonwood Fecal Coliform TMDL found that manure from livestock represents more than 98% of the fecal waste produced in the Cottonwood River Watershed. As such, feedlots, and the cropland within one mile of the facilities were identified as a critical area for livestock and manure management activities (Figure 8).

Figure 14. Runoff risk in the Plum Creek Watershed as modeled using ACPF (Srinivas et al. 2019)

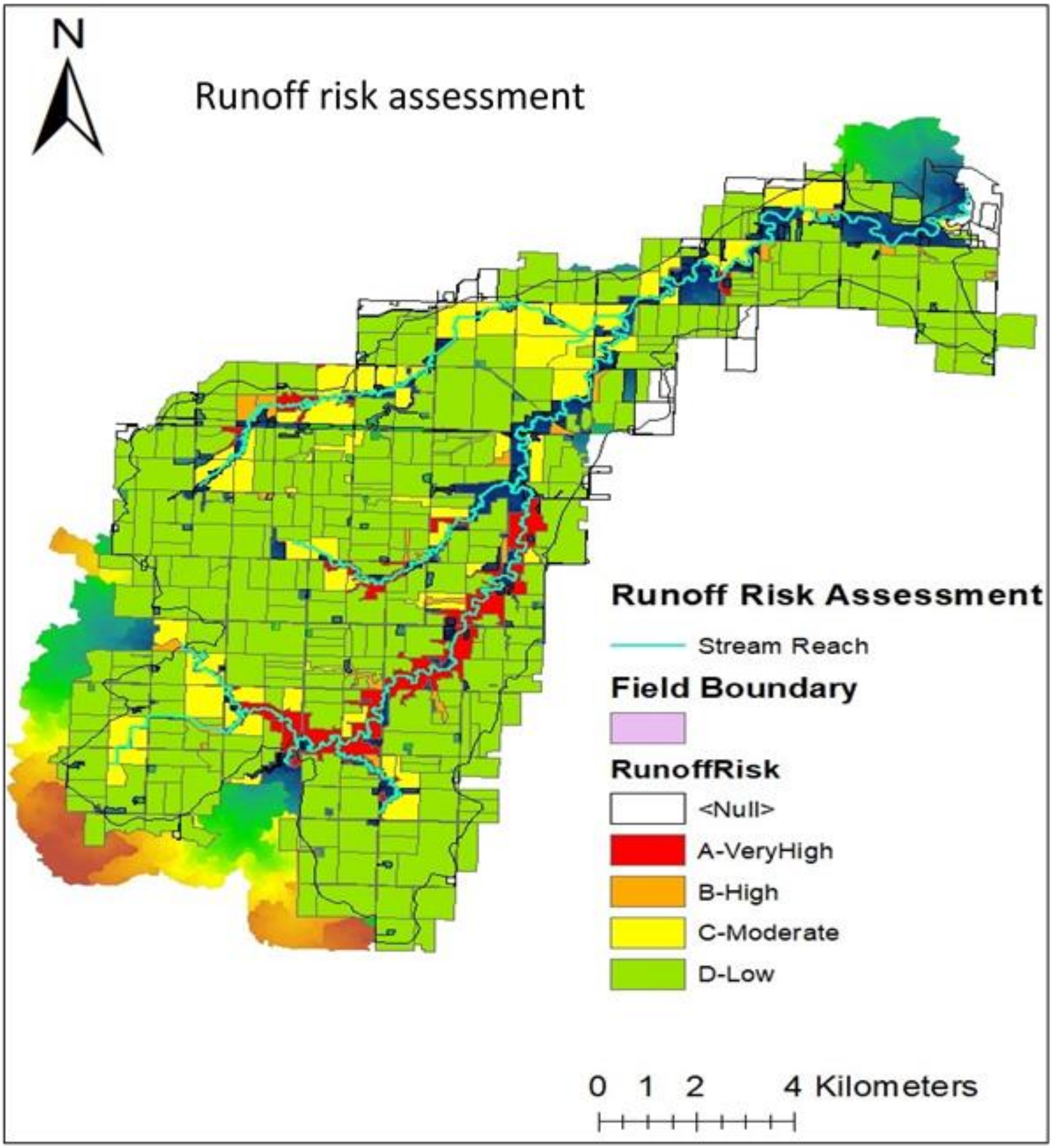
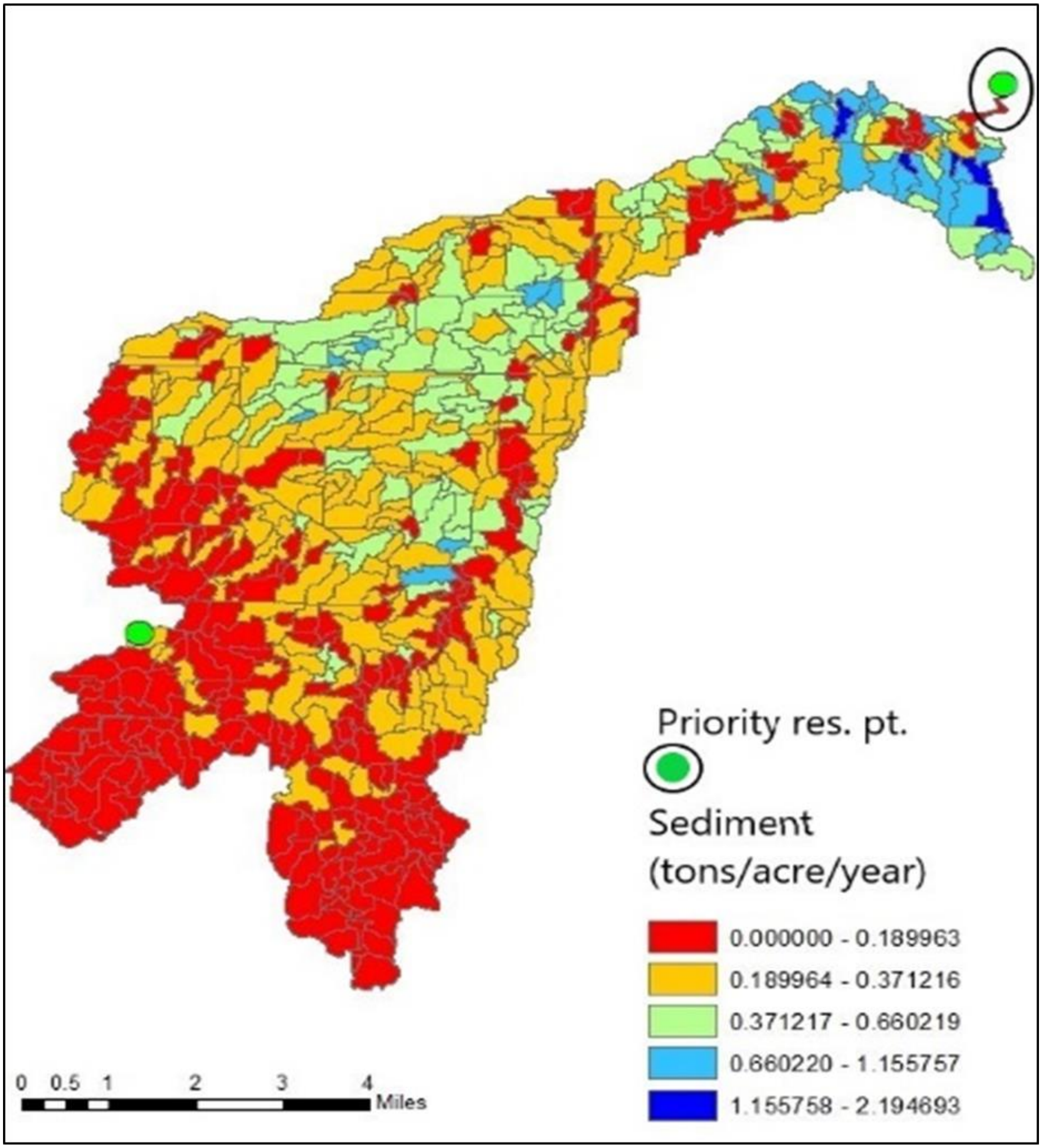


Figure 15. Areal sediment loads estimated with PTMApp



6. Watershed goals

There are draft TSS and approved *E. coli* TMDLs for the Plum Creek Subwatershed. Full implementation of the Plum Creek NKE is estimated to achieve pollutant load reductions to meet water quality standards in 10 years. These goals are:

Meet WQS for *E. coli* in Plum Creek. The draft Plum Creek Subwatershed *E. coli* TMDL calls for an 88% reduction in *E. coli*. The estimated loading reductions for the management activities described in Section 7, if implemented fully, will exceed the percentage required by the TMDL.

Meet TSS WQS in Plum Creek to meet the draft Plum Creek Subwatershed TSS TMDL. The TMDL requires a 63% reduction in TSS loading. If implemented fully, the estimated reductions from the management activities described in Section 7 will exceed the reduction.

7. Management strategies and activities

Management strategies and activities that will be used to meet watershed goals and benchmarks are summarized in this section.

7.1 Implementation plan

The implementation plan for the Plum Creek NKE Plan is provided in Table 12 and includes the estimated load reduction, schedule, and costs for each strategy or activity. Implementation progress will be tracked against biennial milestones for each management activity or strategy. More information about each strategy or activity is provided in the following sections. Total estimated reductions for BMPs are provided for TSS (65%) and fecal coliform (112%). If fully implemented as planned, the following management activities will exceed these required reductions in 10 years. Evaluative monitoring and the milestones and assessment criteria provided in Table 11 will be used to adapt and update the plans as appropriate.

Table 11. Implementation practices and activities for Plum Creek, including milestones, goals, and assessment criteria

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	4-year (2024)	6-year (2026)	8-year (2028)	10-year (2030)			
TSS	Streambank stabilization	Install 1 mile streambank stabilization	Install 1 mile streambank stabilization	Install 1 mile streambank stabilization	Install 1 mile streambank stabilization	Install 1 mile streambank stabilization	Implement 5 miles of streambank stabilization projects	# miles streambank stabilization	$500,000
		Conduct outreach to both DNR and landowners (minimum 10 landowners)	Work with DNR to get permitting	Evaluate effectiveness of outreach and adapt the approach	Continue landowner outreach (minimum 10 landowners)	Continue to work through the permitting process	Successful and cooperative permitting process with the DNR Increase landowner participation	# of permits successfully obtained # of landowners contacted	$2,000
	WASCOBs/Farmable basins	12 WASCOBs / farmable basins	12 WASCOBs / farmable basins	12 WASCOBs / farmable basins	12 WASCOBs / farmable basins	12 WASCOBs / farmable basins	Meter the water coming off the watershed and better idea of concentration when hitting the mainstem	# of WASCOBs/FBs	$300,000
	Grade stabilization structures/road retentions	4 grade stabilizations / road retentions	4 grade stabilizations / road retentions	4 grade stabilizations / road retentions	4 grade stabilizations / road retentions	4 grade stabilizations / road retentions	4 grade stabilizations / road retentions	# of grade stabilizations / road retentions	$1,500,000
Soil health education/ outreach	Soil health promotion	Annual field day of soil health practice examples with at least 20 attendees	Annual field day of soil health practice examples with at least 20 attendees	Annual field day of soil health practice examples with at least 20 attendees	Annual field day of soil health practice examples with at least 20 attendees	Annual field day of soil health practice examples with at least 20 attendees	Increased soil health retains more water and cuts down on TSS, but also increases the life of the structural BMPs on the landscape	# of events # of attendees	$2,500

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	**4-year (2024)**	**6-year (2026)**	**8-year (2028)**	**10-year (2030)**			
	Social media	Social media (FB, Instagram, etc.) 1x post per media	Social media (FB, Instagram, etc.) 1x post per media	Social media (FB, Instagram, etc.) 1x post per media	Social media (FB, Instagram, etc.) 1x post per media	Social media (FB, Instagram, etc.) 1x post per media	5,200 media posts to widely broadcast soil health events, knowledge, etc. Farmer to farmer networks are created by these events to help the farmers to support each other	# of media posts # of farmer-to-farmer relationships built	$240,000
	Billboard	Design and rent a billboard to promote SH	Design and rent a billboard to promote SH	Design and rent a billboard to promote SH	Design and rent a billboard to promote SH	Design and rent a billboard to promote SH	Promote widespread adoption of soil health practices	# of months with billboard in place # of billboards	$15,000
	Signage	Create and design recognition signs (e.g., cover crops here)	Distribution of signs	Evaluate the effectiveness of these promotions by number of acres new adoption	Adapt based on the evaluation		Cover crop promotion	# of new acres in cover crops	$10,000
Soil health practices	Cover crops	Achieving 100% (~50,000 acres) cover crops in the watershed per year	Achieving 100% (~50,000 acres) cover crops in the watershed per year	Achieving 100% (~50,000 acres) cover crops in the watershed per year	Achieving 100% (~50,000 acres) cover crops in the watershed per year	Achieving 100% (~50,000 acres) cover crops in the watershed per year	Maintain 100% adoption of CCs	# of new acres in cover crops	$9,000,000

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	4-year (2024)	6-year (2026)	8-year (2028)	10-year (2030)			
	Conservation tillage	Achieving 100% (~50,000 acres) conservation tillage in the watershed per year	Achieving 100% (~50,000 acres) conservation tillage in the watershed per year	Achieving 100% (~50,000 acres) conservation tillage in the watershed per year	Achieving 100% (~50,000 acres) conservation tillage in the watershed per year	Achieving 100% (~50,000 acres) conservation tillage in the watershed per year	100% of the acres in conservation tillage practices	# of new acres using conservation tillage	$9,000,000
Water storage / drainage	Grassed waterways	2 grassed waterway (avg 1000 feet each)	2 grassed waterway (avg 1000 feet each)	2 grassed waterway (avg 1000 feet each)	2 grassed waterway (avg 1000 feet each)	2 grassed waterway (avg 1000 feet each)	Install and maintain 10 grass waterways	# of feet of waterway	$50,000
	Bioreactors		1 install bioreactor		1 Install bioreactor		Install 2 bioreactors total	# of bioreactors	$25,000
	Buffer	maintain 100% compliance	maintain 100% compliance	maintain 100% compliance	maintain 100% compliance	maintain 100% compliance	Maintain 100% compliance with Buffer Law	100% buffer law compliance	$2,500
	Private ditch buffers	1 mile	2 miles	2 miles	2 miles	2 miles	Buffers on private ditches with overland runoff	# buffers, # miles buffered	$10,000
	Wetland restored	2 wetland restored (avg 2 acres)	2 wetland restored (avg 2 acres)	2 wetland restored (avg 2 acres)	2 wetland restored (avg 2 acres)	2 wetland restored (avg 2 acres)	Increase acceptance of wetlands in the landscape to control excess runoff	# wetlands restored # acres wetland restored	$200,000
	Drainage management practices	1 drainage management project	1 drainage management project	1 drainage management project	1 drainage management project	1 drainage management project	Optimize use of drainage management practices to reduce stream flows	# drainage management practices	$80,000
Livestock manageme nt practices	Rotational grazing	20% (~53 acres) of pasture rotational grazing system	20% (~53 acres) of pasture rotational	20% (~53 acres) of pasture rotational grazing system	20% (~53 acres) of pasture rotational	20% (~53 acres) of pasture rotational	Develop rotational grazing system plans for 100% of the pastureland (768 acres) to limit stream access and allow	# of acres # of paddocks per year	$100,000

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	4-year (2024)	6-year (2026)	8-year (2028)	10-year (2030)			
		planned and implemented	grazing system planned and implemented	planned and implemented	grazing system planned and implemented	grazing system planned and implemented	shoreland to heal between rotations		
	Cover crops/conservation tillage as part of the rotational grazing	Avg. 80 acres of land in cover crops/ conservation tillage based on the rotation	Avg. 80 acres of land in cover crops/ conservation tillage based on the rotation	Avg. 80 acres of land in cover crops/ conservation tillage based on the rotation	Avg. 80 acres of land in cover crops/ conservation tillage based on the rotation	Avg. 80 acres of land in cover crops/ conservation tillage based on the rotation	Encourage adoption of cover crops and reduced tillage through rotational grazing	# of acres in cover crops	$8,000
	Perimeter fencing	13,000 lin ft of fencing/system (avg.)	13,000 lin ft of fencing/syste m (avg.)	13,000 lin ft of fencing/system (avg.)	13,000 lin ft of fencing/syste m (avg.)	13,000 lin ft of fencing/syste m (avg.)	Install a total of 100,750 lin ft of perimeter fencing as part of the rotational grazing plan	# of lin feet of fencing	$1.55/lin ft.
	Livestock acreage exchange	Assisting with design watering system and fencing for pasturing. Add one new participant	Promote livestock exchange by neighbors	Assisting with design watering system and fencing for pasturing. Add one new participant	Promote livestock exchange by neighbors	Assisting with design watering system and fencing for pasturing. Add one new participant	Encourage cover crops and grazing lands between neighbors.	# of new participants	$12,000
	Manure land application	Develop and implement 3 manure management plans	Develop and implement 3 manure management plans	Develop and implement 3 manure management plans	Develop and implement 3 manure management plans	Develop and implement 3 manure management plans	100% of all animal operations are in compliance and using manure management plans	# of manure management plans	$25,000
SSTS	SSTS	Replace 13 failing SSTS	Replace 20 failing SSTS	Replace 20 failing SSTS	Replace 20 failing SSTS		Replace all failing SSTS	# SSTS upgraded or replaced	$365,000

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	4-year (2024)	6-year (2026)	8-year (2028)	10-year (2030)			
	SSTS maintenance/inspection	reach out to SSTS landowners/ education	County inspection rotation/POS inspections	County inspection rotation/POS inspections	County inspection rotation/POS inspections	County inspection rotation/POS inspections	SSTS all in compliance and maintained	# of inspections	$10,000
Nutrients Management Suite of Practices	Nutrient management (non-manure) variable rate testing	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	35% already doing this, increase the participation rate to 25% of the farms	# acres using VRT and application, pest management, and spring N application	$12/acre
	Pest management	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Min. 2000 acres tested for nutrients on 2.5 acre grid and follow the recommendations	Spray and control pests at thresholds on the same acres that are the package		
	Working with crop consultants	Continue to build relationships	Continue to build relationships	Continue to build relationships	Continue to build relationships	Continue to build relationships	Work alongside crop consultants to advise proper management of nutrients and pest management		$5,000
	Spring application of N (urea)	Min. of 2,000 acres spring N application	Min. of 2,000 acres spring N application	Min. of 2,000 acres spring N application	Min. of 2,000 acres spring N application	Min. of 2,000 acres spring N application	Encourage landowners to adopt spring-only application of nitrogen to fields using existing/developed relationships		$5,000

Impairment	Practices	Milestones					Long-Term Goals	Assessment	Estimated costs
		2-year (2022)	**4-year (2024)**	**6-year (2026)**	**8-year (2028)**	**10-year (2030)**			
Groundwater	Well sealing	6 wells sealed by a licensed contractor	6 wells sealed by a licensed contractor	6 wells sealed by a licensed contractor	6 wells sealed by a licensed contractor	6 wells sealed by a licensed contractor	Seal all abandoned/unused wells	# of wells sealed	$22,500

7.2 Reductions

Reductions have been calculated using the Spreadsheet Tool for Estimating Pollutant Load (STEPL) for the practices planned (Table 12). Past watershed work was obtained from the MPCA's Healthier Watersheds website to compile data about projects funded by MPCA, BWSR, and NRCS for accountability (https://www.pca.state.mn.us/water/healthier-watersheds). This project information was pulled from projects reported from 2013 to 2018 and is listed in Table 13. It is expected that practices described in this plan (Table 11), along with the estimated reductions from recent watershed work, will achieve load reductions needed to meet water quality standards when fully implemented. The estimated current loads using STEPL for TSS and *E. coli* loads are 15,350 t/yr and 197,616 billion MPN/yr.

Every two years, the progress of the plan will be checked against the milestones to determine any necessary course corrections and milestones will be amended or new ones added. STEPL estimated reductions for TSS and E. coli planned exceed the reduction required by the draft TSS and approved *E. coli* TMDLs. Therefore, we expect the water quality standard and the goals of this plan to be met.

Table 12. Estimated annual reductions for milestone table BMPs calculated by STEPL

	Sediment Reduction t/yr	***E. coli* Reduction Billion MPN/yr**	**TSS Reduction %**	***E. coli* Reduction %**
26,400 ft streambank restoration	2711	616	18	0.3
60 WASCOBs	38	237	0.2	0.1
800 acres treated by grade stabilizations	25	159	0.2	0.1
Cover crops -- 100% of cultivated fields	790	16571	5	8
Conservation tillage--100% of cultivated fields	3040	0.0	20	0.0
10,000 ft grassed waterways	6	40	0.0	0.0
2 bioreactors	2	30	0.0	0.0
Private ditches with buffers--9 miles	2	22	0.0	0.0
100% MN Buffer Law compliance	2104	21543	14	11
Restore 10, 2 acre wetlands	2	12	0.0	0.0
100% rotational grazing	2	616	0.0	0.3
100% cropland following manure land application plans	790	16571	5	8
Cover conservation crops as part of rotational grazing	2	380	0.0	0.2
Perimeter fencing	1	46	0.0	0.0
Drainage management projects (5)	6	40	0.0	0.0
Nutrient management with variable rate testing	0.0	0.0	0.0	0.0
Spring application of N (urea)	32	663	0.2	0.3
Upgrade/replace 73 failing/nonconforming SSTS		159749		
Total planned reductions	9553	217,295		
Total reductions for recently completed work	370	4108		
Total estimated reductions	**9,923**	**221,402**	**65%**	**112%**

Table 13. Estimated annual reductions for completed BMPs calculated by STEPL

	Sediment Reduction t/yr	*E. coli* Reduction Billion MPN/yr	TSS Reduction %	*E. coli* Reduction %
Willow Creek subwatershed				
14 WASCOBs	8.8	55.7	0.1	0.0
Cover crops	12.3	258.5	0.1	0.1
No till	22.1	138.2	0.1	0.1
1 wetland restoration	6.0	47.7	0.0	0.0
Underground outlets (9,931 ft)	5.1	31.8	0.0	0.0
Plum Creek subwatershed				
17 WASCOBs	10.7	67.6	0.1	0.0
Grassed waterways (1)	0.0	0.2	0.0	0.0
Sediment basin (2)	1.3	8.0	0.0	0.0
Conservation cover	2.0	41.4	0.0	0.0
Critical Area Planting	0.2	3.3	0.0	0.0
No till	28.8	180.0	0.2	0.1
Reduced till	28.8	180.0	0.2	0.1
Cover crops	6.5	135.9	0.0	0.1
Drainage Water Mgmt (4)	5.1	31.8	0.0	0.0
Tile inlets (4)	5.1	31.8	0.0	0.0
Grade Stabilizations (4)	5.1	31.8	0.0	0.0
Wetland restoration (4)	6.8	53.6	0.0	0.0
Nutrient management	5.1	107.7	0.0	0.1
Underground outlet (3,795 ft)	1.3	8.0	0.0	0.0
JD20 subwatershed				
No till	107.7	673.1	0.7	0.3
Cover crops	94.2	1976.9	0.6	1.0
5 WASCOBs	3.2	19.9	0.0	0.0
Grassed waterways (2)	0.2	1.0	0.0	0.0
Drainage Water Mgmt (1)	1.3	8.0	0.0	0.0
Tile inlets (1)	1.3	8.0	0.0	0.0
Grade Stabilizations (1)	1.3	8.0	0.0	0.0
Total estimated reductions	**369.9**	**4107.9**	**2.4%**	**2.1%**

Table 14. Net estimated reductions from milestone table and completed table BMPs

	Sediment Reduction t/yr	E. coli Reduction Billion MPN/yr	TSS Reduction %	E. coli Reduction %
Milestone table	9923	221,402	--	--
Completed BMPs	369.9	4,107.9	--	--
Overlap between milestone and completed BMPs	-163.9	-2689.5	--	--
Total net reductions	10,129	222,821	66%	113%

7.3 Streambank stabilization

Five stream stabilization projects along Plum Creek are needed to stabilize stream and ditch banks and protect personal property. The anticipated time frame for the projects is 2016-2020 (Redwood County SWCD 2016). The Plaetz Project, located in North Hero Township, Section 10 is provided in Figure 15. Milestones and goals are described in Table 11.

Figure 16. Plaetz Project–shoreline and streambank stabilization (NRCS code 580)

7.4 Agricultural BMPs

Several water and sediment control basins (WASCOBs) and grade stabilization structures are sited to address sediment loading from cropland runoff. WASCOBs (NRCS code 638) and grade stabilization structures (NRCS code 410) are embankments that restrict flow through a waterway. Placed perpendicular to flow paths, these berms slow overland flow and reduce soil erosion, suspended sediment loads, and sediment-bound particle loads, such as attached phosphorus, from agricultural land. These plans, including identification of landowners, are with the SWCD. Due to privacy concerns, these will not be included with this NKE Plan.

In addition to these specific projects, additional BMP opportunities have been mapped using ACPF (Srinivas et al. 2019). These maps are on file with the SWCD, but will not be included in this NKE Plan due to explicit identification of private landowners. ACPF-sited BMPs provide a good starting point to further evaluate the watershed. The following BMPs are mapped using ACPF:

- Erosion control practices (Figure 17) such as contour buffer strips and grassed waterways collect and trap sediment and sediment-bound nutrients, and bacteria from surface runoff
- Bioreactors (Figure 18) target dissolved forms of nutrients and are not effective at sediment removal
- Nutrient removal wetlands (Figure 18) target nutrients and sediment
- Drainage management practices (Figure 19) reduce volume and dissolved nutrient transport rates

Figure 17. ACPF outputs: contour buffer strips and grassed waterways (Srinivas et al. 2019)

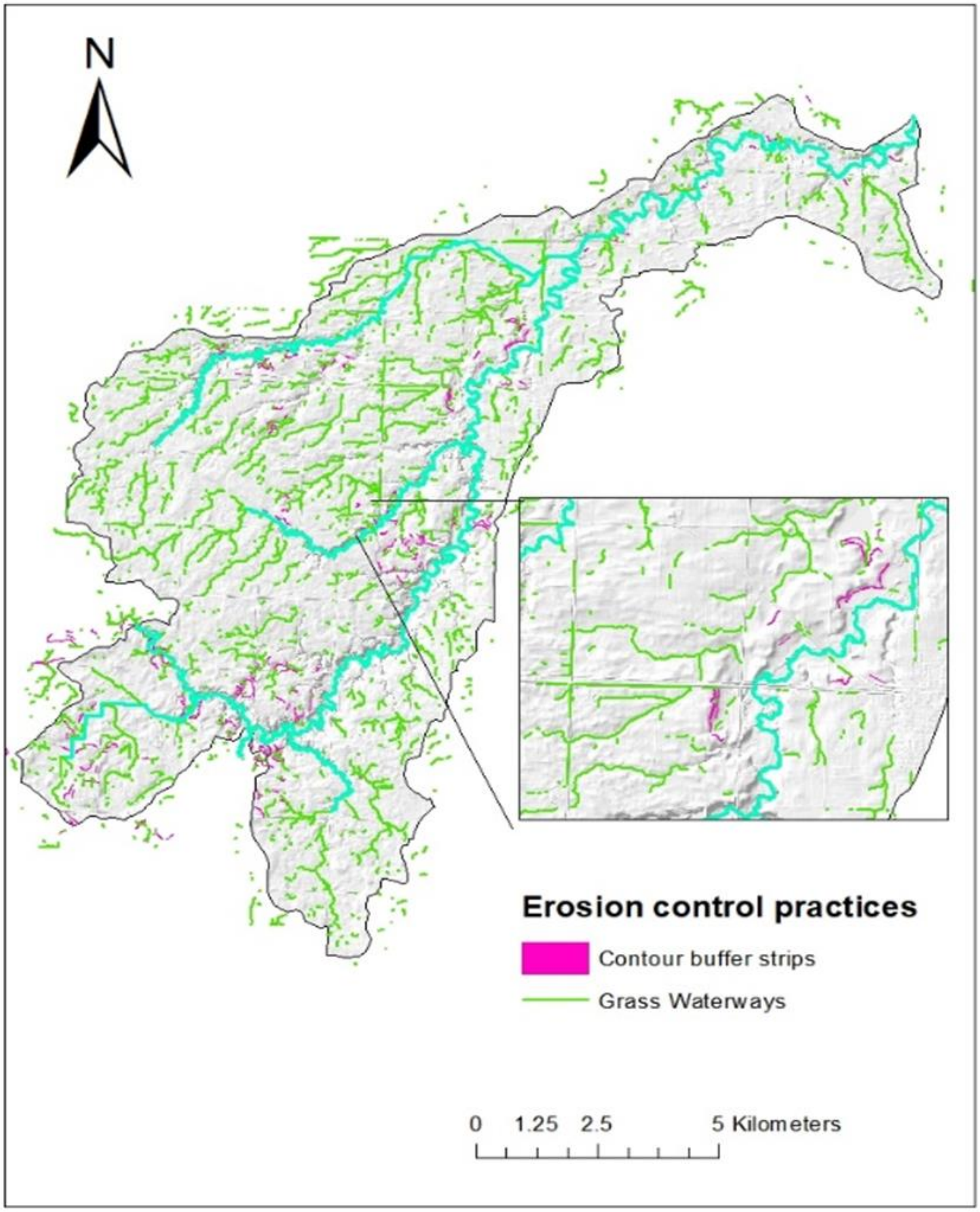


Figure 18. ACPF outputs: bioreactors and nutrient removal wetlands (Srinivas et al. 2019)

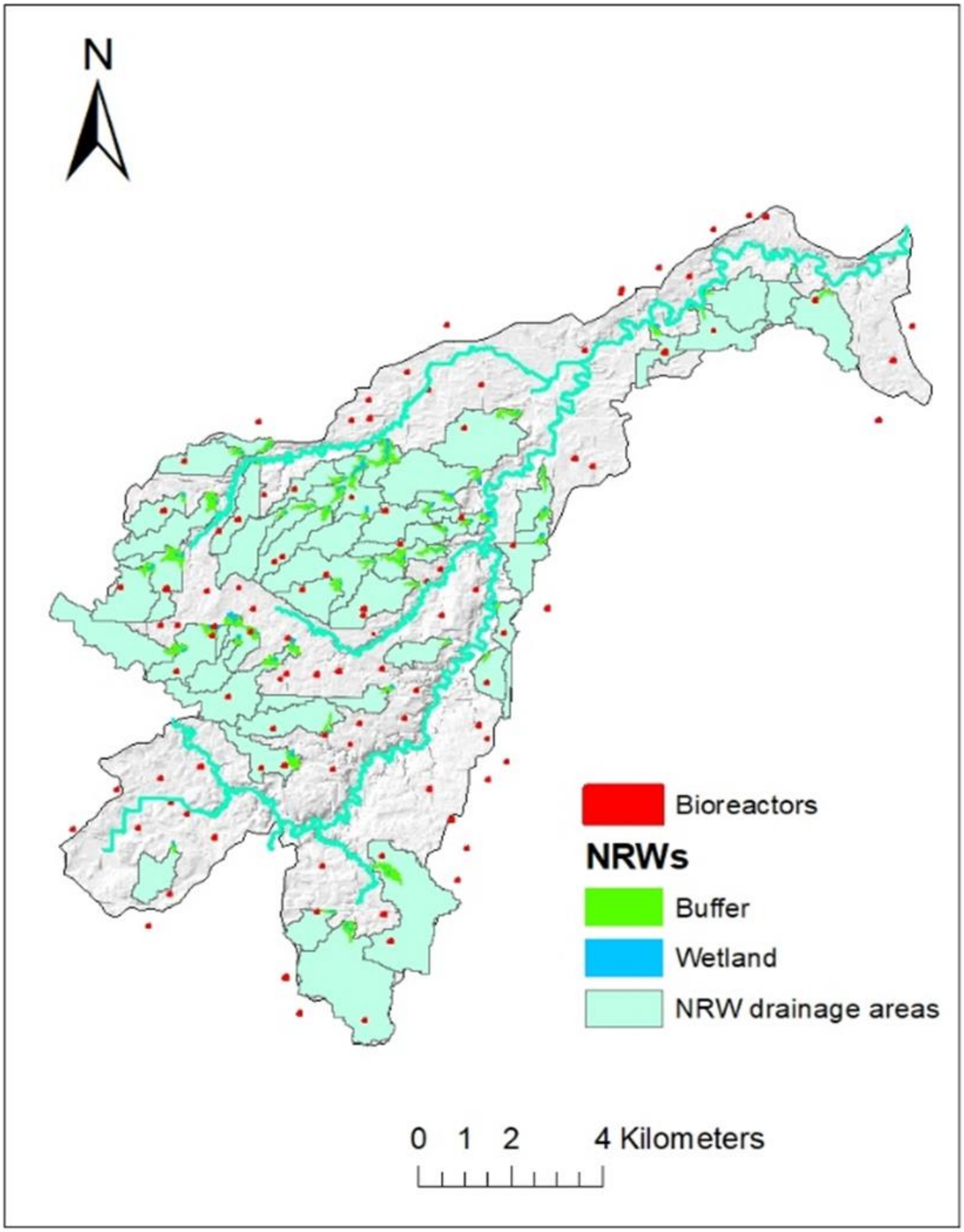
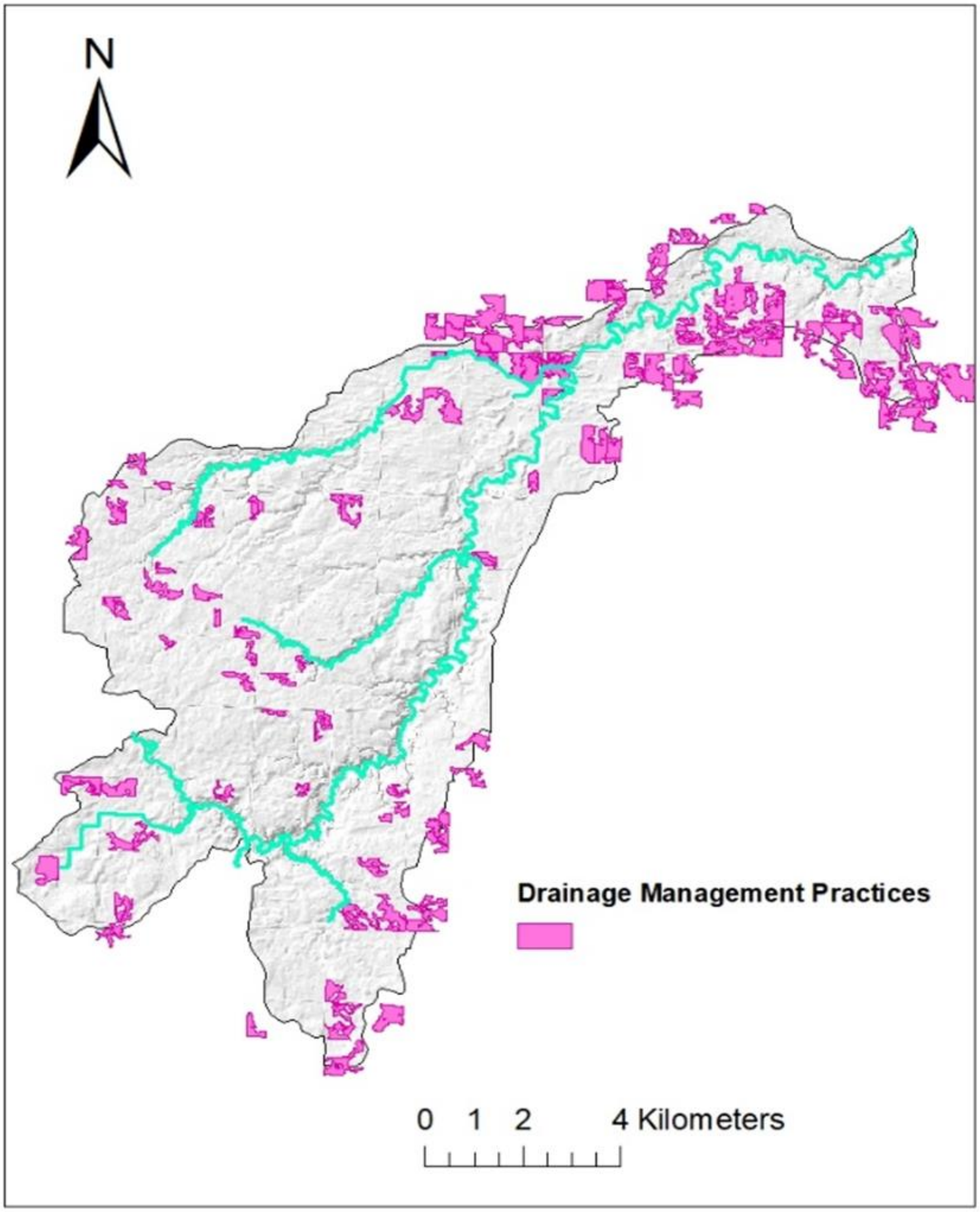


Figure 19. ACPF outputs: drainage water management practices (Srinivas et al. 2019)



7.5 Livestock and Manure Management

Livestock and livestock manure are a potential source of fecal bacteria (e.g., fecal coliform, *E. coli*), sediment, and nutrients to streams, particularly when direct access is not restricted and where feeding structures are located near riparian areas.

BMPs that can be used to limit pollutant loading from livestock and livestock manure.

Exclusion fencing limits or eliminates livestock access to a stream or waterbody. Fencing can be used with controlled stream crossings to allow livestock to cross a stream while minimizing disturbance to the stream channel and streambanks. Providing alternative water supplies for livestock allow animals to access drinking water away from the stream, thereby minimizing the impacts to the stream and riparian corridor. Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90% less time in the stream when alternative drinking water is furnished (EPA 2003). EPA (2003) estimates that fecal coliform reductions from 29-46% can be expected; sediment and nutrient load reductions are also achieved.

Manure land application

Nutrient management strategy (e.g., the 4Rs: Right Source, Right Rate, Right Time, Right Place)

Filter strips and grassed waterways

7.6 SSTS Compliance

SSTS were identified as a source of fecal coliform to Plum Creek (Redwood-Cottonwood Rivers Control Area 2013). In addition, SSTS can contribute nutrients to nearby waterways. SSTSs can fail for a variety of reasons, including excessive water use, poor design, physical damage, and lack of maintenance. Common limitations that contribute to failure include seasonal high water table, fine-grained soils, bedrock, and fragipan (i.e., altered subsurface soil layer that restricts water flow and root penetration). SSTSs can fail hydraulically through surface breakouts or hydro-geologically from inadequate soil filtration. Failure potentially results in fecal bacteria discharges and higher levels of phosphorus loading.

Septic systems that are conforming and are appropriately sited are assumed to not contribute fecal bacteria to surface waters but still discharge small amounts of phosphorus. Failing septic systems do not protect groundwater from contamination.

The most cost-effective BMP for managing loads from septic systems is regular maintenance. EPA recommends that septic tanks be pumped every 3 to 5 years depending on the tank size and number of residents in the household (EPA 2002). When not maintained properly, septic systems can cause the release of pathogens, as well as excess nutrients, into surface water. Annual inspections, in addition to regular maintenance, ensure that systems are functioning properly. An inspection program would help identify those systems that are currently connected to tile drain systems or storm sewers and those that may be failing. Inspections would also help determine if systems discharge directly to a waterbody ("straight pipe").

8. Education and outreach

Information and education activities recommended for the Plum Creek Watershed in existing reports include:

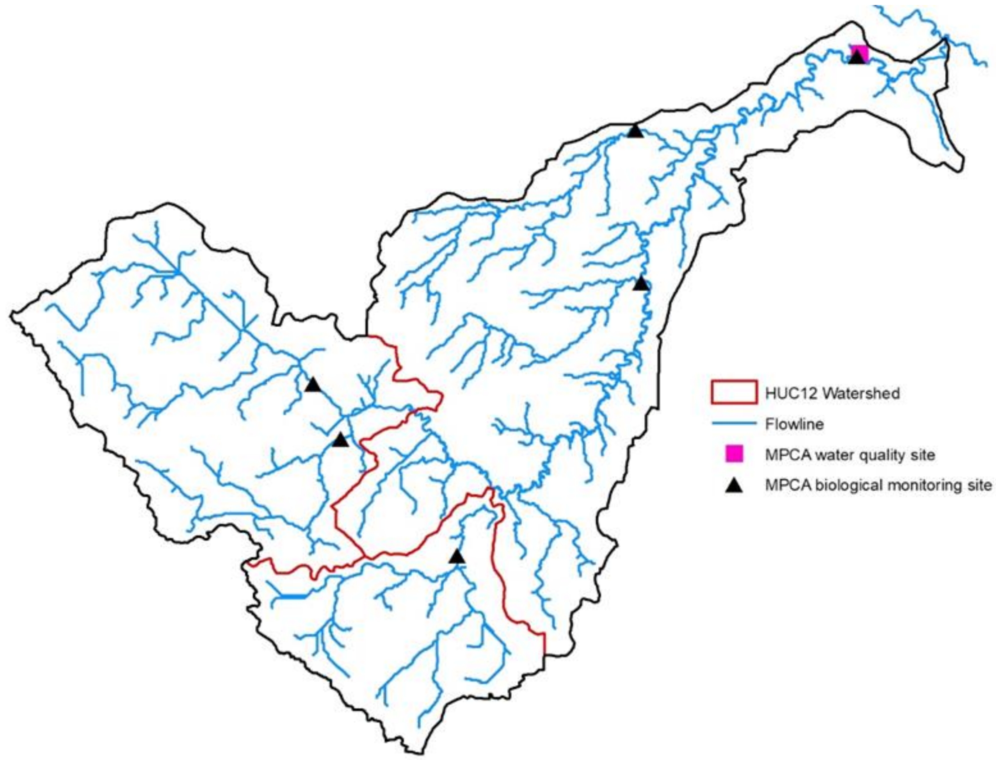
- Hold workshops on topics such as cover crops that show the importance of reducing soil erosion and improving soil health
- Send letters to landowners on the importance of wise land uses such as: nutrient management, pest management, septic compliance or solid waste handling, and others
- Publish annual newsletter and news articles to address water quality and other conservation concerns
- Work with local newspapers to show success stories of practices that reduce pollutant loading
- Provide educational materials to homeowners and contractors on the impact to water quality and human health from septic systems hooked to tile lines and/or outlet to surface water
- Have displays at fairs, Farmfest, and other events
- Participate in the Environmental Fair that provides educational opportunities for 5th and 6th graders on environmental issues
- Hold public informational gathering meeting(s) each year to gather producer concerns and ideas
- Continue hosting educational opportunities including, 4-H camps, environmental fairs, SWCD Women's Agricultural Day, river ecology education events, and others

9. Monitoring

Monitoring in the context of this plan will include elements of various on-going programs and Plum Creek Watershed-specific activities.

The MPCA will begin its second cycle of HUC8-scale intensive watershed monitoring (IWM) in the Cottonwood River Watershed in 2026. The HUC8 monitoring is conducted on a ten-year cycle. The MPCA biological monitoring sites in the Plum Creek Watershed will be sampled for fish, macroinvertebrates, habitat, and water chemistry. At least one water chemistry monitoring site will be sampled as part of IWM with the potential of additional sites being selected through the state and local need selection process conducted prior to IWM monitoring. The IWM monitoring is conducted to provide data for the assessment of aquatic life and recreation uses once every ten years and to eventually provide long-term data for trend analysis.

Figure 20. MPCA IWM monitoring sites



Implementation activities will be tracked using the BWSR eLink database for state and Section 319-funded activities. Implementation activities funded by the USDA are tracked using their database. Field measurements, preliminary and final engineering designs, as-built plans, and photographs will be used to document the improvement in streambank activities. Field measurements will include streambank and streambed profile measurements and field observations to track streambank changes over time due to streambank erosion and subsequent restoration activities.

Changes in land cover and land use not associated with BMP implementation will be tracked using visual observations, field measurements, and aerial imaging.

A stream flow and water quality monitoring site near the mouth of Plum Creek will be established. The site will provide the data needed to determine progress toward and eventual achievement of the TSS and *E. coli* water quality standards. The site will include continuous water level, turbidity, and temperature monitoring, development and maintenance of a streamflow rating curve, routine field measurements, and discrete water sampling and laboratory analysis. A second stream flow and water quality monitoring site on Plum Creek downstream of the upper HUC12 watersheds is proposed to further the performance evaluation monitoring for the watershed. Discrete water samples will be collected on a storm event basis, targeting minimum of 25 samples per year. Lab analysis will include TSS, *E. coli*, TP, and nitrate. Field measurements will include turbidity, Secchi tube transparency, temperature, DO, and specific conductivity. Streamflow and water quality sampling will provide load calculations to evaluate for load reductions and the effectiveness of the practices implemented in the Plum Creek Watershed.

Yearly biological monitoring will be completed, if resources are available. Stream habitat and geomorphology monitoring will be completed in conjunction with the flow, chemistry, and biology monitoring. The estimated cost of conducting this monitoring for ten years is $370,000 (Table 15).

A citizen monitoring program will be pursued using the MPCA Citizen Stream Monitoring Program (https://www.pca.state.mn.us/water/citizen-water-monitoring). Volunteers measure water clarity at least twice a month each summer at designated locations using a Secchi tube. The data can then be correlated with TSS concentrations and be used as an indicator of sediment in the stream. The goal for the watershed partners is to get four volunteer monitoring sites established in the watershed.

Table 15. Monitoring costs in Plum Creek Watershed

Monitoring type	Description	Unit cost (annual)	Total (10-years)
Streamflow and water quality sampling and analysis	0.1 FTE for 2 sites 0.1 FTE for data analysis Lab costs/site Equipment/2 sites	$10,000 $10,000 $2,000 $5,000/site	$230,000
Biological monitoring	0.1 FTE for 10 sites 2-4 person crew and data analysis	$10,000	$100,000
Habitat and stream geomorphology	0.2 FTE (2 times per 10-year period)	$20,000	$40,000
Total			**$370,000**

10. Financial and technical resources

Implementation of the Plum Creek NKE Plan will require additional financial and technical resources. A list of existing funding sources available to support implementation is provided in Table 14.

Table 16. Partial list of funding sources for restoration and protection strategies

Sponsor or information source	Program description
MPCA	**Section 319 Grants:** Federal grant funding from the EPA as part of the Clean Water Act, Section 319. Grants awarded by MPCA to local governmental units and other groups are to address nonpoint source pollution through implementation projects. **Clean Water Partnership Loan**: The state funded Clean Water Partnership Program awards no-interest loans to local governmental units for work on projects that address nonpoint source pollution. **Clean Water State Revolving Fund:** Provides loans to for both point source (wastewater and stormwater) and nonpoint source water pollution control projects.
BWSR	**Clean Water Fund Competitive Grants:** These grants are to restore, protect, and enhance water quality. Eligible activities must be consistent with a comprehensive watershed management plan, county comprehensive local water management plan, soil and water conservation district comprehensive plan, metropolitan local water plan or metropolitan groundwater plan that has been State approved and locally adopted or an approved TMDL, WRAPS document, surface water intake plan, or well head protection plan. **Targeted Watershed Demonstration Program:** This program awards grants to local governments organized for the management of water in a watershed or subwatershed where multiyear plans that will result in a significant reduction in water pollution in a selected subwatershed are in place. **The Erosion Control and Water Management Program**, commonly known as the State Cost-Share Program: This program provides funds to Soil and Water Conservation Districts to share

Sponsor or information source	Program description
	the cost of systems or practices for erosion control, sedimentation control, or water quality improvements that are designed to protect and improve soil and water resources. Through this program, land occupiers can request financial and technical assistance from their local SWCD for the implementation of conservation practices.
Minnesota Department of Agriculture (MDA)	**AgBMP Loan Program:** This program encourages implementation of BMPs that prevent or reduce pollution problems, such as runoff from feedlots, erosion from farm fields and shoreline, and noncompliant septic systems and wells. MDA provides a wide array of other information from their agency as well as other state and federal agencies on conservation programs addressing agriculture and other land uses. In addition, Clean Water Research Projects are available for funding.
Minnesota DNR	**DNR grants** are available for a variety of programs relating to land preservation, wildlife and habitat, native prairie, forestry and wetlands.
USDA NRCS	**Environmental Quality Incentives Program:** A voluntary program to implement conservation practices, or activities, such as conservation planning, that address natural resource concerns for agricultural producers. **Conservation Reserve Program – Continuous Signup:** A USDA Farm Service Agency-funded voluntary program designed to help farmers restore and protect environmentally sensitive land—particularly wetlands, wildlife habitat and water quality buffers. **Conservation Stewardship Program:** A voluntary program to improve resource conditions such as soil quality, water quality, water quantity, air quality, habitat quality, and energy.

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Appendix A
STEPL assumptions and practices

The STEPL was used to estimate TSS and *E. coli* loads and reductions for the watershed. The loads estimated in STEPL were comparable with the loading that was estimated using HSPF-SAM for the development of the draft TMDLs in the watershed. Each of the tools indicated that approximately 70% of the TSS loading is from bed and bank and between 20 to 25% of the overland loading is from cropland.

The reductions for BMPs identified in the ten-year milestone table were summed and entered as individual practices in STEPL. The reductions for BMPs implemented between 2013 and 2018 were estimated in the same way. Reduction efficiencies for *E. coli* were assumed from MPCA (2011) and Wright Water Engineers, Inc. (2010) and added to the "BMPList" worksheet in STEPL. The practices and assumed reduction efficiencies are shown in Table 17. The BMPs with area and percent of watershed treated and assumptions made for STEPL are described in Table 18. The treatment efficiencies for the BMPs that are not in the original list of BMPs and reduction efficiencies (BMPList) in STEPL were assigned based on the similarity of the treatment processes with selected BMPList practices.

Table 17. Land use, BMPs, and efficiencies for STEPL

Land use	BMP & Efficiency	Sediment	*E. coli*
Cropland	Bioreactor	0.533	0.9
Cropland	Buffer - Grass (35ft wide)	0.533	0.65
Cropland	Conservation cover planting	0.2	0.5
Cropland	Conservation Tillage 2 (equal or more than 60% Residue)	0.77	ND
Cropland	Cover Crop 3 (Group A Traditional Early Planting Time) (High Till only for TP and Sediment)	0.2	0.5
Cropland	Critical Area Planting	0.2	0.5
Cropland	Drainage water management	0.4	0.3
Cropland	Grade stabilization	0.4	0.3
Cropland	Grassed waterways	0.4	0.3
Cropland	Manure Land Application	0.2	0.5
Cropland	Nutrient Management 2 (Determined Rate Plus Additional Considerations)	ND	ND
Cropland	Sediment basin	0.4	0.3
Cropland	Spring application of N (Urea)	0.2	0.5
Cropland	Tile inlets	0.4	0.3
Cropland	Underground outlet	0.4	0.3
Cropland	Water and sediment control basin	0.4	0.3
Cropland	Wetland restoration	0.95	0.9
Pastureland	Cover crops and conservation tillage in rotational grazing	0.2	0.5
Pastureland	Perimeter fencing	0.575	0.3
Pastureland	Rotational grazing	0.187	0.65

Table 18. Percent watershed treated and assumptions for milestone and completed BMPs as STEPL inputs

Acres	BMPs	% of land treated	Assumptions
1,200	WASCOBs	2.4%	Assume same efficiencies as STEPL practice Terrace, created water and sediment control basin practice, assume 20 acres treated per WASCOB
800	Grade Stabilizations	1.6%	Assume same efficiencies as STEPL practice Terrace
	Cover crops	100.0%	Assume same efficiencies as STEPL practice Cover Crop 3
	Conservation tillage	100.0%	Assume same efficiencies as STEPL practice Conservation Tillage 2
200	Grassed waterways	0.4%	Assume 1,000 ft of grass waterways treats 20 acres
40	Bioreactors	0.1%	Assume 20 acres treated per STEPL practice bioreactor
38	9 miles of private ditches buffers	0.1%	Assume 47,520 feet of 35' Buffer = 38 acres as STEPL practice grassed buffer
	100% buffer compliance	100.0%	Assume 100% treated as STEPL practice grassed buffer 35' wide
20	Restore 10, 2 acre wetlands	0.0%	Assume 40 acres treated per acres of wetland, created wetland practice as same efficiencies as STEPL practice Land Retirement
460	60% of pasture in rotational grazing plan	100.0%	Assume same efficiencies as STEPL practice pastureland Perimeter Fencing as part of rotational grazing plan, assume same efficiencies as STEPL practice Grazing Land Management (rotational graze with fencing)
768	Manure land application plans	100.0%	Assume the same efficiencies as STEPL practice Nutrient Management 1, created Manure application
80	Cover conservation crops as part of rotational grazing	10.4%	Assume this has the same efficiencies as STEPL practice cropland Critical Area Planting. Created pastureland Cover crops and conservation tillage in rotational grazing practice in STEPL
120	Perimeter fencing	15.6%	Assuming same efficiencies as STEPL practice Stream Protection w/out fencing, created pastureland Perimeter fencing
200	Drainage management projects (5)	0.4%	Assuming same efficiencies as STEPL practice Terrace, with 40 acres treated per project
2,000	Nutrient management with variable rate testing	4.0%	Assuming same efficiencies STEPL practice Nutrient management 2
2,000	Spring application	4.0%	Assuming same efficiencies as STEPL practice Nutrient management 1, created Spring application
280	WASCOB	0.6%	Assume same efficiencies as STEPL practice Terrace, created water and sediment control basin practice, assume 20 acres treated per WASCOB

Acres	BMPs	% of land treated	Assumptions
773	Cover crops	1.6%	Assume same efficiencies as STEPL practice Cover Crop 3
691	No till	1.4%	Assume same efficiencies as STEPL practice Conservation Tillage 2
2	Wetland restoration	0.2%	Assume same efficiencies as STEPL practice Land Retirement, assume 40 acres treated per acre of wetland
160	Underground outlet	0.3%	Assume same efficiencies as STEPL practice Terrace
340	WASCOB	0.7%	Assume same efficiencies as STEPL practice Terrace, created water and sediment control basin practice, assume 20 acres treated per WASCOB
1	Grassed water	0.0%	Assume same efficiencies as STEPL practice Terrace, 1000 ft of grass waterways treats 20 acres
40	Sediment basin	0.1%	Assume same efficiencies as STEPL practice Terrace
123	Conservation cover	0.2%	Assume same efficiencies as STEPL practice Cover Crop 3
1	Critical Area Planting	0.0%	Assume same efficiencies as STEPL practice as Cover Crop 3
901	No till	1.8%	Assume same efficiencies as STEPL practice Conservation Tillage 2
901	Reduced till	1.8%	Assume same efficiencies as STEPL practice Conservation Tillage 2
407	Cover crops	0.8%	Assume same efficiencies as STEPL practice Cover Crop 3
160	Drainage Water Management	0.3%	Assume same efficiencies as STEPL practice Terrace
160	Tile inlets	0.3%	Assume same efficiencies as STEPL practice Terrace
160	Grade Stabilization	0.3%	Assume same efficiencies as STEPL practice Terrace
44	Wetland restoration	0.1%	Assume same efficiencies as STEPL practice Land Retirement, assume 40 acres treated per acre of wetland
44	Wetland restoration	0.1%	Assume same efficiencies as STEPL practice Land Retirement, assume 40 acres treated per acre of wetland
324	nutrient management	0.7%	Assume same efficiencies as STEPL practice as Nutrient Management 2
40	Underground outlet	0.1%	Assume same efficiencies as STEPL practice Terrace
3,366	No till	6.8%	Assume same efficiencies as STEPL practice as Conservation Tillage 2
5,930	Cover crops	11.9%	Assume same efficiencies as STEPL practice Cover Crop 3
100	WASCOB	0.2%	Assume same efficiencies as STEPL practice Terrace, created water and sediment control basin practice, assume 20 acres treated per WASCOB

Acres	BMPs	% of land treated	Assumptions
3	Grassed water	0.0%	Assume same efficiencies as STEPL practice Terrace, assume 1000 ft of grass waterways treats 20 acres
40	Drainage Water Management	0.1%	Assume same efficiencies as STEPL practice Terrace
40	Tile inlets	0.1%	Assume same efficiencies as STEPL practice Terrace
40	Grade Stabilization	0.1%	Assume same efficiencies as STEPL practice Terrace

The reductions for replacing and/or upgrading failing or non-conforming SSTS were estimated using the STEPL septic tab. Outputs from this worksheet are described in Table 19.

Table 19. STEPL output for SSTS *E. coli* load reductions

1. Nutrient load from septic systems

Watershed	No. of SSTS	Pop per SSTS	SSTS Failure Rate %	Failing SSTS	Pop on Failing SSTS	Failing SSTS Flow gal/day	Failing SSTS Flow l/hr	N Load, lb/hr	P Load, lb/hr	BOD, lb/hr	*E. coli*, MPN/hr
Plum Creek	239	2.43	30	72	174	12196	1924	0.254	0.100	1	1.823×10^{10}

2. Septic nutrient load in lb/yr except *E. coli* in MPN/yr)					**Load after reduction**				
Watershed	**N Load lb/yr**	**P Load lb/yr**	**BOD lb/yr**	***E. coli* MPN/ yr**	**N Load lb/yr**	**P Load lb/yr**	**BOD lb/yr**	***E. coli* MPN/yr**	***E. coli* Billion MPN/yr**
Plum Creek	2229	873	9102	1.597×10^{14}	22292	873	9102	1.597×10^{14}	159,749

Assumptions made for SSTS

The direct contribution of nutrients to a stream is mainly from failing septic systems.

Required input for calculating septic nutrient load are number of systems, failure rate, loading rate (lb/hr) and flow (cfs).

Assumption: failing septic systems are distributed evenly across the watershed based on land area.

Assume the average concentrations reaching the stream (from septic overcharge) are:		
Total Nitrogen	60	mg/L (range of 20 to 100)
Total Phosphorus:	23.5	mg/L (range of 18 to 29)
Organics (BOD):	245	mg/L (range of 200 to 290)
*E. coli **	948,000	MPN/100ml
Typical septic overcharge flow rate of:	70	gal/day/person(range of 45 to 100)

** E. coli* effluent # assumed to be 948,000 as equivalent from the BWSR Septic System Improvement Estimator Tool (Heger 2017) assumption