ROCK CREEK WATERSHED PLAN

A ROADMAP FOR IMPROVED WATER, SOIL & HABITAT IN THE ROCK CREEK WATERSHED

Developed by:

Environmental Programs & Services
IOWA SOYBEAN ASSOCIATION

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Project partners include:

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Fishers and Farmers Partnership

Iowa Flood Center

AgSolver Inc.

Pheasants Forever

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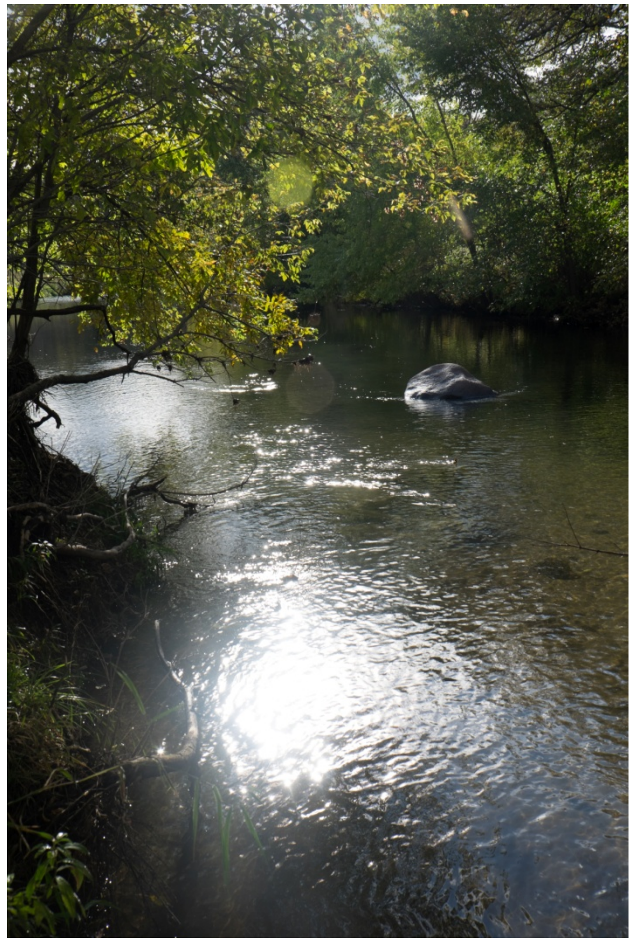

What is the Purpose of the Rock Creek Watershed Plan?

This document is intended to provide a roadmap for water, soil, and habitat improvements in the Rock Creek 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 Plan?

This plan is for all stakeholders interested in the Rock Creek watershed; this includes 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 Mitchell County Soil and Water Conservation District.

Who Approved this Watershed Plan?

This plan was approved by all stakeholders participating in the planning process, their names and signatures below indicate support for the goals and objectives contained within this document.

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EXECUTIVE SUMMARY

A watershed is an area of land that drains to a common point of land, in the case of the Rock Creek watershed, 44,787 acres of land drain to the point where Rock Creek meets the Cedar River southwest of Osage, Iowa. 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. Figure 1 provides an overview of the watershed planning and implementation process.

In 2012 the Mitchell County Soil and Water Conservation District (SWCD) was awarded a Watershed Planning and Development Grant from the Iowa Department of Agriculture and Land Stewardship to assess the Rock Creek watershed. In 2013, the Iowa Soybean Association was awarded a grant from the Walton Family Foundation to develop a watershed plan for the watershed and begin building relationships with conservation professionals, farmers and landowners in the watershed. These two efforts, combining public and private funding, dovetailed to produce this document. The Rock Creek Watershed Plan serves as the culmination of existing research and studies, citizen and stakeholder input, and recommendations for conservation practices aimed at meeting the goals developed through the watershed planning process.

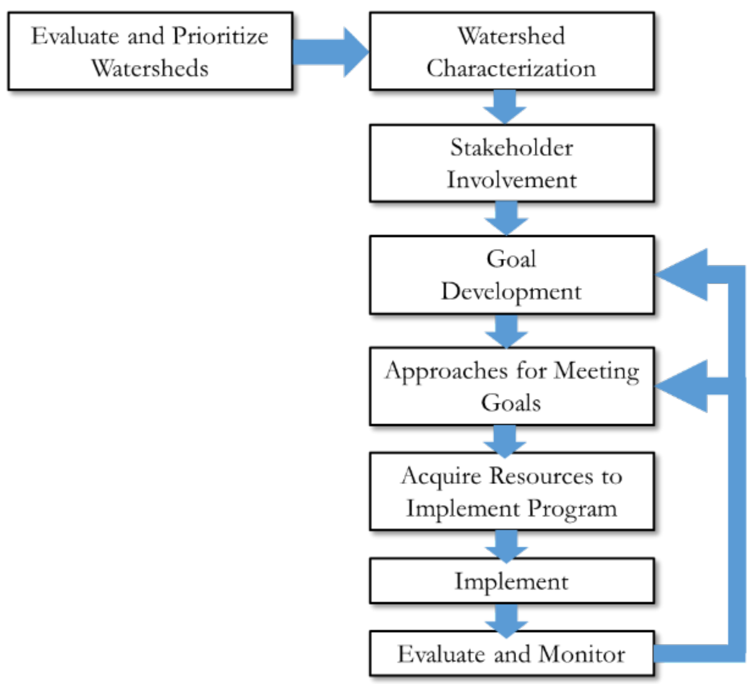


FIGURE 1 WATERSHED PLANNING PROCESS

Watershed improvement goals established in this document focus and fuse 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 Rock Creek Watershed Plan are to:

1. Reduce in-stream nitrogen by 41% from 2009-2011 average levels.
2. Reduce in-stream phosphorus by 29% from 2009-2011 average levels.
3. Increase soil organic matter by 1%.
4. Maintain or increase agricultural productivity and revenues.
5. Reduce flood risk.
6. Maintain or increase upland wildlife habitats.
7. Maintain or improve aquatic life.

Public involvement is a critically important component of every planning process and that was no different in the case of the Rock Creek watershed. Watershed planners initiated public involvement during the planning process and worked to incorporate multiple levels of involvement. Two advisory committees were established to provide input; first, a Technical Advisory Committee was established to address scientific and technical questions within the watershed. Second, a Farmer/Landowner Advisory Committee was created to gather input from those who live, work and recreate in the watershed. In addition to the two committees additional public involvement included a mailed survey, a public input meeting, and media promotion of the project. All feedback provided by the public was used to guide development of this document.

Improving land and water resources in the Rock Creek watershed is a complex and challenging effort and will require significant collaboration and partnerships. The conceptual plan and implementation schedule included in this document have been developed to balance current resources and policies with the desire to make land and water improvements. A phased implementation approach is used to allow for continuous improvements that can be evaluated to determine if progress is being made towards achieving desired goals. Advanced watershed modeling combined with 2014 conservation practice costs indicate a $5,550,000 infrastructure investment combined with a yearly operating investment of $1,367,086 is needed to achieve all goals identified in this plan. This investment would result in water quality and quantity benefits within Rock Creek and downstream in the Cedar River. Additionally, it is believed this investment will result in on-farm benefits, including but limited to, reduced loss of valuable topsoil, increased soil health and productivity, increased resilience to weather extremes, and potentially an increase in on-farm profits.

WATERSHED CHARACTERISTICS

The Rock Creek Watershed is a 44,787 acre watershed dominated by 87% row crop agriculture and relativity flat terrain with some karst influence. Rock Creek begins as a drainage dredge ditch in Worth County just north and east of the community of Grafton. Rock Creek flows southeast into Mitchell County and eventually into Floyd County were the confluence with the Cedar River is located. The only incorporated city or town within the watershed is Grafton, which straddles the northwestern watershed boundary. The unincorporated community of Merda lies within the watershed. Other than 177 acres owned by the Mitchell County Conservation Board and road right of ways, the watershed is entirely privately owned.

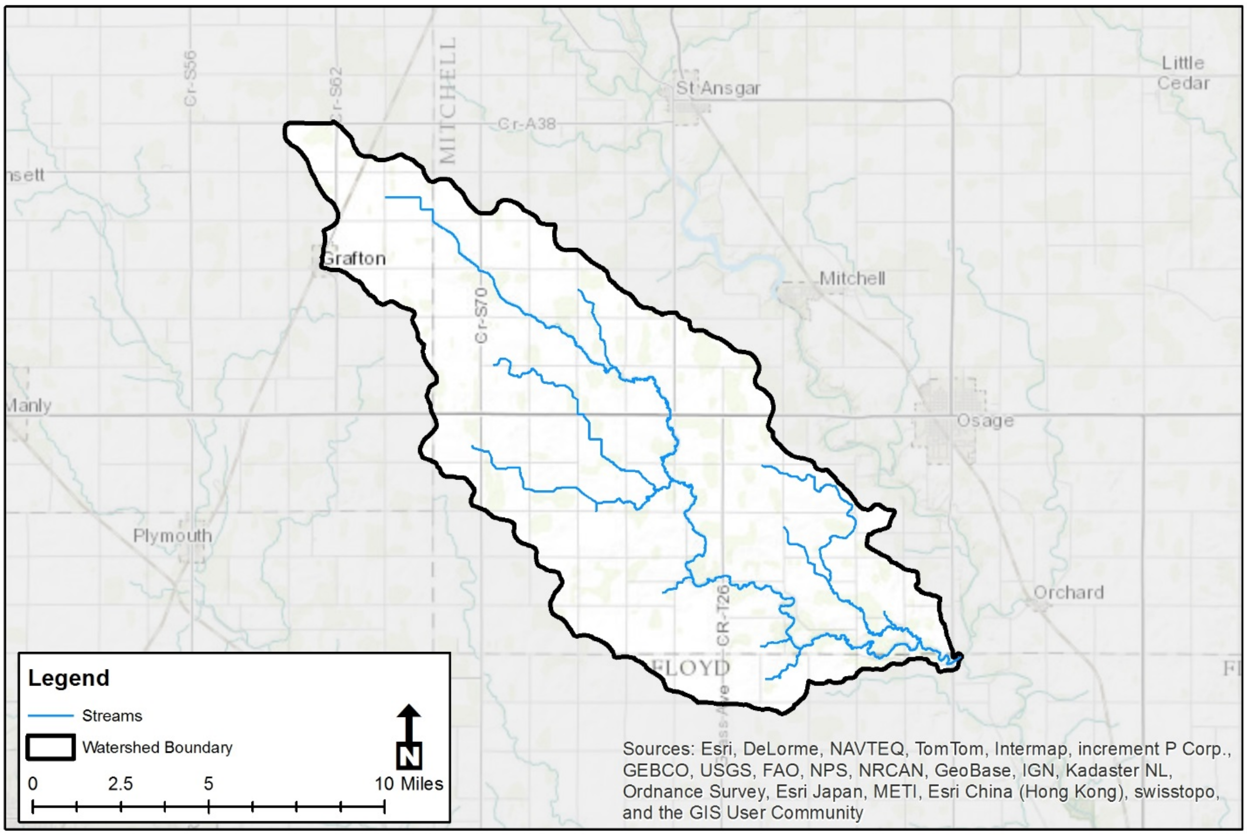


FIGURE 2 ROCK CREEK WATERSHED AND STREAM

TABLE 1 GENERAL WATERSHED DATA.

General Watershed Data – *Rock Creek*			
Location	*Floyd, Mitchell and Worth Counties*	**Waterbody ID Code**	*IA02-CED-0510*
		Major Cities	*None*
Waterbody Type	*Stream*	**Segment Classes**	*Class A1, Class B(WW-1), Class HH*
Watershed Area	*44,787 acres*	**Stream Length**	*87.9 miles*
Dominant Land Use	*Row Crop Agriculture*	**Landowners**	*242+/-*
HUC 12 Watershed	*Rock Creek - Goose Creek* *Rock Creek - Upper Goose Creek*	**HUC 12 ID**	*070802010603* *070802010604*
HUC 10 Watershed	*Rock Creek - Cedar River*	**HUC 10 ID**	*0708020106*
HUC 8 Watershed	*Upper Cedar River*	**HUC 8 ID**	*07080201*

The Rock Creek Watershed is located on the Iowan Surface landform region. The Iowan Surface landform region was last glaciated 16,000 to 21,000 years ago and is dominated by gently rolling terrain created by glacial processes. Glacial boulders lie scattered across the landscape.

GLACIAL BOULDER IN ROCK CREEK.

Water

A well-connected stream network is found within the Rock Creek watershed. Figure 2 shows the identified streams within the Rock Creek Watershed. The National Hydrography Dataset lists 11.9 miles of 1st order streams, and 3.6 miles of 2nd order streams in the watershed. Figure 3 is a map of the identified wetlands in the Rock Creek watershed according to the National Wetland Inventory (NWI), a dataset developed by the U.S. Fish and Wildlife Service. The wetland locations were derived from aerial photo interpretation. The NWI maps do not show all wetlands as the maps were derived from aerial photo interpretation with varying limitations due to scale, photo quality, inventory techniques, and other factors. Consequently, the maps tend to show wetlands that are readily photo interpreted given consideration of photo and map scale.

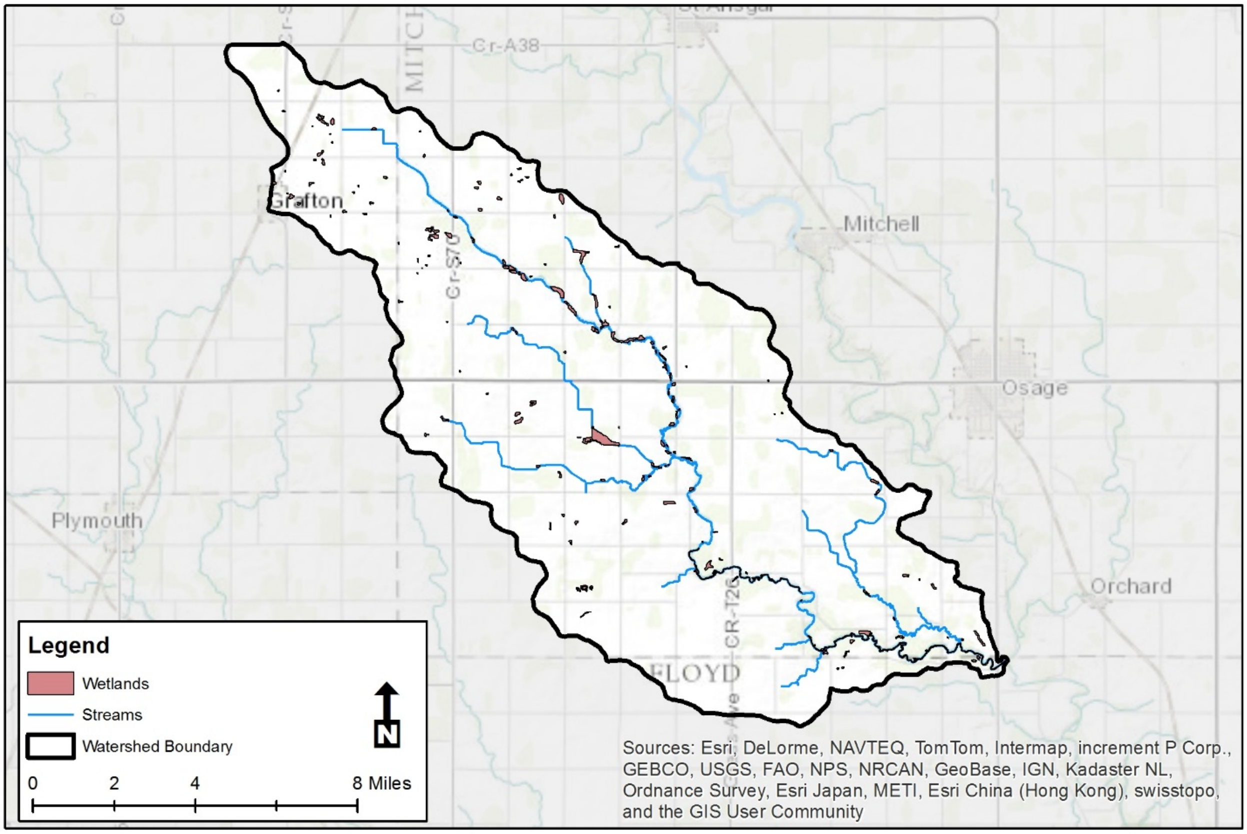


FIGURE 3 WETLANDS WITHIN THE ROCK CREEK WATERSHED ACCORDING TO THE NATIONAL WETLAND INVENTORY.

TABLE 2 CLASSIFICATION OF WETLANDS WITHIN THE ROCK CREEK WATERSHED.

Type	Percent	Acres
Intermittently Exposed	15%	65
Intermittently Flooded - Farmed	20%	84
Intermittently Flooded - Excavated	3%	12
Seasonally Flooded	22%	94
Seasonally Flooded - Farmed/Drained	15%	62
Temporarily Flooded	18%	75
Temporarily Flooded - Farmed/Drained	6%	26
Semipermanently Flooded	1%	5
Total	100%	423

Like many other watersheds in low relief landscapes of Iowa, much of the land within the Rock Creek watershed is artificially drained in order to make agricultural production possible and productive. Figure 4 shows soil types where tile drainage is needed to achieve full agricultural productivity. It should be noted this map may not capture all areas currently having subsurface tile drainage infrastructure installed.

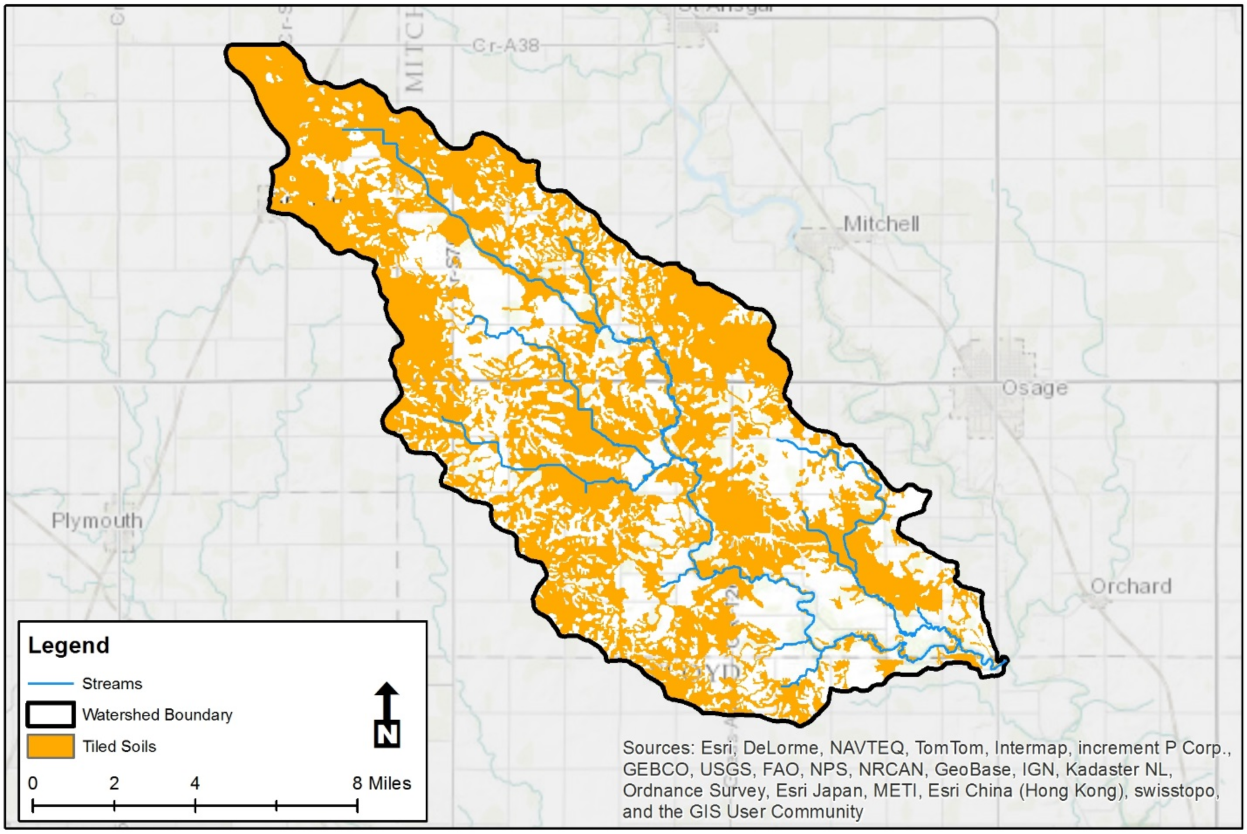


FIGURE 4 AREAS NEEDING TILING TO ACHIEVE FULL AGRICULTURAL PRODUCTIVITY.

Soils

The Rock Creek Watershed is dominated by the Klinger, Maxfield, Dinsdale, Ashdale, Franklin, Waubeek, Donnan, and Clyde soil associations, these eight soil types make up over 65% of the watershed. Figure 5 shows soil types generated from the SSURGO coverage developed by the National Cooperative Soil Survey from the USDA-NRCS.

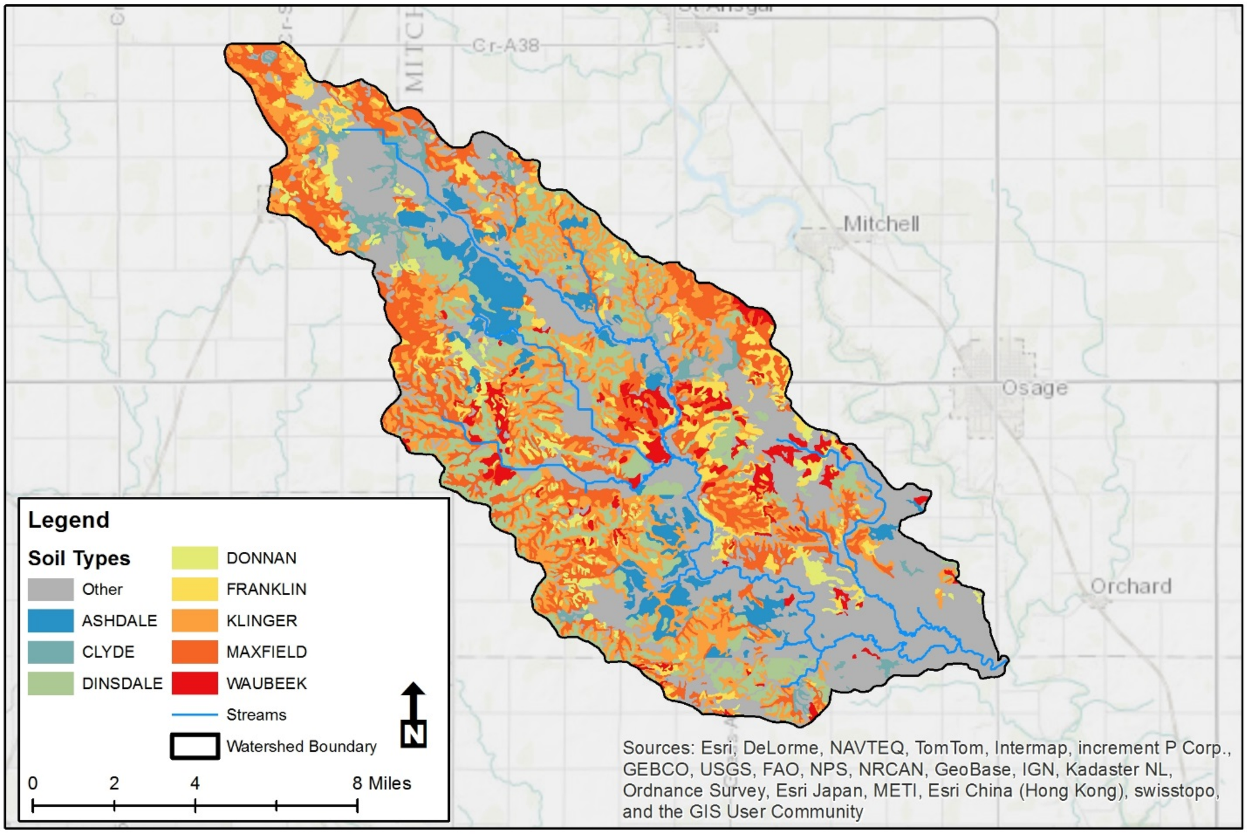


FIGURE 5 ROCK CREEK WATERSHED SOIL MAP DERIVED FROM THE NATIONAL COOPERATIVE SOIL SURVEY, USDA-NRCS.

The Klinger series consists of very deep, somewhat poorly drained soils formed in 50 to 102 centimeters of loess and the underlying glacial till. These soils are on interfluves and long side slopes on dissected till plains. Slope ranges from 0 to 5 percent. The Maxfield series consists of very deep, poorly drained soils formed in 60 to 102 centimeters of loess and underlying glacial till. Maxfield soils are on interfluves and on head slopes of broad, shallow drainage ways on dissected till plains. Slope ranges from 0 to 2 percent. 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. The Ashdale series consists of deep, well drained soils on uplands. These soils formed in loess and residuum weathered from limestone. Slopes range from 0 to 20 percent.

The Franklin series consists of very deep, somewhat poorly drained soils formed in 50 to 100 centimeters of loess and the underlying till. These soils are on interfluves, head slopes, and side slopes on dissected till plains. Slope ranges from 0 to 5 percent. The Waubeek 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. These soils are on convex summits of interfluves and upper side slopes on dissected uplands. Slopes range from 0 to 14 percent. The Donnan series consists of very deep, somewhat poorly drained soils formed in 50 to 91 centimeters (20 to 36 inches) of loamy sediments and the underlying highly weathered paleosol that developed in glacial till. These soils are on convex ridges and side slopes on dissected till plains. Slopes range from 0 to 9 percent. The Clyde series consists of very deep, poorly and very poorly drained soils formed in 75 to 150 centimeters of loamy glacial outwash or erosional sediments and the underlying loamy till. These soils are on nearly level positions, swales and concave drainage ways on interfluves on dissected till plains. Slope ranges from 0 to 4 percent.

Table 3 summarizes the soil characteristics that affect water movement within the Rock Creek watershed. Approximately 25% of the soils are considered to be hydric. A hydric soil is described as being saturated, flooded, or ponded, long enough during the growing season to develop anaerobic conditions in the upper part of the soil structure. Soil series which may or may not have been drained are both included in hydric soils. A majority (56%) of the soils within watershed are considered somewhat poorly drained to very poorly drained.

TABLE 3 SUMMARY OF SOIL CHARACTERISTICS FOUND IN THE ROCK CREEK WATERSHED.

Dominant Soil	SMU	Acres	Percent of Total Area	Slope	Hydrologic Group	Hydric Soil	Drainage Class
Klinger	804	7,839	17.5%	0-5%	B	No	Well
Maxfield	382	7,046	15.7%	0-2%	B/D	Yes	Poor
Dinsdale	377	5,600	12.5%	0-5%	B	No	Well/Mod. Well
Ashdale	804	2,477	5.5%	0-5%	B	No	Well
Franklin	761	2,401	5.3%	1-3%	B	No	Somewhat Poor
Waubeek	771	1,582	3.5%	0-5%	B	No	Well/Mod. Well
Donnan	782	1,297	2.8%	0-5%	C	No	Mod Well/Poor
Clyde	84	1,050	2.3%	0-3%	B/D	Yes	Poor

Figure 6 shows a map of highly erodible land (HEL) within Rock Creek watershed. Approximately 10% of the watershed is considered HEL or potentially HEL. A majority of the HEL land is located in the southeast portion of the watershed where slopes tend to be steeper. Of the 4,394 acres of HEL nearly 80% is used for corn or soybean production as of 2013.

Figure 7 displays the corn suitability rating (CSR) for land within the Rock Creek watershed. CSR's provide a relative ranking of soils mapped in the state based on their potential to be utilized for intensive row crop production. The CSR is an index that can be used to rank one soil's yield potential against another. Ratings range from 100 for soils that have no physical limitations, occur on minimal slopes, and can be continuously row cropped to as low as 5 for soils with severe limitations for row crops. The ratings assume a) adequate management, b) natural weather conditions, c) artificial drainage where required, d) that soils lower on the landscape are not affected by frequent floods, and e) no land leveling or terracing.

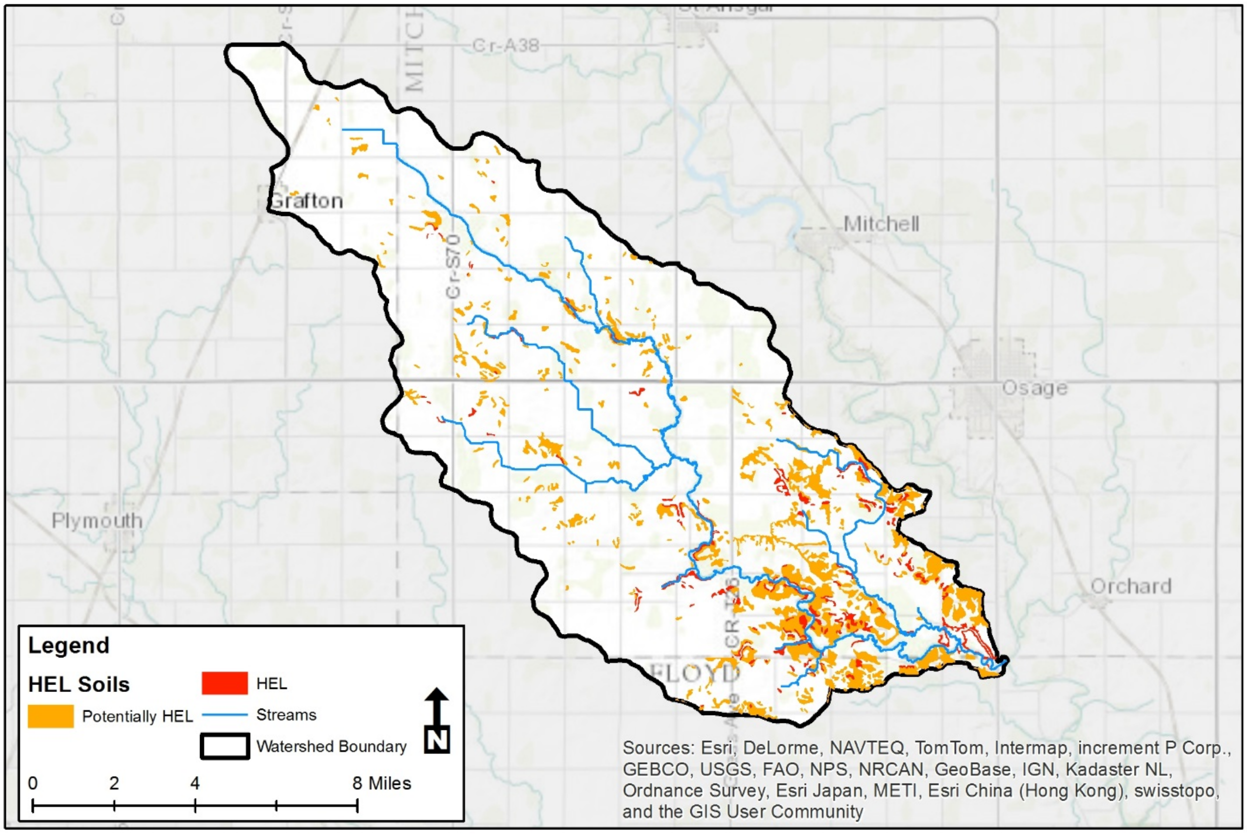


FIGURE 6 HIGHLY ERODIBLE LAND CLASSIFICATION (SSURGO, USDA-NRCS).

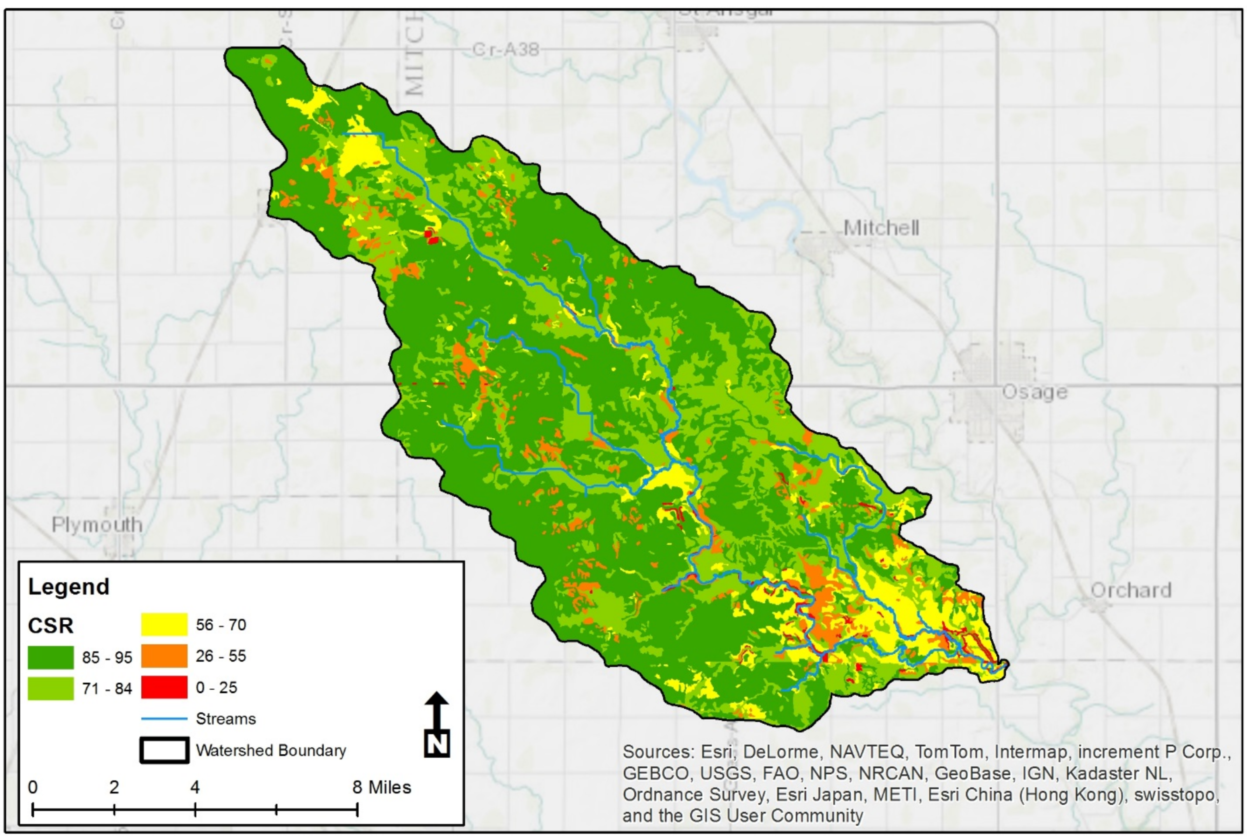


FIGURE 7 CORN SUITABILITY RATING (SSURGO, USDA-NRCS).

Geology & Karst

The entirety of the Rock Creek watershed is classified as karst terrain or potentially karst terrain according to a 2010 Iowa Department of Natural Resources map of karst terrain in Northeast Iowa. Karst terrain is characterized by the presence of easily dissolved bedrock near the ground surface. Because carbonate rocks can be dissolved by groundwater, karst areas are often characterized by sinkholes, springs, and losing streams where some surface flow is lost to groundwater. Groundwaters and surface waters in these areas are highly vulnerable to contamination because contaminants can travel quickly from the surface through open fractures and caves to aquifers, springs, and streams and are not likely to be filtered by soils (Iowa DNR).

A survey of the stream corridor of Rock Creek revealed no visible stream sinks or sinkhole in close proximity to the stream, this is confirmed by the sinkhole and karst map, see Figure 8.

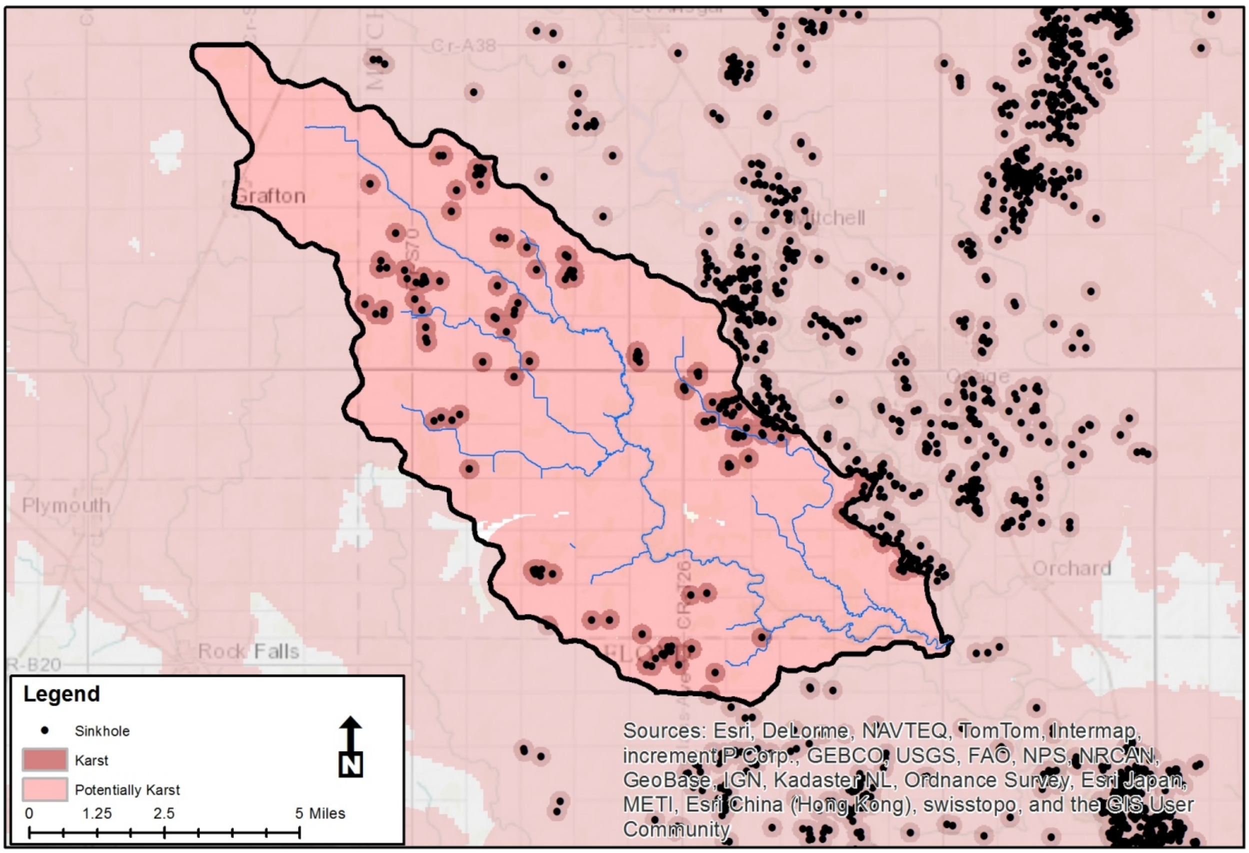


FIGURE 8 KARST MAP OF THE ROCK CREEK WATERSHED

Climate

Climate data from Osage, approximately four miles east of the Rock Creek watershed, shows average precipitation to be 33.8 inches per year, however year to year precipitation totals vary widely. Figure 9 shows yearly precipitation totals from 1951-2012. Monthly temperature averages are shown in Figure 10.

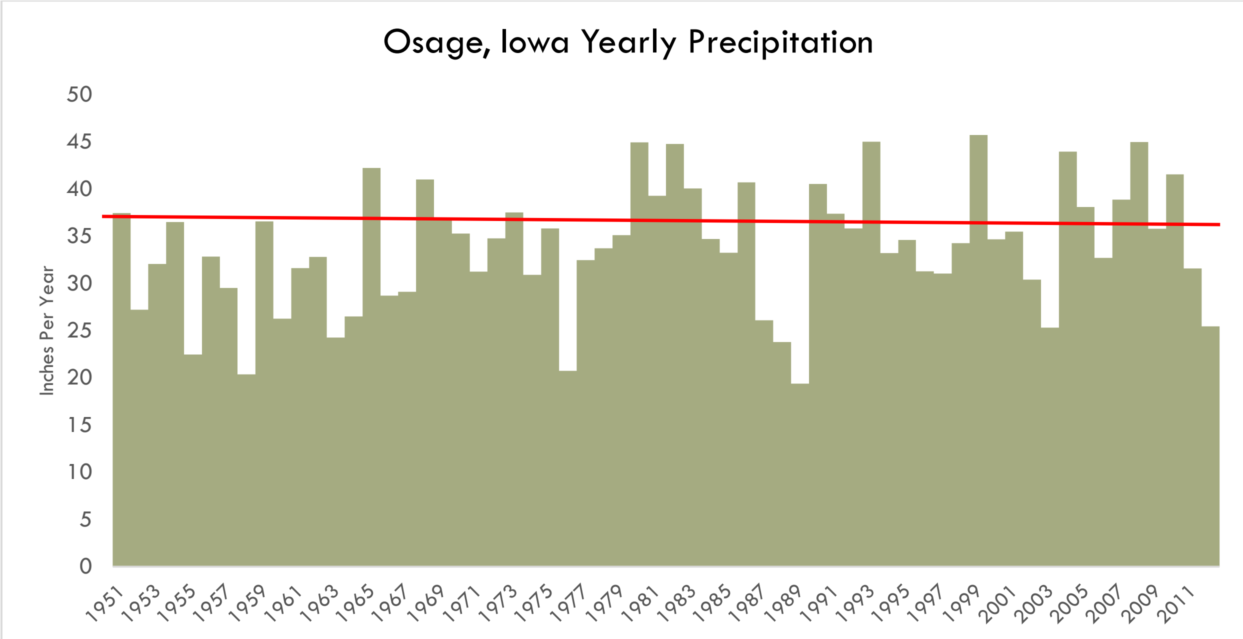


FIGURE 9 OSAGE, IA ANNUAL PRECIPITATION (1951 - 2012).

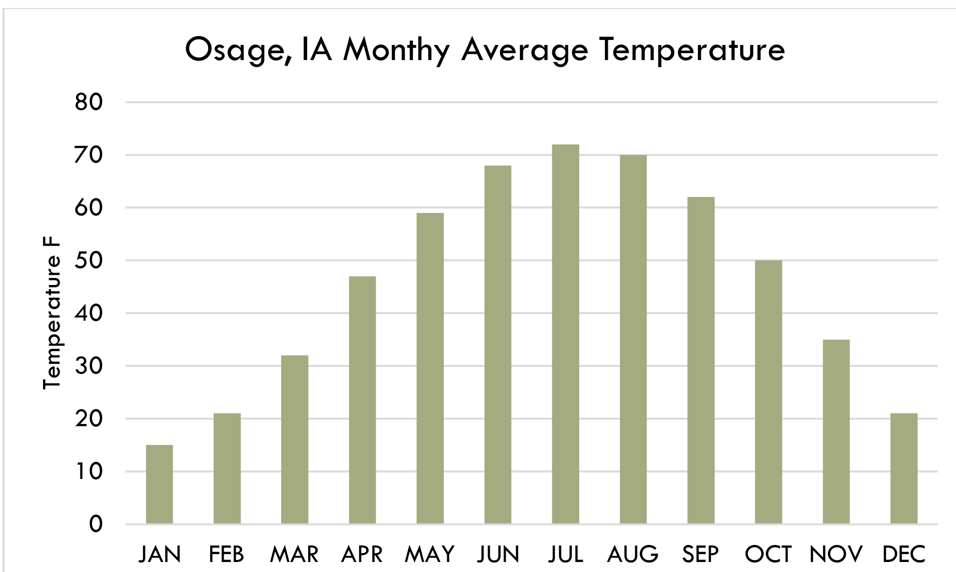


FIGURE 10 OSAGE, IA MONTHLY AVERAGE TEMPERATURE.

Elevation &Slope

The Rock Creek watershed is dominated by gently rolling terrain and relatively low slopes. Figure 11 shows the slope classification of the Rock Creek watershed; the slope information was derived from a LiDAR elevation dataset for the watershed. The highest elevation in the watershed is 1,253 feet above sea level, and the lowest elevation within the watershed is 1,023 feet. Table 4 shows the slope classifications within the watershed. Approximately 67% of the watershed has a slope classification of

A which has a range of slopes from 0-2%. Twenty-six percent of the watershed has slope classifications of B, the remaining 6.5% of the land area has slopes of C or greater.

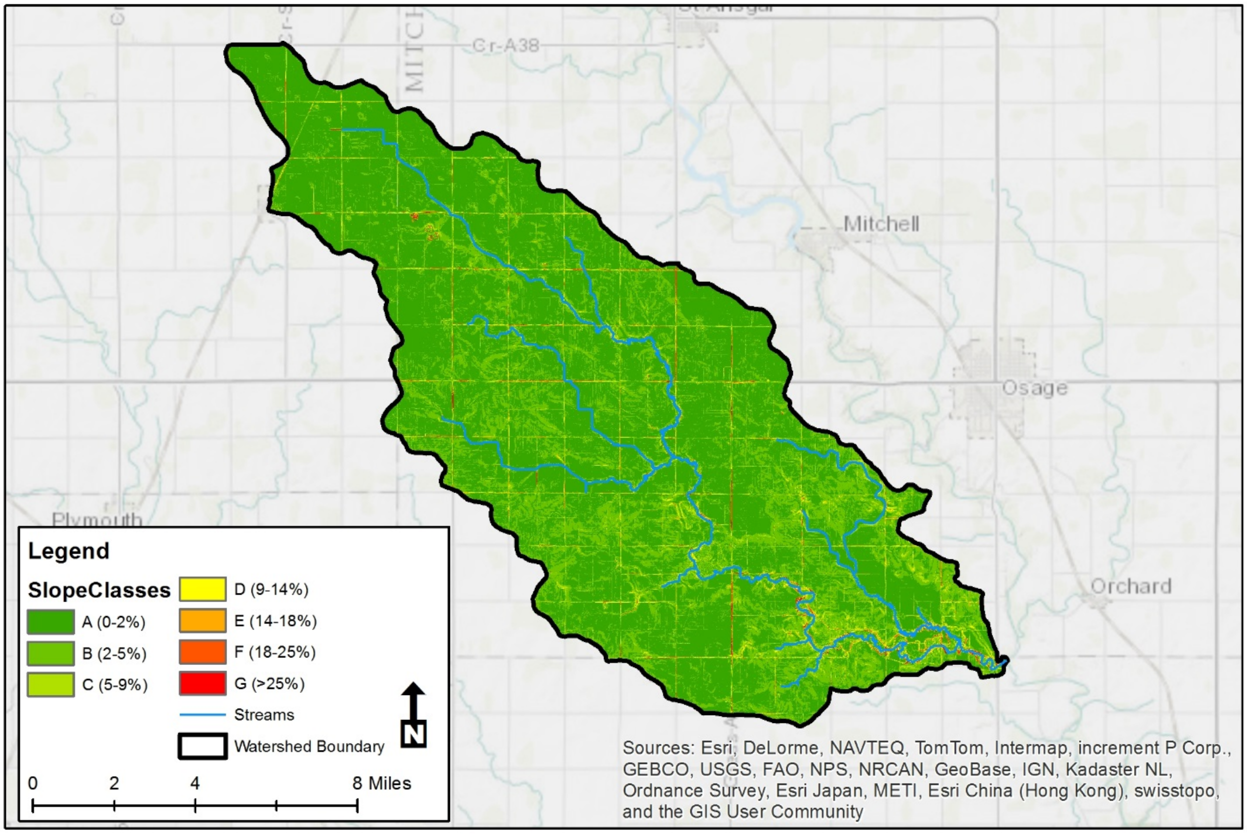


FIGURE 11 ROCK CREEK WATERSHED SLOPE CLASSIFICATION FROM LIDAR ELEVATION DATA.

TABLE 4 SLOPE CLASSIFICATIONS OF ROCK CREEK DERIVED FROM LIDAR ELEVATION DATA.

Slope Classification	Range	Area, acres	% of Total
A	0 – 2%	30,029	67.0
B	2 – 5%	11,866	26.5
C	5 – 9%	1,616	3.6
D	9 – 14%	648	1.4
E	14 – 18%	286	0.6
F	18 – 25%	218	0.5
G	> 25%	123	0.4

Land Use

An assessment of land use practices was conducted using USDA data from 2006 to 2012. These data, collected as part of the USDA Cropland Data Layer project, was grouped into seven land use categories, summaries of the land use data are presented in Figure 12 and Table 5.

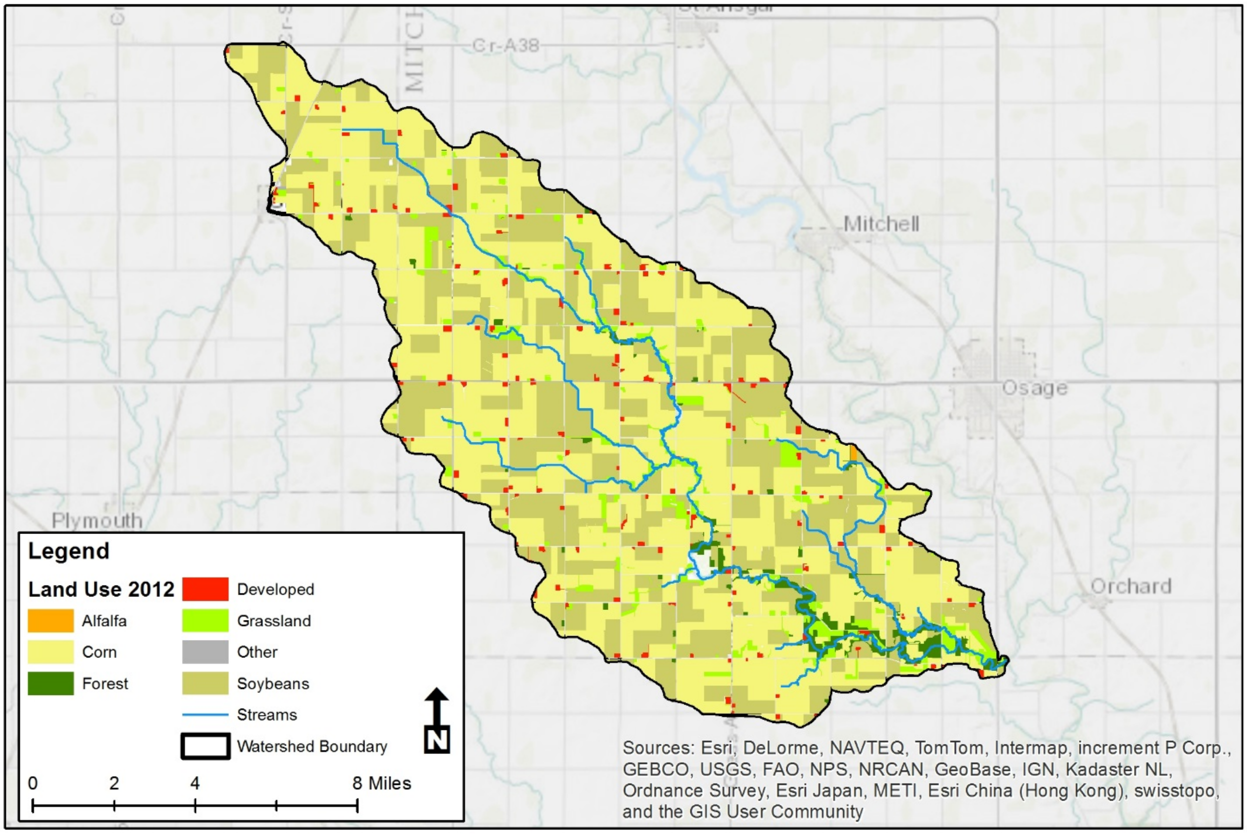


FIGURE 12 2012 USDA CROPLAND DATA LAYER OF ROCK CREEK.

TABLE 5 ROCK CREEK LAND USE 2006-2012.

	2006	2007	2008	2009	2010	2011	2012
Alfalfa	190	39	66	25	33	67	18
Corn	21,329	25,291	23,029	24,641	22,564	24,499	23,154
Forest	1,171	1,128	1,220	1,168	1,261	1,087	1,129
Developed	260	927	742	805	544	738	691
Grassland	1,189	1,798	1,640	1,489	1,735	2,134	2,250
Soybeans	18,457	13,736	16,301	14,869	16,853	14,474	15,750
Other	404	79	0	0	10	0	7

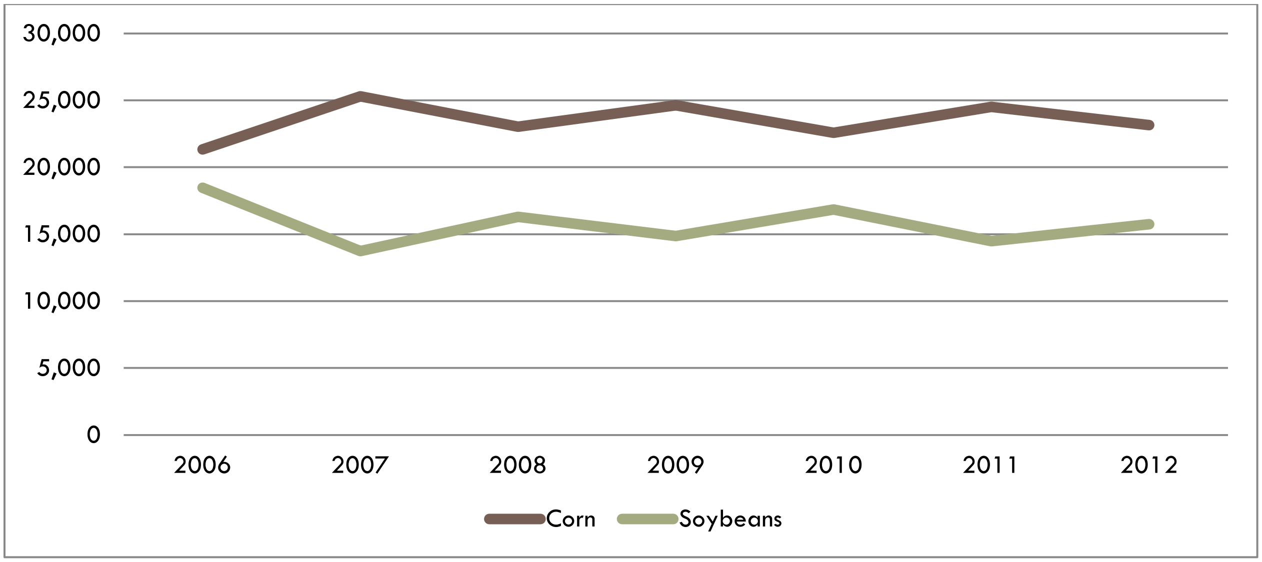


FIGURE 13 ROCK CREEK WATERSHED CORN/SOY ACRES 2006-2012.

The Government Land Office (GLO) conducted the original public land survey of Iowa during the period 1832 to 1859. Surveyors and their assistants produced both field notes and township maps that briefly described the land and its natural resources (vegetation, water, soil, landform, and so on) at the time of the survey. These maps and survey notes are one of few data sources about vegetation distribution before much of Iowa changed to a landscape of intensive agriculture. This data represents the observed vegetation by the deputy surveyors when laying out the public land surveys in Mitchell County. The Rock Creek watershed was classified as 89% prairie, 10% timber, and 1% marsh.

Population & Demographics

According to United States Census Bureau approximately 700 people live in the Rock Creek watershed, this equates to approximately 10 people per square mile. Outside of the community of Grafton, the entire watershed population lives outside of incorporated areas. Within Mitchell County the median age in 2010 was 41 years old. Since its peak in 1900, the population of Mitchell County has declined by 28%. Estimates are not available for the Rock Creek watershed but a similar trend is expected to have occurred.

Land Tenure

Land tenure trends in Iowa are captured every five years in a survey of land ownership, the survey is conducted by Mike Duffy of Iowa State University Extension. The most recent survey was conducted in 2012 and shows impacts of the recent boom in land values (Duffy 2013). In 2012 almost one third of Iowa farmland was owned by someone over the age of 75, the percentage of land owned by people in this age category has been increasing since 1982, when 12% of the land was owned by someone over the age of 75 (Duffy 2013).

Using data from the Mitchell, Worth and Floyd County Assessors an analysis of the land tenure was conducted for the Rock Creek watershed. An analysis of landowner mailing addresses found that 39% of landowners have a mailing address within the boundaries of the Rock Creek watershed. Another 33% live within 5 miles of the watershed boundary. Sixty-seven landowners, or 28% of the total land owners, have mailing addresses five miles or further from the watershed. Figure 14 shows the location of all Rock Creek landowner mailing addresses.

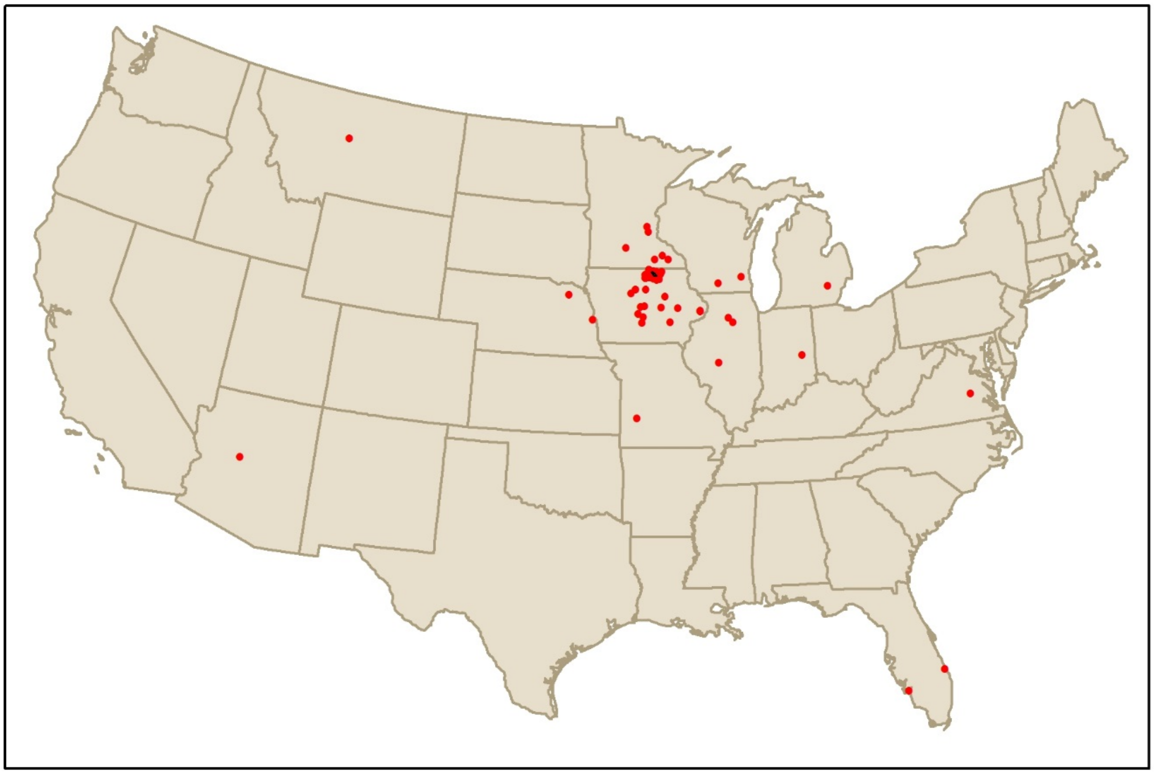


FIGURE 14 ROCK CREEK WATERSHED LANDOWNER MAILING ADDRESS LOCATIONS

Existing 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 implementation. Aerial photography and watershed surveys found many conservation practices currently in place within the watershed. Determining levels of in-field management practices such as nutrient management, have provided difficult and are not included in this report. Table 6 lists all practices identified within the watershed and Figure 15 provides a map of existing conservation practices.

TABLE 6 ROCK CREEK WATERSHED EXISTING CONSERVATION PRACTICES.

Practice	Quantity
Terraces	9,843 feet
Grassed Waterway	105,221 feet
Stream Buffers	79% of all streams
Cover Crops	Unknown
No-Till/Strip-Till	7,640 acres
Nitrate Treatment Wetlands	1 in construction

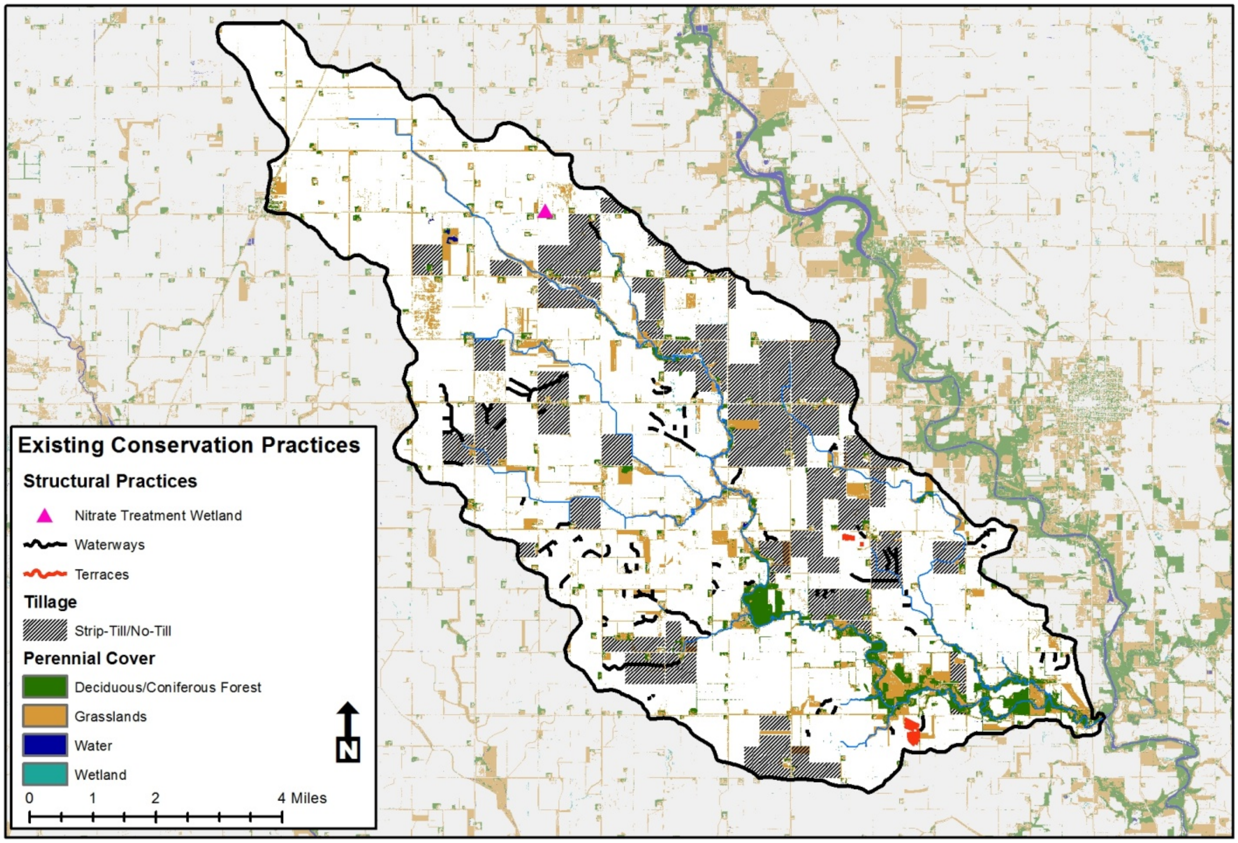


FIGURE 15 EXISTING CONSERVATION IMPLEMENTATION 2013/14

Monitoring of water chemistry and biological conditions in Rock Creek has been ongoing since at least 1996 when an assessment of the in-stream biological community (fish and macroinvertebrates) was conducted. In-depth stream water quality monitoring has occurred since 2006 at one site, and additional sites were added in 2009. As a result of the stream water quality monitoring, portions of Rock Creek have been listed on Iowa's 303(d) Impaired Waters List for indicator bacteria levels that exceed the state's water quality standards. Rock Creek was first added to the Impaired Waters list in 2008 and has remained on the list ever since. A detailed description of this impairment is provided later in this section. A Total Maximum Daily Load (TMDL) for this impairment has not been completed at the time of publication thus the bacteria impairment is not directly addressed in this watershed plan; when a TMDL is completed, the findings may be used to revise this plan.

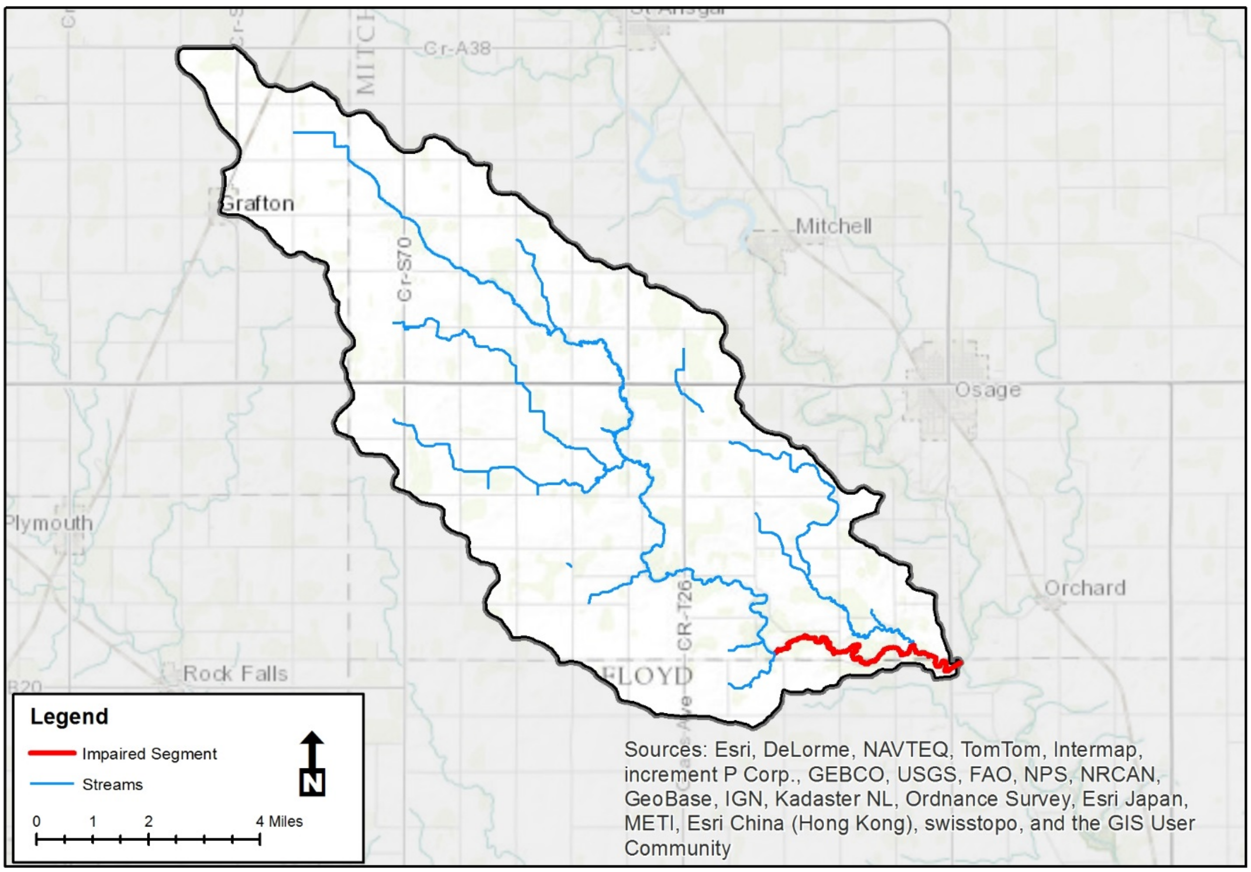


FIGURE 16 IMPAIRED SEGMENT OF ROCK CREEK.

Designated Uses

Segments of streams and rivers in Iowa each have specific designations based on their use, such as recreation, fishing, drinking water and or fish or aquatic habitat. Rock Creek has the following designated uses:

- **Class A1:** Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

- **Class B(WW-1):** Waters in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrate species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.

- **Class HH:** Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

Iowa 305(b) Assessment for Rock Creek

Every two years the State of Iowa is required to prepare two water quality reports; the 305(b) Water Quality Assessment and the 303(d) Impaired Waters Report. Together, these two reports are known as Iowa's Integrated Report. These reports provide information on Iowa's progress in meeting water quality goals. Iowa categorizes waterbodies into one of five categories based on a waterbodies conditions relative to set water quality standards. Category 1 includes waterbodies which meet all designed uses. Category 2 and 3 includes waterbodies which do not have sufficient data to determine whether any or all designed uses are being met. Waterbodies not meeting their designated use fall in either category 4 or 5, both of these categories are considered "impaired." Category 4 waterbodies are considered impaired but have a Water Quality Improvement Plan (aka TMDL) written to address the impairment. Category 5 waterbodies are impaired and in need of a water quality improvement plan (aka TMDL). One segment of Rock Creek, shown in Figure 16, is listed as a category 5 waterbody, the following text is from Iowa's 2012 integrated report for the section of Rock Creek considered impaired.

2012 305(B) Assessment

SUMMARY: The presumptive Class A1 uses are assessed (monitored) as "not supported" due to high levels of indicator bacteria. The Class B(WW1) aquatic life uses are assessed (monitored) as "fully supported" based on results of chemical/physical water quality monitoring from 2008-10. Fish consumption uses remain not assessed due to the lack of fish contaminant monitoring in this assessment segment. The source of data for this assessment is the results of ambient water quality monitoring conducted at station 15340005 at County Road T38 from April 2008 through November 2010 as part of the Cedar River/Mitchell County study.

EXPLANATION: The presumptive Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" due to violations of Iowa's water quality criteria for indicator bacteria. The geometric means of indicator bacteria (E. coli) in the 22 samples collected during the recreational seasons of 2008 through 2010 at CR-MC site 15340005 were as follows: the 2008 geometric mean was 624 orgs/100 ml, the 2009 geometric mean was 206 orgs/100 ml and the 2010 geometric mean was 497 orgs/100 ml. All three geometric means exceed the Class A1 criterion of 126 orgs/100 ml. Thirteen of the 22 samples (59%) exceeded the Class A1 single-sample maximum criterion of 235 orgs/100 ml. According to U.S. EPA guidelines for Section 305(b) reporting and IDNR's assessment/listing methodology, if a recreation season geometric mean exceeds the respective water quality criterion, the contact recreation uses *are "not supported". Thus, because at least one recreation season geometric mean exceeded criteria for Class A1 uses, these uses are assessed as "impaired."*

The Class B(WW1) aquatic life uses are assessed as "fully supported" based on results of chemical/physical monitoring at Cedar River/Mitchell County station 15340005. Results of ambient water quality monitoring at this station during the 2008-2010 assessment period showed no violations of Class B(WW) water quality criteria for dissolved oxygen, pH, or temperature in the approximately 19 samples collected from April 2008 through November 2010. Levels of ammonia were extremely low in this stream during the 2008-10 period with five of the six samples analyzed having less than the detectable level of ammonia (< 0.05 mg/l); the maximum ammonia level of 0.24 mg/l on April 1, 2008 was well below the pH-dependent Class B(WW1) chronic criterion of 4.7 mg/l.

Fish consumption uses remain not assessed due to the lack of fish contaminant monitoring in this assessment segment.

Fish Kill History

The Iowa Department of Natural Resources tracks fish kills in Iowa's streams and rivers via the Iowa DNR Fishkill Database. One fish has been reported and investigated in the Rock Creek watershed. The event occurred on July 27th, 2002. According to the Fishkill Database one mile of Rock Creek was impacted by low dissolved oxygen levels that resulted in an estimated 970 fish being killed. An extensive report can be found at the DNR Field Office in Mason City. It is the opinion of the inspector that the fishkill was caused by a drop in dissolved oxygen in the creek after a rainfall. It is suspected that rainfall runoff carried organic matter into the creek, which resulted in the drop in DO. Area feedlots are the suspected source but due to the time delay a responsible party could not be identified.

Connection to the Cedar River Nitrate Total Maximum Daily Load

As shown in Figure 17 the Rock Creek watershed is part of the larger Cedar River watershed. 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 the impairment status in the Cedar River a Total Maximum Daily Load (TMDL) was developed and approved by the Iowa Department of Natural Resources and the Environmental Protection Agency in 2006.

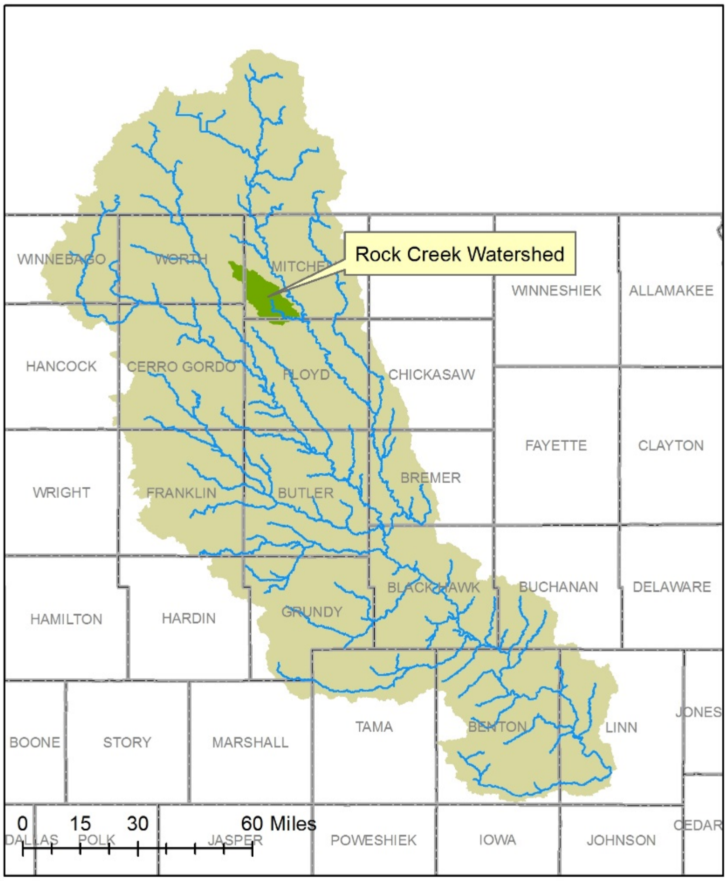


FIGURE 17 CEDAR RIVER WATERSHED (ABOVE CITY OF CEDAR RAPIDS) AND THE ROCK CREEK WATERSHED.

The 2004 305(b) assessment reported that 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 has been 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 north-east Iowa. The watershed is located primarily within the Iowa 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 percent row crops, 18 percent grass, 4 percent forest, 4 percent urban, and 1.2 percent water and wetlands.

Surface water from the Cedar River is used by the City of Cedar Rapids to provide drinking water to over 120,000 residents. The TMDL reported from 2001 to 2004, nitrate concentrations in the river ranged from 0.36 to 14.6 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. 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 up into six sub-basins for the modeling effort. The sub-basins included the Upper Cedar (the location of the Rock Creek watershed), Shell Rock, West Fork, Beaver, Black Hawk and Wolf subbasins. Nitrate loss rates in the subbasins varied from around 10 pounds per acre in the Beaver Creek subbasins to more than 25 pounds per acre in the Upper Cedar sub-basin. 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%.

Sources of nitrates can be divided into two categories, point and nonpoint sources. The TMDL further divides the nonpoint sources into wildlife, septic, atmospheric deposition, manure application, legume fixation, and fertilizer application. The relative nitrate contribution of these sources is shown in Table 7.

TABLE 7 NITRATE CONTRIBUTIONS IN THE CEDAR RIVER WATERSHED.

Subbasins	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	812	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**	**16,131**	**45,647**	**86,876**	**142,673**

The TMDL reports that a 35% reduction in nitrate concentrations is necessary to meet water quality standards. The Rock Creek watershed, being in the Upper Cedar watershed, lies in the highest nitrate contributing area within the Cedar River watershed.

Rock Creek Water Quality Data

Water quality data from a monitoring station near the mouth of Rock Creek has been collected since 2006. Nitrogen and phosphorus results from this station are present in Figure 18 and Figure 19. Monthly samples were collected every year between April and October. Figure 18 and Figure 19 compare the Rock Creek results to yearly median levels collected at approximately 70 other stream and river locations across Iowa. It should be noted the phosphorus monitoring may not capture the episodic nature of phosphorus losses since most phosphorus is transported during high flow events. However, the Rock Creek watershed is likely less prone to soil erosion and phosphorus losses compared to some Iowa watersheds simply due to the flat nature of the landscape. In contract, the Rock Creek watershed may be more prone to nitrogen losses due to the flat nature of the landscape and the presence of tile drainage infrastructure.

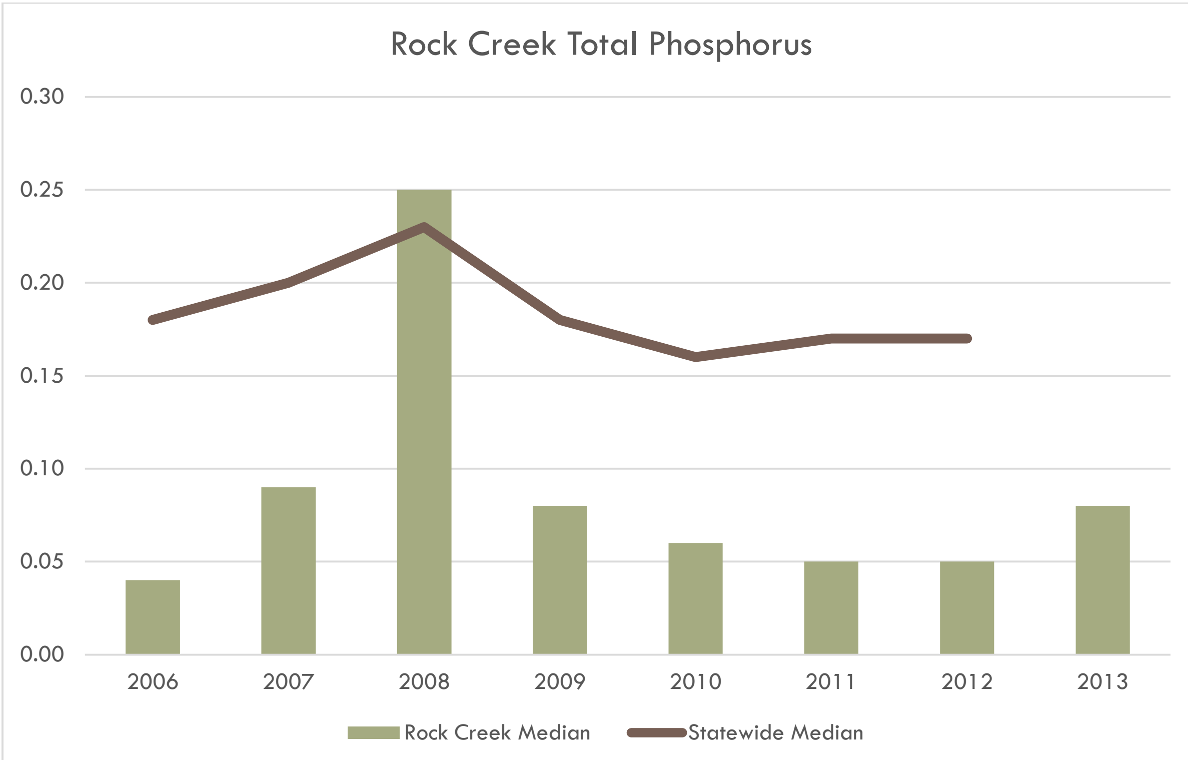


FIGURE 18 ROCK CREEK PHOSPHORUS RESULTS 2006-2013

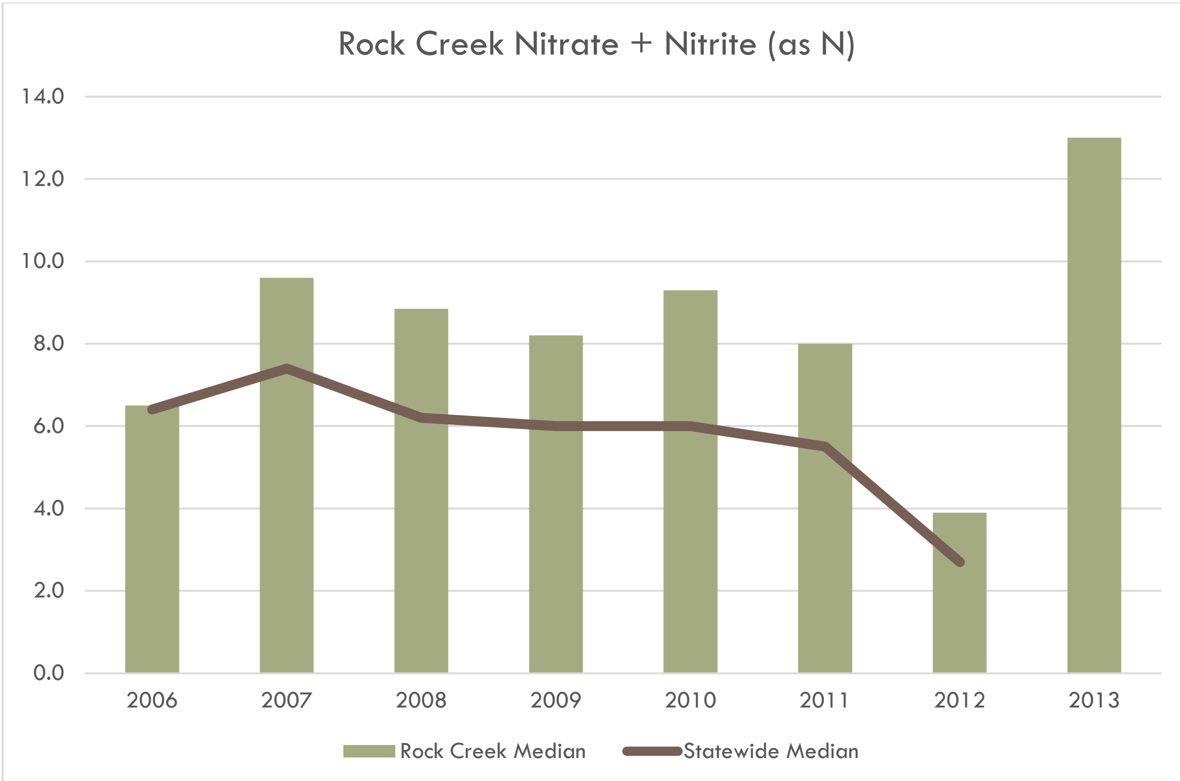


FIGURE 19 ROCK CREEK NITRATE + NITRITE RESULTS 2006-2013

Biological Assessments

The biological community of a stream is a reflection of the chemical and physical quality. Stream health is often characterized by fish and benthic macroinvertebrates inhabiting the stream. The Iowa Department of Natural Resources and the State Hygienic Laboratory have conducted biological assessments across Iowa since 1994 with the goal of assessing the health of Iowa's streams and rivers. Invertebrates that live in, on, or around the bed or bottom of a river or stream are considered benthic in nature. They have also proven to be excellent biological indicators of water quality. In general, good quality streams show greater overall invertebrate diversity and greater diversity and abundance within the sensitive mayfly, stonefly and, caddisfly groups (SHL 2013). As with macroinvertebrates, fish display varying habitat requirements and water quality tolerances making them excellent indicators of stream health. Nearly two thirds of Iowa's species are small, with adults generally less than six, and often, less than four inches long. Darters, sculpins, some minnows, and larger non-game fish like suckers are often more sensitive to degraded conditions than the familiar gamefish (SHL 2013).

A single site on Rock Creek has been monitored since 1996 and is considered a "reference site" for the biological monitoring program. Reference sites represent stream conditions that are least disturbed by human activities, and are used to set biological criteria for measuring the health of other streams within the same ecoregion. Each individual reference site is sampled on at least a 5-year schedule. Stream biological sampling is completed between July 1 and October 15, while stream flow levels are relatively stable. The length of stream segment sampled ranges from 500 to 1150 feet, depending on the stream width and how frequently stream habitat features are repeated (IDNR 2013).

The Iowa DNR uses a Benthic Macroinvertebrate Index of Biotic Integrity (BM-IBI) and a Fish Index of Biotic Integrity (F-IBI) to obtain a broad assessment of stream biological health. The BM-IBI and F-IBI combine many individual measurements or "metrics" to obtain a more complete estimate of stream health. A metric, as the term is used here, is any characteristic of the aquatic community that can be measured reliably and reflects upon stream health. The BM-IBI and F-IBI both contain twelve metrics. The metrics relate to species diversity, relative abundance of sensitive and tolerant organisms, and proportion of individuals belonging to specific feeding and habitat groups. The F-IBI also has a fish abundance metric and a fish health condition metric. The individual metric scores are summed to obtain an index score ranging from 0 (poor) – 100 (optimum). Qualitative scoring ranges of poor, fair, good, and excellent have been established. To determine whether a stream is meeting expectations for supporting aquatic life, the Iowa DNR compares the BM-IBI and the F-IBI scores from that stream against the range of index scores from reference sites located in the same ecoregion (IDNR 2013).

BIOLOGICAL ASSESSMENT OF ROCK CREEK

Additional information about the biological assessments, including the species found in Rock Creek, can be found on the Iowa Department of Natural Resources' BioNet database. The following link provides information about the Rock Creek site: https://programs.iowadnr.gov/bionet/Sites/57.

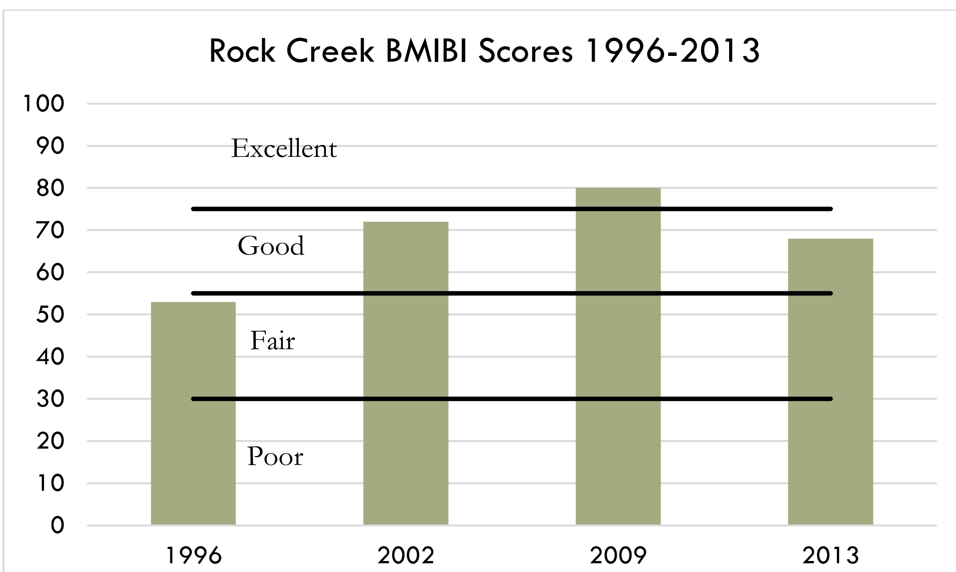


FIGURE 20 ROCK CREEK BENTHIC MACRO-INVERTEBRATE IBI SCORES 1996 - 2013.

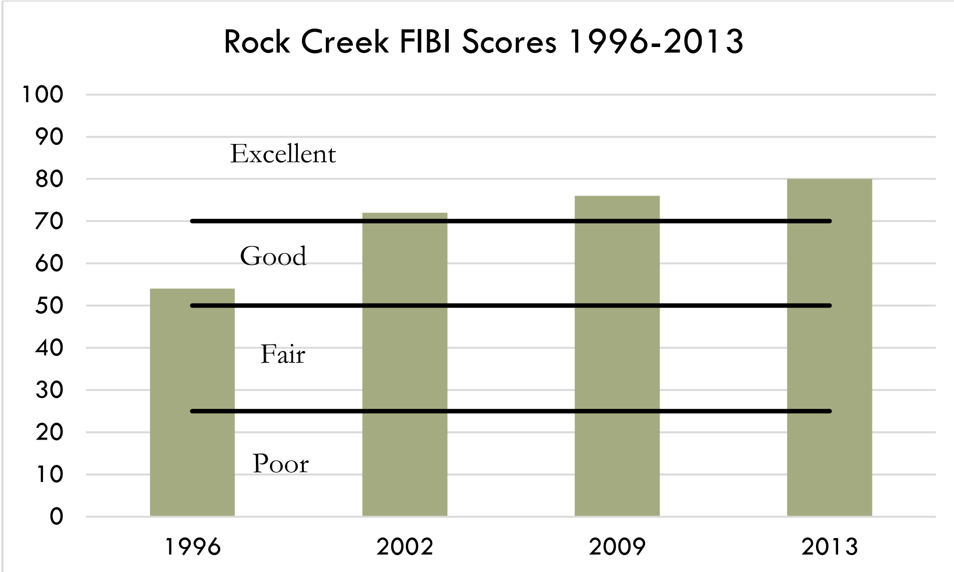


FIGURE 21 ROCK CREEK FISH IBI SCORES, 1996 - 2013.

Stream Physical Conditions

Physical inventories of Rock Creek have taken place in 2008 and again in the fall and winter of 2013. Both surveys followed the Rapid Assessment of Stream Conditions Along Length (RASCAL) protocol for assessing streams in Iowa. Although the surveys capture many attributes of the stream corridor only a few critically important findings are presented in this document, complete assessment results can be found in Appendix E.

The 2008 survey of Rock Creek collected data for 21.3 miles of stream, capturing information for nearly all of the mainstem of Rock Creek. The 2013 survey was able to capture data for 17.5 miles of stream. Due to the differences in stream miles assessed, percentages will be used to report and compare stream assessment results.

Streambank stability is a very important indicator of stream health, in the case of Rock Creek upwards of 90% of the stream length was categorized as showing little to no erosion; this was consistent in both the 2008 and 2013 surveys. Less than 10% of the stream length is categorized as showing moderate or severe erosion. In 2013 a detailed inventory of the eroding streambanks was conducted, this inventory estimated approximately 485 tons of soil is eroding from Rock Creek streambanks each year. A review of streambank vegetation shows 97% of the streambanks show partially or well-established vegetation. The stream survey revealed bank erosion in Rock Creek is not a major resource concern.

Rock Creek is, for the most part, a naturally meandering stream. The exception is the upper most two miles where the stream channel is a trapezoidal drainage ditch. The variability of the stream was evident in the 2013 survey, 46% of the stream was categorized as pool/glide, 25% was riffle/run, 17% was riffle/pool, and 12% was a run.

Substrate of Rock Creek is very diverse, the 2013 survey revealed a good mix of gravel (34%), sand (34%), cobble (17%), and silt (14%). This is in stark contrast to the 2008 survey which reports 87% of the stream substrate was silt and only 11% being cobble or gravel. Surveyors believe significant flood events between the 2008 and 2013 surveys may have flushed sediments from the stream channel.

The survey found that nearly 90% of the stream length has a natural riparian buffer of at least 30 feet, with over 70% of the stream having buffers of 60 feet or greater. Those areas with buffers less than 30 feet could be either pasture areas or areas with row crop in close proximity to the stream. Stream buffer data was consistent in both the 2008 and 2013 survey results.

Both surveys found livestock access to Rock Creek to be in the neighborhood of 10% of the stream miles. The 2013 surveyors report the pastured areas of the stream appear to be in overall good condition.

Stream habitat has improved between the 2008 and 2013 surveys. In 2008, 93% of the stream was categorized as having average habitat, and 5% was excellent. In 2013, 45% was categorized as average habitat, and 49% was excellent.

The 2013 survey also identified 89 tile outlets to the main channel of Rock Creek. The tile size and condition were noted to prioritize future placement of future conservation practices.

The survey also located multiple small dams or obstructions to fish passage within Rock Creek. As of the time of publication these locations have been shared with the Mitchell County Conservation Board and an effort is underway to remedy these obstructions.

Overall, the survey revealed a healthy stream corridor that has shown improvements since 2008. Improvement recommendations include placement of stream buffers on the 10% of the stream corridor without adequate protection, protection of existing stream buffers, treatment of tile discharge water to reduce nitrate levels, and continue removal or mitigation of existing dams and or fish passage obstructions.

SOIL AND LAND CONDITIONS

The productive soils in the Rock Creek watershed are easily the biggest asset to farmers and landowners. The health and quality of soils is a product of inherent (parent material, climate, and topography) and anthropogenic (tillage and crop rotation) interactions. Human impacts on soil health and quality are linked to tillage and crop rotations. A 31-year study of tillage practices on soil health and quality was conducted at the Iowa State University Agronomy Ag Engineering Research and Education Center in Boone County, Iowa. Tillage systems researched included no-till, spring disk, ridge till, moldboard plow, and fall chisel plow. Plots were alternated with a corn/soybean rotation or continuous corn since 1976. Results indicate more aggressive tillage practices had a negative effect on soil health and quality indicators (Karlen et al., 2013).

The value of the soil resource cannot be undersold. Using soils data and average land sales data from 2012 the value of soil (A horizion only) within the Rock Creek watershed is approximately $355 million, or an average of $9,122 per acre. Upon closer examination of the data it was determined every ton of soil in the Rock Creek watershed is worth $3.71. Figure 22 shows the total value of cropland and soils in Rock Creek watershed from 1950 to 2012.

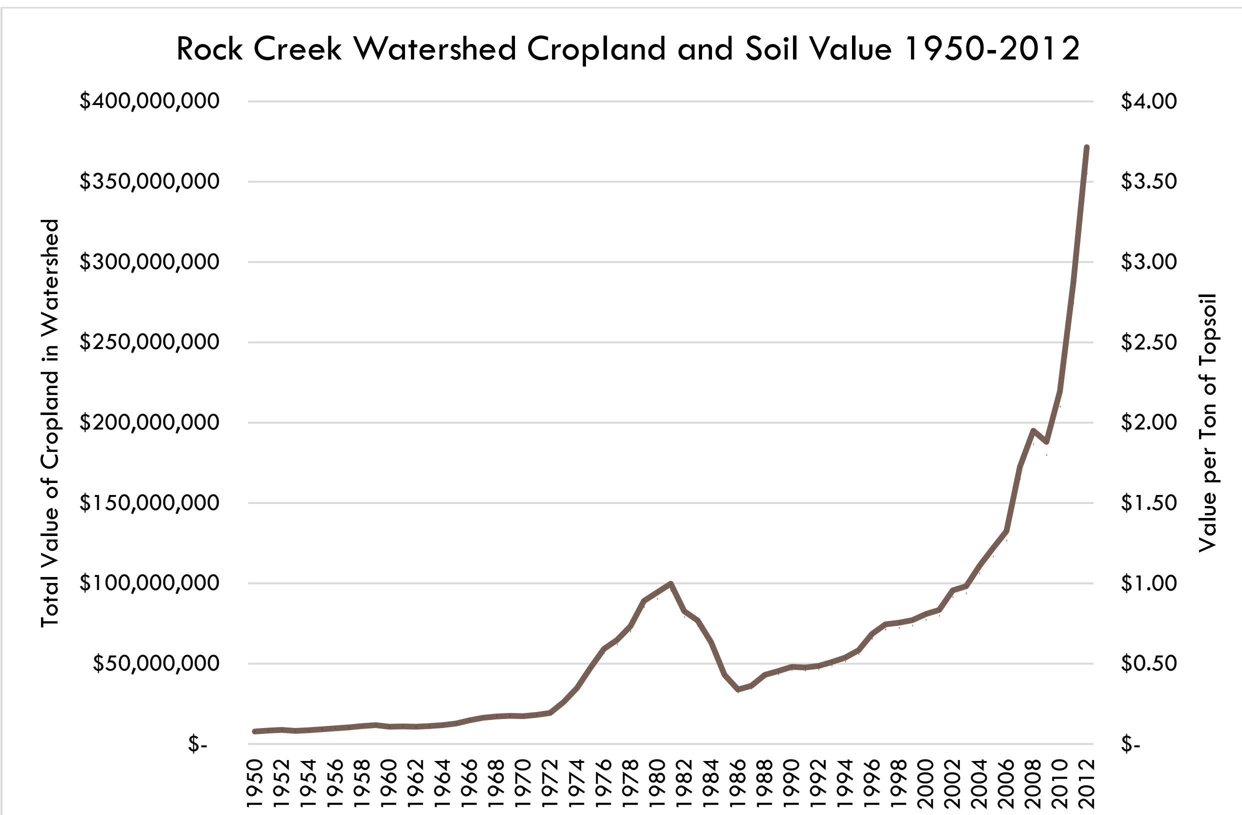


FIGURE 22 ROCK CREEK WATERSHED CROPLAND AND TOPSOIL VALUE, 1950 - 2012.

Soil Erosion Assessment

The Revised Universal Soil Loss Equation (RUSLE) is used by many conservation agencies to predict rates of rill and interrill erosion (also known as sheet and rill erosion) resulting from rainfall and associated overland flow. Four major factors determine the amount of erosion; these include climate, soil, topography, and land use/management. Conservation practices such as no-till can be incorporated into the equation to show the benefits of practice implementation. A RUSLE soil loss model was developed for the entire Rock Creek watershed using 2013 land use and management information along with existing conservation practices. Land use and management is the single biggest factor affecting soil loss rates.

Soil erosion in the Rock Creek watershed averages 0.9 tons per acre per year. In total, nearly 40,000 tons of soil is eroded across the entire watershed each year, but on a per acre basis, the rate is much lower than is found in watersheds with more relief. In addition to the soil erosion rate the amount of sediment lost from the watershed is important to calculate. The amount of gross erosion that is delivered to a specific point is called sediment yield, and this can be calculated by determining the sediment delivery ratio for the watershed area. The sediment delivery ratio defines a watershed's efficiency in moving eroded soil to the outlet of a watershed. Factors influencing the sediment delivery ratio include watershed size and shape, channel density and condition, topography, other factors. The sediment delivery ratio for the Rock Creek watershed is 10.5%, meaning 10.5% of the erosion in the watershed is predicted to reach the outlet of the watershed. This equates to 4,180 tons per year or 0.09 tons per watershed acre.

Figure 23 shows the differing soil erosion rates within the Rock Creek watershed.

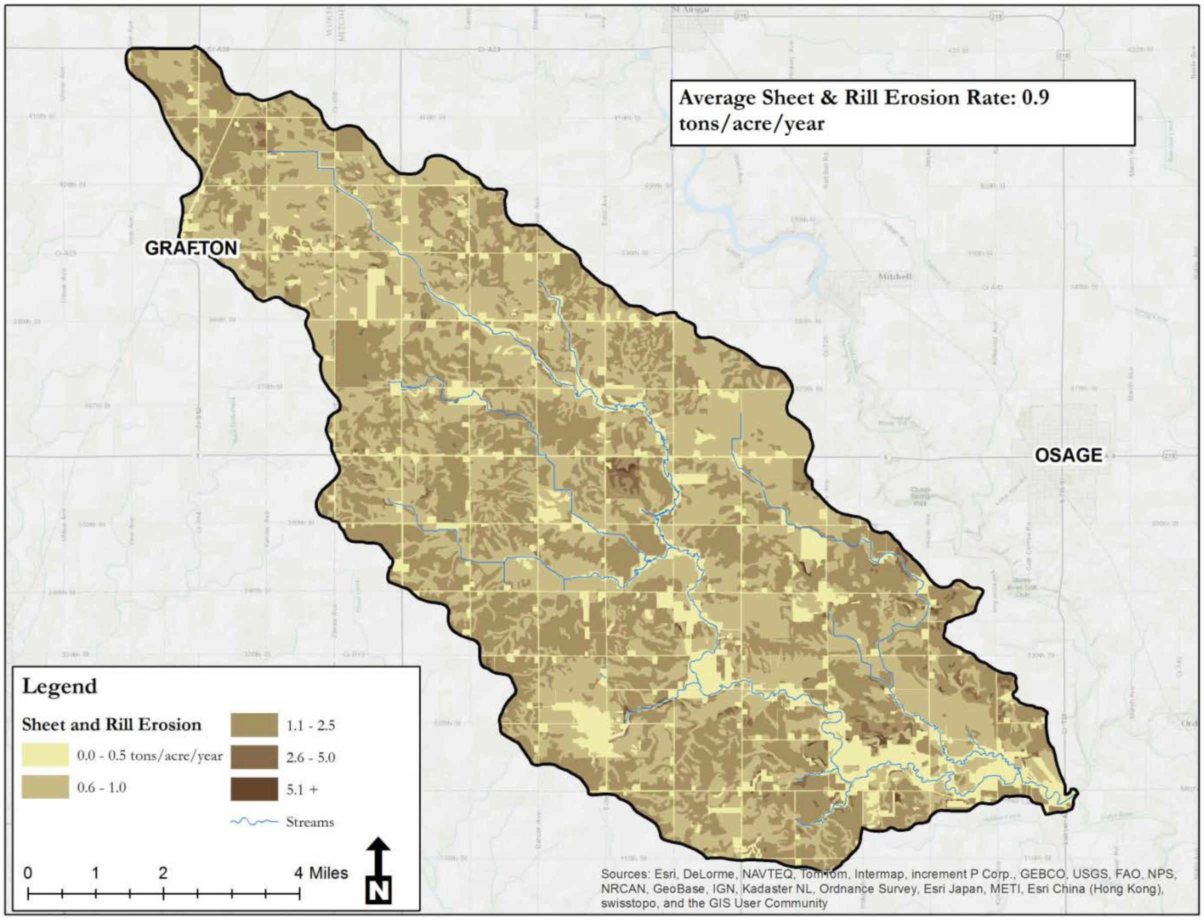


FIGURE 23 SOIL EROSION RATES IN THE ROCK CREEK WATERSHED

GOALS AND OBJECTIVES

This plan will be of little value to real water and soil quality improvement unless watershed improvement activities and practices are implemented and adopted. 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 conservation practices, continued monitoring is necessary. Monitoring is a crucial element to assess the attainment of water quality 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 or different conservation practices.

This plan is intended to be used by local agencies, watershed managers, and citizens for decision-making support and planning purposes. The conservation practices identified in this plan represent a package of tools that will help achieve water quality, soil health, wildlife habitat, agronomic and flood reduction goals. 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 last element of the planning process, which is the implementation of the plan, begins once 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 and objectives are not "cast in concrete." While these goals were developed and prioritized by watershed stakeholders based on the best information available, and the needs and opportunities of the watershed at a point in time, changing needs and desires within the watershed or economy (or Farm Bill) may mean that these goals and objectives will need to be re-evaluated. This plan must remain flexible enough to respond to changing needs and conditions, while still providing a strong guiding mechanism for future work.

Through the watershed planning process both the technical advisory committee and the landowner advisory committee agreed to work towards the following goals addressing water, soil, flood reduction, and habitat. The goals have been prioritized by watershed stakeholders, goal one is the highest priority, while goal seven is lowest priority. It should be noted that many of the conservation practice solutions presented in this document address multiple goals at the same time. Cover crops for example, are beneficial for nearly all goals.

1. **Reduce non-point nitrogen loads by 41% from 2010 levels.** This goal will reach targets for both the Iowa Nutrient Reduction Strategy (41%) and the Cedar River Nitrate TMDL (35%).
2. **Reduce in-stream phosphorus loads by 29% from 2010 levels**. This goal will reach target for the Iowa Nutrient Reduction Strategy.
3. **Increase soil organic matter by 1%.**
4. **Maintain or increase agricultural productivity and profitability.**
5. **Reduce flood risk.** (One percent of organic matter in the top six inches of soil would hold approximately 27,000 gallons of water per acre (NRCS 2013)
6. **Maintain or increase upland wildlife habitats.**
7. **Maintain or improve aquatic life.**

It is with these goals in mind that the conceptual plan, implementation schedule, monitoring plan and other watershed plan components were developed.

CONCEPTUAL PLAN

Conservation practices, either structural or management, are part of the foundation for achieving water, soil, habitat and other watershed goals. Conservation practices are designed to improve water quality and other identified resource concerns. Conservation practices may include changes in land management or land use, physical structures to mitigate against pollutant sources, or changes in human behavior or attitudes about the resources in the watershed and how they are perceived or valued (Watershed Management Action Plan–Iowa DNR, 2009). Efforts are made to encourage conservation practices that are long-term but this is often dependent upon landscape characteristics, land tenure, commodity prices, and other market trends that may potentially compete with conservation efforts. With this in mind, it is important to identify all possible conservation practices needed to achieve the goals of the watershed. From an initial list of all potential practices, priority practices were narrowed down to those that were the most acceptable to watershed stakeholders. Watershed planning facilitators used both a watershed survey stakeholder scoring exercise to prioritize conservation practices. See Appendix K

When selecting and implementing conservation practices it is important to identify if the practice is feasible in a given location. It is also important to determine how effective the practice will be at achieving goals, objectives, and targets. Table 8 provides a list of conservation practices identified by watershed stakeholders. Practices in bold font have been practices included in the conceptual plan as they have been shown to be most accepted by watershed stakeholders and show the greatest benefit toward watershed goals. Included in the table is a rating of each practice's efficacy at addressing identified water, soil, or habitat goals. While only the practices in bold were included in the conceptual plan, other practices will be important to consider when making decisions about water and soil improvement. Figure 24 provides a conceptual implementation scenario, this scenario places conservation practices in locations intended to achieve maximum benefit (e.g. nitrate removal wetlands being placed at strategic locations or bioreactors placed at drainage tile outlets).

TABLE 8 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)	Wildlife Upland Habitat	In-Stream Aquatic Life
In-Field	*Perennial Cover (including CRP)*	3	3	3	3	3	1
	Cover Crops	**3**	**3**	**3**	**1**	**2**	**1**
	No-Till/Strip-Till	**0**	**3**	**3**	**1**	**1**	**1**
	Grassed Waterways	0	2	1	1	1	1
	4R Nutrient Management	**2**	**2**	**1**	**0**	**0**	**1**
	Drainage Water Management	**3**	**0**	**0**	**2**	**0**	**1**
	Nitrification Inhibitor	1	0	0	0	0	1
Edge of Field	*Streamside Buffers*	1	3	0	1	3	2
	Bioreactors	**3**	**1**	**0**	**0**	**0**	**1**
	Saturated Buffers	**3**	**0**	**0**	**0**	**0**	**1**
In-Stream	*Ponds*	1	3	0	3	3	2
	Nitrate Removal Wetlands (CREP)	**3**	**1**	**0**	**2**	**3**	**2**
	Streambank Stabilization	0	2	0	0	1	2
	In-stream dam removal	0	1	0	0	2	3

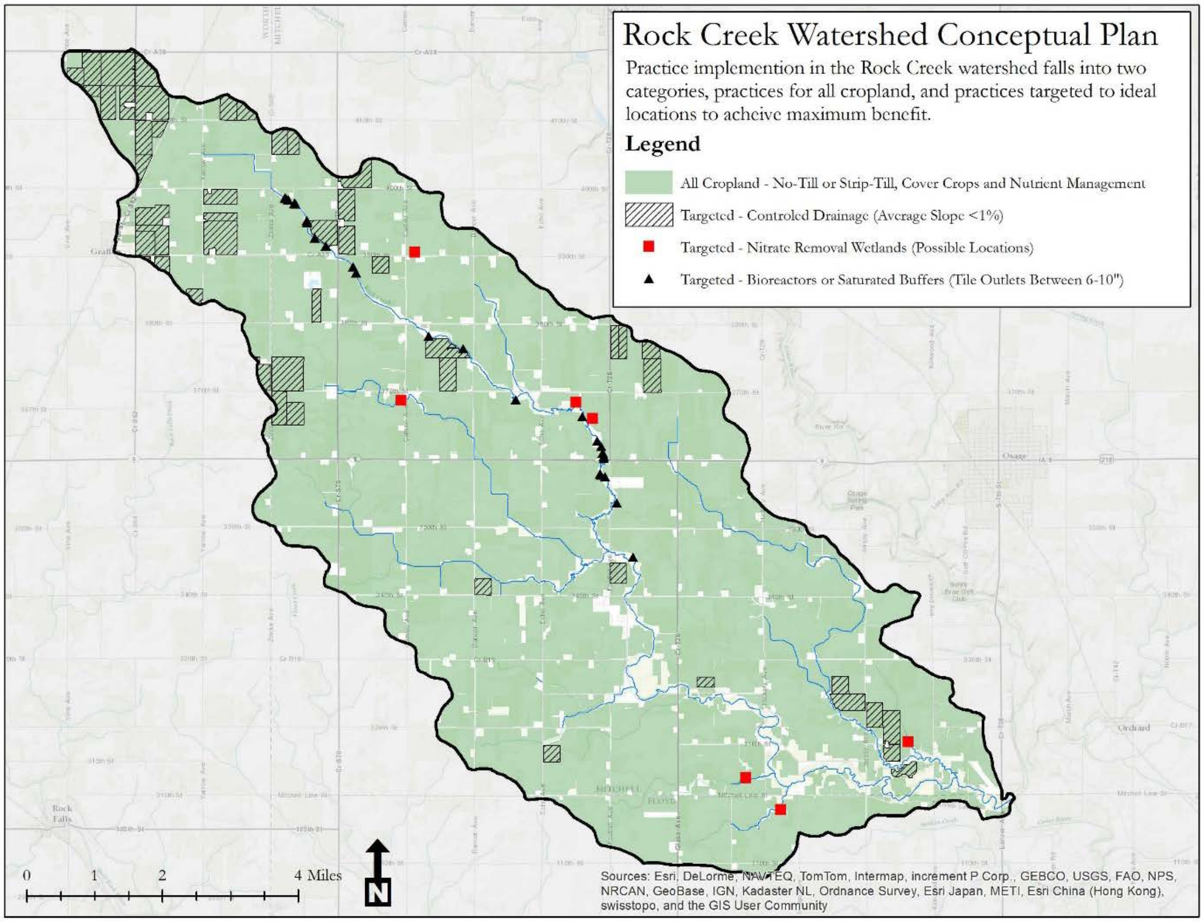


FIGURE 24 CONCEPTUAL IMPLEMENATION PLAN

The conservation practice conceptual plan presented in Figure 24 is very aggressive but this level of implementation is needed to achieve the water quality goals identified in this plan, which include the goals of the Iowa Nutrient Reduction Strategy. Ideally, more structural practices, such as nitrate removal wetlands, could be built to take the burden off management practices, such as cover crops, but the landscape characteristics of the Rock Creek watershed present only a limited number of opportunities to construct structural practices.

The conceptual plan calls for the conservation practices and quantities presented in Table 9.

TABLE 9 CONSERVATION PRACTICES AND QUANTITIES

Practice Type	Quantity
No-Till or Strip-Till	All cropland acres
Cover Crops	All cropland acres
Nutrient Management	All cropland acres
Controlled Drainage	3,000 acres
Bioreactors or Saturated Buffers	25
Nitrate Removal Wetlands	7

IMPLEMENTATION SCHEDULE

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

The implementation schedule presented in Table 10 was established by watershed stakeholders and should be used to set yearly goals and gauge progress. Yearly project evaluations should include a status update relative to goals included in the implementation schedule.

TABLE 10 TARGETED IMPLEMENTATION SCHEDULE.

	Practice	Existing Level (2013)	Unit	2014-2018 Target	2019-2023 Target	2024-2028 Target	2029-2033 Target	2034-2038 Target	Entire Plan Target
In-Field	Perennial Cover (including CRP)	Unknown	Acres	As needed to maintain existing levels.					
In-Field	Cover Crops	Unknown	Acres	4,000	8,000	10,000	5,000	4,260	All Cropland
In-Field	No-Till/Strip-Till	7,640	Acres	4,000	8,000	10,000	5,000	4,260	All Cropland
In-Field	Grassed Waterways	105,221	Feet	As needed to prevent gully erosion.					
In-Field	4R Nutrient Management	Unknown	Acres	As needed to encompass the maximum amount of cropland acres. Minimum of 5,000 acres.					
In-Field	Drainage Water Management	0	Acres	250	500	1,000	500	750	3,000
In-Field	Nitrification Inhibitor	Unknown	Acres	As needed					
Edge of Field	Streamside Buffers	79%	Feet	As needed					
Edge of Field	Bioreactors/Saturated Buffers	0	Number	5	5	5	5	5	25
In-Stream	Ponds	0	Number	As needed					
In-Stream	Nitrate Removal Wetlands (CREP)	0	Number	2	2	1	1	1	7
In-Stream	Streambank Stabilization	Unknown	Feet	As needed					
In-Stream	In-stream dam removal	0	Number	As needed					

MONITORING

Monitoring progress is an important component of watershed plan implementation and provides an opportunity to assess progress. Monitoring can come in many different forms including water monitoring, soil sampling, plant tissue sampling, fish and macro invertebrate sampling, social assessments and more. This section describes recommendations for future monitoring actions to document improvements resulting from watershed plan implementation.

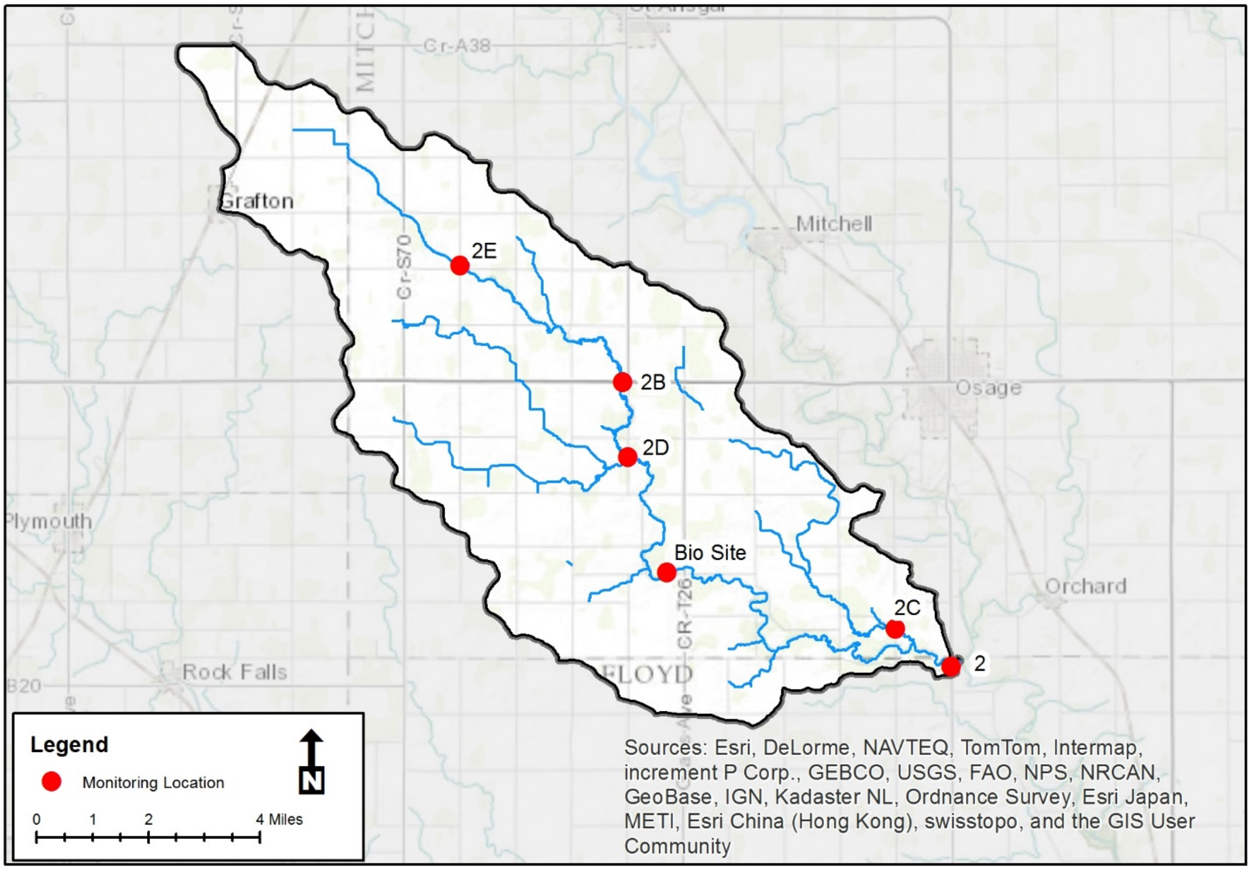


FIGURE 25 MONITORING LOCATIONS

Water Quality Monitoring

Water quality monitoring in the Rock Creek watershed has been taking place since 2006. The Mitchell County Soil and Water Conservation District administers the current monitoring program with support from the Iowa Department of Natural Resources and the Mitchell County Conservation Board. As of 2014, five locations within the watershed have been monitored to evaluate water chemistry, these sites are 2, 2B, 2C, 2D, and 2E shown in Figure 25. Site 2 has been monitored since 2006, site 2B was added in 2009, and sites 2C, 2D, and 2E were added in 2013. In addition to the five stream sties, five tile outlets have been monitored since 2013. Generally, all sites are monitored monthly from April through November. If the budget allows, monitoring should be conducted at a higher frequency, perhaps twice per month.

TABLE 11 WATER MONITORING LOCATIONS

Site Name	UTM X	UTM Y
2	515,397.0	4,784,191.3
2B	505,949.0	4,792,372.0
Bio Site	507,218.5	4,786,912.2
2E	501,254.6	4,795,737.5
2D	506,081.2	4,790,223.0
2C	513,786.0	4,785,282.0

In October of 2014 the Iowa Flood Center installed two stream stage sensors in Rock Creek. Site ROCKCR01 was installed on the T38 (Lancer Avenue) bridge over Rock Creek. This monitoring site corresponds to water quality monitoring site 2. A second site, ROCCR02, was installed on the Highway 9 bridge over Rock Creek. This location corresponds to water quality monitoring site 2B. Data from the Iowa Flood Center sensors is available online at http://ifis.iowafloodcenter.org/ifis.

To determine stream loads of nitrogen, phosphorus, and sediment stream flows should be captured along with stream grab sampling. Stream flow, or discharge, should be captured with a stream water velocity meter. The USGS provides an overview of calculating stream flow on their website, which can be found here http://water.usgs.gov/edu/measureflow.html. At a minimum, stream flow should be captured at monitoring site 2 and 2B. The data from the Iowa Flood Center sensors combined with stream discharge data would allow for the creation of a rating curve. A rating curve is a graph of discharge versus stage (of water level) for a given point in a stream. Once a rating curve is developed stream discharge can be determined by simply looking at the stream stage from the Iowa Flood Center sensors.

In addition to monitoring streams and tributaries in the Rock Creek watershed additional water quality monitoring should be conducted at finer scales to assess the benefits of individual conservation practice installation. Monitoring at this scale can be conducted by monitoring either tile water from subsurface drainage systems or monitoring surface runoff from a targeted area. Monitoring surface runoff proves to be extremely difficult as runoff events are very episodic and are often missed via regularly scheduled monitoring programs. Monitoring of tile water is much easier as tiles tend to have flow that is more consistent. Monitoring tile water may only provide data on nitrate losses, the majority of phosphorus and sediment losses occur via surface runoff.

Tile monitoring should be targeted to drainage systems that drain a single field. This approach allows for changes in field management to be isolated and detected through the monitoring program. Monitoring locations should be targeted to tile outlets which are easily accessible and provide the opportunity to capture tile flow. Flow from tiles can be easily calculated by measuring how long it takes to fill a known volume (e.g. how many seconds it takes to fill a 3-gallon container). Tile flow along with pollutant concentration can be combined to calculate the pollutant loading.

Plant Tissue Monitoring

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 from the lower portion 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 excess or little 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. However, 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. Estimated cost for stalk sampling is approximately $400 per field. This includes aerial imagery, sample collection (using GIS/GPS guided stalk locations) at four locations per field (based on soil type), sample analysis, and report writing.

Biological Monitoring

Previous chapters presented the results of biological monitoring conducted in Rock Creek dating back to 1996. This monitoring was conducted by the Iowa DNR and the University of Iowa State Hygienic Laboratory and should continue as state budgets allow. Assessing the results from this location will be important to understand the biological community's response to watershed improvement efforts. To supplement the biological monitoring conducted at the single reference site, additional biological monitoring locations were established in 2014 by the Iowa Soybean Association. These locations, shown in Table 12, should be monitored on a more frequent basis to better understand the biological community in Rock Creek. The monitoring protocol should follow recommendations outlined in the IOWATER Biological Monitoring Manual.

TABLE 12 BIOLOGICAL MONITORING LOCATIONS

Site ID	2014 IBI Score	UTM X	UTM Y
RCBio1	2.40	515,302.2	4,784,136.4
RCBio2	2.46	513,061.8	4,784,395.9
RCBio3	1.88	512,174.6	4,784,670.9
RCBio4	1.85	508,652.7	4,786,825.7
RCBio5	2.14	507,060.7	4,786,746.4
RCBio6	1.72	506,460.8	4,789,204.1
RCBio7	2.26	506,110.7	4,791,190.6
RCBio8	2.60	506,124.1	4,791,644.2
RCBio9	2.04	505,726.4	4,792,975.2
RCBio10	2.31	505,234.9	4,793,639.7
RCBio11	2.20	504,104.4	4,793,993.0
RCBio12	2.25	501,501.1	4,795,553.1

INFORMATION AND EDUCATION PLAN

Results from past research indicate the producers' actual behavior patterns must be brought into the design of both best management practices and implementation strategies for water quality programs. (Dinnes, 2002). To effect 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, outreach, and awareness of how land management practices influence non-point source losses to surface water resources. Knowledge becomes 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 Rock Creek watershed. The outcome of this education and outreach is to bring attention to what impact their land use and management decisions might be, how they can effectively address those impacts, and what opportunities and innovative solutions exist. In December, 2013 a survey of watershed stakeholders was completed by the Iowa Soybean Association, with assistance provided by the Mitchell Soil and Water Conservation District. A survey was developed to provide an assessment of the community understanding of the watershed. This assessment will help local watershed groups develop effective outreach and education regarding water quality challenges based on the values of the watershed residents. The following plan will guide public outreach activities in the Rock Creek watershed. See Attachment D for the full copy of the survey results. The following text outlines goals, target audiences, messages, partners and strategies relative to an information and education plan in the Rock Creek watershed.

Goal: Increase awareness and adaptation 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 studies have shown farmers and landowners share a sense of shared responsibility while at the same time valuing individualism and personal responsibility, studies also reveal a concern for future generations (Comito 2011). Messaging should attempt to capture these beliefs while at the same time promoting 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/Contacts:

<u>Project Partners (Current and Potential)</u>
Soil and Water Conservation District Commissioners
County Conservation Boards
Natural Resources Conservation Service
Iowa Department of Agriculture and Land Stewardship
Iowa Department of Natural Resources
Agri-Businesses
Farm Cooperatives

<u>Local Agricultural and Outdoor Groups</u>
Pheasants Forever
Ducks Unlimited
4-H
FFA
Farm Bureau

Newspapers
Osage Mitchell County Press-News
Saint Ansgar Enterprise Journal
Stacyville Monitor Review
Northwood Anchor
Manly Junction Signal
Mason City Globe Gazette
Nora Springs Rockford Register
Charles City Press

Radio Stations
KLSS FM 106.1 Mason City
KYTC FM 102.7 Northwood
KQOP FM 94.7 Charles City
KIAI FM 93.3 Mason City
KSMA FM 98.7 Osage
KGLO AM 1300 Mason City
KCHA AM 1580 Charles City
KRIB AM 1490 Mason City
KCHA FM 95.9 Charles City
KYME FM 92.9 Rockford

Outreach Strategies and Tools:

Branding development (e.g. logo)
Website
Fact sheets
Direct mailings
Watershed boundary signs
Stream signs
Conservation practice signage
IOWATER volunteer workshop
Conservation field days
Displays at local events (e.g. County Fair, Rock Creek Lutheran Church Ice Cream Social, etc)
Youth outdoor learning opportunities
Urban-Ag learning exchanges
Stream clean-up events
Public involvement with stream biological monitoring
C*onservation from the Cab*; an opportunity to expose farmers to conservation practices

EVALUATION

Evaluating project success or failure is a critically important step in implementing a watershed plan such as this. 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 in the bullet points below, a project evaluation worksheet can be found in Appendix C.

Project Administration

- Yearly Partner Review Meeting: The partners will host an annual review meeting for the funding, this will provide an opportunity to evaluate project progress using the evaluation matrix.
- Quarterly Project Partner: 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, etc.

Attitudes & Awareness

- Farmer and Landowner Surveys: Periodically throughout the implementation phase a survey should be mailed to 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 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 expansion.

Results

- Practice Scale Monitoring: Tile water or edge of field monitoring results should be used to gage 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 and landowners, 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+) 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, the results will be shared with farmer participants. All soil and agronomic results will be aggregated to the watershed scale and shared with the 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.

ESTIMATED RESOURCE NEEDS

An estimate of resource needs is crucial to gain support from potential funding sources. Table 13 provides an estimate, in 2014 dollars, of the costs to implement conservation practices identified in this plan. Some practices, such as nutrient management, may result in cost savings to farmers and landowners. For those practices with a net benefit, the cost-share rate was used to determine the investment necessary to encourage wide-scale adoption. Information from the Iowa Nutrient Reduction Strategy relating to practice cost and benefits has been extracted and is found in Appendix L.

TABLE 13 ESTIMATED RESOURCE NEEDS. PRIORITY PRACTICES, IN BOLD, WHERE ONLY INCLUDED IN THE TOTAL COST CALCULATION.

	Practice	*Implementation Goal*	*Unit*	*Cost/Unit*	*Total Cost*
In-Field	*Perennial Cover (CRP)+*	*Maintain Existing*	*Acres*	*Unknown*	*As needed*
	Cover Crops+	***38,900 est.***	***Acres***	***$25****	***$972,500***
	No-Till/Strip-Till+	***31,260 est.***	***Acres***	***$18****	***$562,680***
	Grassed Waterways+	*As needed*	*Acres*	*$2,175**	*As needed*
	4R Nutrient Management+	***5,000 minimum***	***Acres***	***$11****	***$55,000***
	Drainage Water Management+	***3,000***	***Acres***	***$ 75***	***$225,000***
	Nitrification Inhibitor+	*As needed*	*Acres*	*$3**	*As needed*
Edge of Field	*Streamside Buffers*	*As needed*	*Acres*	*$241***	*As needed*
	Bioreactors/Saturated Buffers	***25***	***Number***	***$10,000****	***$250,000***
In-Stream	*Ponds*	*As needed*	*Number*	*Varies*	*As needed*
	Nitrate Removal Wetlands (CREP)	***7***	***Number***	***$725,000******	***$5,075,000***
	Streambank Stabilization	*As needed*	*Feet*	*$48.75**	*As needed*
	In-stream dam removal	*As needed*	*Number*	*Varies*	*As needed*
	Total				***$7,140,180***

**2014 incentive payment as identified by the Mitchell SWCD.*
***From the Iowa Nutrient Reduction Strategy.*
****2014 estimated total costs including design, easement, construction and incentive payments.*

Additional costs are associated with watershed improvement projects, these costs include salary and benefits for a coordinator, information and education activities, monitoring, office space, computer, phone, and vehicle.

Excluding cost-share, incentive and rental payments, the total infrastructure investment needed to achieve the goals of this plan is estimated to be $5,550,000.00. This estimate accounts for the design, easement, construction and incentive payments associated nitrate removal wetlands, bioreactors, saturated buffers, controlled drainage (aka drainage water management). Using cost/benefit information presented in the Iowa Nutrient Reduction Strategy the annual operating budget for management practices (e.g. cover crops, no-till, and 4R nutrient management) equates to approximately $35.14 per acre per year for a corn soybean rotation. For all cropland in the watershed, the yearly operating budget is $1,367,086 per year. This estimate accounts for operations, materials, and yield increases/decreases. It does not take into account incentive payments, such as a $25 per acre incentive payment for cover crop. Additional information about the cost/benefit of individual practices is found in Appendix L.

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 therefore other creative and/or sustainable approaches will be needed. Appendix B provides a listing of current local, state, and federal programs and private sources of funding 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 simply cover crop adoption cover crop seeding programs could be developed at the SWCD, County Conservation Board, or local farm cooperatives. Seeding programs have been established in Allamakee and Sac Soil and Water Conservation Districts, 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 crops 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, at seeding rate of 1.5 bushels per acre every acre of rye grown for seed can plant cover crops 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.
- **Conservation Addendum to Agricultural Leases.** More than half of Iowa's farmland is cash rented or crop shared, this increasing 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 are on the same page in terms of 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 Rock Creek watershed.
- **Conservation Easement Programs**. Land easements have proven successful in preservation conservation and recreation land in Iowa (e.g. Iowa Natural Heritage Foundation, Wetland Reserve Enhancement Program, others). 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, local project partners should seek non-traditional partners to assist with project promotion. Involvement could be in the form of cash or in-kind donations.
- **Nutrient or Flood Reduction Trading.** Trading programs are market-based programs involving the exchange of pollutant allocations between sources. The most common form of

trading occurs when trading nutrient credits between point and non-point sources. Trading programs could be established to trade nutrient or flood impact credits.

- **Recreational Leases**. Recreation 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 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 allocation conservation funding. In some watersheds were 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 project 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 Rock Creek may prove to be more successful than existing groups working together without formal organization.
- **Land CSR Increases.** Land values in Iowa are often based on the Corn Suitability Rating (CSR), increasing the CSR by increasing the quality of the soil may be a selling point for conservation practices such as cover crops and no-till or strip-till. The new method for determining CSR has been developed (CSR2) and allows for site specific conditions that might occur with intense conservation practice adoption. Cover crops have been shown to increase soil organic matter and water holding capacity, both have the potential to increase CSR2 input variables.
- **Sub-Field Profit Analysis.** Farmers understand some locations within a field produce higher yields and profits, understanding long-term profitability within fields may be an important selling point for conservation. Private companies in Iowa (e.g. Praxik) are developing tools to analyze profitability within crop fields. Incorporating profitability into conservation could result in higher profit margins and increased conservation opportunities on land resulting is lost revenue.

ROLES AND RESPONSIBILITES

Role	Responsibility
Farmers	Engage with watershed plan implementation, farm, field and subfield evaluation, conservation practice implementation, and knowledge sharing.
Landowners	Engagement with tenants on conservation practices, incorporation of conservation addendums to lease agreements, conservation practice implementation.
Absentee Landowners	Engagement 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, and water monitoring support.
Department of Natural Resources	In-stream monitoring of biological community (fish), project partnership, and 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, and 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, and 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 AND ACRONYMS

APPENDIX A GLOSSARY OF TERMS AND 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, it is 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 & financial assistance, education, & monitoring to implement local nonpoint source water quality projects.
AFO:	Animal Feeding Operation. A livestock operation, either open or confined, where animals are kept in small areas (unlike pastures) allowing manure and feed become concentrated.
Base flow:	The fraction of discharge (flow) in a river which 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.
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.

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.

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), it is land which has the potential for long term annual soil losses to exceed the tolerable amount by eight times for a given agricultural field.

Integrated report: Refers to a comprehensive document which 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 the waste load and load allocations.)

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

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 which originate from a diffuse source.
NPDES:	National Pollution Discharge Elimination System, which 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 which provides technical assistance for the conservation and enhancement of natural resources.
Phytoplankton:	Collective term for all self-feeding (photosynthetic) organisms which provide the basis for the aquatic food chain. Includes many types of algae and cyanobacteria.
Point source pollution:	A collective term for contaminants which 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 which is the same as micrograms per liter (µg/l).
PPM:	Parts per Million. A measure of concentration which is the same as milligrams per liter (mg/l).
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 which actually reaches a water body of concern.
Seston:	All particulate matter (organic and inorganic) in the water column.
Sheet & rill erosion	Soil loss which occurs diffusely over large, generally flat areas of land.
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.
Storm flow (or stormwater):	The fraction of discharge (flow) in a river which arrived 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.

SWCD: Soil and Water Conservation District. Agency which 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 materials, organic and inorganic, 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.)

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

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.

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 which processes municipal, industrial, or agricultural waste into effluent suitable for release to public waters or land application.

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

Appendix B

POTENTIAL FUNDING SOURCES

APPENDIX B 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-DSC
No-Interest Loans	State administered loans to landowners for permanent soil conservation practices	IDALS-DSC
District Buffer Initiatives	Funds for SWCDs to initiate, stimulate and incentivize signup of USDA programs, specifically buffers	IDALS-DSC
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-DSC
Conservation Reserve Enhancement Program	Levering USDA funds to establish nitrate removal wetlands in north central Iowa with no cost to landowner	IDALS-DSC
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-DSC
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 stormwater	IDALS-DSC
State Revolving Loans	Low interest loans provided by SWCDs to landowners for permanent water quality improvement practices; subset of DNR program	IDALS-DSC
Watershed Improvement Fund	Local watershed improvement grants to enhance water quality for beneficial uses, including economic development	IDALS-DSC
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, 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 no-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
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-DSC
State Revolving Fund	Provides low interest loans to municipalities for waste water and water supply; expanding to private septics, livestock, stromwater, and NPS pollutants	DNR
Watershed Improvement Review Board	The Watershed Improvement Review Board (WIRB) was established in 2005 by the Iowa Legislature to provide grants to watershed and water quality projects. The Board is comprised of representatives from agriculture, drinking water and wastewater utilities, environmental	WIRB

	organizations, agribusiness, the conservation community along with two state senators and two state representatives.	
Iowa Water Quality Initiative	Initiated by IDALS-DSC as a demonstration and implementation program for the Nutrient Reduction Strategy. Funds are targeted to 9 priority HUC-8 watersheds.	IDALS-DSC
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

Public 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/
Foundation For the Enhancement of Mitchell County	The Foundation for the Enhancement of Mitchell County was established to serve and enhance the quality of life for the eight communities and unincorporated areas of Mitchell County.	http://www.mitchellcountyia.com/Website/Mitchell%20County%20Foundation.htm
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
Worth County Development Authority	The WCDA's geographic focus is Northern Iowa and Southern Minnesota. The primary focus is Worth County with a secondary focus on surrounding counties. The focus of the grants will be in the following areas: education, community development, tourism, culture, arts and recreation, emergency services, health and human services. To maximize the effect of our granting, WCDA will favor grants that leverage partnerships with other organizations, governmental entities, and fund matching.	http://worthcountydevelopmentauthority.com/

Appendix C

WATERSHED SELF-EVALUATION WORKSHEET

APPENDIX C 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

WATERSHED SOCIAL SURVEY RESULTS

Rock Creek Watershed Social Survey

Survey was sent to 300 addresses within the Rock Creek watershed in February and March of 2014. Of the 300 surveys sent 42 were returned, resulting in a 14% response rate.

Summary	Result	%
Average Age	60.3	
Landowner Not Farmer	12	29%
Farmer and Landowner	23	55%
Farmer operator but do not own land in watershed (rent only)	6	14%
Average acres owned	308.4	
Average acres rented from others	388.7	
Average acres rented to others	154.2	

Thinking generally about farmers and landowners in the Rock Creek watershed, how well do you think they are performing in the following areas? 1 = Very Poor, 2 = Poor, 3 = Average, 4 = Well, 5 = Very Well

Maintaining or enhancing soil productivity	4.00
Improving fertilizer use efficiency	3.58
Improving energy efficiency in their operations	3.51
Reducing runoff of soils and sediments into waterways	3.40
Improving soil health (organic matter)	3.41
Reducing flow of nutrients such as nitrogen and phosphorous into waterways	3.36
Reducing runoff of chemicals such as herbicides, insecticides, and fungicides into waterways	3.37
Reducing soil erosion	3.31
Providing habitat for wildlife	2.87

Thinking about your farm operation or land, how well do you think you and/or your tenant are performing in these areas? 1 = Very Poor, 2 = Poor, 3 = Average, 4 = Well, 5 = Very Well

Maintaining or enhancing soil productivity	4.25
Reducing runoff of soils and sediments into waterways	4.10
Improving fertilizer use efficiency	4.20
Reducing soil erosion	4.00
Reducing flow of nutrients such as nitrogen and phosphorous into waterways	4.05
Reducing runoff of chemicals such as herbicides, insecticides, and fungicides into waterways	4.05
Improving soil health (organic matter)	4.13
Improving energy efficiency in their operations	3.97
Providing habitat for wildlife	3.64

Thinking about the Rock Creek watershed, to what extent do you agree or disagree with the following statements?
1 = Strongly disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree

Farmers and other local residents should work together on water quality issues	4.29
I am concerned about agriculture's impact on water quality	4.14
More data needs to be collected to identify exactly what the major causes (if any) of water quality problems are	3.83
Non-farm sources (municipal wastewater, septic systems, lawn fertilizers) are causing water quality problems	3.74
I would be willing to get more involved in local watershed management efforts	3.54
Farmers need more help to improve the environmental efficiency of their farms	3.59
Farming activities are causing water quality problems	3.46
Streambank erosion is causing water quality problems	3.48
Water quality in waterways is steadily improving	3.43
Tile drainage is causing water quality problems	2.60
Water quality in waterways is just fine	2.50

Thinking about the following conservation practices, which practices 1) have you established or employed on your land over the last ten years (since 2003), 2) do you believe you should establish, but have not done so yet, 3) are not needed on your land, or 4) you are not familiar with practice.

Practice	Have established	Should establish	Practice Not Needed	Not familiar with practice
Soil testing	36	2	2	0
Grassed waterways	29	3	8	0
Stream Buffer/Filter strips	24	2	10	2
Reduced tillage (no-till or strip-till)	20	9	7	2
Wildlife habitat improvement	15	11	8	3
Nutrient management plan	19	7	7	4
Integrated pest management	18	8	6	4
Wetland creation/restoration	3	7	24	4
Field border	9	7	14	8
Streambank stabilization	10	5	18	5
Cover crops (not preventative plant)	12	10	9	7
Terraces	4	2	31	1
Forest buffers along streams	9	4	24	2

Ponds	1	5	25	5
Manure management plan	4	0	32	2
Fencing to keep livestock out of streams	1	0	35	2
Rotational grazing	0	2	33	3
Bioreactor	0	7	16	14
Drainage water management	10	10	8	9

The following are some reasons why people establish conservation practices or modify farm operations. Please rate how important each reason is when deciding to establish conservation practices. 1 = Not very important, 5 = Very Important

Protect the land for the next generation	4.78
Protect my investment in the land	4.65
Maintain or improve soil fertility	4.63
Avoid polluting streams, rivers and lakes	4.63
Keep chemicals and nutrients on the farm	4.55
Protect water quality downstream	4.54
Increase long-term profitability	4.49
Maintain or enhance productivity	4.48
Comply with Farm Bill requirements	4.44
Increase the efficiency of my operation	4.38
Reduce the environmental impact of my farming activities	4.33
Avoid problems with regulatory agencies	4.13
Prepare for programs that reward conservation behavior	4.03
Feeling of responsibility to earlier generations	3.85
Improve habitat for wildlife	3.85
Time saver	3.42
Family member(s) encouraged me to do so	2.74
My neighbors were doing it	2.62
Neighbors encouraged me to do so	2.54

The following are areas in which several agencies, organizations, and private companies provide planning, technical assistance, and other services to help landowners to improve the economic and environmental performance of their farmland. Thinking about your farm operation or farmland, please indicate how interested you would be in receiving more information, technical assistance, or other support in the following areas. Please circle a response for each line.

Response	**Average**	**Very Interested**
Identification of true sources of water quality problems	3.41	23
Assessment of overall environmental performance of your farm	3.19	34
Soil erosion control	3.16	15
Tillage and residue management	3.16	18
Assessment of overall environmental performance	3.11	14
Energy efficiency	3.05	14
Water sampling and monitoring	2.97	13
Nutrient management	3.03	14
Drainage water management	2.92	12
Pest management	2.89	12
Wildlife habitat improvement	2.82	13
Stalk sampling	2.70	8
Soil testing	2.76	13
Carbon sequestration/greenhouse gas management	2.56	8
Legal/regulatory requirement review	2.49	7
While farm resource management	2.50	6
Streambank stabilization	2.26	7
Waste management	2.22	6
Construction of nutrient removal wetlands	2.11	8
Construction of bioreactors	2.03	6
Manure management	1.79	6
Septic system evaluation	1.71	3
Grazing management	1.68	4

Considering the following categories of assistance, please select the means of providing information and technical assistance that you believe would be most appropriate for each of the following areas

	One-on-One Consultation	Workshops and Group Meetings	Demonstration and Field Days	Mailings	Internet websites and email
Soil erosion control	6	8	14	7	3
Water quality improvement	6	8	14	7	3
Pest management	4	11	12	6	4
Soil fertility improvement	5	13	12	4	3
Nutrient management	6	13	8	5	5
Wildlife habitat improvement	10	6	8	5	7

Appendix E

STREAM ASSESSMENT FINDINGS

Rock Creek
In-Stream Assessment Summary 2013

Stream Miles Assessed: **17.52**

Flow at time of survey	*Stream Miles*	*% of Total*
Normal	16.43	93.8%
High	0.00	0.0%
Low	1.09	6.2%
No Flow	0.00	0.0%
Hydrologic Varaibility		
Dry Channel	0.00	0.0%
Pond	0.00	0.0%
Pool/Glide	7.99	45.6%
Riffle/Pool	3.04	17.4%
Riffle/Run	4.46	25.4%
Riffle	0.00	0.0%
Run	2.03	11.6%
Substrate		
Bedrock	0.00	0.0%
Boulder	0.00	0.0%
Cobble	2.90	16.5%
Gravel	5.92	33.8%
Sand	5.88	33.6%
Silt/Mud	2.40	13.7%
Clay/Hard Pan	0.00	0.0%
Sediment Coverage		
Entire Segment	0.22	1.2%
75-90% of Segment	2.52	14.4%
50-75% of Segment	4.30	24.5%
25-50% of Segment	5.21	29.8%
0-25% of Segment	5.27	30.1%
Pool Frequency		
None	3.05	17.4%
1 Pool	1.67	9.5%
2 Pools	4.77	27.2%
3 Pools	3.89	22.2%
4 Pool	2.05	11.7%
5 or More	1.63	9.3%
Riffle Frequency		
None	5.65	32.3%
1 Riffle	2.77	15.8%
2 Riffles	3.09	17.6%
3 Riffles	4.02	23.0%
4 Riffles	1.06	6.1%
5 or More	0.50	2.9%
Losing Flow		
Yes	0.00	0.0%
No	17.52	100.0%
Stream Habitat		
Poor	1.01	5.8%
Average	7.87	44.9%
Excellent	8.64	49.3%

Left Riparian Zone Width	*Stream Miles*	*% of Total*
< 10 Feet	1.16	6.6%
10-30 Feet	0.76	4.3%
30-60 Feet	2.65	15.1%
> 60 Feet	12.95	73.9%
Right Riparian Zone Width		
< 10 Feet	1.20	6.8%
10-30 Feet	1.12	6.4%
30-60 Feet	2.73	15.6%
> 60 Feet	12.47	71.2%
Left Riparian Zone Cover		
Grass	9.03	51.5%
Trees	5.12	29.2%
Pasture	2.11	12.0%
CRP-Trees	0.08	0.4%
CRP-Grass	1.18	6.7%
Residential	0.00	0.0%
Commercial	0.00	0.0%
Right Riparian Zone Cover		
Grass	9.00	51.4%
Trees	4.99	28.5%
Pasture	2.11	12.0%
CRP-Trees	0.00	0.0%
CRP-Grass	1.06	6.1%
Residential	0.35	2.0%
Commercial	0.00	0.0%
Left Adjacent Land Cover		
Row Crop	15.07	86.0%
Trees	0.41	2.3%
Grass	0.44	2.5%
Pasture	1.45	8.3%
CRP	0.00	0.0%
Residential	0.00	0.0%
Commercial	0.00	0.0%
Open Feedlot	0.00	0.0%
Farmstead	0.15	0.9%
Cliff	0.00	0.0%
Other	0.00	0.0%
Right Adjacent Land Cover		
Row Crop	15.37	87.7%
Trees	0.21	1.2%
Grass	0.30	1.7%
Pasture	1.05	6.0%
CRP	0.00	0.0%
Residential	0.00	0.0%
Commercial	0.00	0.0%
Open Feedlot	0.00	0.0%
Farmstead	0.46	2.6%
Cliff	0.00	0.0%
Other	0.00	0.0%

Rock Creek
In-Stream Assessment Summary 2013

Stream Miles Assessed: **17.52**

Bank Stability		
Stable	9.13	52.1%
Minor Erosion	6.50	37.1%
Moderate Erosion	1.37	7.8%
Severe Erosion	0.51	2.9%
Artificially Stable	0.00	0.0%

Bank Height		
0 - 3'	1.30	7.4%
3 - 6'	8.52	48.6%
6 - 10'	5.39	30.8%
10 - 15'	1.05	6.0%
15' +	1.26	7.2%

Bank Erosion		
None	8.62	49.2%
Both Banks	0.15	0.8%
Alternate Banks	2.18	12.5%
Random	6.57	37.5%

Bank Material		
Rock/RipRap	0.00	0.0%
Soil/Silt	16.32	93.1%
Cobble/Gravel	0.75	4.3%
Sand	0.45	2.6%

Bank Vegetation		
None	0.00	0.0%
Overhanging Only	0.55	3.1%
Dislodged	0.00	0.0%
Partially Established	1.89	10.8%
Well Established	15.08	86.1%

Canopy Cover		
0-10%	11.21	64.0%
10-25%	2.46	14.1%
25-50%	1.44	8.2%
50-75%	1.33	7.6%
75-100%	1.08	6.1%

Right Livestock Access		
Yes	1.99	11.3%
No	15.53	88.7%

Left Livestock Access		
Yes	1.99	11.3%
No	15.53	88.7%

Channel Pattern		
Straight	2.46	14.0%
Meandering	15.06	86.0%
Braided	0.00	0.0%

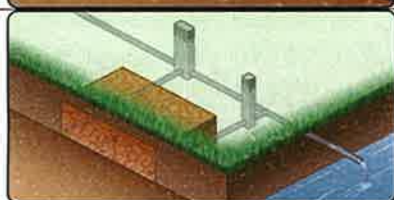
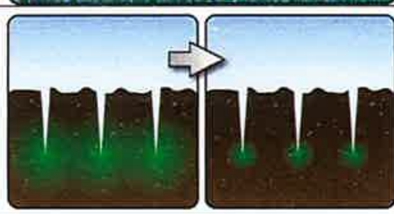
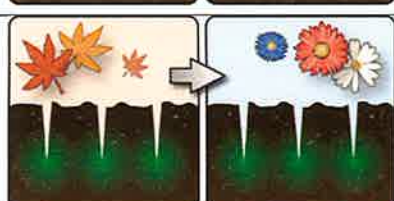
Channel Condition		
Altered Channel	0.00	0.0%
Natural Channel	14.74	84.1%
Past Channel Alteration	2.78	15.9%
Recent Alteration	0.00	0.0%

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

For more information: Laura Christianson, Iowa State University laurac@iastate.edu

Appendix G

2014 BIOLOGICAL ASSESSMENT RESULTS

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 9/15/14 **Time** 0900

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 2

Site Number RCBio1 **# of under 18** –

Other Volunteers Involved James Madden

Was the stream dry when it was monitored? Yes ____ **No** X

X **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*			**Middle Quality Group** *(somewhat pollution tolerant)*			**Low Quality Group** *(pollution tolerant)*		
Tally Column	**Total # found**	**HQ BMI**	**Tally Column**	**Total # found**	**MQ BMI**	**Tally Column**	**Total # found**	**LQ BMI**
	7	Caddisfly			Alderfly			Aquatic Worm
		Dobsonfly			Backswimmer			Black Fly
	57	Mayfly			Crane Fly			Bloodworm
	3	Riffle Beetle		5	Crawdad			Flatworm
	6	Snail (not pouch)			Crawling Water Beetle		1	Leech
	2	Stonefly		1	Damselfly			Midge Fly
		Water Penny Beetle		6	Dragonfly		2	Mosquito
TOTAL	75	(A) 225			Giant Water Bug		23	Pouch Snail
					Limpet			Rat-tailed Maggot
				8	Mussels/Clams			Water Scavenger Beetle
				1	Orbsnail	TOTAL	26	(C) 26
					Predaceous Diving Beetle			
					Scud			
					Sowbug			
					Water Boatman			
				1	Water Mite			
					Water Scorpion			
				1	Water Strider			
					Whirligig Beetle			
			TOTAL	23	(B) 46			

$\frac{297}{124} = 2.39$

___ **Other** ____________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 2.395

(Over)

Revised March 2010

Benthic Macroinvertebrate Collection Time (*check one*)

0-15 min. _____ 15-30 min. _____ 30-45 min. _X_ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)

1 ____ 2 _X_ 3 ____ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)

_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)

___ 0-25 meters ___ 25-50 meters _X_ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present X	Sampled X
Logjams	Present __	Sampled __	**Rocks**	Present X	Sampled X
Root Wads	Present X	Sampled X	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present X	Sampled X	**Undercut Banks**	Present __	Sampled __
Silt/Muck	Present X	Sampled X	**Rip Rap**	Present __	Sampled __
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ______________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)

Riffle _X_ Run _X_ Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?

No _X_ **Yes** _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)

___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes

UTM X: 515302.2
UTM Y: 4784136.3

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 9-5-14 **Time** 9:00

IOWATER Monitor Tony Seeman **# of Adults (incl. you)** 2

Site Number RCBio2 **# of under 18** -

Other Volunteers Involved Heath Ellison

Was the stream dry when it was monitored? Yes ___ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*			**Middle Quality Group** *(somewhat pollution tolerant)*			**Low Quality Group** *(pollution tolerant)*		
Tally Column	**Total # found**	**HQ BMI**	**Tally Column**	**Total # found**	**MQ BMI**	**Tally Column**	**Total # found**	**LQ BMI**
	1	Caddisfly			Alderfly			Aquatic Worm
		Dobsonfly			Backswimmer			Black Fly
	19	Mayfly			Crane Fly		1	Bloodworm
		Riffle Beetle		3	Crawdad			Flatworm
	5	Snail (not pouch)		3	Crawling Water Beetle			Leech
		Stonefly		2	Damselfly			Midge Fly
		Water Penny Beetle		3	Dragonfly			Mosquito
TOTAL	25	(A) 75			Giant Water Bug		2	Pouch Snail
					Limpet			Rat-tailed Maggot
				2	Mussels/Clams			Water Scavenger Beetle
				1	Orbsnail	TOTAL	3	(C) 3
					Predaceous Diving Beetle			
					Scud			
					Sowbug			
					Water Boatman			
					Water Mite			
				2	Water Scorpion			
				4	Water Strider			
					Whirligig Beetle			
			TOTAL	20	(B) 40			

$\frac{118}{48} = 2.458$

___ **Other** ______________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 2.458

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ **15-30 min.** _____ **30-45 min.** _X_ **More than 45 min.** _____

Collection Nets (*How many nets are you using to collect critters?*)
1 ____ **2** _X_ **3** ____ **4** ____ **5** ____ **6+** ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ **I'm not sure**
_____ **I think they've been identified correctly**
_____ **Some are definitely correct, I'm not sure about others** (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ **I'm fairly confident they've all been correctly identified**
_____ **I guarantee they have been identified correctly**

Stream Reach Length (*How far along the stream did you search?*)
___ **0-25 meters** ___ **25-50 meters** ___ **50-75 meters** ___ **75-100 meters** ___ **100+ meters**

Microhabitats (*check all present in stream reach, check if sampled*)
Algae Mats Present __ Sampled __ **Leaf Packs** Present __ Sampled __
Logjams Present __ Sampled __ **Rocks** Present _X_ Sampled _X_
Root Wads Present _X_ Sampled _X_ **Weed Beds** Present __ Sampled __
Fallen Trees Present _X_ Sampled _X_ **Undercut Banks** Present _X_ Sampled _X_
Silt/Muck Present _X_ Sampled _X_ **Rip Rap** Present __ Sampled __
Sand Present _X_ Sampled _X_ **Overhanging Vegetation** Present __ Sampled __
Junk (*tires, garbage, etc.*) Present _X_ Sampled _X_
Other (*describe*) ______________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle _X_ **Run** _X_ **Pool** _____

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% _X_ **25-50%** _____ **50-75%** _____ **75-100%** _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% _X_ **25-50%** _____ **50-75%** _____ **75-100%** _____

Is sewage algae present in the stream?
No _X_ **Yes** _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ **Eurasian water milfoil** ___ **Curly-leaf pondweed** ___ **Zebra mussels**
___ **Brittle naiad** ___ **Purple Loosestrife** ___ **Chinese mystery snails**
___ **Bighead Carp** ___ **Silver Carp** ___ **Rusty Crawfish**

Other Assessment Observations and Notes
UTM X: 513061.8
UTM Y: 4784395.9

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 9-5-14 **Time** 1130

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 4

Site Number RCBio3 **# of under 18** —

Other Volunteers Involved ~~[illegible]~~ Theo Gunther, Anthony Seeman, James Madden

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** (*If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form*)

Benthic Macroinvertebrates (*record the number of each collected, then total each group*)

High Quality Group (*pollution intolerant*)

Tally Column	Total # found	HQ BMI
		Caddisfly
		Dobsonfly
		Mayfly
		Riffle Beetle
		Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	0	(A) 0

Middle Quality Group (*somewhat pollution tolerant*)

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
		Crane Fly
	4	Crawdad
		Crawling Water Beetle
		Damselfly
	6	Dragonfly
	4	Giant Water Bug
		Limpet
		Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
	12	Water Boatman
		Water Mite
	1	Water Scorpion
	5	Water Strider
		Whirligig Beetle
TOTAL	32	(B) 64

Low Quality Group (*pollution tolerant*)

Tally Column	Total # found	LQ BMI
		Aquatic Worm
		Black Fly
	1	Bloodworm
		Flatworm
	2	Leech
		Midge Fly
		Mosquito
	1	Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	4	(C) 4

$\frac{68}{36} = 1.88$

___ **Other** ______________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 1.88

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)

0-15 min. _____ 15-30 min. _X_ 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)

1 ____ 2 ____ 3 ____ 4 _X_ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)

_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)

___ 0-25 meters ___ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present __	Sampled __
Logjams	Present _X_	Sampled _X_	**Rocks**	Present _X_	Sampled _X_
Root Wads	Present __	Sampled __	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present __	Sampled __	**Undercut Banks**	Present __	Sampled __
Silt/Muck	Present _X_	Sampled _X_	**Rip Rap**	Present __	Sampled __
Sand	Present _X_	Sampled _X_	**Overhanging Vegetation**	Present _X_	Sampled _X_

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)

Riffle _____ Run _X_ Pool _X_

Aquatic Plant Cover of Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?

No _X_ Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)

___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes

Under and near bridge. Deep pool. Lots of sediment.

UTMX: 512174.6 UTMY: 4784670.8

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 10-7-14 **Time** 9:40

IOWATER Monitor Tony Seeman **# of Adults (incl. you)** 4

Site Number RLBio4 **# of under 18** –

Other Volunteers Involved Keegan Kult, Adam Kiel, Chris Jones

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*			**Middle Quality Group** *(somewhat pollution tolerant)*			**Low Quality Group** *(pollution tolerant)*		
Tally Column	**Total # found**	**HQ BMI**	**Tally Column**	**Total # found**	**MQ BMI**	**Tally Column**	**Total # found**	**LQ BMI**
	2	**Caddisfly**			**Alderfly**		1	**Aquatic Worm**
		Dobsonfly			**Backswimmer**			**Black Fly**
	6	**Mayfly**		7	**Crane Fly**			**Bloodworm**
		Riffle Beetle		7	**Crawdad**		1	**Flatworm**
		Snail (not pouch)		1	**Crawling Water Beetle**			**Leech**
	1	**Stonefly**		2	**Damselfly**			**Midge Fly**
		Water Penny Beetle		6	**Dragonfly**			**Mosquito**
TOTAL	9	**(A)** 27		2	**Giant Water Bug**		20	**Pouch Snail**
					Limpet			**Rat-tailed Maggot**
				13	**Mussels/Clams**			**Water Scavenger Beetle**
				1	**Orbsnail**	**TOTAL**	22	**(C)** 22
				1	**Predaceous Diving Beetle**			
					Scud			
					Sowbug			
				7	**Water Boatman**			
				2	**Water Mite**			
				2	**Water Scorpion**			
				1	**Water Strider**			
				2	**Whirligig Beetle**			
			TOTAL	54	**(B)** 108			

$\frac{157}{85} =$

___ **Other** ________________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 1.847

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ 15-30 min. X 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)
1 ____ 2 ____ 3 ____ 4 X 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
X I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)
___ 0-25 meters ___ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present X	Sampled X
Logjams	Present __	Sampled __	**Rocks**	Present X	Sampled X
Root Wads	Present X	Sampled X	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present X	Sampled X	**Undercut Banks**	Present X	Sampled X
Silt/Muck	Present X	Sampled X	**Rip Rap**	Present __	Sampled __
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __
Other (*describe*) ________________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle X Run X Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% X 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% X 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?
No X Yes ______ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes
UTM X: 508652.6
UTM Y: 4786825.7

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 9-5-14 **Time** 11:20

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 3

Site Number RCBio5 **# of under 18** –

Other Volunteers Involved Tony Seeman, James Madden

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	10	Caddisfly
		Dobsonfly
	8	Mayfly
		Riffle Beetle
		Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	18	(A) 54

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
	9	Crane Fly
	2	Crawdad
		Crawling Water Beetle
	1	Damselfly
	1	Dragonfly
	1	Giant Water Bug
		Limpet
	14	Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
		Water Boatman
		Water Mite
		Water Scorpion
	24	Water Strider
		Whirligig Beetle
TOTAL	52	(B) 104

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
	1	Aquatic Worm
		Black Fly
	2	Bloodworm
	1	Flatworm
	1	Leech
		Midge Fly
		Mosquito
	2	Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	7	(C) 7

$\frac{165}{77} = 2.142$

___ **Other** ____________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 2.142

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)

0-15 min. _____ 15-30 min. _X_ 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)

1 ____ 2 ____ 3 _X_ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)

_____ I'm not sure

_____ I think they've been identified correctly

_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)

_X_ I'm fairly confident they've all been correctly identified

_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)

___ 0-25 meters ___ 25-50 meters _X_ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present _X_	Sampled _X_
Logjams	Present _X_	Sampled _X_	**Rocks**	Present _X_	Sampled _X_
Root Wads	Present __	Sampled __	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present _X_	Sampled _X_	**Undercut Banks**	Present __	Sampled __
Silt/Muck	Present __	Sampled __	**Rip Rap**	Present __	Sampled __
Sand	Present _X_	Sampled _X_	**Overhanging Vegetation**	Present __	Sampled __

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ______________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)

Riffle _X_ Run _X_ Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?

No _X_ Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)

___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels

___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails

___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes

UTMX: 507060.7

UTMY: 4786746.3

* Reference Site

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 10-7-14 **Time** 11:00

IOWATER Monitor Tony Seeman **# of Adults (incl. you)** 2

Site Number RCBio 6 **# of under 18** –

Other Volunteers Involved Chris Jones

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	1	Caddisfly
		Dobsonfly
	1	Mayfly
		Riffle Beetle
		Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	2	(A) 4

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
		Crane Fly
	1	Crawdad
	6	Crawling Water Beetle
	16	Damselfly
	1	Dragonfly
	2	Giant Water Bug
		Limpet
	5	Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
		Water Boatman
		Water Mite
	5	Water Scorpion
		Water Strider
		Whirligig Beetle
TOTAL	36	(B) 72

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
		Aquatic Worm
		Black Fly
	3	Bloodworm
		Flatworm
		Leech
		Midge Fly
		Mosquito
	12	Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	15	(C) 15

91/53 = 1.716

___ **Other** ________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 1.716

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ 15-30 min. _____ 30-45 min. _X___ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)
1 ____ 2 _X__ 3 ____ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X___ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)
___ 0-25 meters ___ 25-50 meters _X_ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present X	Sampled X
Logjams	Present __	Sampled __	**Rocks**	Present X	Sampled X
Root Wads	Present __	Sampled __	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present X	Sampled X	**Undercut Banks**	Present X	Sampled X
Silt/Muck	Present X	Sampled X	**Rip Rap**	Present X	Sampled X
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present X	Sampled ✓

Junk (*tires, garbage, etc.*) Present __ Sampled __
Other (*describe*) ________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle _____ Run _X__ Pool X___

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% _X__ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% _X__ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?
No _X__ **Yes** ______ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ **Eurasian water milfoil** ___ **Curly-leaf pondweed** ___ **Zebra mussels**
___ **Brittle naiad** ___ **Purple Loosestrife** ___ **Chinese mystery snails**
___ **Bighead Carp** ___ **Silver Carp** ___ **Rusty Crawfish**

Other Assessment Observations and Notes

____
____
____
____

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

* Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct*

Date 9-5-14 **Time** 1:30

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 3

Site Number RCBio 7 **# of under 18** –

Other Volunteers Involved Tony Seeman, James Madden

Was the stream dry when it was monitored? Yes ____ No X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	8	Caddisfly
		Dobsonfly
	4	Mayfly
		Riffle Beetle
		Snail (not pouch)
	2	Stonefly
		Water Penny Beetle
TOTAL	14	(A) 42

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
		Crane Fly
	6	Crawdad
		Crawling Water Beetle
	2	Damselfly
	4	Dragonfly
		Giant Water Bug
		Limpet
	12	Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
	3	Water Boatman
		Water Mite
		Water Scorpion
	3	Water Strider
		Whirligig Beetle
TOTAL	30	(B) 60

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
	1	Aquatic Worm
		Black Fly
	1	Bloodworm
		Flatworm
		Leech
		Midge Fly
		Mosquito
		Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	2	(C) 2

$\frac{104}{46} = 2.26$

___ Other ______________________ (no tolerance group assigned)

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 2.26

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time *(check one)*

0-15 min. _____ 15-30 min. X 30-45 min. _____ More than 45 min. _____

Collection Nets *(How many nets are you using to collect critters?)*

1 ____ 2 ____ 3 X 4 ____ 5 ____ 6+ ___

Identification Confidence Level *(Are you confident that your identification is correct?)*

_____ I'm not sure

_____ I think they've been identified correctly

_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)

X I'm fairly confident they've all been correctly identified

_____ I guarantee they have been identified correctly

Stream Reach Length *(How far along the stream did you search?)*

___ 0-25 meters ___ 25-50 meters X 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats *(check all present in stream reach, check if sampled)*

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present X	Sampled X
Logjams	Present X	Sampled X	**Rocks**	Present X	Sampled X
Root Wads	Present __	Sampled __	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present X	Sampled X	**Undercut Banks**	Present X	Sampled X
Silt/Muck	Present X	Sampled X	**Rip Rap**	Present __	Sampled __
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ______________________________ Present __ Sampled __

Stream Habitat Type *(check all types sampled in stream reach)*

Riffle X Run X Pool _____

Aquatic Plant Cover of Streambed *(at transect – check one)*

0-25% X 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed *(at transect – check one)*

0-25% X 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?

No X Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species *(check all found)*

___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels

___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails

___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes

utmx: 506110.7

utmy: 4791190.6

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

* Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct*

Date 9-4-14 **Time** 1:00

IOWATER Monitor Tony Seeman **# of Adults (incl. you)** 1

Site Number RCBio 8 **# of under 18** -

Other Volunteers Involved -

Was the stream dry when it was monitored? Yes ____ No X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	2	Caddisfly
		Dobsonfly
	1	Mayfly
	3	Riffle Beetle
		Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	6	(A) 18

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
		Crane Fly
	3	Crawdad
		Crawling Water Beetle
	1	Damselfly
		Dragonfly
		Giant Water Bug
		Limpet
		Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
		Water Boatman
		Water Mite
		Water Scorpion
		Water Strider
		Whirligig Beetle
TOTAL	4	(B) 8

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
		Aquatic Worm
		Black Fly
		Bloodworm
		Flatworm
		Leech
		Midge Fly
		Mosquito
		Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	0	(C)

$\frac{26}{10} = 2.60$

___ **Other** ______________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 2.60

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ 15-30 min. _X_ 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)
1 _X_ 2 ____ 3 ____ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)
___ 0-25 meters _X_ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	Leaf Packs	Present __	Sampled __
Logjams	Present __	Sampled __	Rocks	Present X	Sampled X
Root Wads	Present X	Sampled X	Weed Beds	Present __	Sampled __
Fallen Trees	Present __	Sampled __	Undercut Banks	Present X	Sampled X
Silt/Muck	Present X	Sampled X	Rip Rap	Present __	Sampled __
Sand	Present X	Sampled X	Overhanging Vegetation	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __
Other (*describe*) ______________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle _X_ Run _X_ Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?
No _X_ Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes
UTMX: 506124.0
UTMY: ~~[illegible]~~ 4791644.1

IOWATER
Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 9-5-14 **Time** 2:15

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 5

Site Number RCBio9 **# of under 18** -

Other Volunteers Involved Heath Ellison, Theo Gunther, Tony Seeman, James Madden

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	11	Caddisfly
		Dobsonfly
	5	Mayfly
		Riffle Beetle
		Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	16	(A) 48

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
	1	Crane Fly
	19	Crawdad
		Crawling Water Beetle
	7	Damselfly
	7	Dragonfly
	2	Giant Water Bug
		Limpet
	44	Mussels/Clams
	1	Orbsnail
		Predaceous Diving Beetle
		Scud
		Sowbug
	12	Water Boatman
	1	Water Mite
	1	Water Scorpion
		Water Strider
	1	Whirligig Beetle
TOTAL	96	(B) 192

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
		Aquatic Worm
		Black Fly
		Bloodworm
		Flatworm
	3	Leech
		Midge Fly
		Mosquito
	8	Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	11	(C) 11

$\frac{251}{123} = 2.040$

___ **Other** ________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 2.04

(Over)

Revised March 2010

√

Benthic Macroinvertebrate Collection Time (*check one*)

0-15 min. _____ **15-30 min.** _X_ **30-45 min.** _____ **More than 45 min.** _____

Collection Nets (*How many nets are you using to collect critters?*)

1 ____ **2** ____ **3** ____ **4** ____ **5** _X_ **6+** ____

Identification Confidence Level (*Are you confident that your identification is correct?*)

_____ **I'm not sure**
_____ **I think they've been identified correctly**
_____ **Some are definitely correct, I'm not sure about others** (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ **I'm fairly confident they've all been correctly identified**
_____ **I guarantee they have been identified correctly**

Stream Reach Length (*How far along the stream did you search?*)

___ **0-25 meters** ___ **25-50 meters** ___ **50-75 meters** ___ **75-100 meters** ___ **100+ meters**

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present __	Sampled __
Logjams	Present __	Sampled __	**Rocks**	Present X	Sampled X
Root Wads	Present X	Sampled X	**Weed Beds**	Present X	Sampled X
Fallen Trees	Present __	Sampled __	**Undercut Banks**	Present X	Sampled X
Silt/Muck	Present __	Sampled __	**Rip Rap**	Present __	Sampled __
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ______________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)

Riffle _X_ **Run** _X_ **Pool** _____

Aquatic Plant Cover of Streambed (*at transect – check one*)

0-25% _X_ **25-50%** _____ **50-75%** _____ **75-100%** _____

Algae Cover of Stream Streambed (*at transect – check one*)

0-25% _X_ **25-50%** _____ **50-75%** _____ **75-100%** _____

Is sewage algae present in the stream?

No _X_ **Yes** _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)

___ **Eurasian water milfoil** ___ **Curly-leaf pondweed** ___ **Zebra mussels**
___ **Brittle naiad** ___ **Purple Loosestrife** ___ **Chinese mystery snails**
___ **Bighead Carp** ___ **Silver Carp** ___ **Rusty Crawfish**

Other Assessment Observations and Notes

UTM X: 505726.4
UTM Y: 4792975.2

IOWATER
Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 10-7-14 **Time** 11:20

IOWATER Monitor Adam Kiel **# of Adults (incl. you)** 3

Site Number ~~[illegible]~~ RCBio10 **# of under 18** –

Other Volunteers Involved Keegan Kult, Matt Frana

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group (pollution intolerant)			Middle Quality Group (somewhat pollution tolerant)			Low Quality Group (pollution tolerant)		
Tally Column	Total # found	HQ BMI	Tally Column	Total # found	MQ BMI	Tally Column	Total # found	LQ BMI
	62	Caddisfly			Alderfly		2	Aquatic Worm
		Dobsonfly			Backswimmer			Black Fly
	20	Mayfly			Crane Fly			Bloodworm
		Riffle Beetle		2	Crawdad			Flatworm
		Snail (not pouch)			Crawling Water Beetle			Leech
		Stonefly		6	Damselfly			Midge Fly
		Water Penny Beetle		1	Dragonfly			Mosquito
TOTAL	82	(A) 246		5	Giant Water Bug		36	Pouch Snail
					Limpet			Rat-tailed Maggot
				4	Mussels/Clams			Water Scavenger Beetle
					Orbsnail	TOTAL	38	(C) 38
					Predaceous Diving Beetle			
					Scud			
					Sowbug			
				4	Water Boatman			
					Water Mite			
					Water Scorpion			
					Water Strider			
				1	Whirligig Beetle			
			TOTAL	23	(B) 46			

$\frac{330}{143} = 2.307$

___ **Other** ______________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) $= \frac{(AX3)+(BX2)+(CX1)}{A+B+C} =$ 2.307

(Over)

✓

Benthic Macroinvertebrate Collection Time (*check one*)

0-15 min. _____ 15-30 min. _X_ 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)

1 ____ 2 ____ 3 _X_ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)

_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)

___ 0-25 meters ___ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present X	Sampled X	Leaf Packs	Present X	Sampled X
Logjams	Present __	Sampled __	Rocks	Present X	Sampled X
Root Wads	Present X	Sampled X	Weed Beds	Present X	Sampled X
Fallen Trees	Present __	Sampled __	Undercut Banks	Present X	Sampled X
Silt/Muck	Present X	Sampled X	Rip Rap	Present __	Sampled __
Sand	Present __	Sampled __	Overhanging Vegetation	Present X	Sampled X

Junk (*tires, garbage, etc.*) Present __ Sampled __

Other (*describe*) ________________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)

Riffle _X_ Run _X_ Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)

0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)

0-25% _____ 25-50% _X_ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?

No _X_ Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)

___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes

UTM X: 504104.4
UTM Y: 4793992.9

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

*** Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct***

Date 10-7-14 **Time** 1:45 pm

IOWATER Monitor Tony Seeman **# of Adults (incl. you)** 2

Site Number [redacted] RCBio11 **# of under 18** –

Other Volunteers Involved Chris Jones

Was the stream dry when it was monitored? Yes ____ **No** X

Y **Were Benthic Macroinvertebrates Found?** *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*			**Middle Quality Group** *(somewhat pollution tolerant)*			**Low Quality Group** *(pollution tolerant)*		
Tally Column	**Total # found**	**HQ BMI**	**Tally Column**	**Total # found**	**MQ BMI**	**Tally Column**	**Total # found**	**LQ BMI**
	36	Caddisfly			Alderfly			Aquatic Worm
		Dobsonfly			Backswimmer			Black Fly
	5	Mayfly		4	Crane Fly			Bloodworm
		Riffle Beetle		7	Crawdad			Flatworm
		Snail (not pouch)		1	Crawling Water Beetle			Leech
		Stonefly		5	Damselfly			Midge Fly
		Water Penny Beetle		1	Dragonfly			Mosquito
TOTAL	41	(A) 123			Giant Water Bug		22	Pouch Snail
					Limpet			Rat-tailed Maggot
				9	Mussels/Clams			Water Scavenger Beetle
				1	Orbsnail	TOTAL	22	(C) 22
					Predaceous Diving Beetle			
					Scud			
					Sowbug			
					Water Boatman			
					Water Mite			
				1	Water Scorpion			
					Water Strider			
					Whirligig Beetle			
			TOTAL	29	(B) 58			

$\frac{203}{92} = 2.206$

___ **Other** ______________________ **(no tolerance group assigned)**

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 2.206

(Over)

Revised March 2010

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ 15-30 min. _____ 30-45 min. __X__ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)
1 ____ 2 _X_ 3 ____ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
__X__ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)
___ 0-25 meters ___ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present __	Sampled __	**Leaf Packs**	Present _X_	Sampled _X_
Logjams	Present __	Sampled __	**Rocks**	Present _X_	Sampled _X_
Root Wads	Present __	Sampled __	**Weed Beds**	Present _X_	Sampled _X_
Fallen Trees	Present __	Sampled __	**Undercut Banks**	Present _X_	Sampled _X_
Silt/Muck	Present _X_	Sampled _X_	**Rip Rap**	Present __	Sampled __
Sand	Present _X_	Sampled _X_	**Overhanging Vegetation**	Present _X_	Sampled _✓_

Junk (*tires, garbage, etc.*) Present __ Sampled __
Other (*describe*) ______________________________ Present __ Sampled __

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle _X_ **Run** _X_ **Pool** _____

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?
No _Y_ **Yes** _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes
UTM X: 504104.4
UTM Y: 4793992.9

IOWATER

Volunteer Water Quality Monitoring

Biological Assessment

* Recommended frequency – no more than 3 times a year, preferably between mid-July to mid-Oct*

Date 10-7-14 Time 1:30

IOWATER Monitor Adam Kiel # of Adults (incl. you) 3

Site Number RCBio12 # of under 18 –

Other Volunteers Involved Keegon Kult, Matt Frana

Was the stream dry when it was monitored? Yes ___ No X

Y Were Benthic Macroinvertebrates Found? *(If no, please provide any relevant comments in the "Other Assessment Observations and Notes" section at the end of this form)*

Benthic Macroinvertebrates *(record the number of each collected, then total each group)*

High Quality Group *(pollution intolerant)*

Tally Column	Total # found	HQ BMI
	40	Caddisfly
		Dobsonfly
	3	Mayfly
		Riffle Beetle
	1	Snail (not pouch)
		Stonefly
		Water Penny Beetle
TOTAL	44	(A) 132

Middle Quality Group *(somewhat pollution tolerant)*

Tally Column	Total # found	MQ BMI
		Alderfly
		Backswimmer
	5	Crane Fly
		Crawdad
		Crawling Water Beetle
	1	Damselfly
	3	Dragonfly
	1	Giant Water Bug
		Limpet
		Mussels/Clams
		Orbsnail
		Predaceous Diving Beetle
	2	Scud
		Sowbug
	1	Water Boatman
		Water Mite
		Water Scorpion
		Water Strider
		Whirligig Beetle
TOTAL	13	(B) 26

Low Quality Group *(pollution tolerant)*

Tally Column	Total # found	LQ BMI
	1	Aquatic Worm
		Black Fly
		Bloodworm
		Flatworm
	2	Leech
		Midge Fly
		Mosquito
	21	Pouch Snail
		Rat-tailed Maggot
		Water Scavenger Beetle
TOTAL	24	(C) 24

$\frac{182}{81} = 2.246$

___ Other ______________________ (no tolerance group assigned)

Index of Biotic Integrity (IBI) = $\frac{(AX3)+(BX2)+(CX1)}{A+B+C}$ = 2.246

(Over)

✓

Benthic Macroinvertebrate Collection Time (*check one*)
0-15 min. _____ 15-30 min. _X_ 30-45 min. _____ More than 45 min. _____

Collection Nets (*How many nets are you using to collect critters?*)
1 ____ 2 ____ 3 _X_ 4 ____ 5 ____ 6+ ___

Identification Confidence Level (*Are you confident that your identification is correct?*)
_____ I'm not sure
_____ I think they've been identified correctly
_____ Some are definitely correct, I'm not sure about others (*Please clarify in "Other Assessment Observations and Notes" section at the end of this form*)
_X_ I'm fairly confident they've all been correctly identified
_____ I guarantee they have been identified correctly

Stream Reach Length (*How far along the stream did you search?*)
___ 0-25 meters _X_ 25-50 meters ___ 50-75 meters ___ 75-100 meters ___ 100+ meters

Microhabitats (*check all present in stream reach, check if sampled*)

Algae Mats	Present X	Sampled X	**Leaf Packs**	Present __	Sampled __
Logjams	Present __	Sampled __	**Rocks**	Present X	Sampled X
Root Wads	Present X	Sampled X	**Weed Beds**	Present __	Sampled __
Fallen Trees	Present __	Sampled __	**Undercut Banks**	Present X	Sampled X
Silt/Muck	Present X	Sampled X	**Rip Rap**	Present __	Sampled __
Sand	Present X	Sampled X	**Overhanging Vegetation**	Present __	Sampled __

Junk (*tires, garbage, etc.*) Present __ Sampled __
Other (*describe*) ______________________________ Present X Sampled X

Stream Habitat Type (*check all types sampled in stream reach*)
Riffle _X_ Run _X_ Pool _____

Aquatic Plant Cover of Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Algae Cover of Stream Streambed (*at transect – check one*)
0-25% _X_ 25-50% _____ 50-75% _____ 75-100% _____

Is sewage algae present in the stream?
No _X_ Yes _____ *If yes, please submit a photographic record & contact IOWATER.*

Invasive Species (*check all found*)
___ Eurasian water milfoil ___ Curly-leaf pondweed ___ Zebra mussels
___ Brittle naiad ___ Purple Loosestrife ___ Chinese mystery snails
___ Bighead Carp ___ Silver Carp ___ Rusty Crawfish

Other Assessment Observations and Notes
UTM X: 501501.1
UTM Y: 4795553.0

Appendix H

EVALUATION OF THE ROCK CREEK WATERSHED PLANNING PROCESS

A Social Evaluation of the Rock Creek Watershed Planning Process

A report prepared for the Iowa Soybean Association, Fishers and Farmers Partnership, and Rock Creek watershed stakeholders

by Stephanie Enloe

Executive Summary

This document summarizes a utilization-focused social evaluation of the Rock Creek watershed planning process. It relies upon information gathered from twelve interview and four questionnaire responses from members of the Rock Creek watershed farmer advisory committee, local and state level agency staff, non-profit partners, and the Iowa Soybean Association (ISA). The report summarizes the thoughts and opinions of these stakeholders and provides an assessment of objectives related to learning, engagement, satisfaction, and leadership. The report also contains recommendations for ISA and the Rock Creek watershed group.

When questioned about levels of learning, engagement, and satisfaction related to the watershed planning process, the majority of respondents offered positive feedback. Farmers felt that planning meetings were productive and all respondents expressed gratitude for ISA leadership. Agency partners believe the watershed plan and ISA support were instrumental to their ability to apply for and receive Watershed Protection Funding, which became available in late September, 2014 and will support a Watershed Coordinator and provide cost-share opportunities over the next five years.

Foremost among respondents' concerns was the uncertainty regarding future leadership within the Rock Creek watershed. Interviews from July and August indicated that farmers were not yet aware that Rock Creek had a watershed coordinator, and uncertain about what their own role would be upon completion of the planning process. Later interviews and follow-up e-mail correspondence reveal that ISA has since stepped back from a leadership position to allow the watershed coordinator, the Mitchell County Soil and Water Conservation District, and farmer advisory committee members to form a watershed group. While interview data suggest that members of each of these stakeholder groups plan to remain engaged with watershed leadership efforts, the structure of the watershed group has yet to be determined. The lack of certainty regarding leadership and watershed group governance therefore constitutes the largest identifiable gap within the planning process.

The remainder of this document is organized according to four sections: the introduction, evaluation methods and objectives, results, and the conclusion. Results and recommendations are organized by indicators of success for farmer learning, engagement, and satisfaction and for project personnel learning engagement, and satisfaction. Recommendations are intended to guide ISA and watershed group efforts in Rock Creek as well as ISA planning procedures in additional watersheds.

Introduction

The Rock Creek watershed contains 44,787 acres of prime agricultural land in north-central Iowa. The creek drains into the Upper Cedar River at a location southwest of Osage in Mitchell County. The entirety of the watershed is located within the Iowan Surface landform, an area characterized by gently rolling slopes and rich, glacial soils. Because 56% of the soils in the Rock Creek watershed are somewhat or very poorly drained, tile drainage is a common management tool utilized by farmers. Approximately 87% of Rock Creek is in row-crop agriculture, with all but 177 acres under private ownership. Over 70% of landowners live within five miles of the watershed (ISA 2014).

Rock Creek became the focus of a new watershed management initiative when the Mitchell County Soil and Water Conservation District (MCSWCD) received a 2012 Iowa Department of Agriculture and Land Stewardship (IDALS) watershed planning grant. In 2013, the Iowa Soybean Association (ISA) received additional funding from the Walton Foundation to assist with the Rock Creek watershed planning process. Together with other local organizations and farmers, ISA and the MCSWCD devised a watershed plan aimed at reducing nutrient, sediment, and bacteria pollution and improving habitat along Rock Creek. Upon completion of the plan, the MCSWCD received funding to support a full-time watershed coordinator and provide cost-share benefits to farmers willing to try new conservation practices.

In 2014, ISA received funding from the Fishers and Farmers Partnership (FFP) to conduct a social evaluation of the Rock Creek watershed planning process. Social evaluation is crucial to multi-stakeholder watershed management because land-use decisions that affect water quality are driven by social and ecological factors. The FFP monitoring guide suggested a format for social evaluation, which greatly influenced evaluation methods and objectives.

The following report outlines findings from interviews and questionnaires collected between July and October, 2014. This time period covers the end of the watershed planning process and the start of the "implementation phase." During this transition, ISA stepped back from leadership into a supportive role and local stakeholders began to organize a new leadership structure. Additionally, the MCSWCD/ NRCS received funding from the Watershed Protection Fund in fall, 2014 and began working with farmers to plan and implement cost-share practices such as grassed waterways, stream-bank restoration, and a bioreactor.

Evaluation Methods and Objectives

In accordance with the social evaluation approach outlined in *Project Monitoring Guidance for Fishers and Farmers Partnership Habitat Restoration Project in the Upper Mississippi River Basin* (FFP 2012) I conducted a utilization-based evaluation of the Rock Creek watershed planning process (Patton 2000). A utilization-based evaluation "provides an opportunity to gain information that is most needed by managers and partners for timely decision making, and increases the likelihood that the evaluation findings will be both relevant and applicable," (FFP 2012). The advantage of this approach is that the evaluator works directly with project leaders to answer the questions which are of the highest priority to local stakeholders and for guiding future management efforts.

After reviewing the Rock Creek watershed plan and related documents, I met with ISA stakeholders to determine their specific objectives for the Rock Creek evaluation. We agreed that the measureable outcomes included in the FFP monitoring plan – facilitate farmer learning, enhance engagement, and encourage participant satisfaction – were pertinent to the Rock Creek evaluation. ISA stakeholders were particularly interested in the level of farmer and agency partner satisfaction with the ISA staff and planning process. The objective for the Rock Creek watershed evaluation therefore was to measure farmer and agency partner learning, engagement, and satisfaction after completing the watershed planning process.

To measure progress toward the three stated outcomes, I sent a questionnaire to agency personnel stakeholders (response rate = 4) and conducted qualitative interviews with farmers (n = 6) and project personnel (n = 6) who were willing to participate with the evaluation. The questionnaire and interview protocol were designed to determine the respondent's level of participation and measure progress toward learning, satisfaction, and engagement. Questions also were designed to assess the level of trust and connectivity between different stakeholder groups, as relationships have previously been shown to influence effective multi-stakeholder watershed programming (Enloe 2014).

Upon completion of the data collection phase, each interview was reviewed and transcribed. Interviews and questionnaire responses were analyzed for emergent themes and to measure progress toward the stated outcome. To better determine the level of ownership and leadership among local Rock Creek stakeholders, I sent follow-up questions to each farmer respondent and conducted a second interview with one of the agency personnel respondents. I then conducted a secondary analysis to synthesize results according to progress, program gaps or barriers, and recommendations.

Results

Results are organized under two sections: farmer feedback and agency personnel feedback. Each of the feedback sections will be organized according to the three stated outcomes and their corresponding indicators of success. A recommendation or set of recommendations has been included for each indicator of success. Recommendations were taken from local respondents as well as past research and evaluation related to watershed management.

Farmer Feedback

Six of the eight farmers who were involved with the farmer advisory committee (FAC) agreed to meet for an in-person interview. Two of the six respondents replied to follow-up questions sent in September. Farmer interviews followed a semi-structured protocol and lasted 20 – 85 minutes. The interview protocol was intended to measure indicators of success for farmer learning, engagement, and satisfaction. Indicators of success were determined based on conversations with ISA contacts, suggestions from the FFP social evaluation guide, and past experience with watershed program evaluation. Table 1 outlines the chosen indicators of success.

Facilitate Farmer Learning	Enhance Engagement	Encourage Satisfaction
• Project awareness • Knowledge of water quality • Knowledge of practices • Knowing where to seek information • Participation in on-farm trials	• Attendance at meetings • Willingness to try new practices • Willingness/ capacity to retain leadership • Willingness to serve as spokesperson	• Stated level of satisfaction with meetings • Stated level of satisfaction with planning process • Stated level of satisfaction with ISA staff

Table 1: Stated outcomes and associated indicators of success.

FACILITATE FARMER LEARNING

Dominant themes include:

- At the time of farmer interviews (July and August), the majority of respondents were uncertain about the direction of future leadership in Rock Creek. Data from September and October suggest that all but one of the FAC members are committed to continued leadership efforts.

- Farmers were excited to learn about chemical and biological measures of water quality in Rock Creek and would like continued access to monitoring data.

- Farmer respondents appreciated opportunities to collect personalized data about their farms and watersheds (Tile-line samples, profitability studies, stalk nitrate tests, and quantifying the amount of strip-till/ no-till ground).

- Farmer respondents believe that MCSWCD/ NRCS employees, ISA staff, and other FAC members are trustworthy sources of information.

Planning Process Awareness

All six farmer respondents expressed appreciation for the thorough communication about FAC meetings. A personalized letter or e-mail followed by a phone call was therefore an appropriate method to contact farmers about meetings. However, at the time of the interviews several farmers expressed uncertainty about the future direction of Rock Creek watershed management efforts. Farmer respondents did not know who would take charge of leadership or partnership-building initiatives. Recent conversations with agency and farmer contacts revealed that FAC members are now more aware that Rock Creek has a watershed coordinator and that local leadership will be vital to water quality improvement efforts in Rock Creek.

<u>Recommendation:</u> ISA contacts expressed that in hindsight, they would have liked to hold a final FAC meeting. Farmer interview data suggest that FAC members would have appreciated a final meeting intended to clarify individual and organizational roles throughout the implementation phase. In the future, ISA should take steps to avoid farmer uncertainty regarding the transition from watershed planning to watershed plan implementation.

Knowledge of Water Quality

> *"As a landowner or operator you only notice what you see, so it was interesting to get an assessment of the whole creek and the whole watershed."*

Farmer respondents placed high value on water quality and flood mitigation. When asked what they had learned about water quality, most farmers expressed appreciation for the opportunity to learn from chemical and biological data. Farmer respondents stated that Rock Creek "seems to have decent water quality," compared to other water bodies in Iowa, but that they would like to see further improvement. Several farmers added the caveat that recorded improvement to water quality and biological samples could be a result of recent flooding. Farmer responses regarding water quality coincide with statements by local conservation experts. Overall, FAC members appeared to have gained a better understanding of local water quality and aquatic ecosystems.

<u>Recommendations:</u> Local agency partners should continue to monitor chemical and biological indicators of water quality. If possible, ISA should continue to help analyze and interpret samples using their water monitoring lab. Throughout the implementation phase of the Rock Creek plan, effort should be made to ensure all Rock Creek farmers have access to water quality data that has been interpreted so as to be meaningful. Communication about water monitoring may be the responsibility of the watershed group or ISA, as these groups are likely to have higher credibility among farmers who are suspicious of government agencies.

Knowledge of Practices

Farmer respondents were not necessarily a representative sample of the watershed, as they already had high levels of experience with no-till/ strip-till, cover crops, stream-bank restoration, nutrient management, tree-planting, and other soil or water management practices. Although the FAC was composed mostly of farmers who would be considered "innovators," all farmer respondents said they learned about new practices or management techniques. Farmers were especially interested in opportunities to collect tile-line samples or conduct profitability studies. One of the strongest themes to emerge from farmer interviews was the need for localized biophysical and economic data, particularly on practices such as cover crops. Three of the farmer respondents voluntarily mentioned an interest in anonymously aggregating tile-line, on-farm trial, and profitability data with other farmers. They believed such data could help them learn about their own practices as well as advocate more effectively to other farmers in the area.

"Put a dollar amount to practices so when you are trying to tell people about a practice, you can demonstrate the costs versus the benefits. You can show them that conservation can also be profitable."

Recommendations: ISA and the MCSWCD/ NRCS can continue to provide opportunities for farmers to collect and/ or access locally-relevant data regarding water quality management practices. The high level of interest in local data suggests that watershed stakeholders may be interested in learning about the Hewitt Creek Model for a watershed management group. The ISU Extension office provides resources regarding the use of this model.

Knowing Where to Seek Information

All farmer respondents felt confident that they could go to the MCSWCD/ NRCS office for information about cost-share or how to manage a practice. Additionally, most respondents felt comfortable approaching ISA about new practices or on-farm monitoring, and several had already done so. Farmer respondents consistently named four of the FAC members as trusted sources of information for farmers in the area. Overall, farmer respondents have several trusted sources of information regarding conservation practices. However, at the time of the interviews many farmers did not have a relationship with the watershed coordinator or did not know that such a person had been hired.

Recommendations: Whenever possible, ISA contacts and agency personnel should continue to foster trust with Rock Creek farmers. Local stakeholders who have relationships with farmers should continue to help the watershed coordinator build relationships in the Rock Creek area. Farmer leaders can continue to make themselves available as trusted sources of information among the farming community.

ENHANCE FARMER ENGAGEMENT

Dominant themes include:

- Farmer attendance and engagement with meetings was high.
- The farmers who attended FAC meetings already are moderately to very engaged with conservation practices, but still learned about new practices they plan to try.
- Data indicate that farmer advisory committee members would like to retain leadership in the future; however, they are uncertain about what their roles can and should be.
- Rock Creek contains at least four farmers who have been identified as opinion leaders and who are willing to serve as "spokesmen" for conservation practices.

Attendance at Meetings

Of the six farmers who agreed to an interview, four were able to attend all FAC meetings and two were able to attend all but one meeting. The farmers who were unable to attend all meetings cited a time conflict and expressed regret that they were unable to attend.

<u>Recommendation:</u> In future interactions with Rock Creek farmers or other watershed groups, ISA should continue to design meetings that actively engage farmers to learn and participate. ISA contacts, farmers, and experienced local stakeholders should advise the watershed coordinator on how to facilitate productive meetings. The watershed coordinator should personally contact farmers and other stakeholders with invitations to meetings.

Willingness to Try New Practices

All farmer respondents had already worked with ISA or planned to work with ISA or the MCSWCD/ NRCS to implement a new management or monitoring practice. Practices that provide farmers with personalized information about their operations were most popular among farmer respondents. All respondents expressed interest in tile-line sampling, although one respondent specified that he would not trust a government agency to collect or store tile-line data. Four respondents had already sampled tile-lines, and at least two had signed up for profitability studies.

Farmer responses to in-field practices were mostly positive, as all respondents had experimented with or

> *"In our movement toward treating agriculture as a business, maybe we took too much of the "culture" out of agriculture… It should be about a love of the land and passing it on to the next generation, but that is culturally based, not economically based. That's why we need to engage sociologists: because we haven't found the message yet that has people clambering to get involved."*

permanently implemented practices such as strip-till/ no-till, cover crops, side-dressing, and nutrient management plans. Five farmer respondents had previously experimented with strip-till/ no-till or were identified as "champions" for the practice. While farmer responses to conservation tillage techniques were overwhelmingly positive, attitudes toward cover crops were mixed. Farmers who expressed uncertainty about cover crops were concerned that northern Iowa is too cold for winter rye. Several farmers also stressed that cover crops are not the panacea to water quality issues and should be used in combination with other in-field and edge-of-field management techniques.

Farmer responses to edge-of-field practices were also positive. At least five respondents had CRP land or had planted trees. Those same respondents were also interested in implementing additional edge-of-field practices such as wetlands, ponds, stream buffers, and wildlife habitat. Attitudes toward bioreactors were mixed. Although one farmer planned to install a bioreactor and a second farmer expressed that he was open to trying the practice "someday," at least two farmers expressed a preference for practices that serve multiple purposes (nutrient and soil retention, water storage, improved infiltration) rather than a single purpose (nitrate retention or filtering).

<u>Recommendations</u>: While the planning process successfully engaged FAC members to try new practices, widespread farmer engagement with new management practices will become a more important indicator of success as the project moves through the implementation phase. Farmer-leaders and other project stakeholders should continue to disseminate honest information about water quality and new management practices. Farmer leadership and strategic messaging will be particularly important to widespread social acceptance of new management principles. A strong, well-governed watershed group can help facilitate farmer leadership and messaging.

Willingness to Retain Leadership

According to farmer and agency personnel respondents, all but one FAC member has expressed interest in remaining involved with a watershed group. FAC members have already demonstrated continued leadership by working with agency personnel to promote NRCS practice signage, plan a post-harvest FAC meeting, and sign up for cost-share practices. Additionally, two FAC members have spoken to the MCSWCD/ NRCS office about starting a "farmer mentoring program" that will encourage Rock Creek farmers to host farm tours to teach the public about their operations.

"Given time and stimulation, all of the minds involved can exercise their ingenuity to good ends. Continuing a watershed group consisting of not only farmers but all of the entities interested or with expertise, including ISA. If we all have a good idea of the big picture, the weak links in the chain and areas where more leadership needs to be developed can be identified."

Although Rock Creek has a core group of farmers who are committed to working with a watershed group, farmer respondents also indicated that their time is limited and that the area will need a "point person who we can go to for information." Respondents felt that future leadership should come from ISA, from the MCSWCD/ NRCS, or from a diverse group of local stakeholders. Farmers did not envision themselves as primary leaders within Rock Creek, but rather in supportive and advisory roles.

Recommendation: The data indicate that the farmer advisory committee will continue to play a role in Rock Creek watershed management efforts, but that farmers expect ISA and local agencies to facilitate leadership and partnership-building efforts. Key contacts from the MCSWCD expressed confidence in their ability to facilitate leadership, build relationships with local farmers, and strengthen partnerships among Rock Creek agencies and organizations. Because respondents expressed hope that ISA would remain directly involved in Rock Creek, ISA staff should play a strong supportive role as leadership responsibilities transfer to local stakeholders. In the future, ISA may choose to collaborate with ISU Extension agents or other experts to host meetings devoted to defining leadership roles and a watershed group governance structure.

Willingness to Serve as a Spokesperson

Rock Creek leaders have pinpointed several farmers who not only are opinion leaders, but are willing to serve as "spokespeople" for watershed management and conservation efforts. At least four FAC members have served as a visible spokesperson for conservation-minded farmers in Rock Creek. During a recent conversation with an agency partner respondent, s/he said that several Rock Creek farmers had come to the MCSWCD/ NRCS office "practically glowing because they had been featured in the Des Moines Register." Additionally, FAC members have volunteered to host field days or place cost-share practice signs in their fields. Farmer respondents who had acted as spokesmen for Rock Creek farmers said they are comfortable being a visible member of their community. They also expressed that they are comfortable telling neighbors about practices that have worked well on their own farms.

Although the data indicate that several FAC members are willing to serve as spokespeople within Rock Creek, one farmer respondent offered a caveat about working with the press. This respondent indicated that he prefers to read articles in which he will be quoted before the paper is released, as he has been misquoted or comments have been taken out of context in the past. One agency partner respondent also indicated that Rock Creek leaders should exercise care when "putting a spotlight on a farmer," because many farmers are "private people or may not feel they deserve the attention."

Recommendations: Project leaders can continue to work with those farmers who have been willing spokespeople, but exercise caution so as not to overwhelm them with attention or time commitments. Rock Creek leaders may also want to work with members of the press to help them develop trusting relationships with farmers and learn about farming culture and practices.

ENCOURAGE PARTICIPANT SATISFACTION

Dominant themes include:

- Farmers felt meetings were productive and educational.
- Farmers were somewhat satisfied with the watershed plan, but uncertain about how the plan would be implemented.
- Farmers expressed satisfaction and trust for ISA as a group and ISA staff in particular.

Level of Stated Satisfaction with Meetings

All farmer respondents expressed a high level of satisfaction with meetings. Farmers felt their input was taken seriously and that the information provided was useful. Farmer respondents also enjoyed activities that helped them compare practices or understand their watershed in more depth.

> *"People walked away thinking the meetings were valuable and there was a lot of good information. [ISA staff] prepared presentations and had good questions to help fill the time."*

Recommendation: Because farmers appreciated the opportunity to provide feedback and learn about their watershed, Rock Creek leaders and ISA should continue to design meetings that facilitate a horizontal flow of pertinent information.

Level of Satisfaction with the Watershed Plan

Responses to the watershed plan were variable. Several respondents noted that while nutrient reduction is an important goal, they would have liked to place more emphasis on multi-functional practices that offer some degree of flood mitigation. Two farmer respondents felt the plan relied too heavily on cover crops and "felt a bit cookie cutter." These respondents felt practices such as ponds, wetlands, buffers strips, and CRP should be utilized more heavily and that perennials should cover a larger portion of the Iowa landscape. At least one of the two farmer respondents who expressed interest in perennials and extended rotations believed that his opinions would seem too radical to the average farmer, and that the watershed plan had to appeal to a wide audience. Other respondents expressed approval of the plan but wondered whether Rock Creek farmers would be willing to implement the number of practices needed to achieve water quality objectives. Although responses to the plan were mixed, all farmers felt that ISA was genuine about integrating farmer input into the planning process.

Recommendations: ISA should continue to seek out and integrate farmer feedback into watershed planning processes, as this technique was viewed favorably.

Level of Stated Satisfaction with ISA

All farmer respondents expressed a high level of respect and appreciation for ISA as a group and for ISA project staff in particular. Respondents felt ISA staff were knowledgeable and trustworthy, and appreciated their interest in farmer feedback. Furthermore, several respondents indicated that other commodity groups and private sector actors should follow ISA's example.

Recommendation: Respondents indicated that ISA is building a reputation as a leader in watershed management efforts. Farmers appreciate that ISA staff are knowledgeable and accessible. Respondents also appreciate the financial resources that ISA is willing to dedicate to watershed management.

Project Personnel Feedback

Six of the project personnel involved with the technical advisory committee or planning process agreed to meet for an in-person interview. Additionally, four project personnel contacts responded to a questionnaire. Those contacts who responded to the questionnaire were identified as having a low or medium level of involvement with the Rock Creek planning process. Contacts who agreed to meet for interviews had medium to high levels of involvement. Interviews followed a semi-structured protocol and lasted 25 – 35 minutes. The interview protocol was intended to measure indicators of success for farmer learning, partner engagement, and overall satisfaction, whereas the questionnaire primarily aimed to measure satisfaction. Indicators of success were determined based on conversations with ISA contacts, suggestions from the FFP social evaluation guide, and past experience with watershed program evaluation. Table 2 outlines the chosen indicators of success.

Facilitate Farmer Learning	Enhance Engagement	Encourage Satisfaction
• Knowledge of outreach techniques • Ideas on how to increase farmer knowledge	• Perceptions of farmer engagement • Strengthened leadership capacity	• Stated level of satisfaction with input • Stated level of satisfaction with communication • Trust for ISA staff • Satisfaction with watershed plan

Table 2: Stated outcomes and indicators of success for project personnel respondents.

FACILITATE FARMER LEARNING

Dominant themes include:

- Respondents aim to build relationships with farmers and make the watershed project visible.
- Respondents agree that farmers need access to more localized data regarding water quality and management techniques.

Knowledge of Outreach Techniques

When asked whether the watershed planning process taught them anything about effective outreach methods, project partner respondents stressed the importance of relationships, project visibility, and the credibility of an informational source. All six interview respondents stated that strong relationships with farmers are a vital element of outreach. These views reflect similar findings from the Boone River watershed project evaluation from 2013. Three local agency respondents also emphasized the importance of making practices more visible and helping people identify Rock Creek. Partners plan to place NRCS signs near visible practices and indicated that farmer leaders have been supportive of this idea. Partners will also place Rock Creek Watershed signs near stream crossings. Several interview respondents said they learned that outreach materials are sometimes more effective if they are not sent from an agency office. For example, a letter from the Mitchell County Conservation Board may be perceived more positively by farmers than a letter from the USDA-NRCS office.

> *"Once they start getting practices on the ground and made visible, hopefully it will create a snowball effect. Hopefully people will see there is funding and get interested in trying something on their own. So visibility is a big thing."*

Recommendations: Partners should continue to build relationships with farmers and work to make the watershed project more visible to the Rock Creek community. As the advisory committee evolves, the organization may be able to create a recognizable brand to help with marketing activities such as mailings or meeting announcements.

Ideas on How to Increase Farmer Knowledge

Project personnel recognized that farmers need better access to localized data. When asked about their objectives for farmer learning, all respondents mentioned the need for chemical and biological water monitoring data, tile-line samples, and locally-relevant information about how to manage cover crops or other cost-share practices. Several respondents indicated that ISA can continue to play a supportive role in Rock Creek by working with farmers to collect and share local data.

> *"People can look at water quality from a federal or state level, but we need more local data and from the tile outlet. And individuals can be involved with sampling their own tile outlets or their own stream. Maybe they don't have to do it themselves, but have that data that brings that relationship back to me as a landowner."*

Recommendations: As ISA moves into a supportive role in Rock Creek, they can continue to provide credible, science-based data to help farmers and agency contacts manage and evaluate new practices. As mentioned above, the watershed group may also play an instrumental role in collecting and sharing local water quality, practice management, and economic data.

ENHANCE ENGAGEMENT

- Project personnel were pleased with the current level of farmer engagement and feel optimistic that more farmers will become engaged now that outreach efforts have begun and cost-share opportunities are available.
- Project personnel feel they have the capacity to step into a leadership role. Partnerships between local organizations and farmer leaders are strong or developing. Leadership roles have yet to be clearly defined but stakeholders are aware of the need to create an inter-organizational watershed group.

Perception of Farmer Engagement

All project personnel respondents recognize that farmer engagement will be the primary indicator of success as the project moves forward. When asked about the current level of farmer engagement, respondents were pleased with farmer leadership efforts. All respondents indicated that members of the FAC are not only conservation-minded, but well-respected members of the farming community. Respondents also believe that the majority of Rock Creek farmers are likely or very likely to try a new practice or otherwise engage with the watershed plan. Several respondents remarked that while the circumstances were unfortunate, the wet spring of 2013 gave many farmers the opportunity to learn about cover crops through the prevent plant program.

Project personnel respondents were encouraged by high attendance at a public watershed meeting about the plan. Respondents estimated that over 50 farmers and landowners attended the meeting. One respondent stated that he received a great deal of positive feedback on the plan. He explained that working with conservation-minded farmers to write the watershed plan could have resulted in a product that did not reflect the interests of the broader public; however, he believed that the FAC had created a plan that resonated with community needs and interests.

"ISA did a fantastic job of getting people into leadership roles and have done a really good job of facilitating leadership among farmers… They want us to take on a leadership role, which has generated a lot of interest."

Recommendation: Farmers and program personnel felt that ISA did an excellent job of finding and engaging farmers who are practical, conservation-minded leaders. As much as possible, ISA should continue to seek out "opinion leaders" when working with farmers in Rock Creek and other watersheds.

Strengthened Leadership Capacity

Upon completing the watershed plan, ISA staff transferred leadership responsibilities to local Rock Creek stakeholders. ISA contacts were therefore interested in the level of leadership capacity within Rock Creek. Overall, interview data indicate that the Rock Creek watershed contains several individuals and organizations who are able to contribute to leadership efforts and who are currently committed to the advancement of the watershed plan. However, respondents expressed variable degrees of confidence about whether the MCSWCD, FAC, and other project leaders would be able to "keep the ball rolling." While some respondents felt very confident about local leadership capacity, several respondents noted that the project is too big to depend on a single, inexperienced watershed coordinator. However, interview data suggest that local stakeholders have created strong networks and are dedicated to utilizing partnerships to move forward with watershed objectives. This finding is a promising indicator of leadership capacity in Rock Creek.

When asked about the social dynamics between agencies, non-profits, and the local ISU Extension office, all project personnel respondents indicated that they have positive working relationships with other organizations in the Rock Creek area. Respondents from the Mitchell County Conservation Board, Pheasants Forever, and the MCSWCD/ NRCS all stressed the importance of building partnerships and working with the farmer advisory committee.

Overall, interview data indicate that several Rock Creek leaders have a long-term, systems-based perspective regarding their watershed. Key respondents not only discussed the importance of strengthening existing partnerships and building new relationships, they have also raised the issues of how to market practices, define each organization's role in the watershed, find additional funding sources, and learn about additional practices that will help them meet flood mitigation objectives.

Recommendations: ISA staff can provide agency partners with advice to ease their transition into a leadership role. While organizational roles may not always be clear at the beginning of a watershed planning process, ISA should take steps to avoid uncertainty regarding leadership in future watershed projects. Moving forward, the Rock Creek watershed group will need to clarify roles and decide upon a leadership structure. ISU Extension provides a robust set of resources regarding watershed group facilitation and management here: http://extension.agron.iastate.edu/waterquality/default.htm.

ENCOURAGE PARTICIPANT SATISFACTION

- The majority of project personnel respondents were pleased with the level of input they were able to have on the watershed plan.
- The majority of project personnel were pleased with ISA communication efforts.
- The majority of project personnel had a high level of trust and respect for ISA staff and ISA as an organization.
- Project personnel expressed satisfaction with the watershed plan and gratitude for ISA leadership. Like farmers, some respondents felt that the plan focused too heavily on nutrient reduction and would have liked to include practices with greater multifunctionality.

Stated level of Satisfaction with Level of Input

When asked whether they were satisfied with the level of input they had during the watershed planning process, all interview respondents and three of the four questionnaire respondents indicated that they were satisfied or very satisfied. MCSWCD/ NRCS respondents in particular were pleased with the "information swap" that took place between local agencies and ISA contacts during the planning process. However, one questionnaire respondent explained that, "Even though I have no problems with ISA taking the lead on this effort, I would have liked to been more involved during key periods of the planning process. But for the most part, I was not made aware of their progress, public meetings, etc., so it was difficult for me to keep up."

Recommendation: ISA should continue to seek input from key stakeholders when facilitating watershed planning efforts and be mindful about involving state-level technical advisors.

Stated Level of Satisfaction with Communication Efforts

Again, all but one respondent reported feeling satisfied or very satisfied with the communication strategies utilized by ISA to convene meetings or share information. The same respondent who was unsatisfied with his or her level of input also felt unsatisfied with ISA's communication efforts. Although very satisfied with ISA communication overall, another agency respondent noted that s/he experiences occasional difficulties when trying to work as an intermediary between ISA and farmers. For example, several days may pass before s/he is able to talk with ISA staff to answer a farmer's questions about stalk testing or tile line sampling. This respondent suggested that ISA put together a short pamphlet to describe their on-farm services and provide farmers with contact information for ISA staff. The respondent felt that s/he could use such a pamphlet to ensure timely delivery of information to interested farmers and to help them feel more comfortable contacting ISA.

Recommendations: Continue to be diligent about communicating with watershed partners and farmers. ISA should create a pamphlet that MCSWCD/ NRCS offices can give farmers who are interested in implementing on-farm trials, stalk nitrate testing, tile-line sampling, or other ISA-funded practices.

Stated Level of Trust for ISA Staff

Several respondents stated that they initially felt wary about ISA's motives for becoming involved with water quality management efforts. Each of these respondents, however, expressed a high level of trust and respect for ISA after completing the watershed planning process. Respondents were confident that ISA was seeking a science-based approach to balancing production with conservation. One respondent said that s/he "would absolutely recommend working with them."

"Some people might wonder what their main objective is since they are an ag. organization, but most people realize they are trying to create a balance."

This same person explained that ISA "knew how to make local people the leaders," and create a sense of local ownership regarding the project. Several respondents explained that they would not have been able to complete the watershed plan or receive funding so quickly without ISA's leadership. Project personnel indicated that they will continue to reach out to ISA for advice and support.

Recommendation: Overall, program personnel respondents had positive comments about ISA staff and ISA as an organization. By taking a balanced, science-based approach and dedicating resources toward water quality improvement, ISA can continue to build relationships with diverse stakeholders.

> *"I'm just really impressed with ISA and would like to congratulate them on putting this approach together and taking on the leadership."*

Stated Level of Satisfaction with the Watershed Plan

Like farmers, project personnel expressed mixed levels of satisfaction with the watershed plan. When asked directly about their views on the plan, respondents expressed a high level of satisfaction. All respondents were grateful to have the plan, were very satisfied with the information contained in the plan, and felt that the plan had and would continue to help them secure funding. Upon further questioning, two respondents indicated that the scenario outlined in the plan was "a good starting point" and that they would like to see a heavier focus on multi-functional practices and flood mitigation. One of the respondents who expressed such a view also noted that the plan had received positive feedback from the public and that s/he was optimistic about the project implementation phase. Although the plan may evolve as time goes on, respondents felt the planning process provided necessary background information, an opportunity to foster local leadership, and a solid foundation for public dialogue.

Recommendations: Project leaders should first focus on creating a watershed group and leadership structure that facilitate collaboration, clarify stakeholder roles, and define short-term objectives. Because the conceptual plan outlined in the Rock Creek watershed plan is intended to guide and measure progress, leaders can adapt practice objectives to best suit biophysical, social, and economic realities on the ground.

Conclusion

This evaluation aimed to provide an assessment of the Rock Creek watershed planning process facilitated by the Iowa Soybean Association as well as to conduct a preliminary assessment of the leadership capacity within the watershed. Based on interview and questionnaire responses, ISA did an exemplary job of seeking input from pertinent stakeholders, facilitating productive meetings, fostering trust and communication, and supporting local agencies to secure the necessary resources to implement a watershed project. The largest identifiable gap relates to uncertainty regarding leadership responsibilities within the Rock Creek watershed. Farmer respondents were unsure about the source of future leadership and what role they will be expected to play. Despite this uncertainty, the data provide some positive indicators of leadership potential. Rock Creek stakeholders have a strong social network, are committed to fostering a culture of stewardship, and have the resources to employ a watershed coordinator to serve as "point person." Because their ability to utilize leadership potential will depend upon efficient organization and communication, stakeholders would benefit from informational resources and guidance on how to build a well-governed watershed group. ISA and/ or ISU Extension may be a valuable source of such support. Moving forward, the data suggest that the plan may evolve to place a higher priority on multi-functional practices and flood mitigation. However, the majority of respondents were happy with the final product and feel the plan provides a solid foundation for future watershed management efforts in Rock Creek.

Suggested Resources

- ISU Extension provides general resources on watershed management at http://extension.agron.iastate.edu/waterquality/default.htm.
- ISU Extension provides information on Performance-based Environmental Management (the Hewitt Creek Model) at http://extension.agron.iastate.edu/waterquality/performance.html.
- Based on farmer responses, Rock Creek stakeholders may be interested in prairie conservation strips. Information on prairie strips (STRIPS) can be found at prairiestrips.org or by contacting Tim Youngquist (timyoung@iastate.edu) or Lisa Schulte Moore (lschulte@iastate.edu).

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Appendix I

HYDROLOGIC MODELING OF ROCK CREEK WATERSHED FOR FLOW AND NUTRIENT REDUCTION USING HYDROGEOSPHERE

THE UNIVERSITY OF IOWA

COLLEGE OF ENGINEERING
IIHR—Hydroscience & Engineering
100 Hydraulics Laboratory
Iowa City, Iowa 52242-1585 USA
319-335-5237 *Fax* 319-335-5238

November 26, 2014

Adam Kiel, Iowa Soybean Association
1255 SW Prairie Trail Parkway
Ankeny, IA 50023

Dear Adam,

A report summarizing the hydrologic and nitrate modeling performed for the Rock Creek Watershed is attached. Numerical modeling of flow and nitrate transport within the watershed was performed with HydroGeoSphere, a physically-based, fully-coupled surface-subsurface hydrologic model with the ability to simulate solute transport as well. The model was calibrated to the month of May 2009 to establish a baseline, existing condition and then hypothetical scenarios were simulated to consider the impact single and combined best management practices could have on reducing flow and nitrate loading in the watershed. Three practice implementation scenarios were considered: (1) the impact of non-structural practices (implementation of no- or strip-till practices and cover crops on all cropland in the watershed), (2) the impact of structural practices (seven nitrate removal wetlands dispersed throughout the watershed), and (3) a multi-practice implementation of both non-structural and structural practices. Comparisons were made between each hypothetical practice implementation scenario and the baseline existing conditions scenario to estimate flow and nitrate load reductions.

Modeling results suggest the practices will provide variable but relatively small peak flow reduction benefits and more significant nitrate load reduction benefits for hydrologic conditions similar to those the watershed experienced in May 2009. Because of the watershed's flat topography, surface runoff resulting from overland flow is not a significant part of the water balance as compared to other watersheds with steeper land slopes. High amounts of infiltration were simulated, as expected. The multi-practice implementation scenario with a 2-meter wetland dam height provided the greatest peak flow reduction benefit (13.6%), while the peak flow reduction for all other scenarios was less than 5%.

On the other hand, nitrate load reductions resulting from cover crop uptake and wetland treatment processes were more significant. Nitrate load reductions of 15-41%, 9%, and 22-46% were estimated for the cover crop and conservation tillage, wetlands, and multi-practice implementation scenarios, respectively. A range in the nitrate load reductions resulting from scenarios involving cover crops is provided based on different assumed nitrogen uptake rates by cover crops (described more fully in the report). While the absolute values of simulated water quantity and quality parameters may differ somewhat in reality, we believe the relative reductions can provide important insight into the flow and nitrate reduction benefits that could

The University of Iowa

College of Engineering
IIHR—Hydroscience & Engineering
100 Hydraulics Laboratory
Iowa City, Iowa 52242-1585 USA
319-335-5237 *Fax* 319-335-5238

potentially be achieved by these practices, at least for similar hydrologic conditions to the simulation time period (May 2009).

Thanks for your help and patience on this project. Feel free to contact us with any questions.

Sincerely,

Larry Weber, Principal Investigator, IIHR-Hydroscience & Engineering, University of Iowa
Antonio Arenas Amado, modeler, IIHR-Hydroscience & Engineering, University of Iowa
Chad Drake, modeler, IIHR-Hydroscience & Engineering, University of Iowa

Enclosure: Rock Creek Modeling Report

I. Introduction and Review of Project Scope

On June 1, 2014, IIHR – Hydroscience & Engineering at the University of Iowa (IIHR) was hired by the Iowa Soybean Association (ISA) to perform hydrologic modeling of the Rock Creek Watershed to evaluate the impact several conservation or best management practices (BMPs) could have on flow and nutrient reduction. ISA had previously developed a comprehensive watershed plan for Rock Creek that specified the type and extent of certain best management practices that would need to be implemented in the watershed in order to meet certain water quality and quantity goals identified by local farmer and conservation stakeholders in the watershed. IIHR was hired by ISA to perform hydrologic modeling of the Rock Creek Watershed to determine quantitatively if the conceptual plan developed could meet the flow and nutrient reduction goals selected by the watershed and/or identified in the Iowa Nutrient Reduction Strategy.

Review of Watershed Goals for Rock Creek

This report summarizes the hydrologic modeling efforts performed by IIHR for the Rock Creek Watershed as specified by ISA. As discussed in the *Rock Creek Watershed Land and Water Improvement Plan* developed by ISA, conservation practices placed in strategic locations are sought to achieve the following watershed goals:

1. Reduce in-stream nitrogen by 41% from 2009-2011 average levels.
2. Reduce in-stream phosphorus by 29% from 2009-2011 average levels.
3. Increase soil organic matter by 1%.
4. Maintain or increase agricultural productivity and revenues.
5. Reduce flood risk.
6. Maintain or increase upland wildlife habitats.
7. Maintain or improve aquatic life.

IIHR Scope of Work

In order to meet these watershed goals, ISA developed a conceptual plan that identified the type and location of various practices that would need to be implemented. To verify the legitimacy of the proposed plan, ISA hired IIHR to perform hydrologic modeling of the watershed to estimate flow and nutrient reductions resulting from the best management practice implementation scenarios identified by ISA. The IIHR project deliverables established between the two parties were:

1. Hydrograph development for existing conditions (a period from 2009-2011).
2. Hydrograph development for one multi-practice implementation scenario provided by ISA.
3. Validation of nutrient (nitrate) reductions resulting from the multi-practice implementation scenario provided by ISA.

The remainder of this report summarizes the Rock Creek Watershed modeling performed by IIHR in order to estimate the flow and nutrient reductions resulting from multiple best management practices proposed by ISA. This includes a description of the pertinent watershed characteristics needed for model development, hydrologic model development, and evaluation of watershed scenarios for flow and nutrient reduction.

II. Watershed Characteristics

The Rock Creek Watershed drains an area of approximately 70 mi^2 (44,787 acres) and is located in north central Iowa. Rock Creek is a HUC 10 watershed (HUC 0708020106) composed of two smaller HUC 12 watersheds (Goose Creek and Upper Goose Creek) and is a tributary to the Upper Cedar River (HUC 07080201). The watershed spans Mitchell, Worth and Floyd counties and flows from northwest to southeast. The watershed is characterized by relatively flat terrain, row crop agriculture, and moderately to poorly draining soils. The watershed is mostly rural. The largest community in the watershed is the town of Grafton whose population was estimated at 250 during the 2012 census.

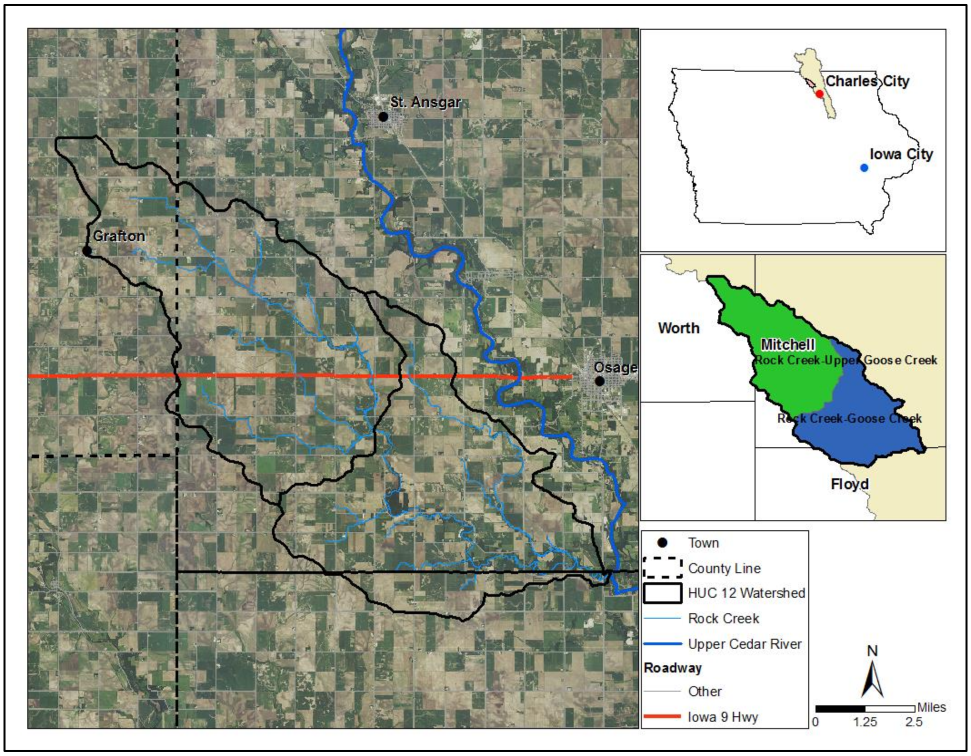

Figure 1. Overview of Rock Creek Watershed (HUC 0708020106).

Topography

The watershed is mostly flat with some gently rolling hills. Elevations range from 1,255 feet in the northwest part of the watershed to 1,024 feet at the watershed outlet (231 feet of total relief). Typical land slopes are less than 2.5% (75th percentile), indicating the watershed lacks topographic relief.

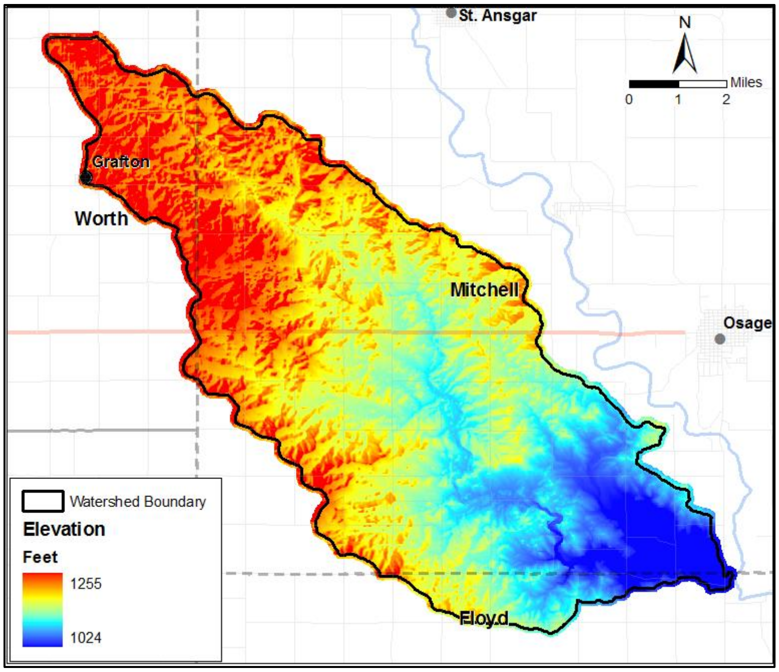

Figure 2. Rock Creek Watershed elevations.

Land Use

Land use in the watershed is dominated by row crop agriculture (primarily corn and soybeans) at 86.5% of the acreage. Developed areas (impermeable areas such as roads and buildings), grass and pasture, and deciduous forest account for most of the remaining area (12.9%).

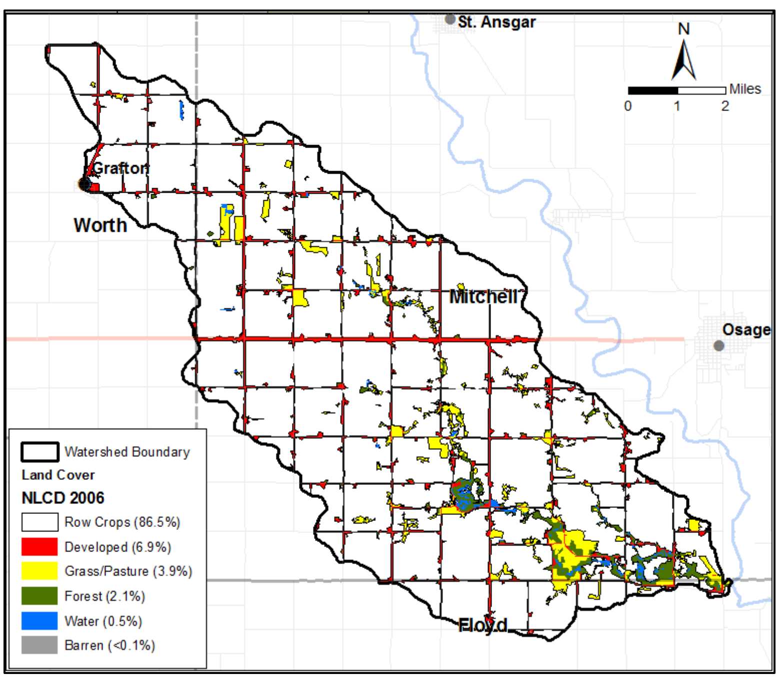

Figure 3. Land use in the Rock Creek Watershed according to the 2006 National Land Cover Dataset (NLCD).

Geology and Soils

Rock Creek is characterized by moderately to poorly draining soils. Silt and loam soil textures are common, with the silty clay loam soil texture class comprising over half the area, followed by silty loam, loam, and clay loam.

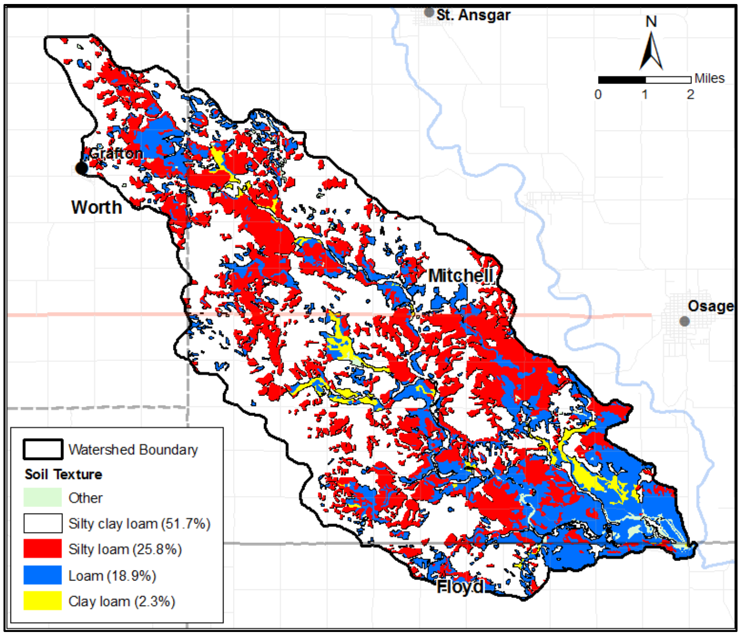

Figure 4. Soil texture classes in the Rock Creek Watershed according to the 2006 NRCS Soil Survey (SSURGO) Geographic Databases for Worth, Mitchell, and Floyd counties.

The watershed also has a karst influence. Areas of shallow carbonate bedrock, fractured bedrock, and sinkholes are prevalent. The depth to bedrock in many areas is less than five feet.

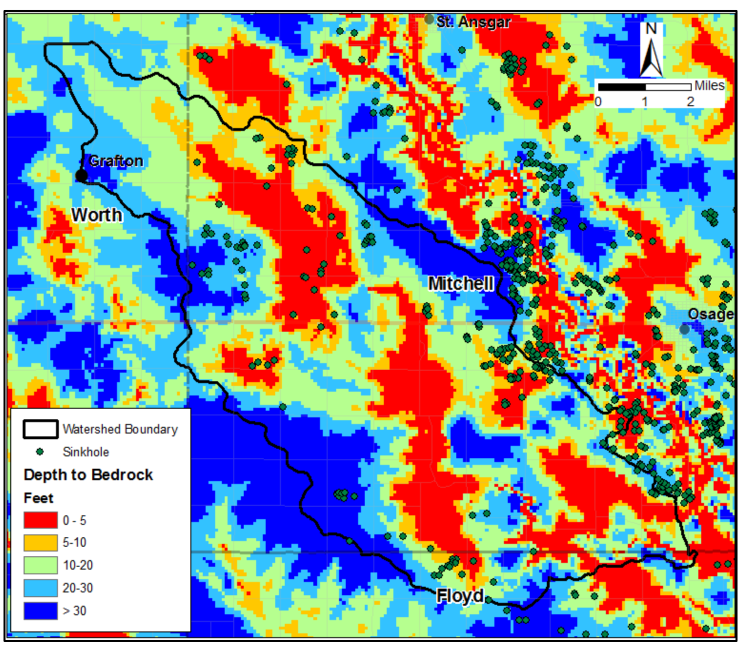

Figure 5. Depth to bedrock and sinkhole locations in the Rock Creek Watershed.

Instrumentation

No hydrologic or meteorologic instrumentation is known to currently exist in the watershed. Several NOAA rain gages are within 20-30 miles of the watershed, and the closest of these gages (Osage: GHCND: USC00136305) was selected to provide the rainfall input for the hydrologic simulations.

Some water quality monitoring has taken place in the watershed. Beginning in 2006, in-stream water quality measurements for a variety of water quality indicators, including nitrate, have been taken at the intersection of Rock Creek and Highway 9 and at the watershed outlet on County Road T38. In most years, monitoring has consisted of 1-2 monthly measurements taken from April-November. Some water quality measurements at tile outlets from agricultural fields have also been collected.

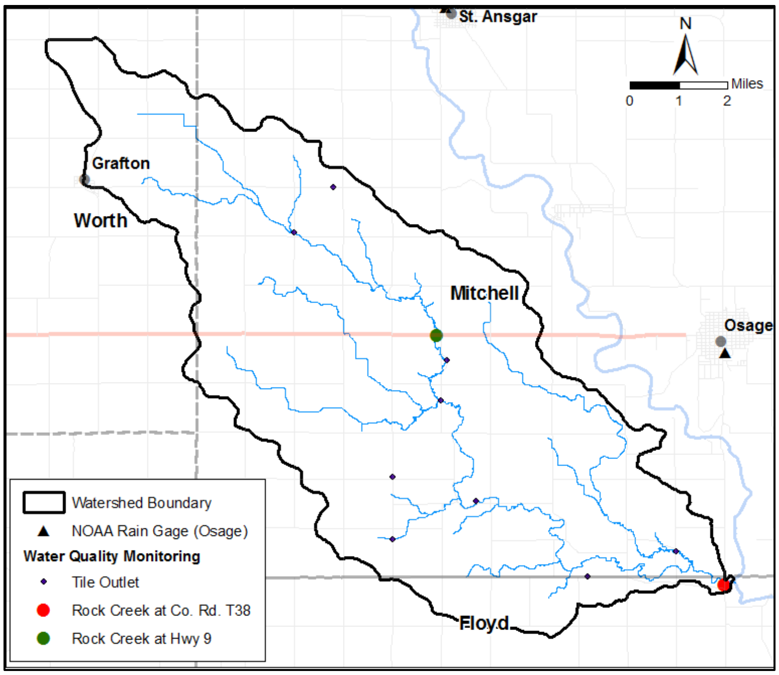

Figure 6. Water quality monitoring and NOAA rain gage locations in or near the Rock Creek Watershed.

Clear seasonality in in-stream nitrate concentrations can be observed from the limited amount of measured water quality data. Higher nitrate concentrations are observed in April – June when spring fertilizer is applied. Nitrate concentrations decrease during the growing season as a result of plant uptake and dilution from heavy rain events. A secondary, smaller peak is observed in November – December during low flow conditions.

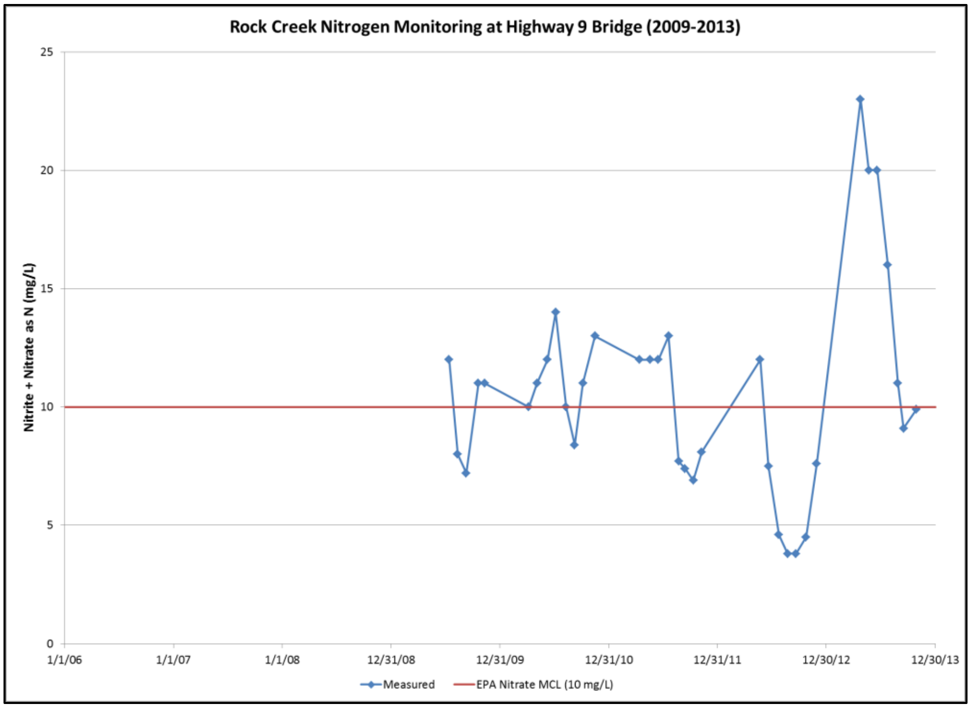

Figure 7. Measurements for nitrate + nitrite at the intersection of Rock Creek and Highway 9 (2009-2013).

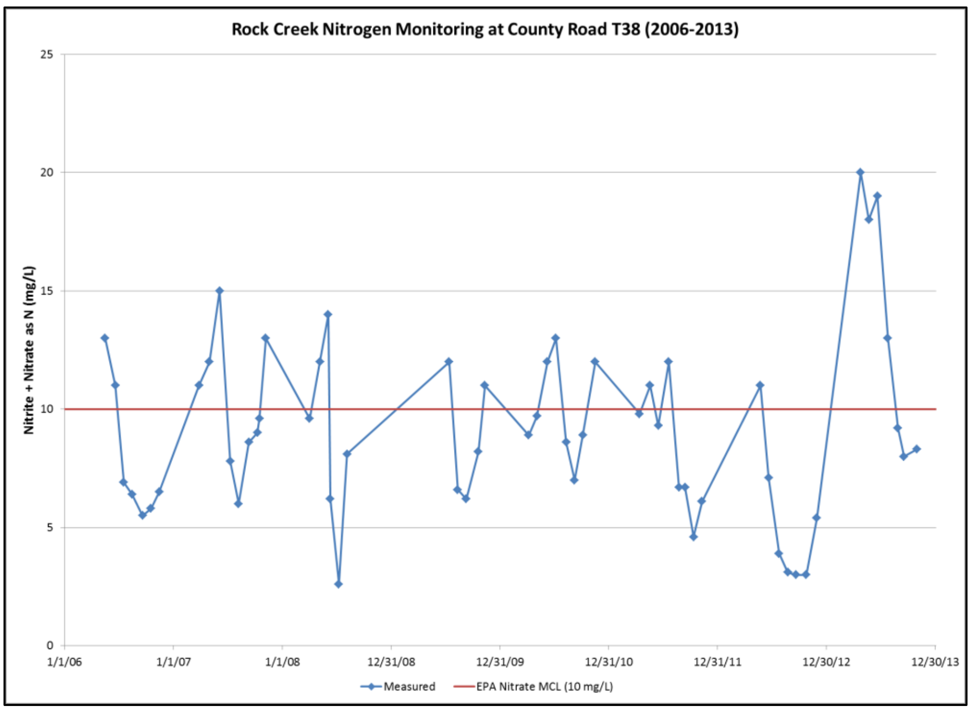

Figure 8. Measurements for nitrate + nitrite at the intersection of Rock Creek and County Road T38 (2006-2013).

Because no discharge gages exist in the watershed, discharge estimates for Rock Creek were computed using regional regression equations derived by the USGS. Daily mean discharge estimates for the outlet of Rock Creek were calculated using the Flow Anywhere method described in the USGS report *Computing Daily Mean Streamflow at Ungaged Locations in Iowa by using the Flow Anywhere and Flow Duration Curve Transfer Statistical Methods* (Linhart et al., 2012). The Flow Anywhere Method estimates the discharge at an unknown location using a reference USGS discharge gage for which discharge measurements exist and knowing the drainage area of the unknown and reference locations. Iowa was separated into three aggregated regions based on similar hydrologic characteristics, and a regional regression equation was developed for each region to compute streamflow at ungaged locations. Rock Creek is located in aggregated region three, for which the regional regression equation for computing daily mean streamflow at an ungaged location is given as

$$Q_u = 3.3 \left(\frac{DA_u}{DA_r}\right)^{1.07} Q_r^{\,0.8} \tag{1}$$

where

Q_u = daily mean streamflow at ungaged location (ft^3/s)
Q_r = daily mean streamflow at reference stream gage (ft^3/s)
DA_u = drainage area at ungaged location (mi^2)
DA_r = drainage area at reference stream gage (mi^2)

Three USGS discharge gages were selected as reference gages – the Little Cedar River at Ionia, the Cedar River at Charles City, and the Winnebago River at Mason City – to compute discharge estimates at the outlet of Rock Creek for model comparison and calibration. The reference gage information is summarized in Table 1 and shown in Figure 9 below.

Table 1. Summary of the USGS reference discharge gages used for computing daily mean discharge estimates at the outlet of Rock Creek using regional regression equations derived from the Flow Anywhere Method.

USGS Discharge Gage	*Discharge Gage Name*	*Drainage Area (mi^2)*	*Period of Record*
05458000	Little Cedar River at Ionia	295	1955-present
05457700	Cedar River at Charles City	1075	1965-present
05459500	Winnebago River at Mason City	517	1932-present

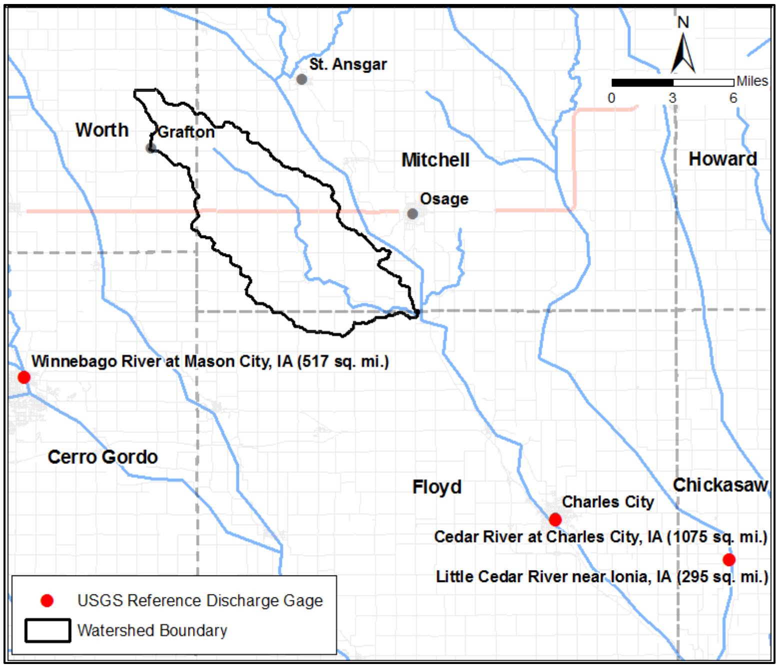

Figure 9. Locations of USGS reference discharge gages (3) used for computing daily mean discharge estimates at the outlet at Rock Creek using regional regression equations derived from the Flow Anywhere Method.

III. Hydrologic Model Development

This section summarizes the hydrologic model development and calibration performed for the Rock Creek Watershed. Flow and solute transport in the watershed were simulated for pre- and post-practice implementation using HydroGeoSphere (HGS). HGS is a physically-based, spatially distributed, coupled surface-subsurface hydrologic model. Each component of the hydrologic cycle is accounted for and the governing equations of fluid flow (conservation of mass and momentum) are solved (Figure 10). Subsurface flow is represented in a three-dimensional manner and Richard's equation is solved for transient, fully saturated, or variably saturated flow conditions using a control volume finite element approach. Surface flow is represented in a two-dimensional manner by solving the depth-averaged St. Venant equations (diffusive wave approximation), which is valid when a vertical hydrostatic pressure distribution can be assumed, bottom shear stresses dominate, and slopes are mild (subcritical flow).

Nitrate transport in the watershed was simulated using the solute transport component of HGS. Solute transport is predicted from the three-dimensional advective-dispersion equation, which describes the movement (advection) and spread (diffusion) of a particular chemical species through the surface and subsurface over time. It is important to recognize that plant uptake and other processes of the nitrogen cycle, such as fixation, mineralization, nitrification, denitrification, etc., are not explicitly simulated in HGS. Hence, only the transport (movement) of nitrate, and no nitrogen processing, was represented.

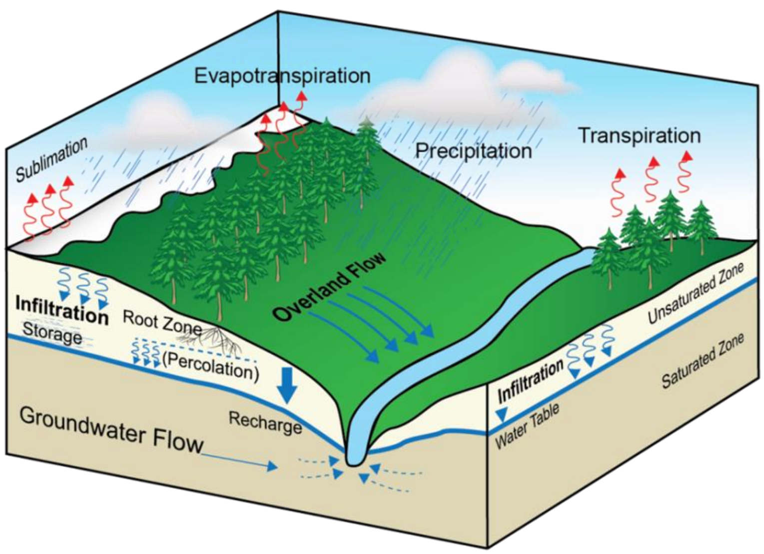

Figure 10. Summary of the hydrologic processes represented in HGS.

Mesh Development

In order to run HGS, a numerical mesh was developed so the governing equations of fluid flow could be discretized and solved numerically. A mesh consists of several components including nodes (1D), faces (2D), and elements (3D). Subsurface soil properties are assigned to each element, while surface flow and land use properties and evapotranspiration properties are assigned to faces. The governing equations are solved at each node. Because the governing equations are solved numerically, grid spacing (spacing between the nodes) can impact the solution. To ensure a more accurate solution near the regions of most interest while balancing computational cost, the mesh was refined near the stream channel and less refined moving away from it. The mesh for Rock Creek was developed in the mesh generation software Gridgen Version 15.18 and is shown below. The surface (2D) mesh consists of 15,378 nodes and 30,278 elements, corresponding to an average element size of approximately 1.5 acres. Nodal spacing along the stream channel centerline is approximately 250 ft and increases to 650 ft along the watershed boundary. The subsurface was modeled to a variable depth of 30-50 ft below the surface by vertical projection of the surface mesh. The subsurface is defined by 12 layers ranging in thickness from a few inches near the surface to several feet in the deeper subsurface near the bottom of the domain. In total, the 3D domain contains over 184,000 nodes and 333,000 elements.

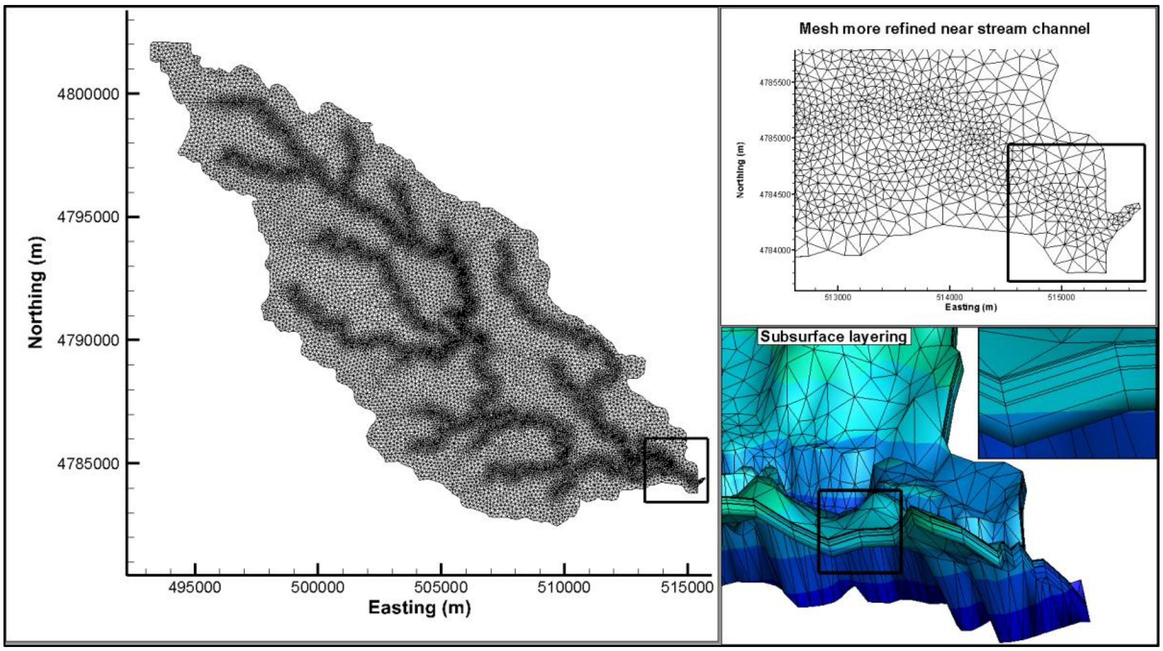

Figure 11. Numerical mesh developed for the Rock Creek Watershed for HGS simulations. The governing equations of flow are solved at each node simultaneously.

HydroGeoSphere Model Inputs

Model calibration and scenario simulations were performed for the month of May 2009. This time period falls within the time period for which flow and nitrate comparisons are desired (2009-2011). Additionally, noticeable streamflow responses are evident during this time period at the USGS reference gages used to compute discharge estimates at the Rock Creek outlet, bettering the opportunity for the flow and nutrient impact of practices to be observed.

Rainfall

The NOAA rain gage at Osage (GHCND: USC00136305), located approximately seven miles from the watershed centroid, provided hourly rainfall input to HGS. Rainfall was assumed to fall uniformly in space and time across the entire watershed during each hour. The daily rainfall hyetograph observed at Osage from April 15 – May 31, 2009 is shown in Figure 12. The maximum daily rainfall total was 1.2 inches while the latter half of April and the entire month of May received 2.7 and 5.4 inches of total rainfall, respectively. Both the maximum daily and monthly rainfall totals correspond to less than a one-year average recurrence interval for this area, indicating the simulation time period is more representative of typical hydrologic/meteorologic conditions than extreme flood conditions (Perica et al., 2013). The 5.4 inches of rain received in May represents about 16% of the average annual rainfall amount for the watershed (approximately 33-34 inches per year reported for Grafton, IA).

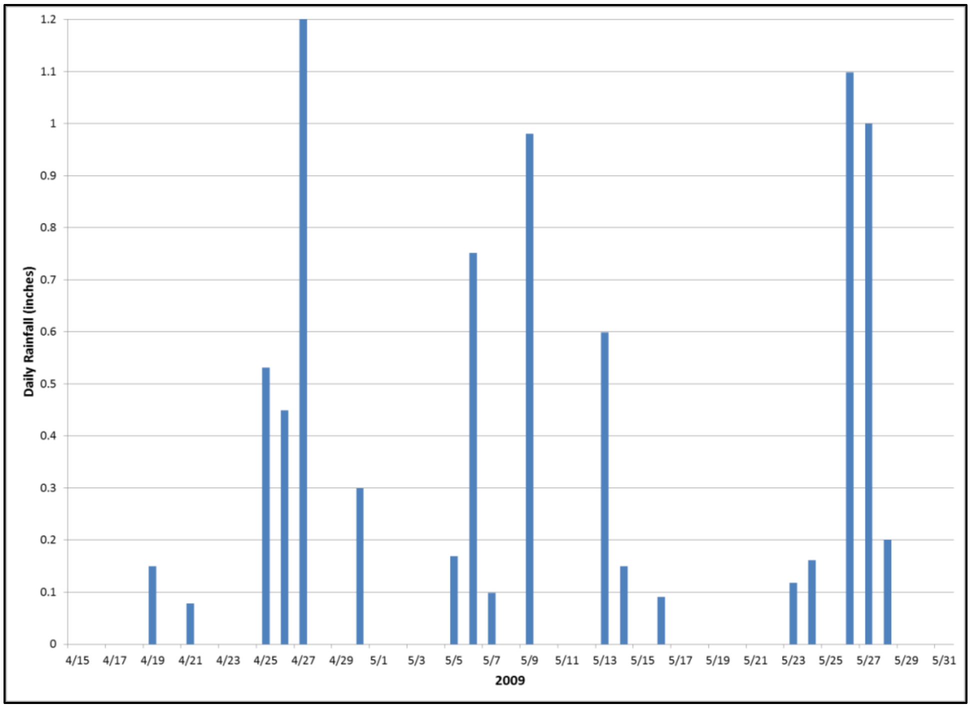

Figure 12. Daily rainfall hyetograph measured at the Osage NOAA rain gage location (GHCND: USC00136305) for April 15-May 31, 2009. May 2009 served as the simulation time period and was characterized by 5.4 inches of total rainfall.

Surface, Subsurface, and Evapotranspiration Properties

Flow resistance in the 2D depth-averaged St. Venant equations for surface flow is resolved through assigned surface roughnesses (Manning's n-values). Manning's n-values were assigned to six different land cover classes – agriculture, developed, grass, forest, open water/wetlands, and the stream channel – based on acceptable values reported in literature.

Subsurface properties describing infiltration characteristics and other parameters needed to numerically solve the 3D Richard's equation for subsurface flow were assigned to each soil texture class defined by the SSURGO dataset (Figure 4). The spatial distribution of soil texture classes shown in Figure 4 was projected downward to a depth of 3 ft below the surface. This region was resolved numerically by the development of 4 layers ranging in thickness from 2-15 inches. To account for the impacts of tile drainage on agricultural lands, a thin 4 in layer was defined at a depth 3 ft below the ground surface. This layer is of greater permeability than the layers above and below it and is intended to represent a tile line. As a result, most of the water that intersects this thin layer will eventually be transported to the stream nodes, reflecting flow through an actual tile line that eventually outfalls to a stream. For reference, the tile layer is defined by infiltration characteristics similar to that of sand while the deeper layers were defined similar to that of a clay loam.

Evaporation and transpiration (evapotranspiration) from the surface and shallow subsurface are estimated based on vegetation type and water availability from the surface and subsurface.

Transpiration from vegetation occurs in the root zone of the subsurface and is estimated as a function of vegetation type (leaf area index), soil water content, and various parameters describing the root zone. Evaporation from the surface and shallow subsurface is proportional to the potential evapotranspiration minus various losses including transpiration and canopy evaporation. Evapotranspiration is coupled with the surface and subsurface flow equations. Daily potential evapotranspiration values for the simulation period were obtained from the Iowa Mesonet website for Nashua, IA (Floyd County, NASI4). Potential evapotranspiration was estimated based on a derived version of the Penman-Monteith equation.

Solute Transport

Nitrate transport through the surface and subsurface was simulated using the 3D advective-dispersive transport equation. Because of the relatively short time period being simulated, no temporal decay of nitrate was assumed. A combination of experimental measurements collected by the USDA Agricultural Research Service at a field site near Nashua, IA and IIHR in-house recommendations from individuals experienced in water quality aided in defining an initial subsurface nitrate concentration profile representative of agricultural areas in Iowa. A fixed nitrate concentration of 25 mg/L was assigned to the tile layer (3 ft depth). The other initial concentrations in the subsurface were assigned so as to achieve simulated soluble nitrate concentrations of approximately 5 mg/L in the shallow subsurface (0-3 ft depth) to reflect ambient conditions and simulated in-stream nitrate concentrations at the watershed outlet that were comparable to measured data (Figure 8, around 10 mg/L).

Calibration

Calibration refers to the process of modifying and adjusting model input parameters in order to match the predicted hydrologic response of the watershed to a historical time series (most commonly a discharge hydrograph). This is done so the model has some amount of predictive capability for estimating the watershed response under different hydrologic conditions or when comparative analyses are desired (such as pre and post-practice implementation scenarios). Model parameters are adjusted within physically reasonable bounds based on literature sources or measured data.

Several methods exist for calibrating physically-based models. The method implemented here is described below. The first calibration step for the Rock Creek model was to establish the initial condition for the subsurface to reflect actual conditions at the beginning of the simulation period. To do so, a fully saturated subsurface was simulated with evapotranspiration but no rainfall and the watershed was allowed to “drain” out over time until the simulated baseflow recession matched the baseflow (or at least low flow conditions) predicted by the regional regression equation (1). Subsurface model parameters were adjusted as needed and simulations were performed iteratively until the simulated baseflow condition was acceptable. A start date of April 22nd, corresponding to a low flow condition, was selected for the start time of the simulation so the simulated subsurface hydraulic heads and soil water contents calculated from the baseflow analysis could be used as initial conditions. This start date also allows some time for any numerical instabilities to be resolved so model outputs during the period of most interest, May 2009, are less likely to be influenced by numerical inconsistencies.

Once the subsurface initial condition was established, fully-coupled simulations with rainfall and nitrate transport were performed until an acceptable outlet discharge hydrograph was simulated for May 2009. Water balance components, including the proportions of evapotranspiration and surface runoff to total precipitation, and solute concentrations were also analyzed after each run to ensure model results made physical sense. Model input parameters described above were adjusted as needed until the simulated outlet hydrograph reasonably matched the discharge estimates predicted from regional regression and the simulated in-stream nitrate concentrations were similar to the collected water quality measurements shown in Figure 8 (around 10 mg/L). The calibrated hydrograph at the watershed outlet (aggregated to daily average values for easier comparison to regional regression discharge estimates) is compared against the average of the daily discharge time series' estimated from the three reference sites using regional regression in Figure 13. Overall, the calibrated HGS model does a reasonable job simulating the correct magnitude and temporal trend of discharge as compared to the regional regression discharge estimates, particularly when considering the high levels of uncertainty associated with the regional regression estimates. The outlet hydrograph and corresponding nitrate concentration and load time series' represent the watershed existing conditions and was used as the baseline case for practice scenario comparison. Comparison of the HGS simulated and regional regression daily mean discharge estimates for each of the three reference sites is provided in Appendix 1.

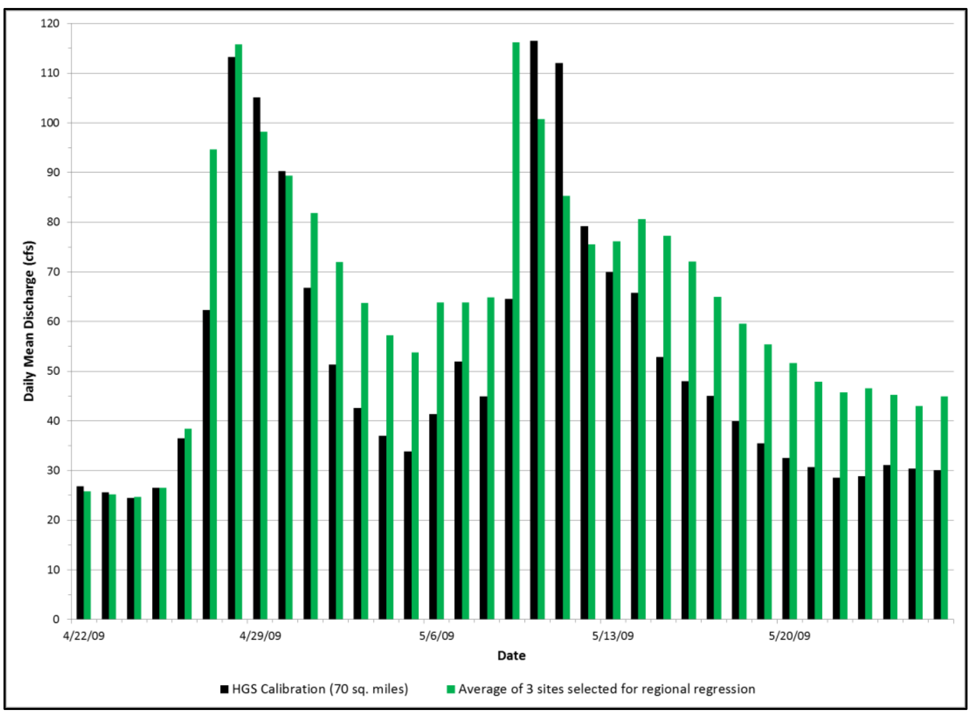

Figure 13. Comparison of simulated (black) and estimated (green) daily mean discharges using regional regression equations (average of the three USGS reference gages) at the outlet of Rock Creek for May 2009.

IV. Modeling Results for Practice Implementation Scenarios

Once hydrograph development for existing conditions was complete, the primary modeling objective became hydrograph development for a multi-practice implementation scenario provided by ISA to provide insight as to whether or not their proposed conceptual plan could meet the identified water quality and quantity goals for the watershed. More specifically, the main goal was to quantify the flow and nitrate load reductions that might be expected post-practice implementation to see if the proposed practices could meet the water quality goal of reducing in-stream nitrogen by 41% from 2009-2011 average levels.

The multi-practice implementation scenario provided by ISA is defined by a combination of structural and non-structural practices geared at reducing flood risk and improving water quality. Due to limitations of HGS and the time table for this project, not all practices were modeled. Controlled drainage, bioreactors, and saturated buffers were not modeled in HGS. Table 2 summarizes the practices defining the multi-practice implementation scenario originally provided by ISA and those that were actually modeled in HGS.

Table 2. Summary of the multi-practice implementation scenario provided by ISA and the modified scenario modeled in HGS. Controlled drainage, bioreactors, saturated buffers were not modeled in HGS.

Conservation Practice	*Type of Practice*	*Modeled in HGS*
No-Till or Strip-Till Cover Crops Nutrient Management (all cropland)	Non-Structural	Yes
Controlled Drainage (average slope < 1%)	Structural	No
Nitrate Removal Wetlands (7)	Structural	Yes
Bioreactors or Saturated Buffers	Structural	No

Figure 14 shows the original multi-practice implementation scenario provided by ISA (left) along with the modified scenario with fewer practices that was modeled in HGS (right).

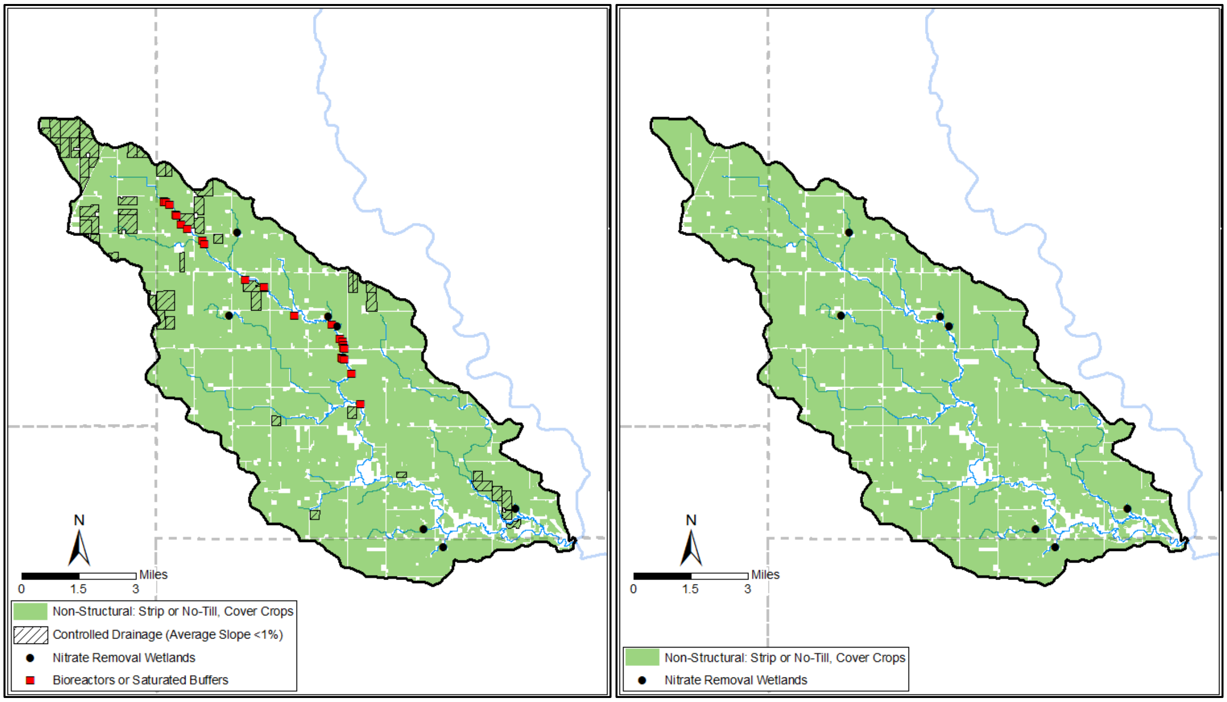

Figure 14. Comparison of the multi-practice implementation scenario provided by ISA (left) and the practices modeled in HGS (right). Controlled drainage, bioreactors, and saturated buffers were not modeled.

The two single practices from the conceptual plan modeled in HGS (no/strip-till and cover crops and nitrate removal wetlands) were simulated independently of each other and together for May 2009 to assess the individual and combined impact of practices for flow and nitrate reduction. Post-practice implementation scenarios were compared to the baseline scenario (no practices) to quantify the flow and nitrate reductions that might be possible for hydrologic conditions similar to May 2009. Results for the two individual practice scenarios and the single multi-practice implementation scenario are described below.

Scenario 1 – Non-Structural Practices: No-Till or Strip-Till, Cover Crops

Due to the flat nature of the watershed, ISA established that no-till or strip-till practices and cover crops would need to be implemented on all cropland (86.5% of the watershed area) in order to assist in meeting the water quality goal of reducing in-stream nitrogen by 41% from 2009-2011 levels. The goal of no-till or strip-till practices is to keep the soil more intact and maintain greater residue cover to reduce soil erosion losses. Fall-planted cover crops (also termed winter cover crops) are thought to provide a variety of water quality, hydrologic, and soil benefits including reduced nitrate leaching to groundwater and surface waters, reduced tile flow, improved infiltration, increased soil organic matter and soil moisture retention, and reduced erosion and soil losses (Malone et al., 2014). Common cover crops include clovers, annual and cereal ryegrasses, winter wheat, and oilseed radish (Mutch, 2010).

The impacts of conservation tillage practices and fall-planted cover crops on agricultural lands were represented in HGS through changes to surface roughness, infiltration rate, and the initial nitrate concentration assumed for the tile drainage subsurface layer. Fall-planted winter cover crops have been shown to increase surface roughness (Dabney, 1998), particularly when spring crops (corn/soybeans) are planted directly into the remaining cover crop residue. To represent increased surface roughness due to cover crops, the Manning's n-value assigned to agricultural land use was increased by 40%. An increase of 40% was selected based on comparing the relative differences in Manning's n-values reported for fallow and cultivated soils with residue (*Urban Hydrology for Small Watersheds*, 1986). Cover crops and conservation tillage practices have also been shown to increase a soil's minimum infiltration rate by variable amounts, ranging from approximately 30% to well over 100% in some studies (Folorunso et al. 1992; Dabney, 1998). To represent increased infiltration characteristics, the saturated hydraulic conductivity of all soils was increased by a logarithmic factor of 1.3. Finally, the uptake of residual nitrogen in the soil column by fall-planted cover crops has been shown to potentially reduce annual nitrate loss in tile drain flow across the Midwest by over 40% (Malone et al., 2014). Because HGS does not account for nitrogen losses due to plant processing, this key feature of cover crops was represented in HGS by reducing the fixed nitrate concentration in the tile drainage subsurface layer from its baseline value of 25 mg/L. Simulations were performed assuming 20% (C_o = 20 mg/L), 40% (C_o = 15 mg/L), and 60% (C_o = 10 mg/L) reductions in tile flow nitrate concentration due to cover crop uptake.

A summary of model parameter adjustments made for the no/strip-till and cover crop scenario is provided in Table 3.

Table 3. Summary of HGS model parameter adjustments for the no/strip-till and cover crop single practice scenario.

Cover Crop and/or Conservation Tillage Effect	*Representation in HydroGeoSphere*	*Change to Model Input Parameter*	*Literature Sources*	*Literature Findings*
Increased surface roughness	Increase Manning's n defined for agricultural land use	Increase n by 40%	Dabney, 1998; *Urban Hydrology for Small Watersheds* (1986)	20% increase in n for < 20% residue cover; 240% increase in n for > 20% residue cover compared to fallow field (no residue)
Increased infiltration	Increase saturated hydraulic conductivity, K_{sat}	Increase K_{sat} by logarithmic factor of 1.3	Folorunso et al. 1992; Dabney, 1998	Reported K_{sat} increases of 37-147%
Reduction of available nitrate in subsurface and tile water due to cover crop uptake	Reduce nitrate concentration in tile drainage layer	Reduce C_o (25 mg/L) by 20%, 40%, and 60%	Malone et al., 2014	Potential load reductions of over 40% in annual nitrate in agricultural drain flow possible across the Midwest

The simulated hydrograph, nitrate concentration, and nitrate load curves at the watershed outlet for the no/strip-till and cover crop scenario (dashed lines) are compared against the baseline scenario (solid lines) in Figures 15-17 for 20%, 40%, and 60% assumed reductions in the tile flow nitrate concentration due to cover crop uptake, respectively. Evident from the pre- and post-practice hydrographs, conservation tillage and cover crops provide a relatively small flow reduction benefit for the hydrologic conditions of May 2009. The cover crops and conservation tillage reduce the first peak discharge occurring on April 28th by 1.7% and the second peak discharge occurring between May 10th and 11th by 2.8%, reflecting the relatively unaltered infiltration capacity of the cover crop and conservation tillage-influenced landscape even after the first major rain event. The reduction in runoff volume over the simulation period is also relatively small (0.4%). The relatively small hydrologic impact simulated by the non-structural practices is in part due to the flat topography of the watershed. Because of the lack of slope across the landscape to help generate surface runoff, infiltration is relatively high to begin with for the existing conditions scenario. As a result, further increasing infiltration to represent one effect of cover crops has a fairly minimal impact. The hydrologic impact of increased infiltration due to cover crops is expected to be more significant in areas where existing infiltration is lower.

The nitrate load reductions are more significant and are largely driven by the decrease in subsurface nitrate concentration due to cover crop uptake. Approximately 15%, 28%, and 41% nitrate load reductions were predicted over the simulation period for the 20%, 40%, and 60% tile flow concentration reduction cases, respectively.

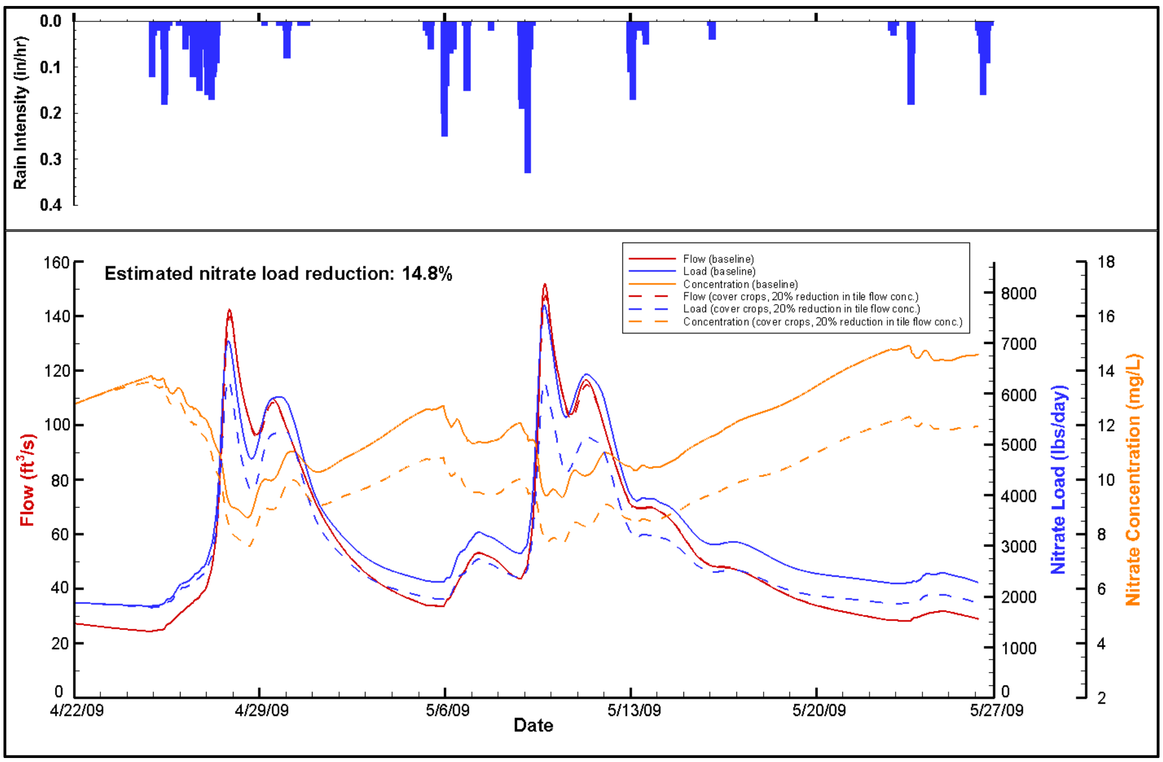

Figure 15. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the no/strip-till and cover crops scenario (20% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

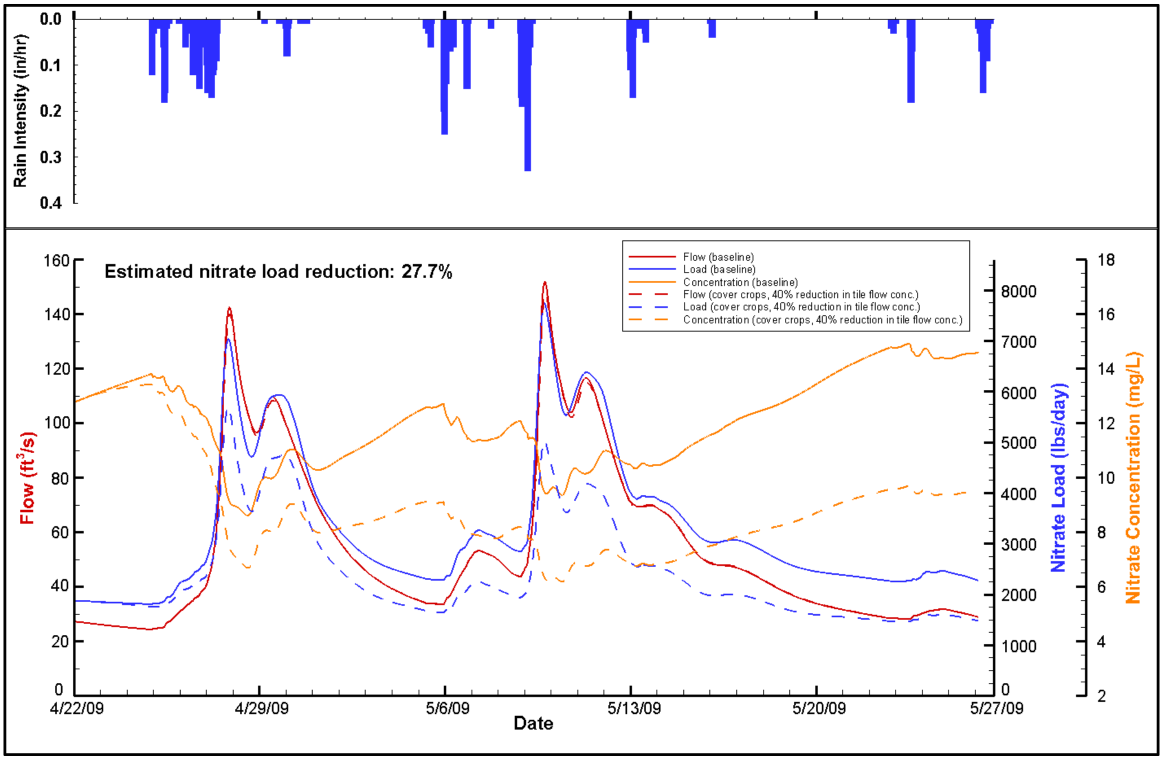

Figure 16. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the no/strip-till and cover crops scenario (40% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

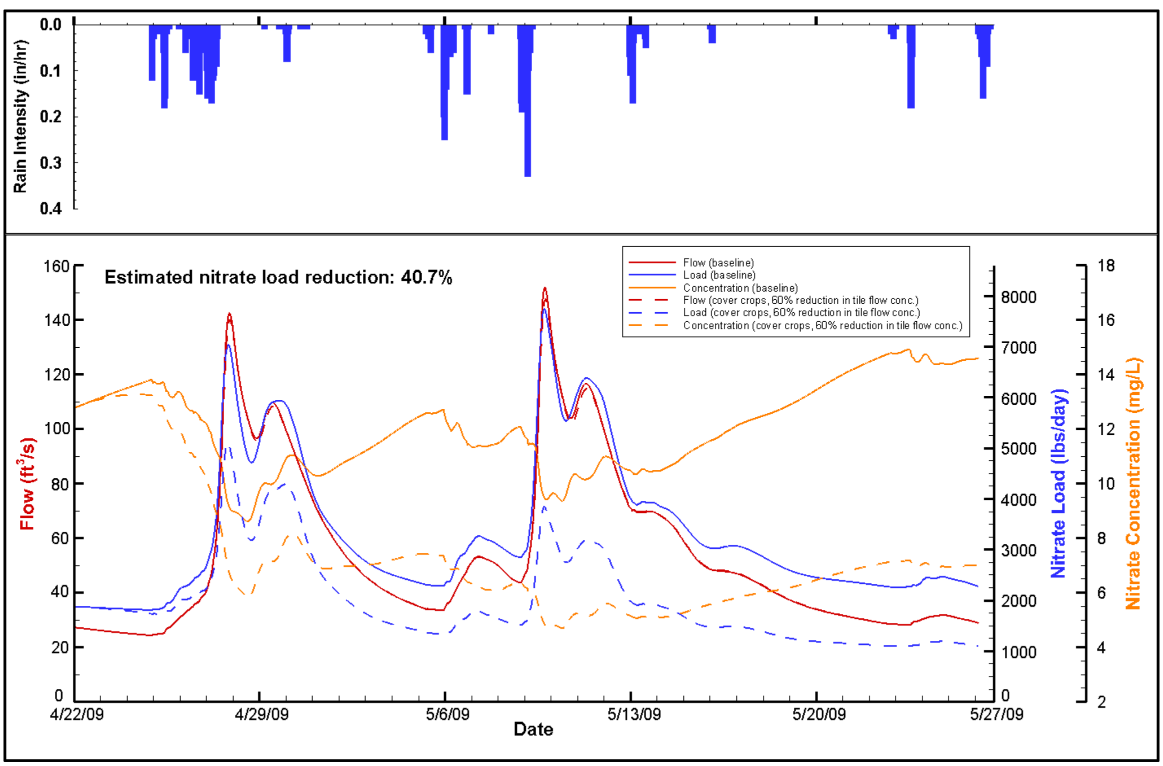

Figure 17. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the no/strip-till and cover crops scenario (60% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

Scenario 2 – Structural Practices: Nitrate Removal Wetlands (7)

ISA also identified seven possible locations in the watershed for implementation of nitrate removal wetlands. These wetlands would be placed at strategic locations to intercept and store nitrate-contaminated tile water so a greater amount of denitrification could occur by natural and microbial processes. The wetlands will likely abide by the design guidelines provided by the Iowa Conservation Reserve Enhancement Program (CREP), which has specific design guidelines to maximize nitrate removal. In general, nitrate removal from wetlands or other water storage structures like ponds is a function of residence time; the more time the contaminated water has to reside in the wetland, the more denitrification that can occur from microbial processes. Although CREP-style wetlands are intended primarily for water quality, they can also provide some water quantity benefits. Wetlands can store the tile and surface runoff water from rain events temporarily and release it back to the stream at a lower rate than if the wetland were not present, resulting in peak flow reductions that are largest directly downstream of the structures.

To gain a sense for the potential water quality and quantity benefits provided by the seven nitrate removal wetlands, a surface storage parameter known as the depressional storage height was modified in HGS at the wetland locations to represent the presence of a dam. In the absence of specific wetland sizing and outlet structure design criteria, this method provides a reasonable way to estimate the potential impact of the proposed nitrate removal wetlands. Depressional storage refers to surface storage features such as undulations, depressions, and pits in the landscape that store water and prevent it from continuously flowing. The depressional storage height represents the amount of storage that must be filled before any lateral surface flow can occur. Two wetland scenarios were run in which the depressional storage height of the elements corresponding to each wetland outlet location was set to one meter or two meters to represent a hypothetical dam height. Once the collected runoff reaches the depressional storage height, water can flow out of the selected elements, similar to how outflow from a constructed pond or wetland occurs when the water level exceeds the outflow structure (pipe or spillway) elevation. Depressional storage heights of one and two meters were selected based on a review of CREP wetlands already constructed in the Upper Cedar River Watershed (HUC 07080201) and in close proximity to Rock Creek. Wetlands were assumed to be initially empty to start the simulation.

As with the non-structural practice scenario, an estimate of the water quality benefit provided by the wetlands needed to be made outside of HydroGeoSphere. CREP wetlands have been shown to have 40-90% nitrate removal efficiencies (Iovanna et al., 2008; Crumpton et al, 2007). For simplicity, the wetlands were assumed to treat all the contaminated inflow water so that the outflow from each wetland was uncontaminated (100% nitrate removal efficiency). To represent this effect in HGS, the simulated nitrate load was reduced by a factor involving the "clean" water exiting the wetlands and the watershed outlet hydrograph.

The simulated hydrograph, nitrate concentration, and nitrate load curves at the watershed outlet for the two wetland scenarios (dashed lines) are compared against the baseline scenario (solid lines) in Figures 18 (1-m dam height) and 19 (2-m dam height). The seven wetlands drain a total area of approximately 6100 acres (13.6% of the watershed area). As expected, the peak flow reductions calculated at watershed outlet are less for the smaller simulated wetlands (1-m dam height) than the larger simulated wetlands (2-m dam height). The smaller wetlands reduce the peak discharge of the first (second) event by 3.5% (0.3%), while the larger wetlands reduce the peak discharge of the first (second) event by 13.5% (4.3%). In both cases, the peak reduction is less for the second major event as the wetlands' storage capacity has diminished and less of the collected runoff is detained behind the dam. The greatest peak flow reductions are expected directly downstream of the wetlands and will generally decrease moving further downstream as a smaller proportion of the upstream area is controlled or drained by wetlands. The nitrate load reductions calculated at the watershed outlet over the simulation period were similar for both wetland scenarios (8.7% for the small wetlands and 9.0% for the large wetlands).

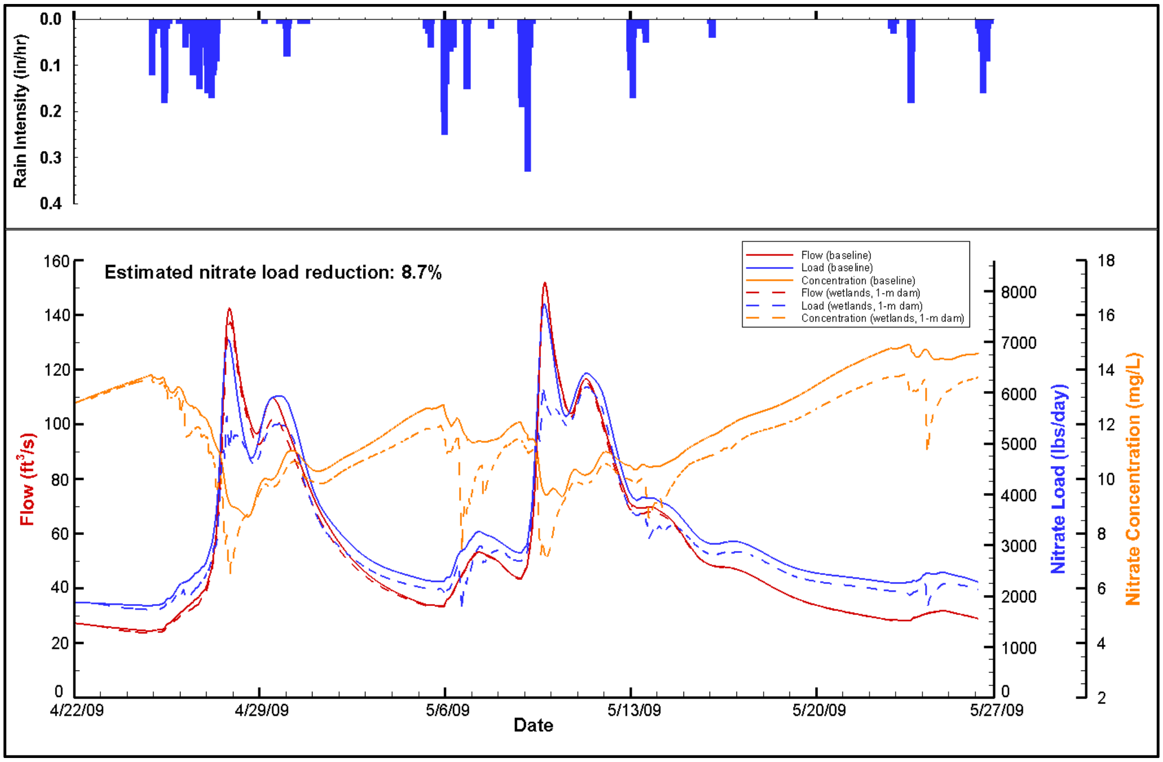

Figure 18. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the nitrate removal wetlands scenario (1-m dam height) as compared to the baseline, existing conditions scenario.

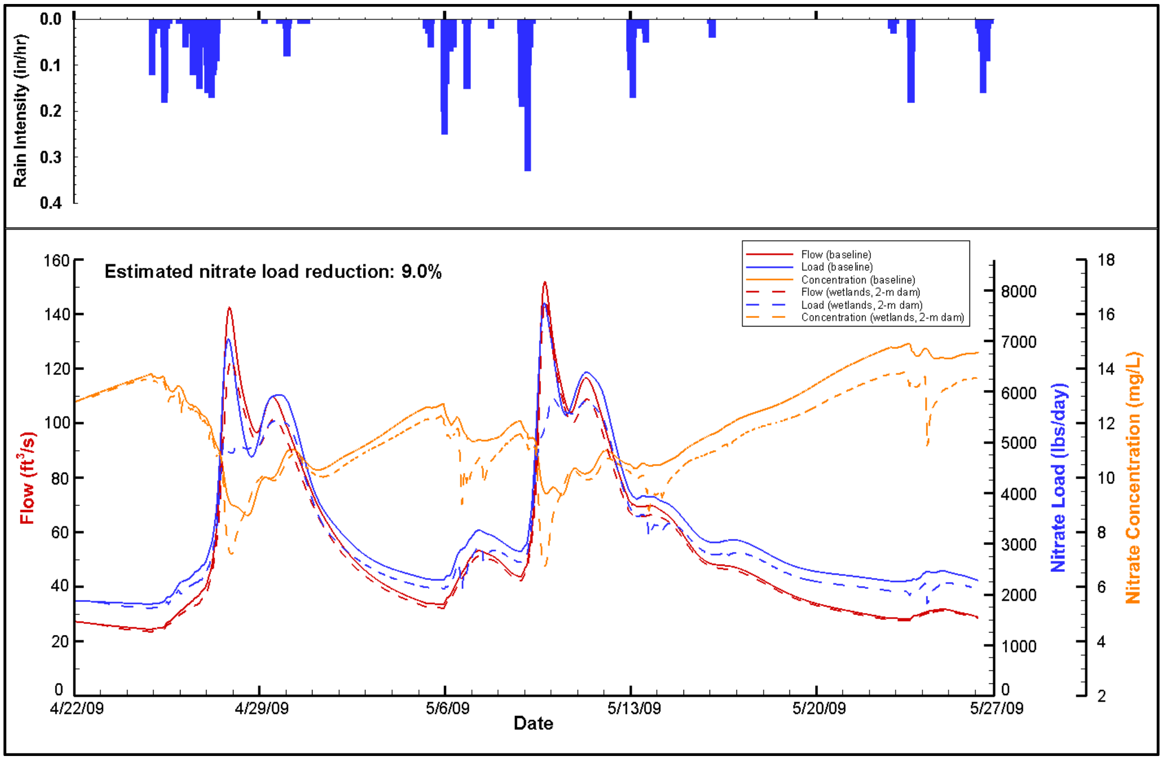

Figure 19. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the nitrate removal wetlands scenario (2-m dam height) as compared to the baseline, existing conditions scenario.

Scenario 3 – Multi-Practice Implementation: No-Till or Strip-Till, Cover Crops and Nitrate Removal Wetlands (7)

The multi-practice implementation scenario assessed the impact both no/strip-till, cover crops, and nitrate removal wetlands could have on flow and nitrate load reduction. Changes made to HGS model inputs to reflect practices were identical to those made for each individual practice scenario considered separately. Results for the multi-practice implementation scenarios (6 total) assuming 20%, 40%, and 60% reductions in the tile flow nitrate concentration due to cover crop uptake paired with either the small (1-m dam height) or large (2-m dam height) wetland scenarios are compared against the baseline scenario at the watershed outlet in Figures 20-25. The outflow hydrographs shown are the same for each respective wetland size (Figures 20, 22, and 24 for the multi-practice scenario with small wetlands; Figures 21, 23, and 25 for the multi-practice scenario with large wetlands), while the nitrate concentration and load curves differ in each figure due to the different tile flow nitrate concentrations assigned to account for crop uptake.

The peak flow reductions resulting from cover crops/small wetlands and cover crops/large wetlands scenarios for the first (second) events were 3.6% (1.1%) and 13.6% (4.7%), respectively. In both scenarios, both practices contribute to a greater peak flow reduction for the first event than was observed from either practice separately. For the second event, however, the multi-practice scenario with the smaller wetlands actually has a lower peak flow reduction (1.1%) than when cover crops/conservation tillage was simulated by itself (2.8%). While this observation does not initially make intuitive sense and needs further attention, it may be possible that when the two single practice scenarios are combined, the timing of the runoff is altered such that the magnitude of the peak flow actually increases. In general, for both multi-practice scenarios involving the small and large wetlands, the wetlands contribute predominantly to the calculated peak flow reduction.

Nitrate load reductions of 22.0% (22.6%), 33.7% (34.0%), and 45.5% (45.6)% were calculated for the multi-practice scenarios with small (large) wetlands and where 20%, 40%, and 60% reductions in the tile flow concentration were assumed to account for cover crop uptake. While the peak flow reductions calculated for the multi-practice scenario with large wetlands were substantially greater than for the multi-practice scenario with small wetlands, the total runoff volume (area under hydrograph) of each scenario is fairly similar since water storage structures generally only alter the timing of runoff and not the total runoff volume. As a result, the load reductions calculated for the multi-practice scenarios with small and large wetlands are fairly similar for each respective cover crop scenario. The load reductions are greater than each practice considered separately, as expected, but less than the sum of individual practices.

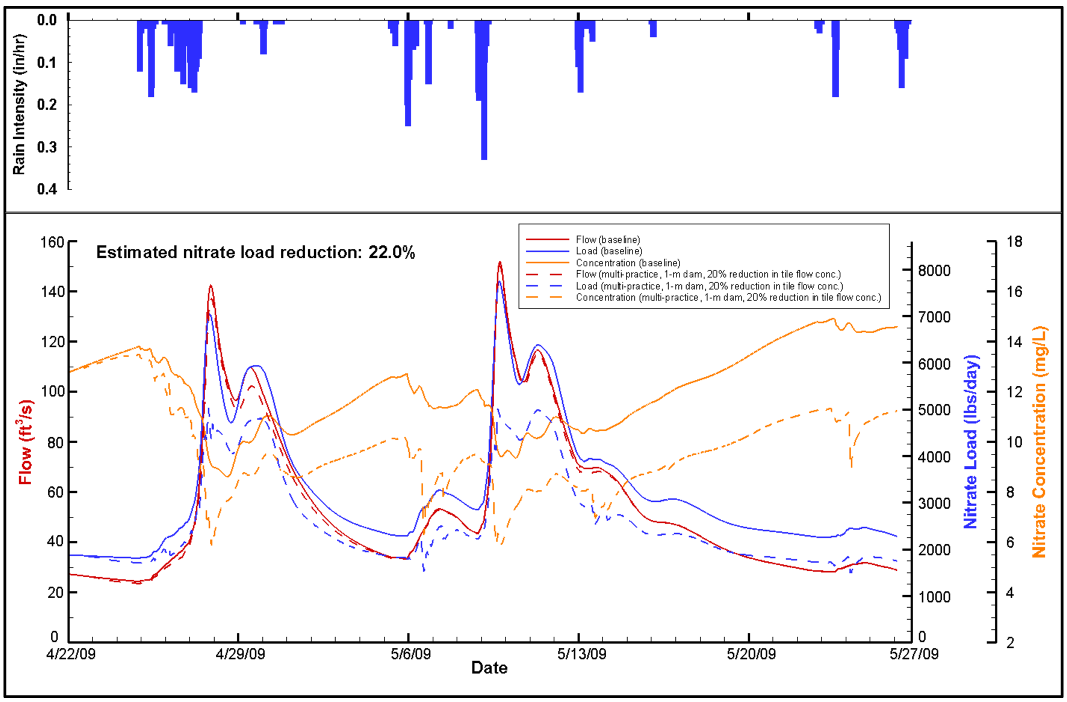

Figure 20. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (1-m dam height, 20% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

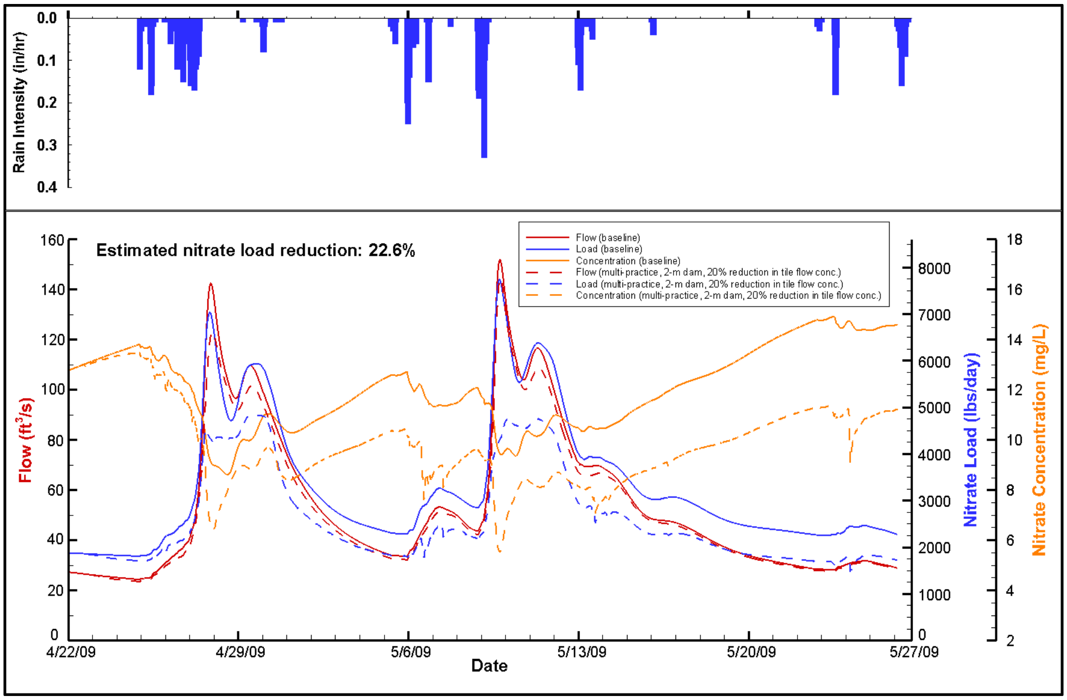

Figure 21. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (2-m dam height, 20% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

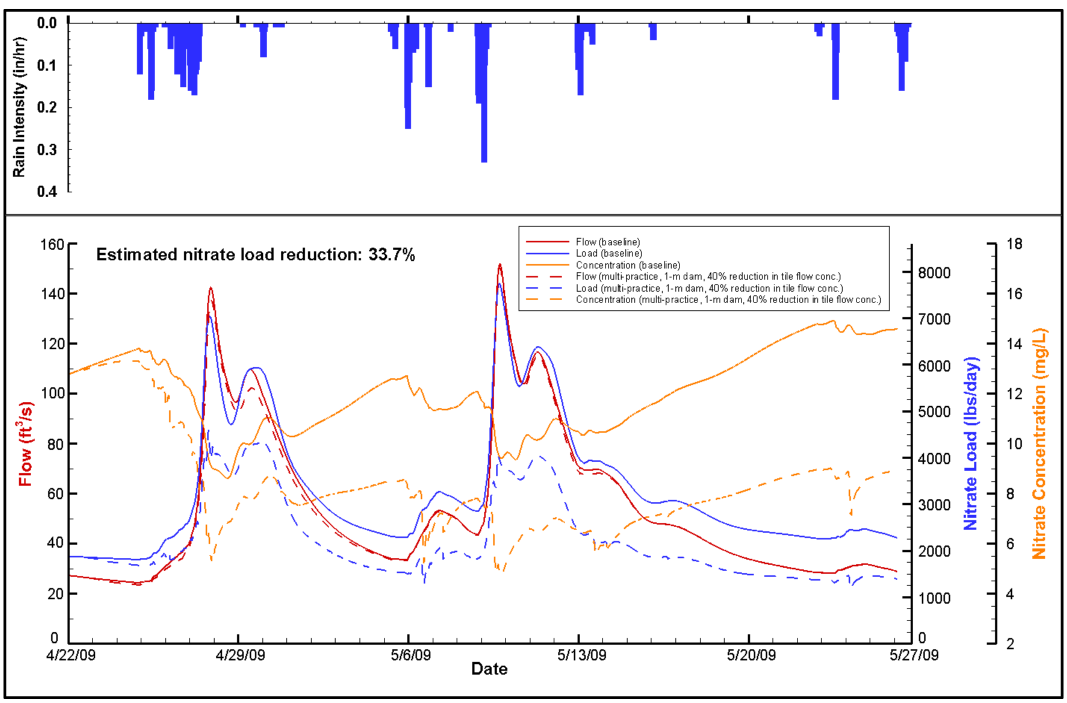

Figure 22. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (1-m dam height, 40% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

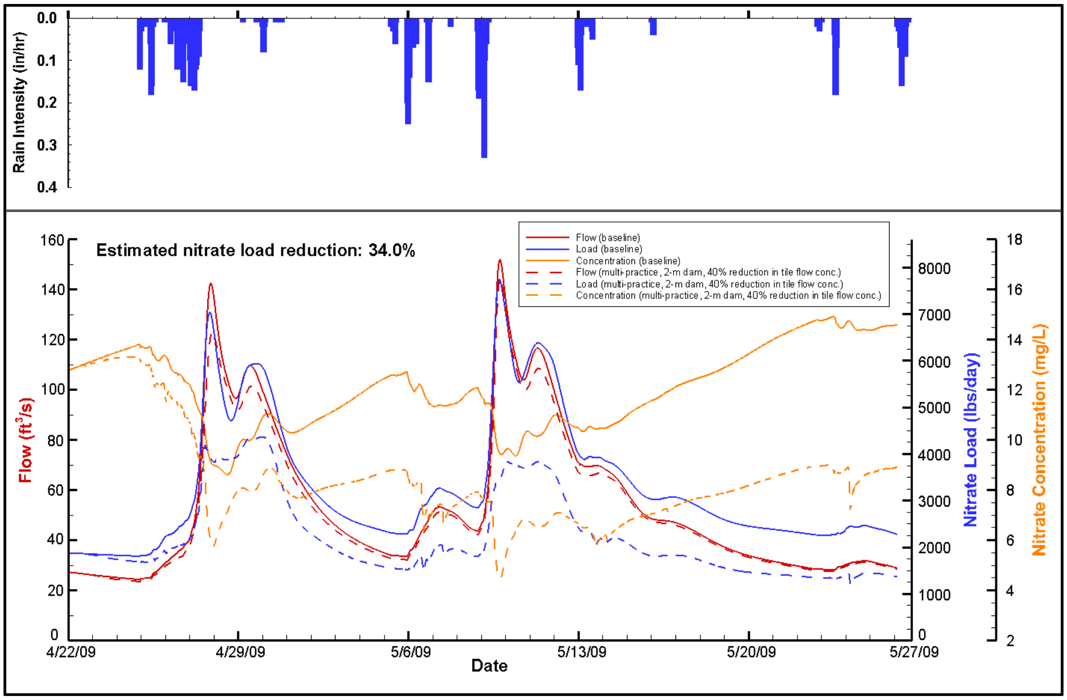

Figure 23. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (2-m dam height, 40% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

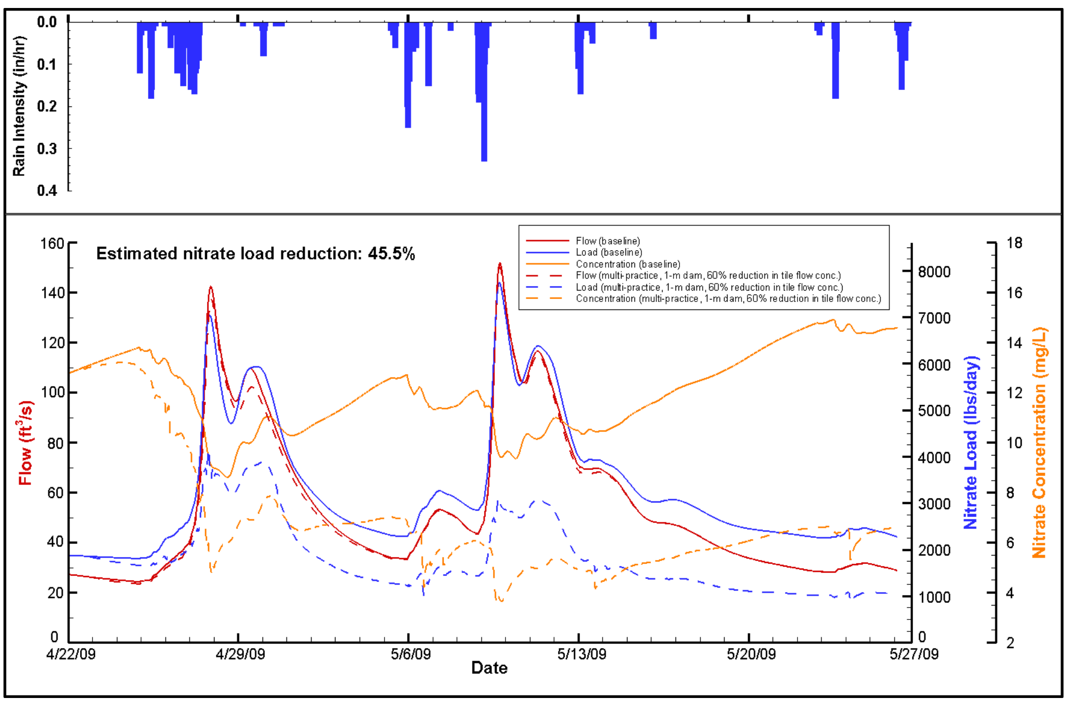

Figure 24. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (1-m dam height, 60% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

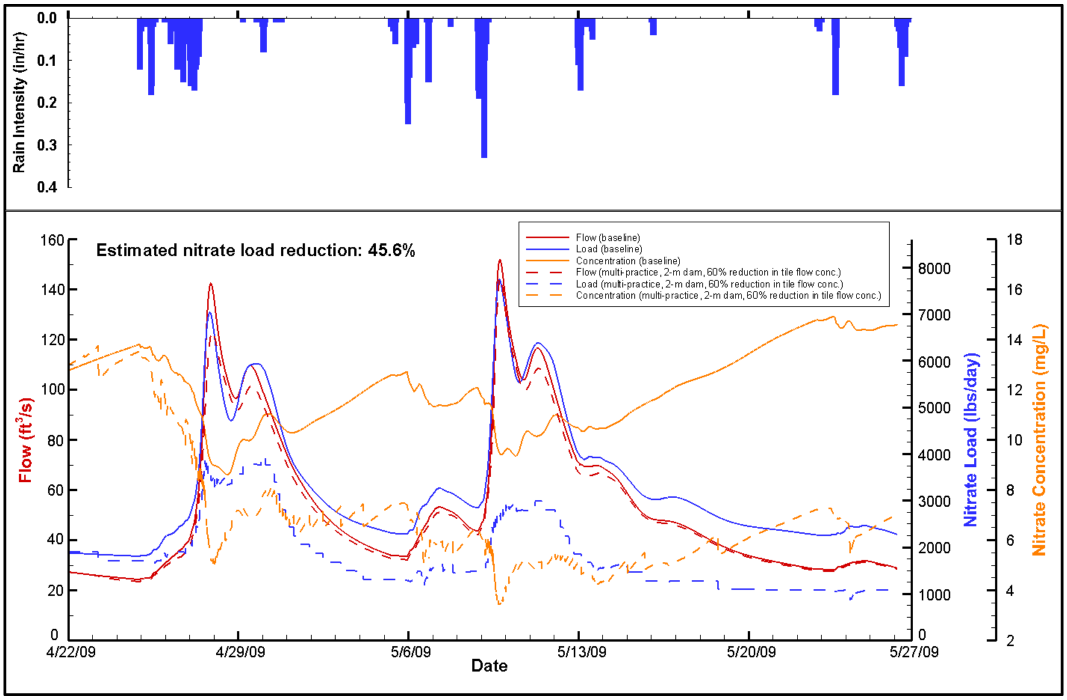

Figure 25. Simulated hydrograph and nitrate load/concentration curves at the watershed outlet for the multi-practice implementation scenario (2-m dam height, 60% reduction in tile flow concentration) as compared to the baseline, existing conditions scenario.

V. Summary and Conclusions

This report summarizes the hydrologic modeling performed for the Rock Creek Watershed to assess the impact of both structural and non-structural conservation practices for flow and nitrate reduction. Modeling was performed with HydroGeoSphere, a physically-based surface-subsurface hydrologic model, to evaluate the potential for a multi-practice implementation scenario to reduce flood risk and in-stream nitrogen levels by 41% compared to 2009-2011 levels. The month of May 2009 was selected as the simulation period, for which relatively typical rather than extreme hydrologic/meteorologic conditions existed. The hypothetical multi-practice implementation scenario was defined by (1) no/strip-till and cover crops on all cropland and (2) seven nitrate removal wetlands located throughout the watershed. Different nitrogen uptake rates by cover crops and the effect of wetland size on flow and load reductions were analyzed. The flow and nitrate reductions predicted for each single practice scenario and the combined multi-practice implementation scenario for the simulation period (May 2009) are summarized in Table 4.

Table 4. Summary of maximum peak flow and nitrate load reductions estimated at the outlet of Rock Creek for the single and multi-practice implementation scenarios simulated by HydroGeoSphere for May 2009.

Scenario	*Peak Discharge Reduction from Baseline Scenario*	*Nitrate Load Reduction from Baseline Scenario*
No-Till or Strip-Till, Cover Crops		
20% reduction in tile flow concentration	2.8%	14.8%
40% reduction in tile flow concentration	2.8%	27.7%
60% reduction in tile flow concentration	2.8%	40.7%
Nitrate Removal Wetlands (7)		
1-m (3-ft) dam height	3.5%	8.7%
2-m (6.5-ft) dam height	13.5%	9.0%
Multi-Practice Implementation Scenario		
1-m dam height and cover crops 20% reduction in tile flow concentration	3.6%	22.0%
1-m dam height and cover crops 40% reduction in tile flow concentration	3.6%	33.7%
1-m dam height and cover crops 60% reduction in tile flow concentration	3.6%	45.5%
2-m dam height and cover crops 20% reduction in tile flow concentration	13.6%	22.6%
2-m dam height and cover crops 40% reduction in tile flow concentration	13.6%	34.0%
2-m dam height and cover crops 60% reduction in tile flow concentration	13.6%	45.6%

Peak flow and load reductions estimated for the multi-practice implementation scenario consisting of conservation tillage, cover crops, and several nitrate removal wetlands are expected to vary depending on several factors including cover crop nitrogen uptake rate, wetland size, and hydrologic conditions. Because of the watershed's flat topography, infiltration for existing conditions is expected to be relatively high to begin with, so the non-structural practices simulated provided a relatively small additional flow reduction benefit. More noticeable peak flow reductions may possibly be achieved by storing excess runoff on the landscape with wetlands, but implementation of this structural practice in the watershed is somewhat limited by the watershed's lack of topographic relief. The conservation practices considered showed the potential to reduce nitrate loading by approximately 22-46% in the watershed for hydrologic conditions similar to 2009, depending in large part on cover crop efficiency for uptake of excess nitrogen stored in the soil. As a final note, it is important to recognize that the flow and load reductions calculated reflect one set of hydrologic conditions and that nitrogen processing and other biochemical processes were not explicitly represented. While the results provide insight into the types of reductions that might be achievable, practice performance is expected to vary for different hydrologic and crop conditions.

Appendix 1 – Supplementary Materials

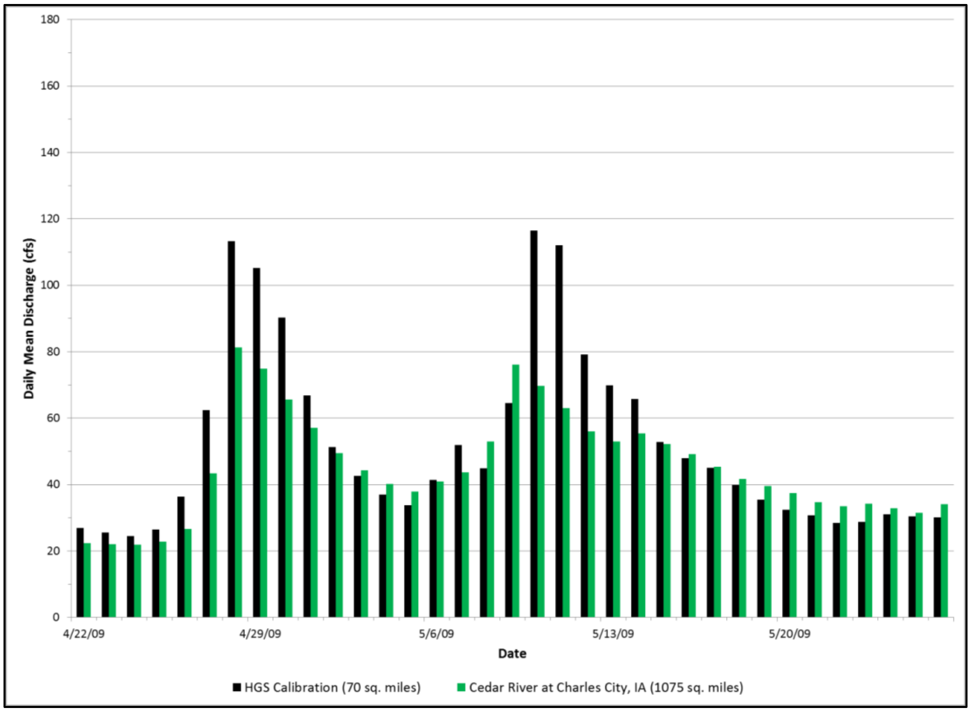

Figure 26. Comparison of simulated (black) and estimated (green) daily mean discharges using regional regression equations (USGS reference gage: Cedar River at Charles City, IA) at the outlet of Rock Creek for May 2009.

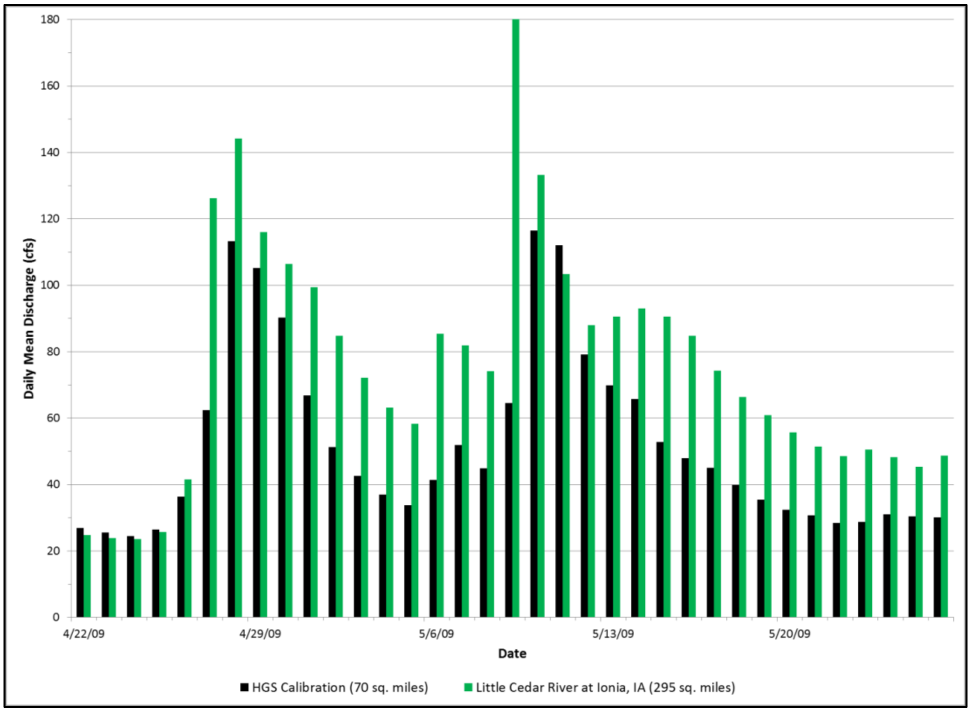

Figure 27. Comparison of simulated (black) and estimated (green) daily mean discharges using regional regression equations (USGS reference gage: Little Cedar River at Ionia, IA) at the outlet of Rock Creek for May 2009.

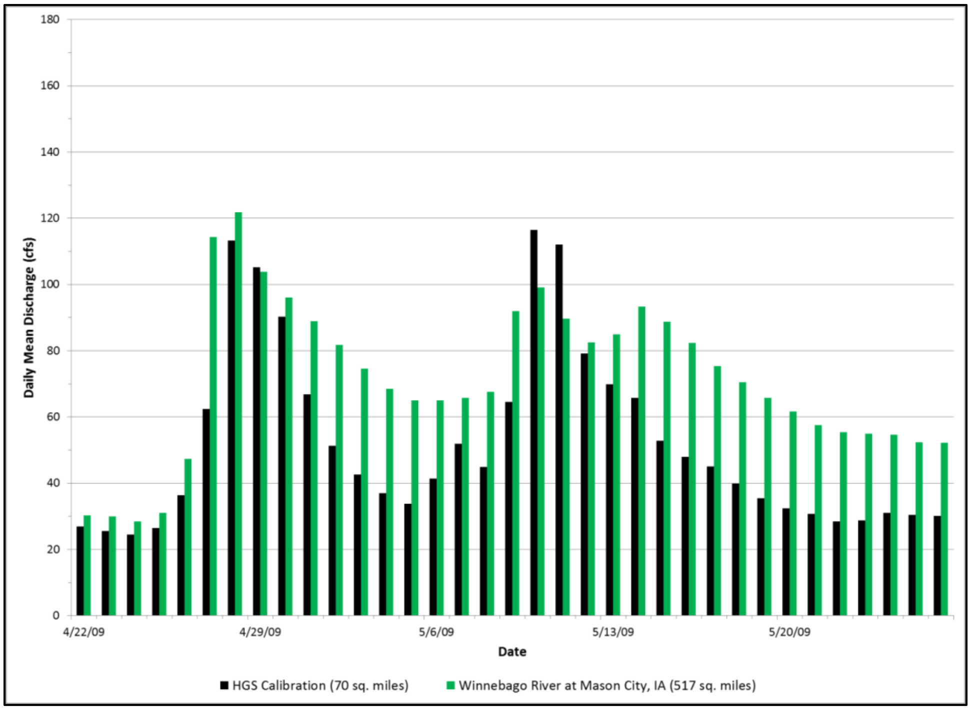

Figure 28. Comparison of simulated (black) and estimated (green) daily mean discharges using regional regression equations (USGS reference gage: Winnebago River at Mason City, IA) at the outlet of Rock Creek for May 2009.

Appendix 2 – References

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Appendix J

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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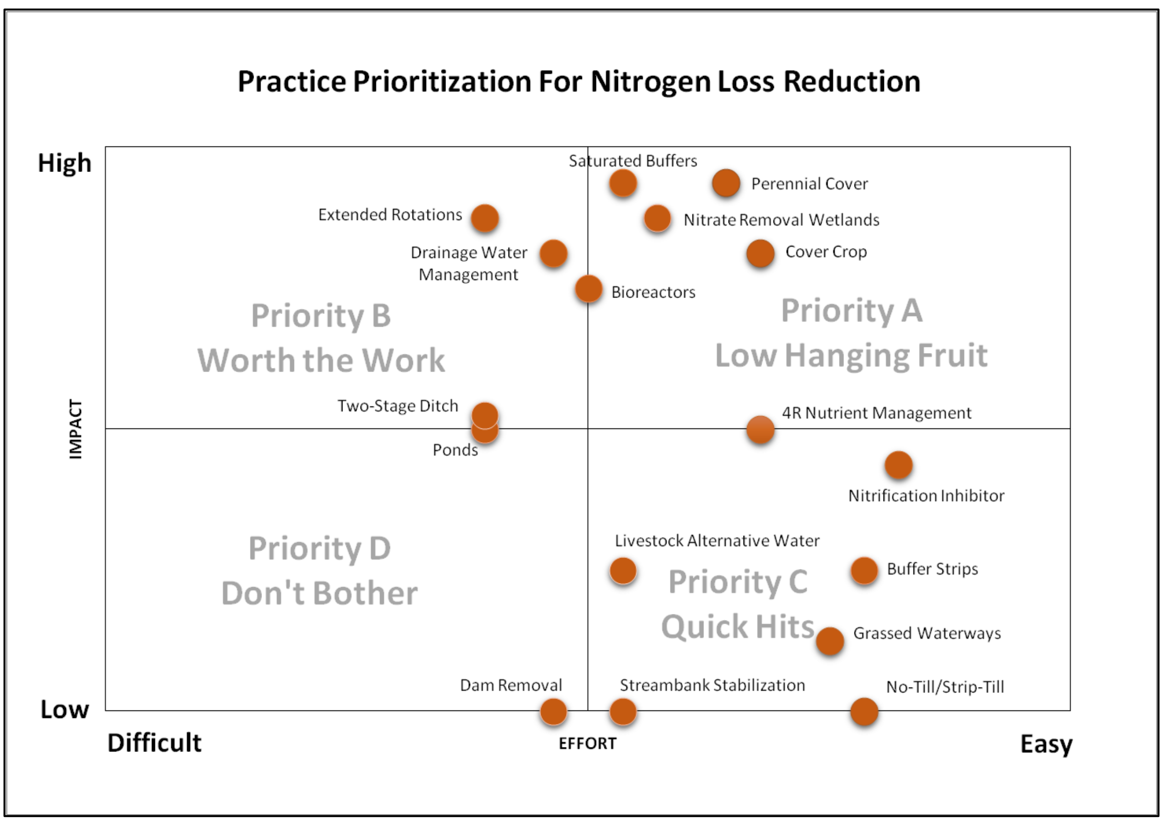
IOWA STATE UNIVERSITY
Extension and Outreach

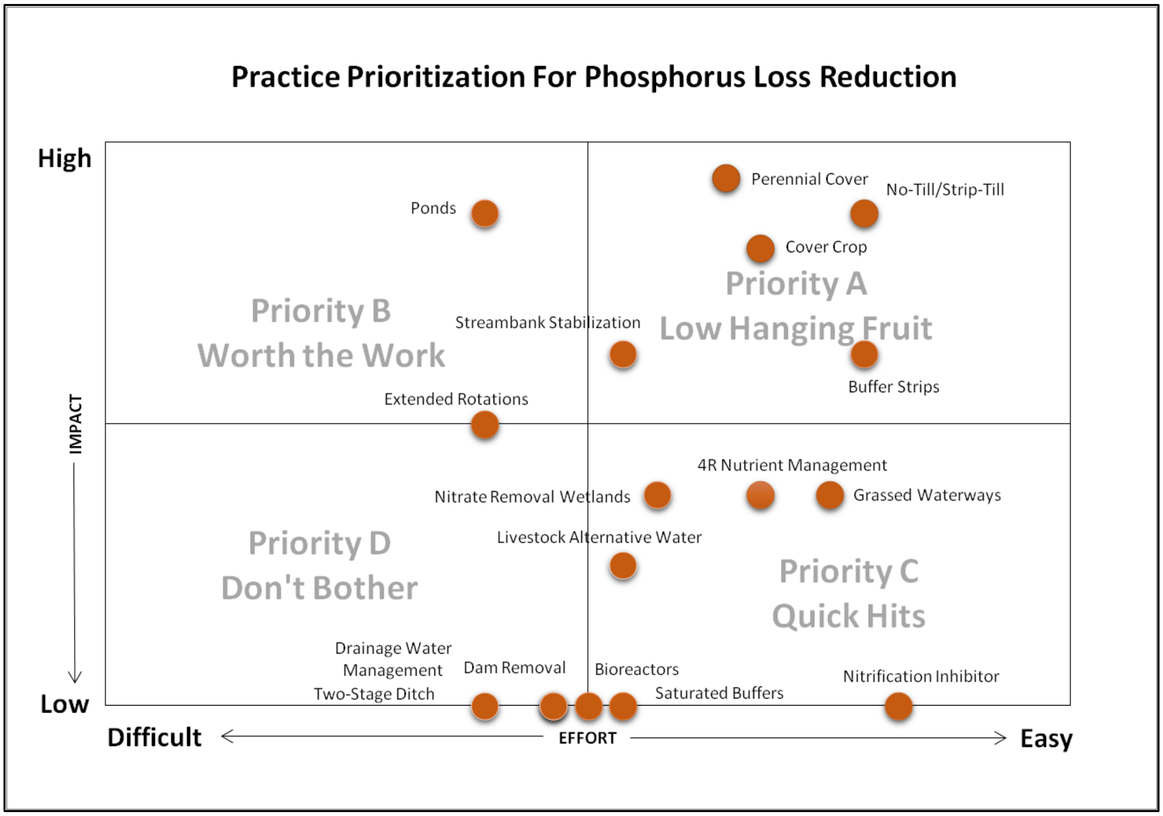
Appendix K

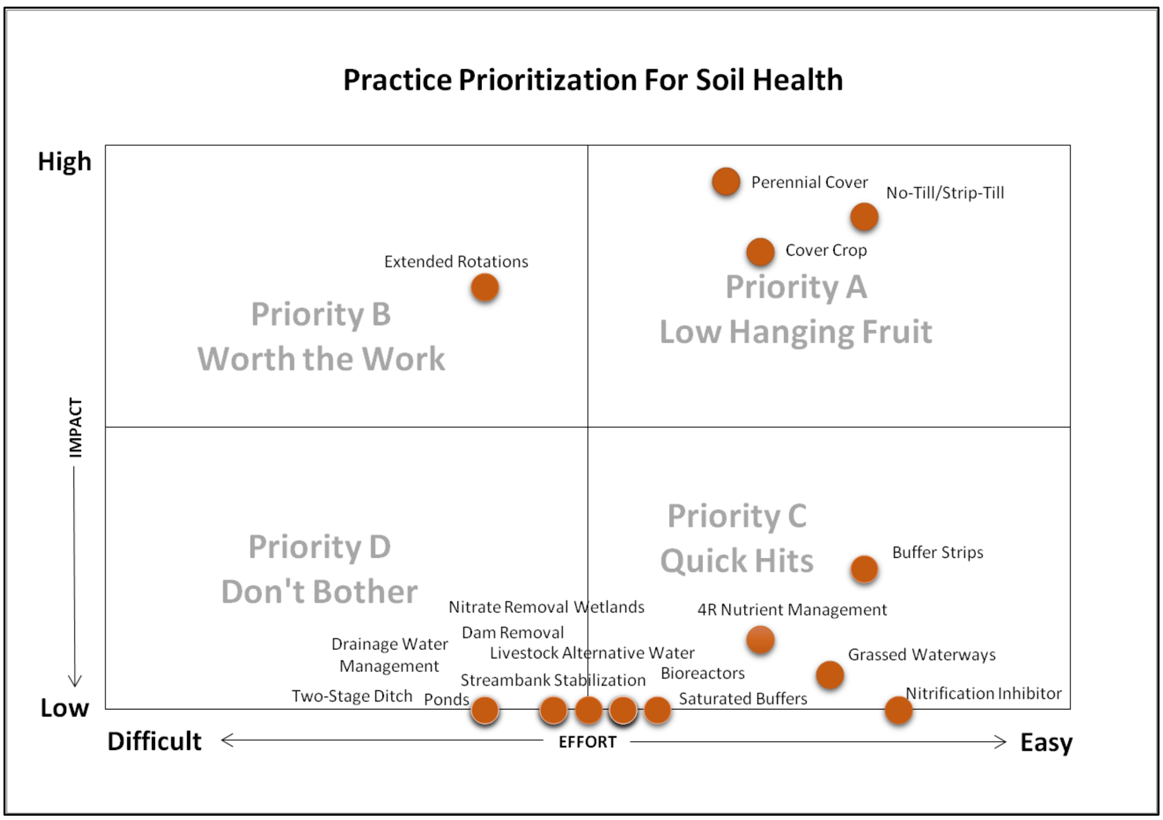
IMPACT/EFFORT MATRIX

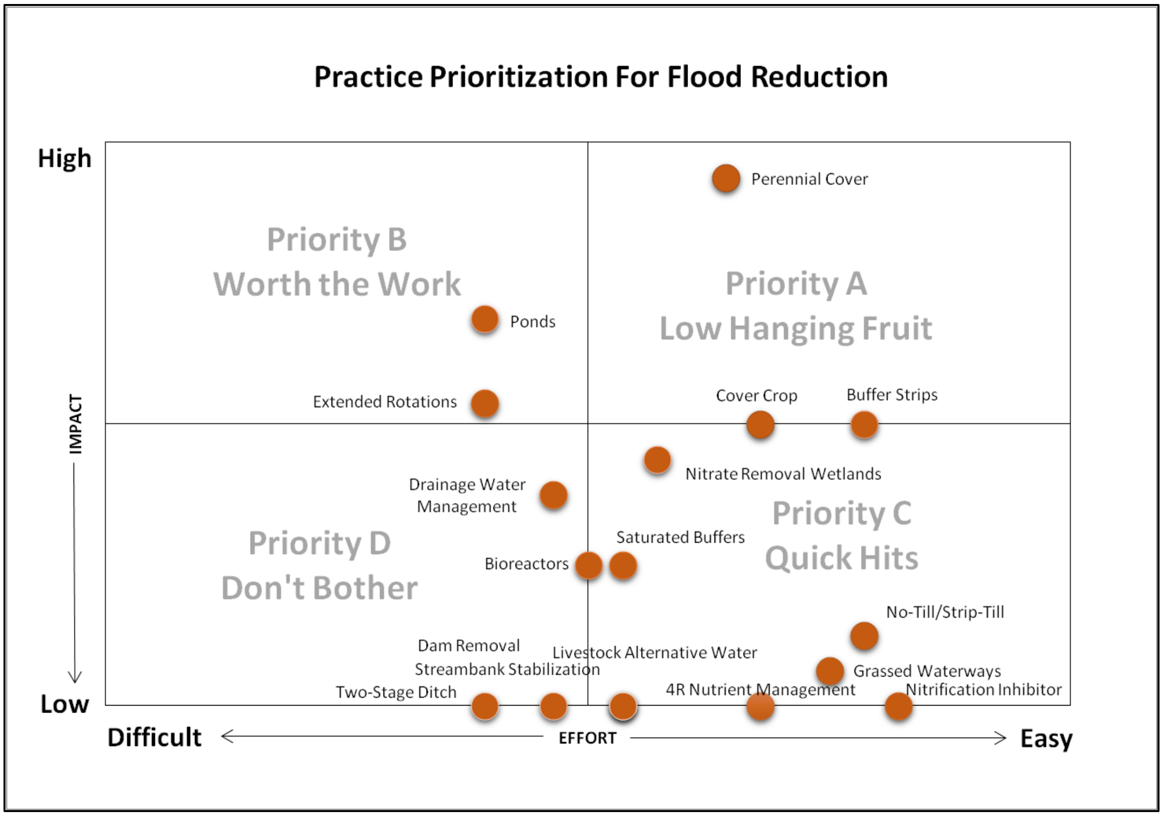
Impact/Effort Matrix

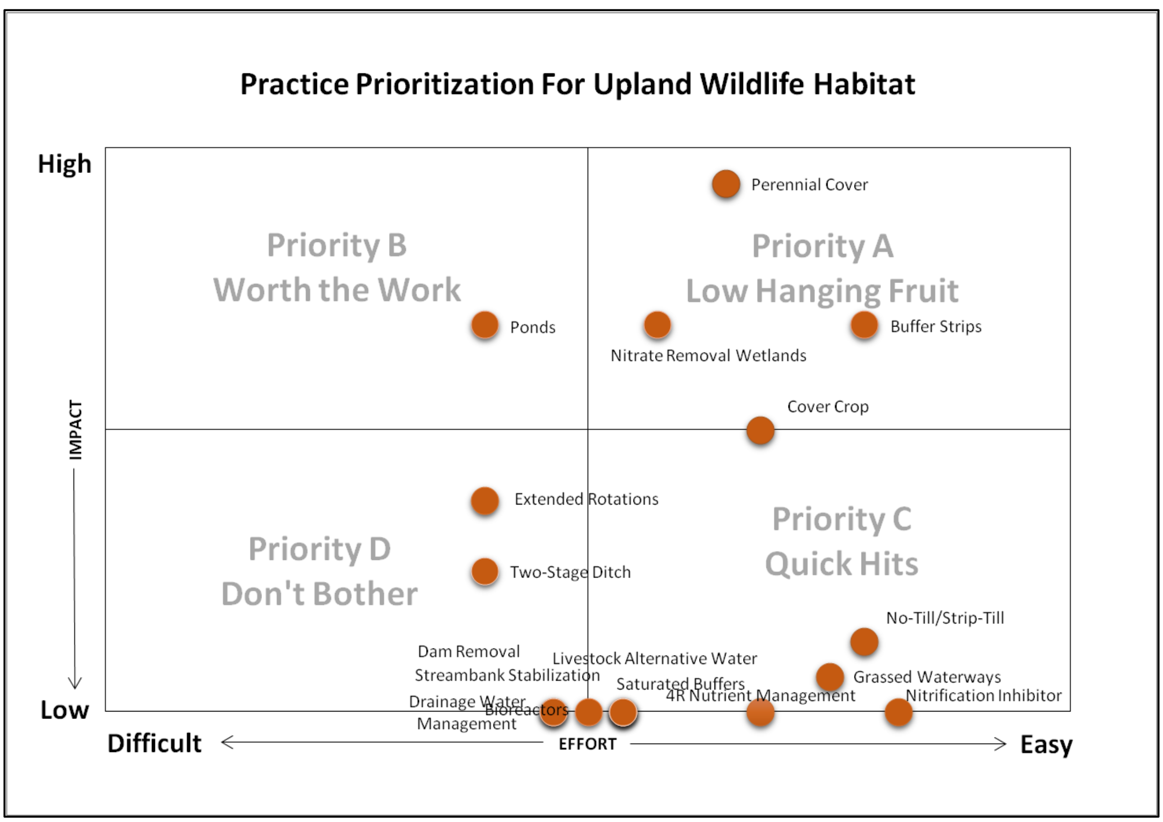
The Impact/Effort Matrix was a tool used during the Rock Creek watershed planning process to help the group decide which conservation practices should be the focus of the watershed plan and specifically the best management practice implementation scenario. The impact/effort tool was presented in the University of Wisconsin Office of Quality Improvement Facilitator Tool Kit document. The impact/effort exercise was lead by staff from the Iowa Soybean Association. Farmer participants were asked to rate the "effort" they thought it would take to accomplish an action, such as install a pond. The "effort" included all components of installation, including time, lost productivity, cost, maintenance, etc. Staff from the Iowa Soybean Association then rated each practice's impact relative to each goal included in the Rock Creek Watershed Plan, the higher the impact score the more benefit that practice provides. A matrix was then developed for each goal showing how all conservation practices scored for both effort and impact. The matrices were used to identify practices most suited for the best management practice implementation scenario. Practices in the "Priority A" category are those that will make the most difference for the least amount of effort. Practices in "Priority B" provide benefit but the effort is greater. Practices in "Priority C" provide little benefit but may be easily implemented. Practices in "Priority D" should not be implemented relative that that particular goal, these practices are difficult and provide little benefit.

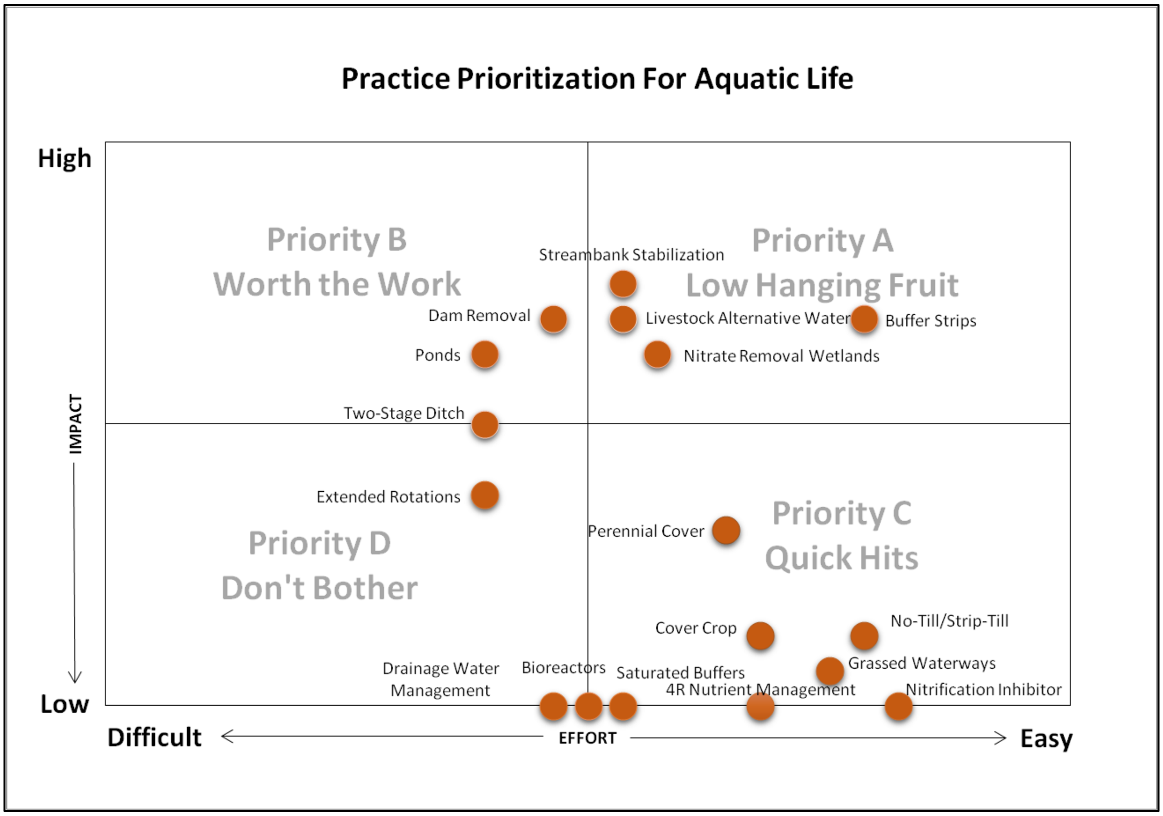



Practice Prioritization For Phosphorus Loss Reduction
High
Low
IMPACT
Difficult
Easy
EFFORT
Priority B
Worth the Work
Priority A
Low Hanging Fruit
Priority D
Don't Bother
Priority C
Quick Hits
Perennial Cover
No-Till/Strip-Till
Ponds
Cover Crop
Streambank Stabilization
Buffer Strips
Extended Rotations
4R Nutrient Management
Nitrate Removal Wetlands
Grassed Waterways
Livestock Alternative Water
Drainage Water Management
Dam Removal
Bioreactors
Nitrification Inhibitor
Two-Stage Ditch
Saturated Buffers


Practice Prioritization For Soil Health
High
Low
IMPACT
Difficult
Easy
EFFORT
Priority B
Worth the Work
Priority A
Low Hanging Fruit
Priority D
Don't Bother
Priority C
Quick Hits
Perennial Cover
No-Till/Strip-Till
Cover Crop
Extended Rotations
Buffer Strips
Nitrate Removal Wetlands
4R Nutrient Management
Dam Removal
Drainage Water Management
Livestock Alternative Water
Grassed Waterways
Bioreactors
Streambank Stabilization
Nitrification Inhibitor
Two-Stage Ditch
Ponds
Saturated Buffers


Practice Prioritization For Flood Reduction
High
Low
IMPACT
Difficult
EFFORT
Easy
Priority B
Worth the Work
Priority A
Low Hanging Fruit
Priority C
Quick Hits
Priority D
Don't Bother
Perennial Cover
Ponds
Extended Rotations
Cover Crop
Buffer Strips
Nitrate Removal Wetlands
Drainage Water Management
Saturated Buffers
Bioreactors
No-Till/Strip-Till
Dam Removal
Streambank Stabilization
Livestock Alternative Water
Grassed Waterways
Two-Stage Ditch
4R Nutrient Management
Nitrification Inhibitor


Practice Prioritization For Upland Wildlife Habitat
High
Low
IMPACT
Difficult
EFFORT
Easy
Priority B
Worth the Work
Priority A
Low Hanging Fruit
Priority C
Quick Hits
Priority D
Don't Bother
Perennial Cover
Ponds
Nitrate Removal Wetlands
Buffer Strips
Cover Crop
Extended Rotations
Two-Stage Ditch
No-Till/Strip-Till
Dam Removal
Streambank Stabilization
Livestock Alternative Water
Grassed Waterways
Saturated Buffers
4R Nutrient Management
Nitrification Inhibitor
Drainage Water Management
Bioreactors


Practice Prioritization For Aquatic Life
High
Low
IMPACT
Difficult
EFFORT
Easy
Priority B
Worth the Work
Priority A
Low Hanging Fruit
Priority C
Quick Hits
Priority D
Don't Bother
Streambank Stabilization
Dam Removal
Livestock Alternative Water
Buffer Strips
Ponds
Nitrate Removal Wetlands
Two-Stage Ditch
Extended Rotations
Perennial Cover
Cover Crop
No-Till/Strip-Till
Grassed Waterways
Drainage Water
Management
Bioreactors
Saturated Buffers
4R Nutrient Management
Nitrification Inhibitor