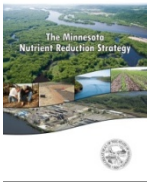
September 2015

Acknowledgements

Research in the document is based on multiple agencies and researchers across Minnesota who have been working together to develop Minnesota's Nutrient Reduction Strategy. Watershed based information can be found in the Minnesota Nutrient Planning Portal which is organized by 81 watersheds across the state.

Minnesota Nutrient Reduction Strategy
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/nutrient-reduction/nutrient-reduction-strategy.html



Minnesota Nutrient Planning Portal
http://mrbdc.mnsu.edu/mnnutrients/

MINNESOTA NUTRIENT PLANNING PORTAL

This nutrient pilot project is a collaboration among:

Dakota County SWCD
Curt Coudron
Brad Becker

Cannon River Watershed Partnership
Beth Kallestad
Paul Wotzka

Minnesota Pollution Control Agency
Wayne Anderson
Dave Wall

Water Resources Center, Minnesota State University, Mankato
Kimberly Musser
Jessica Nelson
Andrew Meyer
Rick Moore

The subwatershed analysis is based on Agricultural Conservation Planning Framework developed by Mark Tomer, David James and Sarah Porter from the USDA National Laboratory for Agriculture and the Environment

Funding provided by the Minnesota Pollution Control Agency.

Table of Contents

Executive Summary

Nutrient Reduction Strategy

The Minnesota Pollution Control Agency recently released the Minnesota Nutrient Reduction Strategy (NRS) in Sept 2014 to guide the state in reducing excess nutrients in waters so that in-state and downstream water quality goals are ultimately met. The state-level nutrient reduction strategy is meant to establish a large-scale big picture framework, under which fits individualized watershed planning. While the NRS is written initially to establish the large scale framework it acknowledges that for the goals and actions to be effective it will need to be relevant and works at three scales.

- Federal and state planning and program management. This level is strategic and is responsible for managing large-scale goals and results.
- The local scale consists of watershed planning and implementation assistance delivery.
- The third scale is the decision level and consists of nutrient source decision makers, and especially farm managers and city decision makers.

How much reduction is needed?

To do its fair share for the Gulf of Mexico, Minnesota needs a 45 Percent reduction in nitrogen and phosphorus to the Mississippi River compared with loading occurring prior to the year 2000. City wastewater treatment improvements and other rural and urban sources have substantially reduced phosphorus; however, more work is needed to reach the following targets:

- Achieve a progress milestone of a 20 percent nitrate load reduction by 2025 (45 percent by 2040).
- Reduce phosphorus by 45 percent in nearly 500 lakes impaired for eutrophication (algae growth).
- More than 40 percent reduction in phosphorus for many eutrophication-impaired Minnesota rivers.
- Reduce nitrate to meet standards for thousands of wells and some cold water streams.

Nutrient Pilots

The purpose of the Nutrient Reduction Strategy Pilot Projects is to explore some ground-truthing at the local level. In 2013, project partners reached out to local partners across the state to better understand what types of information would be helpful for nutrient planning and how we could enhance watershed scale information exchange. This resulted in the Minnesota Nutrient Planning Portal, a website that synthesizes and organizes information by watershed (HUC 8) in a manner designed to meet the needs of local decision-making for accelerating the pace of nutrient planning across the state.

The Nutrient Pilots Project takes this process a step further and focuses in on three watersheds of the state. The goal was to work with stakeholders from three pilot project areas to document and learn more about their goals, process, social readiness, and outreach efforts. The pilots focus in on subwatersheds in Le Sueur, Root and Cannon River Watersheds. Each of these pilots are embedded in the Minnesota Water Management Framework, the watershed planning approach that assesses, restores and protects waters. This approach sets a 10-year cycle of water assessments, watershed restoration and protection strategy (WRAPS) development at the hydrologic unit code 8 (HUC8) watershed level, and local water planning (e. g., One Watershed One Plan). We hope that these pilots

can provide a snapshot view from 2015 and help to inform and add value to the longer term and larger scale planning processes occurring in these watersheds.

Cannon River Watershed – Trout Brook Subwatershed Pilot

Dakota County SWCD has a long history of engaging citizens in this region. Staff has been working one-on-one with landowners in the Trout Brook area for over 20 years. Historically, Dakota County used a first come, first serve approach to landowners seeking conservation assistance. They are now changing their outreach approach, networking with landowners on a more targeted, subwatershed approach. Next steps to target BMPs in Trout Brook include a desktop analysis with the ACPF Tool. Broadly, Dakota SWCD staff commented about the potential time-savings that this type of GIS tool can offer. After potential areas were identified, field work was performed in spring and early summer 2015 while crops were short. Based on field and GIS measurements and construction costs based on similarly completed projects, they created a table of projects based on the cost-benefit table of each of the BMPs that was deemed practical. Next step is to finalize and rank the list of potential projects based on potential pollutant removal, and costs per project.

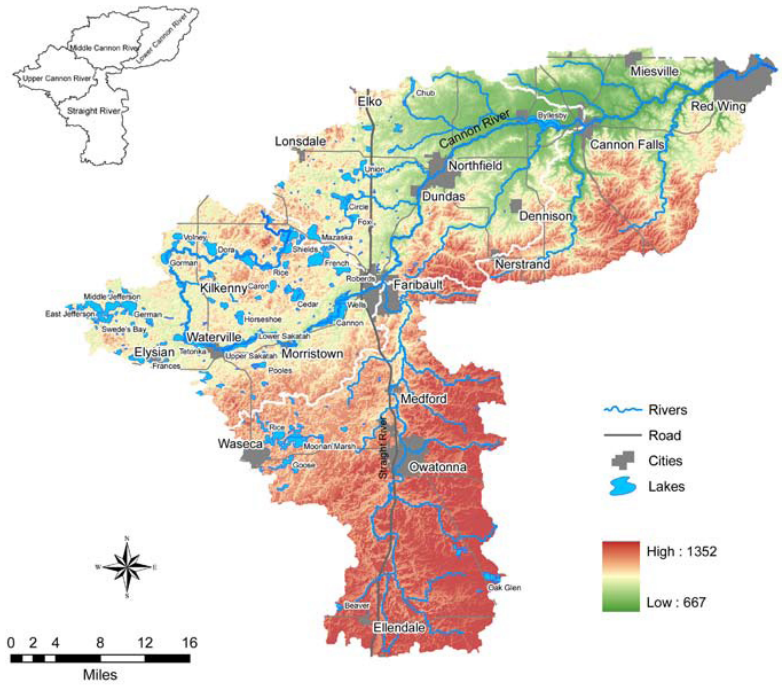
Dakota SWCD staff will reach out to landowners to discuss BMP options in targeted areas. Dakota County SWCD is currently developing its landowner outreach strategy. It will be built upon the long-term relationships that staff has developed over the years. Dakota County SWCD staff will promote cover crops and Nitrogen reduction through fertilizer management as well as to apply for other funding sources to support BMP implementation over the upcoming years.

Cannon River Watershed

Overview

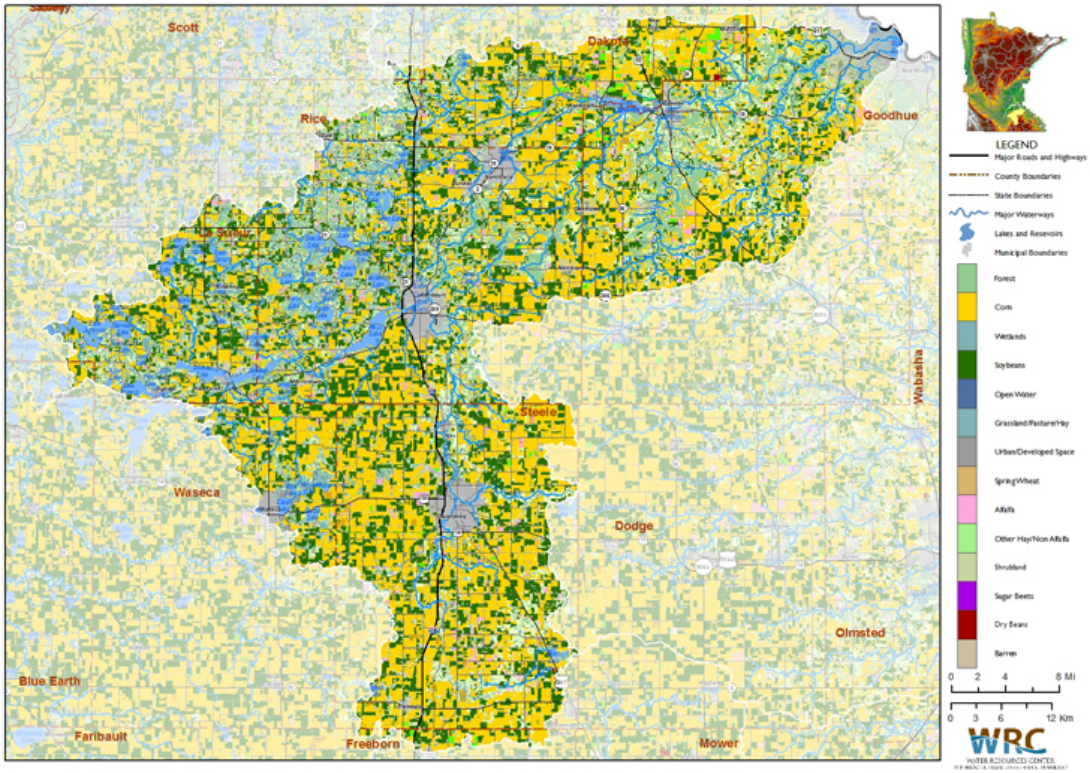
The Cannon River Watershed lies in southeast Minnesota and covers portions of nine counties. It encompasses approximately 941,000 acres (1,460 square miles). The watershed has two main channels, the Cannon and Straight Rivers, and drains into the Mississippi at Red Wing. Larger cities include Northfield, Faribault, and Owatonna. Major lakes include: Byllesby, Jefferson, Tetonka, and Cannon. Major rivers and streams include: Cannon, Straight, Little Cannon River, Trout Brook, and Rice Creek.

The topography varies across the watershed, from flat and undulating hills in the Straight River lobe, the lake-rich headwaters to the Cannon River, to flat headwater land and steep forested hills in the Middle and Lower Cannon River lobes of the watershed (MPCA, 2014).



River courses within the Cannon River Watershed.

Land Use



CANNON RIVER MAJOR WATERSHED - LAND USE

The Cannon River Watershed is comprised of a variable mix of agriculture, forest, and developed land. Agriculture is the dominant land use (76.3%), consisting of cropland (60.5%) and rangeland (15.7%). Cropland is used predominantly for growing corn and soybeans.Forest (9.4%) and wetland (3.1%) comprise 12.5%. Developed land (e.g., industrial land use, urban and rural housing, roads) is 8.4%. Open water (e.g., lakes, rivers, streams, ditches) accounts for 2.9% (Cannon River Monitoring and Assessment).

Water Quality Monitoring

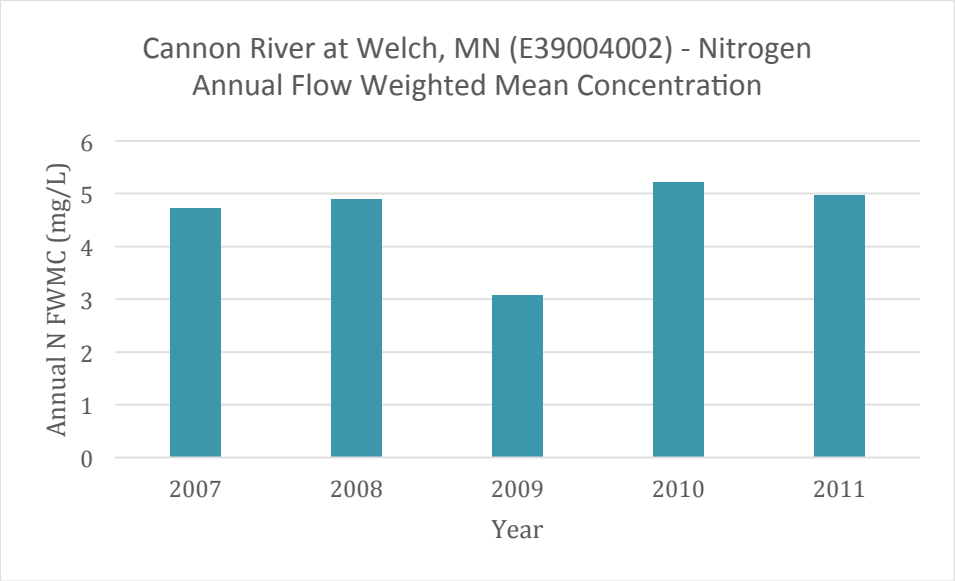
Watershed Pollutant Load Monitoring Network

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term program designed to measure and compare regional differences and long-term trends in water quality among Minnesota's major rivers including the Red, Rainy, St. Croix, Mississippi, and Minnesota, and the outlets of the major tributaries (8 digit HUC scale) draining to these rivers.

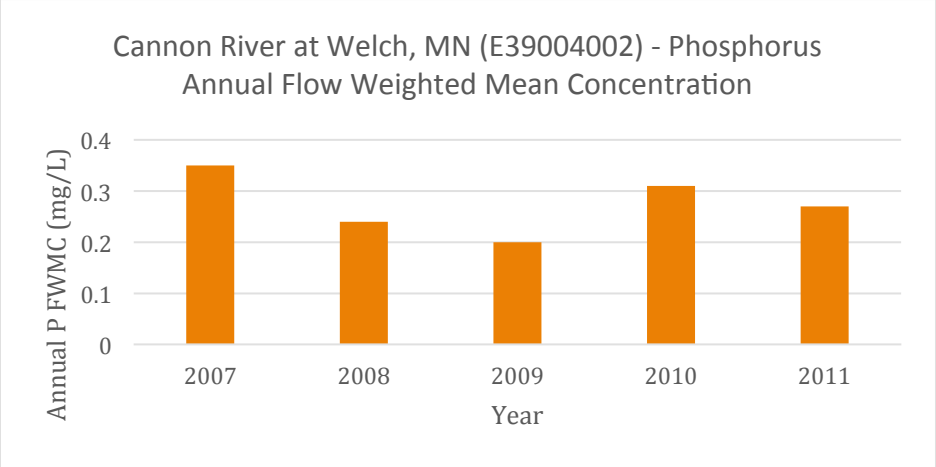
The WPLMN is designed to obtain spatial and temporal pollutant load information from Minnesota's rivers and streams and track water quality trends. Site-specific stream flow data from United States Geological Survey and Minnesota Department of Natural Resources is combined with water quality data collected by the MPCA, local units of government, state universities, nonprofit organizations and Metropolitan Council Environmental Services to compute annual pollutant loads at river monitoring sites across Minnesota.

The WPLMN has a site on the Cannon River at Welch, MN.

Cannon River Nitrogen (WPLMN)



Cannon River Phosphorus (WPLMN)



Intensive Watershed Monitoring

The Cannon River Watershed is engaged in Minnesota Pollution Control Agency's (MPCA) intensive watershed monitoring strategy which utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse to a fine scale. Each of the 81 major watersheds (8-HUC) within Minnesota will use this approach within the 10-year cycle. Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. Smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach.

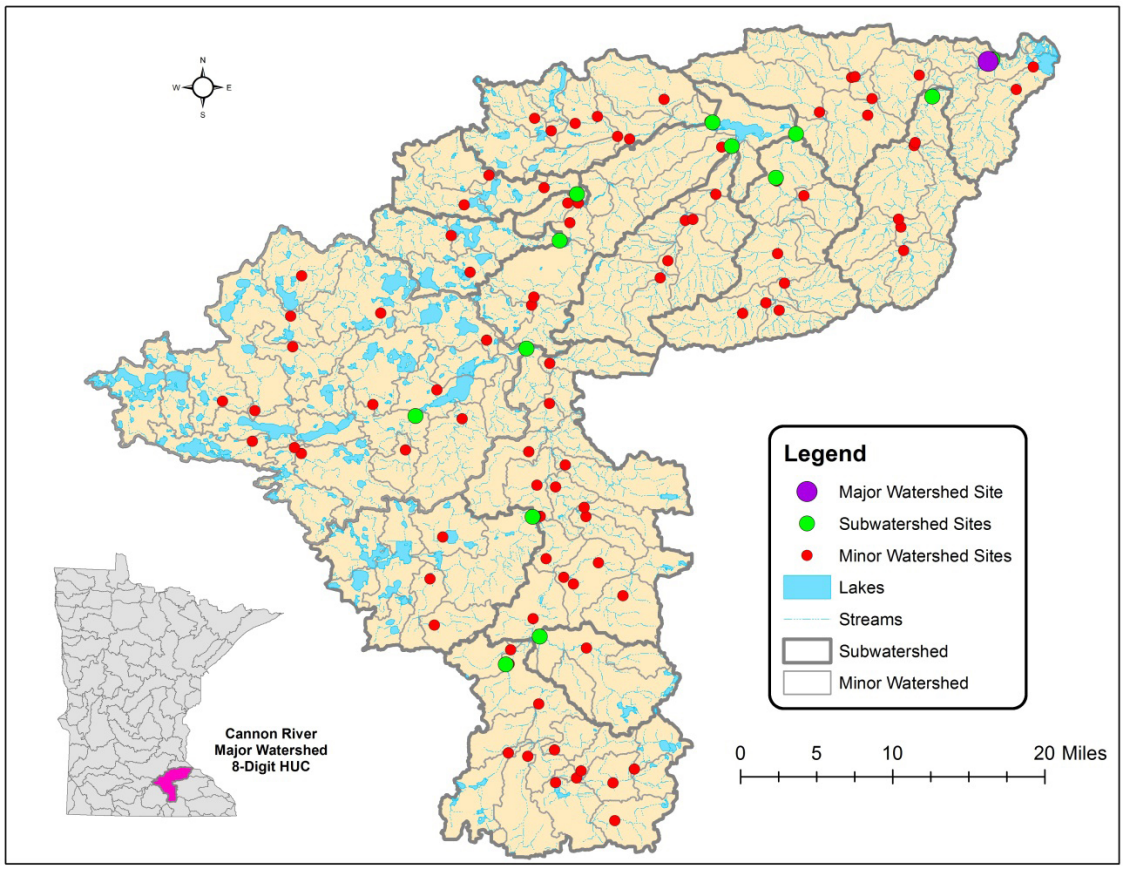
MPCA started this process in the Cannon in 2011 and undertook an intensive watershed monitoring effort of the Cannon River Watershed's surface waters. One hundred and two (102) sites were sampled for biology at the outlets of variable sized subwatersheds. These locations included: the outlet of the Upper, Middle, and Lower Cannon River; the Upper and Lower Straight River; and several tributaries such as Belle Creek, Little Cannon River, Prairie Creek, Maple Creek, Wolf Creek, Turtle Creek, Heath Creek, Crane Creek, and many smaller headwater streams. Also sampled were a number of trout streams including Trout Brook, Pine Creek, Spring Creek, Little Cannon River, and Spring Brook (also known as Rice Creek).

As part of this effort, MPCA also contracted with the Cannon River Watershed Partnership (CRWP) who completed stream water chemistry sampling at the outlets of the Cannon River's 13 major subwatersheds. Over the course of the 10-year assessment window (2002 – 2012), 125 biological stations were sampled for fish and 116 stations were sampled for macroinvertebrates, while water chemistry data was collected on numerous lakes and stream stations by agencies, local watershed groups, and volunteer citizen monitors. In 2013, a holistic approach was taken to assess all of the watershed's surface water bodies for support of drinking water, aquatic life, aquatic recreation, and fish consumption uses where sufficient data were available. During this process, 45 lakes and 70 stream reaches were assessed for aquatic recreation and/or aquatic life. (Not all lake and stream reaches were able to be assessed due to insufficient data and modified channel condition).
Source: MPCA. Cannon River Monitoring and Assessment Report, 2014

Stream water chemistry sampling

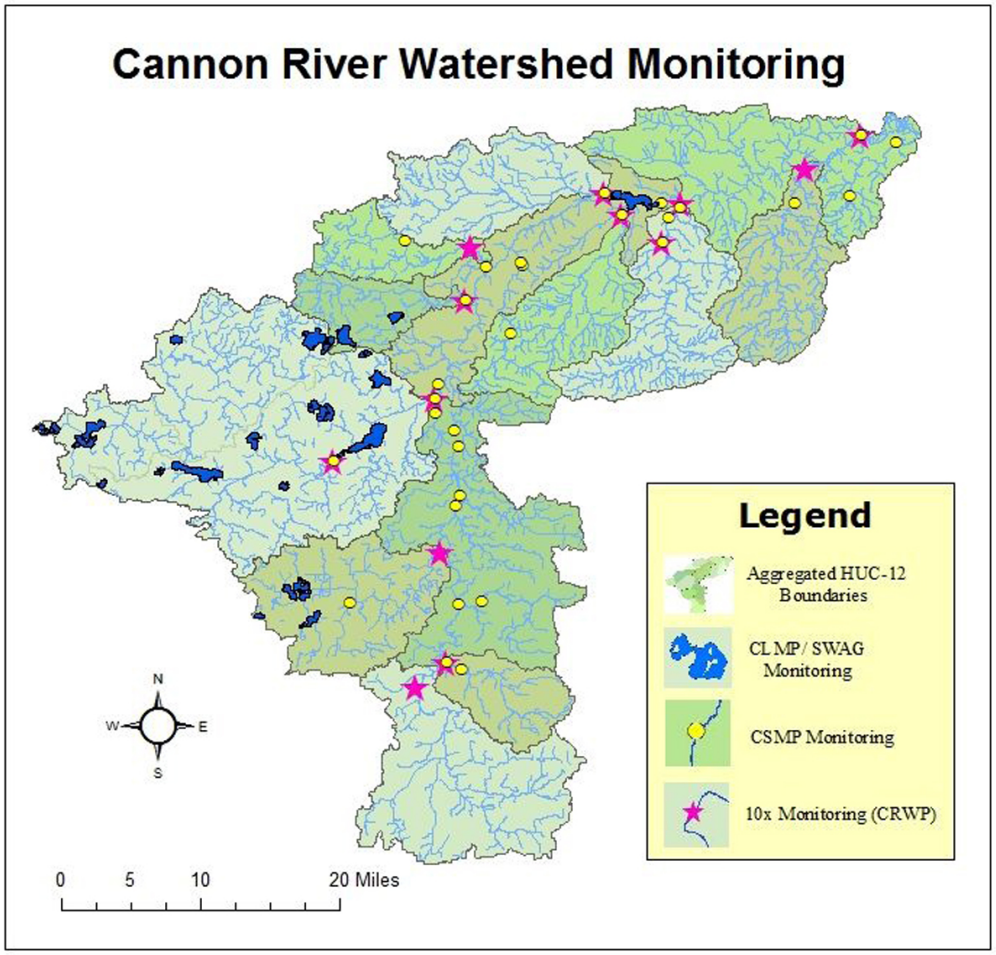
During the 2013 assessment cycle, there were 86 stream reaches that had sufficient chemistry data to assess against current water quality standards. Water chemistry data were collected by locals and volunteers at many locations throughout the watershed over a number or sampling seasons.

http://www.pca.state.mn.us/index.php/view-document.html?gid=16141.



Citizen and Local Group Monitoring

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years.

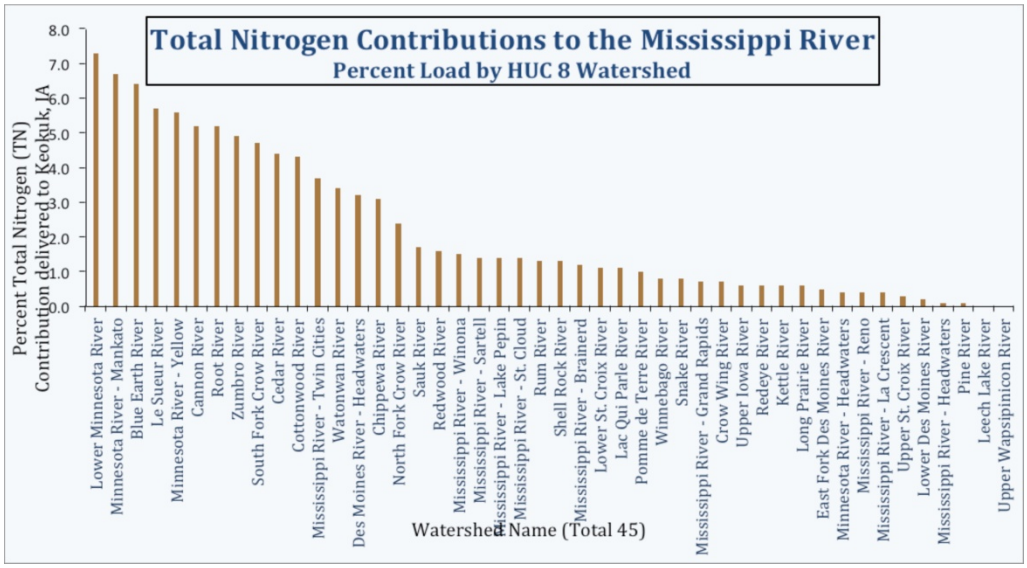


Cannon River Monitoring and Assessment Report, 2014

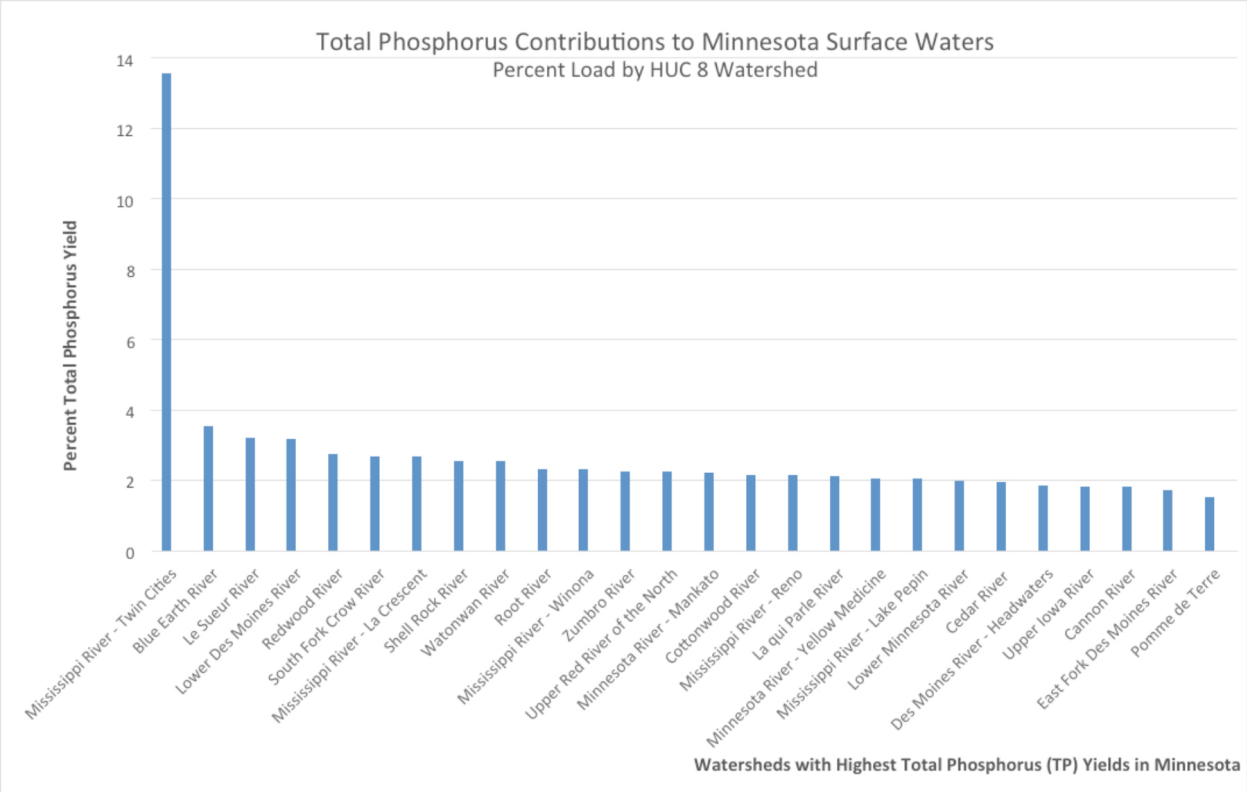
An illustration of the locations where citizen monitoring data were used for assessment in the Cannon River Watershed. Locations depicted were active in the 2012 monitoring year.

Cannon River Watershed Downstream Impacts – High Nitrogen Load to Mississippi River

Fifteen of the 45 watersheds draining into the Mississippi River from Minnesota each contribute over 3 percent of the modeled load delivered to the Mississippi River in southern Iowa (Keokuk). Combined, these 15 watersheds contribute 73.7 percent of the total nitrogen load delivered to Keokuk from Minnesota. These higher loading watersheds are mostly located in South-central and southeastern Minnesota. The other thirty watersheds each contribute between 0 and 2.4 percent of the load, and are thus considered relatively minor contributors. The Cannon River Watershed ranks 6th contributing ___% of the load to the Mississippi River at Keokuk, Iowa.



Percent contribution of TN delivered to the Mississippi River in Keokuk, Iowa, from each of Minnesota's HUC8 Watersheds which ultimately drain into the Mississippi River.



The graph above depicts Watersheds with Highest Total Phosphorus (TP) Yields in Minnesota. Cannon River ranks 24th(Minnesota Nutrient Reduction Strategy , 2013).

Nutrient Trends

Water chemistry data from MPCA's milestone monitoring stations on the Cannon River and Straight River were analyzed for trends for a long term period of record and a near term period of record. For the Cannon River, there were significant increases in nitrite/nitrates and chloride during the long term period of record (1953-2008) and for only nitrite/nitrates for the near term period of record (1999-2009). Conversely, there were significant decreases in total suspended solids, total phosphorus, ammonia, and biological oxygen demand for the long term periods of record for both the Cannon River and Straight River, while there were no trends with the near term periods.

Water quality trends at long-term monitoring stations
Cannon River at Welch (CA-13) (1953 - 2009)

Nitrogen Trends
Modeling shows increasing trends

1953-2009 Nitrite/Nitrate
overall annual change - increase of 1.4%

Recent -1995 – 2009 Nitrite/Nitrate
overall annual change - increase of 1.9%

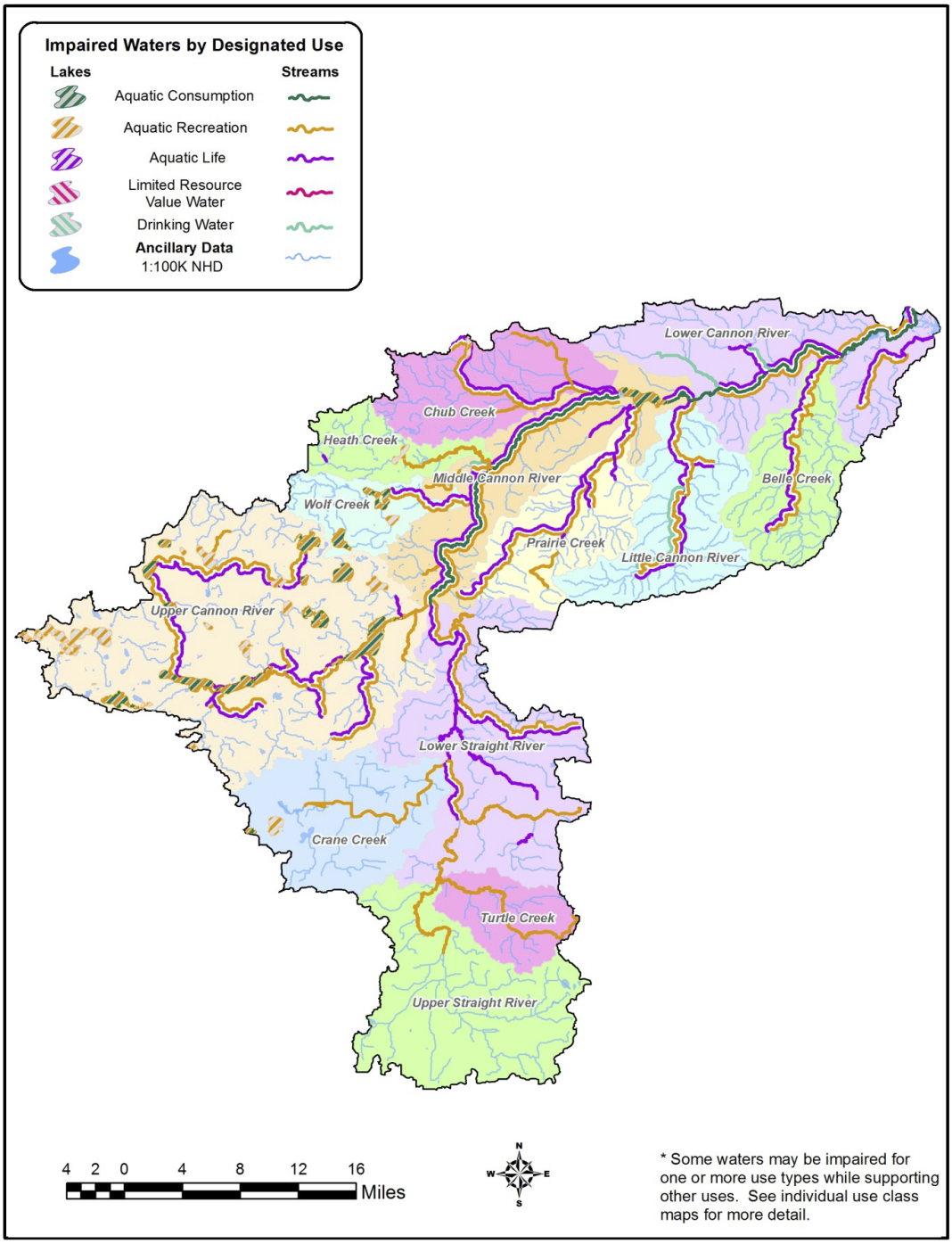
Phosphorus Trends

Overall Total Phosphorus Trend (1953-2009) – decrease -2.3%
Recent Trend (1995 – 2009)* - no trend

(Cannon River Monitoring and Assessment Report, 2014)

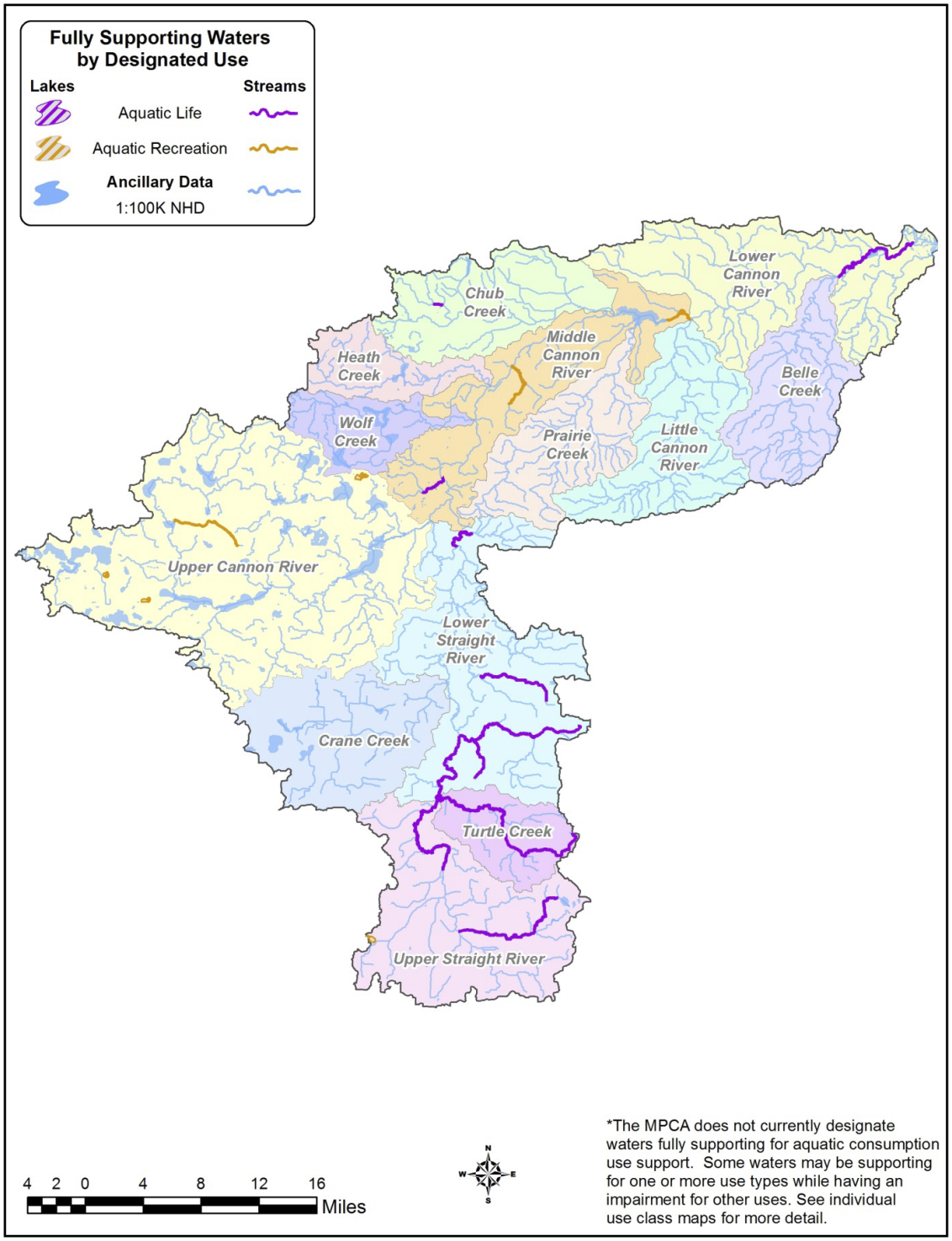
Water Quality Impairments

Impaired waters by designated use in the Cannon River Watershed



MPCA. Cannon River Monitoring and Assessment Report, 2014

Fully supporting waters by designated use in the Cannon River Watershed

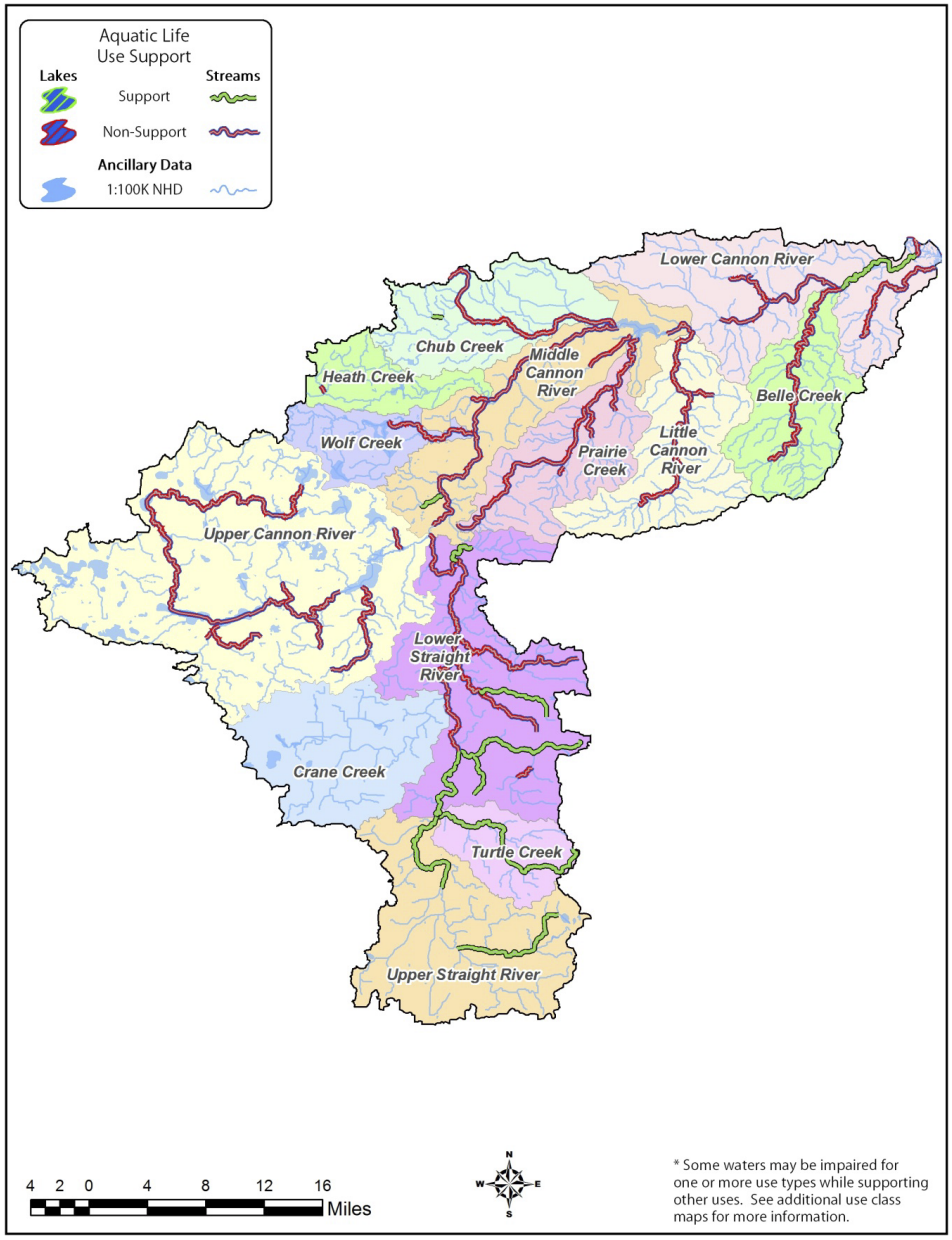


MPCA. Cannon River Monitoring and Assessment Report, 2014

Coldwater Stream Impairments

Across the watershed, four coldwater streams have elevated nitrates which may make drinking water unsafe: Pine Creek and Little Cannon River in Goodhue County, Spring Brook (a.k.a. Rice Creek) in Rice County, and Trout Brook in Dakota County. The only coldwater stream not impaired due to elevated levels of nitrates in drinking water is Spring Creek in Goodhue County.
MPCA. Cannon River Monitoring and Assessment Report, 2014

Aquatic life use support in the Cannon River Watershed



MPCA. Cannon River Monitoring and Assessment Report, 2014

Aquatic Life Use Support Impairments

Fish and Macroinvertebrates

Fish and macroinvertebrate communities across the watershed are showing a loss of sensitive species due to water pollution and habitat issues. While many streams are impaired for aquatic life use, there are other streams that were assessed as fully supporting or have special concern species with specific habitat requirements. The Middle and Lower Cannon River subwatersheds also have a number of beautiful coldwater streams that support brook and brown trout communities, including Trout Brook, Pine Creek, Spring Brook, Belle Creek, Spring Creek (a.k.a. Rice Creek) and the Little Cannon River. However, many of these coldwater streams have macroinvertebrate impairments. These streams and others should be considered for additional protection to prevent additional aquatic life impairments in the future (Cannon River Monitoring and Assessment Report, 2014).

Nutrient Related Water Quality Data

Additional Cannon River water quality monitoring information can be found in the following documents, databases and websites:

Minnesota Pollution Control Agency. June 2014. Cannon River Watershed Monitoring and Assessment Report

Minnesota Nutrient Planning Portal (website) contains Cannon River nutrient information including nitrogen and phosphorus sources, monitoring, modeling, and trends.

 Watershed Pollutant Load Monitoring Network - MPCA

 DNR/MPCA Cooperative Stream Gaging Network – USGS, DNR, MPCA – Stream discharge and links to Division of Waters Resources, climate information, river levels, water quality information, recreation and commonly used hydrologic terms

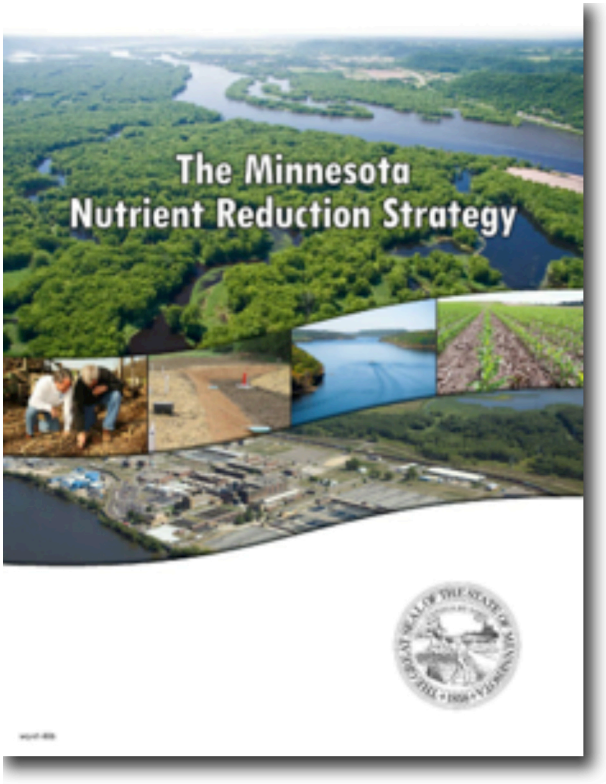
 USGS – USGS discharge Information

 EDA Environmental Data Access – Water quality data collected for all MPCA monitoring projects

 EQuIS – Environmental Quality Information System – Water quality data from more than 17,000 sampling locations across the state.

Existing Watershed Plans & Goals

Minnesota Nutrient Reduction Strategy



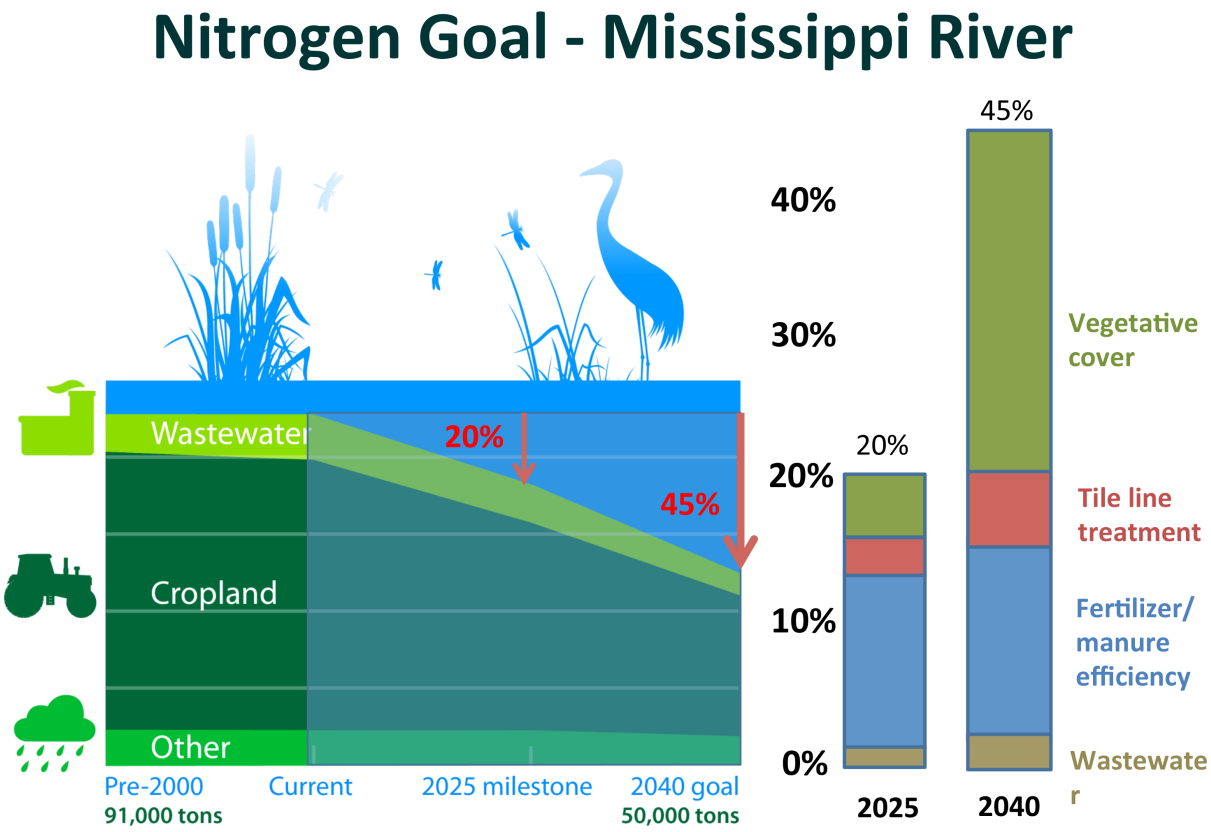
The goal of the Minnesota Nutrient Reduction Strategy (NRS) is to guide the state in reducing excess nutrients in waters so that in-state and downstream water quality goals are ultimately met. Fundamental elements of the NRS include: Clear goals, building on current efforts, prioritizing problems and solutions, supporting local planning and implementation, and improving tracking and accountability. Successful implementation of the NRS will require broad support, coordination, and collaboration among agencies, academia, local government, private industry, and citizens.

The Minnesota Nutrient Reduction Strategy outlines key measures that could be implemented in urban and agricultural areas in the Mississippi River Basin in Minnesota where phosphorus and nitrogen reductions are needed in order to reduce nutrient loading to Lake Pepin and the Mississippi River. Some best management practices highlighted include: increasing fertilizer use efficiencies through soil testing and application via subsurface banding; increasing living (perennial) cover by using cover crops, increasing riparian buffers and conservation reserve acres; controlling field erosion by using conservation tillage; managing stormwater volume and velocity through wetland restoration and controlled drainage practices; and continued and improved waste management for waste water treatment facilities, septic systems, and feedlots, among others (Cannon River Monitoring and Assessment Report, 2013).

Learn more about the Nutrient Reduction Strategy on the MPCA website.
Minnesota Nutrient Reduction Strategy (wq-s1-80)
Executive Summary (wq-s1-80a)

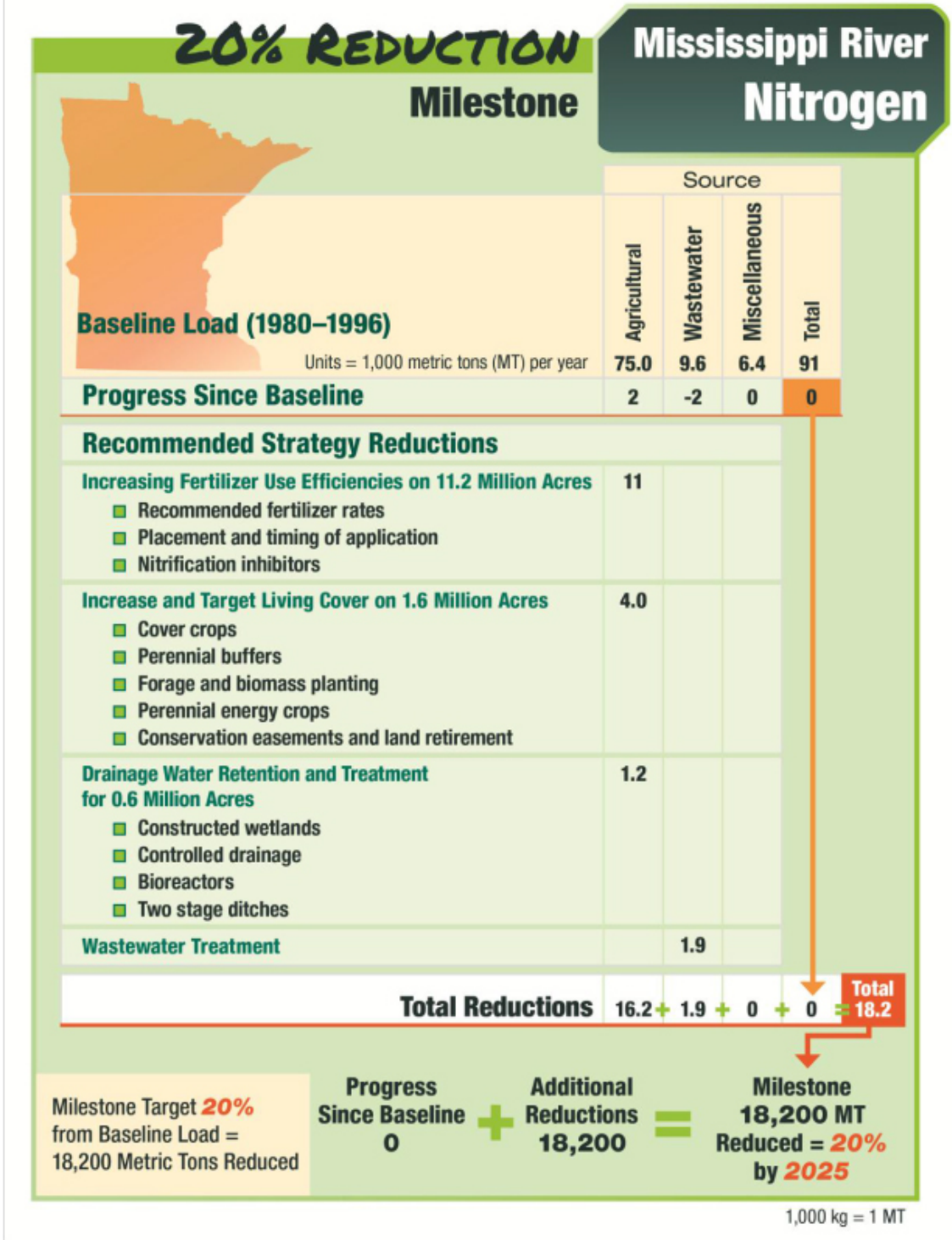
Nutrient Reduction Strategy - Two-page summary (wq-s1-80q)
Minnesota Nutrient Planning Portal webpage

Minnesota Nutrient Strategy - Mississippi River Nutrient Reduction Goals
The image below illustrates the Nitrogen Goal for Mississippi River – 20 percent by 2025 and 45% by 2040 (MPCA, 2015)



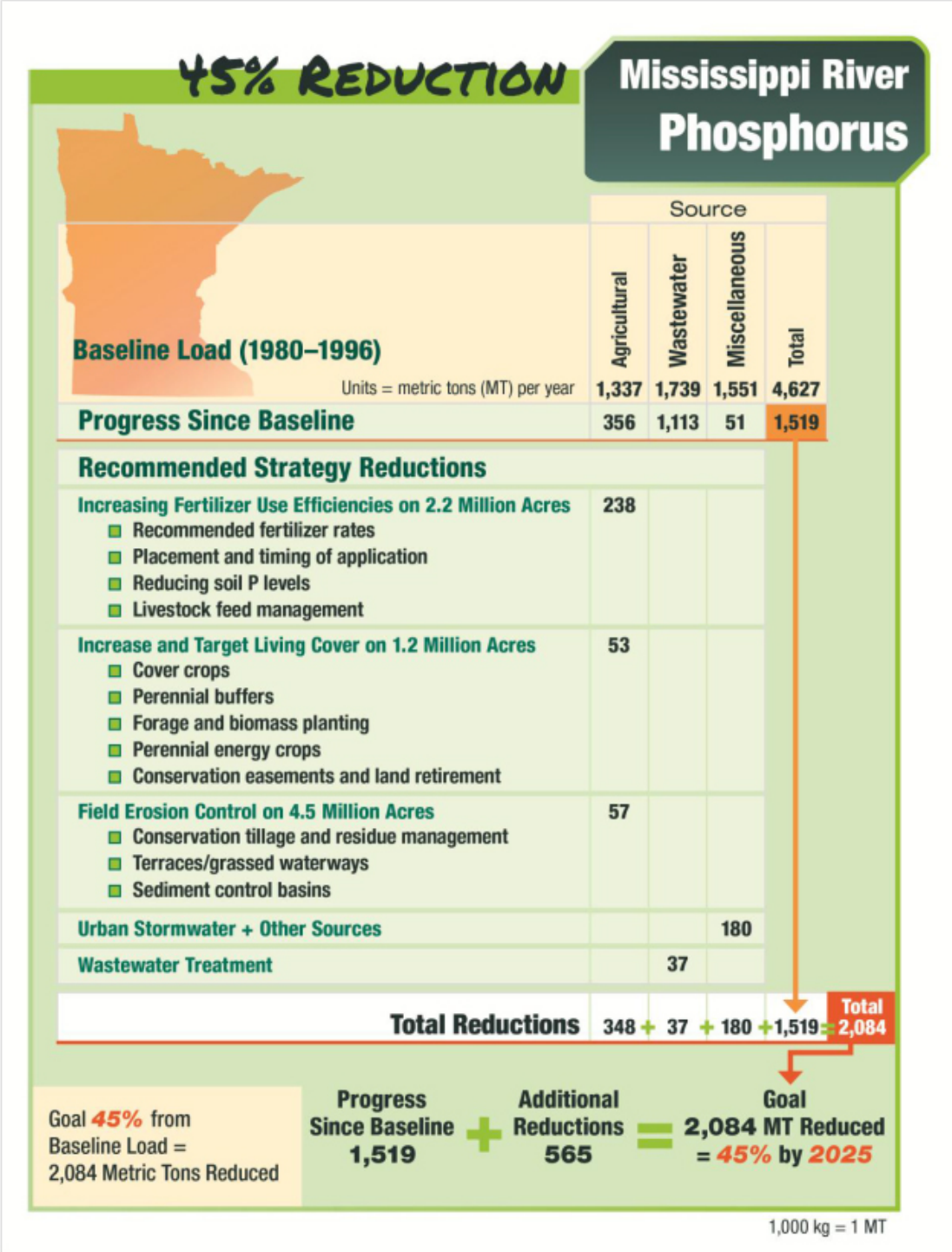
Mississippi River 2025 Milestone – Nitrogen

The graphic below illustrates the Minnesota Nutrient Reduction Strategy recommended approach for Nitrogen milestone reductions for the Mississippi River.


20% Reduction
Milestone
Mississippi River
Nitrogen
Source
Agricultural
Wastewater
Miscellaneous
Total
Baseline Load (1980–1996)
Units = 1,000 metric tons (MT) per year
75.0
9.6
6.4
91
Progress Since Baseline
2
-2
0
0
Recommended Strategy Reductions
Increasing Fertilizer Use Efficiencies on 11.2 Million Acres
11
Recommended fertilizer rates
Placement and timing of application
Nitrification inhibitors
Increase and Target Living Cover on 1.6 Million Acres
4.0
Cover crops
Perennial buffers
Forage and biomass planting
Perennial energy crops
Conservation easements and land retirement
Drainage Water Retention and Treatment for 0.6 Million Acres
1.2
Constructed wetlands
Controlled drainage
Bioreactors
Two stage ditches
Wastewater Treatment
1.9
Total Reductions
16.2 + 1.9 + 0 + 0 = Total 18.2
Milestone Target 20% from Baseline Load = 18,200 Metric Tons Reduced
Progress Since Baseline 0
+
Additional Reductions 18,200
=
Milestone 18,200 MT Reduced = 20% by 2025
1,000 kg = 1 MT

Mississippi River 2025 Milestone – Phosphorus

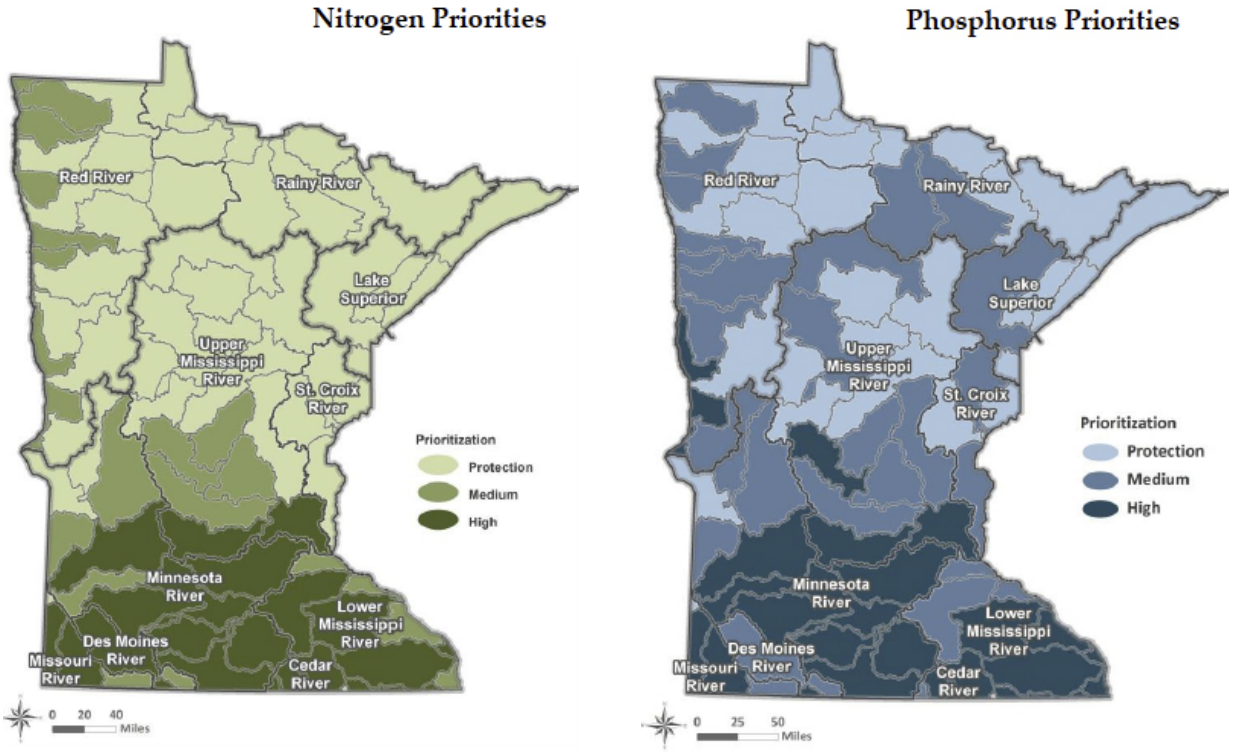
The graphic below illustrates the Minnesota Nutrient Reduction Strategy recommended approach for Phosphorus milestone reductions for the Mississippi River.



Priority Watersheds

The Minnesota Nutrient Reduction Strategy (NRS) identifies priority watersheds that have the highest nutrient yields (loads normalized to area) and also includes watersheds with high phosphorus levels in rivers. In the maps below, the HUC8 watersheds with highest loads are shaded dark. The darker shaded watersheds are the higher priority watersheds for nitrogen and phosphorus reduction.

The Cannon River Watershed is indicated as a "high" priority watershed for Nitrogen and "medium" priority for Phosphorus. The NRS is a big picture strategy which sets up the framework for local detailed strategies. The real action and decisions happen at the local level – within the watersheds. Individual watersheds will determine how to specifically achieve the reductions needed in their watershed and for downstream purposes.



Minnesota's Watershed Approach

Minnesota is implementing a watershed approach that assesses, restores and protects waters under the umbrella of the Minnesota Water Management Framework. This approach sets a 10-year cycle of water assessments, watershed restoration and protection strategy (WRAPS) development at the hydrologic unit code 8 (HUC8) watershed level, and local water planning (e. g., One Watershed One Plan). The NRS provides the information and collective objectives needed to address watershed nutrient goals downstream of the HUC8 watersheds. These downstream objectives can then be integrated with needs and prioritized actions within the HUC8 watershed. HUC8 watershed goals and milestones should be developed so that cumulative reductions from all watersheds will achieve the goals and milestones in waters downstream.

Watershed Planning Approach

The Cannon River Watershed is engaged in MPCA's 10-year watershed planning approach. The MPCA and partner organizations evaluate water conditions, establish improvement goals and priorities, and take actions designed to restore or protect water quality on a 10-year cycle. The Cannon River Watershed began the cycle in 2011.

According to MPCA's Cannon River Watershed website, the following steps and products have been completed (to date September 2015):

1. **Monitor water bodies and collect data**

Cannon River Watershed Monitoring and Assessment Report
2015 Follow-up Stream Assessments for three reaches in the Cannon River Watershed

2. **Assess the data**

3. **Develop Strategies**

   Cannon River Major Watershed WRAP Strategy – In Progress
   Upper Cannon Lakes and Excess Nutrients TMDL Project – In Progress

4. **Conduct restoration and protection projects**
   MPCA's Cannon River Watershed website lists a host of implementation activities in progress and/or completed.

Targeting Tools and Models

There are many different modeling tools and economic calculators available or currently in development in Minnesota and across the United States. Appendix A includes a matrix that describes some of these tools for prioritizing and targeting.

Using Tools Together

Each tool and model has different goals and capacities. The chart below illustrates how the tools could be used together to try to frame up nutrient reduction in a watershed.

Priority Areas	**Which BMPs N& P**	**Which BMPs N& P, Sed ++**	**BMP suites & adoption levels to reach goals?**	**BMP placement in watershed**
HSPF-SAM		HSPF-SAM	HSPF-SAM	
	N-BMP/P-BMP		N-BMP/P-BMP	
PTM-app		PTM-app	PTM-app	PTM-app
Zonation				
		ACPF (Tomer)		ACPF (Tomer)
				PMZ

Wall et al 2015

Pilot Project Approach

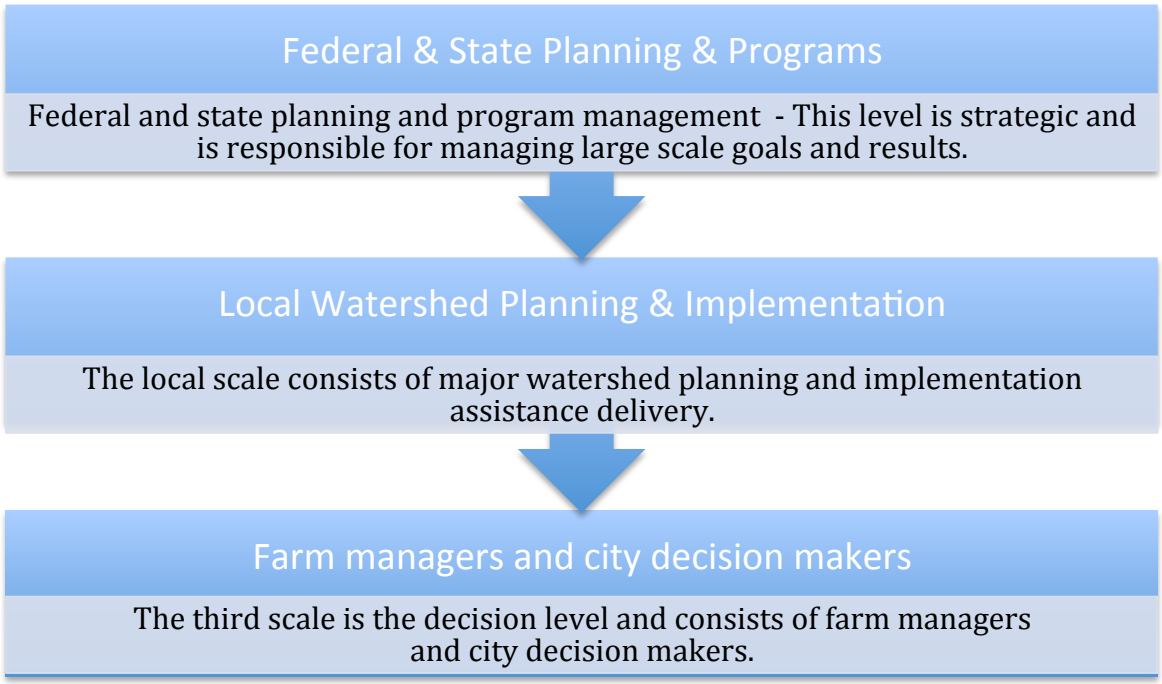
After searching possible tools for this pilot study, the team decided on the following approach:

- Priority Area – Determined by local partners based on long term local priorities
- Which BMPs - To explore the use of N-BMP/P-BMP tools
- BMP placement in the Watershed - Agricultural Conservation Planning Framework (ACPF) due to the availability and promise of these new tools

We should note that this pilot project is intended to add additional information to the broader and longer term efforts underway in Trout Brook Subwatershed. Dakota County is working with Houston Engineering and plans to use the PTM-app in the near future when it is available (slated for spring 2016) to inform project targeting.

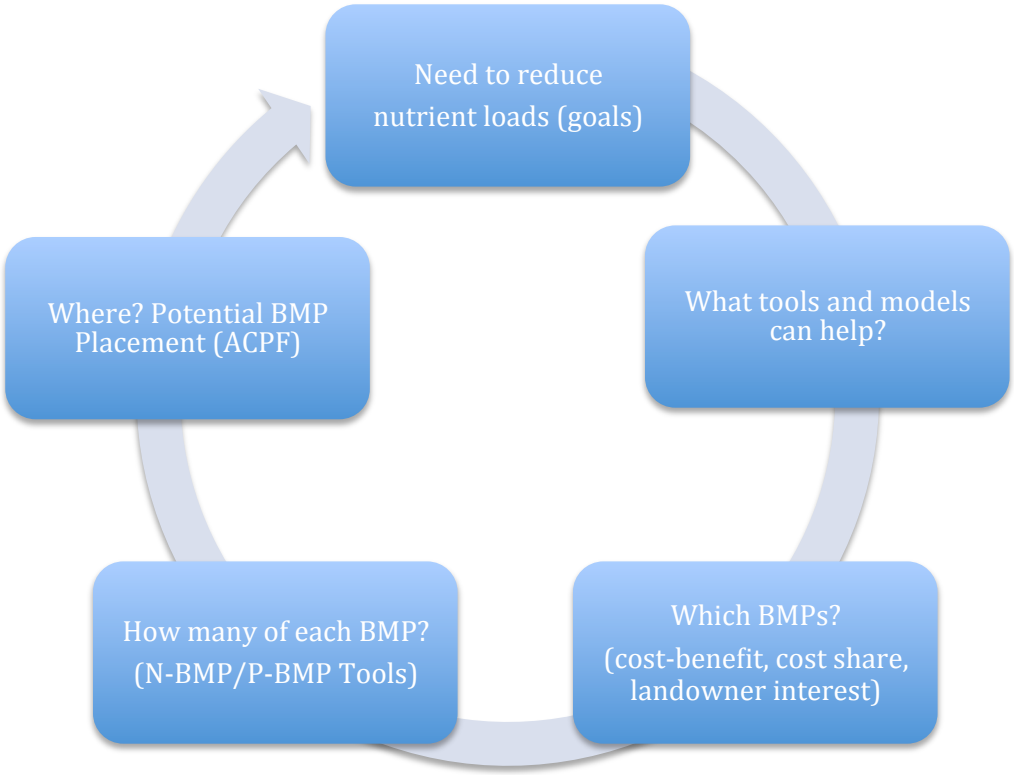
Nutrient Reduction Strategy - 3 scales or levels of management

Broadly, the Minnesota Nutrient Reduction Strategy works at three scales. The state-level nutrient reduction strategy is meant to establish a large-scale big picture framework, under which fits individualized watershed planning.



The Minnesota Nutrient Reduction Strategy works at the largest scale but recognizes that it must be relevant at where the action occurs, at the local and farm levels. Boosting state and federal programs is designed to support the local efforts. Action happens at the local level – on the farms and in the cities. (Wall et al, 2015)

Nutrient Pilot Framework



The Nutrient Reduction Strategy and local water quality monitoring, studies and goals all point to the need to reduce nitrogen loads in Trout Brook Subwatershed.

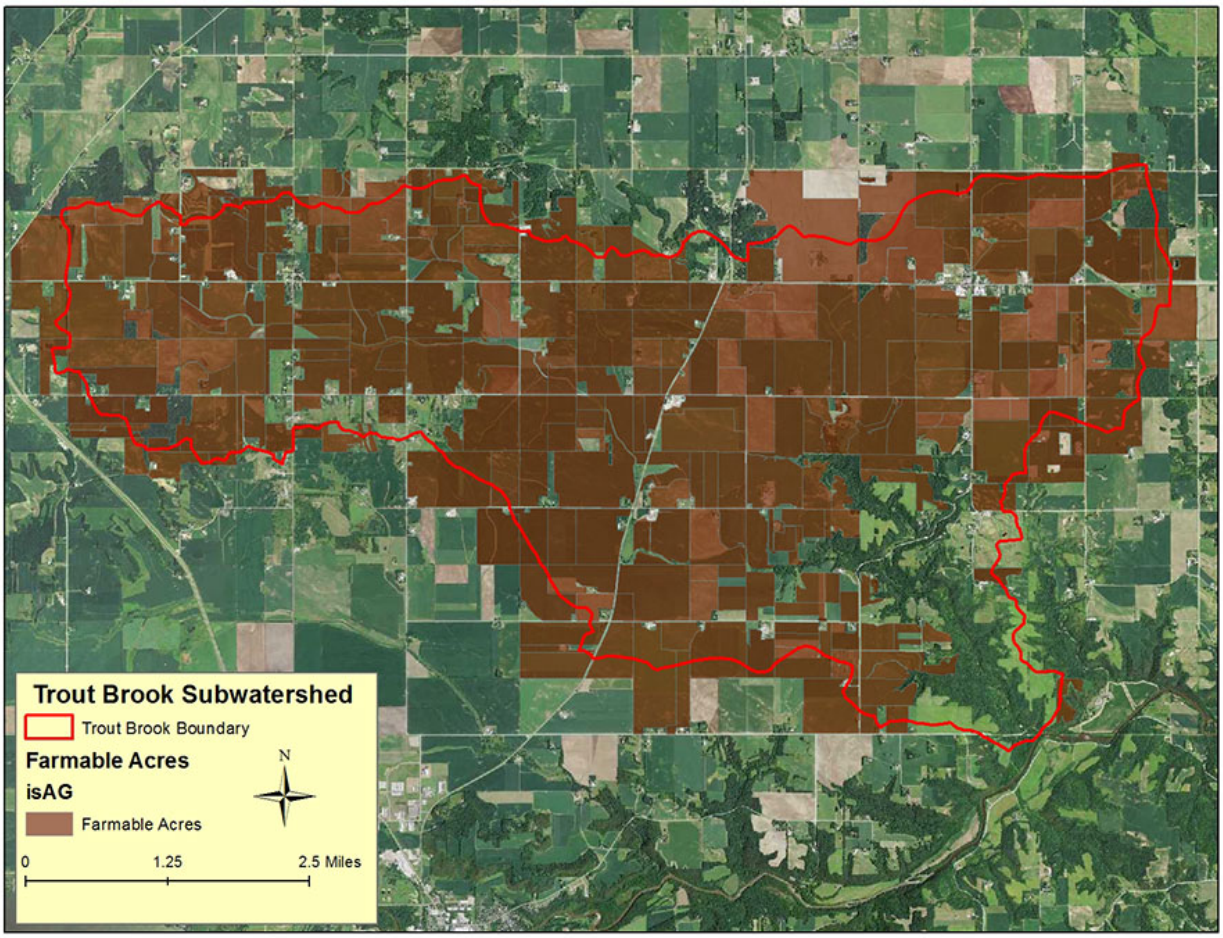
Trout Brook Subwatershed

Trout Brook Overview

Trout Brook Subwatershed lies within the Lower Cannon River Lobe of the Cannon River Watershed. East of Cannon Falls and west of Red Wing and encompasses the Cannon River between the Byllesby Reservoir and the Mississippi River. The southeastern most area of the watershed is drained by Spring Creek which also empties into the Mississippi River upstream of Red Wing. Split between Dakota and Goodhue Counties, this 140 square-mile subwatershed is well known for its prized trout fishing streams that are in close proximity to the Twin Cities, as well as excellent game fishing and recreational opportunities including canoeing and tubing along the Cannon River at Welch Village and hiking and skiing in parks. Miesville Ravine Park Preserve maintains ~1600 acres of biologically diverse land and beautiful spring fed streams such as Trout Brook. Trout Brook, as the name implies, is a coldwater (2A) stream located in the Miesville Ravine Park Preserve (Cannon River Management Strategy, 2011).

Land Use

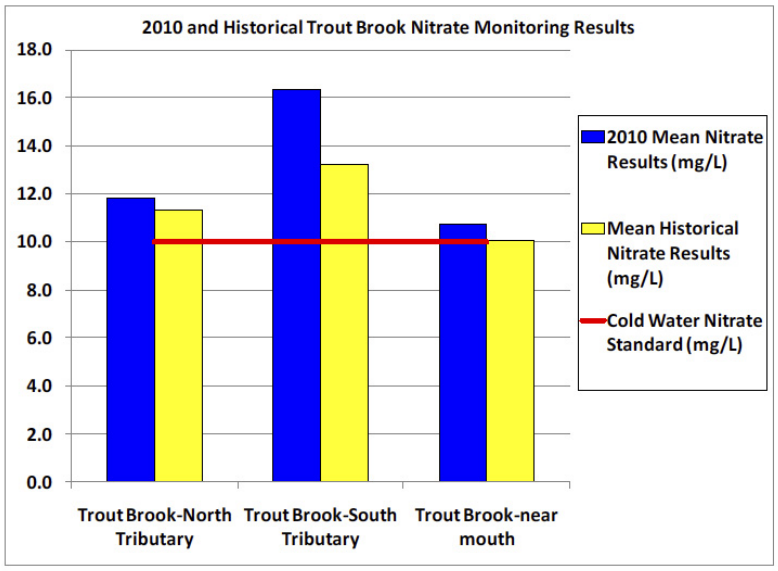
Trout Brook Subwatershed encompasses ___ acres.The Trout Brook watershed is dominated by agricultural land uses, primarily corn and soybean farming.
This watershed is on the western edge of the karst landscape.



Water Quality Monitoring History

Since 2001, the North Cannon Watershed Management Organization has sponsored periodic water quality monitoring within this subwatershed. Results of this monitoring effort have revealed several interesting findings, including unusually high nitrate concentrations. Based on these results and according to the Minnesota Pollution Control Agency, Trout Brook has the most chronically high nitrate results of any monitored stream in southeast Minnesota (Cannon River Management Strategy, 2011)

2010 data indicated that mean nitrate concentrations remain well above state water quality standards within Trout Brook, at all monitoring sites. In fact, 2010 mean nitrate concentrations even exceeded historical mean nitrate results for these monitoring locations. Additional research is needed in this watershed to help identify nitrate sources and develop management strategies to reduce nitrate concentrations in this stream.



Water Quality Impairments

This reach was listed as impaired for drinking water use in 2010 (high nitrates) and aquatic life use in 2006 (turbidity) and 2013 (M-IBI). High nitrate concentrations (>10 mg/L) were consistently observed during both stormflow and baseflow conditions.

Biological Impairments

Two tributaries to Trout Brook are impaired due to a lack of sensitive macroinvertebrates.
High nitrates in Trout Brook are higher than acceptable for drinking water

Western Branch (04LM144)
During three biological visits at station 04LM144 in 2004 and 2011, nitrates ranged from 13 to 19 mg/L. Biological monitoring data collected yielded M-IBI scores below the impairment threshold for southern coldwater streams.

Eastern Branch (99LM005)
During sampling at a station (99LM005) on an adjacent tributary, nitrates were slightly lower at 11 mg/L. Biological monitoring data collected yielded M-IBI scores below the impairment threshold for southern

coldwater streams.

Researchers noted a puzzling difference in nitrate concentrations between these two branches of Trout Brook. While both branches of Trout Brook have extremely high nitrate concentrations, the eastern branch is showing signs of eutrophication (i.e., dense filamentous algae,) to a much greater extent than the western branch. They attributed the difference to a relatively sparse forest canopy along the eastern branch's riparian corridor allowing more sunlight to reach the water's surface. Recent flooding in 2012 has further degraded the riparian canopy (Biological Monitoring Report - confirm). This reach (99LM001) on Trout Brook was also listed due to turbidity in 2006 although more recent data suggest that this stream is now meeting the standard; however, additional data are needed to propose a delisting for turbidity.

Trout Brook Plans and Goals

Nutrient Reduction Strategy

Minnesota Nutrient Reduction Strategy Goals – Mississippi River

Nitrogen - 10 Year Target: **20% reduction**

Phosphorus - 10 Year Target: 12% reduction (33% already obtained) for a total **45% reduction**

Overall Nutrient Reduction Goals in Trout Brook

Trout Brook subwatershed is well studied and of great interest to because it has some of the highest measured nitrate in Southeastern Minnesota. Many existing plans call for nutrient reduction in the Cannon River Watershed and Trout Brook in particular. NRCS Cannon River Watershed Assessment calls for nutrient management, sediment and erosion control, animal waste management, and groundwater protection throughout the Cannon River Watershed. Dakota County Comprehensive Plan future strategies include systematic water quality monitoring that provides sound scientific data for future planning, focus on educational outreach programs to inform individuals and organizations of present and future conservation needs within the county, among many other objectives within their 5 year plan.

Dakota County SWCD staff met with project partners (March 30, 2015) and delineated two over-riding goals within the Trout Brook subwatershed:

- Reduce Nitrogen from commercial and manure fertilizer. The primary source of Nitrogen in this subwatershed is fertilizer.
- Reduce Phosphorus - Elevated sediment is also a concern.

Cannon River Watershed Strategy

The Cannon River Watershed Strategy (CRWP, 2011) identifies Trout Brook as a priority management zone due to unusually high nitrate concentration. The Trout Brook Management priorities included: Erosion control with a focus on Highly Erodible Land (HEL) and Nitrate management in karst areas. The strategy includes specific actions for Trout Brook:

Trout Brook Actions

The karst landscape in this watershed increases the interaction of groundwater and surface water and the potential for nitrate contamination of groundwater. Action items should focus on reducing nitrates that leave the land and reach drinking water supplies. The focus should be on reducing nitrate loading from commercial fertilizer and manure applications.

1. Provide a nutrient management staff person at the SWCD or Extension office who can serve as a resource to help producers with nutrient management plans.
2. Encourage producers to sign up for nutrient management trials and other demonstration projects to help them reduce commercial nitrogen fertilizer use as much as possible.
3. Encourage grid soil sampling, nitrate testing of corn stalks, manure testing, and other diagnostic practices so producers have the best possible understanding of the nitrogen

and other nutrient needs of their crops.

4. Host *Value of Manure* workshops so producers gain a better understanding of what manure is worth and how best to use it so they reduce over application.
5. Work with cooperatives and agricultural retail stores to ensure they understand the issues of nitrate contamination of surface and ground water and are doing what they can to advise producers to make choices that will be good for production and protective of water quality.

Cannon River Monitoring and Assessment Report Recommendations

Cannon River Monitoring and Assessment Report (MPCA, June 2014) identified resource concerns due to past and present land use that is degrading the water quality throughout the subwateshed.

Nitrogen

Trout Brook in Dakota County is impaired for nitrates. Nitrate is a well-documented contaminant of concern for drinking water sources in the Cannon River Watershed and other karst regions in Minnesota, due to the porous nature of karst geology that allows rapid transfer of pollutants, like nitrate, between surface water and groundwater. Groundwater quality can best be preserved by protecting groundwater recharge zones and preventing contamination from identified sources.

Drinking water standards for nitrates and other constituents apply to coldwater (2A) streams in Minnesota since nitrate levels measured in groundwater dominated trout streams are likely to indicate the level of nitrates in groundwater that could be used for drinking as well. (MPCA, 2014)

Elevated Turbidity

Water clarity (turbidity) impairments are spread throughout, indicating that too much sediment is moving through the system which may impact habitat quality and potentially carry excess phosphorus that fuels the growth of algae. This could cause daily highs and lows in DO that could be a stress to sensitive fish and macroinvertebrates—as well as mussels and other aquatic life.

Downstream Concerns

Poor water quality conditions leaving the Cannon River Watershed may be contributing to poor water quality conditions downstream on Lake Pepin and further downstream on the Mississippi River to the Gulf of Mexico.

Elevated Nutrients and Macroinvertebrates - Macroinvertebrate Impairments

High nitrates observed in streams may be a stress to pollution sensitive fish and macroinvertebrates. High nutrients such as phosphorus and nitrates leaving this subwatershed indicate the nutrient loading of the entire Cannon Watershed.

Trout Brook is a coldwater streams that support healthy brook and brown trout communities. However, many of these coldwater streams have macroinvertebrate impairments that when the stressors present are addressed should also maintain and improve habitat and water quality conditions for the fish communities as well.
<insert about macros here>

Dakota Co SWCD – Nitrate in Trout Brook Study

A recent study by Dakota Dakota County Soil and Water Conservation District Nitrate in Trout Brook (Dakota SWCD, 2014) delineated the following recommendations:

> Trout Brook is of great interest for nitrate monitoring because it has some of the highest measured nitrate in Southeastern Minnesota, it has an established historical record, and the karst landscape in which it is found increases its susceptibility to pollution.
>
> Nitrate concentrations in springs contributing to Trout Brook have been increasing at rates of 0.11 to 0.40 mg/L/year from 1985 to 2014. The surface water monitoring sites also show increasing trends of nitrate concentrations at the Main Branch and West Branch from 2001 to 2014, with the nitrate concentrations decreasing at the East Branch since about 2006.
>
> Groten and Alexander (2013) suggest that row crop agriculture and animal feedlots are the likely sources of nitrate contamination in Trout Brook, although the proportion attributed to each source is difficult to determine. In addition to monitoring nitrate, Groten and Alexander had measured other anions and the data were indicative of animal waste sources. Lastly, Watkins (2011) showed that nitrate concentrations in Southeastern Minnesota trout streams are strongly correlated with the percentage of row crop acres in a watershed; a conclusion which Trout Brook data supports.

Recommendations

- Understanding pollution movement and susceptibility in karst landscapes is complicated. The rate and direction of water movement underground can be very different than what surface topography suggests. Continued work to delineate springsheds would help to determine the types and percentages of land use that may be impacting Trout Brook. This information could then be used to determine groundwater management areas, which may be quite different than surface watersheds.

- Continued education and assistance to local landowners and land users. Provide technical assistance and cost sharing for Best Management Practices which reduce nitrate pollution, targeting identified sources including row crop agriculture and animal feedlot operations.

Dakota County Soil and Water Conservation District 2011-2015 Comprehensive Plan

Dakota County has a very diverse set of land uses and therefore a variety of conservation programs is necessary. Dakota Co SWCD continues to build staff credentials and skills to develop solutions that address conservation issues as the demand to change landscapes continues.

Cost-Share Program Requirements

Nature and Extent of High Priority Problems

The SWCD has designated all watersheds, both urban and rural, within Dakota County as high priority watersheds for technical and financial assistance. This comprehensive approach is necessary as the SWCD continues to rely on others for all of its funding.

B. Conservation Measures Needed

Some of the conservation practices currently being implemented within Dakota County include the establishment of grassed waterways, water and sediment control basins, vegetated buffers, lakeshore and streambank stabilization projects, feedlot improvements, raingardens, infiltration basins, retention basins, and wetland restorations. Additional grant funds will need to be sought to adequately assist landowners and LGUs with their conservation planning and implementation needs.

The Dakota Board of Supervisors and staff currently have adopted the following policy in regards to executing contracts with landowners:
Practices eligible for cost-share may be approved up to:

- 85% of total cost for projects when federal USDA funding is sought.
- 75% of the total cost for rural land projects that use only State or local funds.
- 65% of the total cost for projects that involve stormwater management.
- 50% of the total cost for projects that seal unused wells (State Policy).

The SWCD currently has five cost share programs for which policy has been established. More detailed information can be found on their website at www.dakotaswcd.org. The five cost share programs include:

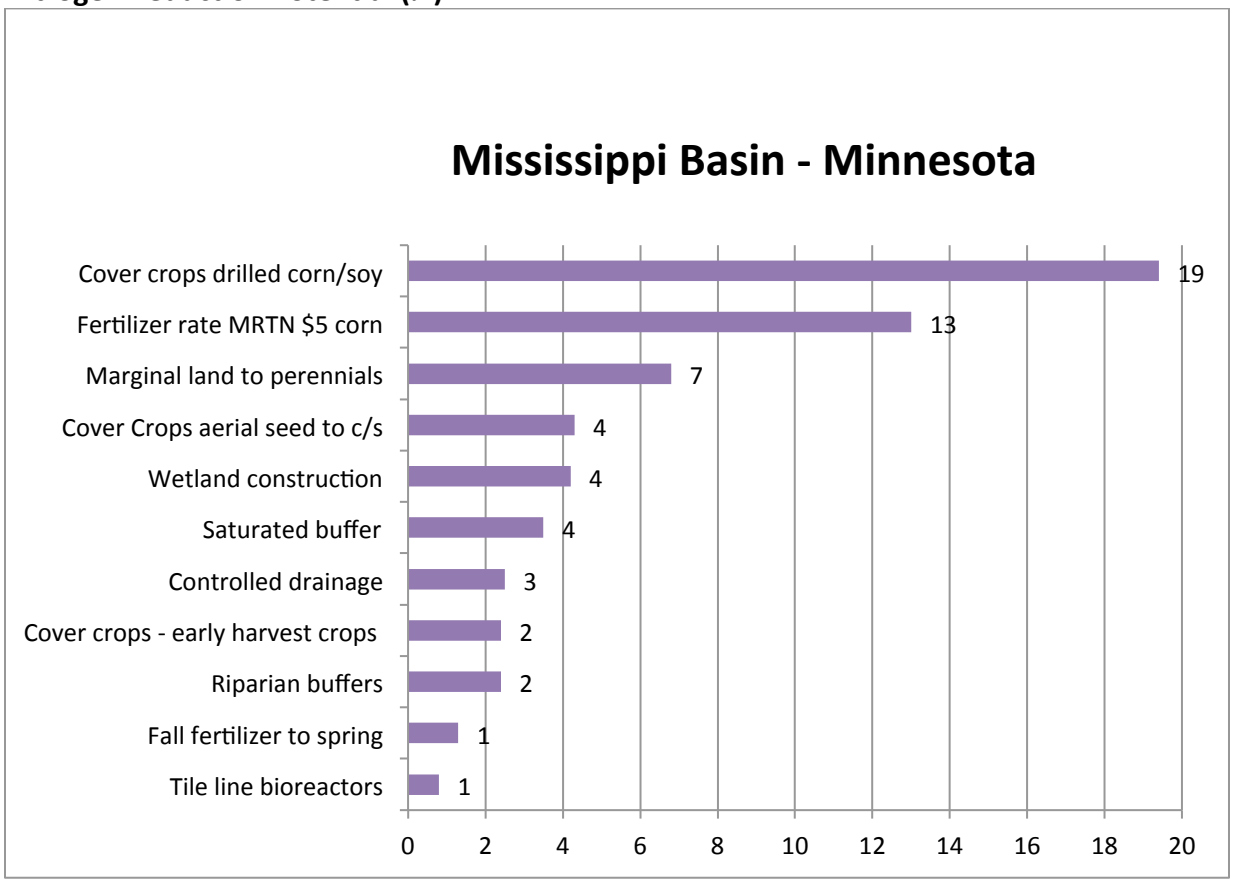
- Blue Thumb Grant (BTG)
- State Cost Share (SCS)
- Community Cost Share (CCS)
- Conservation Initiative Funding (CIF)
- Conservation Partners Cost Share (CCP)

Which BMPs – Cost Effectiveness

The N-BMP and P-BMP Tools were developed by the University of Minnesota (William Lazarus, David Mulla,et al.) to assist the MPCA and local resource managers to better understand the feasibility and cost of various "best management practices" to reduce Nitrogen and Phosphorus loading from Minnesota cropland. These tools allows water resource managers and planners to approximate the percent reduction of Nitrogen and Phosphorus entering surface waters when either a single BMP or a suite of BMPs is adopted at specified levels across the watershed. The tool also enables the user to identify which BMPs will be most cost-effective for achieving Nitrogen and Phosphorus reductions. The following charts summarize the Nitrogen and Phosphorus reduction potential, cost per pound, cost to benefit ratio and combined benefits of a suite of BMPs delineated in the Nutrient Reduction Strategy (Minnesota Watershed Nitrogen Reduction Planning, Lazarus, Mulla et al). http://www.extension.org/pages/67624/minnesota-watershed-nitrogen-reduction-planning-tool#.VgqibhnGJe5

Nitrogen

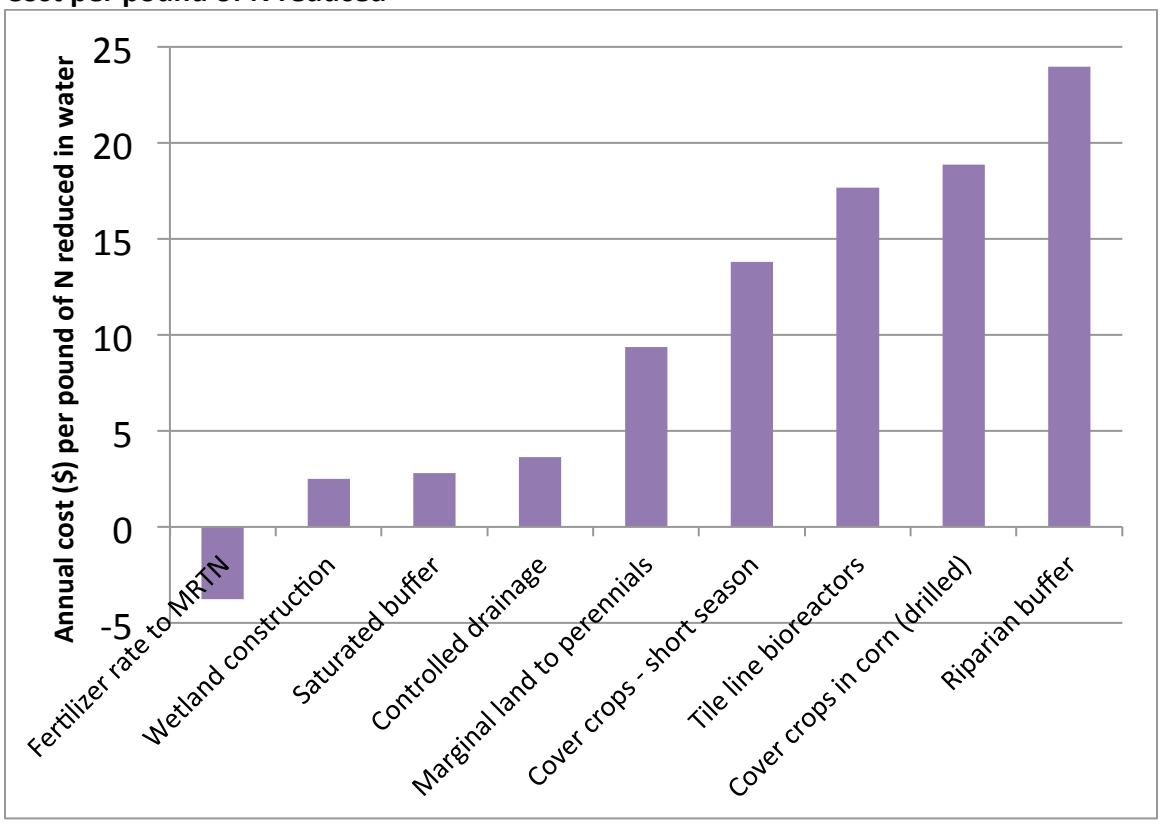
Nitrogen Reduction Potential (%)



% nitrogen reduced to waters in Mississippi Basin *BMPs on 80% of suitable acres

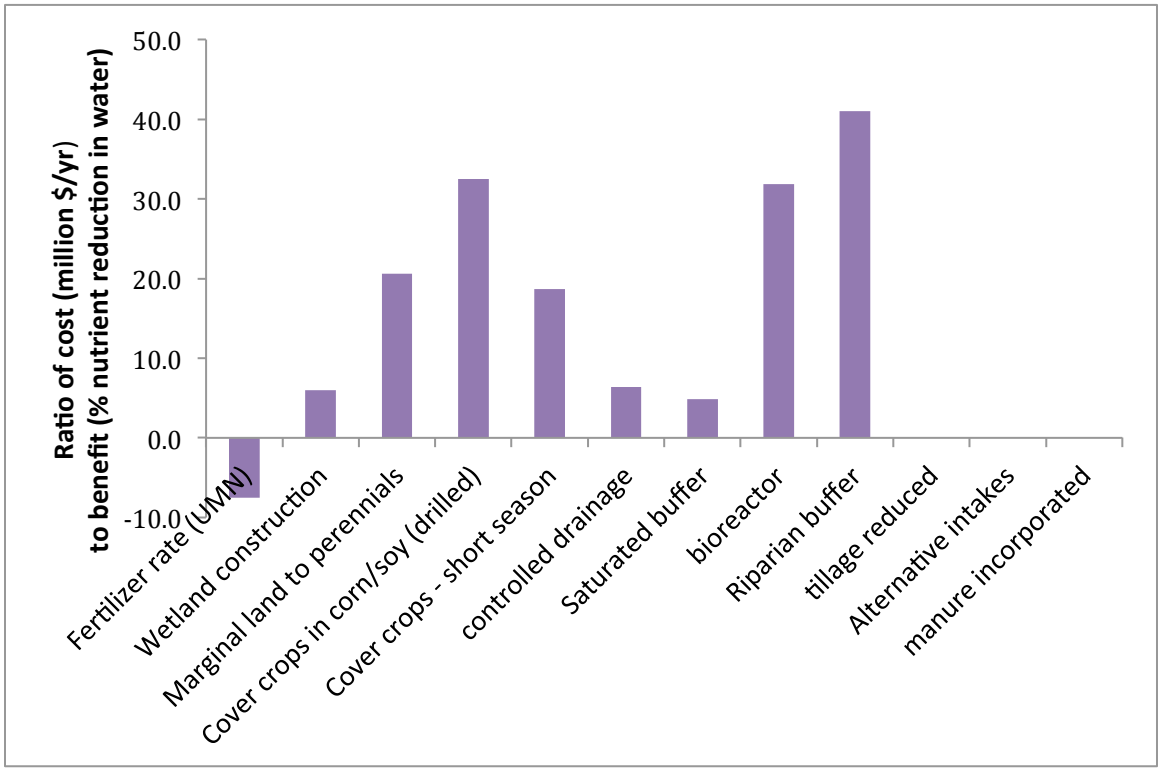
Nitrogen reduction potential in Mississippi Basin largest with: successful cover crops (23%); fertilizer efficiency gains (10-20%);

Cost per pound of N reduced



The most cost-effective BMPs for Nitrogen include Nitrogen fertilizer efficiency, wetland construction, saturated buffers and controlled drainage.

Cost to benefit ratio – Nitrogen only

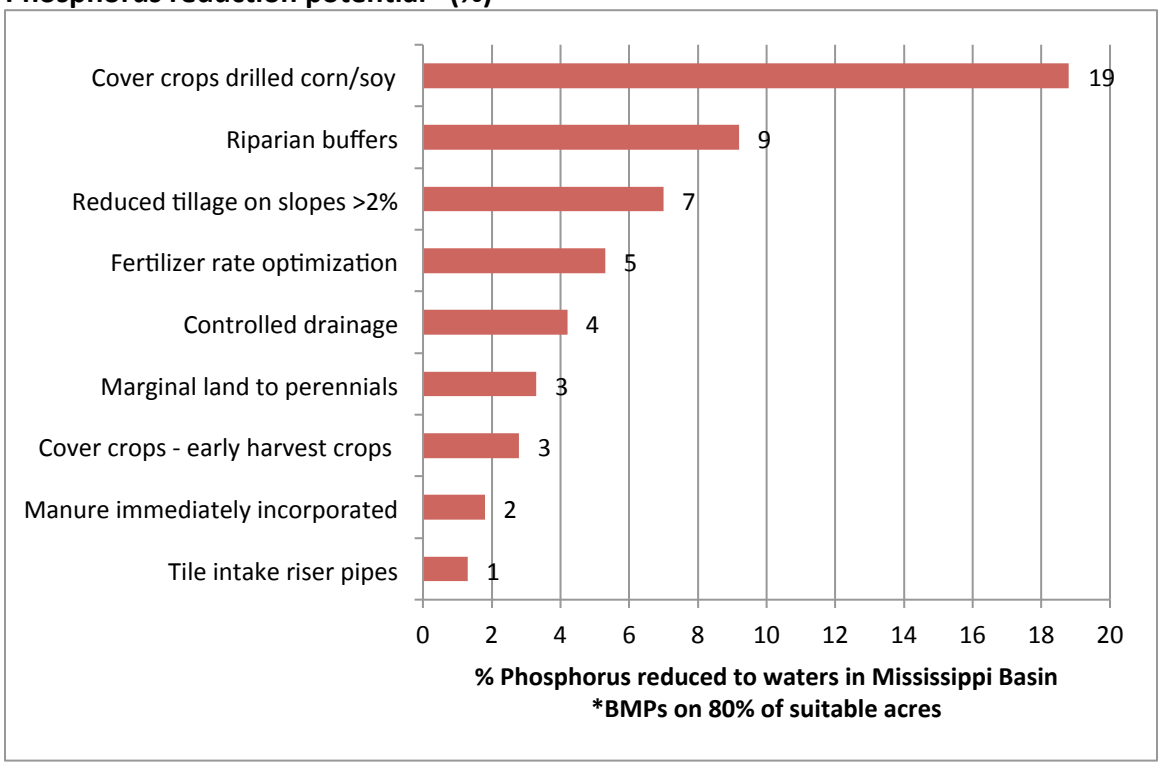


Cost to benefit ratio – Nitrogen only

BMP	Cost benefit ratio (N only)
Fertilizer rate (UMN)	This is free or profitable
Saturated buffer Controlled drainage Wetland construction Cover crops – short season Marginal land to perennials Bioreactor Cover crops in corn/soy (drilled) Riparian buffer	Less expensive $  More expensive $$$

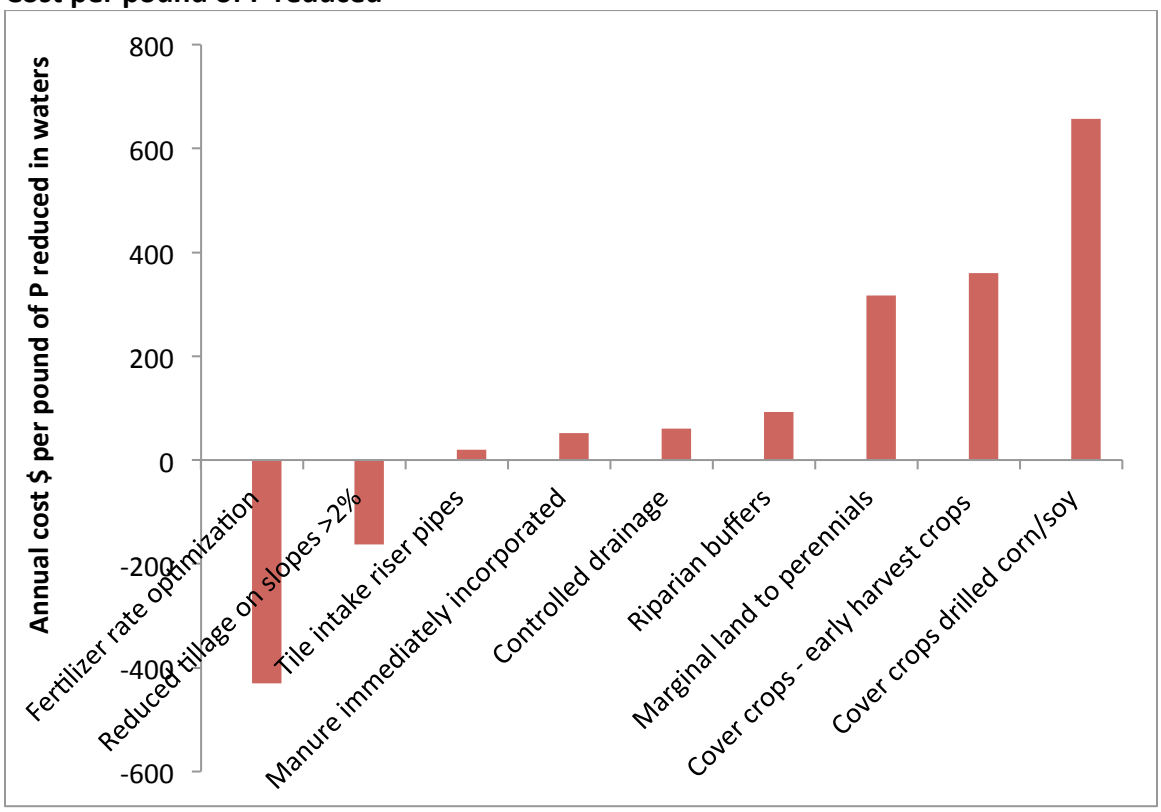
Phosphorus

Phosphorus reduction potential* (%)



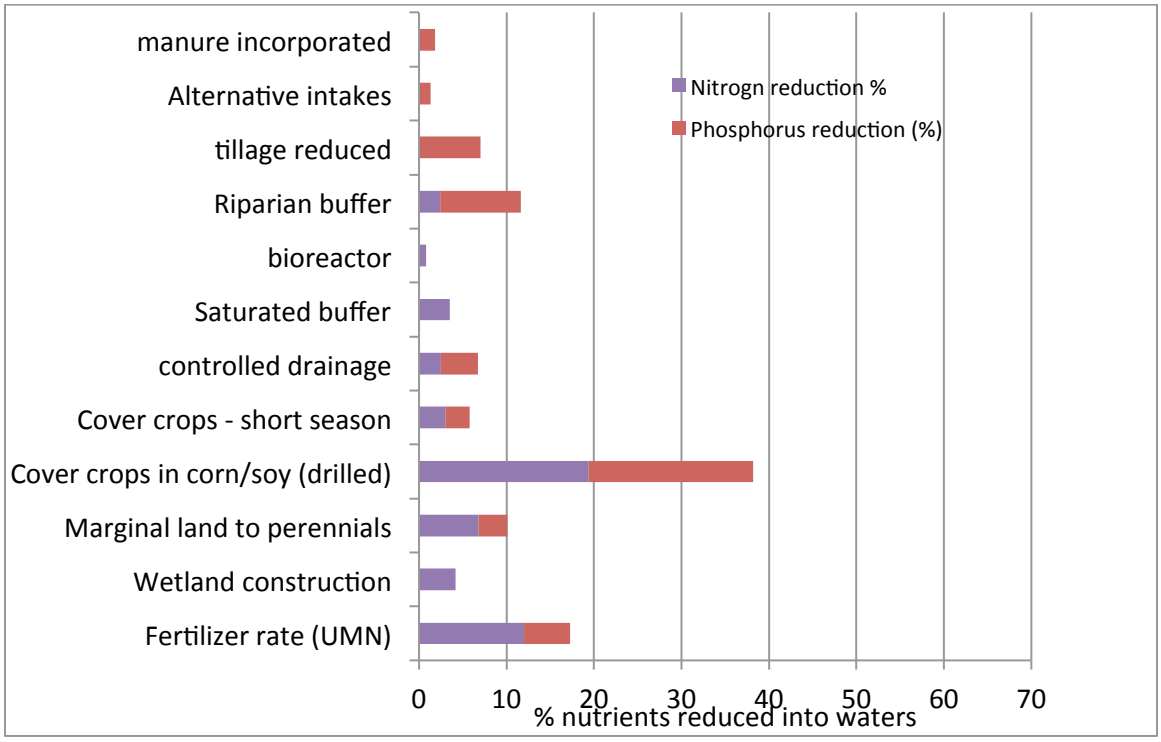
Phosphorus reduction potential in Mississippi Basin largest with cover crops (22%); riparian buffers (9%); reduced/conservation tillage (7%)

Cost per pound of P reduced

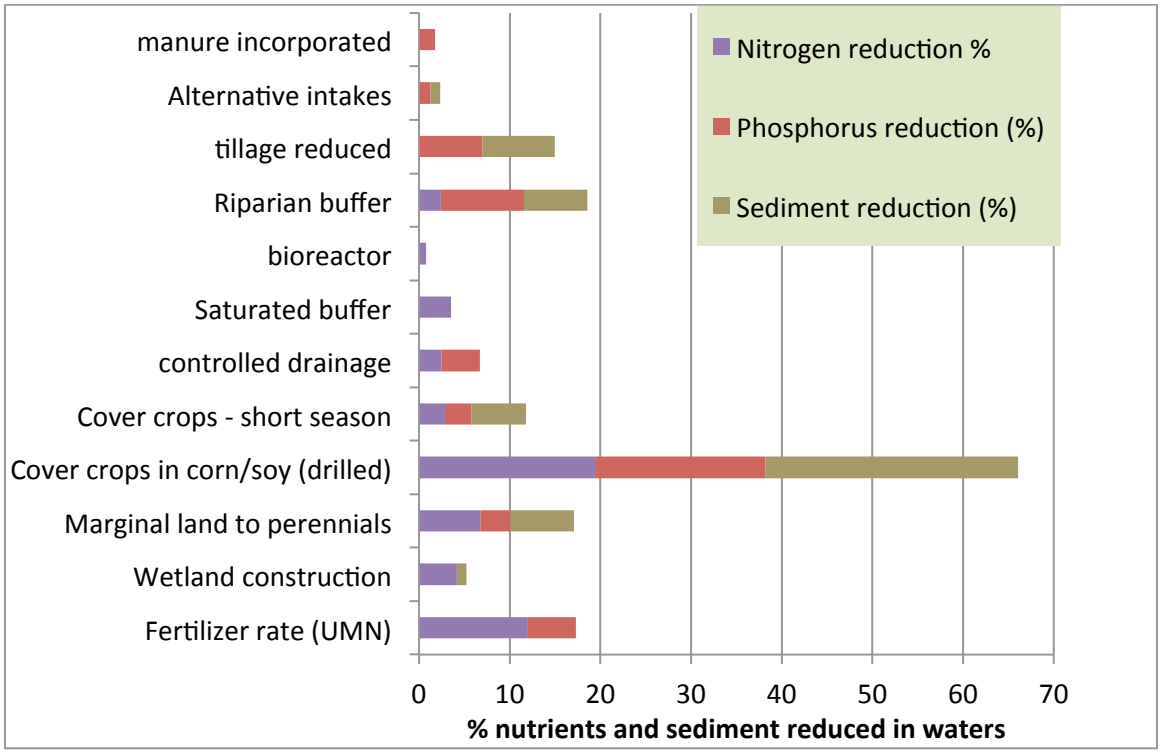


The most cost-effective BMPs for Phosphorus include Phosphorus fertilizer efficiency, reduced tillage, intake riser pipes, and manure incorporated.

Combined benefits N + P

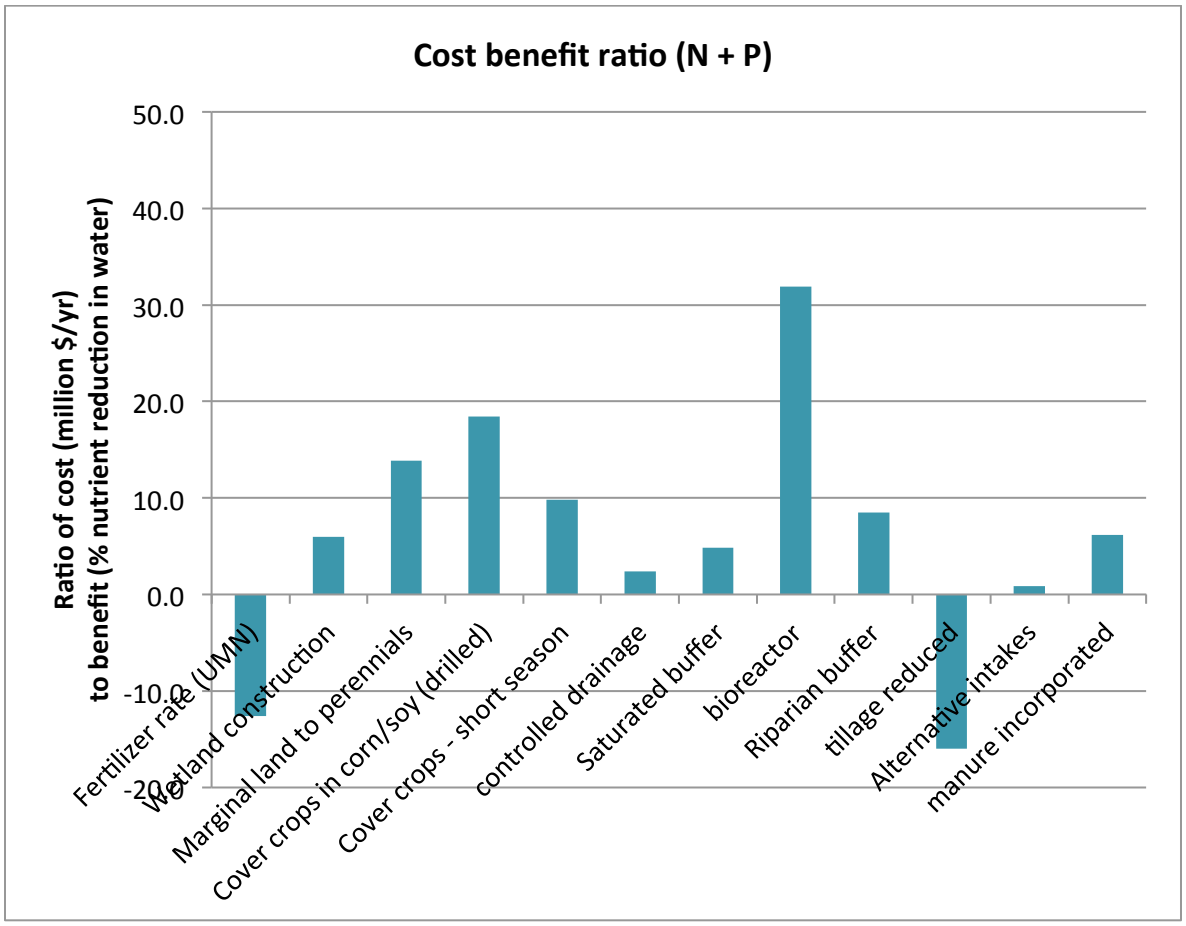


Combined benefits N + P + Sediment



When multiple benefits are needed, cost-effective BMPs can include cover crops, buffers, perennials on marginal lands, and most other BMPs in the tools except bioreactors.

Cost to benefit ratio – both N & P



BMP	Cost benefit ratio (N+P)	
Tillage reduced Fertilizer rate (UMN)	These are free or profitable	Less expensive $
Alternative intakes Controlled drainage Saturated buffer Manure incorporated Wetland construction Riparian buffer Cover crops – short season		
Marginal land to perennials Cover crops in corn/soy (drilled) Bioreactor	Treat effectively but more costly	More expensive $$$

Landowner Perspectives in Trout Brook

General Landowner Perspectives in Trout Brook

Dakota County SWCD staff summarized general landowner perspectives in Trout Brook Subwatershed (Meeting March 30, 2015).

- Overall, staff believes area landowners are aware of the elevated Nitrogen and sediment
- Also, they have heard "what is the big deal with nitrates?" If we didn't have a trout stream… there wouldn't be such an issue…
- Landowners have said that the UM nitrogen recommendations are not appropriate on the coarse textured soils in their region
- Landowner say that they need more N then recommended rates and there is a temptation to put 20 pounds per acre more than they may need
- Generally, they trust crop advisors more than University of Minnesota recommendations
- Landowners know that more regulation is on the horizon in these high N areas
- In December 2014, they learned that in 5 years the MDA will be phasing out fall N applications

Landowner Perspectives on Particular BMPs in Trout Brook

Another snapshot view of landowner interest in particular BMPs is illustrated in Appendix B. This survey was filled out by Dakota County SWCD Resource Conservationist Todd Matzke who has over two decades of experience working with landowners in the Trout Brook Subwatershed (March 2015).

More willingness (score of 4)

- Recommended fertilizer rates
- Placement and timing of application
- Livestock feed management
- Nitrification inhibitors
- Terraces/grass waterways
- Sediment control basins

Medium (score of 3)

- Reducing soil P
- Controlled drainage
- Bioreactors
- Two stage ditches
- Conservation tillage and residue management

Less willingness (score of 2 or 1)

- Perennial Buffers
- Forage and biomass planning
- Perennial energy crops
- Conservation easements and land retirements

Comparison of Nutrient Reduction Strategy, Existing Programs & Landowner Interest

Minnesota Nutrient Reduction Strategy	Dakota County SWCD Current Programs	Snapshot of Current Landowner Interest – Trout Brook Pilot	Cost benefit ratio (N+P)
Fertilizer Use Efficiencies			
Recommended Fertilizer Rates (B)		More willing	Free or profitable
Placement and Timing of application (B)		More willing	
Reducing soil P (P)		Medium	
Livestock feed management (P)	Feedlot improvements	More willing	
Nitrification inhibitors (N)		More willing	
Increase and Target Living Cover			
Cover Crops (B)			Higher cost
Perennial Buffers (B)	Vegetated buffers	Less willing	Lower cost - saturated buffer
Forage and biomass planting (B)		Less willing	
Perennial energy crops (B)		Less willing	
Conservation easements and land retirements (B)		Less willing	Higher cost
Drainage Water Retention and Treatment Infiltration and retention basins			
Constructed Wetlands (N)	Wetland restoration		
Controlled drainage (N)		Medium	Lower cost
Bioreactors (N)		Medium	Higher cost
Two stage ditches (N)		Medium	
Field Erosion Control			Lower cost - Alt-Intakes
Conservation Tillage and residue management (P)		Medium	Free or profitable
Terraces/grasses waterways (P)	Grass waterways	More willing	

Sediment control basins (P)	WASCOB	More willing	
Urban Stormwater and Other sources	Raingardens		
Wastewater Treatment			
Other	Lake and streambank stabilization projects		
Education and Outreach	Continued education and assistance to local landowners and land users.		

Cannon River Watershed Strategy

- Provide a nutrient management staff person at the SWCD or Extension office who can serve as a resource to help producers with nutrient management plans.
- Encourage producers to sign up for nutrient management trials and other demonstration projects to help them reduce commercial nitrogen fertilizer use as much as possible.
- Encourage grid soil sampling, nitrate testing of corn stalks, manure testing, and other diagnostic practices so producers have the best possible understanding of the nitrogen and other nutrient needs of their crops.
- Host *Value of Manure* workshops so producers gain a better understanding of what manure is worth and how best to use it so they reduce over application.
- Work with cooperatives and agricultural retail stores to ensure they understand the issues of nitrate contamination of surface and ground water and are doing what they can to advise producers to make choices that will be good for production and protective of water quality. (Cannon River Watershed Strategy)

How many of each BMP? Cropland BMP Watershed Planning Tools

Nitrogen BMPs & Phosphorus BMPs Planning Tool

Part of the Nutrient Reduction Strategy and the Nitrogen in Minnesota Surface Water Report included an evaluation of the expected reductions to Minnesota waters from individual practices adopted on all land statewide where the practice is suitable for adoption. Two watershed planning tools were created to allow water resource managers and planners to create planning scenarios that depict either a single BMP or a suite of BMPs is adopted at specified levels across the watershed to achieve reductions delineated in Nutrient Reduction Strategy. These cropland BMP Watershed Planning Tools are quick and easy to use:

- N-BMP – Nitrogen BMPs spreadsheet
- P-BMP – Phosphorus BMPs spreadsheet

The N-BMP and P-BMP spreadsheets were developed by the University of Minnesota (William Lazarus, David Mulla,et al.) to enable water resource planners developing either state-level or watershed-level Nitrogen reduction strategies to gauge the potential for reducing Nitrogen and Phosphorus loads to surface waters from cropland, and to assess the potential costs of achieving various reduction goals. The tool merges information on Nitrogen and Phosphorus reduction with landscape adoption limitations and economics. These tools allows water resource managers and planners to approximate the percent reduction of Nitrogen and Phosphorus entering surface waters when either a single BMP or a suite of BMPs is adopted at specified levels across the watershed. The tool also enables the user to identify which BMPs will be most cost-effective for achieving Nitrogen and Phosphorus reductions.

Spreadsheets and documentation at: http://z.umn.edu/nbmp

More information about the N-BMP tool is included in the:

Nitrogen in Minnesota Surface Water Report

Minnesota Watershed Nitrogen Reduction Planning Tool

Cannon River Watershed – Reduction Scenarios

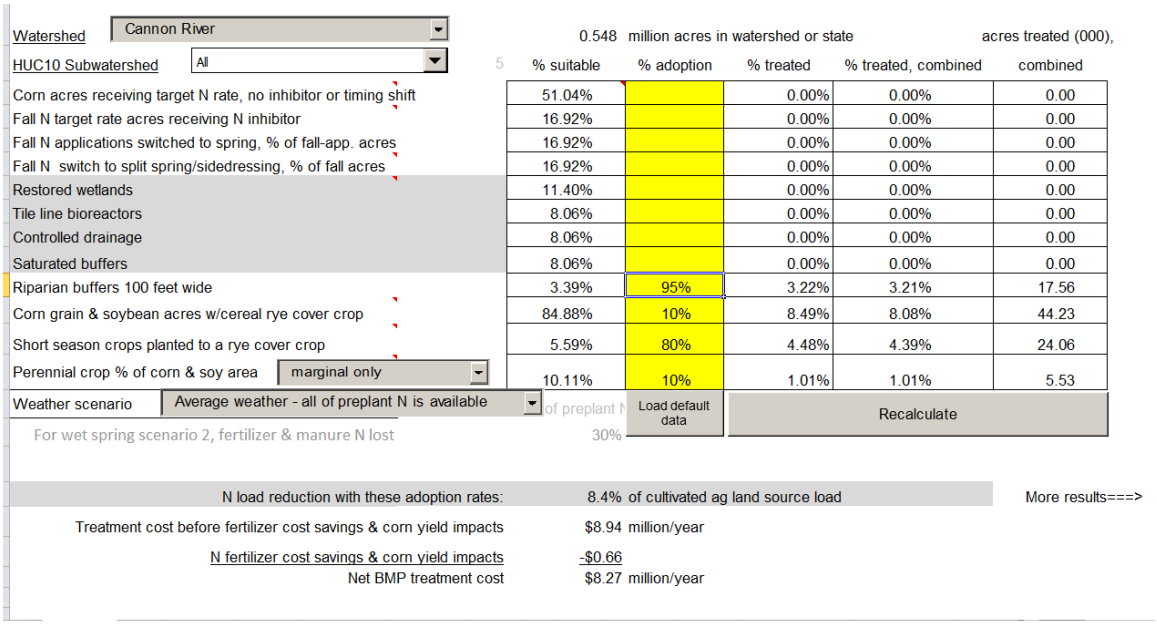
How many of each BMP? Cropland BMP Watershed Planning Tools can help to elucidate how many of different BMPs may be needed to reach nutrient reduction targets. The following scenarios are outputs from the N-BMP and P-BMP spreadsheets to provide an example of what suite of BMPs it would take to achieve target reductions in the Cannon River Watershed. N-BMP and P-BMP can estimate acreages of BMP combinations to achieve specific N and P reductions at watershed (HUC8 or HUC10) scale. These scenarios paint a picture of the combination at a watershed scale but can also be used to broadly inform the potential combination of practices on a subwatershed scale (HUC 12).

N-BMP Tool

The tables below are the output from the N-BMP Tool. It depicts what suite of BMPs adopted at specified levels across the watershed it would take to achieve 20 percent nitrogen reductions in the Cannon River Watershed. These reduction scenarios are examples of how this tool can be used by water resource managers and planners to approximate the percent reduction of Nitrogen entering surface waters when either a single BMP or a suite of BMPs is adopted at specified levels across the watershed.

Scenario #1 - Cannon River Nitrogen Reductions

This scenario starts with BMPs needed for multiple benefits.



Watershed: Cannon River — 0.548 million acres in watershed or state — acres treated (000),
HUC10 Subwatershed: All — 5

	% suitable	% adoption	% treated	% treated, combined	combined
Corn acres receiving target N rate, no inhibitor or timing shift	51.04%		0.00%	0.00%	0.00
Fall N target rate acres receiving N inhibitor	16.92%		0.00%	0.00%	0.00
Fall N applications switched to spring, % of fall-app. acres	16.92%		0.00%	0.00%	0.00
Fall N switch to split spring/sidedressing, % of fall acres	16.92%		0.00%	0.00%	0.00
Restored wetlands	11.40%		0.00%	0.00%	0.00
Tile line bioreactors	8.06%		0.00%	0.00%	0.00
Controlled drainage	8.06%		0.00%	0.00%	0.00
Saturated buffers	8.06%		0.00%	0.00%	0.00
Riparian buffers 100 feet wide	3.39%	95%	3.22%	3.21%	17.56
Corn grain & soybean acres w/cereal rye cover crop	84.88%	10%	8.49%	8.08%	44.23
Short season crops planted to a rye cover crop	5.59%	80%	4.48%	4.39%	24.06
Perennial crop % of corn & soy area: marginal only	10.11%	10%	1.01%	1.01%	5.53

Weather scenario: Average weather - all of preplant N is available — of preplant N — Load default data — Recalculate

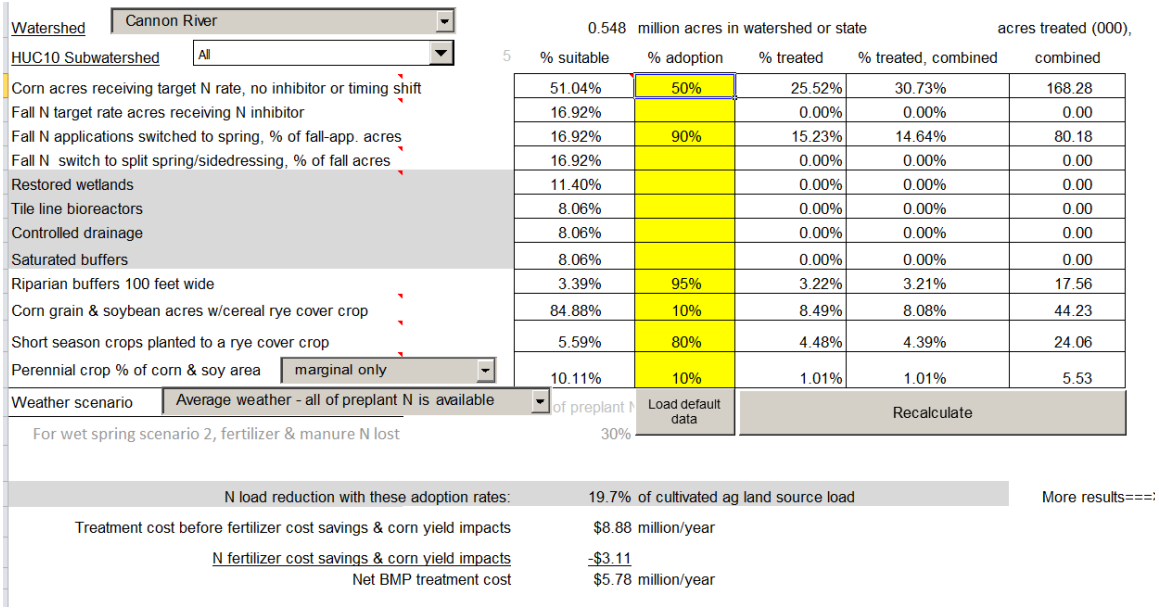
For wet spring scenario 2, fertilizer & manure N lost — 30%

N load reduction with these adoption rates:	8.4%	of cultivated ag land source load
Treatment cost before fertilizer cost savings & corn yield impacts	$8.94	million/year
N fertilizer cost savings & corn yield impacts	-$0.66	
Net BMP treatment cost	$8.27	million/year

More results===>

Scenario #2 - Cannon River Nitrogen Reductions

This scenario adds cost-effective BMPs.

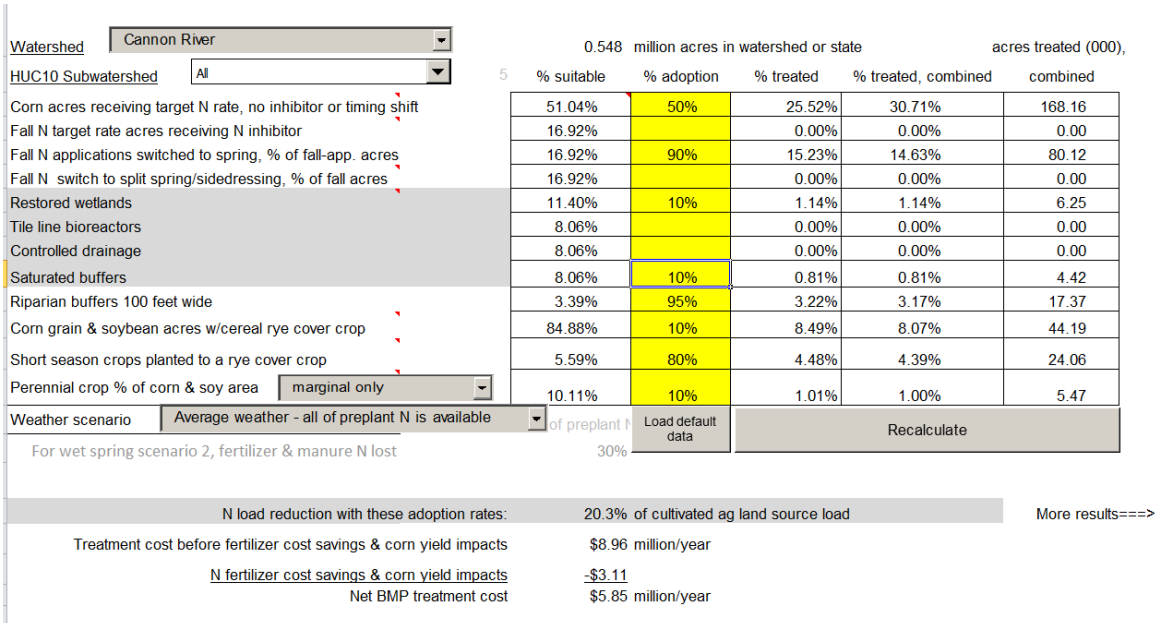


Watershed: Cannon River	0.548 million acres in watershed or state				acres treated (000),
HUC10 Subwatershed: All	5 % suitable	% adoption	% treated	% treated, combined	combined
Corn acres receiving target N rate, no inhibitor or timing shift	51.04%	50%	25.52%	30.73%	168.28
Fall N target rate acres receiving N inhibitor	16.92%		0.00%	0.00%	0.00
Fall N applications switched to spring, % of fall-app. acres	16.92%	90%	15.23%	14.64%	80.18
Fall N switch to split spring/sidedressing, % of fall acres	16.92%		0.00%	0.00%	0.00
Restored wetlands	11.40%		0.00%	0.00%	0.00
Tile line bioreactors	8.06%		0.00%	0.00%	0.00
Controlled drainage	8.06%		0.00%	0.00%	0.00
Saturated buffers	8.06%		0.00%	0.00%	0.00
Riparian buffers 100 feet wide	3.39%	95%	3.22%	3.21%	17.56
Corn grain & soybean acres w/cereal rye cover crop	84.88%	10%	8.49%	8.08%	44.23
Short season crops planted to a rye cover crop	5.59%	80%	4.48%	4.39%	24.06
Perennial crop % of corn & soy area: marginal only	10.11%	10%	1.01%	1.01%	5.53
Weather scenario: Average weather - all of preplant N is available	of preplant N	Load default data	Recalculate		
For wet spring scenario 2, fertilizer & manure N lost	30%				

N load reduction with these adoption rates:	19.7% of cultivated ag land source load	More results===>
Treatment cost before fertilizer cost savings & corn yield impacts	$8.88 million/year	
N fertilizer cost savings & corn yield impacts	-$3.11	
Net BMP treatment cost	$5.78 million/year	

Scenario #3 - Cannon River Nitrogen Reductions

This scenario adds tile drainage treatment.



Watershed: Cannon River	0.548 million acres in watershed or state				acres treated (000),
HUC10 Subwatershed: All	5 % suitable	% adoption	% treated	% treated, combined	combined
Corn acres receiving target N rate, no inhibitor or timing shift	51.04%	50%	25.52%	30.71%	168.16
Fall N target rate acres receiving N inhibitor	16.92%		0.00%	0.00%	0.00
Fall N applications switched to spring, % of fall-app. acres	16.92%	90%	15.23%	14.63%	80.12
Fall N switch to split spring/sidedressing, % of fall acres	16.92%		0.00%	0.00%	0.00
Restored wetlands	11.40%	10%	1.14%	1.14%	6.25
Tile line bioreactors	8.06%		0.00%	0.00%	0.00
Controlled drainage	8.06%		0.00%	0.00%	0.00
Saturated buffers	8.06%	10%	0.81%	0.81%	4.42
Riparian buffers 100 feet wide	3.39%	95%	3.22%	3.17%	17.37
Corn grain & soybean acres w/cereal rye cover crop	84.88%	10%	8.49%	8.07%	44.19
Short season crops planted to a rye cover crop	5.59%	80%	4.48%	4.39%	24.06
Perennial crop % of corn & soy area: marginal only	10.11%	10%	1.01%	1.00%	5.47
Weather scenario: Average weather - all of preplant N is available	of preplant N	Load default data	Recalculate		
For wet spring scenario 2, fertilizer & manure N lost	30%				

N load reduction with these adoption rates:	20.3% of cultivated ag land source load	More results===>
Treatment cost before fertilizer cost savings & corn yield impacts	$8.96 million/year	
N fertilizer cost savings & corn yield impacts	-$3.11	
Net BMP treatment cost	$5.85 million/year	

Scenario #4 - Cannon River Nitrogen Reductions

This scenario provides another example of BMPs at different adoption rates.

has been included which will trace the precedent cells for any formula. Press ctrl-T to run this macro. Press ctrl-Y to remove the arrows afterward.

0.515 million acres in watershed or state

Watershed: Cannon River

	5 % suitable	% adoption	% treated	% treated, combined	acres treated (000), combined
Corn acres receiving target N rate, no inhibitor or timing shift	51.52%	40%	27.93%	26.61%	136.93
Fall N target rate acres receiving N inhibitor	18.29%		0.00%	0.00%	0.00
Fall N applications switched to spring, % of fall-app. acres	18.29%	80%	14.63%	14.03%	72.20
Fall N switch to split spring/sidedressing, % of fall acres	18.29%		0.00%	0.00%	0.00
Restored wetlands	11.81%	40%	4.73%	4.73%	24.32
Tile line bioreactors	8.07%		0.00%	0.00%	0.00
Controlled drainage	8.07%		0.00%	0.00%	0.00
Saturated buffers	8.07%	40%	3.23%	3.23%	16.61
Riparian buffers	3.25%	95%	3.08%	2.97%	15.30
Corn grain & soybean acres w/cereal rye cover crop	86.65%	10%	8.67%	8.25%	42.47
Short season crops planted to a rye cover crop	5.21%	80%	4.17%	4.11%	21.14
Perennial crop % of corn & soy area (marginal only)	8.39%	10%	0.84%	0.81%	4.17

Weather scenario: Average weather - all of preplant N is available

Load default data | Recalculate

For wet spring scenario 2, fertilizer & manure N lost: 30%

N load reduction with these adoption rates:	19.8%	of cultivated ag land source load
Treatment cost before fertilizer cost savings & corn yield impacts	$9.60	million/year
N fertilizer cost savings & corn yield impacts	-$2.45	
Net BMP treatment cost	$7.14	million/year

More results===>

P-BMP Tool

Phosphorus Best Management Practice Watershed Planning Tool (P-BMP)

Scenario #1 - Cannon River Watershed Phosphorus

The table below is the output from the P-BMP Tool. It depicts what suite of BMPs adopted at specified levels across the watershed it would take to achieve 12 percent Phosphorus reductions in the Cannon River Watershed. This tool can be used by water resource managers and planners to approximate the percent reduction of P entering surface waters when either a single BMP or a suite of BMPs is adopted at specified levels across the watershed.

Watershed: Cannon River — 0.515 million acres o

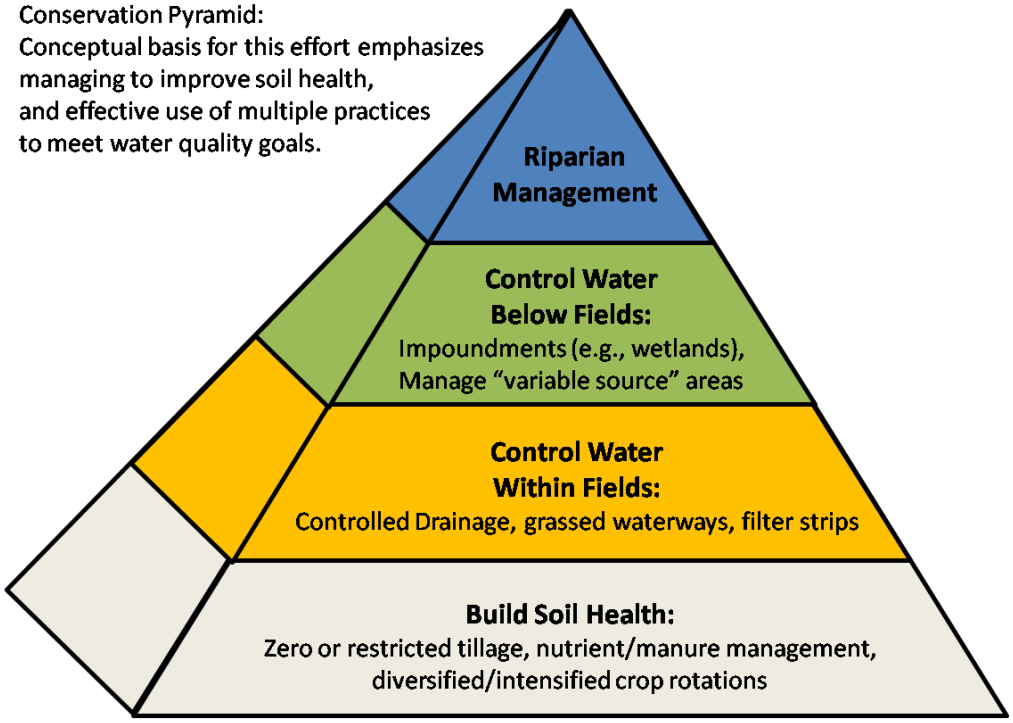
Pathway	% existing	% suitable	% adoption	% treated	acres treated (million)
Apply U of MN recs					
Target P2O5 rate	45.93%	45.93%	10%	4.59%	0.02
Fall corn&wheat fert to preplant/starter	38.25%	13.27%	0%	0.00%	0.00
Use reduced tillage	34.53%	65.47%	40%	26.19%	0.13
Riparian buffers, 50 ft wide	7.80%	4.01%	95%	3.81%	0.02
Perennial crop % of marginal only	0.00%	8.22%	10%	0.82%	0.00
Corn grain & soybean acres w/cereal rye cover crop	0.00%	86.65%	10%	8.67%	0.04
Short season crops planted to a rye cover crop	0.00%	5.21%	80%	4.17%	0.02
Controlled drainage	0.00%	8.07%	0%	0.00%	0.00
Alternative tile intakes	2.22%	6.66%	40%	2.66%	0.03
Inject or incorp manure	8.76%	5.01%	40%	2.00%	0.01
Total for all BMPs					
Weather Scenario:	Average weather		Load default data		Recalcu

P load reduction with these adoption rates:	12.3%	
Treatment cost before fertilizer cost savings	$6.75	million/year
P fertilizer cost savings	-$0.69	
Net BMP treatment cost	$6.06	million/year

Agricultural Conservation Planning Framework (ACPF)

The Agricultural Conservation Planning Framework (ACPF) was developed at the National Laboratory for Agriculture and the Environment by Mark Tomer, Sarah Porter and David James. The ACPF is a set of precision conservation planning tools to help facilitate a "watershed approach" to conservation planning through a participatory process involving landowners. The approach emphasizes the need to improve soil health across a watershed, and provides multiple options to place a variety of structural and vegetative practices to control, trap, and treat water flows within and below fields in locations suited to each type of practice.

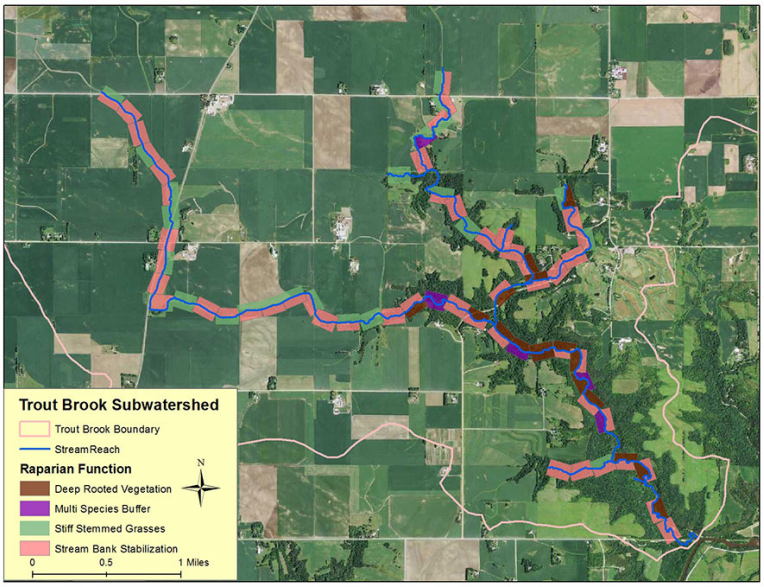
The Agricultural Conservation Planning Framework (ACPF) comprises a set of ArcTools that can identify multiple options for site-specific placement of conservation practices throughout a watershed based on landscape (hydrologic) and soil criteria, which allows local farm producers the discretion to select preferred practices and locations. The ACPF tools have been applied in HUC12 watersheds in four states. Using these precision conservation GIS tools, we can illustrate the flexibility of planning approaches and options that can be provided at the watershed-scale and work with farm operators towards watershed reduction goals.



More information about the ACPF can be found: *Journal of Soil and Water Conservation September/October 2013 vol. 68 no. 5 113A-120.* Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning.
http://www.swcs.org/documents/filelibrary/15ac/Final_Program_7222015_web_78B3A47472B56.pdf

ACPF Summary of Trout Brook

Appendix C includes summary output from the ACPF for Trout Brook Subwatershed.



Dakota County SWCD Staff Reflections on ACPF Tool

A few comments from Dakota County SWCD staff that have been working with the outputs:

- The Flow Network closely resembles the manually digitized flowlines that out GIS Specialist created several years ago. This helps instill confidence in the level of precision in the data.
- The outputs are a good starting point when doing the field reconnaissance. A lot of time was saved by prioritizing locations and knowing where to look.
- Many of the WASCOB locations which were identified would have a low probability of being installed. This really stems from a lack of contour farming and unwillingness to change farming practices.
- Land use data was good to have, even though reliability long-term may not be that great due to changing rotations/landowners. We were wondering how much time was needed to generate this data- whether the upfront time would be worth it on future projects.
- Burnlines and culverts are great for hydrology /design. How much time went into creating a hydrologically corrected DEM?
- As far as future use, we are still comparing available tools. As of now, it is looking like the ACPF tool or the PTMApp would be most likely for future use. Once the PTMApp is further developed, we will be doing a close comparison to see which tool is most useful.

ACPF Development

ACPF developers from the National Laboratory for Agriculture and the Environment created another version of the tool after hearing feedback from project partners and addressed many of the concerns in the latest version. Additionally, ACPF developers are currently including more economic data into the ACPF and anticipate completion in Winter 2015.

Trout Brook Goals & Strategies

The NRS acknowledges that the real action and decisions happen at the local level – within the watersheds. The strategy is a big picture strategy which sets up the framework for local detailed strategies. Individual watersheds will determine how to specifically achieve the reductions needed in their watershed and for downstream purposes.

The NRS works at the largest scale but recognizes that it must be relevant at where the action occurs, at the local and farm levels. The state-level nutrient reduction strategy is meant to establish a large scale big picture framework, under which fits individualized watershed planning. Action happens at the local level – on the farms and in the cities.

Nitrogen Goals

Minnesota Nutrient Reduction Strategy Goals – Mississippi River
10 Year Target: **20% reduction**

Cannon River Watershed Partnership
Priority Management Zone to reduce high nitrates (CRWP)

Dakota County SWCD
Provide technical assistance and cost sharing for Best Management Practices which reduce nitrate pollution, targeting identified sources including row crop agriculture and animal feedlot operations (Dakota County SWCD)

Local Partners are currently working to craft WRAPS…

Sources:
Research suggests that row crop agriculture and animal feedlots are the likely sources of nitrate contamination in Trout Brook, although the proportion attributed to each source is difficult to determine (Groten and Alexander 2013)

Phosphorus Goals

Minnesota Nutrient Reduction Strategy Goals – Mississippi River

Phosphorus - 10 Year Target: 12% reduction (33% already obtained) for a total **45% reduction**

Dakota County SWCD – Nutrient Planning Approach

Subwatershed Approach

Dakota County SWCD has a long history of engaging citizens in this region. Staff has been working one-on-one with landowners in the Trout Brook area for over 20 years. Historically, Dakota County used a first come, first serve approach to landowners seeking conservation assistance. They are now changing their outreach approach, networking with landowners on a more targeted, subwatershed approach. Dakota County has 10 subwatersheds and they are planning to rotate through them on a 10 year cycle. They plan to pick a subwatershed, create a targeted list where BMPs are needed, get them designed and work with landowners to get them funded and implemented. Dakota SWCD is currently interested in applying for Clean Water Funds and developing a list of projects in hopes of securing funding for many of them.

Dakota County SWCD specified their broad approach in the report Nitrate in Trout Brook (Dakota SWCD, 2014):

> Continued education and assistance to local land owners and land users. Provide technical assistance and cost sharing for Best Management Practices which reduce nitrate pollution, targeting identified sources including row crop agriculture and animal feedlot operations.

Step 1 – Desktop Analysis with ACPF Tool

Dakota County met with ACPF developers on May 12, 2015 and acquired the latest version of the ACFP. Using the outputs from the ACPF tool, Dakota County SWCD staff created field maps for each mile section showing identified BMPs as well as relevant information such as parcel boundaries, landowner information, existing and previously installed BMPs.

Broadly, Dakota SWCD staff commented about the potential time-savings that this type of GIS tool can offer. From their point of view, the SWCD could send experienced technician to focus on part of the subwatersed with aerial maps and pour over landscape for three weeks to ground truth and identify basins and waterways. Their philosophy was that an experienced person with local knowledge is hard to replicate but tools can help to focus effort.

Appendix C includes the outputs from the ACPF tool in Trout Brook Subwatershed.

Step 2 – Field Reconnaissance

Dakota County SWCD Resource Conservationist staff members used the maps for field reconnaissance to determine the feasibility and effectiveness of each BMP. Field work was performed in spring and early summer 2015 while crops were short. Based on field and GIS measurements and construction costs based on similarly completed projects, we created a table of projects based on the cost-benefit table of each of the BMPs that was deemed practical.

Step 3 – Finalizing and Ranking Projects

Staff examined the table of potential projects, potential pollutant removal, and costs per project. Dakota SWCD is in the process of finalizing and ranking of projects based on cost-benefit analysis. Pollution reduction ranking is also part of their equation. Initial research showed 330 potential projects

in Trout Brook Subwatershed. Staff anticipate that they would like to target 100 projects for implementation priorities. These tools can help to clarify which BMPs to prioritize and where.

Step 4 – Landowner Outreach

Dakota SWCD staff will reach out to landowners to discuss BMP options in targeted areas. Dakota County SWCD is currently developing its landowner outreach strategy. It will be built on the long-term relationships that staff have developed over the years.

Step 5 – BMP Implementation

The next step is to promote BMP adoption using existing programs and apply for other funding sources to support BMP implementation over the upcoming years.

Dakota SWCD Potential Focused BMPs for Trout Brook Nutrient Reduction

Nitrogen

- Cover Crops
- N Reduction through Fertilizer Management

Dakota SWCD approach aligns with the research for Nitrogen reduction in the NRS. Nitrogen reduction potential in Mississippi Basin largest with: successful cover crops (23%); fertilizer efficiency gains (10-20%) Phosphorus reduction potential in Mississippi Basin largest with cover crops (22%); riparian buffers (9%); reduced/conservation tillage (7%)

Sediment

- Gully Management
- Residue Management
- WASCOBS
- Grass Waterways

References

Cannon River Watershed Partnership. 2011. Cannon River Watershed Strategy.

Cannon River Watershed Partnership, MSU-WRC. 2011. Signs of Progress: The State of the Cannon and Straight Rivers.

Dakota County Soil and Conservation District. March 2014. Nitrate in Trout Brook, Dakota County, Minnesota.

Dakota County Soil and Conservation District. Dakota County Soil and Water Conservation District Comprehensive Plan 2011-2015

Groten, J and E.C. Alexander, Jr. 2013. Karst Hydrogeologic Investigation of Trout Brook, Dakota County, Minnesota.

Hoisington Koegler Group, Inc.. July 2005. Miesville Ravine Park Master Plan for Dakota Parks.

Minnesota Pollution Control Agency. June 2014. Cannon River Watershed Monitoring and Assessment Report

Minnesota Pollution Control Agency. Runkel, C., J.R. Steenberg, R.G. Tipping, A.J. Retzler (2013). Geologic Controls on Groundwater and Surface Water Flow in Southeastern Minnesota and its Impact on Nitrate Concentrations in Streams.

Minnesota Pollution Control Agency. Wall, D., D. Mulla, S. Weiss, D. Wasley, T.E. Pearson, B. Henningsgaard. June 2013. Nitrogen in Minnesota Surface Waters.

Minnesota Pollution Control Agency. September 2014. Minnesota Nutrient Reduction Strategy.

NRCS. 2009. Cannon River - Rapid Watershed Assessment.

Minnesota Nutrient Planning Portal (website)

St. Olaf. Cannon River Project (website)

Watkins, J., N. Rasmussen, G. Johnson, B. Beyer. 2011. Relationship of Nitrate-Nitrogen Concentrations in Trout Streams to Row Cropland Use is Karstland Watershed of Southeast Minnesota, 2011 GSA Annual Meeting, Poster Session No. 108.

Tomer, M.D., S.A. Porter, D.E. James, K.M.B. Boomer, J.A. Kostel, and E. McLellan. 2013. Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning. Journal of Soil & Water Conservation. 68:113A-120A.

Agricultural Conservation Planning Framework: 1. Developing Multipractice Watershed Planning Scenarios and Assessing Nutrient Reduction Potential

Agricultural Conservation Planning Framework: 2. Classification of Riparian Buffer Design Types with Application to Assess and Map Stream Corridors

http://www.swcs.org/documents/filelibrary/15ac/Final_Program_7222015_web_78B3A47472B56.pdf