BENTON/TAMA WATERSHED IMPROVEMENT PLAN

A roadmap for improved water quality, sustained agricultural productivity & reduced flood risk

Prepared by:

Environmental Programs & Services
IOWA SOYBEAN ASSOCIATION

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Planning partners include:

Watershed residents, farmers and landowners
Benton & Tama Soil and Water Conservation Districts
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Iowa Soybean Association
Iowa Pork Producers Association
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A roadmap for improved water quality, sustained agricultural productivity, and reduced flood risk in the Benton/Tama watershed.

What is the purpose of the Benton/Tama Watershed Improvement Plan?

This document is intended to provide a roadmap for water and soil improvements in the Benton/Tama watershed while at the same time maintaining or improving agronomic performance and quality of life. Environmental improvements are a big task, and trying to tackle everything at once can be daunting. This plan lays out a phased approach to implementation to ensure continuous improvements are being made towards achieving long-term goals for the watershed.

Who owns this watershed plan?

This plan is for all stakeholders interested in the Benton/Tama watershed including landowners, famers, residents, nongovernmental organizations, and local, state, and federal units of government and others. Ultimately, successful implementation of this plan will rest with these stakeholders.

Who developed this watershed plan?

This plan was developed by the Iowa Soybean Association with guidance and input from representatives of landowners, famers, residents, nongovernmental organizations, local, state, and federal units of government and others. The watershed planning process and document preparation was led by the Iowa Soybean Association with assistance from the Benton and Tama Soil and Water Conservation Districts and the Natural Resources Conservation Service.

Contents

1 EXECUTIVE SUMMARY

A watershed is an area of land that drains to a common point of land. In the Wolf Creek, Rock Creek, and Pratt Creek watersheds, 92,220 acres of land drain through Wolf Creek, Rock Creek, and Pratt Creek into the Cedar River between La Porte City, IA, and Vinton, IA. This document defines and addresses existing land and water quality conditions and shortfalls and provides a path for improvement. The development of this document followed the watershed planning process and incorporated input from many different stakeholders, both public and private. In 2015, the Middle Cedar Partnership Project (MCPP) was initiated and focused federal, state, local government, and non-governmental funding to the Wolf Creek, Rock Creek, and Pratt Creek watersheds, which are also targeted in the Benton/Tama Nutrient Reduction Demonstration Project. The first step of the MCPP is to develop watershed plans for the project areas. The Iowa Soybean Association led the development of this document with input from watershed farmers and landowners, conservation professionals, and others. The Benton/Tama Watershed Improvement Plan serves as the culmination of existing studies, citizen and stakeholder input, and recommendations for conservation practices aimed at meeting the goals developed through the watershed planning process.

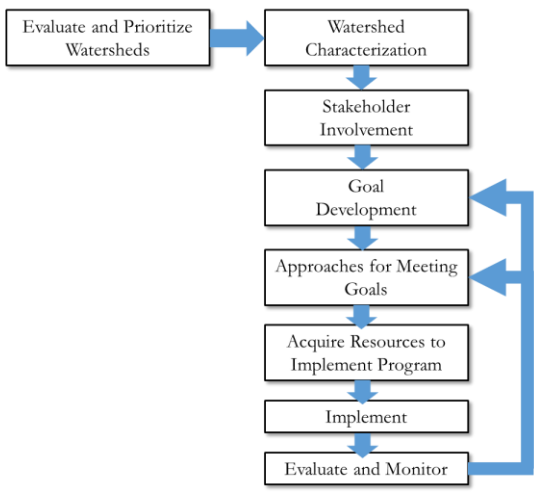


Figure 1. The watershed planning process.

Goals have been established in order to achieve the vision of all stakeholders. This document guides stakeholders through a continuous improvement approach to watershed management, understanding that big changes come from a succession of small changes. The long-term goals of the Benton/Tama Watershed Improvement Plan are to:

1. Reduce in-stream nonpoint source nitrogen loads by 41% from 2009-2011 levels.
2. Reduce in-stream nonpoint source phosphorus loads by 29% from 2009-2011 levels.
3. Maintain or increase agricultural productivity and profitability.
4. Reduce flood risk within Wolf Creek, Rock Creek, Pratt Creek, and downstream.

Public involvement was a very important component of the watershed planning process. Watershed planners initiated public participation during the planning process and worked to incorporate multiple levels of involvement. A watershed advisory committee was established to provide input from the farmers, landowners, and residents of the watershed. Input provided by the watershed advisory committee and other stakeholders was used to guide development of this document.

Improving land and water resources in the Wolf Creek, Rock Creek, and Pratt Creek watersheds is a complex and challenging effort and will require significant collaboration and partnerships. The implementation schedule included in this document has been developed to balance current resources and the desire to make land and water improvements. A 25-year phased implementation schedule has been created to allow for continuous improvements that can be evaluated to determine if progress is being made towards achieving desired goals. The total investment needed to achieve the goals identified in this plan is estimated to be approximately $10,355,000 for structural practices and $1,302,000 for management practices.

Figure 2. Wolf Creek.

2 WATERSHED CHARACTERISTICS

2.1 GENERAL INFORMATION

The Wolf Creek, Rock Creek, and Pratt Creek watersheds (the Benton/Tama watershed, Figure 3) encompass 92,220 acres and are dominated by 80% row crop agriculture and gently rolling terrain. Many smaller streams in the watersheds flow into Wolf Creek, Rock Creek, and Pratt Creek. The three main streams flow northeast to confluences with the Cedar River. The two incorporated communities within the Benton/Tama watershed are La Porte City and Mount Auburn. The majority of land in the watershed is privately owned. Public land in the watershed includes Hickory Hills Park in Tama County and four wildlife management areas. Table 1 lists general information for each of the three Hydrologic Unit Code (HUC) 12 watersheds that together make up the Benton/Tama watershed.

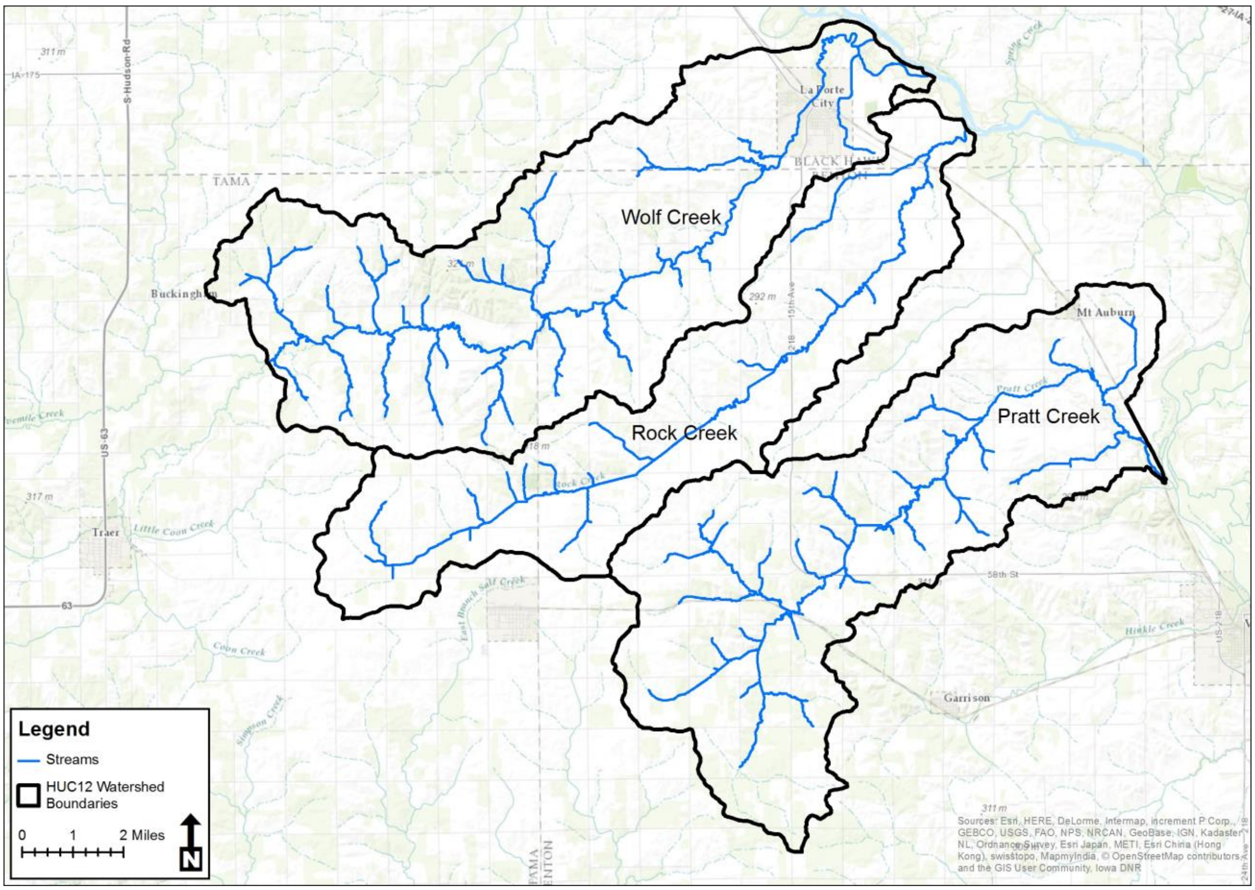


Figure 3. Benton/Tama project watersheds and streams: Wolf Creek, Rock Creek, and Pratt Creek.

Table 1. General watershed data for Wolf Creek, Rock Creek, and Pratt Creek. All streams total 153 miles in length and the watersheds occupy a total area of 92,220 acres.

	Wolf Creek	Rock Creek	Pratt Creek
Location	Benton, Tama, and Black Hawk counties		
Waterbody ID Code	IA 02-CED-0300_0	IA 02-CED-0290_1	IA 02-CED-0250_0
Designated Uses*	A1, B(WW-1), HH	A1, B(WW-1)	A1, B(WW-2)
Main Stream Length	20.8 miles	13.9 miles	9.4 miles
Watershed Area	36,195 acres	24,349 acres	31,676 acres
Dominant Land Use	Row crop agriculture		
Major Cities	None		
HUC 8 Watershed	Middle Cedar		
HUC 8 ID	07080205		
HUC 10 Watershed	Wolf Creek	Spring Creek-Cedar River	Pratt Creek-Cedar River
HUC 10 ID	0708020508	0708020510	0708020511
HUC 12 Watershed	Wolf Creek	Rock Creek-Cedar River	Pratt Creek
HUC 12 ID	070802050809	070802051001	070802051101

**Class A1: Primary Contact Recreation, Class B: Aquatic Life, Class HH: Fish Consumption. See Appendix B for full definitions of designated uses.*

2.2 Water

A well-connected surface stream network lies within the Benton/Tama watershed. Figure 3 shows the identified streams within the Wolf Creek, Rock Creek, and Pratt Creek watersheds. Figure 4 is a map of wetlands in the Benton/Tama watershed as identified by the National Wetlands Inventory (NWI), which are summarized in Table 2. The NWI dataset was developed by the U.S. Fish and Wildlife Service but may not capture all wetlands since the original maps were derived from aerial photo interpretation and may therefore be limited by image quality and scale.

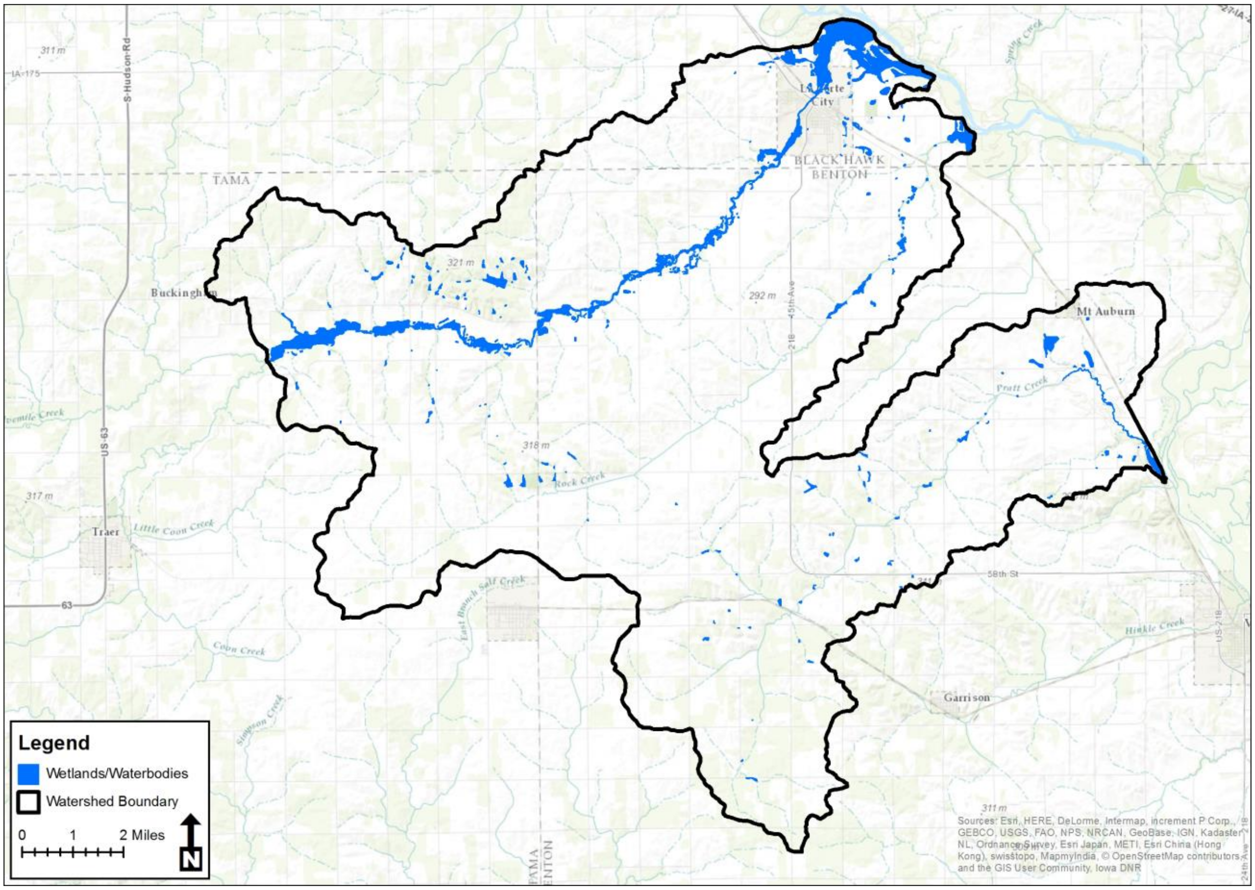


Figure 4. Wetlands of the Benton/Tama watershed according to the National Wetlands Inventory.

Table 2. Classification of wetlands within the Benton/Tama watershed.

Type	Acres	Percent of Total Wetland Area
Artificially Flooded	1.4	0.1%
Intermittently Exposed	269.9	11.7%
Intermittently Flooded	108.7	4.7%
Permanently Flooded	58.1	2.5%
Saturated	1.0	< 0.1%
Seasonally Flooded	241.6	10.5%
Semipermanently Flooded	64.6	2.8%
Temporarily Flooded	1508.8	65.4%
Other	51.3	2.2%
Total	**2305.4**	**100%**

Like many other watersheds in the relatively flat landscapes of Iowa, much of the land within the Wolf Creek, Rock Creek, and Pratt Creek watersheds is artificially drained in order to make agriculture possible and productive. Figure 5 shows soil where tile drainage is needed to achieve full agricultural productivity. This map may not capture all areas currently having subsurface tile drainage infrastructure.

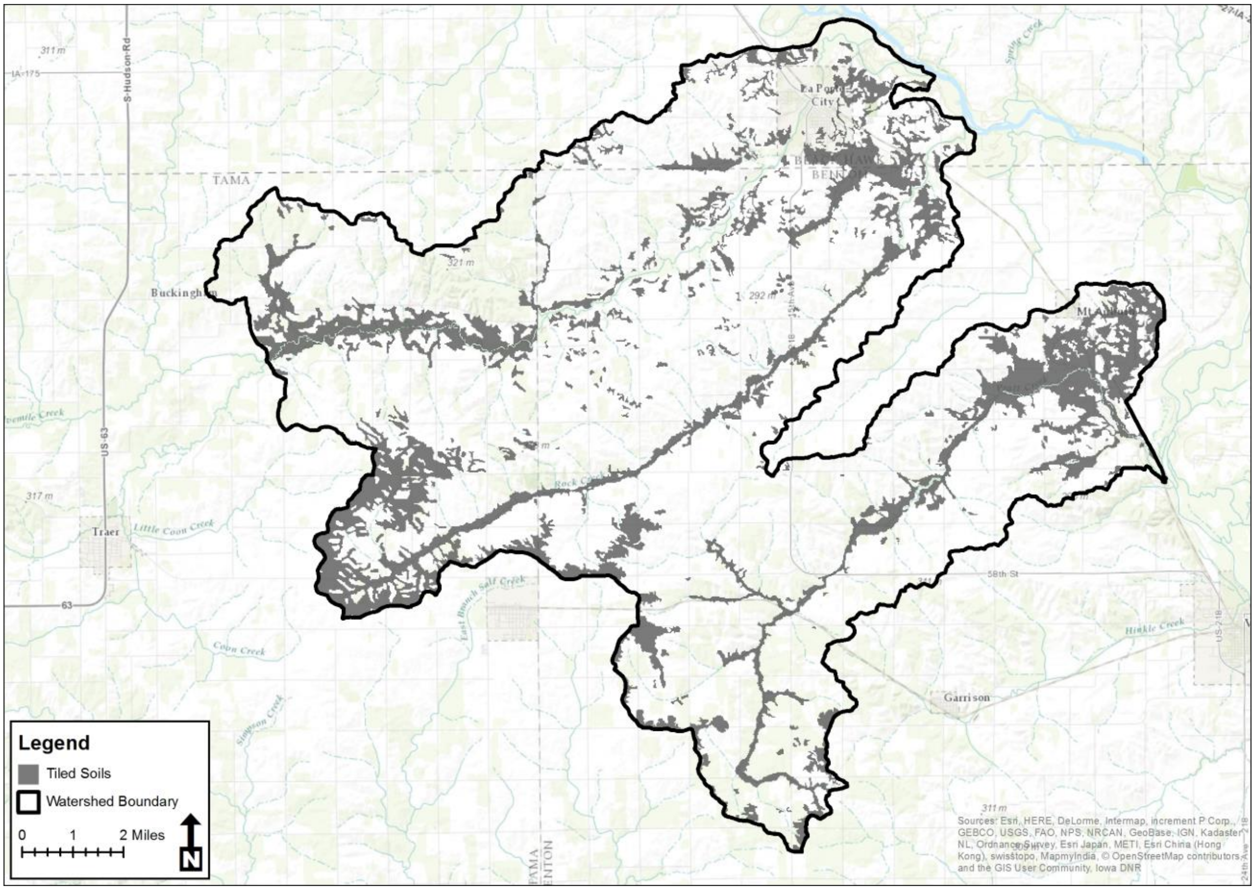


Figure 5. Areas requiring tile drainage to achieve full agricultural productivity.

2.3 Soils

The Benton/Tama watershed is dominated by the Dinsdale, Tama, Colo-Ely, Muscatine, and Kenyon soil associations. These five soil map units comprise over two-thirds of the watershed. Figure 6 shows a map of the most common soils within the watershed according to the Soil Survey Geographic Database (SSURGO) coverage developed by the National Cooperative Soil Survey and the USDA-NRCS, and descriptions of the dominant soils are given in Table 3.

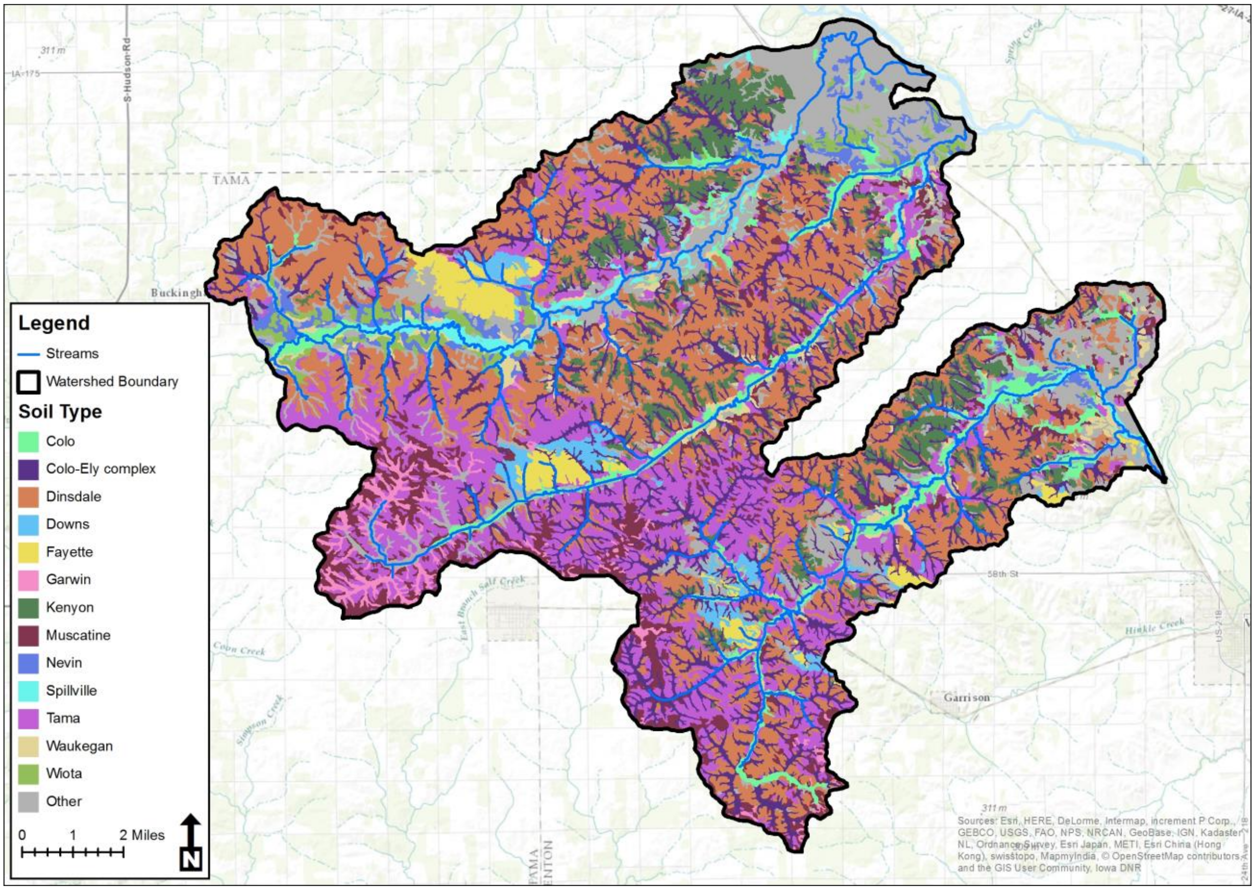


Figure 6. Benton/Tama watershed soil map derived from the National Cooperative Soil Survey (SSURGO, USDA-NRCS).

Table 3. Descriptions of common soil series of the Benton/Tama watershed (USDA-NRCS).

Soil Series	Description
Dinsdale	The Dinsdale series consists of very deep, moderately well drained soils that formed in 50 to 102 centimeters (20 to 40 inches) of loess and the underlying glacial till. Dinsdale soils are on interfluves, ridges and side slopes on dissected till plains. Slopes range from 0 to 14 percent.
Tama	The Tama series consists of very deep, well drained soils formed in loess. These soils are on interfluves and side slopes on uplands and on treads and risers on stream terraces in river valleys. Slope ranges from 0 to 20 percent.
Colo	The Colo series consists of very deep, poorly drained soils formed in alluvium. These soils are on floodplains, low stream terraces, alluvial fans, and upland drainageways. Slope ranges from 0 to 5 percent.
Ely	The Ely series consists of very deep, somewhat poorly drained soils formed in colluvium. These soils are on foot slopes, alluvial fans, and drainageways. Slope ranges from 0 to 9 percent.
Muscatine	The Muscatine series consists of very deep, somewhat poorly drained soils formed in loess. These soils are on summits of interfluves on dissected till plains and on treads and risers on stream terraces. Slopes range from 0 to 5 percent.
Kenyon	The Kenyon series consists of very deep, moderately well drained soils formed in 30 to 75 centimeters of silty or loamy sediments and the underlying till. These soils are on interfluves and side slopes on dissected till plains on the Iowan Erosion Surface. Slope ranges from 2 to 35 percent.

Table 4 summarizes the soil characteristics which affect water movement within the watershed. Approximately 38.1% of the soils are classified as hydric, which means that they are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper portion of the soil profile. A soil is classified as hydric regardless of its drainage status.

Table 4. Drainage characteristics of common soils found in the Benton/Tama watershed.

Soil	Acres	Percent of Total Area	Hydrologic Soil Group	Flood Frequency	Drainage Class
Dinsdale	24,072	26.1%	B	None	Moderately Well
Tama	14,162	15.4%	B	None	Well
Colo-Ely	12,321	13.4%	B	None	Poorly to Somewhat Poorly
Muscatine	5,842	6.3%	B	None	Somewhat Poorly
Kenyon	5,788	6.3%	B	None	Moderately Well

Figure 7 shows a map of highly erodible land (HEL) within the Benton/Tama watershed. Approximately 25.8% of the watershed is considered HEL or potentially HEL.

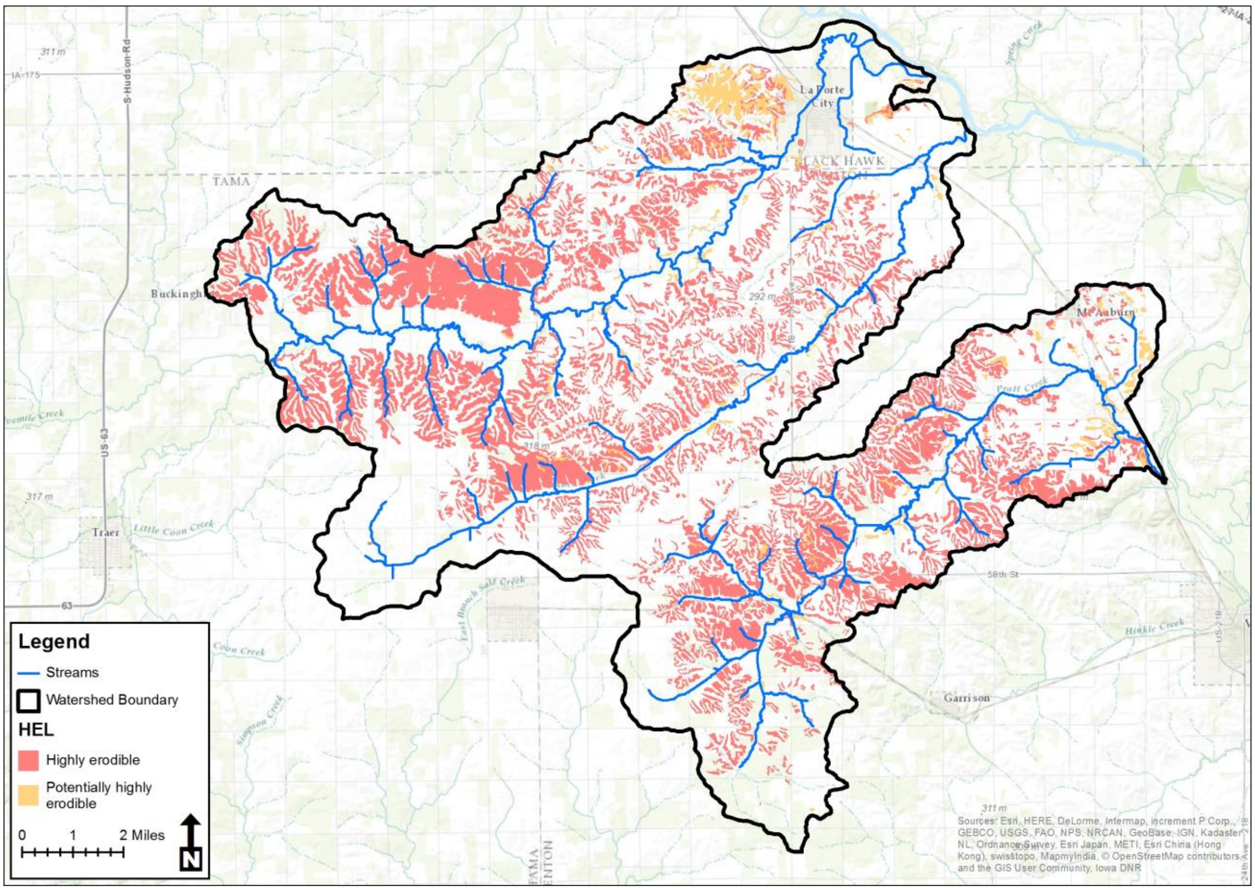


Figure 7. Highly erodible land (HEL) classification (SSURGO, USDA-NRCS).

Figure 8 displays the corn suitability rating (CSR) for land within the Benton/Tama watershed. The CSR is an index that provides a relative ranking of soils mapped in Iowa based on their potential to be utilized for intensive row crop production and can thus be used to rank one soil's yield potential against another. Corn suitability ratings range from 5 (severely limited soils) to 100 (soils with no physical limitations, no or low slope, and can be continuously farmed). The ratings assume adequate management, natural precipitation, artificial drainage where necessary, no negative effects from flooding, and no land leveling or terracing.

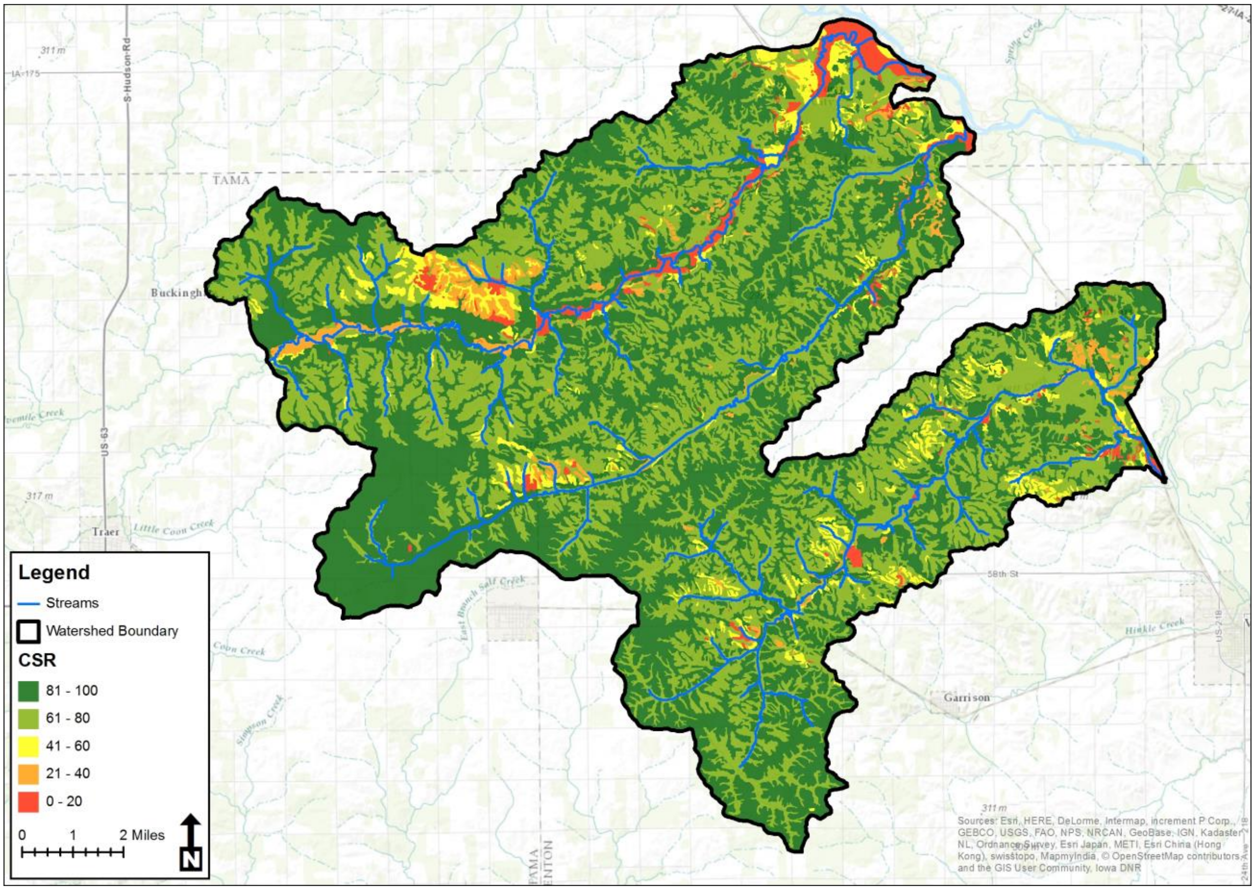


Figure 8. Corn suitability rating (CSR) (SSURGO, USDA-NRCS).

2.4 Geology

The entire Benton/Tama watershed is located on the Iowan Surface landform region. The Iowan Surface was last glaciated approximately 300,000 years ago. The present day landscape is dominated by gently rolling terrain created by glacial processes and ensuing episodes of intense erosion, which most recently occurred between 21,000 and 16,500 years ago. The watershed is also located within the Eastern Iowa and Minnesota Till Prairies Major Land Resource Area (MLRA 104). Five small quarries exist in the watershed. Approximately 20,400 acres or 22% of the watershed has alluvial deposits.

2.5 Climate

Climate data from Waterloo, just north of the Benton/Tama watershed, shows average annual total precipitation to be 34.5 inches per year. However, year to year precipitation totals vary widely. Monthly temperature and precipitation averages are shown in Figure 9.

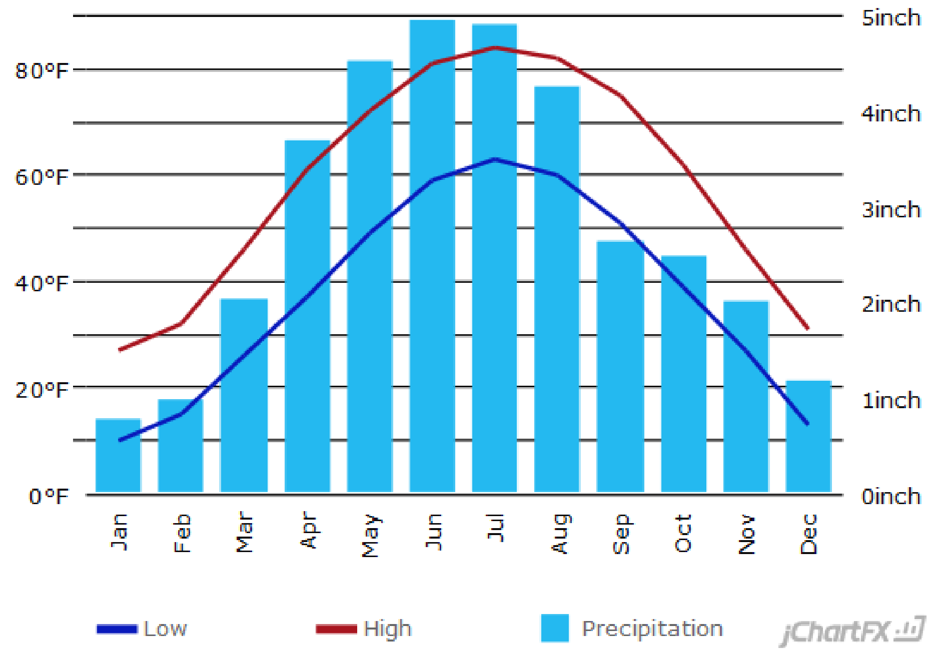


Figure 9. Waterloo, Iowa, 1981 to 2010 average monthly precipitation and temperature data (US Climate Data).

2.6 Elevation & Slope

Figure 10 displays the slope classification of the Benton/Tama watershed according to Light Detection and Ranging (LiDAR)-derived elevation data. Surface elevation in the watershed ranges from 236 to 323 meters above sea level. Table 5 contains the slope classifications within the watershed. Approximately 24% is classified as A slopes (0–2% slope), 43% as B slopes (2–5%), and 25% as C slopes (5–9%). The remaining 8% of the watershed area has slopes of D or greater.

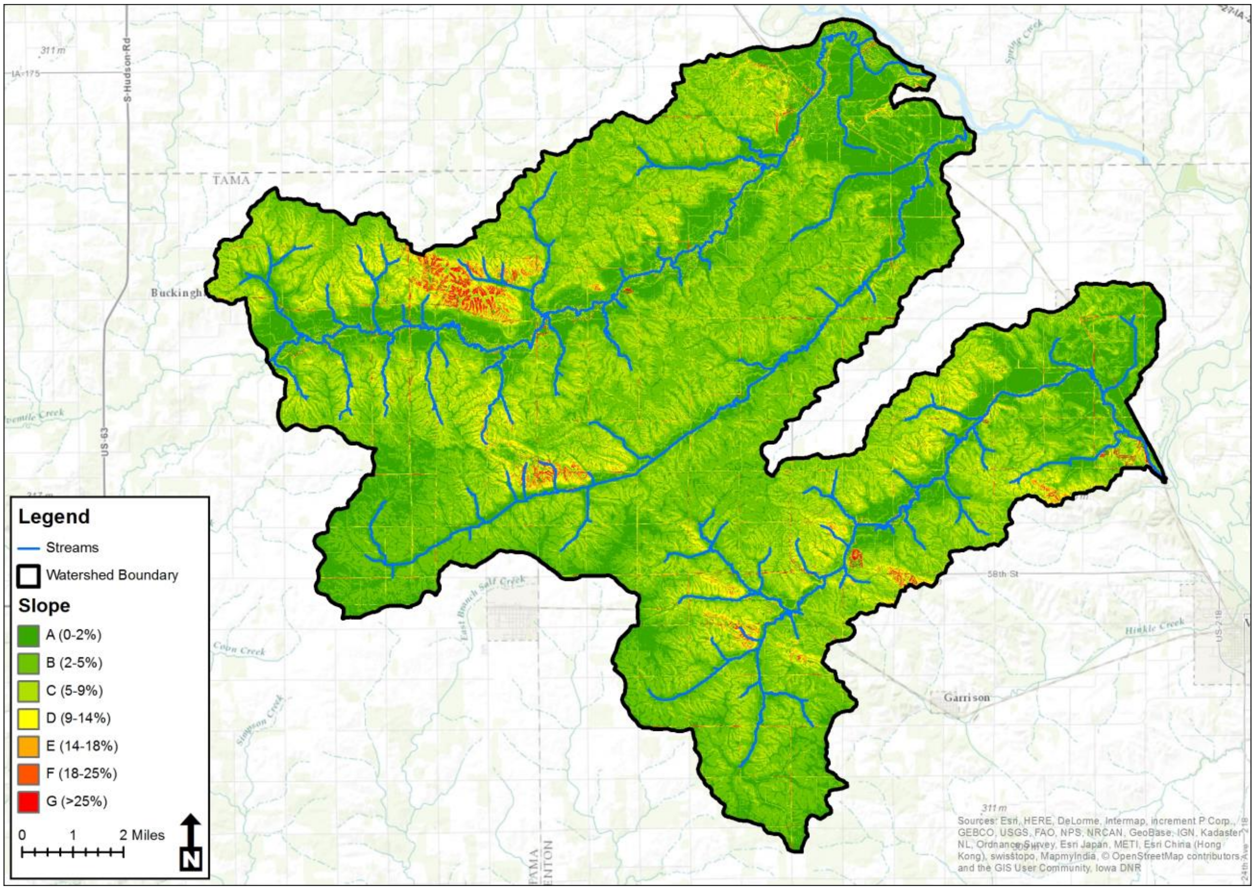


Figure 10. Benton/Tama watershed slope classification derived from LiDAR elevation data.

Table 5. Slope classification of the Benton/Tama project watersheds derived from LiDAR data.

Slope Classification	Range	Acres	Percent of Total Area
A	0–2%	21,767	23.6%
B	2–5%	39,893	43.3%
C	5–9%	23,197	25.2%
D	9–14%	4,631	5.0%
E	14–18%	1,219	1.3%
F	18–25%	923	1.0%
G	> 25%	589	< 1%

2.7 LAND USE & MANAGEMENT

Land use practices were assessed using Iowa Department of Natural Resources (DNR) data from 2009. The land use data was developed from aerial imagery and LiDAR elevation data. A summary of the land use data is presented in Figure 11 and Table 6. Notably, 79.7% of the watershed is used for corn and soybean agriculture.

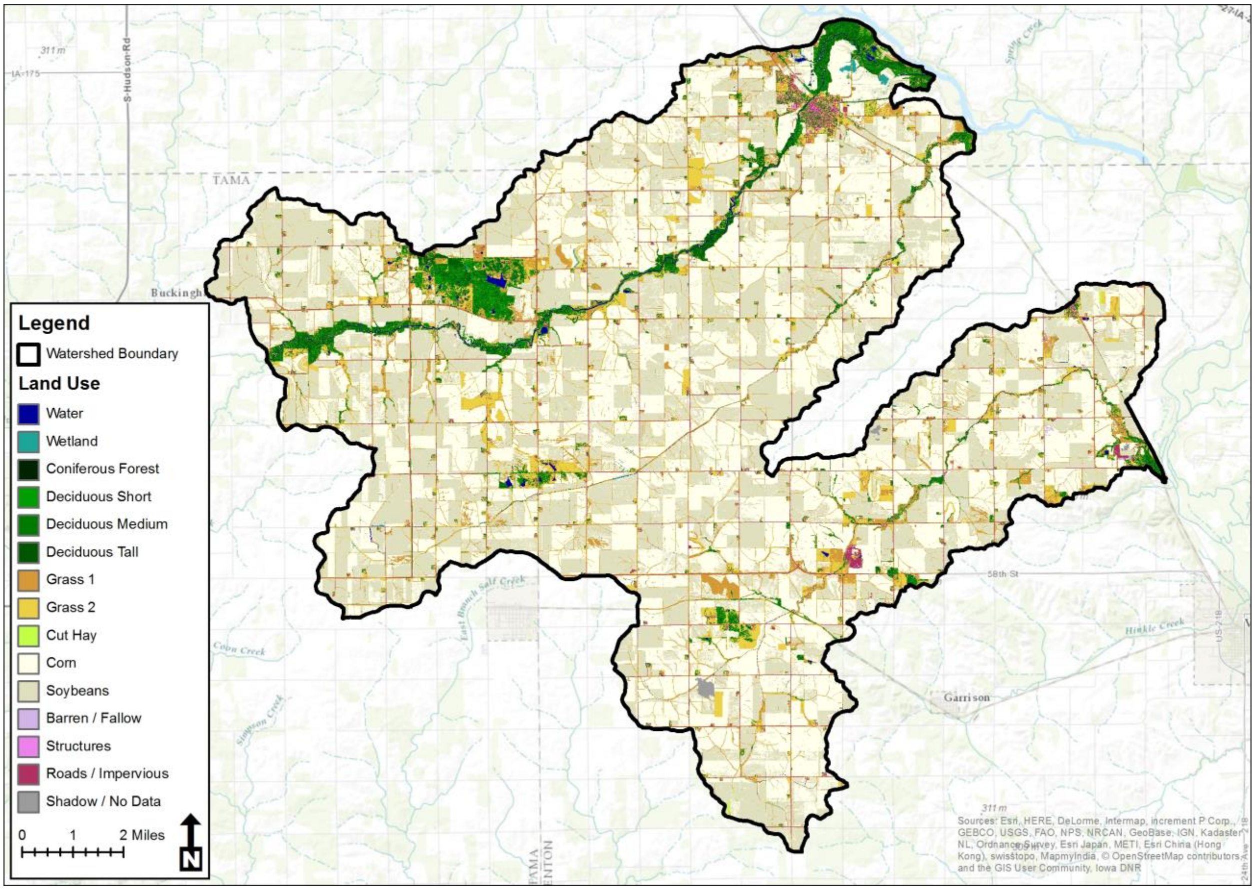


Figure 11. Land use of the Benton/Tama watershed.

Table 6. Benton/Tama watershed land use.

Land Use	Acres	Percent of Total Area
Water	478	0.5%
Wetland	137	0.2%
Coniferous Forest	29	< 0.1%
Deciduous Short	1,939	2.1%
Deciduous Medium	1,309	1.4%
Deciduous Tall	1,278	1.4%
Grass 1 (Warm Season)	6,834	7.4%
Grass 2 (Cool Season)	4,711	5.1%
Cut Hay	51	< 0.1%
Corn	40,387	43.8%
Soybeans	33,105	35.9%
Barren / Fallow	77	< 0.1%
Structures	182	0.2%
Roads / Impervious	1,555	1.7%
Shadow / No Data	148	0.2%

The General Land Office (GLO) first surveyed the land in Iowa between 1832 and 1859. Surveyors recorded descriptive notes and maps of the landscape and natural resources such as vegetation, water, soil, and landform. The collection of historic GLO maps and survey notes is one of few sources of information about native vegetation before much of Iowa's landscape was converted to intensive agriculture. The GLO surveyors classified the Benton/Tama watershed as 95% prairie and 3% timber, with the remaining 2% classified as water or mixed vegetation.

2.8 Population & Demographics

According to United States Census Bureau 2010 census data 3,687 people live in the Benton/Tama watershed, which equates to a population density of 25.6 people per square mile. There are approximately 1,571 housing units within the watershed.

2.9 Conservation Infrastructure

Cataloging existing conservation infrastructure is an important assessment of current conditions as well as a useful exercise for determining the need for future conservation practice placement. Aerial photography and watershed surveys revealed many conservation practices currently in place within the watershed. Determining levels of in-field management practices (e.g. nutrient management, tillage, cover crops) can be difficult. NRCS provided information on cover crops and reduced tillage in the Benton/Tama watershed to aid the conservation practice assessment. Table 7 lists all practices and known existing implementation levels within the watershed. Figure 12 provides a map of existing conservation practices as of 2015. See Appendix I for a larger map of conservation practices.

Table 7. Benton/Tama watershed existing conservation practices.

Practice	Quantity
Terraces	278,292 feet
Grassed Waterways	1,585,740 feet
CRP	1,340 acres
100’ Stream Buffer	58% in grass or trees
Cover Crops	> 4,000 acres
No-Till/Strip-Till	> 2,500 acres
Saturated Buffers	1
Wetlands/Ponds	132 acres
Nutrient Management	Unknown

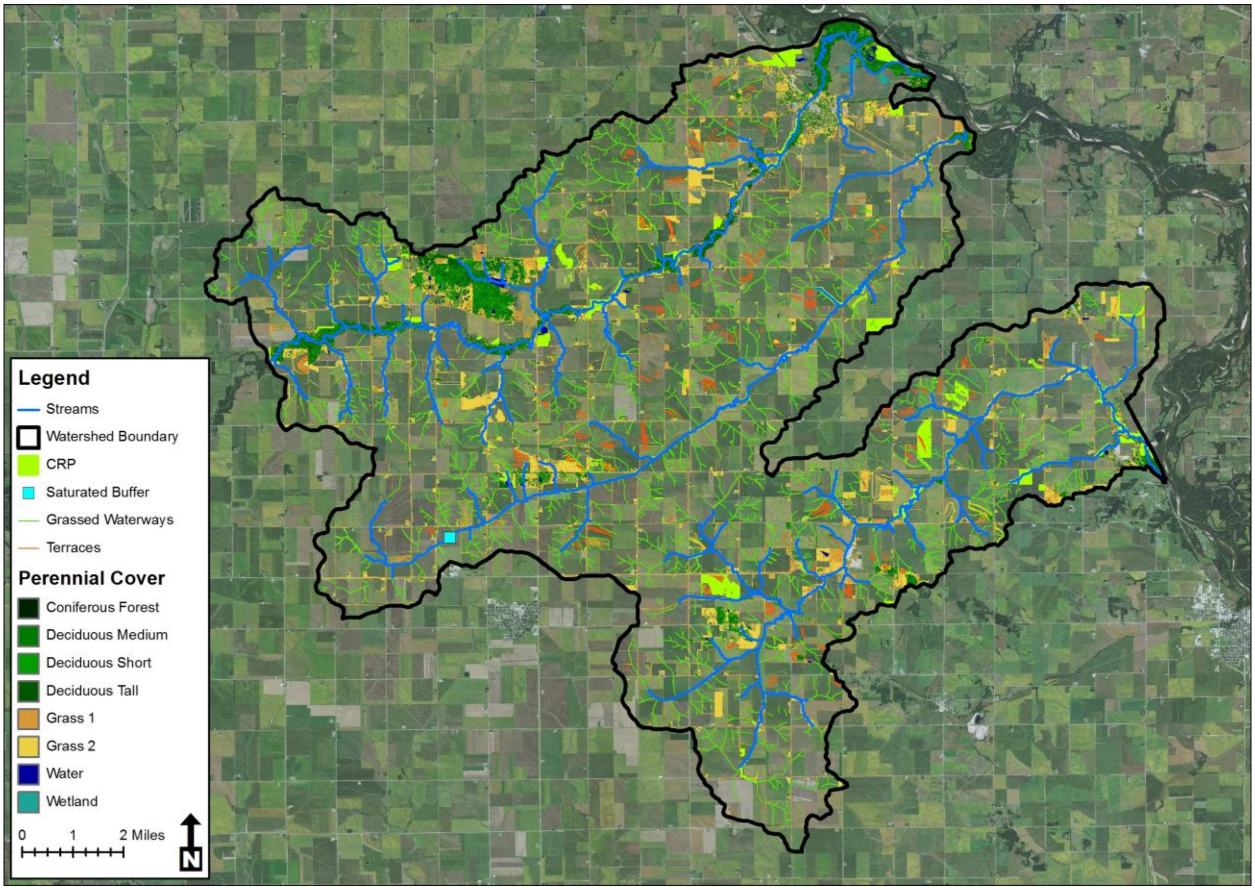


Figure 12. Existing conservation practices with known locations in the Benton/Tama watershed as of 2015.

3 Stream Physical, Chemical & Biological Conditions

3.1 Cedar River Nitrate Impairment

The Benton/Tama watershed is part of the larger Cedar River watershed (Figure 13). The Cedar River near Cedar Rapids is impaired for elevated levels of nitrate that impact the drinking water source of the City of Cedar Rapids. Because of this impairment a Water Quality Improvement Plan (or total maximum daily load, TMDL) for nitrate was developed by the Iowa DNR and approved by the Environmental Protection Agency (EPA) in 2006.

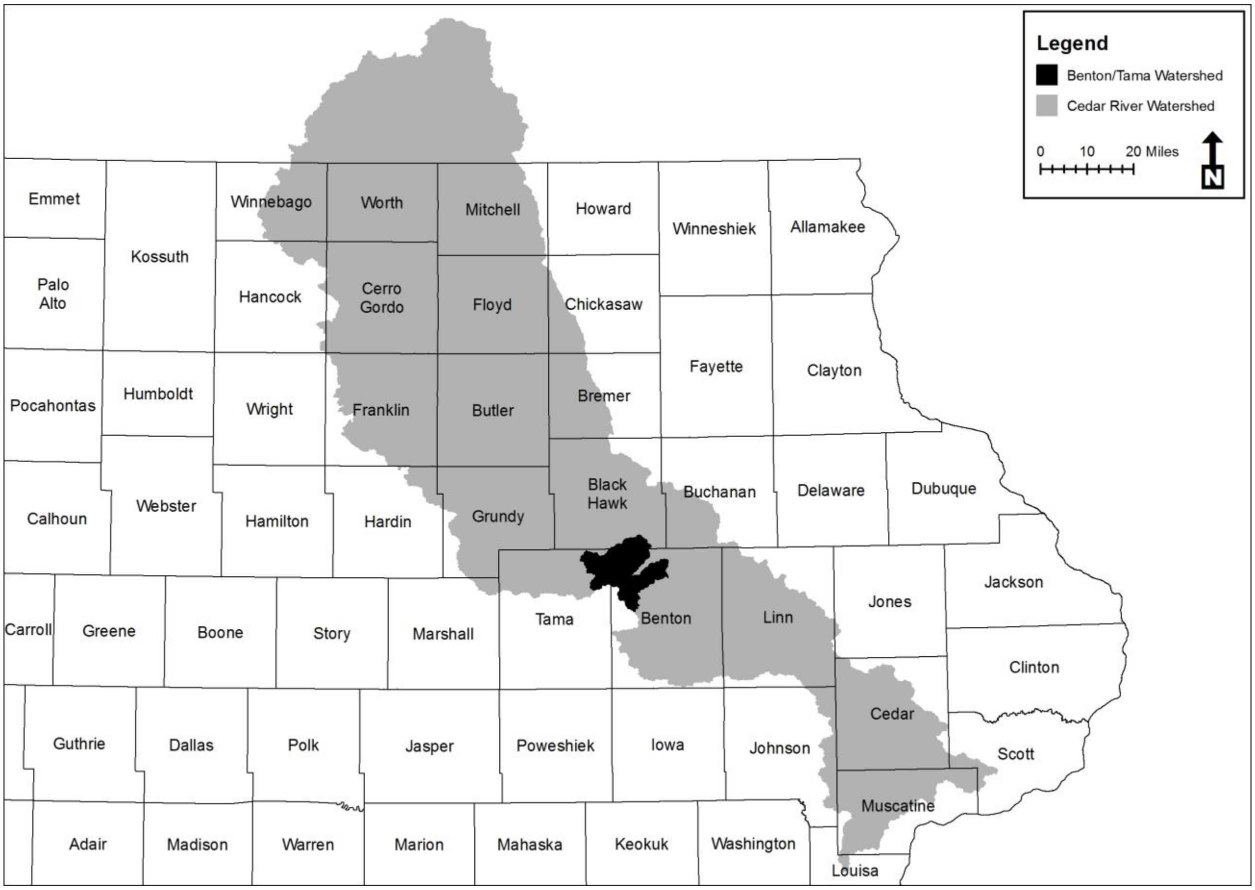


Figure 13. Location of the Benton/Tama watershed within the Cedar River watershed.

The 2004 305(b) Iowa Integrated Report showed the designated drinking water use of the Cedar River in Cedar Rapids (segment IA 02-CED-0030_2) was impaired due to nitrate-nitrogen (nitrate) concentrations exceeding state water quality standards. For the impaired segment, the Class C (drinking water) uses were assessed as “not supporting” due to the level of nitrate that exceeds state water quality standards and EPA maximum contaminant level (MCL). The applicable water quality standard for nitrate is 10 milligrams per liter (mg/L). A Water Quality Improvement Plan was developed to calculate the maximum allowable nitrate load for the impaired segments of the Cedar River that will ensure compliance with water quality standards.

The Cedar River in Cedar Rapids drains a watershed of 6,530 square miles flowing from its headwaters in Minnesota through north-central and northeast Iowa. The watershed is located primarily within the Iowan Surface landform region of Iowa characterized by gently rolling landscapes and mature drainage patterns. Land cover in the Cedar River watershed is predominantly agricultural, consisting of 73% row crops, 18% grass, 4% forest, 4% urban, and 1.2% water and wetlands.

Surface water from the Cedar River is used by the City of Cedar Rapids to provide drinking water to approximately 130,000 residents. The TMDL reported nitrate concentrations in the river from 2001 to 2004 ranged from 0.36 to 14.7 mg/L and averaged 6.75 mg/L. Nitrate concentrations exhibit clear seasonality, with higher concentrations occurring during April, May, and June as well as November and December. The sources of nitrate can be divided into two major categories: point sources and nonpoint sources. The Cedar River TMDL reports 91% of the nitrates in the Cedar River can be attributed to nonpoint sources, while the remaining 9% are from point sources.

The TMDL incorporated two water quality models to evaluate stream flow and pollutant loading patterns in the Cedar River watershed. The Diffusion Analogy Surface Water Flow (DAFLOW) model was used to route and estimate stream flows. A second model, Water Quality Simulation Program (WASP), was used to interpret and predict water quality parameters in aquatic systems such as the Cedar River. The model inputs included climate, topography, land use, soils, feedlots and confinements, manure application areas, waste water treatment plants, and census data. The Cedar River watershed was divided into seven subbasins for the modeling effort. These included the Upper Cedar, Shell Rock, West Fork, Beaver, Black Hawk and Wolf tributaries and the Middle Cedar subbasin. Nitrate loss rates in the subbasins varied from about 10 pounds per acre per year in the Beaver Creek subbasin to more than 25 pounds per acre per year in the Upper Cedar subbasin. When combined with stream flow information it was found that the Upper Cedar subbasin contributes 42% of the nitrate load, the Shell Rock 29%, West Fork 16%, Black Hawk 5%, Beaver 4%, and Wolf 4%.

Nitrate sources are separated into point and nonpoint sources. The TMDL further divides the nonpoint sources into wildlife, septic, atmospheric deposition, manure application, legume fixation, and fertilizer application. The nitrate contribution of these sources is shown in Table 8.

Table 8. Nitrate contributions in the Cedar River watershed.

Subbasin	Point Sources (t/yr)	Wildlife (t/yr)	Septic Systems (t/yr)	Atmospheric Deposition (t/yr)	Manure (t/yr)	Legume (t/yr)	Fertilizer (t/yr)
Upper Cedar River	794	105	114	4,117	13,070	22,201	33,061
Shell Rock River	464	64	90	4,312	9,629	23,183	38,822
West Fork Cedar	45	31	36	2,097	9,298	11,364	18,702
Beaver Creek	29	12	22	976	4,169	5,567	8,684
Black Hawk Creek	28	9	15	828	2,264	4,835	8,574
Wolf Creek	30	12	15	814	1,260	4,692	7,694
Middle Cedar	1,132	149	131	2,989	5,957	15,034	27,136
Total	**2,522**	**382**	**423**	**16,133**	**45,647**	**86,876**	**142,673**

The TMDL reports that a 35% reduction in Cedar River nitrate concentration is necessary to attain a maximum daily nitrate concentration of 9.5 mg/L in order to meet water quality standards. The Benton/Tama watershed is located in the Wolf and Middle Cedar subbasins.

3.2 Wolf Creek, Rock Creek & Pratt Creek Water Monitoring

Recent physical, chemical, and biological water monitoring efforts in the Benton/Tama watershed have been sparse. According to current Iowa DNR water quality assessment data, only Wolf Creek has been recently monitored and listed in Iowa's 305(b) Assessed Waters Report whereas Rock Creek and Pratt Creek have not been assessed within the last ten years. Wolf Creek is listed in Iowa's 303(d) Impaired Waters Report as "not supporting" the Class A1 (primary contact recreation) designated use due to high levels of indicator bacteria. 2010 through 2012 monitoring data from Wolf Creek at La Porte City showed that the geometric mean *E. coli* concentration exceeded the Class A1 standard of 126 organisms/mL in each of the three years. No Class B(WW-1) (aquatic life) criteria (dissolved oxygen, pH, ammonia-nitrogen, temperature, chloride, and sulfate) were exceeded during the 2010 to 2012 assessment period.

In 2015 seven stream monitoring sites were established in the Benton/Tama watershed. Water samples were periodically collected from each site and analyzed for nitrate-nitrogen and orthophosphate. The monitoring sites are mapped in Figure 14 and average June 2015 through August 2015 nitrate concentrations are displayed in Figure 15.

Eleven tile sites were periodically sampled during 2015. The average nitrate concentration of tile sites within the Benton/Tama watershed was 20.9 mg/L, which is slightly higher than the Iowan Surface average of 18.3 mg/L and statewide average of 15.5 mg/L.

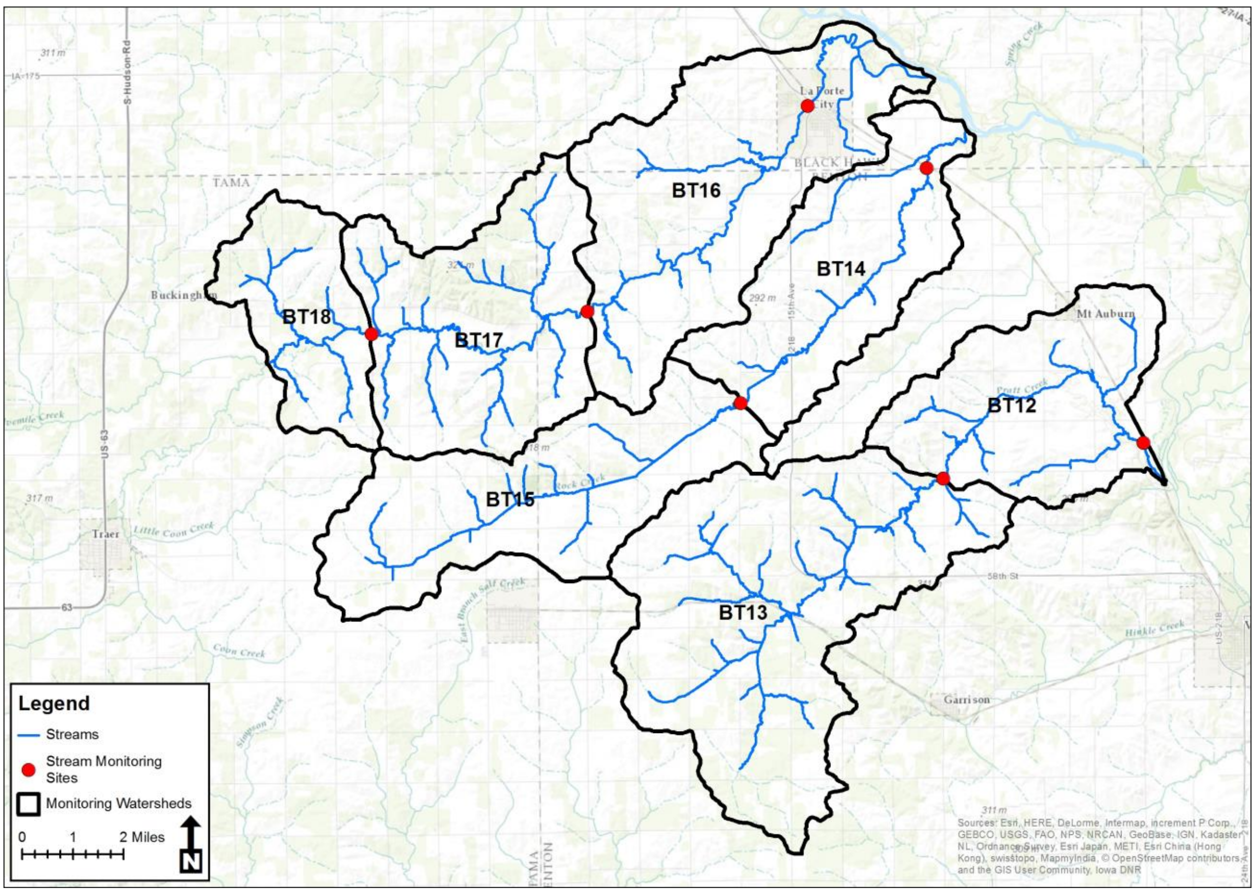


Figure 14. Seven stream water quality monitoring sites and their drainage areas within the Benton/Tama watershed.

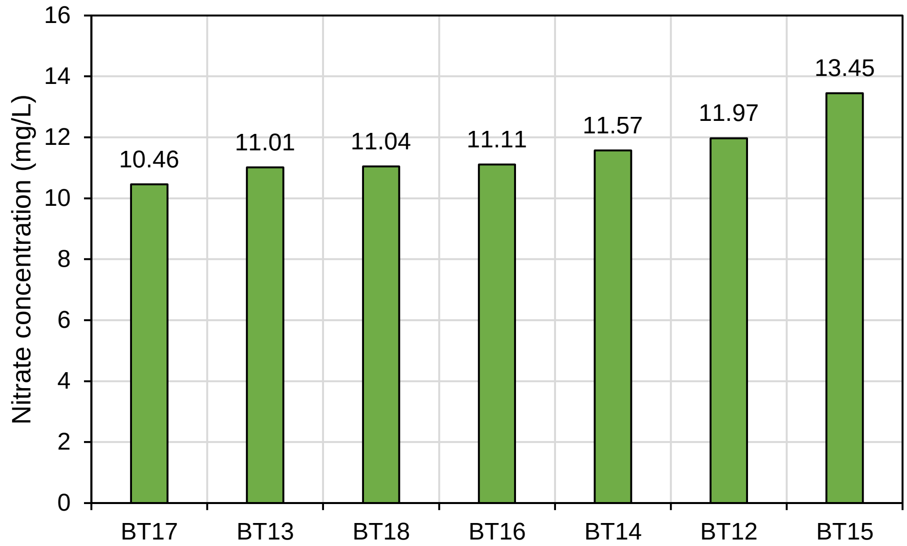


Figure 15. Average summer 2015 nitrate (NO_3^-) concentration at seven stream monitoring sites in the Benton/Tama watershed.

4 Goals & Objectives

This watershed management plan will be of little value to real water and soil quality improvement unless watershed improvement activities and best management practices (BMPs) are implemented. This will require the active engagement of local stakeholders and the collaboration of local, state, and federal agricultural and conservation agencies. In addition to the implementation of BMPs, continued water quality monitoring is necessary. Monitoring is a crucial element to assess the status of water quality goals, standards, and designated uses; to determine if water quality is improving, degrading, or remaining unchanged; and to assess the effectiveness of implementation activities and the possible need for additional BMPs.

This plan is intended to be used by local agencies, watershed managers, and citizens for decision-making support and planning purposes. The BMPs listed below represent a suite of tools that will help achieve water quality, soil health, agronomic, and quality of life goals if appropriately utilized. It is up to all stakeholders to determine exactly how to best implement them. Locally driven efforts have proven to be the most successful in obtaining real and significant water quality improvements.

The final element of the planning process, which is the implementation of the plan, begins after the goals, objectives, and action statements have been identified. Plan implementation continues through adherence to the goals, objectives, and action statements set forth in this plan. However, it should be emphasized that these goals, objectives, and action statements are not “set in stone.” While these goals, objectives, and action statements have been developed with input from local stakeholders based on the best information available and based on the current needs and opportunities of the watershed, changing needs and desires within the watershed, economy, or Farm Bill may mean that these goals, objectives, and action statements will need to be re-evaluated. This plan must allow for sufficient flexibility to respond to changing needs and conditions, while still providing a strong guiding mechanism for future work.

Through the watershed planning process the following goals addressing water, soil, and flood reduction have been identified:

1. **Reduce in-stream nonpoint source nitrogen loads by 41% from 2009-2011 levels.** This goal will reach targets for both the nonpoint source goal within the Iowa Nutrient Reduction Strategy (41%) and the Cedar River Nitrate TMDL (35%).
2. **Reduce in-stream nonpoint source phosphorus loads by 29% from 2009-2011 levels**. This goal will reach the nonpoint source goal included in the Iowa Nutrient Reduction Strategy.
3. **Maintain or increase agricultural productivity and profitability.**
4. **Reduce flood risk within Wolf Creek, Rock Creek, Pratt Creek, and downstream.**

This watershed plan uses the year 2010 as a baseline for practice implementation and determining progress towards reaching set goals. Watershed models were developed by the Iowa Soybean Association to determine the baseline, current, and future nitrogen, phosphorus, and sediment loads and associated reductions in the Benton/Tama watershed. Table 9 provides estimates of watershed loading rates for the 2010 baseline, 2015 conditions, and conditions after the implementation of practices identified in this watershed plan. Table 10 provides percent reduction estimates from the 2010 baseline. A practice-based model was used to determine the nitrogen load reductions. The Iowa Nutrient Reduction Strategy Science Assessment provided the practice efficiencies. A Revised Universal Soil Loss Equation (RUSLE) and Sediment Delivery Model was developed to estimate erosion and sediment delivery levels and reductions. A phosphorus enrichment ratio of 1.6 pounds of phosphorus per ton of sediment delivery was used to estimate the phosphorus load.

Table 9. Baseline, existing, and estimated future total contaminant loading within Wolf Creek, Rock Creek, and Pratt Creek.

	Units	2010 Baseline Conditions	2015 Conditions	Watershed Plan Implementation
Nitrogen Load	pounds/year	1,021,410	1,004,778	604,563
Phosphorus Load	pounds/year	75,399	74,471	52,855
Sheet & Rill Erosion	tons/year	357,967	352,694	246,076
Streambank Erosion	tons/year	8,609	8,609	6,629
Sediment Delivery	tons/year	47,124	46,544	33,034

Table 10. Estimated load reductions under current and future scenarios relative to 2010 baseline conditions.

	Units	2010 Baseline Conditions	2015 Conditions	Watershed Plan Implementation
Nitrogen Load	% reduction	-	1.6%	41%
Phosphorus Load	% reduction	-	1.2%	30%
Sheet & Rill Erosion	% reduction	-	1.5%	31%
Streambank Erosion	% reduction	-	0%	23%
Sediment Delivery	% reduction	-	1.2%	30%

5 CONCEPTUAL PLAN

Best management practices are part of the foundation for achieving water quality, soil health, and flood reduction goals. BMPs include practices and programs designed to improve water quality and other identified resource concerns, such as changes in land use or management, physical pollutant mitigation structures, and changes in social norms and human behavior pertaining to watershed resources along with their perception and valuation (Iowa DNR, 2009). Efforts are made to encourage BMPs that are long-term but this is often dependent upon landscape characteristics, land tenure, commodity prices, and other market trends that potentially compete with conservation efforts. With this in mind it is important to identify all possible BMPs needed to achieve the goals of the watershed project. From an initial list of potential practices, priority practices were narrowed down to those that were the most acceptable to watershed stakeholders. Watershed planning facilitators used an effort versus impact exercise to prioritize BMPs which provide the greatest benefit and are the most acceptable to local stakeholders.

When selecting and implementing BMPs it is important to identify if a particular practice is feasible in a given location. Site feature suitability and practice alignment with stakeholder values should be considered. It is also important to determine how effective the practice will be at achieving goals, objectives, and targets. Table 11 provides a list of BMPs identified by watershed stakeholders. BMPs in bold font show those practices included in the conceptual plan. Included in Table 11 is a rating of each practice's efficacy to address identified water and soil goals. While only the practices in bold are included in the conceptual plan and nutrient reduction calculations, the other practices will be important to consider when making decisions about water and soil improvement. Figure 16 provides a map of a conceptual BMP implementation scenario that sites BMPs in locations intended to achieve maximum benefit (e.g. nitrate removal wetlands being placed at strategic locations or bioreactors placed at drainage tile outlets). See Appendix I for a larger map of the conceptual plan.

Table 11. Best management practices (3 = high impact, 2 = moderate impact, 1 = low impact, 0 = no impact).

	Practice	**Water Quality: Nitrogen**	**Water Quality: Phosphorus**	**Soil Health**	**Water Quantity (Flood Reduction)**
In-Field	**Perennial Cover (including CRP)**	**3**	**3**	**3**	**3**
	Cover Crops	**3**	**3**	**3**	**1**
	No-Till/Strip-Till	**0**	**3**	**3**	**1**
	Grassed Waterways	0	2	1	1
	4R Nutrient Management	**1**	**1**	**1**	**0**
	Drainage Water Management	3	0	0	2
	Nitrification Inhibitor	1	0	0	0
Edge-of-Field	Stream Buffers	1	3	0	1
	Bioreactors	**3**	**1**	**0**	**0**
	Saturated Buffers	**3**	**0**	**0**	**0**
In-Stream	Ponds	1	3	0	3
	Nitrate Removal Wetlands (CREP)	**3**	**1**	**0**	**2**
	Streambank Stabilization	**0**	**2**	**0**	**0**

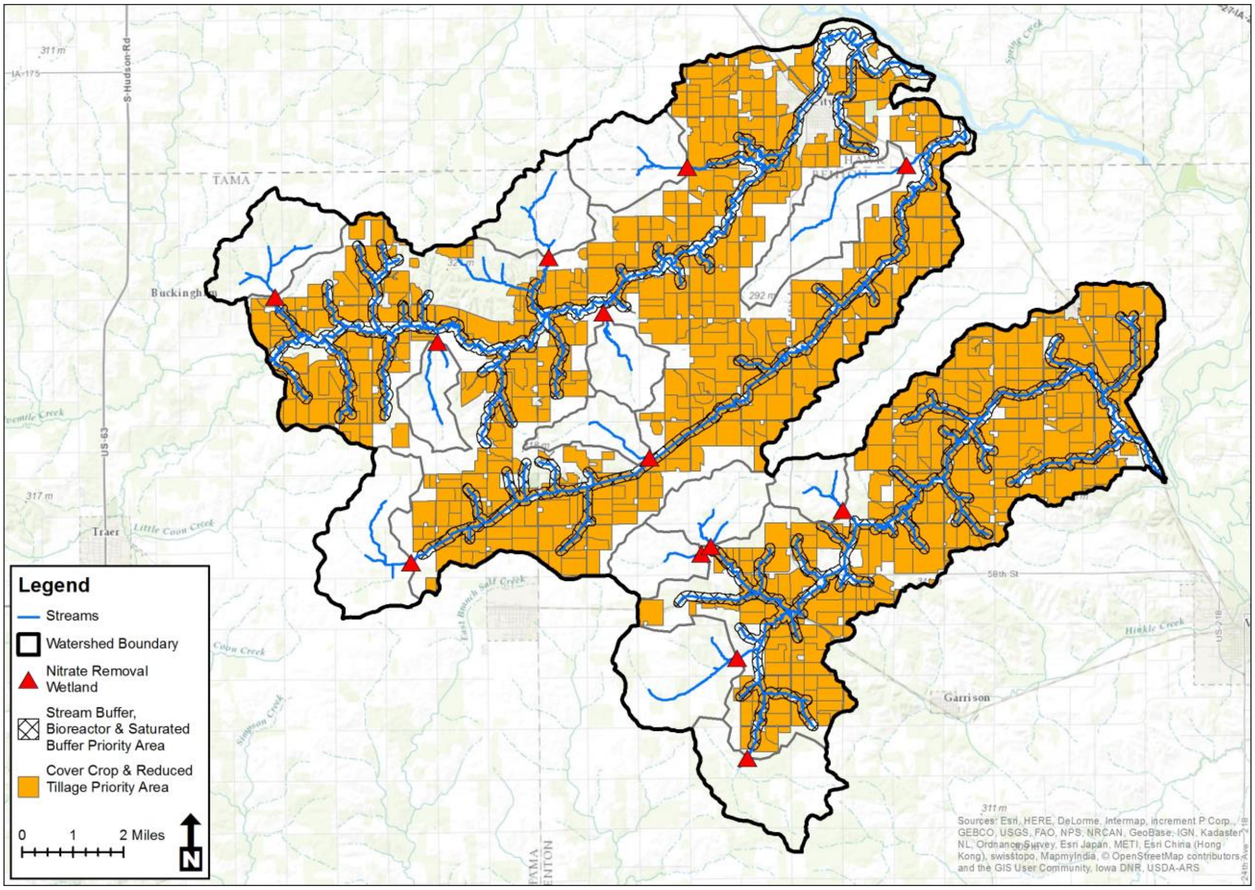


Figure 16. BMP conceptual implementation plan.

The BMP conceptual plan presented in Figure 16 is ambitious, but this level of implementation is needed to achieve the goals identified in this watershed management plan. This scenario is one of many potential combinations of BMPs that would allow for this plan's goals to be reached. Deviations from the proposed implementation plan should be made with the knowledge that additional practices may then be needed in other locations within the watershed to ensure that goals are met. For example, cover crops grown within a wetland drainage area may not result in the same downstream water quality benefit as cover crops grown downstream of a wetland.

A team of scientists have developed the Agricultural Conservation Planning Framework (ACPF) to facilitate the selection and implementation of conservation practices in watersheds with predominately agricultural land use (Tomer et al., 2013). The ACPF outlines an approach for conservation-oriented watershed management. The framework can conceptually be considered as a pyramid. This "conservation pyramid" is built on a foundation of soil health. The cover crop and reduced tillage priority area delineated in Figure 16 has been identified for maximum water quality improvement potential at the outlets of the HUC 12 watersheds, but such practices that build soil health may result in additional benefits including erosion control, water retention and flood reduction, increased soil organic matter, and improved nutrient cycling. Therefore management practices that improve soil health like cover cropping and reducing tillage should be promoted and implemented on all cropland within the Benton/Tama watershed. According to the "conservation pyramid" concept, structural practices to control and treat water should then be targeted to specific in-field, edge-of-field, and in-stream locations where maximum water quality benefits can be realized.

6 IMPLEMENTATION SCHEDULE

Implementation schedules are intended to serve as a reference tool to recognize tasks that are scheduled for the upcoming year and to help focus the necessary resources for the current phase of the project. The implementation schedule should be adaptable and updated on a regular basis due to shifting priorities, new opportunities, and unexpected delays.

The following schedule was established by watershed stakeholders and should be used to set yearly goals and gauge progress. It should be noted that practices included in the implementation table only include those identified to reach the watershed plan goals. Other practices such as drainage water management, structural runoff control (e.g. grass waterways, terraces, contour filter strips), and stream buffers should be promoted whenever appropriate.

Perennial cover such as CRP and energy crops should be targeted to locations on the landscape with maximum potential to improve water quality. For example, the STRIPS project has demonstrated the effectiveness of such targeted conservation. In addition to nutrient removal, fields with strategic portions in perennial cover may provide other ecosystem services such as wildlife and pollinator habitat.

Table 12. Targeted implementation schedule.

	Practice	Existing (2015)	Units	2016-2020 Target	2021-2025 Target	2026-2030 Target	2031-2035 Target	2036-2040 Target	Total 2040 Target
Soil Health & Nutrient Management	No-Till/Strip-Till	> 2,500	acres	*Maximum possible acres (at least 15,000 acres)*					
	Cover Crops	> 4,000	acres	6,000	10,000	15,000	10,000	5,000	50,000
	Nutrient Management	Unknown	acres	5,000	10,000	15,000	5,000	5,000	40,000
	Perennial Cover, CRP	1,340	acres	300	200	160	-	-	2,000
	Perennial Energy Crops	Unknown	acres	200	500	800	800	700	3,000
In-Field	Grassed Waterways	1,585,740	feet	*Where necessary*					
	Terraces	278,292	feet	*Where necessary*					
Edge-of-Field	Stream Buffers	58%	feet	*Remaining 42% of streams*					
	Bioreactors	0	number	8	10	5	5	2	30
	Saturated Buffers	1	number	8	12	10	5	5	40
In-Stream	Nitrate Removal Wetlands	0	number	2	3	3	3	2	13
	Streambank Stabilization	0	feet	500	500	1,000	500	-	2,500

7 MONITORING PLAN

Monitoring is an essential component of watershed plan implementation and provides an opportunity to assess progress. Monitoring can come in many different forms including water monitoring, biological surveys, soil and plant tissue sampling, and social assessments. This section describes recommendations for future monitoring actions to document improvements that result from watershed plan implementation.

Stream Monitoring

Perhaps the most important monitoring activity is stream sampling due to the charge laid out in the Iowa Nutrient Reduciton Strategy to reduce nutrient loading in Iowa's rivers. Figure 17 displays sites where water samples have been collected for various stream monitoring efforts.

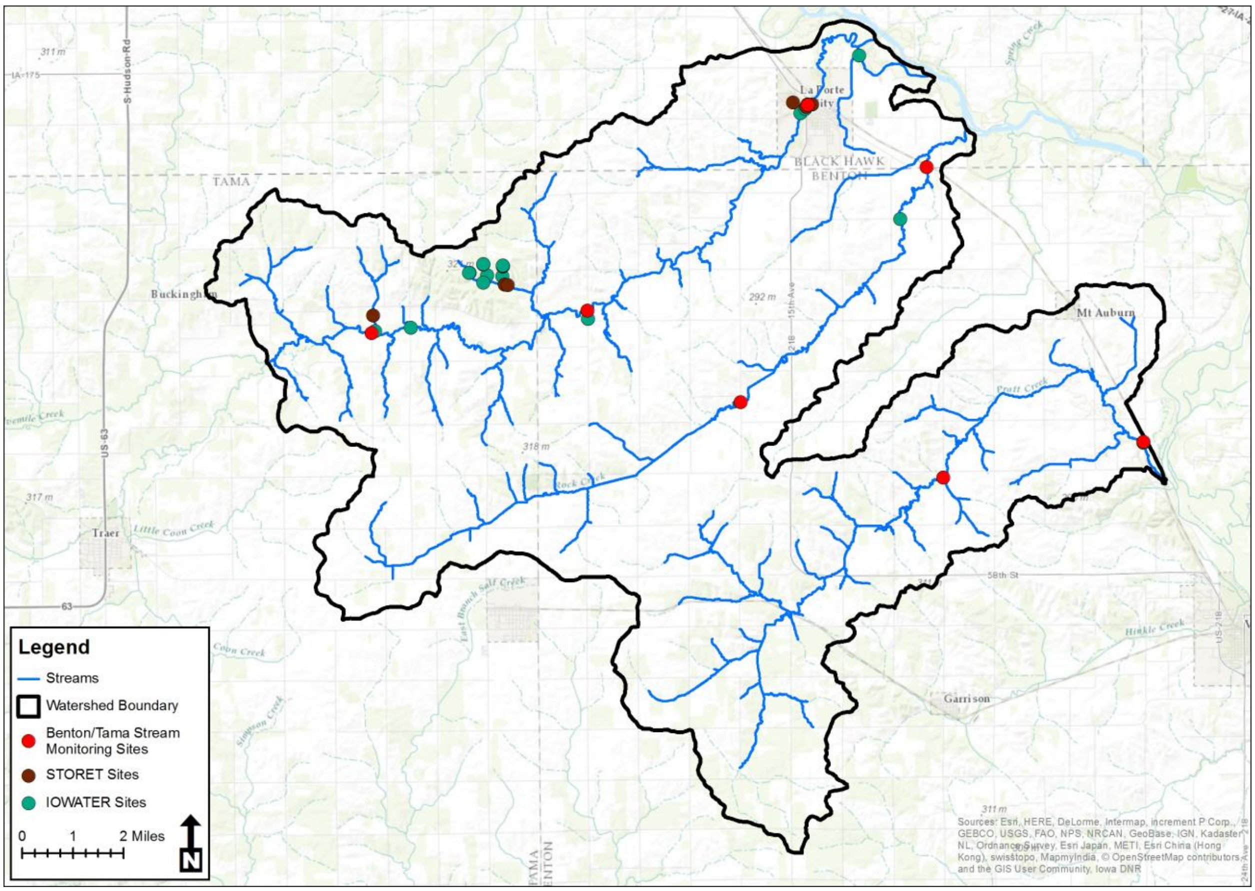


Figure 17. Active and previously sampled water monitoring sites in the Benton/Tama watershed.

Seven stream monitoring sites were established in 2015 for the Water Quality Initiative Benton/Tama Nutrient Reduction Demonstration Project. This site network will allow for consistent water quality information to be gathered throughout the entire Benton/Tama watershed. Water sampling should continue long-term at these locations to document changes in water quality throughout the different phases of watershed plan implementation. Ideally, bi-weekly samples should be collected beginning in April and extending through October. The samples should be analyzed for nitrate, phosphorus, and sediment. Table 13 lists the coordinates for the seven stream monitoring sites in the Benton/Tama watershed.

Table 13. Location of Benton/Tama watershed stream monitoring sites (Figures 14 and 17).

Site ID	Longitude	Latitude
BT18	-92.362509°	42.251496°
BT17	-92.279306°	42.257424°
BT16	-92.193861°	42.315603°
BT14	-92.148211°	42.297465°
BT15	-92.220604°	42.230833°
BT13	-92.142960°	42.208782°
BT12	-92.065964°	42.218354°

In addition to water grab sampling, stream discharge should also be recorded in order to determine nitrogen, phosphorus, and sediment loading. One method to capture stream discharge is to measure the stream stage and use a hydrograph to calculate discharge. The U.S. Geological Survey Water Science School provides an overview of this process. At a minimum, streamflow should be captured at sites BT16, BT14, and BT12 at the outlets of each of the HUC 12 watersheds.

Other existing water sampling programs offer additional data sources or opportunities to document water quality in Wolf Creek, Rock Creek, and Pratt Creek. The Iowa STORET database maintained by the DNR contains water physical, chemical, biological, and habitat data. The DNR's ADBNet database documents Iowa's water quality assessments for Clean Water Act section 305(b) reporting. Volunteer water quality monitoring such as IOWATER can also be important sources of information, especially to yield a detailed, one-time "snapshot" of water quality.

Biological Monitoring

The biological community of a stream reflects its overall health and chemical and physical water quality. Surveys of benthic macroinvertebrate species in streams are excellent biological indicators of water quality. In general, good quality streams display greater overall diversity and higher diversity and abundance within the sensitive mayfly, stonefly, and caddisfly groups (SHL, 2015). The IOWATER program provides protocols and recommendations for assessing the stream biological community in its Biological Monitoring Manual. Fish surveys could also be conducted to provide further indication of water quality, particularly if habitat improvement projects such as oxbow restoration or streambank stabilzation and shading are implemented. Existing biological monitoring data are stored in the DNR BioNet database.

Field Scale Water Monitoring

In addition to monitoring streams and tributaries in the Benton/Tama watershed, water quality monitoring at finer scales should be conducted to assess the effectiveness of individual conservation practice installations. Water samples at this scale should be collected from either tile water exiting subsurface drainage systems or surface runoff from a targetted area. Monitoring surface runoff is extremely difficult because runoff events are episodic and often missed via regularly scheduled monitoring programs. Tile water monitoring is easier because tiles tend to flow more consistently. However, monitoring tile water may only provide data on nitrate loss as the majority of phosphorus and sediment loss occurs via surface runoff.

Tile monitroing should be targeted to drainage systems that drain a single field to allow for changes in management practices to be isolated and detectable. Tile outlets that are easily accessible and provide the opportunity to capture sufficient tile flow should be selcted for monitoring. Flow volume from tiles can be calculated by measuring the time needed to fill a container of known volume. Tile flow along with pollutant concentrations can be used to calculate the pollutant loading at a tile outlet.

Soil Sampling

Agricultural soils contain many nutrients, especially where fertilizer or manure have been applied. Soil samples should be analyzed for phosphorus, nitrogen, and organic matter (which affects nutrient cycling) at a minimum. Improved soil fertility data will better inform nutrient management, which can result in the multiple benefit scenario of increased profitability and decreased nutrient export due to precise nutrient application. Additionally, collection of soil samples in coordination with field scale water monitoring could improve understanding of the relationship between nutrient management practices and water quality. Soil samples should be collected for multiple years, particularly if agronomic management practices are altered or conservation practices such as cover crops are implemented.

Plant Tissue Sampling

The end-of-season corn stalk nitrate test is a tool that can be used to evaluate the availability of nitrogen to the corn crop. Nitrate concentrations measured from stalk sections for the lower poriton of a corn plant taken after the plant reaches maturity are indicative of nitrogen availability to the plant. The corn plant will move available nitrogen to the grain first. By measuring the amount of nitrogen that was left after grain fill, a determination can be made as to how much nitrogen was left in the plant above (or below) what was needed for optimal grain yield. This is a very basic and easy management evaluation tool. It should be noted that the test is a point in time and producers should collect samples over multiple years to account for weather and seasonal variations before adopting wide scale change.

Social Surveys

Biophysical assessments are certainly useful benchmarks of natural resource quality, but conservation practices will only be adopted and implemented in the Benton/Tama watershed if local stakeholders recognize and value how such BMPs align within the contexts of both individual farming operations and broader watershed goals. Surveys are one tool that should be used to periodically assess awareness and attitudes regarding the general issue of water quality and the goals of this watershed plan. For example, a detailed survey could be conducted during each 5-year phase of the implementation schedule (Table 12). Surveys could also be paired with specific educational events like field days to assess the effectiveness of different outreach formats, which could improve information and education strategies as the project proceeds.

8 INFORMATION & EDUCATION PLAN

Research indicates that producers' actual behavior patterns must be brought into the design of both BMPs and implementation strategies for water quality programs (Dinnes, 2004). To affect changes in behavior there must be strategies in place to direct education and outreach to the target audience. Many obstacles to the adoption of conservation practices may be overcome by providing adequate education and outreach of how land management practices influence nonpoint source pollutant losses to surface water resources. Knowledge increases awareness, which may then motivate changes in behavior.

As with any watershed project, an education, communication, and outreach program will need to be designed to teach producers and other stakeholders about the resource issues within the Benton/Tama watershed. The anticipated outcome of this education and outreach is to bring stakeholders' attention to what impact their land use and management decisions might make, how they can effectively address those impacts, and what opportunities and innovative solutions exist.

Goal: Increase awareness and adoption of practices to achieve watershed land and water goals.

Target Audience: Watershed community, including farmers, local landowners, absentee landowners, residents, educators, students, and others.

Message: Recent research has shown farmers and landowners to have a sense of shared responsibility while at the same time valuing individualism and personal responsibility, and studies also reveal a concern for future generations (Comito et al., 2011). Messaging should attempt to capture these beliefs while at the same time promote the project goals. For example, *"Be a part of the cover crop movement, do your share to protect land and water for the future."*

Key Partners and Contacts:

Project Partners (Current and Potential)
Soil and Water Conservation District Commissioners
Benton, Tama, and Black Hawk County Conservation Boards
Natural Resources Conservation Service
Iowa Department of Agriculture and Land Stewardship
Iowa Department of Natural Resources
Agri-Businesses
Farm Cooperatives

Local Agricultural and Outdoor Groups
4-H
Future Farmers of America
Farm Bureau
Pheasants Forever
Ducks Unlimited

Newspapers
Waterloo Courier
La Porte City Progress-Review

Vinton Cedar Valley Times
Vinton Eagle
Traer Star-Clipper
Dysart Reporter

Radio Stations
KRQN 107.1 FM Vinton

Outreach Strategies and Tools:

Branding development (e.g. logo)
Website and social media
Fact sheets
Direct mailings
Conservation demonstration field days
Watershed boundary signs
Stream signs
Conservation practice signs
IOWATER volunteer workshops
Youth outdoor learning opportunities
Urban-Ag learning exchanges
Stream clean-up events

9 EVALUATION

Evaluating project success or failure is a critically important step in implementing any watershed plan. This section lays out a self-evaluation process for project partners to use to gauge project progress in four categories: 1) project administration, 2) attitudes and awareness, 3) performance, and 4) results. These four indicator categories are described in the bullet points below. A project evaluation worksheet can be found in Appendix C.

Project Administration

- **Yearly Partner Review Meeting.** Project partners should host an annual review meeting. This will provide an opportunity to evaluate project progress using the evaluation matrix.
- **Quarterly Project Partner Update.** Each quarter a project meeting will be held to ensure project goals and objectives are being accomplished. The meeting will also be an opportunity to plan logistics and coordinate field days, events, trials, monitoring, etc.

Attitudes & Awareness

- **Farmer and Landowner Surveys.** Periodically a survey should be conducted with a statistically valid sample of farmers and landowners in the watershed. Results of the surveys should be used to determine changes in attitudes and behaviors.
- **Field Day Attendance.** Field days are an important outreach component of watershed projects. To gauge the impact of the field days a short survey should be administered at the conclusion of each field day. The goal of the surveys will be to determine if attitudes were changed as a result of the field day events.
- **Regional and Statewide Media Awareness.** Media awareness and promotion of the project should be tracked by collecting and cataloging all articles and stories related to the watershed project.

Performance

- **Practice Adoption Levels.** Locations of implemented practices should be tracked over the life of the project. Practice adoption rates will be aggregated to the watershed scale and reported to partners.
- **Practice Retention.** The project will place an emphasis on retention of management practices such as cover crops. Yearly follow-up with farmers implementing practices will help gauge practice retention trends.

Results

- **Practice Scale Monitoring.** Tile water or edge-of-field monitoring results should be used to gauge water quality improvements at the field scale. Individual results should be provided to farmer participants. All monitoring data should be aggregated to the watershed scale and shared with other famers, landowners, and partners. This aggregated data may also be used in a publication to bring broader recognition to these and other Iowa water quality efforts.
- **Stream Scale Monitoring.** In-stream water monitoring sites should be used to determine if long-term water quality improvements are being realized. Year to year improvements will likely be undetectable but long-term (10 years or more) progress may be evident if significant practice adoption takes place in the watershed.
- **Soil and Agronomic Analysis.** Scientifically valid methods will be used to determine soil and agronomic impacts of practice adoption. These results will be shared with farmer participants.

All soil and agronomic results should be aggregated to the watershed scale and shared with other farmers, landowners, and partners.

- **Modeled Improvements.** The project should work with appropriate groups or individuals to estimate soil and water improvements resulting from practice implementation. Appendix D can be used to estimated nitrate reduction based on BMP implementation.

10 ESTIMATED RESOURCE NEEDS

An estimate of resource needs is crucial to gain support from potential funding sources. Table 14 provides an estimate, in 2015 dollars, of the total cost to implement conservation practices identified in this plan. Some practices, such as nutrient management and cover crops, may result in cost savings to farmers and landowners. Therefore cost share and/or incentive payment rates will need to be evaluated during the implementation phase of this plan.

Table 14. Estimated resource needs to reach the Benton/Tama watershed plan targets (*estimated cost share).

	Practice	2016-2020 Cost	2021-2025 Cost	2026-2030 Cost	2031-2035 Cost	2036-2040 Cost	2016-2040 Total Cost	Estimated Cost Notes
Soil Health & Nutrient Management	No-Till/Strip-Till	$10,000	$5,000	$5,000	-	-	$20,000	$10/acre*
	Cover Crops	$150,000	$250,000	$375,000	$250,000	$125,000	$1,150,000	$25/acre*
	Nutrient Management	-	-	-	-	-	-	
	Perennial Cover, CRP	$60,000	$40,000	$32,000	-	-	$132,000	$200/acre
	Perennial Energy Crops	-	-	-	-	-	-	
In-Field	Grassed Waterways	-	-	-	-	-	-	
	Terraces	-	-	-	-	-	-	
Edge-of-Field	Stream Buffers	-	-	-	-	-	-	
	Bioreactors	$96,000	$120,000	$60,000	$60,000	$24,000	$360,000	$12,000/unit
	Saturated Buffers	$24,000	$36,000	$30,000	$15,000	$15,000	$120,000	$3,000/unit
In-Stream	Nitrate Removal Wetlands	$1,500,000	$2,250,000	$2,250,000	$2,250,000	$1,500,000	$9,750,000	$750,000/unit
	Streambank Stabilization	$25,000	$25,000	$50,000	$25,000	-	$125,000	$50/foot*

The investment needed to construct all proposed structural practices (bioreactors, saturated buffers, and wetlands) is estimated at **$10,355,000**. Annual investments are necessary to continue adoption and implementation of management practices (cover crops, nutrient management, and potentially reduced tillage). The estimated yearly total for management practices is **$1,302,000**. This estimate is based on a cost-share funding structure and does not include investments needed to maintain existing acres of cover crops and nutrient management. Cost-share payments may not be permanently available, so alternative funding sources for management practices may need to be pursued or developed. The estimated cost in Table 14 for no-till/strip-till implementation assumes continued adoption throughout the project and a phasing out of cost-share to reduce tillage as this practice becomes more common. The dollars necessary to fund structural and management practices could come from many different sources, including farmers and landowners, downstream municipalities, other local or regional stakeholders, or conservation organizations.

Additional costs associated with watershed improvement such as salary and benefits for a watershed coordinator, information and education activities, monitoring, office space, computer, phone, and vehicle are estimated at **$85,000** per year.

11 Funding Opportunities & Approaches

To achieve the goals of this watershed plan significant resources will be needed. Current funding mechanisms provided by local, state, and federal units of government may not be adequate to address all goals outlined in this plan, so other creative and/or sustainable approaches will be needed. Appendix E provides a listing of current local, state, and federal programs and grants that may be able to provide resources for plan implementation. The list below provides some ideas to leverage additional "nontraditional" resources. Further research is needed to determine feasibility.

- **Locally Organized Cover Crop Seeding Programs.** Farmer and landowners are often busy with harvest during the prime cover crop seeding time period. To simplify cover crop adoption, cover crop seeding programs could be developed at the Soil and Water Conservation District (SWCD), County Conservation Board, or local farm cooperatives. Seeding programs have been established in Allamakee and Sac SWCDs, and these programs have resulted in a simplified process for farmers and expanded cover crop adoption.
- **Local Cover Crop Seed Production.** Access to and cost of cover crop seed will likely become problematic as acceptance of cover crops increases in Iowa and the Upper Mississippi Basin. A solution to this problem is to promote local production of cover crop seed, such as cereal rye. Typical yield of rye is 30-50 bushels per acre, so a seeding rate of 1.5 bushels per acre means that every acre of rye grown for seed would allow a rye cover crop to be planted on 20-33 acres of row crop land. To avoid taking productive land out of corn and soybean production, rye plantings could be targeted to marginal soils or lands.
- **Property or Income Tax Deductions.** Currently, some income tax deductions are available to landowners implementing soil and water conservation programs. More details can be found in the publication Implications of Soil and Water Conservation Programs. Additional local property tax deductions could be developed that promote the adoption of cover crops and other conservation practices.
- **Conservation Addendum to Agricultural Leases.** More than half of Iowa's farmland is cash rented or crop shared, and an increase in this trend presents issues for ensuring proper conservation measures are in place on Iowa farms. Conservation addendums may be a way to ensure both the landowner and the tenant agree on conservation. Addendums could include just about any conservation measure, but the practices included in this plan would be of most benefit. A standard conservation addendum could be developed and shared with all absentee landowners in the Benton/Tama watershed.
- **Conservation Easement Programs.** Land easements have proven successful in preservation of conservation and recreation land in Iowa (e.g. Iowa Natural Heritage Foundation, Wetland Reserve Enhancement Program, etc.). Some landowners may be interested in protecting sensitive land for extended periods of time or into perpetuity. For these landowners long-term conservation easements may be a good fit.
- **Non-Traditional Watershed Partners.** Traditional watershed partners (e.g. IDALS, DNR, SWCD, and NRCS) likely will not have the financial resources to fully implement this plan, so local project partners should seek non-traditional partners to assist with project promotion and funding. Involvement could be in the form of cash or in-kind donations.
- **Nutrient or Flood Reduction Trading.** Water quality trading programs are market-based programs involving the exchange of pollutant allocations between sources within a watershed.

The most common form of trading occurs when trading nutrient credits between point and nonpoint sources. Trading programs could be established to trade nutrient or flood impact credits.

- **Recreational Leases.** Recreational leases, such as hunting leases, may be promoted as a tool to increase landowner revenue generated from conservation lands, such as wetlands or grasslands.
- **Equipment Rental Programs.** Farmers are often hesitant to invest in new conservation technologies that require new equipment or implements. Project partners could invest in conservation equipment, such as a strip-till bar or cover crop drill, and then rent the equipment to interested farmers.
- **Reverse Auctions.** Reverse auctions or pay for performance programs can be a cost-effective way to allocate conservation funding. In some watersheds where reverse auctions have been used, the environmental benefits per dollar spent have been significantly more efficient than traditional programs such as the Environmental Quality Incentives Program (EQIP). In a reverse auction, landowners or farmers compete to provide a service (or conservation practice) to a single buyer (e.g. SWCD). All bids are analyzed for their environment benefits and the organizer (e.g. SWCD) begins providing funds to the most efficient bids (environmental benefit per dollar).
- **Watershed Organization.** Often the most successful watershed projects are those that are led by formalized watershed organizations. Groups can be formed via a non-profit organization, 28E intergovernmental agreement, Watershed Management Authority, or other agreement or organization. Most watershed projects have significant partner involvement, each with an existing mission or goal. Creating a watershed organization with a mission to improve land and water quality in the Wolf Creek, Rock Creek, and Pratt Creek watersheds may prove to be more successful than existing groups working together without formal organization.
- **Sub-Field Profit Analysis.** Farmers understand that some locations within a field produce higher yields and profits, so understanding the distribution of long-term profitability within fields may be an important selling point for conservation. Private companies in Iowa are developing tools to analyze profitability within crop fields. Incorporating profitability analysis into conservation planning could result in higher profit margins and increased conservation opportunities on land that consistently yields zero or lost revenue.

12 Roles & Responsibilities

Role	Responsibility
Farmers	Engage with watershed plan implementation, farm, field and sub-field evaluation, conservation practice implementation, knowledge sharing.
Landowners	Engage with tenants on conservation practices, incorporation of conservation addendums to lease agreements, conservation practice implementation.
Absentee Landowners	Engage with tenants on conservation practices, incorporation of conservation addendums to lease agreements, conservation practice implementation.
Natural Resources Conservation Service District Conservationist	Provide conservation practice design and engineering services, project partnership, house project staff, provide computer and office space.
Soil and Water Conservation District Commissioners	Provide project leadership, participate in project meetings and events, hire staff, advocate for project goals, promote project locally and regionally.
County Conservation Board, Director, and Staff	Project partnership, easement management, public education, water monitoring support.
Iowa Department of Natural Resources	In-stream monitoring of biological community (fish, macroinvertebrates), project partnership, technical advice.
Iowa Department of Agriculture and Land Stewardship	Provide technical support to project via a regional coordinator, provide the opportunity to receive state funding for soil and water conservation, provide a contact for the Iowa CREP program.
County Supervisors	Engage with project to determine mutual benefits.
Agri-Business	Engage project partners, promote project goals to members and/or customers.
Commodity Groups	Engage project partners, promote project goals to members and/or customers, provide agronomic and environmental services when appropriate.
Conservation Groups	Engage project partners, provide habitat-planning services, promote practices that have a habitat and water quality benefit.
Media	Develop and distribute news stories related to project activities and/or goals, attend project events.

Appendix A

Glossary of Terms & Acronyms

Glossary of Terms & Acronyms

303(d) list: Refers to section 303(d) of the Federal Clean Water Act, which requires a listing of all public surface water bodies (creeks, rivers, wetlands, and lakes) that do not support their general and/or designated uses. Also called the state's "Impaired Waters List."

305(b) assessment: Refers to section 305(b) of the Federal Clean Water Act. A comprehensive assessment of the state's public water bodies' ability to support their general and designated uses. Those bodies of water which are found to be not supporting or just partially supporting their uses are placed on the 303(d) list.

319: Refers to Section 319 of the Federal Clean Water Act, the Nonpoint Source Management Program. Under this amendment, states receive grant money from EPA to provide technical and financial assistance, education, and monitoring to implement local nonpoint source water quality projects.

ACPF: Agricultural Conservation Planning Framework. Software toolbox that allows watershed planners and stakeholders to identify on-farm conservation options using soils, land use, and topographic data.

AFO: Animal Feeding Operation. A livestock operation, either open or confined, where animals are kept in small areas (unlike pastures) allowing manure and feed to become concentrated.

Base flow: The fraction of discharge (flow) in a river that comes from ground water.

Benthic: Of or relating to or happening on the bottom under a body of water.

BMIBI: Benthic Macroinvertebrate Index of Biotic Integrity. An index-based scoring method for assessing the biological health of streams and rivers (scale of 0-100) based on characteristics of bottom-dwelling invertebrates.

BMP: Best Management Practice. A general term for any structural or upland soil or water conservation practice. For example, terraces, grass waterways, sediment retention ponds, reduced tillage systems, etc.

CAFO: Confinement Animal Feeding Operation. An animal feeding operation in which livestock are confined and totally covered by a roof, and not allowed to discharge manure to a water of the state.

CREP: Conservation Reserve Enhancement Program. Farm Service Agency (FSA) program that targets high-priority conservation issues by paying annual rent to producers to remove agricultural land from production. Iowa CREP focuses on wetland restorations in heavily tile-drained portions of the state.

CRP: Conservation Reserve Program. Farm Service Agency (FSA) program in which farmers receive annual rental payments to remove environmentally sensitive land from production by planting perennial species.

CSR: Corn Suitability Rating. Index developed by Iowa State University to rate the productivity of a given soil based primarily on its profile properties.

Designated use(s): Refer to the type of economic, social, or ecologic activities that a specific water body is intended to support. See Appendix B for a description of all general and designated uses.

DNR (or IDNR): Iowa Department of Natural Resources.

Ecoregion: A system used to classify geographic areas based on similar physical characteristics such as soils and geologic material, terrain, and drainage features.

EPA (or USEPA): United States Environmental Protection Agency.

EQIP: Environmental Quality Incentives Program. Natural Resources Conservation Service (NRCS) program that provides financial and technical assistance to farmers to address natural resource concerns.

FIBI: Fish Index of Biotic Integrity. An index-based scoring method for assessing the biological health of streams and rivers (scale of 0-100) based on characteristics of fish species.

FSA: Farm Service Agency (United States Department of Agriculture). Federal agency responsible for implementing farm policy, commodity, and conservation programs.

General use(s): Refer to narrative water quality criteria that all public water bodies must meet to satisfy public needs and expectations. See Appendix B for a description of all general and designated uses.

GIS: Geographic Information System(s). A collection of map-based data and tools for creating, managing, and analyzing spatial information.

GLO: General Land Office. Federal agency that conducted first survey of public lands in Iowa. Later dissolved into the United States Department of the Interior Bureau of Land Management.

Gully erosion: Soil movement (loss) that occurs in defined upland channels and ravines that are typically too wide and deep to fill in with traditional tillage methods.

HEL: Highly Erodible Land. Defined by the USDA Natural Resources Conservation Service (NRCS) as land that has the potential for long term annual soil losses to exceed the tolerable amount by eight times or more for a given agricultural field.

HUC: Hydrologic Unit Code. A unique watershed identification number with two to twelve digits, where more digits correspond to a more precise (smaller) watershed.

IDALS: Iowa Department of Agriculture and Land Stewardship. IDALS includes the Division of Soil Conservation & Water Quality (DSCWQ).

Integrated report: Refers to a comprehensive document that combines the 305(b) assessment with the 303(d) list, as well as narratives and discussion of overall water quality trends in the state's public water bodies. The Iowa Department of Natural Resources submits an integrated report to the EPA biennially in even numbered years.

LA: Load Allocation. The fraction of the total pollutant load of a water body which is assigned to all combined *nonpoint sources* in a watershed. (The total pollutant load is the sum of load allocation and waste load allocation.)

LiDAR: Light Detection and Ranging. Remote sensing technology commonly used to measure topography or elevation.

Load: The total amount (mass) of a particular pollutant in a waterbody.

MCPP: Middle Cedar Partnership Project. Regional Conservation Partnership Program (RCPP) project led by the City of Cedar Rapids and local partners to install best management practices (BMPs) to improve soil and water quality and quantity.

MLRA: Major Land Resource Area. Geographic area identified by the Natural Resources Conservation Service (NRCS) to have similar soils, climate, water resources, and land use.

MOS:	Margin of Safety. In a total maximum daily load (TMDL) report, it is a set-aside amount of a pollutant load to allow for any uncertainties in the data or modeling.
Nonpoint source pollution:	A collective term for contaminants that originate from a diffuse source.
NPDES:	National Pollution Discharge Elimination System. Allows a facility (e.g. an industry or a wastewater treatment plant) to discharge to a water of the United States under regulated conditions.
NRCS:	Natural Resources Conservation Service (United States Department of Agriculture). Federal agency that provides technical assistance for the conservation and enhancement of natural resources.
Nutrient Reduction Strategy:	Science-based approach developed by Iowa Department of Natural Resources, Iowa Department of Agriculture and Land Stewardship, and Iowa State University College of Agriculture and Life Sciences to establish baseline conditions, needed goals, and potential practices to reduce nutrient export to surface waters from point and nonpoint source pollution.
NWI:	National Wetlands Inventory. Mapping and classification of wetlands by the United States Fish and Wildlife Service based on aerial imagery. May exclude some farmed wetlands.
Phytoplankton:	A collective term for all self-feeding (photosynthetic) organisms that provide the basis for the aquatic food chain. Includes many types of algae and cyanobacteria.
Point source pollution:	A collective term for contaminants that originate from a specific point, such as an outfall pipe. Point sources are generally regulated by an NPDES permit.
PPB:	Parts per Billion. A measure of concentration approximately equal to micrograms per liter (μg/L).
PPM:	Parts per Million. A measure of concentration approximately equal to milligrams per liter (mg/L).
RCPP:	Regional Conservation Partnership Program. Natural Resources Conservation Service (NRCS) program that promotes formation of partnerships to facilitate conservation practice implementation. Each partner within a project must make a significant cash or in-kind contribution.

Riparian: Refers to site conditions that occur near water, including specific physical, chemical, and biological characteristics that differ from upland (dry) sites.

RUSLE: Revised Universal Soil Loss Equation. An empirical model for estimating long term, average annual soil losses due to sheet and rill erosion.

Secchi disk: A device used to measure transparency in water bodies. The greater the secchi depth (measured in meters), the more transparent the water.

Sediment delivery ratio: A value, expressed as a percent, which is used to describe the fraction of gross soil erosion that is ultimately delivered to a water body of concern.

Seston: All particulate matter (organic and inorganic) in the water column.

Sheet & rill erosion: Soil loss that occurs diffusely on hillslopes ranging from generally flat areas of land to steep hillsides.

SHL: State Hygienic Laboratory (University of Iowa). Provides physical, biological, and chemical sampling for water quality purposes in support of beach monitoring and impaired water assessments.

SI: Stressor Identification. A process by which the specific cause(s) of a biological impairment to a water body can be determined from cause-and-effect relationships.

SSURGO: Soil Survey Geographic Database. Database of soils information including tables, maps, and metadata compiled by the National Cooperative Soil Survey for nearly all United States lands.

Storm flow (or storm water): The fraction of discharge (flow) in a river which arrives as surface runoff directly caused by a precipitation event. *Storm water* generally refers to runoff which is routed through some artificial channel or structure, often in urban areas.

STP: Sewage Treatment Plant. General term for a facility that processes municipal sewage into effluent suitable for release to public waters.

STRIPS: Science-based Trials of Rowcrops Integrated With Prairie Strips. Collaborative project that researches and promotes installation of small prairie restorations in targeted locations in farm fields to improve ecosystem services in agricultural landscapes.

SWCD:	Soil and Water Conservation District. Agency that provides local assistance for soil conservation and water quality project implementation, with support from the Iowa Department of Agriculture and Land Stewardship.
TMDL:	Total Maximum Daily Load. As required by the Federal Clean Water Act, a comprehensive analysis and quantification of the maximum amount of a particular pollutant that a water body can tolerate while still meeting its general and designated uses.
TSI (or Carlson's TSI):	Trophic State Index. A standardized scoring system (scale of 0-100) used to characterize the amount of algal biomass in a lake or wetland.
TSS:	Total Suspended Solids. The quantitative measure of seston, all organic and inorganic materials which are held in the water column.
Turbidity:	The degree of cloudiness or murkiness of water caused by suspended particles.
UAA:	Use Attainability Analysis. A protocol used to determine which (if any) designated uses apply to a particular water body. See Appendix B for a description of all general and designated uses.
USDA:	United States Department of Agriculture.
USGS:	United States Geologic Survey (United States Department of the Interior). Federal agency responsible for implementation and maintenance of discharge (flow) gauging stations on the nation's water bodies.
Watershed:	The land (measured in units of surface area) which drains water to a particular body of water or outlet.
WLA:	Waste Load Allocation. The fraction of waterbody loading capacity assigned to point sources in a watershed. Alternatively, the allowable pollutant load that an NPDES permitted facility may discharge without exceeding water quality standards.
WMA:	Watershed Management Authority. Interagency partnership between cities, counties, and Soil and Water Conservation Districts (SWCDs) established under a Chapter 28E Agreement to assess and address water resource concerns, educate watershed residents, and identify and allocate funds.

WQI: Water Quality Initiative. Program established by Iowa legislature in 2013 to implement the Nutrient Reduction Strategy. Funds include support for conservation practice cost-share, water monitoring, and watershed project administration.

WQS: Water Quality Standards. Defined in Chapter 61 of Environmental Protection Commission [567] of the Iowa Administrative Code, they are the specific criteria by which water quality is gauged in Iowa.

WWTP: Waste Water Treatment Plant. General term for a facility that processes municipal, industrial, or agricultural waste into effluent suitable for release to public waters or for land application.

Zooplankton: Collective term for all animal plankton that serve as secondary producers in the aquatic food chain and the primary food source for larger aquatic organisms.

Appendix B

List of Designated Uses

List of Designated Uses

Descriptions of designated uses for Iowa's public water bodies are provided below. General uses refer to narrative water quality criteria that all public water bodies must meet to satisfy public needs and expectations. Designated uses refer to the type of economic, social, or ecologic activities that a specific water body is intended to support.

The Iowa Department of Natural Resources (DNR) defines a general use for intermittent waters that "flow only for short periods, are above the water table, and do not maintain viable aquatic community or pooled conditions during periods of no flow." The DNR establishes designated uses for waters that "maintain flow throughout year or sufficient pools during intermittent flow to maintain viable aquatic community." Rulemaking is only required for assessed streams with designated uses, i.e. those with perennial flow or sufficient intermittent flow. Designated uses can be classified as recreational, aquatic life, human health, and drinking water. The following text is from DNR publicly available resources.

Designated Uses

Waterbody segments designated for recreational use are protected for uses that involve human contact with the water. Three types of recreational uses are:

- **Class A1 - Primary contact recreational use:** The water's recreation uses involve full body immersion with prolonged and direct contact with the water, such as swimming and water skiing.
- **Class A2 - Secondary contact recreational use:** Water recreation uses involve incidental or accidental contact with the water, where the probability of ingesting water is minimal, such as fishing and shoreline activities.
- **Class A3 - Children's recreational use:** Water recreation uses where children's activities are common, like wading or playing in the water. These waters are commonly located in urban or residential areas where the banks are defined and there is visible evidence of flow.

Warm water waterbodies can also be designated to protect aquatic life, such as fish, plants and insects that live in and around the water. Streams that maintain flow throughout the year, or contain sufficient pooled areas during intermittent flow periods to maintain a viable aquatic community, can be designated for aquatic life uses for warm water species. The three warm water uses include:

- **Class B(WW-1):** Typically large interior and border rivers and the lower segments of medium-size tributary streams capable of supporting and maintaining a wide variety of aquatic life, including game fish.
- **Class B(WW-2):** Typically smaller, perennially flowing streams capable of supporting and maintaining a resident aquatic community, but lack the flow and habitat necessary to fully support and sustain game fish populations.
- **Class B(WW-3):** Intermittent stream with non-flowing perennial pools capable of supporting and maintaining a resident aquatic community in harsher conditions. These waters lack the flow and habitat necessary to fully support and sustain a game fish population.

Iowa also has a small group of cold water waterbodies, many of which are located in the northeast portions of the state. These can also be designated to protect aquatic life, such as fish, plants and insects that live in and around these streams. Waters in which the temperature and flow are suitable can be designated for aquatic life uses for cold water species. The two cold water uses include:

- **Class B(CW-1):** Waters in which temperature and flow are suitable for the maintenance of a variety of coldwater species, including populations of trout (Salmonidae) and associated aquatic communities.
- **Class B(CW-2):** Waters including small, channeled streams, headwaters, and spring runs that possess natural coldwater attributes of temperature and flow. Do not support populations of trout (Salmonidae), but may support vertebrate and invertebrate organisms.

Other designated uses are related to fish and water consumption:

- **Class HH - Human Health:** Waters in which fish are routinely harvested for human consumption or waters both designated as public water supply and routinely harvested for human consumption.
- **Class C - Drinking Water Supply:** Waters which are used as a raw water source of potable water supply.

Appendix C

Watershed Self-Evaluation Worksheet

Watershed Self-Evaluation Worksheet

Purpose: This self-evaluation worksheet is a means to assess annual watershed project progress and to identify areas of strength and weakness. The evaluation worksheet should be completed annually by project leaders and partners. Results should be compiled and shared with all project partners.

Evaluation Watershed Project: ______________________________

Evaluator Name: _________________

Evaluation Date: _________________

Evaluation Time Period: _________________ to _________________

Project Administration

	Exceeds	**Meets**	**Partially Meets**	**Does Not Meet**	**NA**
Project annual review meeting held.					
Watershed partners represent a broad and diverse membership which represents most interests in the watershed.					
Watershed partners represent a broad and diverse membership which represents most interests in the watershed.					
Watershed partners understand their responsibilities and roles.					
Watershed partners share a common vision and purpose.					
Watershed partners are aware of and involved in project activities.					
Watershed partners understand decision making processes.					
Watershed meetings are well-organized and productive.					
Watershed partners advocate for the mission.					

Attitudes and Awareness

	Exceeds	**Meets**	**Partially Meets**	**Does Not Meet**	**NA**
Positive changes in attitudes, beliefs, and practices have occurred in the watershed.					
Field days and other events have been held in the watershed.					
Watershed project has received publicity via local and regional media outlets.					

Performance

	Exceeds	Meets	Partially Meets	Does Not Meet	NA
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
Yearly _____________ (insert conservation practice) implementation goals have been met.					
The majority of implemented conservation practices have been retained after cost share payments have ended.					

Results

	Exceeds	Meets	Partially Meets	Does Not Meet	NA
Monitoring of _________ (insert variable) has shown progress towards reaching plan goals.					
Monitoring of _________ (insert variable) has shown progress towards reaching plan goals.					
Monitoring of _________ (insert variable) has shown progress towards reaching plan goals.					
Impact (financial or other) to farmers and landowners has been positive or minimal.					
Modeled impacts on ____________ (insert variable) have shown progress towards reaching plan goals.					
Modeled impacts on ____________ (insert variable) have shown progress towards reaching plan goals.					
Modeled impacts on ____________ (insert variable) have shown progress towards reaching plan goals.					

Strengths, Weaknesses, Opportunities, and Threats Analysis

Thinking about the goals of the watershed plan, brainstorm the Strengths, Weaknesses, Opportunities, and Threats (SWOTs) that are relevant to the project. Identification of SWOTs is important as they can help shape successful watershed plan implementation.

Strengths	Opportunities
Weaknesses	**Threats**

Appendix D

Nitrogen Reduction Calculation Worksheet

Nitrogen Reduction Calculation Worksheet

This worksheet can be used to estimate nitrate-nitrogen reduction at the watershed outlet based on the number of acres treated with best management practices (BMPs).

Instructions

1. Enter acres covered by, treated with, or drained into BMPs into "Acres Treated" column for each BMP.
2. Multiply "Acres Treated" by "Multiplier" for each BMP and enter result into "N Load Reduction" column.
3. "Total N Load Reduction" equals the sum of the "N Load Reduction" column.
4. Obtain "Baseline N Load" value from watershed plan document.
5. Calculate "Percent N Reduction" as "Total N Load Reduction" divided by "Baseline N Load" multiplied by a factor of 100.

Best Management Practice	**Acres Treated**	**Multiplier**	**N Load Reduction**
Cover Crops, below EOF*		4.0	
Cover Crops, above EOF*		2.0	
Nutrient Management**		1.2	
Perennial Cover		10.2	
Bioreactors		5.6	
Saturated Buffers		6.5	
Wetlands		6.8	
Total N Load Reduction			
Baseline N Load			
Percent N Reduction			

*The location of cover crops relative to edge-of-field (EOF) practices is important. Cover crops "below", or downstream of, EOF practices result in greater nitrate-nitrogen reduction than cover crops located "above", or upstream of, EOF practices.

**Include only acres treated with nutrient management (MRTN application rate, nitrification inhibitor, etc.) that do not also have cover crops.

Appendix E

Potential Funding Sources

Potential Funding Sources

Public Funding Sources

Program	Description	Agency/ Organization
Iowa Financial Incentives Program	50 percent cost-share available to landowners through 100 SWCDs for permanent soil conservation practices.	IDALS-DSCWQ
No-Interest Loans	State administered loans to landowners for permanent soil conservation practices.	IDALS-DSCWQ
District Buffer Initiatives	Funds for SWCDs to initiate, stimulate, and incentivize signup of USDA programs, specifically buffers.	IDALS-DSCWQ
Iowa Watershed Protection Program	Funds for SWCDs to provide water quality protection, flood control, and soil erosion protection in priority watersheds; 50-75 percent cost-share.	IDALS-DSCWQ
Conservation Reserve Enhancement Program	Leveraging USDA funds to establish nitrate removal wetlands in north central Iowa with no cost to landowner.	IDALS-DSCWQ
Soil and Water Enhancement Account - REAP Water Quality Improvement Projects	REAP funds for water quality improvement projects (sediment, nutrient and livestock waste) and wildlife habitat and forestry practices; 50-75 percent cost-share. Used as state match for EPA 319 funding.	IDALS-DSCWQ
Soil and Water Enhancement Account - REAP Water Quality Improvement Projects	Tree planting, native grasses, forestry, buffers, streambank stabilization, traditional erosion control practices, livestock waste management, ag drainage well closure, urban storm water.	IDALS-DSCWQ
State Revolving Loans	Low interest loans provided by SWCDs to landowners for permanent water quality improvement practices; subset of DNR program.	IDALS-DSCWQ
Watershed Improvement Fund	Local watershed improvement grants to enhance water quality for beneficial uses, including economic development.	IDALS-DSCWQ
General Conservation Reserve Program	Encourages farmers to convert highly erodible land or other environmentally sensitive land to vegetative cover; farmers receive annual rental payments.	USDA-FSA
Continuous Conservation Reserve Program	Encourages farmers to convert highly erodible land or other environmentally sensitive land to vegetative cover, filter strips, or riparian buffers; farmers receive annual rental payments.	USDA-FSA
Farmable Wetland Program	Voluntary program to restore farmable wetlands and associated buffers by improving hydrology and vegetation.	USDA-FSA

Grassland Reserve Program	Provides funds to grassland owners to maintain, improve, and establish grass. Contracts of easements up to 30 years.	USDA-FSA
Environmental Quality Incentives Program	Provides technical and financial assistance for natural resource conservation in environmentally beneficial and cost-effective manner; program is generally 50 percent cost-share.	USDA-NRCS
Wetland Reserve Program	Provides restoration of wetlands through permanent and 30 year easements and 10 year restoration agreements.	USDA-NRCS
Emergency Watershed Protection Program	Flood plain easements acquired via USDA designated disasters due to flooding.	USDA-NRCS
Wildlife Habitat Incentives Program	Cost-share contracts to develop wildlife habitat.	USDA-NRCS
Farm and Ranchland Protection Program	Purchase of easements to limit conversion of ag land to non-ag uses. Requires 50 percent match.	USDA-NRCS
Cooperative Conservation Partnership Programs	Conservation partnerships that focus technical and financial resources on conservation priorities in watersheds and airsheds of special significance.	USDA-NRCS
Conservation Security Program	Green payment approach for maintaining and increasing conservation practices.	USDA-NRCS
Conservation Innovation Grants	National and state grants for innovative solutions to a variety of environmental challenges.	USDA-NRCS
Regional Conservation Partnership Program	Grants from national, state, or Critical Conservation Area funding pools to promote formation of partnerships to facilitate conservation practice implementation. Each partner within a project must make a significant cash or in-kind contribution.	USDA-NRCS
Conservation Stewardship Program	Encourages farmers to begin or continue conservation through five-year contracts to install and maintain conservation practices and adopt conservation crop rotations.	USDA-NRCS
Aquatic Ecosystem Restoration - Section 206	Restoration projects in aquatic ecosystems such as rivers, lakes, and wetlands.	US Army Corps
Habitat Restoration of Fish and Wildlife Resources	Must involve modification of the structures or operations of a project constructed by the Corps of Engineers.	US Army Corps
Section 319 Clean Water Act	Grants to implement NPS pollution control programs and projects in watersheds with EPA approved watershed management plans.	EPA/DNR

Iowa Water Quality Loan Fund	Source of low-cost financing for farmers and landowners, livestock producers, community groups, developers, watershed organizations, and others.	DNR
Sponsored Projects	Wastewater utilities can finance and pay for projects, within or outside the corporate limits, that cover best management practices to keep sediment, nutrients, chemicals, and other pollutants out of streams and lakes.	DNR/Iowa Finance Authority
Resource Enhancement and Protection Program	Provides funding for enhancement and protection of State's natural and cultural resources.	DNR
Streambank Stabilization and Habitat Improvement	Penalties from fish kills used for environmental improvement on streams impacted by the kill.	DNR/IDALS-DSCWQ
State Revolving Fund	Provides low interest loans to municipalities for waste water and water supply; expanding to private septics, livestock, storm water, and NPS pollutants.	DNR
Watershed Improvement Review Board	Comprised of representatives from agriculture, water utilities, environmental organizations, agribusiness, the conservation community, and state legislators and provides grants to watershed and water quality projects.	WIRB
Iowa Water Quality Initiative	Initiated by IDALS-DSCWQ as a demonstration and implementation program for the Nutrient Reduction Strategy. Funds are targeted to 9 priority HUC-8 watersheds.	IDALS-DSCWQ
Fishers and Farmers Partnership	Fishers & Farmers Partnership for the Upper Mississippi River Basin is a self-directed group of nongovernmental agricultural and conservation organizations, tribal organizations, and state and federal agencies working to achieve the partnership's mission "… to support locally-led projects that add value to farms while restoring aquatic habitat and native fish populations."	U.S Fish and Wildlife Service and others

Private Funding Sources (Not Inclusive)

Program	**Description**	**Website**
Field to Market® Alliance	Field To Market® is a diverse alliance working to create opportunities across the agricultural supply chain for continuous improvements in productivity, environmental quality, and human well-being. The group provides collaborative leadership that is engaged in industry-wide dialogue, grounded in science, and open to the full range of technology choices.	https://www.fieldtomarket.org/members/

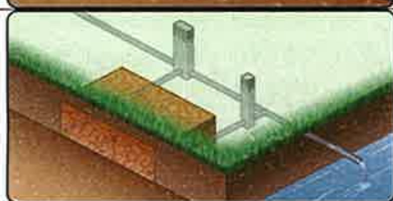
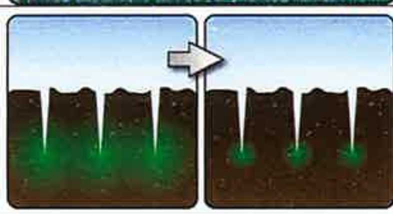
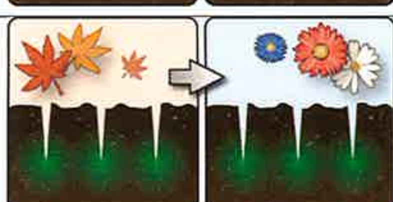
International Plant Nutrition Institute	The International Plant Nutrition Institute (IPNI) is a not-for-profit, science-based organization dedicated to the responsible management of plant nutrition for the benefit of the human family.	http://www.ipni.net
Iowa Community Foundations	Iowa Community Foundations are nonprofit organizations established to meet the current and future needs of our local communities.	http://www.iowacommunityfoundations.org/
Iowa Natural Heritage Foundation	Private nonprofit conservation organization working to ensure Iowans will always have beautiful natural areas – to bike, hike, and paddle – to recharge, relax and refresh – to keep Iowa healthy and vibrant.	http://www.inhf.org
McKnight Foundation - Mississippi River Program	Program goal is to restore the water quality and resilience of the Mississippi River.	www.mcknight.org/grant-programs/mississippi-river
National Fish and Wildlife Foundation	NFWF provides funding on a competitive basis to projects that sustain, restore, and enhance our nation's fish, wildlife, and plants and their habitats.	www.nfwf.org
National Wildlife Foundation	Works to protect and restore resources and the beneficial functions they offer.	www.nwf.org
The Fertilizer Institute	TFI is the leading voice in the fertilizer industry, representing the public policy, communication and statistical needs of producers, manufacturers, retailers and transporters of fertilizer. Issues of interest to TFI members include security, international trade, energy, transportation, the environment, worker health and safety, farm bill and conservation programs to promote the use of enhanced efficiency fertilizer.	http://www.tfi.org
The Nature Conservancy	The Nature Conservancy is the largest freshwater conservation organization in the world – operating in 35 countries with more than 300 freshwater scientists and 500 freshwater conservation sites globally. TNC works with businesses, governments, partners and communities to change how water is managed around the world.	http://www.nature.org
Trees Forever - Working Watersheds Program	Annually work with 10-15 projects in Iowa that emphasize water quality through our Working Watersheds: Buffers and Beyond program.	www.treesforever.org/
Walton Family Foundation - Environmental Program	Work to achieve lasting change by creating new and unexpected partnerships among conservation, business and community interests to build durable solutions to big problems.	www.waltonfamilyfoundation.org/environment

Appendix F

Cost Comparison of Practices that Reduce Nitrate in Drainage

Cost Comparison of Practices that Reduce Nitrate in Drainage

In Iowa, tile drainage allows great gains in agricultural productivity, but there is also concern about nitrate loss from these systems. The water quality of our streams, rivers, and lakes can be negatively impacted by this nitrate in tile drainage. Fortunately, there are a number of practices that can be done to reduce the amount of nitrate in drainage water. This handout provides a cost comparison for several of these practices† with mention of a few other possible benefits to the environment.

Practice		$ per Acre Treated per Year	$ per lb Nitrate-Nitrogen Removed	Other Environmental Benefits
Controlled Drainage		$3.82 to $15.91	$0.26 to $1.60	=
Woodchip Bioreactor		$6.49 to $13.99	$0.52 to $1.27	=
Wetland		$12.95 to $19.30	$1.03 to $1.95	↑ Wildlife habitat, Removal of other pollutants
Nitrogen Management: Lowering the Application Rate from 150 lb N per ac to 125 lb N per ac		-$2.99*	-$0.74*	=
Nitrogen Management: Moving the Application from Fall to Spring		-$36.42*	-$19.22* to $7.79	=
Cover Crop		$46.72 to $74.22	$0.82 to $13.40	↑ Soil enhancement, Prevents erosion
Crop Rotation		$39.88 to $72.47	$2.79 to $14.19	↑ Soil enhancement, Prevents erosion

† Information based on ISU Custom Rate Surveys and published literature

Images by John Petersen (www.petersenart.com)

* Negative costs are benefits or revenues

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Appendix G

Reducing Nutrient Loss: Science Shows What Works

Reducing Nutrient Loss:
Science Shows What Works

Iowa has been working for decades to protect and improve water quality. However, progress measured toward reduction targets at the watershed scale has been challenging, and many complex nutrient-related impacts in Iowa's lakes, reservoirs, and streams remain to be addressed.

The Iowa Nutrient Reduction Strategy is a science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico. It directs efforts to reduce nutrients in surface water from both point and nonpoint sources in a scientific, reasonable, and cost-effective manner.

It was prompted by the 2008 Gulf Hypoxia Action Plan that calls for Iowa and other states along the Mississippi River to develop strategies to reduce nutrient loadings to the Gulf of Mexico. The plan established a goal of at least a 45 percent reduction in total nitrogen and total phosphorus loads.

The Iowa strategy is a coordinated approach for reducing nutrient loads discharged from the state's largest wastewater treatment plants, in combination with targeted practices designed to reduce loads from nonpoint sources such as agriculture.

Success can be achieved using the tools known to work, such as targeted, voluntary conservation measures, in conjunction with research, development, and demonstration of new approaches. The goal is application of proven practices in fields and cities across Iowa.

Science Provides Guidance

The strategy related to farmland is built on a scientific assessment of practices and associated costs to reduce loading of nitrogen (N) and phosphorus (P) to Iowa surface waters.

The College of Agriculture and Life Sciences at Iowa State University and the Iowa Department of Agriculture and Land Stewardship partnered to conduct the scientific assessment. The science team consisted of 23 individuals representing five agencies or organizations.

The objective of the science assessment was to identify and model the effectiveness of specific practices at reducing N and P reaching the Gulf of Mexico.

The assessment involved establishing baseline conditions, reviewing scientific literature, estimating potential load reductions, and estimating implementation costs. The assessment shows that broad implementation of a combination of practices will be needed to reach desired load reductions.

A Closer Look

The need to increase voluntary efforts to reduce nutrient loss is one of the key points related to agriculture in Iowa's Nutrient Reduction Strategy.

The science assessment identified effective nutrient reduction practices in three categories — nitrogen and phosphorus management, land use, and edge-of-field. (See charts on pages 3-4.)

Management practices involve application rate, timing, and method, plus the use of cover crops and reduced tillage.

Land use practices include perennial energy crops, extended rotations, grazed pastures, and land retirement.

Edge-of-field practices involve drainage water management, wetlands, bioreactors, buffers, terraces, and sediment control.

Some practices that have the greatest potential are highlighted here.

Management Practices – Nitrogen

Rate Reduction: Matching N application rates with the Corn Nitrogen Rate Calculator, a university developed online tool, has potential to reduce nitrate-N loss. This tool estimates optimal N rates based on fertilizer and corn prices. (Find the calculator here: http://extension.agron.iastate.edu/soilfertility/nrate.aspxis).

Nitrification Inhibitor: Research shows a corn yield increase plus a nitrate-N loss decrease when using a nitrification inhibitor (Nitrapyrin) with fall applied anhydrous ammonia. The only cost associated with this practice is the material. There is a corn yield increase of approximately 6 percent.

Sidedress: Sidedressing N can be done in different ways and with different sources of N, yet the concept of applying fertilizer after corn emergence is consistent. This strategy includes applying N during plant uptake, as well as timing to reduce the risk of loss from leaching events. Sidedressing also allows the N rate to be optimized by either soil sampling or crop canopy sensing.

Management Practices – Phosphorus

Consider Soil-Test P: This practice involves not applying P on fields where the Soil-Test P (STP) values exceed the upper boundary of the optimum level for corn and soybean in Iowa. The practice would continue until the STP level reaches the optimum level.

Cover Crops: Planting a late summer or early fall seeded cover crop can reduce P loss. For example, winter rye offers benefits of easy establishment, seeding aerially or by drilling, growth in cool conditions, initial growth when planted in the fall, and continued growth in the spring. Cover crops also are effective at reducing N loss.

Reduced Tillage: Conservation tillage, where 30% or more of the soil surface is covered with crop residue after planting, or no-till, where 70% or more of the soil surface is covered with crop residue after planting, reduces soil erosion and surface runoff. Reduced erosion and runoff also reduces P transport.

Land Use Practices – Nitrogen and Phosphorus

Extended Rotations: Extended rotations reduce the application and the loss of both P and nitrate-N. If a shift to extended rotations is significant, the amount of corn and soybean produced in Iowa would be reduced, along with an increase in alfalfa production that could support increased livestock production for alfalfa feeding. Another benefit would be improved soil quality.

Energy Crops Replacing Row Crops: Although there is not a current large market for perennial biomass crops as a source for energy or transportation fuel production, there are local and regional markets. Replacing row crops with energy crops or integrating energy crops within the rowcrop landscape decreases erosion, surface runoff, and leaching losses in the area implemented; therefore, the loss of both P and nitrate-N is reduced. An added benefit is an increase in wildlife habitat.

Edge-of-Field Practices – Nitrogen and Phosphorus

Wetlands: Wetlands targeted for water quality benefits show great potential for nitrate-N reduction. Wetland costs include design, construction, buffer seeding, maintenance, and land acquisition. In addition to water quality benefits, these wetlands provide other benefits such as improved aesthetics and habitat.

Bioreactors: Subsurface drainage bioreactors also show good potential for nitrate-N reduction. Bioreactor costs include control structures, woodchips, design, construction, seeding, additional tile, management, and maintenance.

Buffers: Edge-of-field technologies such as buffers are designed to settle sediment and sediment-bound N and P, along with retaining nitrate-N and dissolved P. Buffers also provide wildlife habitat, sequester carbon, reduce greenhouse gas emissions, stabilize stream banks, and potentially reduce flood impacts. Costs of buffers can vary greatly depending on width, type of vegetation, and the amount of earthwork required.

Saturated Buffers: Field tile drainage is intercepted in a riparian buffer and a fraction of the flow is diverted as shallow groundwater within the buffer. The nitrate-N contained in the tile drainage water is partially removed by plant uptake, microbial immobilization, or denitrification.

What's Next?

Iowa's Nutrient Reduction Strategy is a key step toward improving Iowa's water quality while ensuring the state's continued economic growth and prosperity. The Practices List will evolve over time as new information, data, and science are discovered and adopted.

The path forward to reducing nutrient impacts will not be easy, as it will require a high adoption rate of multiple practices to achieve the goal of cleaner water and a profitable agriculture. To learn more about the practices that may be right for your farm, attend a field day, contact the Iowa Department of Agriculture and Land Stewardship, Iowa State University Extension and Outreach, or a certified crop adviser.

More information on Iowa's Nutrient Reduction Strategy is available at **www.nutrientstrategy.iastate.edu**.

Iowa Strategy to Reduce Nutrient Loss: Nitrogen Practices

This table lists practices with the largest potential impact on nitrate-N concentration reduction (except where noted). Corn yield impacts associated with each practice also are shown as some practices may be detrimental to corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% Nitrate-N Reduction[+]	% Corn Yield Change[++]
			Average (SD*)	Average (SD*)
Nitrogen Management	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)[**]
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – http://extension.agron.iastate.edu/soilfertility/nrate.aspx can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
Land Use	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
Edge-of-Field	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	
	Saturated Buffers	Divert fraction of tile drainage into riparian buffer to remove Nitrate-N by denitrification.	50 (13)	

[+] A positive number is nitrate concentration or load reduction and a negative number is an increase.

[++] A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

* SD = standard deviation. Large SD relative to the average indicates highly variable results.

** This increase in crop yield should be viewed with caution as the sidedress treatment from one of the main studies had 95 lb-N/acre for the pre-plant treatment but 110 lb-N/acre to 200 lb-N/acre for the sidedress with soil test treatment so the corn yield impact may be due to nitrogen application rate differences.

Iowa Strategy to Reduce Nutrient Loss: Phosphorus Practices

Practices below have the largest potential impact on phosphorus load reduction. Corn yield impacts associated with each practice also are shown, since some practices may increase or decrease corn production. If using a combination of practices, the reductions are not additive. Reductions are field level results that may be expected where practice is applicable and implemented.

	Practice	Comments	% P Load Reduction[a]	% Corn Yield Change[b]
			Average (SD[c])	Average (SD[c])
Phosphorus Management Practices	Phosphorus Application	Applying P based on crop removal – Assuming optimal STP level and P incorporation	0.6[d]	0
		Soil-Test P – No P applied until STP drops to optimum or, when manure is applied, to levels indicated by the P Index[f]	17[e]	0
	Source of Phosphorus	Liquid swine, dairy, and poultry manure compared to commercial fertilizer – Runoff shortly after application	46 (45)	-1 (13)
		Beef manure compared to commercial fertilizer – Runoff shortly after application	46 (96)	
	Placement of Phosphorus	Broadcast incorporated within 1 week compared to no incorporation, same tillage	36 (27)	0
		With seed or knifed bands compared to surface application, no incorporation	24 (46)	0
	Cover Crops	Winter rye	29 (37)	-6 (7)
	Tillage	Conservation till – chisel plowing compared to moldboard plowing	33 (49)	0 (6)
		No till compared to chisel plowing	90 (17)	-6 (8)
Land Use Change	Perennial Vegetation	Energy Crops	34 (34)	
		Land Retirement (CRP)	75	
		Grazed pastures	59 (42)	
Erosion Control and Edge-of-Field Practices	Terraces		77 (19)	
	Buffers		58 (32)	
	Control	Sedimentation basins or ponds	85	

[a] A positive number is P load reduction and a negative number is increased P load.

[b] A positive corn yield change is increased yield and a negative number is decreased yield. Practices are not expected to affect soybean yield.

[c] SD = standard deviation. Large SD relative to the average indicates highly variable results.

[d] Maximum and average estimated by comparing application of 200 and 125 kg P_2O_5/ha, respectively, to 58 kg P_2O_5/ha (corn-soybean rotation requirements) (Mallarino et al., 2002).

[e] Maximum and average estimates based on reducing the average STP (Bray-1) of the two highest counties in Iowa and the statewide average STP (Mallarino et al., 2011a), respectively, to an optimum level of 20 ppm (Mallarino et al., 2002). Minimum value assumes soil is at the optimum level.

[f] ISU Extension and Outreach publication (PM 1688).

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Appendix H

Iowa Nutrient Reduction Strategy Practice Costs & Benefits

Iowa Nutrient Reduction Strategy Practice Costs & Benefits

The following text is from the Iowa Science Assessment of Nonpoint Source Practices to Reduce Nitrogen and Phosphorus Transport in the Mississippi River Basin (Iowa State University Science Team, 2013). The text outlines the costs and benefits of conservation practices, many of which are identified in this watershed plan. None of the costs or benefits include cost-share, incentive, or rental payments offered to farmers and landowners within the watershed. The cost estimates below are based on local conditions for MLRA 104, Eastern Iowa and Minnesota Till Prairies. The costs included are farm level costs associated with each practice, so some practices may have additional costs or benefits.

Moving from Fall to Spring Nitrogen Application

This practice is dynamic between Major Land Resource Areas (MLRAs) because the yield impact by moving from fall to spring varies by the different baseline corn yield in each MLRA. Although there may be a risk of not having enough suitable days to apply all nitrogen in the spring, this was not factored into the cost as the "value" of risk was not a component of this practice evaluation. This value could be included in future practice evaluations, with as an example by Hanna and Edwards (2007).

Cost in a Corn/Soybean Rotation is -$18.00/acre (negative cost results in a benefit)
Cost in a Continuous Corn System is -$35.00/acre

Reducing Nitrogen Rate

This practice involves reducing the MLRA average nitrogen rate applied to corn to the Maximum Return to Nitrogen (MRTN) recommendation, the rate currently recommended in Iowa for continuous corn and corn following soybean. This practice utilizes the online Corn Nitrogen Rate Calculator (MTRN based recommendation system) (Sawyer et al., 2011b) to determine nitrogen rate impacts on fertilizer cost and yield return. Application rate is highly dynamic as any nitrogen application rate may be selected and each MLRA has different baseline application rates.

Sidedress All Spring Applied Nitrogen

Since the number of field trips due to various field activities in the spring and early summer can vary depending on the year, producer, and crop, simply adding the cost of an additional operation for side dressing was not possible. As a result, there was no cost associated with switching to a sidedress application and there was no corn yield benefit.

Using a Nitrification Inhibitor

Use of nitrapyrin with all fall applied anhydrous ammonia could have an impact on demand for the product, which could increase cost, but for this analysis it is assumed the cost of nitrapyrin would not change with increased use.

Research shows a corn yield increase and nitrate-N loss decrease when using nitrapyrin with fall applied anhydrous ammonia when compared to anhydrous ammonia applied at the same nitrogen rate without nitrapyrin. Because yield is impacted, the Equal Annualized Cost (EAC) for nitrapyrin application is different for each MLRA. Additionally, there is a product cost of approximately $11.50/acre (Sawyer, 2011).

Cost in a Corn/Soybean Rotation is -$22.00/acre
Cost in a Continuous Corn System is -$43.00/acre

Cover Crops

The cover crop in this practice/scenario is late summer or early fall seeded winter cereal rye. Winter rye offers benefits of easy establishment, seeding aerially or with drilling, growth in cool conditions and initial growth when planted in the fall, and continued growth in the spring.

The winter rye cover crop practice is an annual cost with little to no capital investment. Items included in the annual cost are seed and seeding, and cover crop termination (chemically killed and/or plowed down). Seeding at a rate of 60 lb/acre and at a cost of $0.125/lb seed the total seed cost would be $7.50/acre per year (Singer, 2011). There were several cost sources for seeding using a no-till drill, which range from $8.40/acre (Duffy, 2011) to $15/acre (Singer, 2011), with Edwards et al. (2011) estimating $13.55/acre. In order to grow the primary crop, the cover crop must be terminated (chemically killed and/or plowed down). Glyphosate is the primary herbicide used for this procedure, and Singer (2011) suggested use at 24 oz product/acre with a cost of $0.083/oz, or $2.00/acre. Additionally, there is a cost associated with hiring spray equipment between $6 to $8/acre (Edwards et al., 2011).

The base cost of this practice (before any corn yield impact) ranges from $29/acre to $32.50/acre per year (value of $32.5/acre used for cost analysis). Any cost associated with a corn yield reduction due to the preceding rye cover crop depends on the baseline corn yields in each MLRA. From the review of literature, the estimated yield impact for corn following rye is -6%. No yield impact occurs with soybean following a preceding rye cover crop, therefore, no soybean yield impact is included in the implementation cost.

Cost in a Corn/Soybean Rotation is $42.50/acre
Cost in a Continuous Corn System is $87.50/acre

This cost is for operations, materials, and corn yield decrease of 6%.

Other ecosystem or environmental services include wildlife habitat, decreased erosion and loss of surface runoff contaminants (e.g. reduced phosphorus loss), and benefits to soil health and soil organic matter.

Wetlands (Targeted for Water Quality)

Wetland installation and maintenance cost estimates (from Christianson et al., In Preparation) include design cost, construction, seeding (buffer area around wetland), outflow structure, land acquisition, management (mowing), and control structure replacement. The example used (Christianson et al., In Preparation) was based on a 10-acre wetland, with 35-acre buffer, treating 1,000 acres. The resulting EAC was $14.94/treated acre per year (net present value cost of $321/treated acre). They used a 4% discount rate and 50-year design life. With wetlands, it may be possible to target the highest nitrate yielding areas of the landscapes and areas of the state in order to maximize overall nitrate-N reduction.

Other ecosystem or environmental services include increased aesthetic landscape, increased habitat for Iowa game and waterfowl, and depending on design, could provide hydrologic services through water flow attenuation.

Bioreactors

Bioreactor installation and maintenance cost estimates (from Christianson et al., In Preparation) include control structures, woodchips, design, construction, seeding, additional tile, management, and maintenance. The example used in (Christianson et al., In Preparation) was based on a 0.25 acre bioreactor with a 50 acre treatment area. The resulting EAC was $10.23/treated acre per year (net present value cost of $220/treated acre).

Buffers

Buffers have the potential to be implemented adjacent to streams to intercept shallow groundwater and reduce nitrate-N concentrations. While there could be broad implementation of this practice, the nitrate-N load reduction will be limited by the amount of shallow groundwater intercepted by the buffer.

Costs of buffers can vary greatly depending on width, type of vegetation, and if substantial earthwork is required. For the analysis, a cost of establishment and implementation was assumed to be $300/acre with an EAC of $13.96/acre/year. In addition, there would be a cost of land out of production which was assumed to be equal to the average cash rent for corn and soybean land for each MLRA (Edwards and Johanns, 2011a; Edwards and Johanns, 2011b).

Cost to implement buffers is $241.00/acre

Other ecosystem or environmental services include buffers would be expected to reduce nitrate-N load from shallow groundwater, buffers would provide wildlife habitat benefits, reduce greenhouse gas emissions, vegetation would sequester carbon, stabilize stream banks and potentially reduce flood impacts, improve aquatic ecosystem integrity.

Controlled Drainage

Controlled drainage, also known as drainage water management (DWM), has limited applicability in Iowa due to the requirement of low slopes. This scenario considers controlled drainage, but drainage water management could also be achieved through shallower drain placement. However, shallower drain placement would have significant costs due to replacement of existing tile systems.

Controlled drainage and drainage water management installation and maintenance cost estimates (from Christianson et al., In Preparation) include structure cost (assumption of 20 acres per structure), system design, contractor installation, farmer management time (raise and lower control gate devices), structure replacement, and control device replacement. Resulting EAC was $9.86/acre per year.

Other ecosystem or environmental services include managing the water table at a shallower depth could result in increased surface runoff, which would have implications for soil erosion and transport of other surface runoff contaminants (e.g. phosphorus).

Land Retirement - Replacing Row Crops with Perennial Vegetation

Cost estimates for land retirement were based on income lost by taking land out of corn and soybean production (cash rent for corn and soybean) plus an annual maintenance cost. The maintenance was assumed to be mowing twice per year at a cost of $13.85/acre/mowing event ($27.70/acre/year) (Edwards et al., 2011).

Cost to implement is $254.00/acre (not including a CRP payment)

Other ecosystem or environmental services include increased wildlife habitat; decreased soil erosion, surface runoff, and surface runoff transported pollutant export (e.g. P); hydrologic services, that is, reduction of water runoff amount and rate; increased carbon sequestration; and reduced greenhouse gas emissions.

Land Conversion - Perennial Energy Crops Replacing Row Crops

Although there is not a current large market for perennial biomass crops as a source for energy or transportation fuel production, there are local and regional markets for those crops with current prices (example $50/ton). A publication from 2008 in the Ag Decision Maker series (Duffy, 2008) had estimates on the cost of production, transportation, and storage of switchgrass. At an assumed 4 ton/acre production level, the resulting revenue is $200/acre. The $50/ton does not cover the cost to harvest, store, and transport, thus, land retirement is more profitable. The Ag Decision Maker costs factor in a land charge, and land rent for corn and soybean was used to represent the cost of switching from row crops to perennials.

Cost to implement is $405.00/acre

This cost includes production, transportation, land rent, and estimated sales return.

Not Applying P on Acres with High or Very High Soil-Test P

This practice involves not applying phosphorus (P) on fields where soil-test P (STP) values exceed the upper boundary of the optimum level for corn and soybean in Iowa (20 ppm, Bray-1 or Mehlich-3 tests, 6-inch sampling depth). This practice would be employed until the STP level reaches the optimum levels.

The average estimated STP values from Mallarino et al.(2011) were used, along with the estimate of 1 ppm STP per year reduction in high or very high testing soils when growing a corn-soybean rotation without P application (Mallarino and Prater, 2007) for each MLRA to estimate the number of years required for not applying P. Cost savings were based on $0.59/lb of phosphate ($P_2O_5$) and an application rate of 56 lb P_2O_5/ac (average annual need for a corn-soybean rotation with 180 bu/ac corn and 55 bu/ac soybean). This equates to $36/ac/year savings in continuous corn and $33/ac/year savings in a corn-soybean rotation.

Cost to implement is -$9.00/acre

Convert all Tilled Area to No-Till

Tillage reduction will reduce P transport associated with soil erosion and surface runoff. This practice involves the conversion of all tillage to no-till, whereby the soil is left undisturbed from harvest to planting except for strips up to 1/3 of the row width made with the planter (strips may involve only residue disturbance or may include soil disturbance). This practice assumes approximately 70 percent or more of the soil surface is covered with crop residue, after planting, to reduce soil erosion by water.

Practice limitations, concerns, or considerations include no-till results in lower corn yield than with moldboard or chisel-plow tillage. However, the yield reduction is less or none for other minimum tillage options that, on the other hand, are less efficient at controlling soil erosion and surface runoff. No-till or conservation tillage does not affect soybean yield significantly.

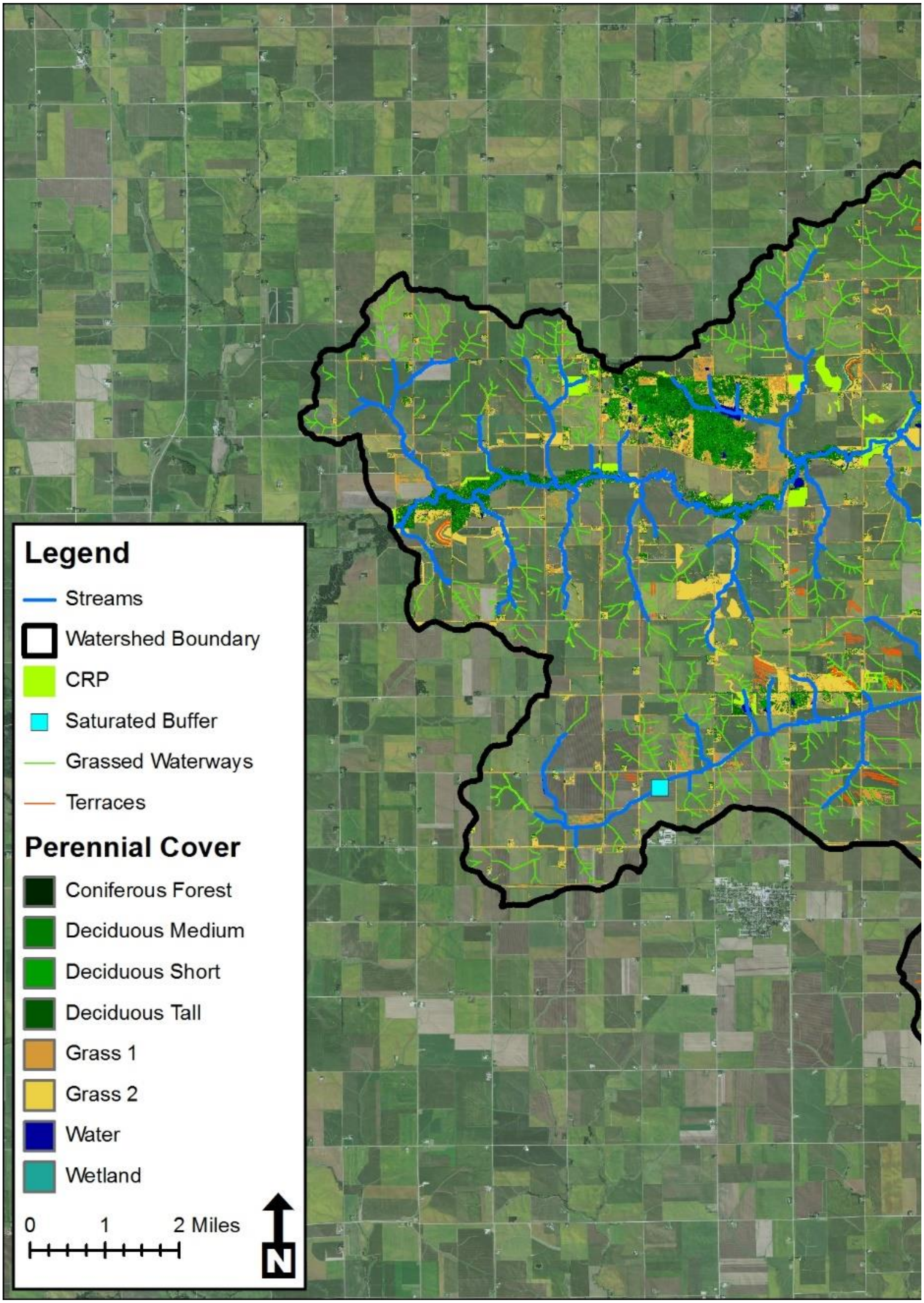
The EAC of converting to no-till (70% residue) from either “conventional” (<20% residue) or “conservation” (30% residue) tillage systems were based on data from the publication *Estimated Costs of Crop Production in Iowa* (Duffy, 2012). Costs varied with average land rent in each MLRA. Also, since there is a 6% corn yield reduction when using no-till, there was a different cost for each MLRA associated with variable MLRA yields.

Cost of Converting from Conventional Tillage to Conservation Tillage = -$1.18/acre
Cost of Converting from Conservation Tillage to No-Till = $13.41/acre
Cost of Converting from Conventional Tillage to No-Till = $10.64/acre

Other ecosystem or environmental services include increased long-term soil productivity and crop yield, reduced sediment loss, which extends the longevity of reservoirs, and reduced suspended and bedded sediments, thereby improving aquatic ecosystem integrity.

Appendix I

Detailed Maps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CRP
Saturated Buffer
Grassed Waterways
Terraces
Perennial Cover
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Grass 2
Water
Wetland
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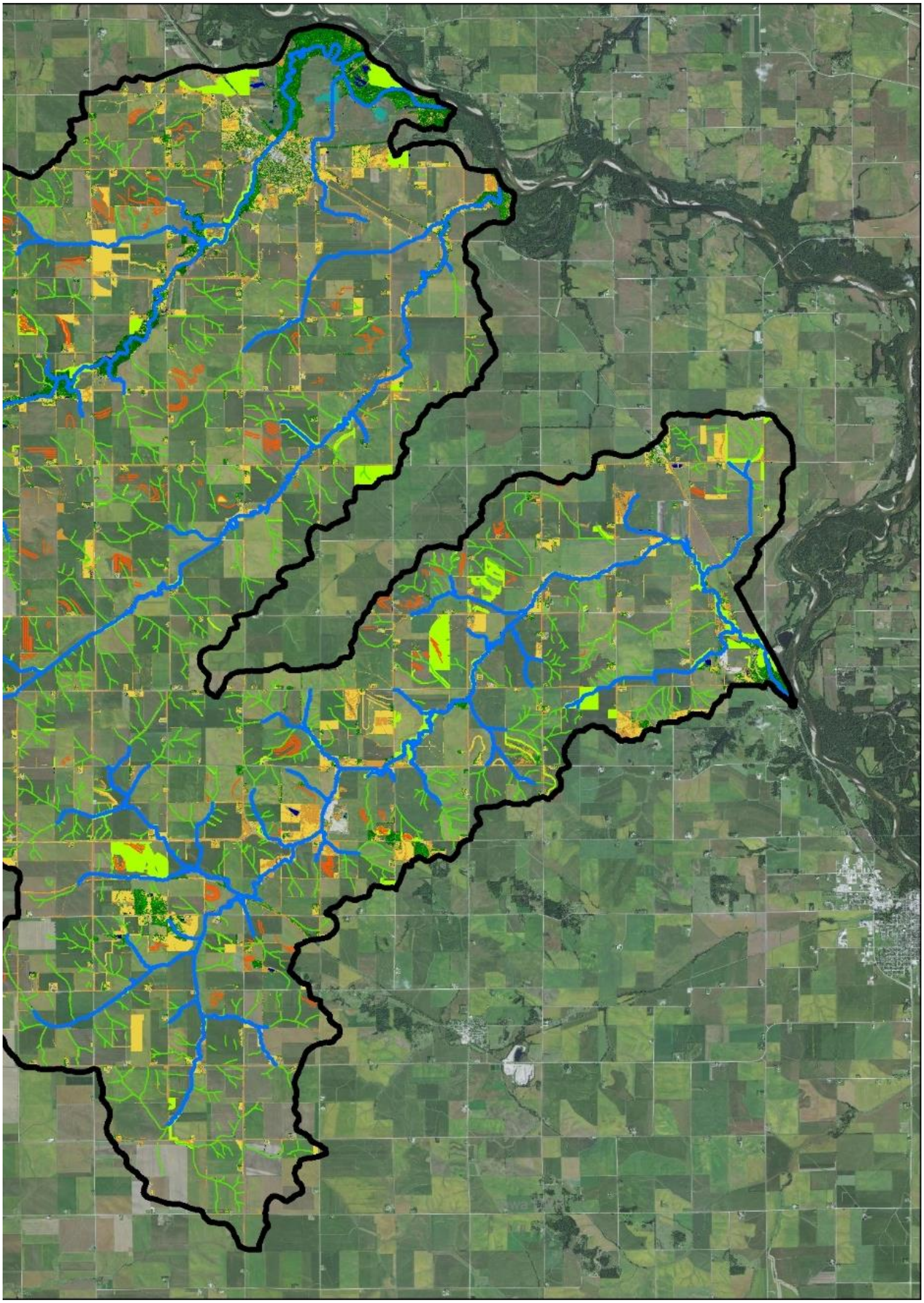
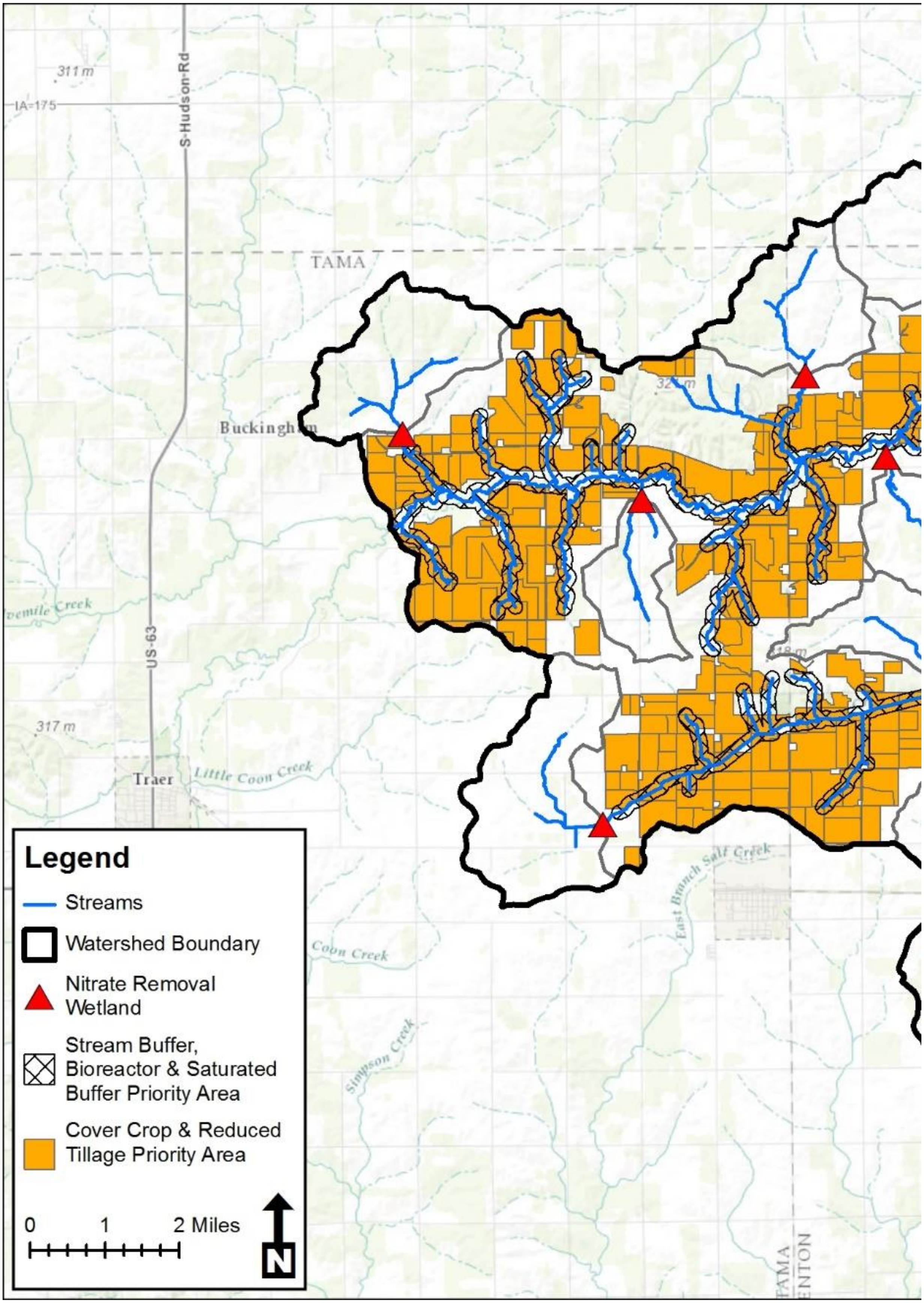
1
2 Miles
N





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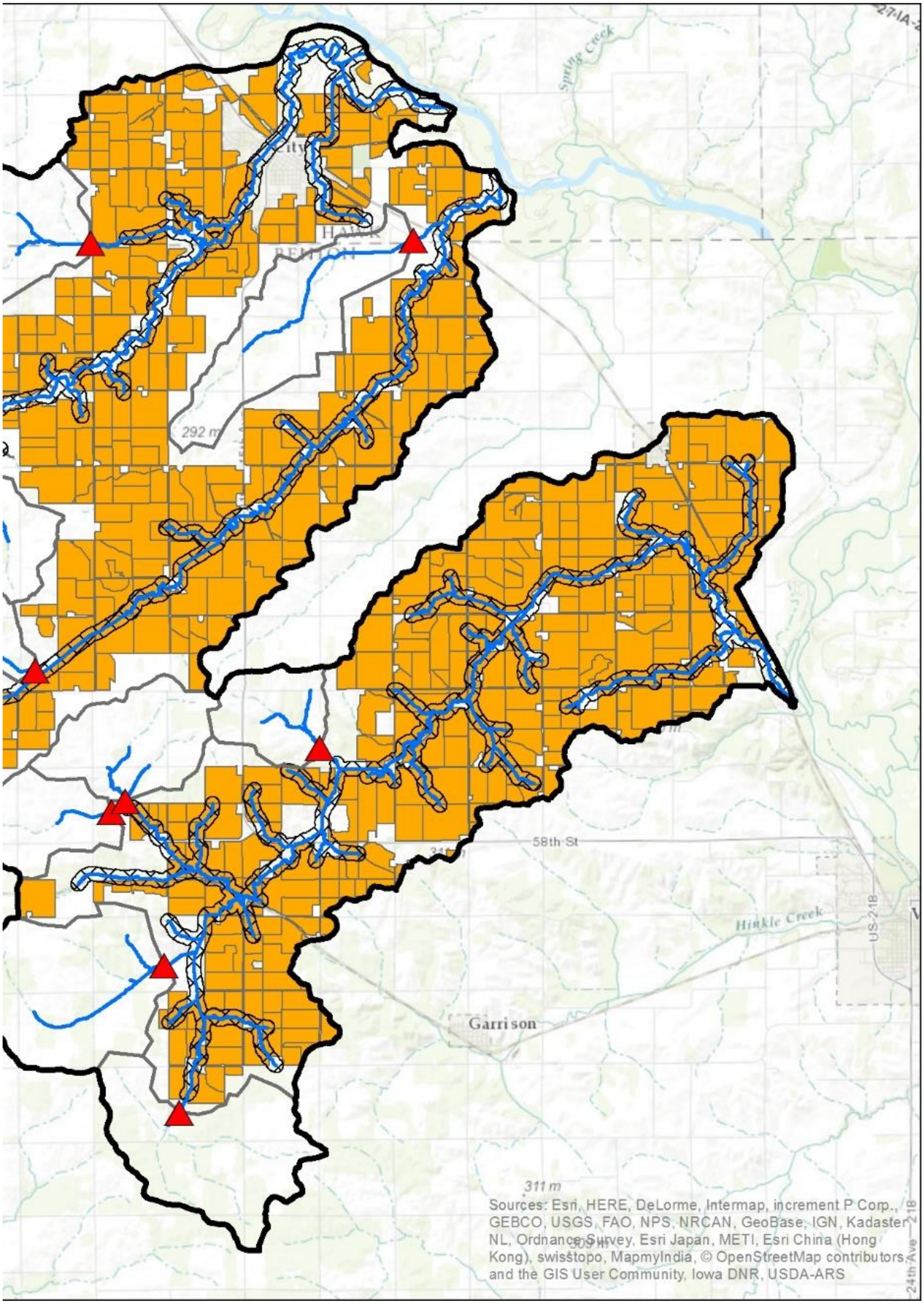
IA-175
S-Hudson-Rd
TAMA
Buckingham
US-63
317 m
Traer
Little Coon Creek
Coon Creek
Simpson Creek
East Branch Salt Creek
TAMA
BENTON
Legend
Streams
Watershed Boundary
Nitrate Removal Wetland
Stream Buffer, Bioreactor & Saturated Buffer Priority Area
Cover Crop & Reduced Tillage Priority Area
0
1
2 Miles
N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58th St
Hinkle Creek
US-218
Garrison
311 m
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community, Iowa DNR, USDA-ARS
24th Ave

Appendix J

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