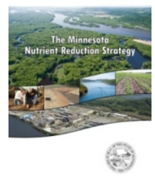
September 2015

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 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:

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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

Cover photo of Watson Creek courtesy of Minnesota Pollution Control Agency

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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.

Root River Watershed – Watson Creek Subwatershed Pilot

Fillmore County SWCD has a long history of working with landowners in the Watson Creek Subwatershed to address pollution problems. For their next steps, they are currently working with Minnesota Department of Agriculture to set up demonstration plots in Watson Creek to continue to connect with and educate producers they have already been working with as well as to expand the conversation with more producers across the subwatershed. In 2017, Fillmore County will be working with Minnesota Department of Agriculture on the Township (Nitrate) Testing Program as part of the Minnesota Nitrogen Fertilizer Management Plan to determine current nitrate-nitrogen concentrations in private wells on a township scale. Fillmore County staff envision that they will assemble a local advisory committee as an outgrowth of the Nitrate Township Testing Program to address emerging groundwater concerns. They envision the committee being comprised of producers that they have been working with over the years as well as cooperators on the well testing and demonstration plots. Additionally, recent geologic research has enabled managers to better understand how water flows through karst landscapes and is helping them to prioritize BMP placement in the upper part of the subwateshed where the karst influence is the greatest.

Nutrients in the Root River Watershed

Root River Watershed Overview

The Root River watershed covers 1,064,961 acres in southeast Minnesota within the Lower Mississippi River Basin. The watershed drains west to east before joining the Mississippi River approximately five miles east of the small town of Hokah, Minnesota. The watershed primarily lies within the Driftless Area ecoregion with a small portion in part of the Western Corn Belt Plains ecoregion.

Counties containing parts of this watershed include Dodge, Mower, Olmsted, Winona, Fillmore, and Houston. The Root River watershed avoided much of the historic glaciation that covered Minnesota, and is comprised of karst (limestone) topography. The limestone rock, as it erodes, forms underground streams, springs, and sink holes (USDA-NRCS, 2009).

The land has limited capacity to store water on the land surface; as a result, there are few lakes in the Root River watershed. Numerous small tributaries drain to the various forks and branches of the Root River (Root River Monitoring and Assessment Report, 2012).

Land use summary

The Root River watershed has a variety of different land uses making up the landscape. Cropland is the most prevalent land use type (41.02 percent). This land use is common in the fertile plains area in the western portion of the watershed, but also in the river valleys located throughout the driftless area. Rangeland (30.7 percent) and forest/shrubland (22.1 percent) are the next most common land uses and found primarily in the rolling hills and bluff regions located in the eastern half of the watershed. Some development (5.3 percent) exists in the watershed and is located around the smaller cities and communities including Chatfield, Rushford, Stewartville, Preston, Spring Valley, Houston, Lanesboro, Grand Meadow, Hokah, and Mabel. Very few areas of wetlands (0.7 percent) and open water (0.2 percent) exist in the watershed (Root River Monitoring and Assessment Report, 2012).

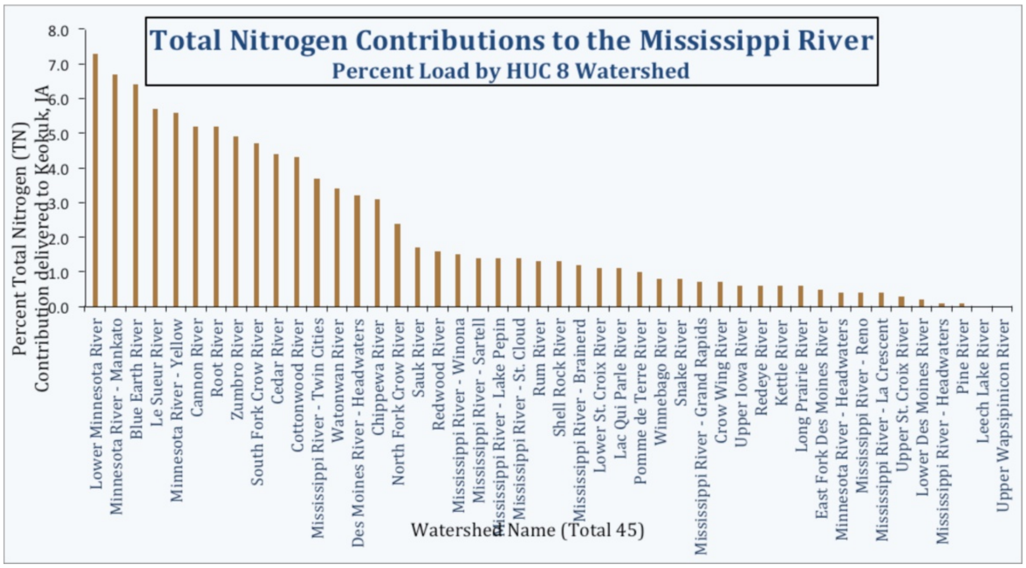
Hydrology and groundwater quality

Geology in southeast Minnesota is characterized by karst features. These geologic features occur where limestone is slowly dissolved by infiltrating rainwater, sometimes forming hidden, rapid pathways from pollution release points to drinking water wells or surface water (MPCA 2011). Karst aquifers, like those commonly used in the Root River watershed, are very difficult to protect from activities at the ground surface. While pollutants are quickly transported to drinking water wells or surface water, conventional hydrogeologic tools such as monitoring wells are of limited usefulness. The best strategy is pollution prevention from common sources like septic systems, abandoned wells, and animal feedlot operations (Root River Monitoring and Assessment Report, 2012).

The Ambient Groundwater Monitoring Program at the MPCA tracks trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. Three locations within the Root River watershed are monitored by the MPCA. These wells are domestic supply wells and draw from bedrock aquifers. Results from this monitoring have shown no exceedances of health-based standards for the sampled analytes (Root River Monitoring and Assessment Report, 2012).

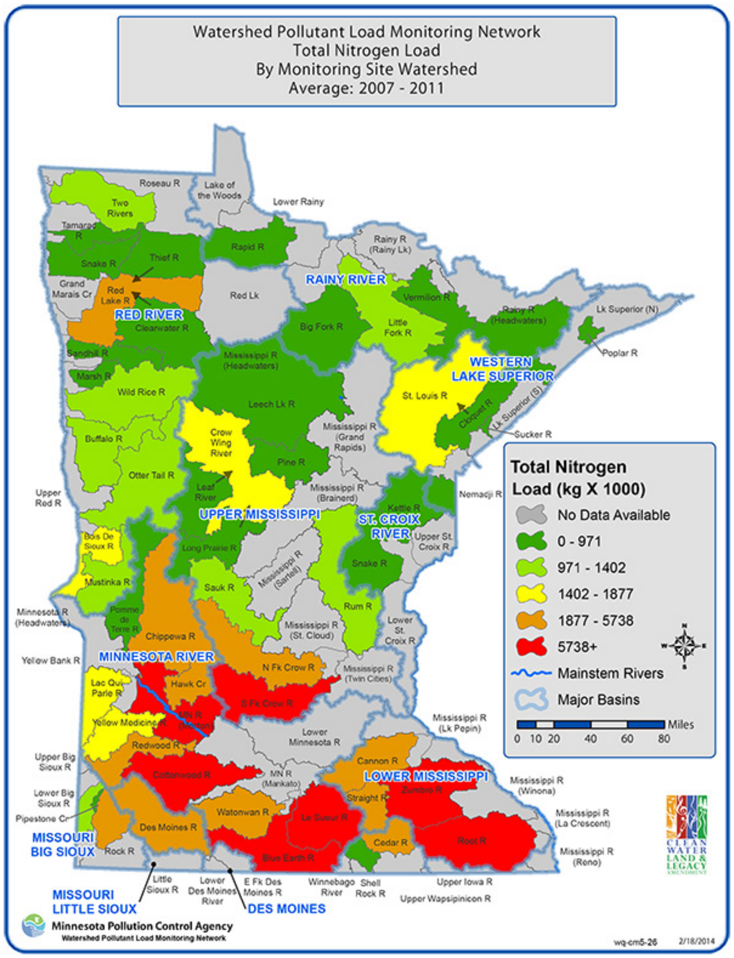
Nitrogen Load: Mississippi River

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 Root River Watershed ranks 7th contributing 5.2% of the load to the Mississippi River at Keokuk, Iowa (Nitrogen in Minnesota Surface Waters, 2013).



Minnesota Nutrient Planning Portal, Nitrogen in Minnesota Surface Waters, 2013

MPCA's Watershed Pollutant Load Monitoring Network data shows Root River as a high loader of Nitrogen to the Mississippi River. Higher loading watersheds are indicated in red.



http://www.pca.state.mn.us/index.php/view-document.html?gid=19288

Root River Long Term Nitrogen Trends

(Bridge on MN 26, 3 miles east of Hokah)

Long term water chemistry data indicate that nitrates are increasing in the Root River from 1958-2008.

1958-2008

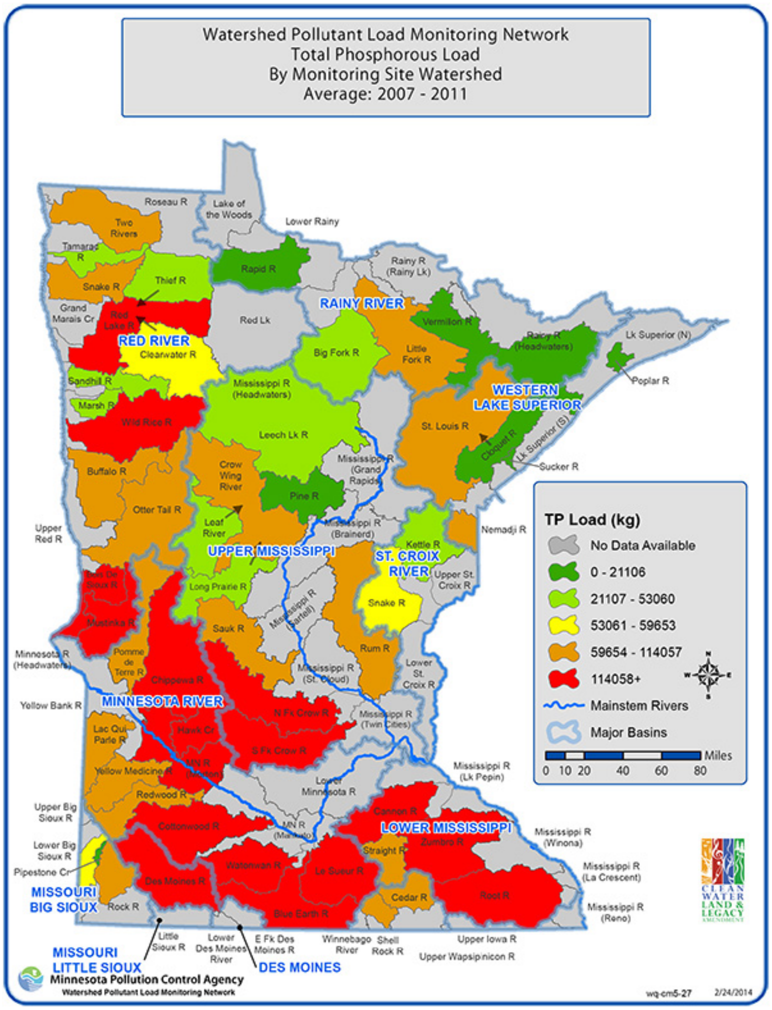
Indicates an increase in Nitrite/Nitrate
Average Annual Change: Increase +3.7% (355% total change)

1995-2009

Indicates an increase in Nitrite/Nitrate
Average Annual Change: Increase +2.2% (39% total change)
(Root River Monitoring and Assessment Report, 2012)

Phosphorus Load

MPCA's [Watershed Pollutant Load Monitoring Network] data shows Root River as a high loader of Total Phosphorus to the Mississippi River. Higher loading watersheds are indicated in red.



http://www.pca.state.mn.us/index.php/view-document.html?gid=19287

Root River Long Term Phosphorus Trends

(Bridge on MN 26, 3 miles east of Hokah)

Long term water chemistry stations indicate that phosphorus and turbidity levels are decreasing while nitrates are increasing in the Root River (1958-2008).

1958-2008

Indicates a decrease in Total Phosphorus
Average Annual Change: - 2.4% (-70% total change)

1995-2009

Indicates no trend in Total Phosphorus
(Root River Monitoring and Assessment Report, 2012)

Nutrient Related Water Quality Data

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

Minnesota Pollution Control Agency. June 2012. Root River Watershed Monitoring and Assessment Report.

Minnesota Pollution Control Agency. January 2015. Root River Watershed Stressor Identification Report.

Minnesota Nutrient Planning Portal (website) contains Root River nutrient information about 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

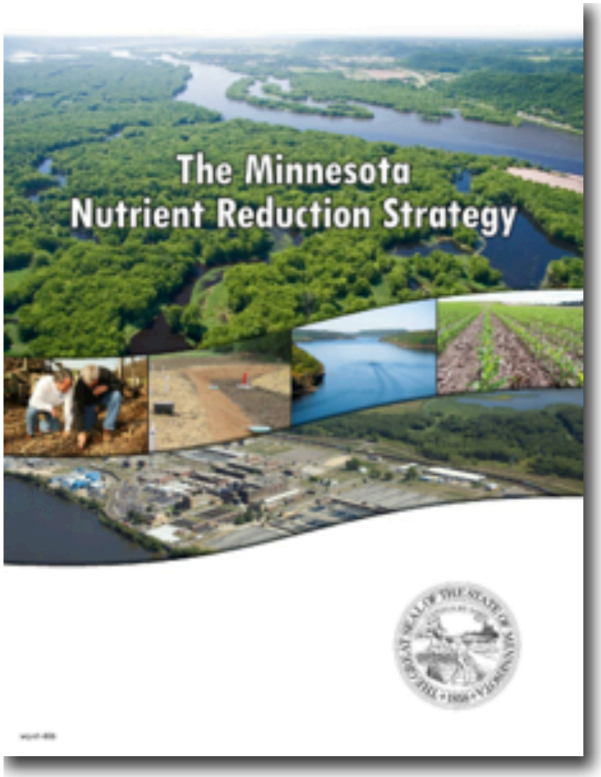
USGS – USGS discharge Information

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.

Root River Watershed Existing Plans and 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.

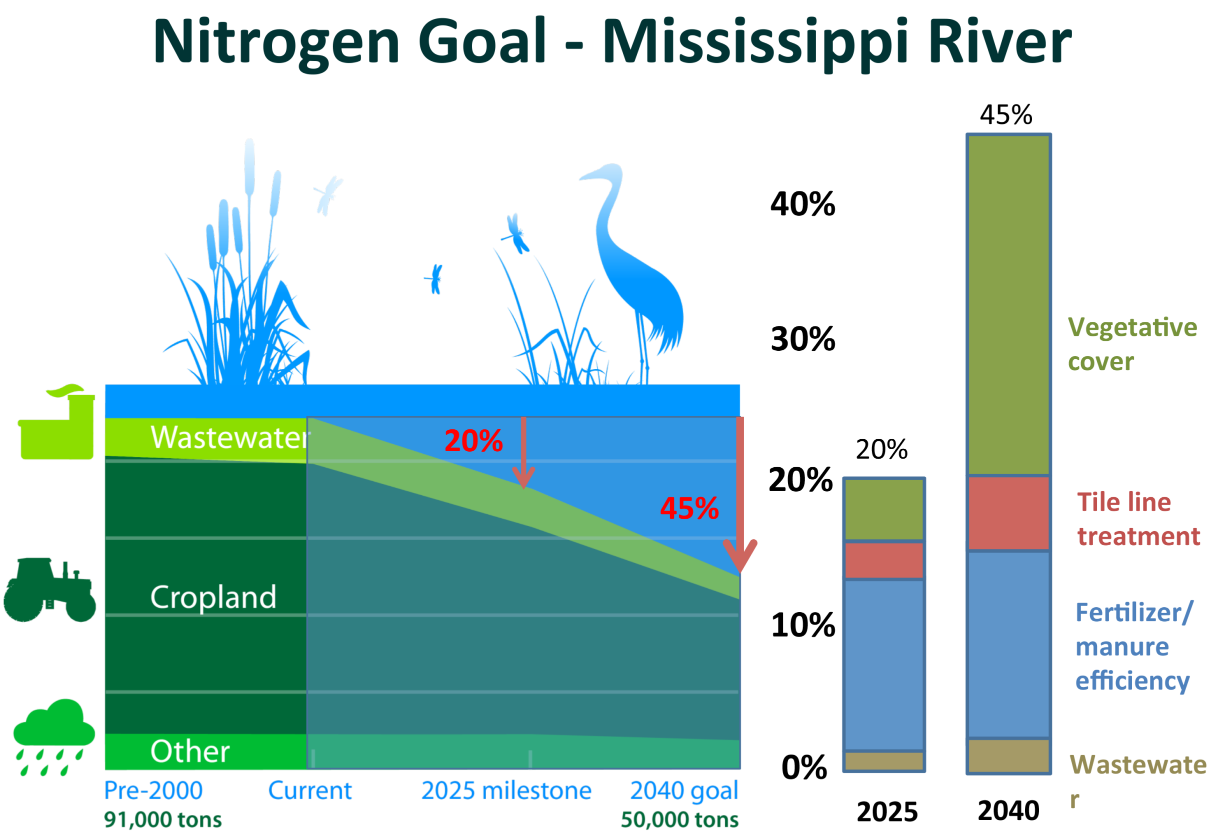
The Minnesota Nutrient Reduction Strategy outlines key measures that could be implemented in urban and agricultural areas in the Mississippi River Basin in Minnesota where phosphorus and nitrogen reductions are needed in order to reduce nutrient loading to Lake Pepin and the Mississippi River. Some best 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.

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

Baseline Load (1980–1996) Units = 1,000 metric tons (MT) per year	Agricultural	Wastewater	Miscellaneous	Total
	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 ▪ Recommended fertilizer rates ▪ Placement and timing of application ▪ Nitrification inhibitors	11			
Increase and Target Living Cover on 1.6 Million Acres ▪ Cover crops ▪ Perennial buffers ▪ Forage and biomass planting ▪ Perennial energy crops ▪ Conservation easements and land retirement	4.0			
Drainage Water Retention and Treatment for 0.6 Million Acres ▪ Constructed wetlands ▪ Controlled drainage ▪ Bioreactors ▪ Two stage ditches	1.2			
Wastewater Treatment		1.9		
Total Reductions	16.2 +	1.9 +	0 +	0 = Total 18.2

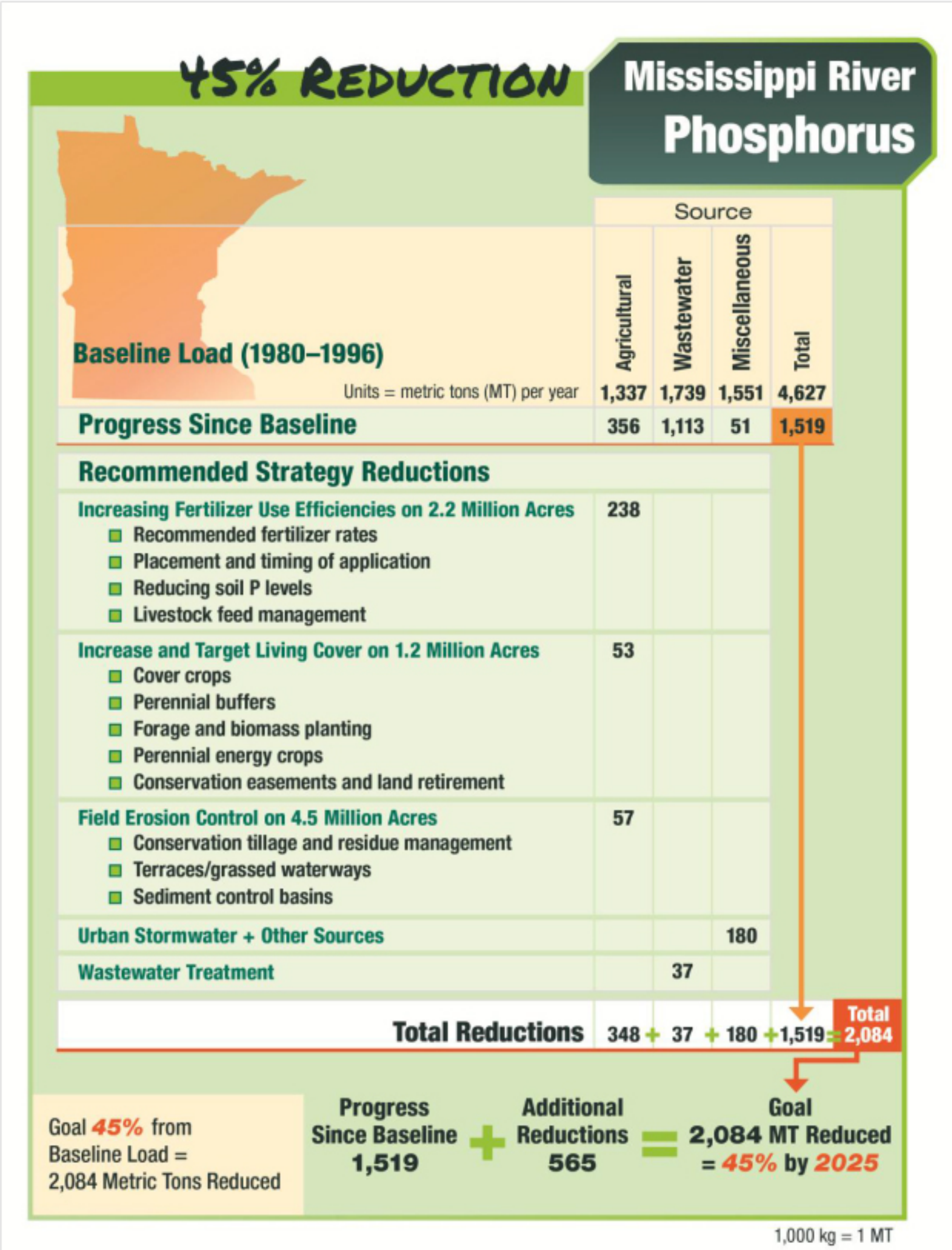
Milestone Target **20%** from Baseline Load = 18,200 Metric Tons Reduced

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

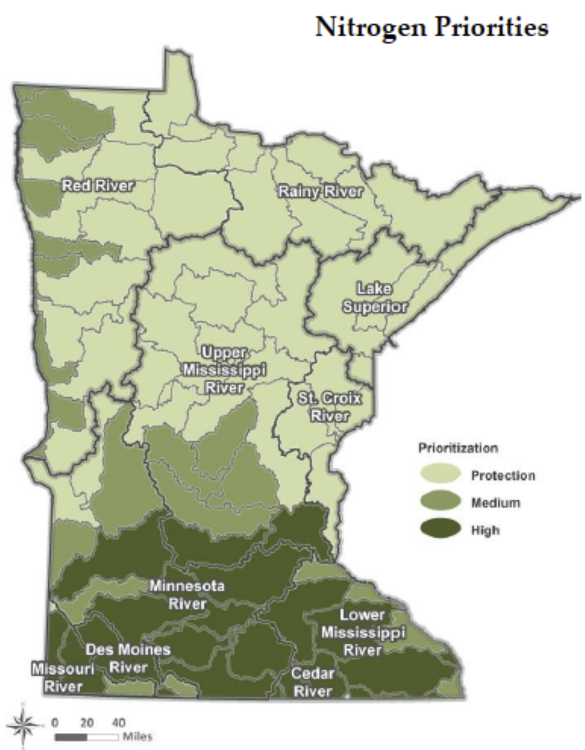
The graphic below illustrates the Minnesota Nutrient Reduction Strategy recommended approach for Phosphorus milestone reductions for the Mississippi River.

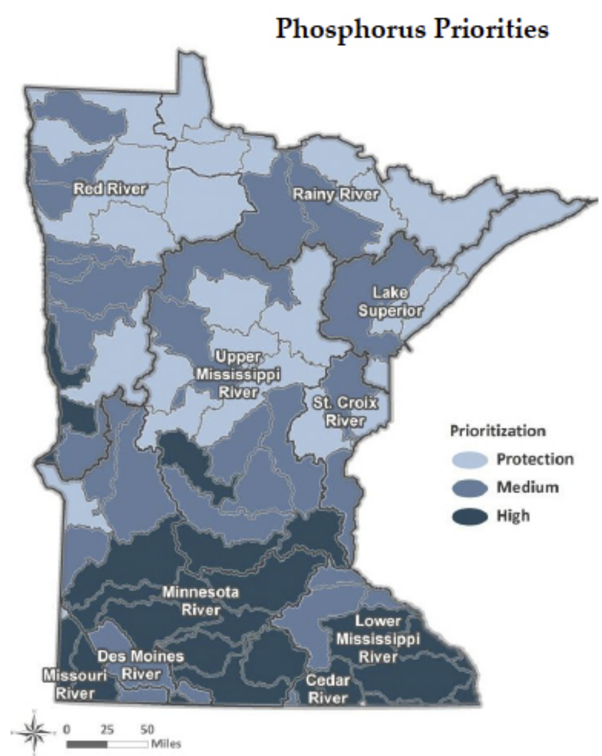


Priority Watersheds

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.

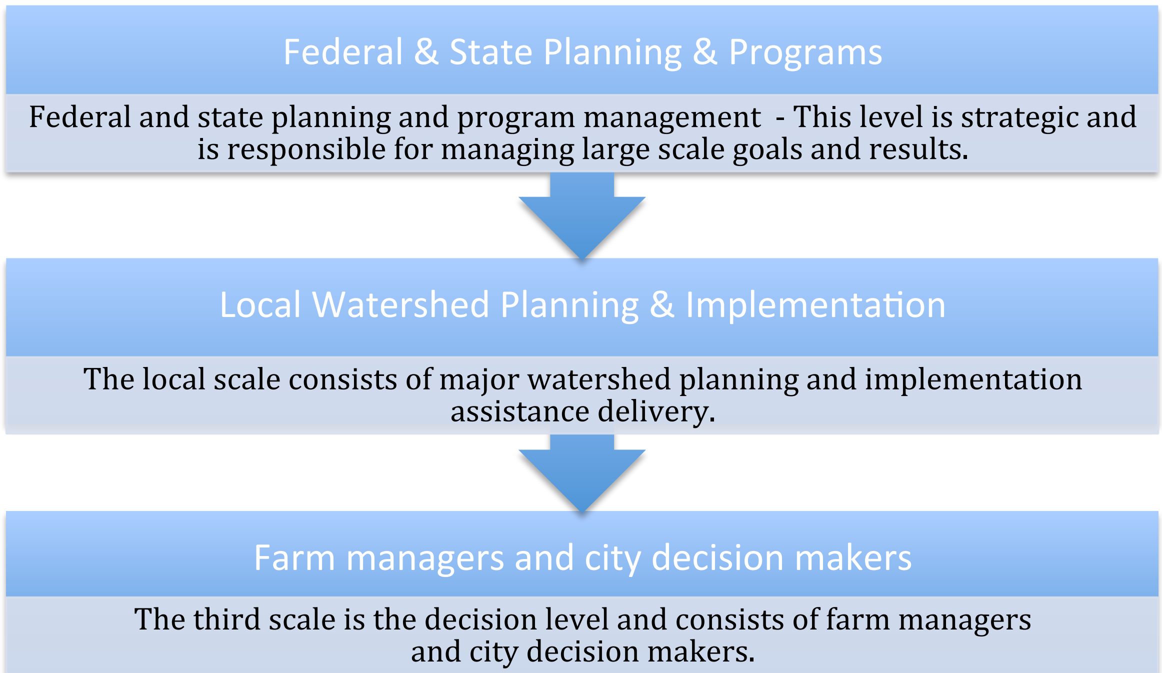
The Root River Watershed is indicated as a "high" priority watershed for both Nitrogen and Phosphorus. The NRS is a big picture strategy which sets up the framework for local detailed strategies. The real action and decisions happen at the local level – within the watersheds. Individual watersheds will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





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).

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.

MPCA Watershed Planning Approach

The Root 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 Root River Watershed began the cycle in 2008.

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

Monitor water bodies and collect data

Root River Watershed Monitoring and Assessment Report

Root River Watershed Stressor Identification Report

Summary — Root River Watershed Stressor Identification Report

Assess the data

Develop Strategies

Root River Watershed Restoration and Strategies (WRAPS) & Total Maximum Daily Load (TMDL) Reports are currently in development (as of September 2015).

Conduct restoration and protection projects

MPCA's Root River Watershed website lists a host of implementation activities in progress and/or completed.

NRCS Rapid Assessment – Resource Concerns

All of the Resource Concerns delineated in NRCS Root River Rapid Watershed Assessment (USDA-NRCS, 2009) have nutrient related concerns. County Soil and Water Conservation Districts in the watershed have identified the following resource concerns as top priorities for conservation and cost sharing efforts:

- **Sediment and Erosion Control.** Excessive amounts of suspended solids from cropland, urban lands, streambanks and streambeds is a primary threat to area waters. Working hand-in-hand with stormwater pollution and prevention plans and nutrient management plans, counties in the watershed seek to retain water on the landscape to reduce flooding and subsequent soil erosion, and improve water resources.

- **Stormwater Management.** Local districts recognize that stormwater runoff volume from impervious surfaces will likely increase as development of the watershed continues. Existing stormwater systems typically bypass treatment plants and discharge storm water directly into sinkholes and stream

- **Drinking Water and Source Water Protection.** The Root River region is particularly susceptible to groundwater contamination as a result of permeable soils and karst features. Ease of infiltration, aging septic systems, abandoned wells and historical tiling practices threaten public drinking water supplies.

- **Feedlot and Animal Waste Management**. Managing farms to minimize excess nutrients, pathogens, and odors released into the environment is important to the health of surface and ground water. Setback of open tile intakes and placement of agricultural waste systems in high priority riparian areas and areas with highly permeable soils will greatly reduce the effects of animal feed operations on area waters.

- **Nutrient Management.** Excessive amounts of nutrients, namely phosphorus and nitrogen, contaminate groundwater and create nuisance algae presence in area waters. Major contributors are cropland, urban grasses, municipal wastewater, aging or non-compliant septic systems, and internal cycling.

- **Wetland Management.** Due to the historical draining of much of the areas wetlands, homogenic agricultural practices priority is given to both wetlands preservation and restoration. Restoration of wetlands, dam repair and placing flood-prone lands in CRP/RIM all serve to lessen the impact of flooding and sedimentation, and improve drainage (NRCS-USDA, 2009).

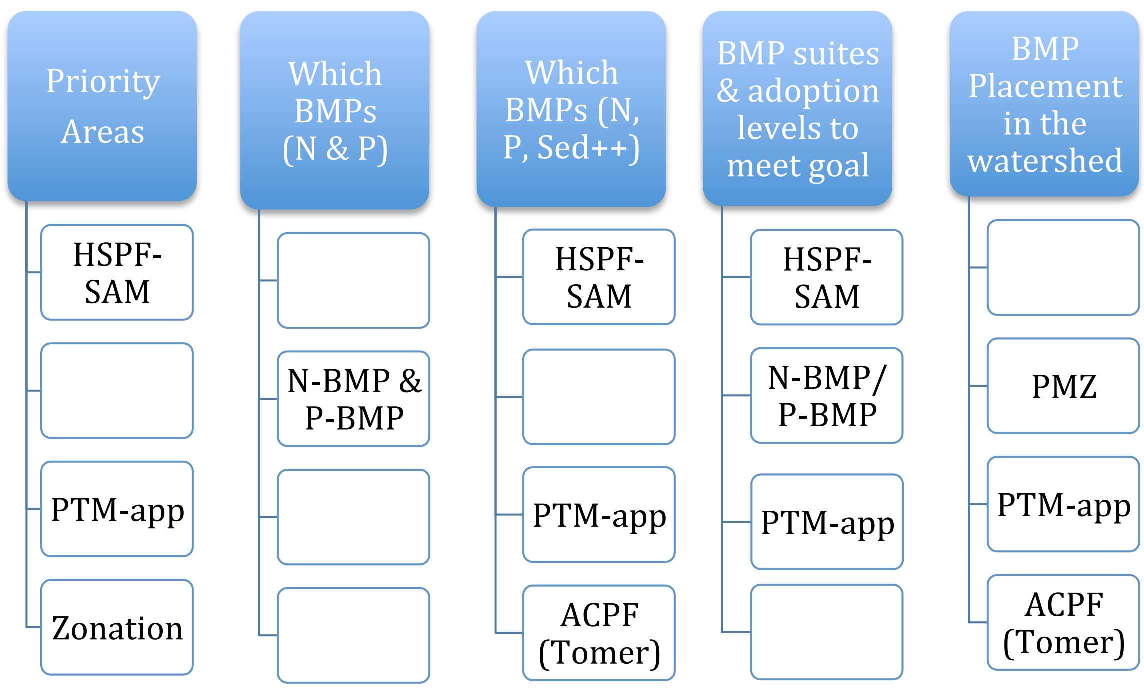
Targeting Tools

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.

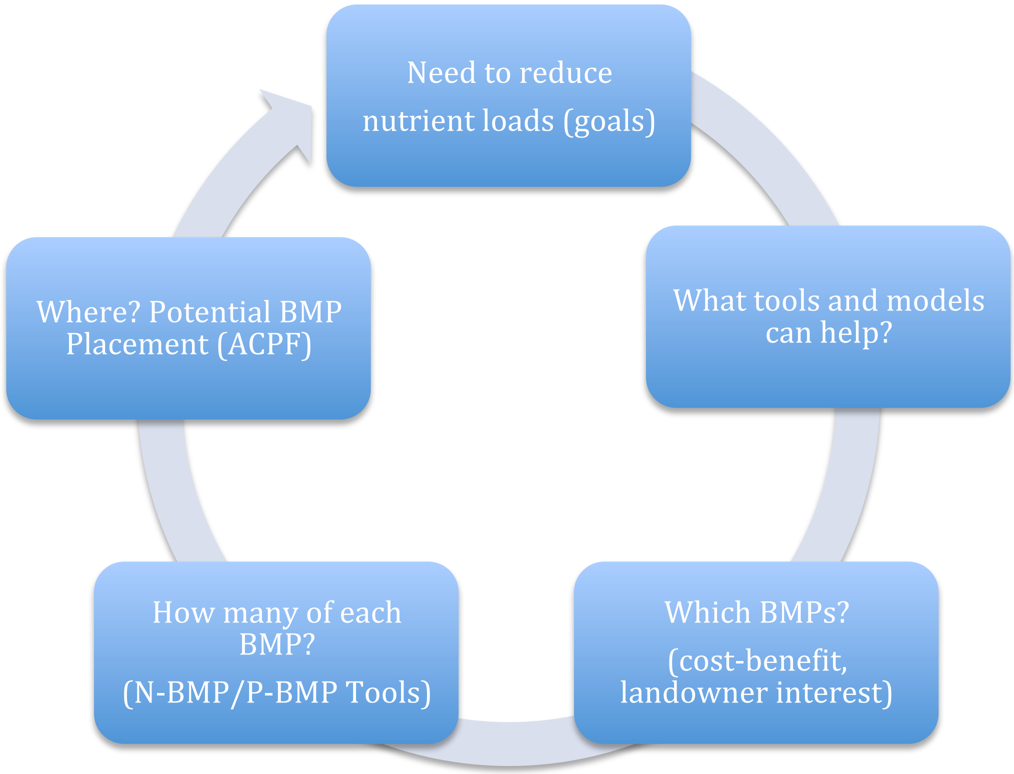


Wall et al 2015

After searching possible tools for this pilot study, the team decided on the following approach due to the availability and promise of these new tools. This pilot project is intended to add some additional information to the broader and longer term efforts underway in Watson Creek Subwatershed.

- Priority Area – Determined by local partners based on long term local priorities
- Which BMPs - Used the N-BMP/P-BMP tools
- BMP placement in the Watershed - Agricultural Conservation Planning Framework (ACPF)

Pilot Project Approach



The graphic above illustrates the framework used for this pilot project in the Watson Creek Subwatershed.

Need to reduce nutrient loads

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

What tools and models can help?

There are many tools available or in development that can help inform subwatershed planning. Fillmore County SWCD is working with watershed planning partners in the Root River Watershed and Watson Creek Subwatershed, using different models as they become available

Which BMPs?

Outputs from the N-BMP and P-BMP tools can help to identify which BMPs will be most cost-effective for achieving Nitrogen and Phosphorus reductions. Reflections from local staff and producers in the Watson Creek Subwatershed also provide a snapshot of nutrient pollution awareness and openness to particular BMPs as of Spring 2015.

How many of each BMP?

The N-BMP and P-BMP tools enable local resource managers to create scenarios that illustrate percent reduction of Nitrogen or Phosphorus entering surface waters when either a single BMP or a suite of BMPs is adopted at specified levels across the watershed.

Where? Potential BMP Placement

The pilot project includes a series of maps for Watson Creek Subwatershed that illustrate opportunity areas for BMPs from the Agricultural Conservation Planning Framework (ACPF) developed at the National Laboratory for Agriculture and the Environment by Mark Tomer, Sarah Porter and David James.

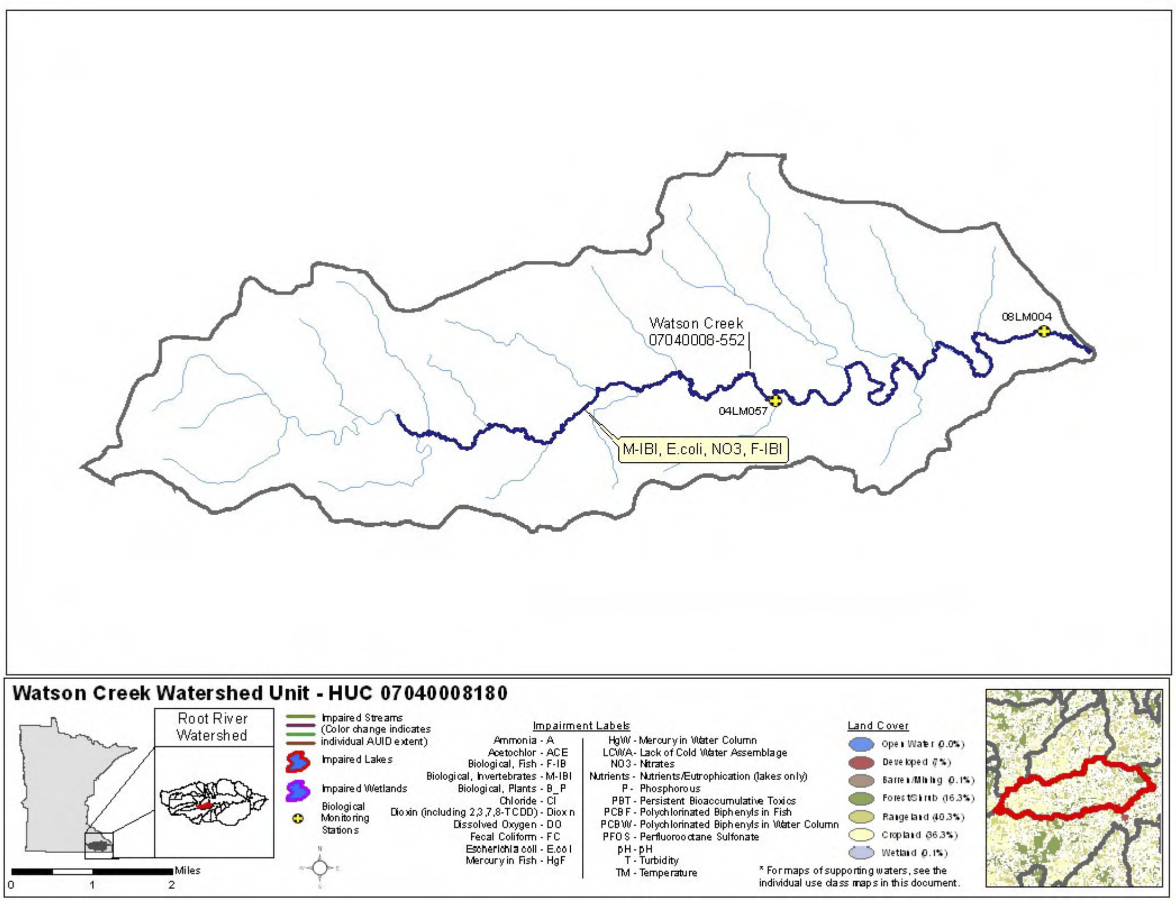
Watson Creek Subwatershed

Watson Creek Overview

The Watson Creek Watershed Unit, located in central Fillmore County, drains an area of 33.9 square miles. The watershed begins in the Township of Fillmore and flows easterly before entering the South Branch Root River approximately 2.5 miles west of the city of Lanesboro. Watson Creek flows through an area of mostly rangeland (40.3 percent) and cropland (36.3 percent) with smaller forested (16.3 percent) and developed (7 percent) areas scattered throughout the watershed. A roughly 15.5 mile reach of Watson Creek is a designated trout stream. Watson Creek is the only named stream within the watershed. The outlet of the watershed is represented by monitoring station 08LM004 on Watson Creek about 3 miles northeast of the city of Preston (Root River Monitoring and Assessment Report, 2012).

Watson Creek Impairments

Currently listed impaired waters by parameter in the Watson Creek Watershed Unit



Root River Monitoring and Assessment Report, 2012

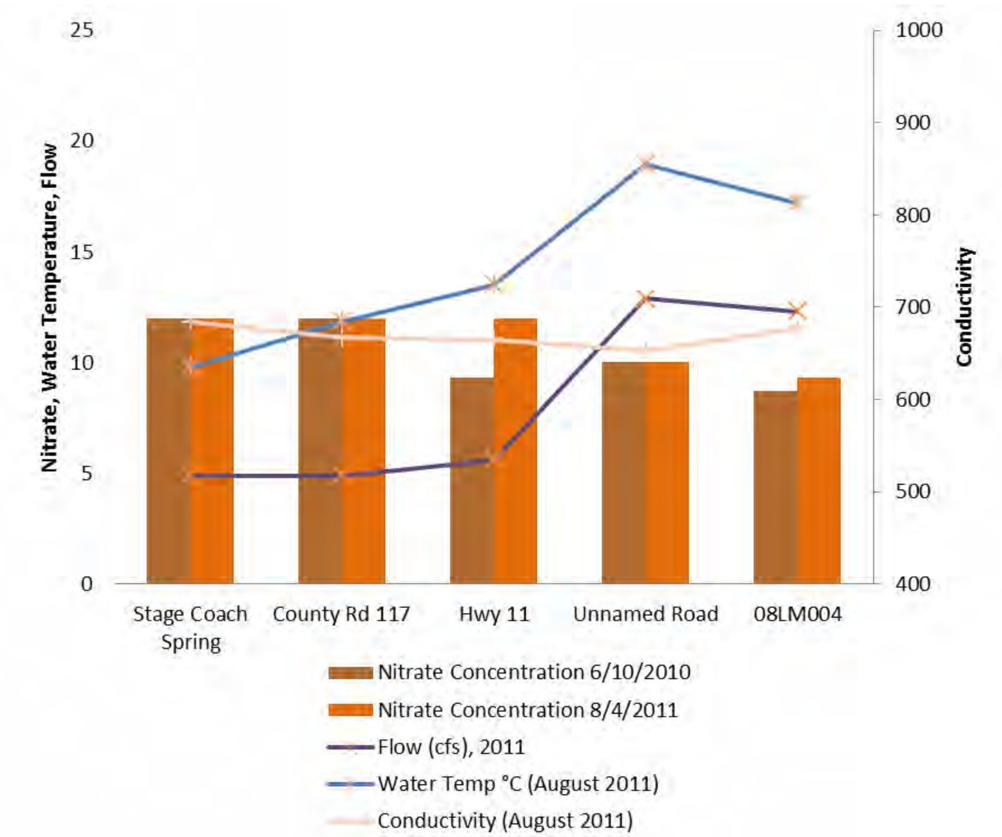
Water Quality Impairments

Water quality data was available on the 16 mile reach of Watson Creek immediately upstream of the South Branch Root River. An existing impairment of drinking water was confirmed and a new impairment for aquatic recreation use due to excessive bacteria was added for this reach. Sediment was identified as a possible stressor to aquatic life on this reach.

Nitrate

Watson Creek is listed impaired for drinking water use from nitrate. The average nitrate concentration from 24 values, 2001-2008, is 9.7 mg/L. During fish sampling, the nitrate concentration at 08LM004 and 04LM057 were 10 and 14 mg/L respectively. The maximum concentration of nitrate measured in Watson Creek was 14 mg/L (n=27).

In 2010, longitudinal surveys of nitrate concentrations show concentrations decrease longitudinally downstream, but are still elevated throughout the creek.



Root River Monitoring and Assessment Report, 2012

Bank erosion, land use, instability and entrenched channel at Station 04LM057. MPCA photograph, 2004

Biological Impairments

There are two biological stations on Watson Creek, one near the central portion of the watershed (04LM057) and one near the mouth (08LM004). Both fish and macroinvertebrates scores at both sites are below impairment threshold. Field sampling in 2008 noted severe bank erosion, excess sedimentation and channel incision.

The Watson Creek watershed showed impairments for fish, invertebrates, and bacteria. The nitrite/nitrate levels confirm an existing impairment for drinking water. The habitat evaluation performed on Watson Creek showed a “fair” rating at the headwaters site and a “good” rating at the pour point location. The watershed has shown potential sediment stressors during water chemistry samplings as well as in the habitat metrics. Elevated temperatures for a coldwater system may also be inhibiting the biological communities (Root River Monitoring and Assessment Report, 2012).

Watson Creek Subwatershed – Existing Plans and Goals

Watson Creek Nutrient Goals

Local partners have expressed concern about elevated Nitrates and need to reduce levels within the Watson Creek Subwatershed. The amount of reduction will be discussed and decided upon in part of a larger, longer planning process. State agencies and local partners have been working together to develop the WRAPS Strategies table that will delineate goals and strategies for reducing Nitrogen and Phosphorus within the watershed. The Root River Watershed is in the final stages of developing a draft *Watershed Restoration and Protection Strategy* (WRAPS) (September 2015). The document will contain watershed goals and strategies for the Root River Watershed based on local input.

Minnesota Nutrient Reduction Strategy Goals

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

Phosphorus
Minnesota Nutrient Reduction Strategy Goals – Mississippi River
10 Year Target: 12% (33% already obtained) for a total of 45% reduction

Root River Stressor Identification Report

Strength of evidence, conclusions, and recommendations

Multiple stressors exist throughout Watson Creek. Elevated nitrate, suspended sediment, temperature, and physical habitat are all influencing the biological communities present. TSS and habitat, and nitrate all appear to be playing primary roles in the degradation of the biological community. There is strong field evidence of severe stream bank erosion, and subsequent habitat degradation. The lack of channel stability and excess sedimentation throughout the creek is a clear limiting factor. Both fish and macroinvertebrate communities are showing consistent biological response to support this.

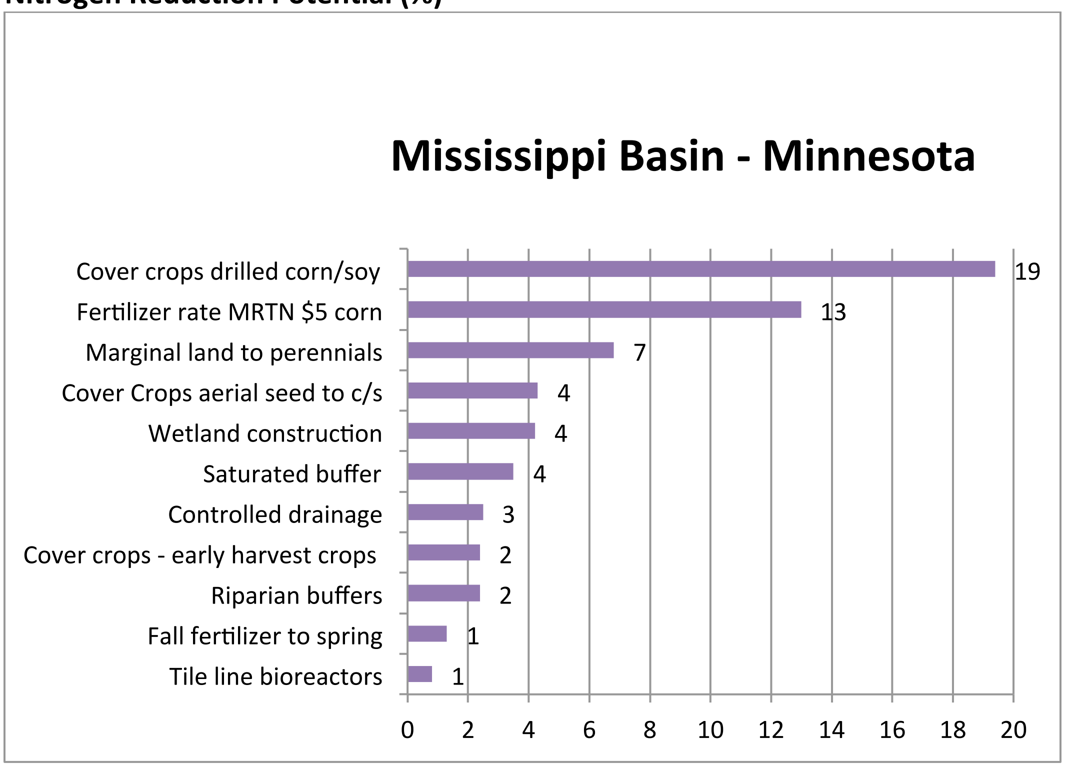
In MDNR's 2010 Management Plan, one of the recommendations is to protect the spring source (Stagecoach) spring at any cost. "Further development or agriculture use near the spring source should be discouraged and setbacks need to be enforced." It is also noted that Tributary Two, (Thunderhead Spring) which is considered to be the most significant tributary to Watson Creek, should also be protected from development and degradation. Both of these are important sources of coldwater to Watson Creek and will be important for improvement in the fish community found in Watson Creek More information should be collected on DO, as there is simply a lack of chemical information and a mixed biological response. Additional information will help further the understanding of whether DO is a stressor to the biological communities. While a good amount of temperature information has been collected on Watson Creek, additional information spanning multiple years may be important in understanding affects in varying flow conditions each year. The impact of Fountain WWTP is largely unknown, but should be monitored over time. Connectivity is not well understood in Watson Creek, but may warrant further investigation of both natural causes of barriers and anthropogenic.

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 Tool; Lazarus, Mulla et al).
http://www.extension.org/pages/67624/minnesota-watershed-nitrogen-reduction-planning-tool#.VgqibhnGJe5

Nitrogen

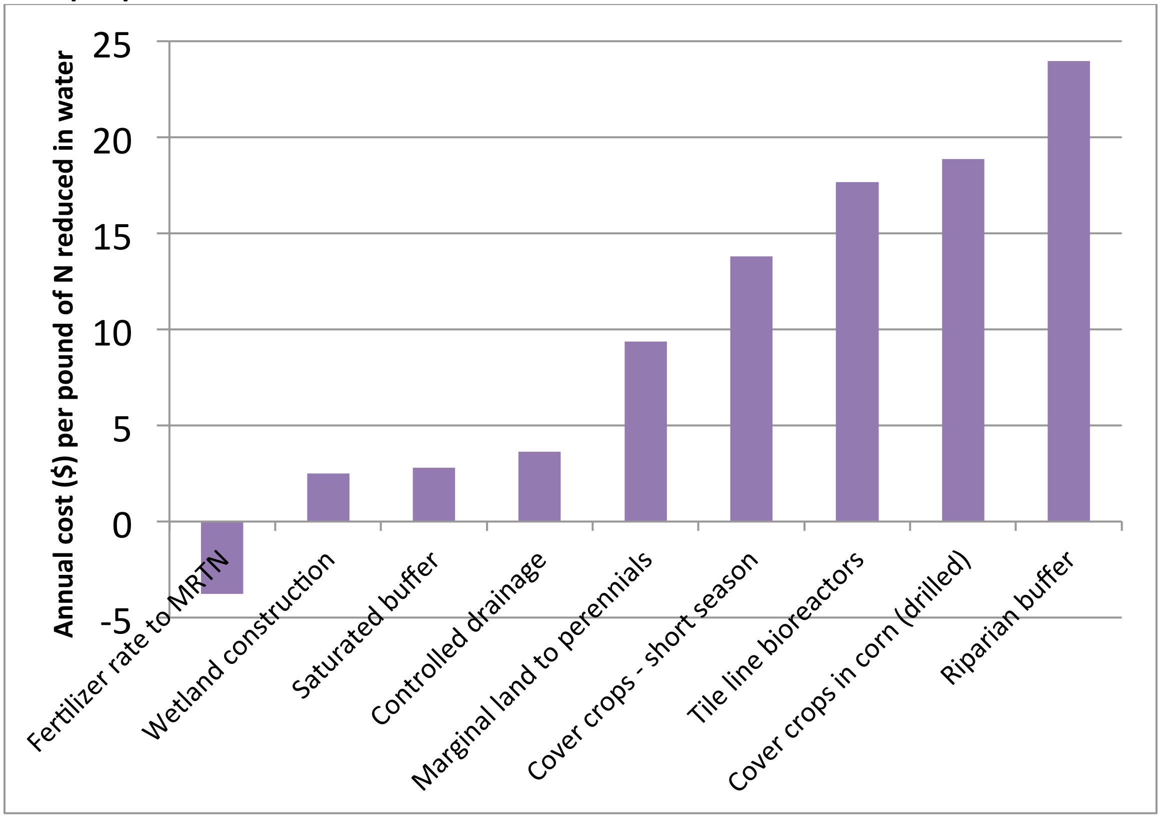
Nitrogen Reduction Potential (%)



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

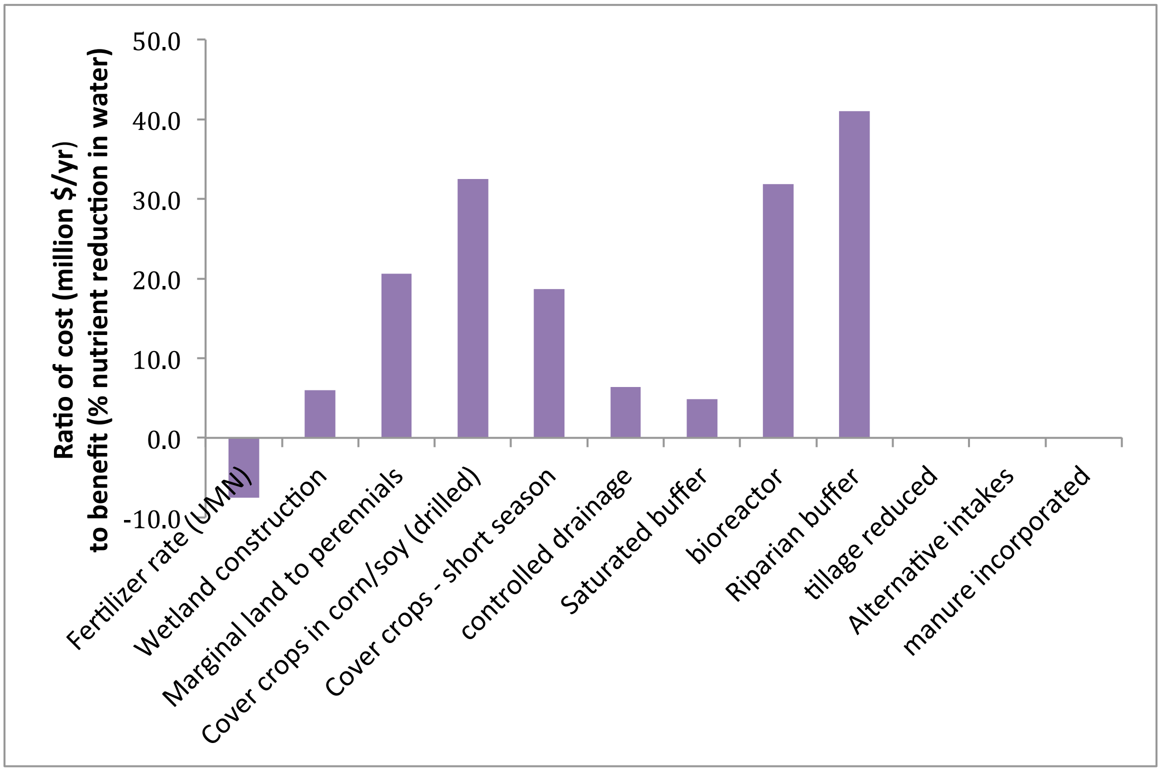
Nitrogen reduction potential in the Mississippi Basin are largest with: successful cover crops (23%); fertilizer efficiency gains (10-20%).

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

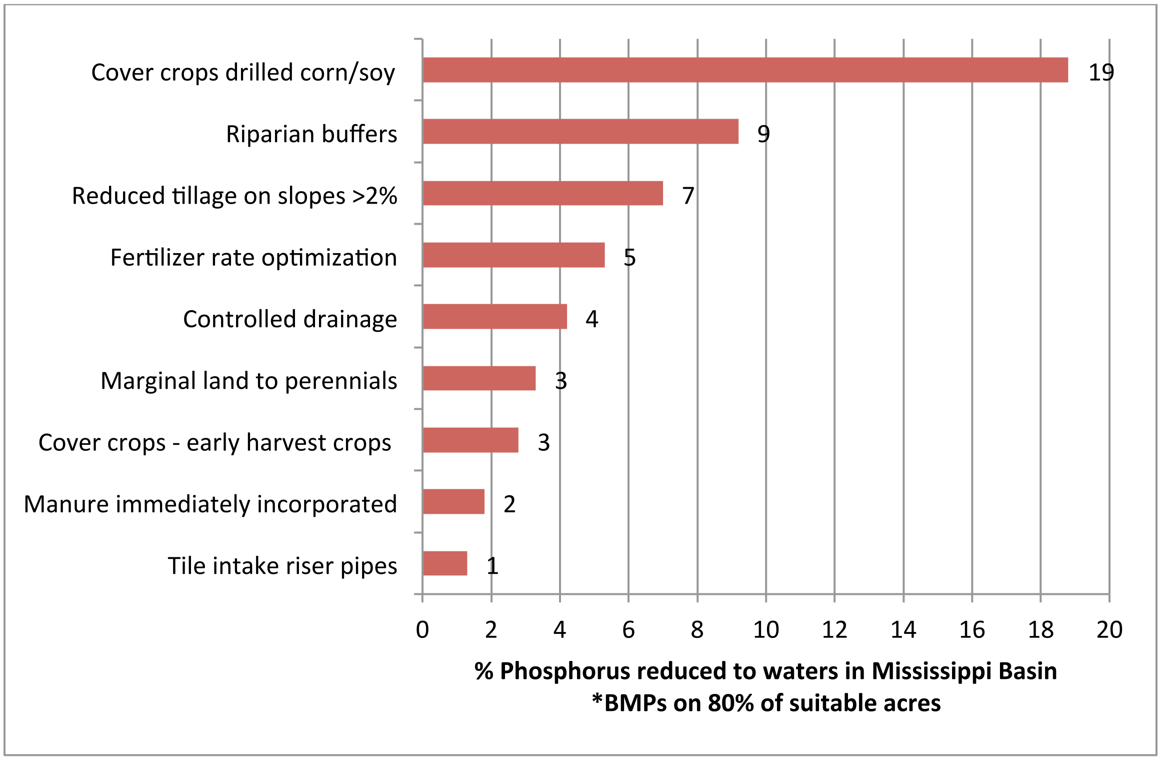


Cost to benefit ratio – Nitrogen only

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 $$$

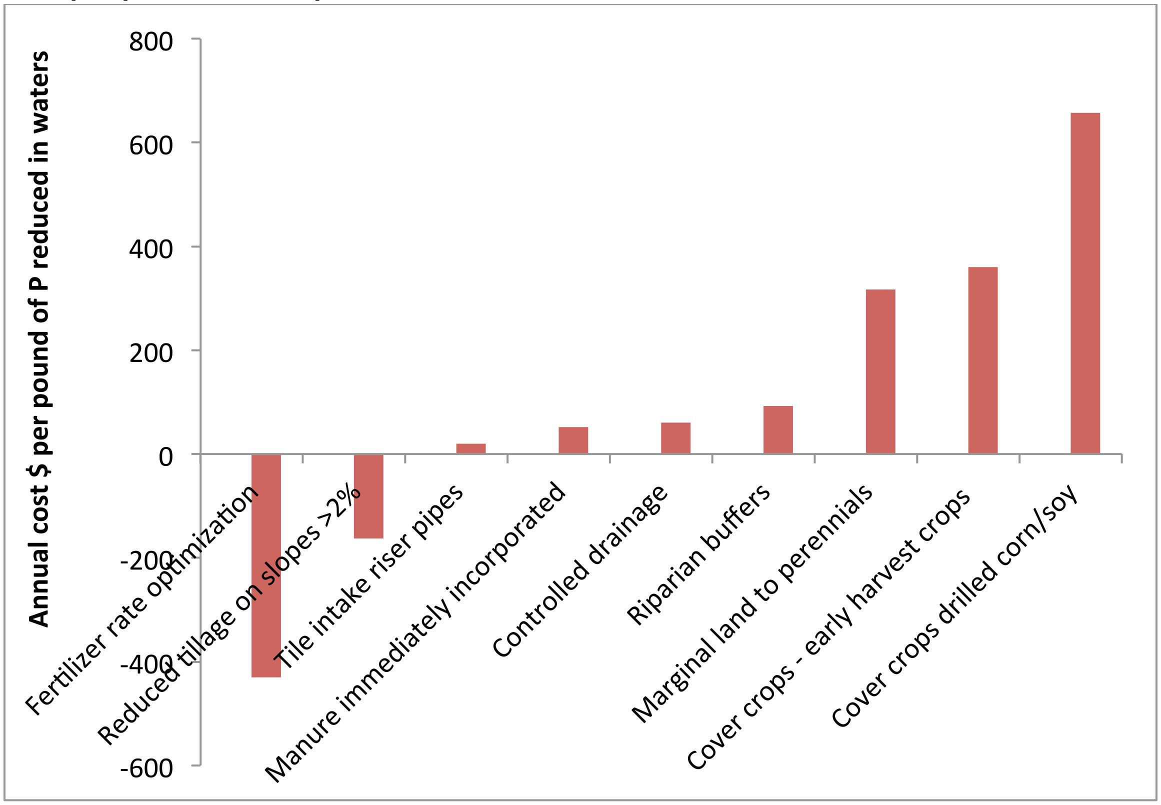
Phosphorus

Phosphorus reduction potential* (%)



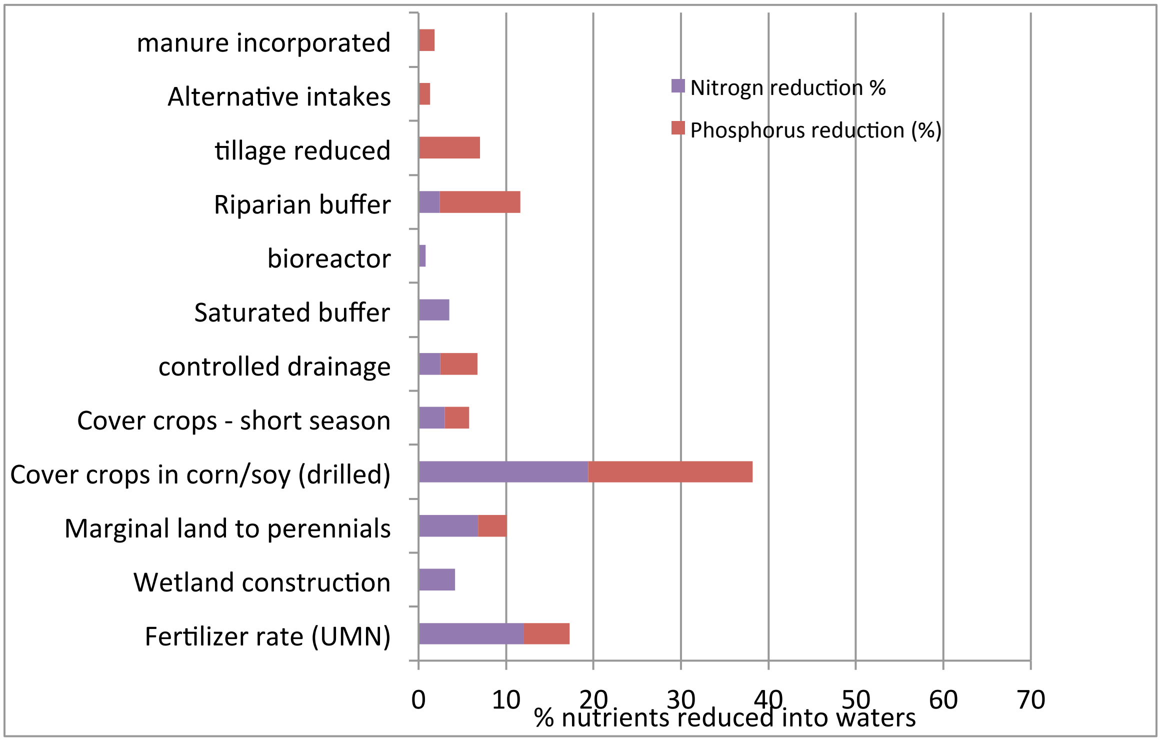
Phosphorus reduction potential in Mississippi Basin largest with cover crops (22%); riparian buffers (9%); reduced/conservation tillage (7%)

Cost per pound of Phosphorus reduced

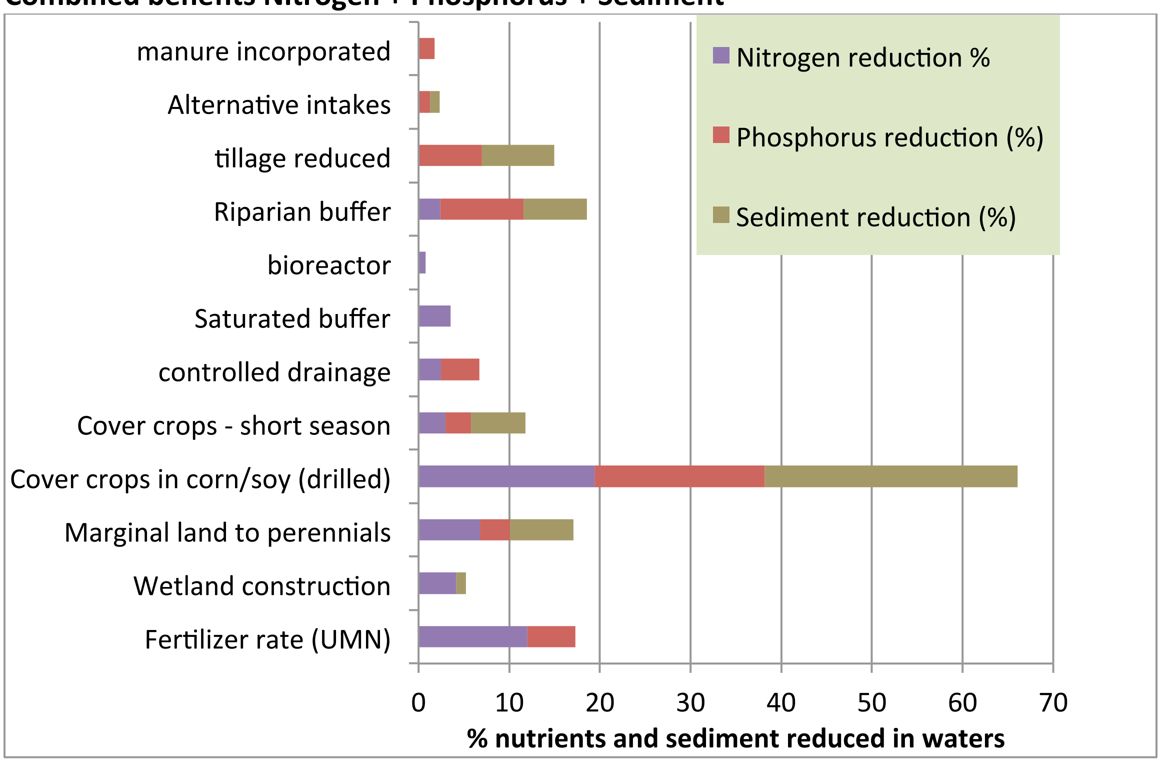


The most cost-effective BMPs for Phosphorus include Phosphorus fertilizer efficiency, reduced tillage, intake riser pipes, and manure incorporated.

Combined benefits Nitrogen + Phosphorus

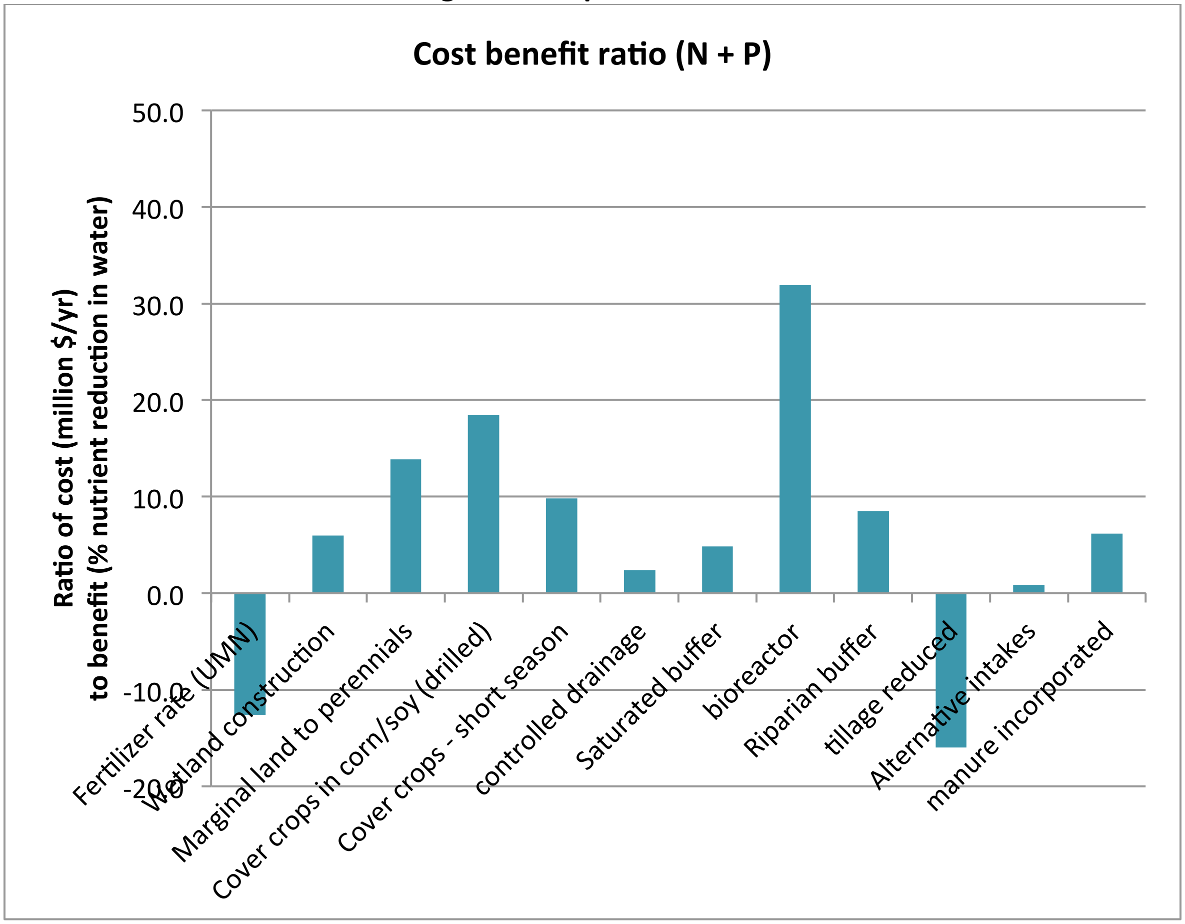


Combined benefits Nitrogen + Phosphorus + Sediment



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 Nitrogen + Phosphorus



BMP	Cost benefit ratio (N+P)	
Tillage reduced Fertilizer rate (UMN)	These are free or profitable	Less expensive $ More 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	

Local Staff & Landowner Perspectives

Pilot project partners hosted two meetings with local staff and agricultural producers (March 24 and July 2, 2015) to promote information flow about the Nutrient Reduction Strategy, Minnesota Nutrient Planning Portal, and N-BMP Tool and to understand current nutrient planning efforts and local staff and producer perspectives in the Watson Creek Subwatershed. The reflections below serve as a snapshot of local staff and landowner perspectives based on reflections of approximately a dozen people in Spring and Summer 2015.

Staff-Identified Priorities & Challenges

Need for Coordinated Communication & Outreach

Common questions that need to be answered when beginning the conversation with producers and landowners

- Where do we get the data from?
- How often do we monitor those points?
- What does impairment even mean (local folks still recreate, fish, etc. in waterbodies)?
- What are the "natural" nitrate levels?
- What happens when cover crop dies? Where does that "captured" N go? (Skeptic on movement of N leaching)
- What are Iowa application rates?

How do we facilitate participation with producers moving forward?

- Good information flow and building relationships
- Producers want to be informed on what we are trying to do – keep building the relationships
- Get the technicians out there
- Farm visits every year
- Get absentee landowners involved

Field Scale

- Take it down to the field-scale

Success Stories

- Make sure to raise up good projects and recognize that work

Policy Change

- Get rid of farm assistance if not complying (needs to be added)
- Make the application rates regional!!

Producer Perspectives about BMPS

Existing Landowner Perspectives/opinions

- Producers are willing to experiment, or already are (cost of N is about $35/acre)
- Producers are afraid of being singled out and persecuted

More Willing

Field Erosion Control – Tillage and residue, terraces

Survey results, Appendix C, indicates that there is more landowner interest in field erosion control, tillage and residue, and terraces

Fertilizer Application Rates

Local staff noted that producers that they work with feel like they are already working to control application rates.

- Nobody wants to over apply fertilizer because it costs money
- Lots of corn/corn, which may suggest why they don't feel they need to do the fertilizer application rates
- Manure is most effective when incorporated
- 6% reduction in fertilizer use (currently 94% efficient)
- Split application not so good in this area

Grassed waterways

Staff expressed that there is a big need and probably a pretty acceptable practice in Watson
Producers also expressed that grassed waterways are promising

- Cross-slope forming is common (not contour)
- Program to accommodate 2 split runs

Water/sediment storage practices

Staff expressed that water/sediment storage practices such as WASCOBs, would be another practice that might be acceptable in the transition areas from cropland to woods at the edge of the valleys.

Less Willing, Harder Sell

Cover crops

- Staff expressed that cover crops could be a hard sell since most of the upper end of the watershed is corn/bean rotation, but if they would do aerial seeding especially on flatter fields, it could be a great practice. Both practices would be good to look at in the watershed.
- Timing is tricky for cover crops
  - Maybe after soybeans (loosens soil)
  - Could meet reduction goals with 20% cover crop adoption – meeting participants felt that was an optimistic number for cover crop adoption

Land Retirements and Easements

How many of each BMP? Cropland BMP Watershed Planning Tools

Nitrogen BMPs & Phosphorus BMPs Planning Tool

Part of the Minnesota 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 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.

Using the Nitrogen and Phosphorus reduction planning model involves three steps:

1. The first step is to select a watershed, enter hypothetical adoption rates for each BMP, and compare the effectiveness and cost of the individual BMPs.
2. The second step is to compare suites of the BMPs that would attain any given reduction in the N or P load at minimum cost.
3. The third step is to “drill down” to the details and assumptions behind the models of effectiveness and costs of any particular BMP and make any adjustments to reflect your particular situation.

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

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 Root 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 Root 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.

N-BMP Scenario

The scenario below is an output from the N-BMP tool to achieve a 20 percent reduction in cropland nitrogen loads going into the Root River Watershed. This is an example of one of many different scenarios that could be run on the N-BMP tool to illustrate a 20 percent reduction scenario.

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.

0.560 million acres in watershed or state

Watershed: Root River (52)

	% suitable	% adoption	% treated	% treated, combined	acres treated (000), combined
Corn acres receiving target N rate, no inhibitor or timing shift	54.92%	55%	31.27%	28.29%	158.51
Fall N target rate acres receiving N inhibitor	4.27%		0.00%	0.00%	0.00
Fall N applications switched to spring, % of fall-app. acres	4.27%	80%	3.42%	3.12%	17.51
Fall N switch to split spring/sidedressing, % of fall acres	4.27%		0.00%	0.00%	0.00
Restored wetlands	3.38%	80%	2.71%	2.71%	15.17
Tile line bioreactors	2.37%		0.00%	0.00%	0.00
Controlled drainage	2.37%		0.00%	0.00%	0.00
Saturated buffers	2.37%	80%	1.89%	1.89%	10.61
Riparian buffers	5.35%	100%	5.35%	5.24%	29.37
Corn grain & soybean acres w/cereal rye cover crop	80.87%	10%	8.09%	7.34%	41.15
Short season crops planted to a rye cover crop	4.74%	80%	3.79%	3.51%	19.65
Perennial crop % of corn & soy area (marginal only)	5.79%	40%	2.32%	2.30%	12.91

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 — More results===>

Treatment cost before fertilizer cost savings & corn yield impacts: $16.01 million/year

N fertilizer cost savings & corn yield impacts: -$3.11

Net BMP treatment cost: $12.91 million/year

P-BMP Scenario

The P-BMP scenario below depicts a 12 percent reduction of Phosphorus in the Root River Watershed. This is one of many possible scenarios to illustrate a 12 percent Phosphorus load reduction. In this scenario where N-BMP and P-BMPs are the same, the same percentage of adoption is used.

Watershed: Root River — 0.560 million acres o

Pathway	% existing	% suitable	% adoption	% treated	acres treated (million)
Apply U of MN recs Target P2O5 rate	42.80%	42.80%	40%	17.12%	0.10
Fall corn&wheat fert to preplant/starter	50.96%	3.96%	0%	0.00%	0.00
Use reduced tillage	48.46%	51.54%	40%	20.62%	0.12
Riparian buffers, 50 ft wide	12.88%	7.38%	100%	7.38%	0.04
Perennial crop % of marginal only	0.00%	5.55%	40%	2.22%	0.01
Corn grain & soybean acres w/cereal rye cover crop	0.00%	80.87%	10%	8.09%	0.05
Short season crops planted to a rye cover crop	0.00%	4.74%	80%	3.79%	0.02
Controlled drainage	0.00%	2.37%	0%	0.00%	0.00
Alternative tile intakes	1.42%	4.25%	40%	1.70%	0.02
Inject or incorp manure	10.15%	9.40%	50%	4.70%	0.03
Total for all BMPs			Load default data		Recalcu
Weather Scenario:	Average weather				

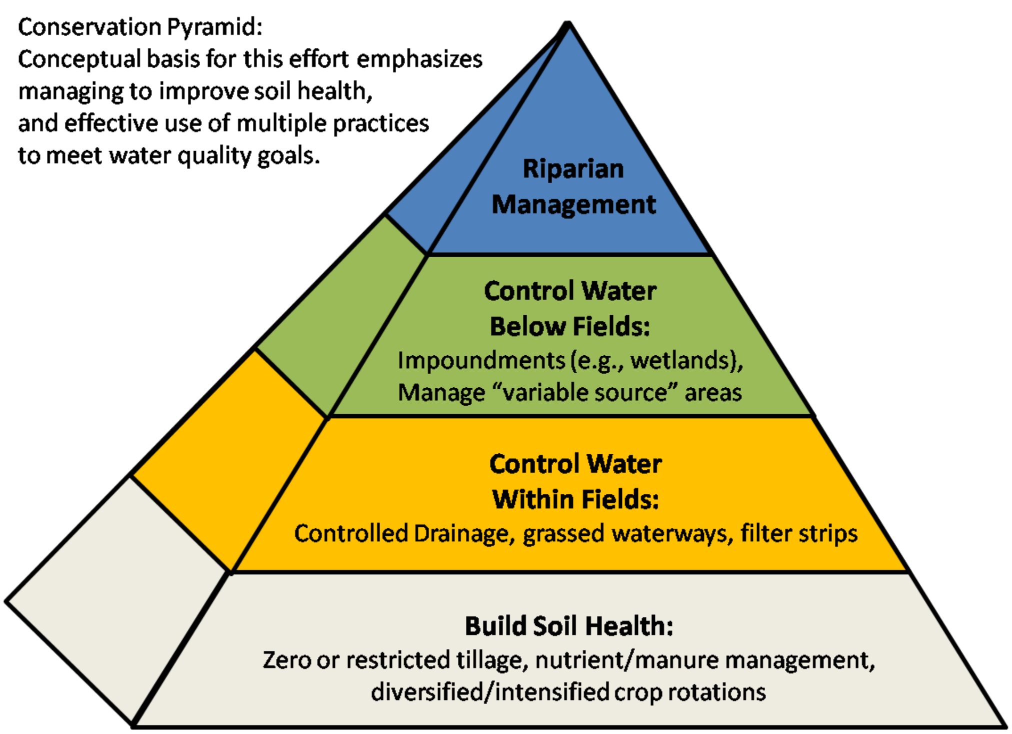
P load reduction with these adoption rates:	12.1%	
Treatment cost before fertilizer cost savings	$8.91	million/year
P fertilizer cost savings	-$2.99	
Net BMP treatment cost	$5.92	million/year

Potential Targeting Locations

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

Watson Creek ACPF Summary
A ACPF summary of Watson Creek Subwatershed is available in Appendix B.

Root River Watershed – Fillmore County ACPF Tool Reflections

- Tomer tool is another "tool" in the toolbox, how can it be more accessible via web?
- How to make it easy to deliver to landowner (well and easily written, open source)
- Does this apply to Ag certification program?
- Make more compatible to NRCS specs and regulations may be helpful (e.g. 30 acres for sediment control basins – according to NRCS). NRCS won't build a holding pond larger than 30 acres.
- NWR – add soil type
- Focus on funding and small field, focus site
- Converting measurement (meters to feet, hectares to acres)
- Economic relation to BMP, Tomer Tool, financial benefits
- Education may be directed to agronomists

Editorial Note: These reflections are based on a meeting in March 24, 2015. Since then staff developing the ACPF have revised the tool and incorporated many of these suggestions. Additionally, ACPF developers are currently including more economic data into the ACPF and anticipate completion in Winter 2015.

Watson Creek Subwatershed - Nutrient Planning

Elevated Nitrogen
Watson Creek has well documented elevated nitrogen problems. It is listed impaired for drinking water use from nitrate. The average nitrate concentration from 24 values, 2001-2008, is 9.7 mg/L. In 2010, longitudinal surveys of nitrate concentrations show concentrations decrease longitudinally downstream, but are still elevated throughout the creek (Root River Stressor Identification Report, 2105).

Excess Sedimentation
Multiple stressors exist throughout Watson Creek. Elevated nitrate, suspended sediment, temperature, and physical habitat are all influencing the biological communities present. TSS and habitat, and nitrate all appear to be playing primary roles in the degradation of the biological community. There is strong field evidence of severe stream bank erosion, and subsequent habitat degradation. The lack of channel stability and excess sedimentation throughout the creek is a clear limiting factor. Both fish and macroinvertebrate communities are showing consistent biological response to support this (Root River Stressor Identification Report, 2105).

Nutrient Planning Next Steps

Demonstration Plots
Fillmore County is currently working with Minnesota Department of Agriculture to set up demonstration plots in Watson Creek. These demonstration plots include experimenting with a variety of nitrogen application rates, split application rates, soil nitrate testing, tissue and basal stalk analysis, as well as whole plant sampling. Through this effort, Fillmore County will continue to connect with and educate producers they have already been working with as well as to expand the conversation with more producers across the subwatershed. Producers will be able to learn first-hand and locally about effective nitrogen management.

Nitrate Township Testing Program
In 2017, Fillmore County will be working with Minnesota Department of Agriculture on the Township (Nitrate) Testing Program as part of the Minnesota Nitrogen Fertilizer Management Plan.

The goal of the program is to determine current nitrate-nitrogen concentrations in private wells on a township scale. The MDA has identified townships throughout the state that are vulnerable to groundwater contamination and have significant row crop production. Through the program, MDA plans to offer nitrate testing to 70,000 private well owners, within approximately 250 townships, over the next six years. This work will be done in partnership with local governments across the state.

Fillmore County will 1) Provide overall coordination 2) Develop initial list of well owners 3) Promote and advertise the program and 4) Conduct education and outreach activities. Test kits will be sent to everyone in the chosen township.

After the MDA receives all the well testing results in a township, the data is analyzed and information about well depth, well age and well construction is reviewed. In some cases, visits to wells may be needed to confirm results. After the analysis is complete, the MDA writes a summary document and sends it to Fillmore County SWCD and shares it on the MDA website.

Local Advisory Committee

Fillmore County staff envision that they will assemble a local advisory committee as an outgrowth of the Nitrate Township Testing Program to address emerging groundwater concerns. Currently, there is a barrier of staff time and funding to convene this group. They envision the committee being comprised of producers that they have been working with over the years as well as cooperators on the well testing and demonstration plots.

Understanding Role of Geology and Targeting

Research by Tony Runkel from the Minnesota Geological Survey has helped local planners better understand complex connection of karst influencing nitrogen management efforts in Watson Creek. Research indicates that there is a trend of higher nitrate rates in the upper portion of the subwatershed with trends decreasing downstream. Springs that feed Watson Creek are connected to the land surface through a concentration of sink holes.

The upper part of the watershed where karst influence is the greatest could be an important region to target. Local planners are anticipating targeting BMP implementation efforts in the headwater springs to reduce Nitrate rates throughout the subwatershed. Anticipated practices include: reducing N application rates, promoting more cover crops through aerial application, and generally promoting better soil health to promote slower release of nutrients from the soil (Runkel, 2012).

Other Root River Watershed Nutrient-Related Planning Efforts

WRAPS and One Watershed, One Plan

The Root River Watershed Restoration and Protection Strategy (WRAPS) is currently in progress. Local staff have helped to develop a strategies table. Root River Watershed was selected as one of five major watersheds across the state to pilot the One Watershed, One Plan Pilot Project. Local staff are participating in the Planning Work Group. For more information:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/root-river.html
http://www.fillmoreswcd.org/rootRiverWatershed.html

MDA Field to Stream Partnership- Headwaters of the Root River

MDA is working with project partners in three subwatersheds of the Root River: South Branch Root River Headwaters, Crystal Creek, and Bridge Creek. This is collaborative project among farmers and their advisors, The Minnesota Department of Agriculture, Minnesota Agricultural Water Resources Center, The Nature Conservancy, Fillmore and Mower County Soil and Water Conservation Districts, Monsanto and academic researchers. A strong local partnership is in place as well as a productive relationship between agency staff and the local farm industry.

Research Projects include: Evaluation of phosphorus contributions from edge-of-field and within streams; On-farm nitrogen rate comparisons; Corn stalk testing to determine nitrogen availability to the crop; Springshed mapping using sinkhole dye tracing and intensive nitrate nitrogen sampling of natural spring and tributaries; Digital Terrain Analysis to identify areas of the landscape where conservation practices may have the largest environmental benefit; Assessment of stream channel characteristics; Sediment fingerprinting to track sources and soil loss; A sediment budget for the Root River. A vital

portion of the project is Education, Outreach, and Civic Engagement. Farm management surveys have already been completed on many of the fields in the watershed. LiDAR based terrain analyses, the Agricultural Conservation Planning Framework, inventories of existing practices, springshed mapping and farm walkovers are being used for prioritizing conservation practice placement on the landscape. MDA has collected 5 years of edge of field and in-stream water quality monitoring to date, to help establish a baseline condition and track improvements.
For more information:
http://www.mda.state.mn.us/protecting/cleanwaterfund/onfarmprojects/rootriverpartnership.aspx
Video: https://www.youtube.com/watch?v=TD8GLuRL-wg&feature=youtu.be

Root River: Promise of Pasture

The bluffland topography of the Root River watershed in SE Minnesota (mostly) lends itself beautifully to the perennial-based systems of pastured livestock. Were such stewardship management to prevail, resource concerns shared by watershed farmers and non-farmers alike – water and sediment control, grassland bird habitat, and nutrient management, for examples – would become safeguarded resource assets. Fillmore County SWCD is working with The Nature Conservancy, and Grazing Land Conservation Initiative of Minnesota on this project in Watson Creek, Rush Pine Creek, and Upper South Fork and Wisel Creek Subwatersheds. For more information:
http://landstewardshipproject.org/stewardshipfood/foodsystemslandstewardship/rootriverwatershed

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