Lyons Creek Watershed
Management Plan for Nitrate Reduction

Vision Statement

Implement a feasible watershed management plan that balances quality of life and agriculture in the Lyons Creek watershed by maintaining productivity and prosperity, while preserving and enhancing aquatic biodiversity, water quality, and hydrologic function of the watershed

Document Approved: March 2012
Time Period Covered: 2012-2032
Update Frequency: At least once every 5 years

1. Introduction

1.1 Lyons Creek Watershed

Lyons Creek Watershed (Hydrologic Unit Code # 071000050701) is an 11,073 acre (17.3 square miles) watershed located in north-central Hamilton County, Iowa. Lyons Creek is a subwatershed of the Boone River Watershed (HUC # 7100005) which eventually drains into the Des Moines Middle Basin (HUC #07100004).

1.2 Background

In the spring of 2004, the convergence of environmental and agricultural interests in the Boone River Watershed brought Prairie Rivers of Iowa RC&D (PRRCD), the Iowa Soybean Association (ISA), and the Nature Conservancy (TNC) together to initiate a fresh approach to watershed improvement and management. The resulting Boone River Watershed project is a performance-based, watershed scale effort with a significant focus on local producers, community objectives and the integration of economics, merging environmental and agricultural goals.

In 2004, the Boone River Watershed Association was created, facilitated by the Prairie Rivers RC&D and with help from ISA, TNC, and local stakeholders. In 2008, The Nature Conservancy completed a Conservation Action Plan (CAP) for the Boone River Watershed which completed an ecological assessment of the entire basin, and defined an action strategy for the watershed. In addition, in 2007, Iowa State University Department of Natural Resources Ecology and Management (NREM) received a USDA grant to conduct a Boone River Rapid Watershed Assessment. The assessment process included multiple stakeholder meetings throughout the watershed.

Until 2007, only one IDNR ambient water monitoring site collected data on water quality within the Boone River watershed. In 2007, ISA and TNC partnered to implement baseline water monitoring at all thirty (30) HUC-12 sub-watersheds located within Boone River basin. This bi-weekly sampling, beginning in April and lasting through August, provided the initial baseline data for the entire watershed. Results from this data identified Lyons Creek as one of the sub-watersheds to target for further monitoring due to high nutrient concentrations, and prompted the BRWA to apply for an IDALS/IDNR Planning and Development Grant.

The Planning and Development grant application was approved and awarded in 2008 to the Hamilton County SWCD. The grant included funding to conduct watershed assessments, conduct water monitoring and prepare a watershed management plan. The Hamilton County SWCD sub-contracted with the Iowa Soybean Association to help prepare the watershed plan, and conduct the necessary monitoring. In 2001, Lyons Creek was placed on the Iowa 303(d) Impaired Waters List for a biological impairment from an unknown origin. Due to its pending TMDL status, ISA leveraged its resources with the Iowa Department of Natural Resources (IDNR) to assist in monitoring and data collection to be utilized in the pending TMDL.

2. Watershed Characteristics

2.1 General Watershed

Lyons Creek Watershed (LCW) is an 11,073 acre watershed dominated by 85% row crop agriculture. Lyons Creek begins as a drainage district tile and flows southwest into Webster City were the confluence with the Boone River is located. Only 8% of the watershed is within the incorporated boundaries of Webster City and considered urban. Other than road right of ways and a small publicly owned prairie preserve, the watershed is entirely privately owned.

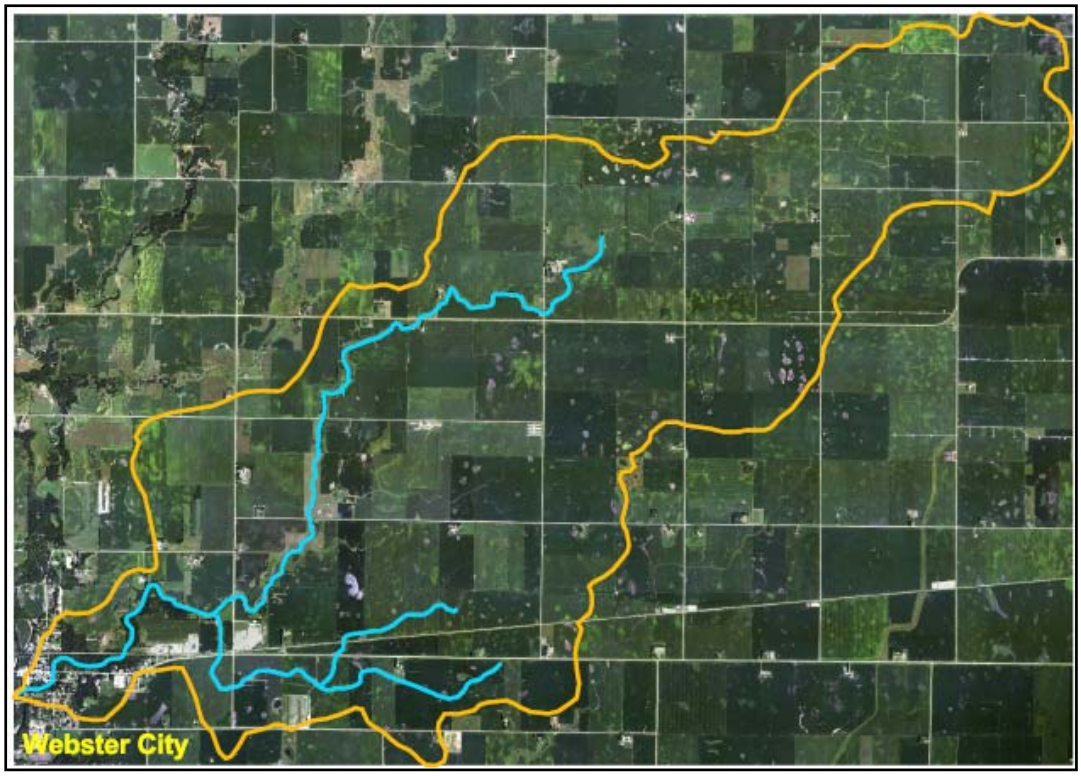


Figure 1 Lyons Creek watershed and stream

Table 1 General watershed data.

General Watershed Data – *Lyons Creek*			
Location	*Hamilton County, Iowa. Mouth (NW ¼, S6, T88N, 25W, Hamilton Co. to headwaters in S18, T89N, R24W, Hamilton Co.*	**Waterbody ID Code**	*IA 04-UDM-0215*
		Major Cities	*Webster City*
Waterbody Type	*River*	**Segment Classes**	*Class A1, Class B(WW-1)*
Watershed Area	*11,073 acres*	**Stream Length**	*15.5 miles*
Dominant Land Use	*Row Crop Agriculture*	**Owners/Operators**	*81/45*
HUC 12 Watershed	*Lyons Creek*	**HUC 12 ID**	*71000050701*
HUC 10 Watershed	*Lower Boone River*	**HUC 10 ID**	*710000507*
HUC 8 Watershed	*Boone River*	**HUC 8 ID**	*7100005*

Lyons Creek Watershed is located on the Des Moines Lobe landform region and the Western Corn Belt Plains ecoregion. The Des Moines Lobe is the most recently glaciated landscape in Iowa. As a result the area is defined by a poorly drained landscape with a poorly defined drainage network. The land is flat with areas of moraine providing gentle relief.

2.2 Hydrology

Figure 2 shows the identified stream segments within Lyons Creek Watershed consists of 1st and 2nd order streams according to the Strahler stream classification system. The National Hydrography Dataset, lists 11.9 miles of 1st order streams, and 3.6 miles of 2nd order streams in the watershed.

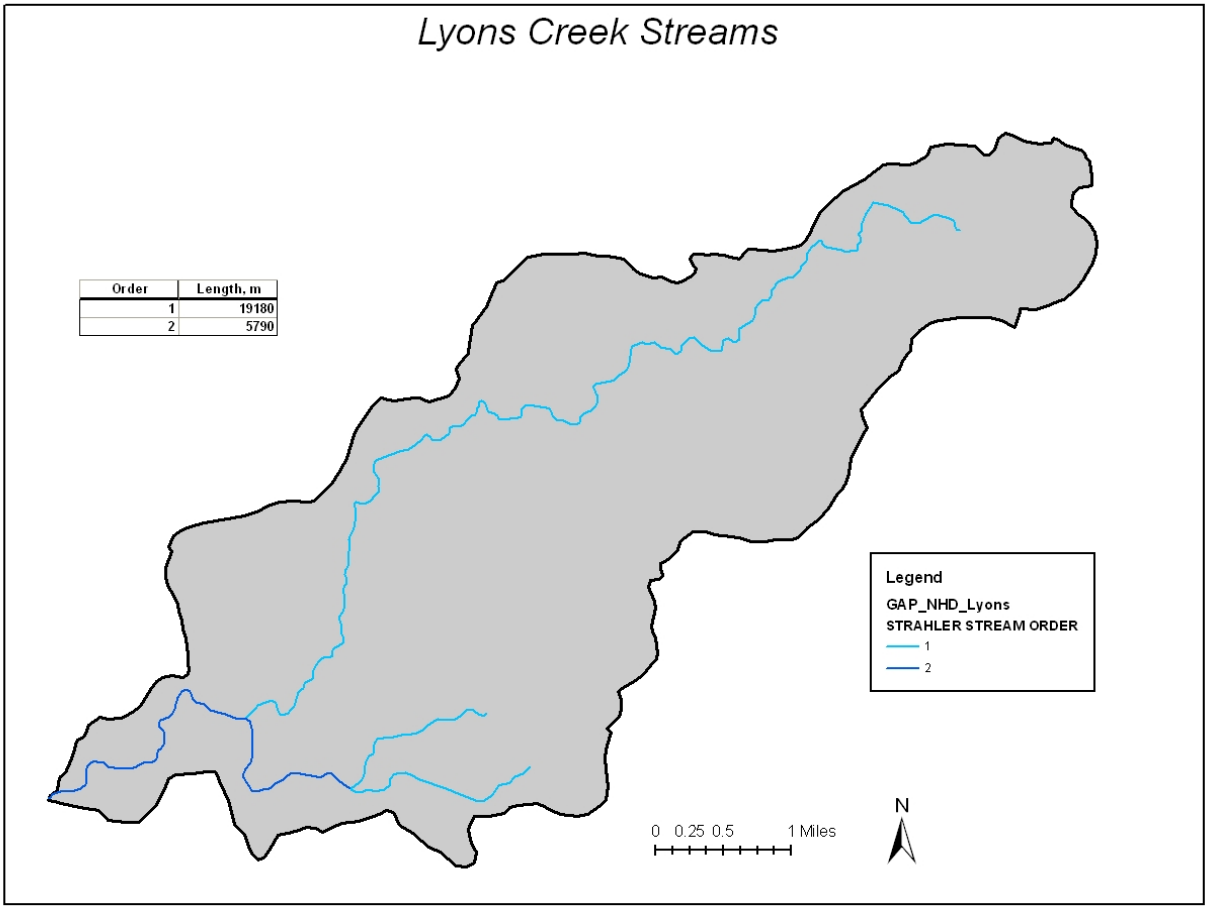


Figure 2 Lyons Creek stream orders according to the National Hydrography Dataset.

Figure 3 is a map of the identified wetlands in Lyons Creek watershed. The National Wetland Inventory data set was developed by the U.S. Fish and Wildlife Service and derived from aerial photo interpretation. The classification system was adopted as a national classification standard in 1996 by the Federal Geographic Data Committee.

The NWI maps do not show all wetlands since the maps are 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.

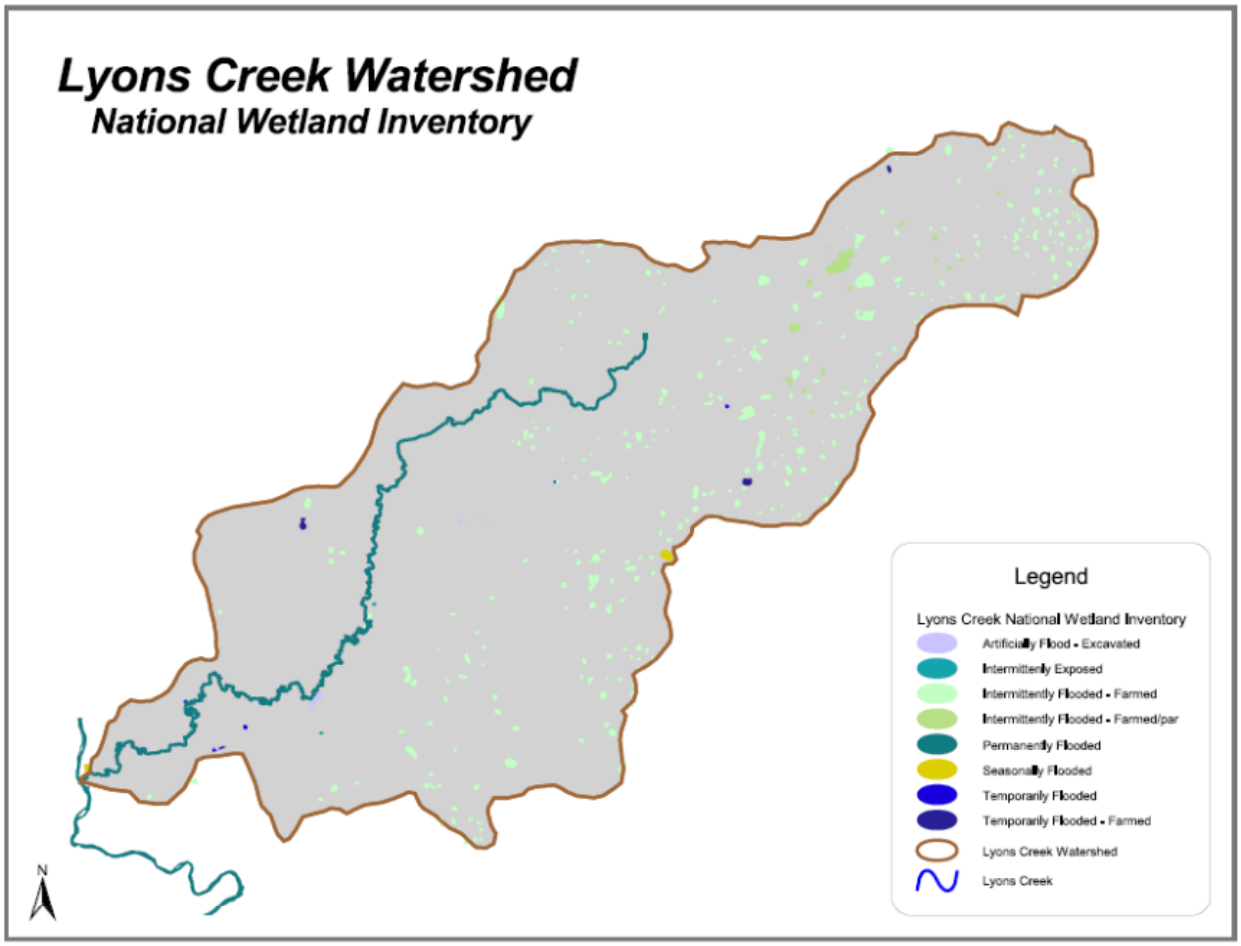


Figure 3 Wetlands within Lyons Creek Watershed according to the National Wetland Inventory.

Table 2 Classification of wetlands within Lyons Creek Watershed.

TYPE	Percent	Acres
Artificially Flood - Excavated	0.5%	3
Intermittently Exposed	0.1%	1
Intermittently Flooded - Farmed	31.9%	209
Intermittently Flooded - Farmed/partially drained	3.4%	22
Permanently Flooded	62.3%	408
Seasonally Flooded	0.7%	5
Temporarily Flooded	0.3%	2
Temporarily Flooded - Farmed	0.7%	5
Total	*100%*	*655*

Like many other watersheds in north-central Iowa, much of the land within Lyons Creek watershed is artificially drained in order to make agriculture possible. Figure 4 shows the drainage information for Lyons Creek. The Iowa DNR Geologic Survey has compiled GIS coverages of drainage district boundaries and drainage infrastructure by merging public and

county coverages. The result of this work shows over 30 miles of mapped tile lines. These coverages do not show privately owned tile networks.

Beginning in the late fall of 2008, the Iowa Soybean Association (ISA) started a Rapid Assessment of Stream Conditions Along Length (RASCAL), which involved identifying tile outlets. The inventory identified 55 tile outlets draining into the stream. It is likely that there are additional tile outlets that were not identified during the assessment.

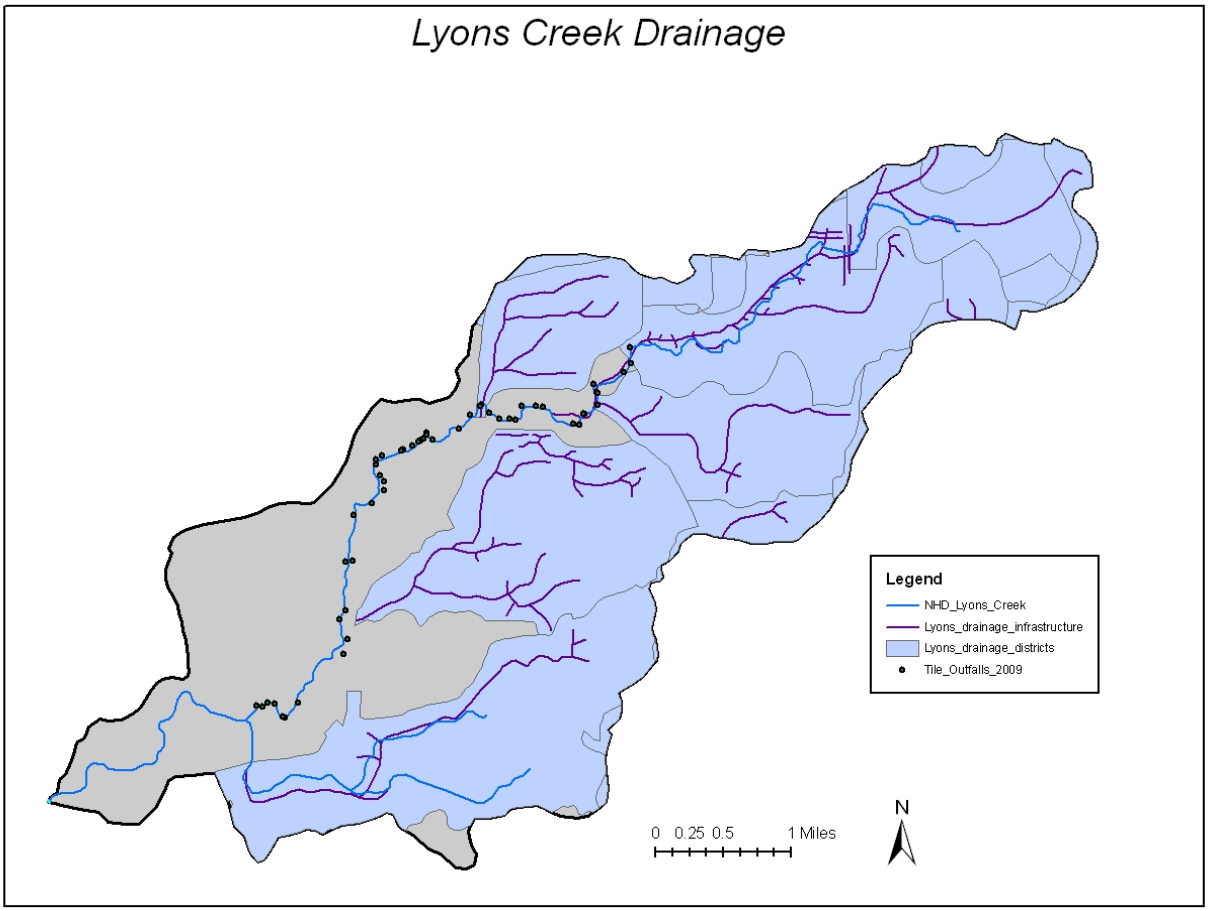


Figure 4 Identified drainage within Lyons Creek Watershed.

Figure 5 shows the slope classification which was derived from LiDAR data. The highest elevation in the watershed is 384.3 meters above sea level, and the lowest elevation within the watershed is 308.4 meters. Table 2 shows the slope classifications within the watershed. Approximately 50% of the watershed has a slope classification of B which has a range of slopes of 2 - 5%. Twenty-three percent and 20% of the watershed has slope classifications of C and A respectively.

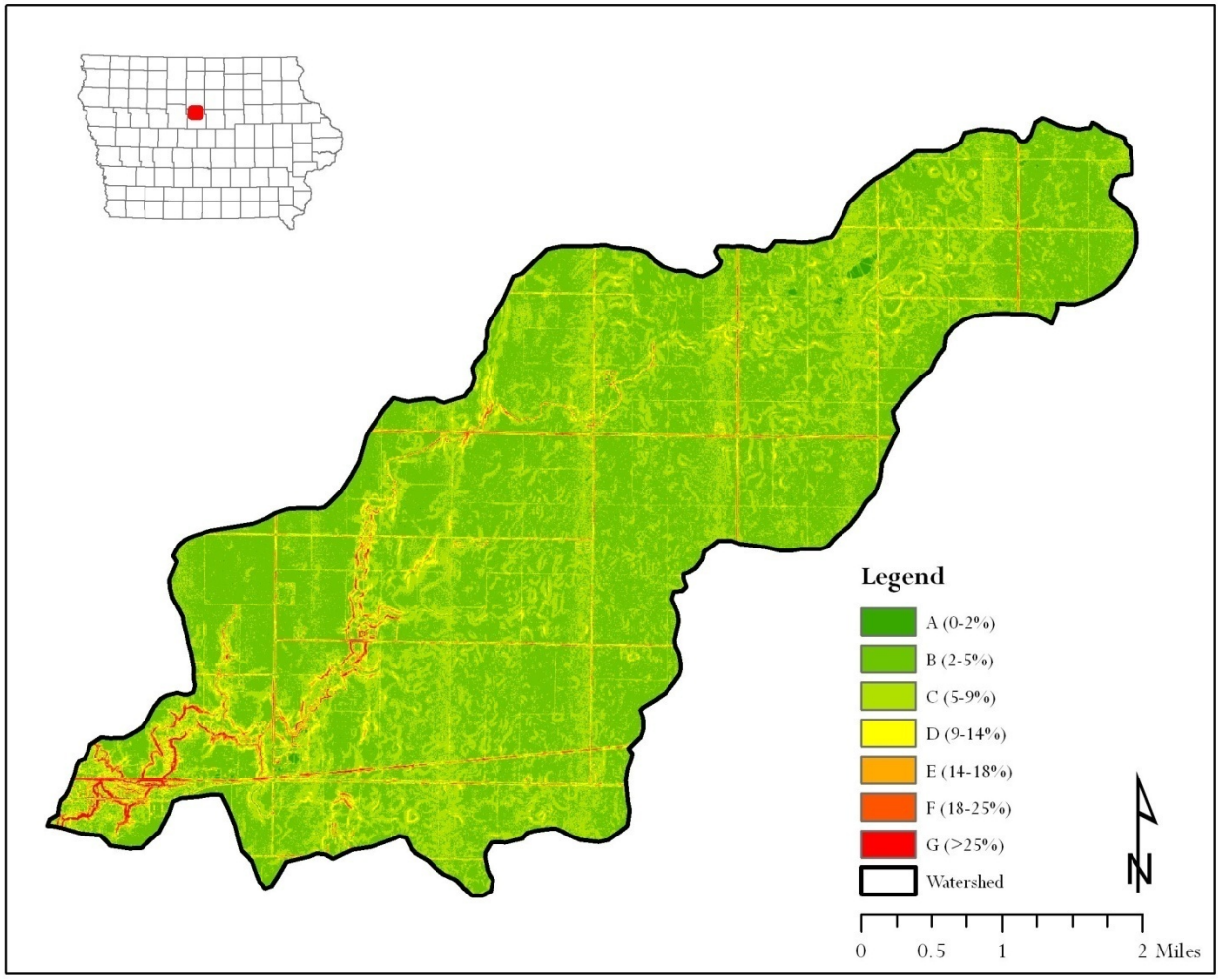


Figure 5 Lyons Creek Watershed slope classification from LiDAR Elevation Data

Table 3 Slope classifications of Lyons Creek derived from LiDAR data.

Slope Classification	Range	Area, acres	% of Total
A	0 – 2%	2,180	20
B	2 – 5%	5,510	50
C	5 – 9%	2,600	23
D	9 – 14%	470	4
E	14 – 18%	110	1
F	18 – 25%	100	1
G	> 25%	110	1

2.3 Soils

Lyons Creek Watershed is dominated by the Kossuth-Ottosen-Bode soil association. Figure 6 shows the soil map from generated from the SSURGO coverage developed by the National Cooperative Soil Survey from the USDA-NRCS.

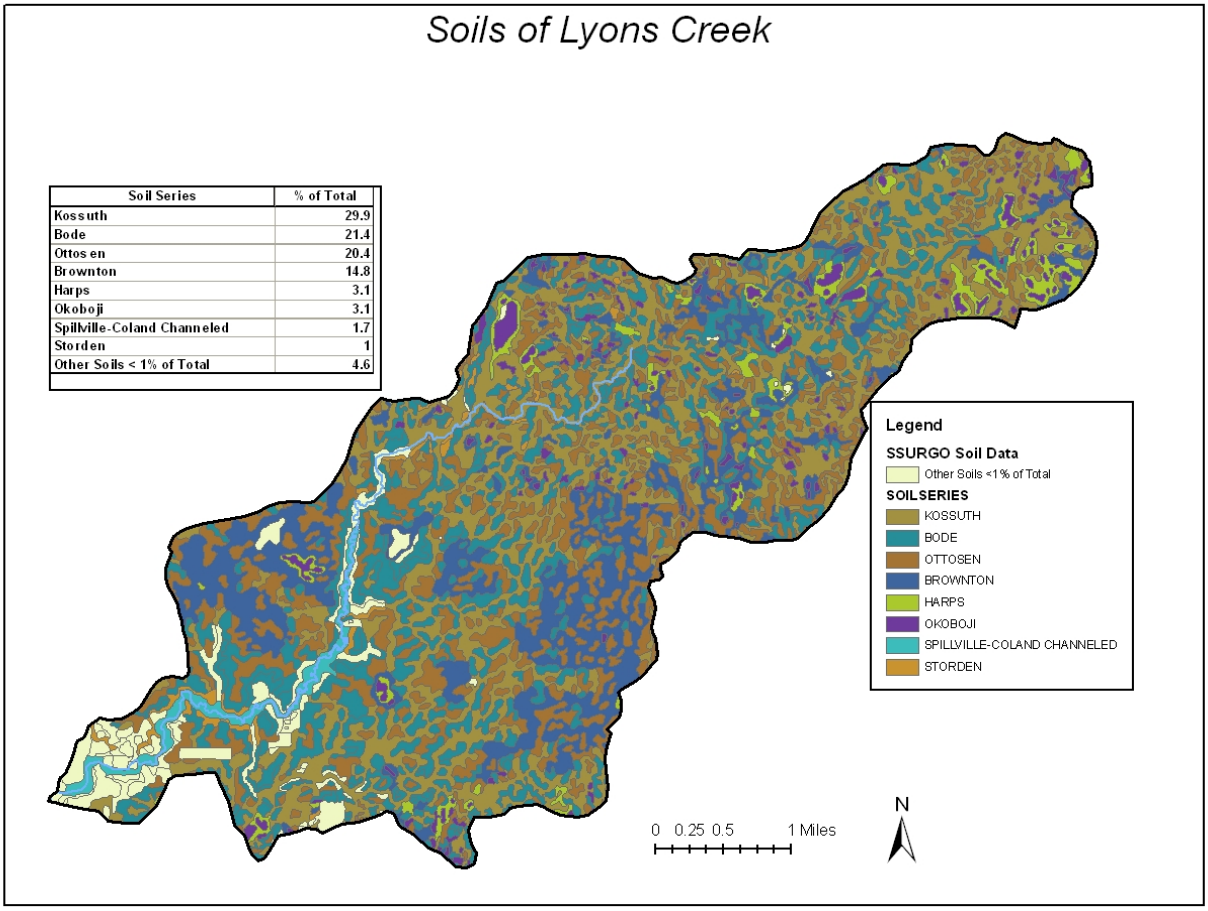


Figure 6 Lyons Creek soil map derived from the National Cooperative Soil Survey, USDA-NRCS.

The Kossuth soils series accounts for the 30% of the watershed area in Lyons Creek. The Kossuth series consists of deep, poorly drained soils that formed in moderately fine textured glacial or lacustrine sediments and in underlying medium textured glacial till or sediments on ground moraines. These soils are moderately slowly permeable in the upper part and moderately permeable material. Slope ranges from 0 to 2 percent.

Bode soils account for 21% of the watershed area and consist of deep, well drained, moderately permeable soils formed in moderately textured glacial or lacustrine sediments that overlie medium textured glacial till. Slopes range from 2 to 18 percent.

The Ottosen series accounts for 20% of the watershed area and consists of very deep, somewhat poorly drained soils formed in moderately fine textured glacial or lactustrine sediments that overlie medium textured glacial till or sediments. They are on nearly level and gently undulating ground moraines. Slope ranges from 0 to 3 percent.

The Brownton series accounts for 15% of the watershed area and consists of very deep, poorly drained soils that formed in clayey glacial lacustrine sediments or in a mantle of clayey glacial lacustrine sediments and underlying loamy glacial till. These soils are on glacial lacustrine

plains or moraines. They have slow permeability. Their slopes are less than 2 percent. Other soil series account for 14% of the watershed area.

Table 4 summarizes the soil characteristics which affect water movement within the watershed. Approximately 53% of the soils (Kossuth, Browntown, Harps, Okoboji, and Spillville/Coland) are considered to be a hydric soil. 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 (73%) of the soils within LCW are considered somewhat poorly drained to very poorly drained.

Table 4 Summary of soil characteristics found in Lyons Creek Watershed.

Dominant Soil	SMU	Acres	Percent of Total Area	SLOPE	HYDRO-GROUP	HYDRIC SOIL	DRAINAGE CLASS
KOSSUTH	388	3,306	29.9%	0-2%	B/D	Yes	Poorly
BODE	52B	2,367	21.4%	5-9%	B	No	Well
OTTOSEN	288	2,259	20.4%	1-3%	B	No	Somewhat
BROWNTON	1507	1,638	14.8%	0-2%	C/D	Yes	Poorly
HARPS	95	346	3.1%	0-2%	B/D	Yes	Poorly
OKOBOJI	6	344	3.1%	0-1%	B/D	Yes	Very poorly
SPILLVILLE/COLAND	1585	183	1.6%	0-2%	B/D	Yes	Poorly
STORDEN	62C	114	1.0%	9-14%	B	No	Well

Figure 8 shows a map of highly erodible land within Lyons Creek Watershed. Approximately 16% is considered HEL or potential HEL. A majority of the HEL land is located near the stream network.

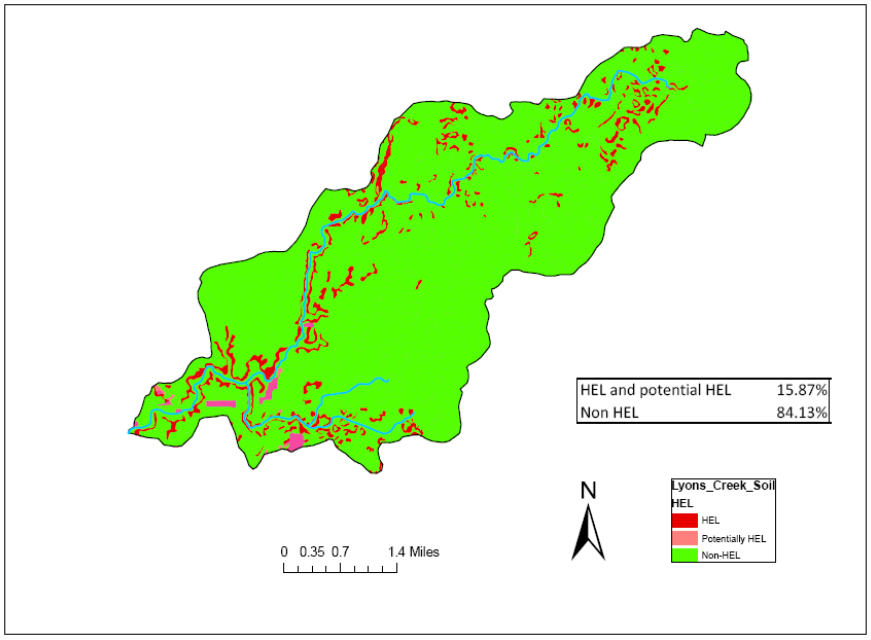


Figure 7 Highly erodible land classification (SSURGO, USDA-NRCS).

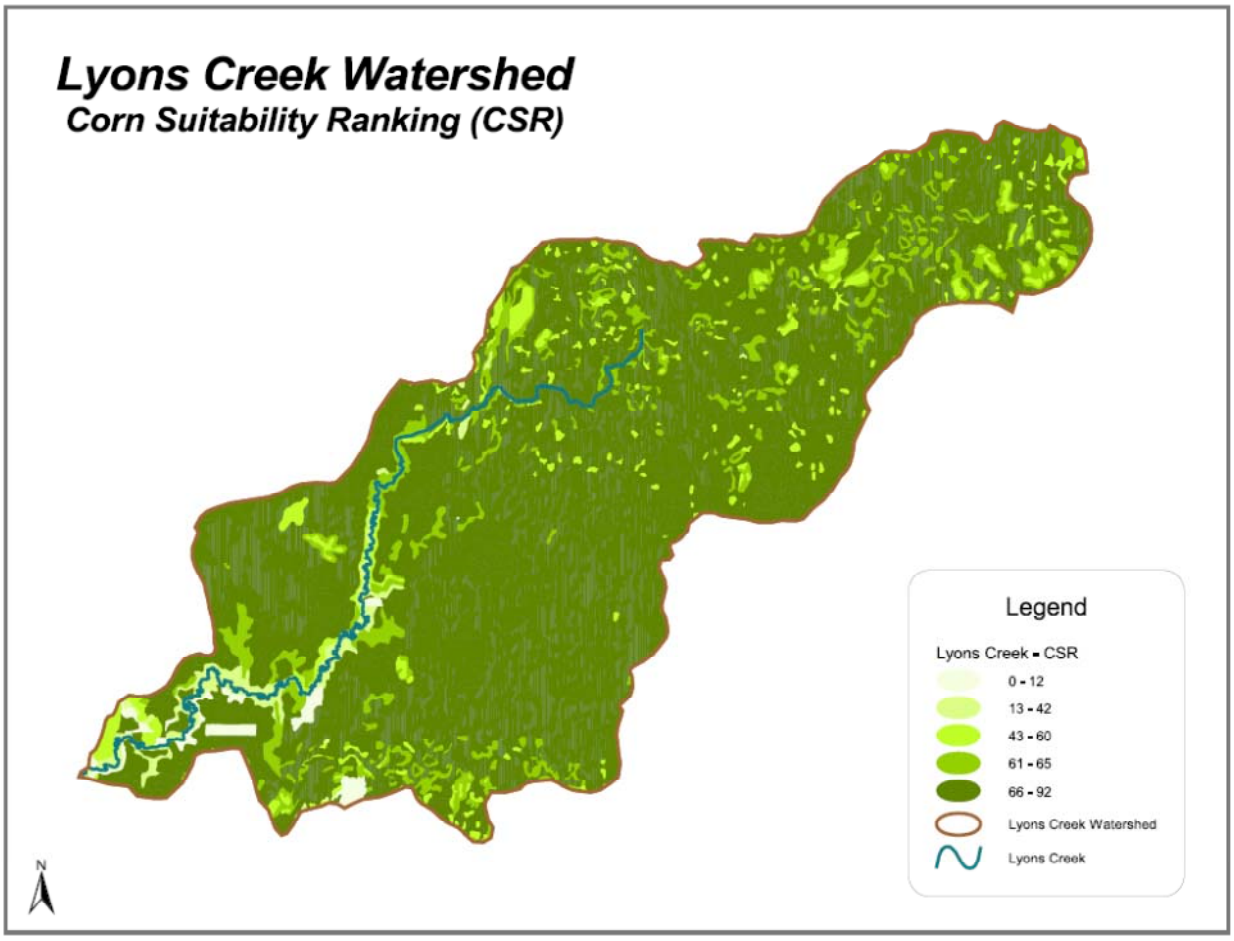


Figure 8 Corn suitability rating in Lyons Creek Watershed (SSURGO, USDA-NRCS).

Corn suitability ratings 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 listed in this table 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.

2.4 Historical Land Use

The Government Land Office (GLO) conducted the original public land survey of Iowa during the period 1832 to 1859. Deputy 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 coverage represents the observed vegetation by the deputy surveyors when laying out the public land surveys in Hamilton County.

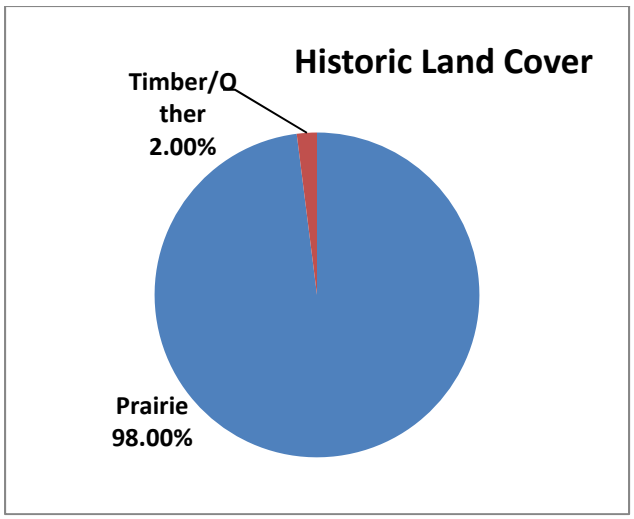


Figure 9 Historical land use of Lyons Creek Watershed, source: Government Land Office Vegetation 1832 – 1859 of Hamilton County.

2.5 Current Land Use

A field level land use survey was conducted in 2005 for the entire Boone River Watershed and in 2009 for just Lyons Creek in order to obtain land use and conservation practice data at the field level. The key data collected as part of the survey included current land use, crop rotation, tillage practice, crop residue, and conservation practices. The survey was performed primarily via visual reconnaissance, although local NRCS and other agency personnel were consulted to obtain information on certain parts of the watershed. While there is a certain level of subjectivity to this type of survey, especially when determining crop rotations and residue levels, this approach is the only way to collect this amount of detail at this time.

2.5.1 Crop Rotations

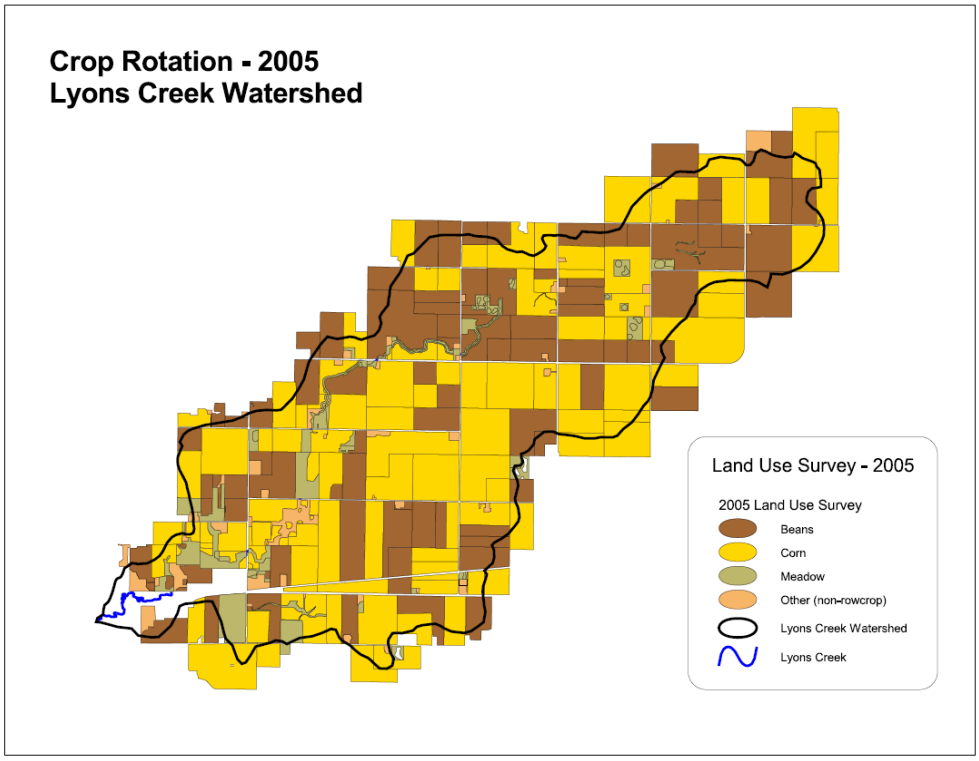


Figure 10 2005 Land use survey/assessment

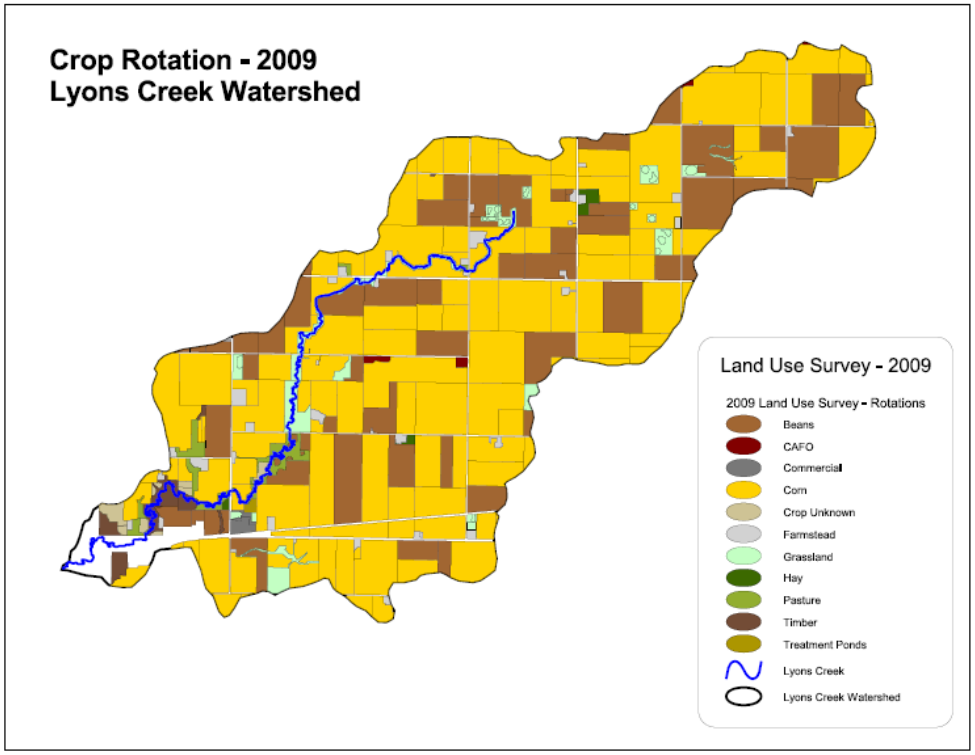


Figure 11 2009 Land use survey/assessment

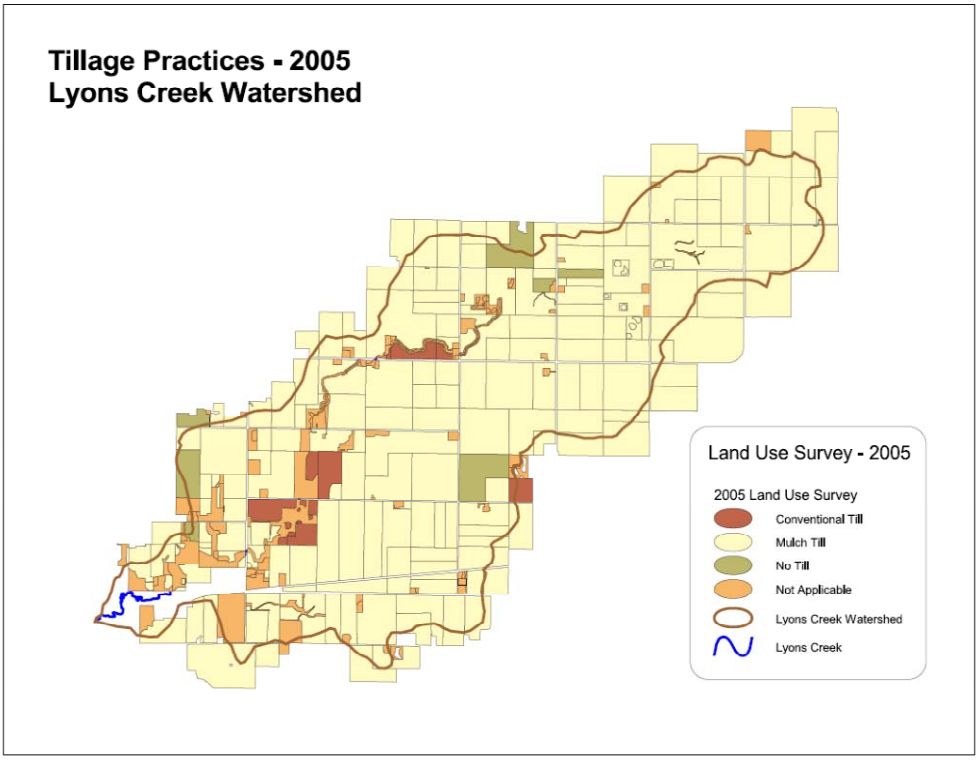
While there are more categories included in the 2009 survey, there is still a large shift over the four years to more corn acres versus bean acres (an approximate increase 1,413 acre increase

in 2009). This is more than likely due to an increase demand for corn (for ethanol, other) and higher market prices.

Table 5 Comparison of 2005 and 2009 land use survey/assessments.

2009 Land Use	2009 Percent	2009 Acres	2005 Percent	2005 Acres	Change Acres
CB (Corn-soybean rotation)	78.61%	8,705	78.14%	8,653	52
CB0MMM (corn-bean-oats-meadow)	0.12%	13	0.12%	13	0
CCB (corn-corn-beans)	3.98%	440	3.66%	405	35
CRP	2.00%	222	1.79%	198	24
Commercial	0.37%	41	0.37%	41	0
Cont. Corn	4.95%	548	7.13%	789	-241
Farmstead	1.65%	183	1.70%	189	-6
Grassland	1.55%	172	1.74%	192	-20
Grazed Timber	0.03%	3	0.03%	3	0
Hayfield	0.09%	11	0.26%	29	-18
Pasture	1.97%	218	2.13%	236	-18
Shrub/Scrub	0.00%	0	0.11%	12	-12
Timber	0.36%	40	0.38%	42	-2
Unknown	0.36%	40	0.21%	23	17
Urban/Residential	0.21%	23	0.05%	5	18
Other	3.73%	413	2.19%	242	171

2.5.2 Tillage Practices



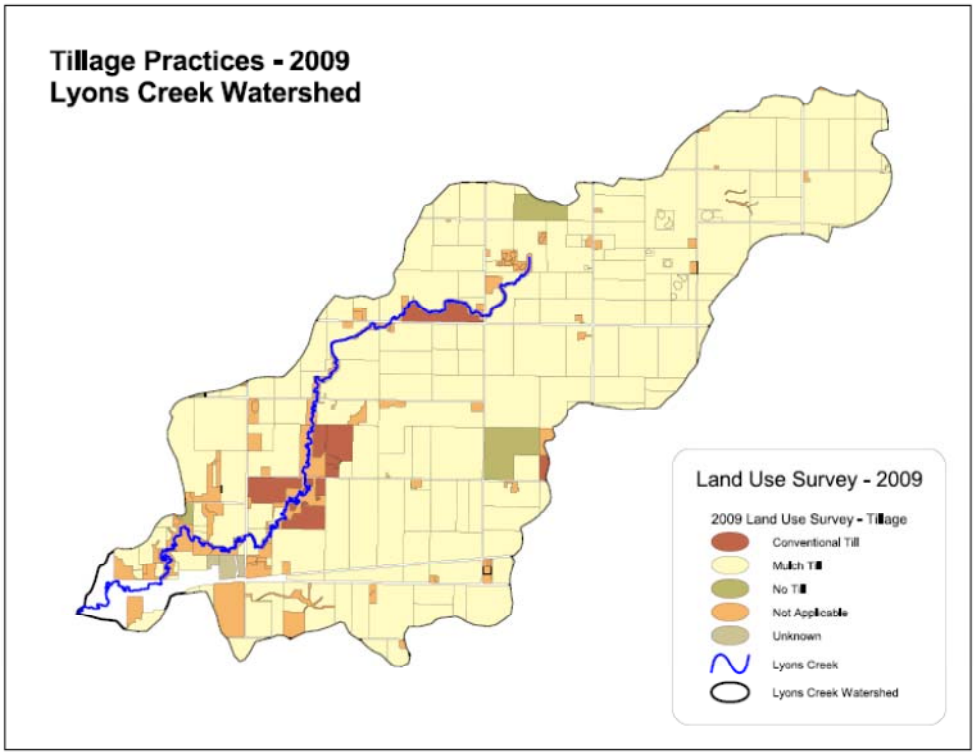


Figure 12 2005 and 2009 tillage practices in Lyons Creek Watershed.

In comparing 2005 and 2009, very little change has been observed between conventional till, mulch till and no till tillage practices. One opportunity to examine within Lyons Creek is a shift to more strip tillage practices. A BMP that is gaining more attention, strip tillage improves soil qualities (e.g. – infiltration, carbon), while decreasing sediment and nutrient loss. Several producers within the watershed are starting to examine this practice.

Table 6 Changes in tillage between 2005 and 2009 assessments.

2009 Tillage	2009 Percent	2009 Acres	2005 Percent	2005 Acres	Change Acres
Conventional Till	2.57%	285	2.56%	283	2
Mulch Till	83.81%	9,280	84.24%	9,328	-48
No Till	1.87%	207	2.88%	319	-112
Not Applicable	11.75%	1,301	10.32%	1,143	158
Total	*100.00%*	*11,073*	*100.00%*	*11,073*	

2.5.3 Residue Cover Quality

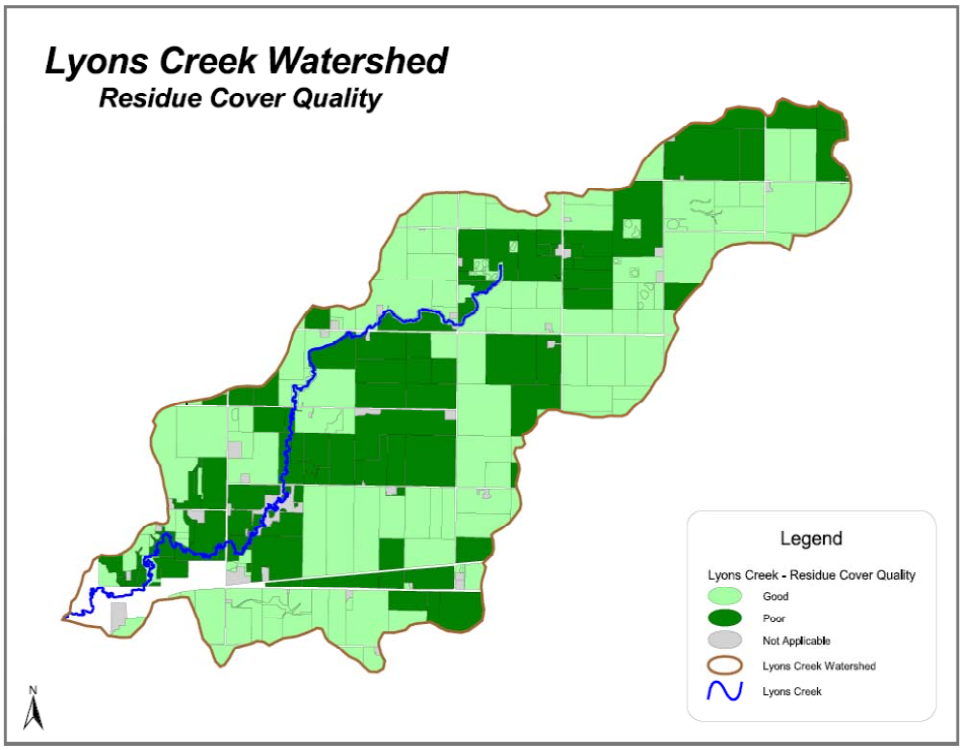


Figure 13 Residue cover from 2009 land use survey

Table 7 Residue management in Lyons Creek Watershed.

Residue Management	Percent	Acres
Good	55%	6,089
Poor	39%	4,284
Not Applicable	6%	700
Total	100%	11,073

3. Pollutant(s) and Impairments(s)

Lyons Creek itself is listed on Iowa's 2008 303(d) Impaired Waters List for a biological impairment resulting from a fish kill in 2001. Lyons Creek is also listed on the Impaired Waters List for bacteria levels that exceed state water quality criteria. Detailed descriptions of these impairments are provided in Section 3.2. A TMDL for these impairments has not been completed at the time of publication, when completed the findings may be used to revise this plan. As previously mentioned the Lyons Creek watershed is part of the larger Des Moines River watershed, the Des Moines River is impaired for elevated nitrate levels and a TMDL was approved by EPA in 2009. A description of the nitrate impairment and TMDL is provided in Section 3.3. This watershed plan will implement practices aimed at addressing the nitrate impairment only, discussion of the bacteria impairment and fish kill are included to provide additional background information.

3.1 Impaired Designation

The designated uses for Lyons Creek are:

- **Class A1**
- **Class B(WW-1)**

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.

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.

**Definitions from Chapter 61 – Water Quality Standards*

3.2 2008 305(b) Assessment for Lyons Creek:

Prior to the current (2008) Section 305(b) cycle, this stream segment was classified only for general uses. Due to changes in Iowa's surface water classification, which were approved by U.S. EPA in February 2008 (see www.iowadnr.com/water/standards/files/06mar_swc.pdf), this segment is now presumptively designated for Class A1 (primary contact recreation) uses and for Class B(WW1) aquatic life uses. According to the Iowa Water Quality Standards, all perennial rivers and streams and all intermittent streams with perennial pools that are not specifically listed in the Iowa surface water classification are designated as Class A1 and Class B(WW1) waters. Thus, for the current (2008) assessment, the available water quality monitoring data will be compared to the applicable Class A1 and Class B(WW1) water quality criteria. This water body has not been assessed for Section 305(b)/303(d) purposes prior to the current (2008) assessment/listing cycle.

Summary: The presumptive Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" due to levels of E. coli that exceed state water quality criteria. The presumptive Class B(WW1) aquatic life uses remain assessed (evaluated) as "partially supported" due to a fish kill in 2001. Results of recent chemical water quality monitoring,

however, do not suggest an impairment of the aquatic life uses of this stream. The sources of data for this assessment are (1) the results of the IDNR investigation of the 2001 fish kill and (2) the results of IDNR/UHL TMDL-related monitoring from June 2006 through April 2007 at Site LC1 (STORET station 11400002). Note: due to (1) the lack of a sufficient number of samples for the 2008 assessment period (calendar years of 2004 through 2006), water quality data generated at this monitoring in 2007 (seven samples) were combined with data from the eight samples collected in 2006. Although the data cutoff period for the 2008 assessment/listing cycle is the end of calendar year 2006, the inclusion of the 2007 data is necessary have a sufficient number of samples (i.e., greater than 10 samples over a three-year period) to develop a higher confidence ("monitored") assessment that can support a Section 303(d) listing.

Explanation: The presumptive Class A1 (primary contact recreation) uses are assessed (monitored) as "not supported" due to levels of indicator bacteria (E. coli) that violate state water quality criteria. Due to recent changes in Iowa's Water Quality Standards, Iowa's assessment methodology for indicator bacteria has changed. Prior to 2003, the Iowa WQ Standards contained a high-flow exemption for the Class A criterion for indicator bacteria (fecal coliforms) designed to protect primary contact recreation uses: the water quality criterion for fecal coliform bacteria (200 orgs/100 ml) did not apply "when the waters [were] materially affected by surface runoff." Due to a change in the Standards in July 2003, E. coli is now the indicator bacterium, and the high flow exemption was eliminated and replaced with language stating that the Class A criteria for E. coli apply when Class A1, A2, or A3 uses "can reasonably be expected to occur." Because the IDNR Technical Advisory Committee on WQ Standards could not agree on what flow conditions would define periods when uses would not be reasonably expected to occur, all monitoring data generated for E. coli during the assessment period, regardless of flow conditions during sample collection, will be considered for determining support of Class A uses for purposes of Section 305(b) assessments and Section 303(d) listings.

The geometric mean level of indicator bacteria (E. coli) in the 13 samples collected in the recreational seasons of 2006 and 2007 (772 orgs/100ml) far exceeds the Iowa Class A1 water quality criterion of 126 orgs/100ml. Eleven of the 13 samples (85%) exceed Iowa's single-sample maximum criterion of 235 orgs/100 ml. According to U.S. EPA guidelines for Section 305(b) reporting and according to IDNR's assessment/listing methodology, if the geometric mean level of E. coli is greater than the state criterion of 126 orgs/100 ml., the primary contact recreation uses should be assessed as "not supported" (see pgs 3-33 to 3-35of U.S. EPA 1997b).

The Class B(WW1) aquatic life uses remain assessed (evaluated) as "partially supported" due to occurrence of a fish kill in September 2001. No cause or source of this kill was identified. Due to the absence of kills in at least three years following this kill, this assessment is considered "evaluated" (i.e., of lower confidence). Due, however, to EPA uncertainty regarding the full recovery of the aquatic life in this stream subsequent to the kill, this stream segment will remain on Iowa's 2008 Section 303(d) list (IR Category 5b). This kill occurred on this segment of Lyons Creek on September 6, 2001. The kill affected 1.14 miles of stream in Sections 5 and 6 of T89N, R25W, Hamilton Co. An estimated 7,200 fish were killed. Although the IDNR investigation showed that the kill started at the outfall of a tile line leading from an industrial park area of Webster City, no cause or source of kill was identified.

According to IDNR's 2006 assessment methodology, the occurrence of a single pollutant-caused fish kill, or a fish kill of unknown origin, on a waterbody or waterbody reach during the most recent assessment period indicates a severe stress to the aquatic community and

suggests that the aquatic life uses should be assessed as "impaired". If a cause of the kill is identified, and the cause is either known, or suspected, to be a "pollutant", the assessment type is considered "monitored" and the affected waterbody is a candidate for Section 303(d) listing. If, however, no additional fish kills have occurred over at least a three-year period, the assessment of impairment should be considered "evaluated" (i.e., of lower confidence), and the waterbody segment should be moved from IR Category 5b to IR Category 3b (list of waters in need of further investigation). Due, however, to EPA uncertainty regarding the recovery of the aquatic life in this stream subsequent to the kill, this stream segment will remain indefinitely on Iowa's Section 303(d) list (IR Category 5b).

Results of IDNR/UHL TMDL-related monitoring in 2006 and 2007 do not suggest a water quality problem in this stream segment. This monitoring showed no violations of Class B(WW1) water quality criteria for pH or ammonia-nitrogen in the approximately 15 samples collected from June 2006 through April 2007. One of 15 samples analyzed for dissolved oxygen violated the Class B(WW1) criterion of 5.0 mg/l: the sample collected on August 22, 2006 contained 3.9 mg/l of dissolved oxygen. According to U.S. EPA guidelines for Section 305(b) water quality assessments (U.S. EPA 1997b, page 3-17), the percentage of violations for dissolved oxygen at this station (7%) does not suggest a water quality impairment (the EPA guidelines allow up to 10% violations of these conventional parameters before impairment of water quality is indicated).

3.2.1 Fish Kill Information

FKID# 493
Date of Kill: 9/6/01
Cause Type: Human
Cause: Unknown – Human Suspected
Est. Fish Killed: 7230
Length (miles): 1.14

Kill traveled 1.14 miles in sections 5&6 of Boone Township. Kill started at the outfall of a tile line leading from an industrial park area of Webster City. EPD Field Office 2, Scott Wilson, was unable to find a source or detect any contaminant during their investigations. Fish counts were made from three randomly selected sites.

3.3 Des Moines River TMDL

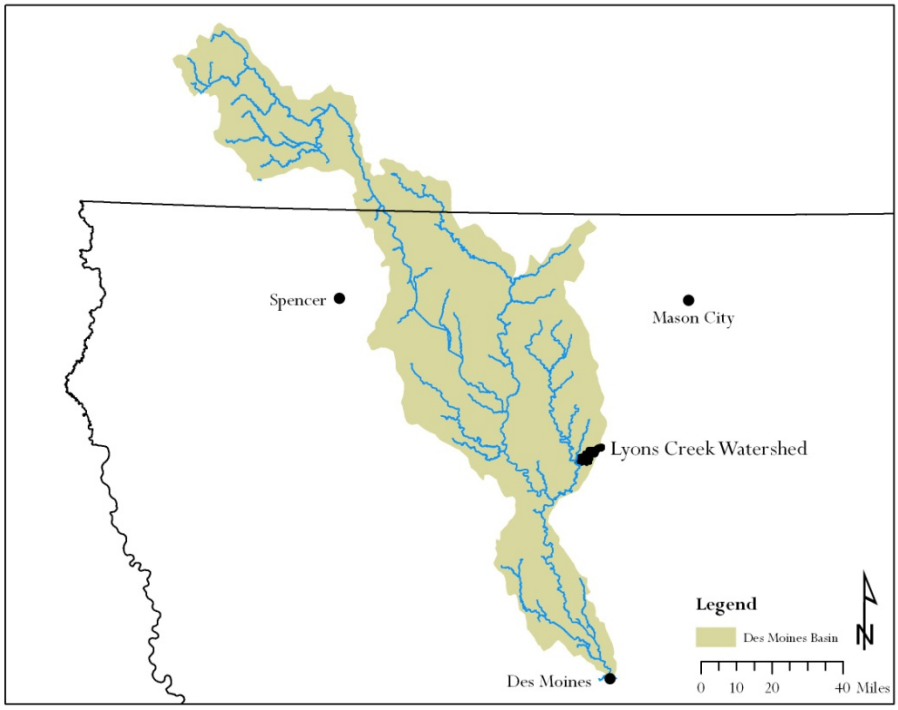


Figure 14 Des Moines River Basin (above city of Des Moines) and Lyons Creek Watershed.

The Federal Clean Water Act requires the Iowa Department of Natural Resources (IDNR) to develop a Water Quality Improvement Plan, also known as a Total Maximum Daily Load (TMDL), for waters that have been identified on the state's 303(d) list as impaired by a pollutant. The 2004 305(b) assessment reported that the designated drinking water use of the Des Moines River from Center Street dam in Des Moines to Interstate 80 bridge (segment 04-UDM-0010_2) was impaired due to nitrate-nitrogen (nitrate) concentrations. 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 USEPA 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 Des Moines River that will ensure compliance with water quality standards.

The Des Moines (DSM) River at 2nd Avenue in Des Moines drains a watershed of 6,245 square miles flowing from its headwaters in Minnesota through north-central Iowa. The watershed is located within the Des Moines Lobe landform region of Iowa dominated by low relief and poor surface drainage. Land cover in the DSM River watershed is predominantly agricultural, consisting of 78.5 percent row crops, 14.3 percent grass, 2.7 percent forest, 2.5 percent urban, and 1.9 percent water and wetlands. The average annual precipitation total for the watershed for the 1995 to 2006 period ranged from 30.9 at Algona to 31.9 inches at Ft Dodge and Ankeny. Total streamflow and baseflow in the DSM River at 2nd Avenue averaged 7.34 and 5.23 inches respectively.

Surface water from the DSM River is used by the City of Des Moines for drinking water. During the 1995 to 2006 period, nitrate concentrations in the river ranged from 0.5 to 14.5 mg/l and averaged 6.3 mg/l. Concentrations exceeded 10 mg/l approximately 16.4 percent of the time

from 1995 to 2006 (719 out of 4382 values). Nitrate concentrations exhibit clear seasonality, with higher concentrations occurring during April, May and June as well as November and December. Nitrate concentrations measured in various large sub-basins in the DSM River watershed from 1999 to 2006 indicated substantial variation. Nitrate concentrations exceeded the MCL in over 30 percent of the measured values in four basins, whereas nitrate concentrations in the West Fork of the DSM River exceeded the MCL only 6.6 percent of the time. Upstream of Saylorville Reservoir, nitrate concentrations exceeded 10 mg/l about 26 percent of the time but downstream of the reservoir, nitrate exceeded 10 mg/l only 16.6 percent of the time. The sources of nitrate can be divided into two major categories, point sources and nonpoint.

The Soil and Water Assessment Tool (SWAT) model was used to evaluate stream flow and pollutant loading patterns in the DSM River watershed. The model inputs included climate, topography, land use, soils, feedlots and confinements, manure application areas, WWTPs and census data. The stream flow and nitrate calibration process was completed by varying several SWAT calibration parameters within their acceptable ranges. There were a total of 173 sub-basins included in the model. Nitrate loss rates in sub-basins varied from less than 5 kilograms per hectare (kg/ha) (0.45 pounds per acre, lb/ac) to more than 20 kg/ha (18 lb/ac) in the Des Moines River watershed. Eight sub-basins had nitrate losses greater than 20 kg/ha (18 lb/ac), with four of these sub-basins located in the eastern half of the Boone River watershed (Upper White Fox Creek, Buck Creek, Lyons Creek and Drainage Ditch 206). Elevated nitrate loading rates were also associated with the Beaver Creek watershed located in the southern extent of the Des Moines River basin. Lowest nonpoint source loading rates in sub-basins were mainly located in the central core of the watershed containing the Des Moines River floodplain corridor. Point sources contribute to 6.4 percent of the total nitrate load and nonpoint sources contribute 93.6 percent of the total nitrate load in the watershed. A total of 67 of the 173 sub-basins (38.7 percent) had total nitrate losses greater than 15 kg/ha (13 lb/ac) when point sources were included in the model.

Although the Lyons Creek watershed is not the highest nitrate contributing subwatershed in the Des Moines River watershed it is a watershed where a number of conservation groups have come together to address nutrient loss, for this reason Lyons Creek was considered the priority watershed to begin nutrient reduction in the Des Moines River watershed. This watershed plan links to the Des Moines River nitrate TMDL calling for a 34% reduction in nitrates.

3.4 Water Quality Data

The Iowa Soybean Association monitors eight sites within LCW, Figure 15 shows the site locations. Grab samples are taken on a bi-weekly schedule along with event monitoring at sites LCR1, LCR3T, LCR4T, and LCR5T. Samples are analyzed by using ion-chromatography for the anions nitrate, nitrite, chloride, ortho-P, and sulfate. Samples are also analyzed for total coliforms, E. coli, and turbidity. ISA's sampling began August of 2008 and is continuing through the present. LCR3T, LCR4T, and LCR5T are also part of a paired watershed study. All of these sites are located at the outlet of known drainage districts ranging in size from 618 to 1482 acres. The sites are equipped with ISCO sampling and flow monitoring equipment in order to determine responses to storm events and to evaluate loading patterns. There will be two treatment watersheds with one control watershed. Implemented BMPs will be monitored and the relative change in loading between the control and treatments will be considered the treatment effect. The sites started calibration in the fall of 2008 and will be completed in the fall of 2010. This will give two growing seasons of data, allowing for the monitoring of the crop rotation cycle. The treatment phase of the paired watershed study will begin following the harvest in 2010.

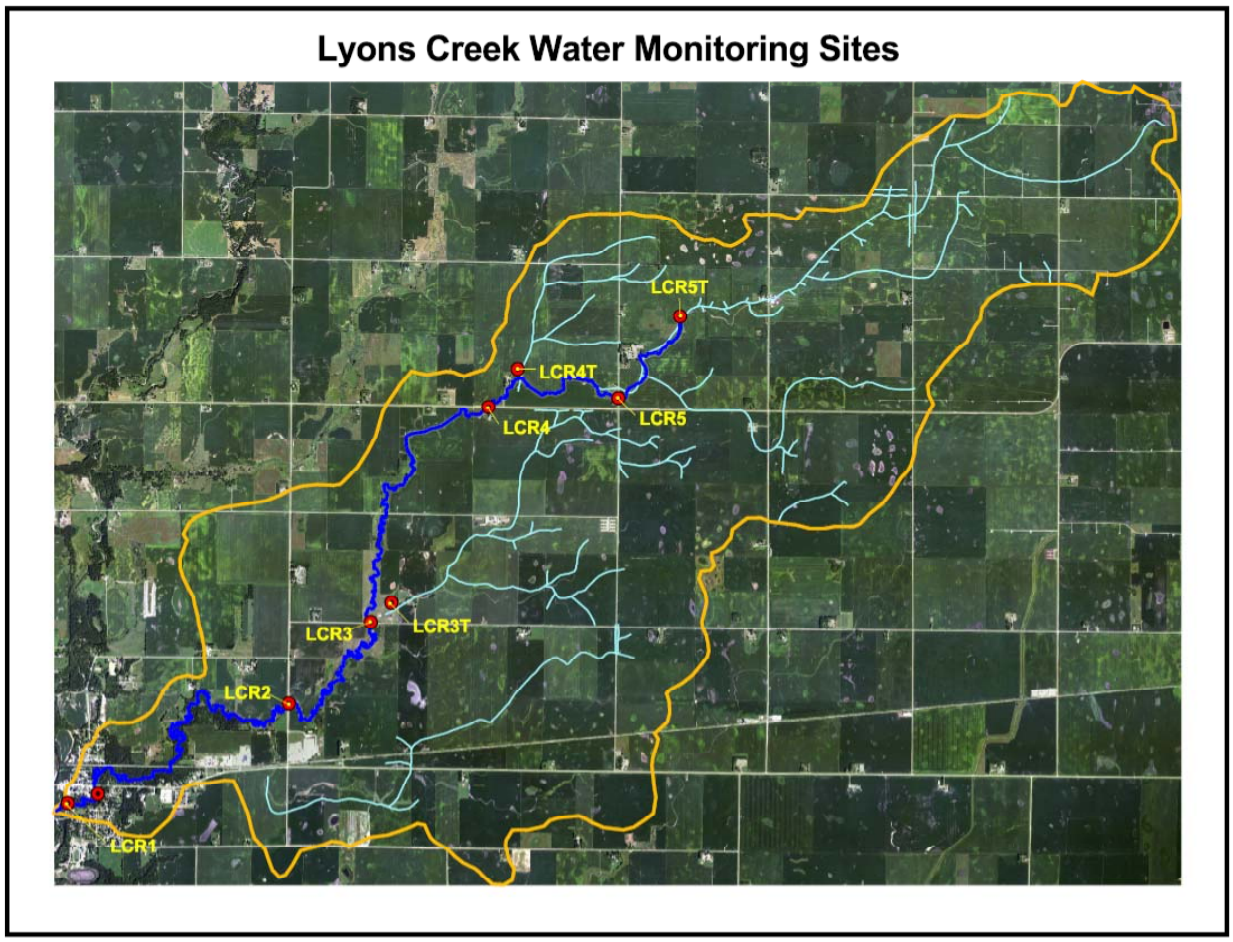


Figure 15 Locations of sites monitored bi-weekly by ISA.

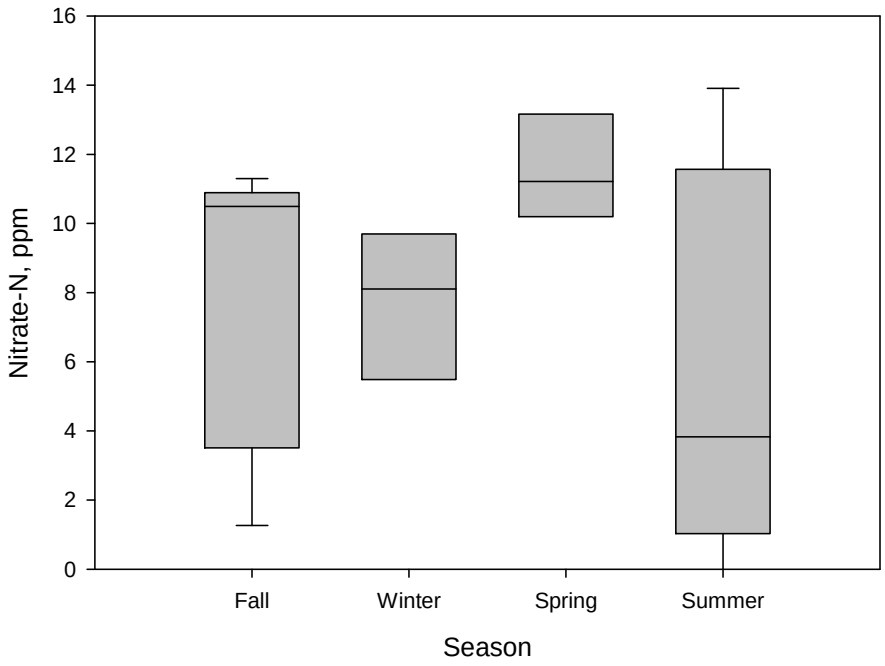


Figure 16 Seasonal Nitrate-N data at LCR1 (August 2008 - February 2010).

Figure 15 shows the nitrate-N concentration data at site LCR1 which is located at the lower end of Lyons Creek just prior to the confluence with the Boone River. Seasonal median values for nitrate-N concentrations were: Fall 10.49 ppm, Winter 8.11 ppm, Spring 11.2 ppm, and Summer 3.83 ppm. Sample's nitrate-N concentrations were higher than the maximum contaminant level (MCL) for drinking water 46% (16 out 35 samples) of the time. 100% of samples taken in the spring were higher than the MCL whereas only 13% of the samples taken in the winter were above the MCL.

See Appendix A for additional water monitoring data.

4. Pollutant Data Analysis

4.1 Pollutant Source Assessment

Nitrate-N monitoring has shown that Lyons Creek has had high nitrate-N concentrations at all monitoring sites throughout the watershed (Appendix A). The TMDL for the Des Moines River has identified Lyons Creek as having the fifth highest nitrate-N load of the 173 subwatersheds modeled. As seen in Figure 17, Lyons Creek is dominated by row crop agriculture. Row crop agriculture is very dependent on high inputs of nitrogen. The Des Moines River TMDL results found agricultural sources account for 85.8% of the nitrate-N from nonpoint sources. Other sources of nitrate-N include developed land and natural sources, these sources account for 1.5% and 12.7% respectively.

Due to the fact that the Lyons Creek watershed is dominated by row crop agriculture with similar crop rotations combined with the uniform nature of soils and slopes makes identifying priority areas for nitrate-N loss is difficult. Also, the private nature of fertilizer application rates, methods and timing combined with the lack of information about in-field tile drainage networks makes it nearly impossible to prioritize lands. Water quality monitoring within Lyons Creek (Appendix A) was conducted in hopes of identify priority areas but is has shown fairly consistent nitrate-N concentrations at all monitoring locations in Lyons Creek.

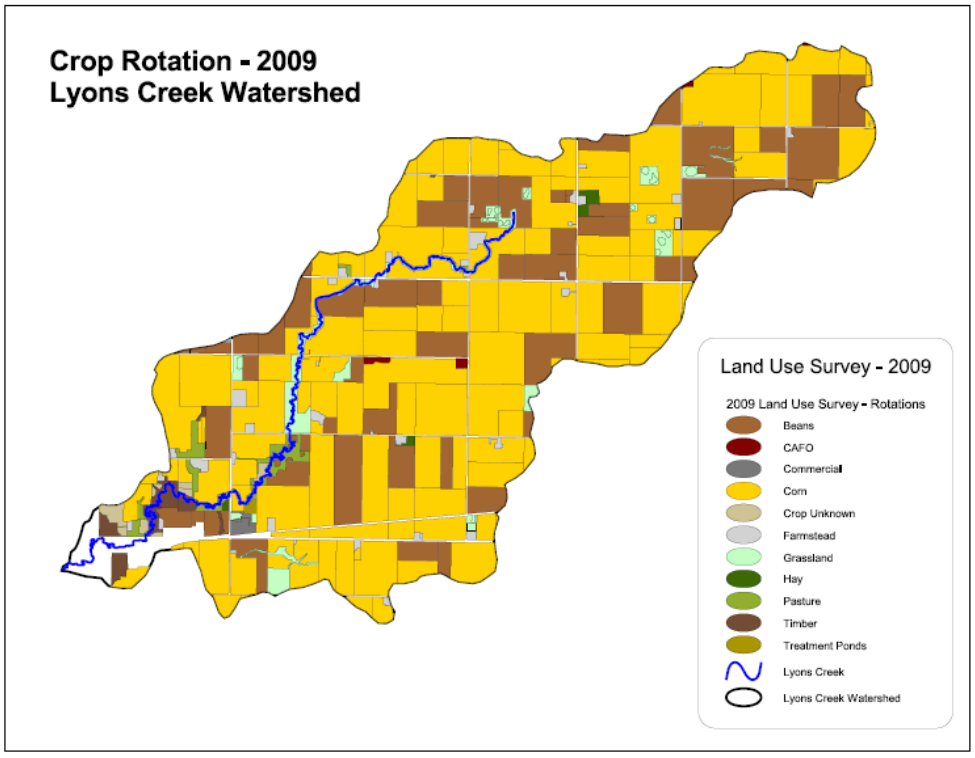


Figure 17 Lyons Creek Watershed crop rotation determined by land use survey 2009.

According to the Des Moines River TMDL SWAT model non-point sources of nitrate-N loading is responsible for nearly 100% of the output of nitrate-N for the watershed. Non-point nitrate-N loads were estimated to be 104,197 kg whereas the point source load for the watershed is only 414 kg.

Table 8 Des Moines River SWAT model output for Lyons Creek.

Source	NO_3-N load, kg
Point Source	414
Non-point sources	104,197
Total	**104,611**
Total NO3-N load	**22.92 kg/ha**
NO3-N concentration	**9.238 mg/l**

5. Goals and Objectives

5.1 LYONS CREEK GOALS AND OBJECTIVES

Goal 1: Within 20 years of project start date reduce nitrate-N loads leaving the Lyons Creek watershed by 34% or 80,616 pounds per year while maintaining agricultural productivity. This is the required reduction from the Des Moines River Nitrate TMDL.

Objective 1: Implement best management practices aimed at avoiding, trapping and treating nitrate-N in surface water within the Lyons Creek watershed.

Task 1: Enroll 4,000 acres of nutrient management plans.

Task 2: Install 12 denitrifying bioreactors.

Task 3: Install 3 nitrate removal wetlands.

Task 4: Implement 3,000 acres of cover crops.

Task 5: Implement 150 acres of pasture management.

Task 6: Install 200 acres of streamside buffers.

Task 7: Implement 2,000 acres of reduced tillage practices.

Task 8: Restore 8 oxbow wetlands.

Objective 2: Implement a coordinated monitoring and evaluation approach to measure baseline water quality trends, and management performance to determine whether progress is being made on water quality improvements.

Task 1: Continue grab sampling and storm event sampling to monitor water quality in Lyons Creek.

Task 2: When possible monitor effectiveness of best management practices.

Task 3: Conduct fall stalk nitrate testing.

Objective 3: Inform the public on the benefits of improved resource management while sustaining the local economy and maintaining agricultural productivity.

Task 1: Conduct one field day annually to promote BMP adoption.

Task 2: Distribute newsletter to watershed residents twice annually.

Task 3: Hold two stakeholder meetings annually in the watershed.

5.2 Targets and Load Reduction

A 34.4% nitrate load reduction target has been set for nonpoint sources per the Des Moines River TMDL. This document sets a 20 year timeframe for reaching this load reduction within the Lyons Creek watershed. The current estimated nitrate load leaving the Lyons Creek watershed is 230,627 pounds or 104,611 kilograms per year. To achieve a 34.4% reduction the nitrate load must be reduced by 36,614 kilograms or 80,720 pounds per year. The TMDL found that nearly 100% of the nitrate can be traced to non-point sources within Lyons Creek.

5.3 BMP Load Reductions and Implementation Levels

The BMPs necessary to meet load reduction goals are listed below. As previously mentioned this version of the Lyons Creek Watershed Management Plan addresses the nitrate impairment on the Des Moines River, thus load reductions have been estimated only for nitrates. As with most conservation practices multiple benefits often result after practice implementation, these additional benefits have not been quantified.

As previously discussed in the Pollutant Source Assessment section prioritizing or targeting areas for nitrate-N reductions is extremely difficult due to 1) the uniform land use within the watershed 2) the uniform soils and slopes of the Lyons Creek watershed 3) the lack of information regarding placement and functionality of private in-field drainage tile networks and 4) the private nature of producers nutrient application rates, application methods and application timing. For these reasons the development of a priority map was not possible, but for this plan all row crop land will be treated as a priority.

Using SWAT Model outputs from the Des Moines River TMDL and a spreadsheet model the following BMPs have been identified to achieve the 34.95% or 80,615 lb/year reduction target. Figure 18 provides one of many BMP implementation scenarios to achieve the necessary nitrate-N load reduction. Nitrate load reductions were calculated using the following formula. BMP reduction efficiencies were found in **Assessments of Practices to Reduce Nitrogen and Phosphorus Nonpoint Source Pollution of Iowa's Surface Waters 2004.** The reduction efficiency for oxbow wetlands was determined from nitrate water quality monitoring conducted at oxbow wetlands near Lyons Creek.

Load Reduction = Acres Treated x Average nitrate-N Load from SWAT x BMP Reduction Efficiency

Cover Crops (NRCS 340): A total of 3,000 acres of cover crops will be implemented reducing the nitrate load to Lyons Creek by an estimated 30,660 lbs/year. Cover crops will be targeted to row crop lands. Two difference cover crops will be recommended and available to producers. A cereal rye (winter hardy) that will overwinter and an annual rye/oats that will winterkill. The cover crop species have been selected for their potential ability to absorb large amounts of nutrients from the rooting profile of the soil. Each will be managed according to standard specifications developed for Iowa.

De-Nitrifying Bioreactors (NRCS 747): A total of 12 bio-reactors will be implemented reducing the nitrate load to Lyons Creek by an estimated 7,849 lbs/year. Bio-reactors will be targeted to appropriate size private drainage tile lines, typically tiles less than 12'' in diameter.

Nutrient Management (NRCS 590): A total of 4,000 acres of nutrient management will be implemented reducing the nitrate load to Lyons Creek by an estimated 16,352 lbs/year. Nutrient Management will be targeted to row crops lands.

Nitrate Removal Wetlands : A total of 3 nitrate removal wetlands will be implemented reducing the nitrate load to Lyons Creek by an estimated 15,330 lbs/year. The specific location and design of these wetlands will be carried out by the Iowa Department of Agriculture and Land Stewardship – Division of Soil Conservation CREP program. Site location is determined using detailed tile and elevation data so that treatment can be maximized.

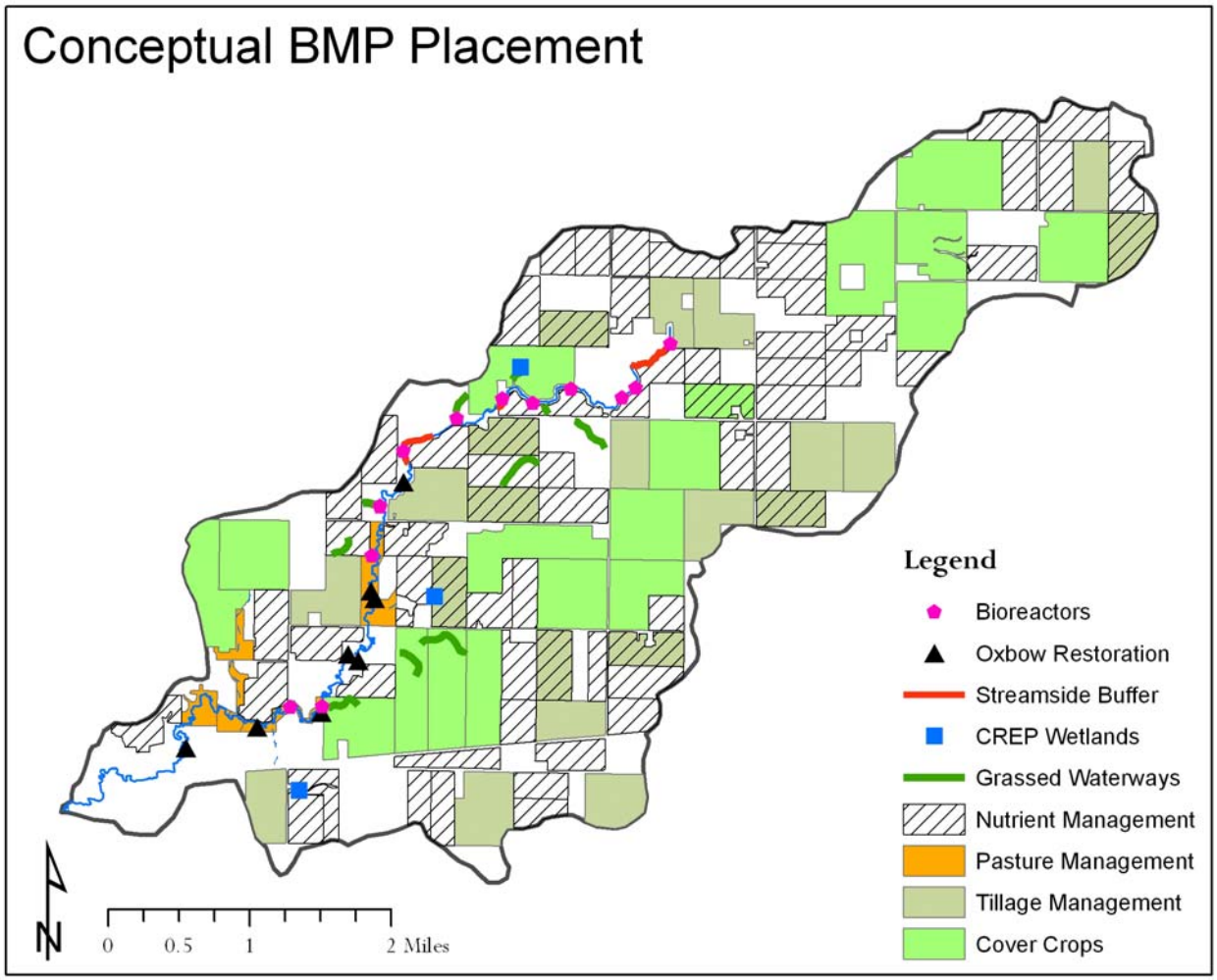
Pasture Management (NRCS 512, 528, 382): A total of 150 acres of pasture management will be implemented reducing the nitrate load to Lyons Creek by an estimated 613 lbs/year.

Filter Strips (NRCS 393/CRP) : A total of 40 acres of buffers will be implemented reducing the nitrate load to Lyons Creek by an estimated 2,044 lbs/year. It is anticipated the 40 acres of filter strips will treat 400 acres of land.

Tillage Management (NRCS 329): A total of 2,000 acres of tillage management will be implemented reducing the nitrate load to Lyons Creek by an estimated 2,044 lbs/year. This practice will also be targeted for bacteria and sediment load reductions.

Oxbow Restoration: Eight oxbow wetlands will be resorted along Lyons Creek, during the restoration process drainage nearby field drainage tile will be rerouted to the oxbow wetlands. Research at the Smeltzer Demonstration Farm in nearby Webster County has shown that oxbow wetland can treat and remove significant amounts of nitrate-N from drainage tile water. It is anticipated that the eight oxbow wetlands will treat 400 acres and will remove an estimated 5,723 lbs/year of nitrate-N.

Figure 18. Ideal BMP placement scenarios to achieve necessary nitrate-N load reduction.



6. Water Quality Monitoring Plan

Bi-weekly grab sampling has been conducted at five sites (LCR1, LCR2, LCR3, LCR4, and LCR5) in the Lyons Creek watershed since January 2009 (see Figure 15). A Quality Assurance Project Plan (QAPP) was developed for the Upper Des Moines River Watershed and sub-watersheds, including Lyons Creek and approved in March 2009 and is on file with the Iowa DNR.

The following monitoring plan is being proposed within the Lyons Creek watershed. The plan builds upon the monitoring that has been ongoing since March 2009. The plan consisits of three components, bi-weekly grab sampling, storm event sampling and fall stalk nitrate testing.

6.1 Grab Sampling

This plan proposes bi-weekly grab sampling at five sites in the Lyons Creek watershed; these sites are LCR1, LCR2, LCR3, LCR4, and LCR5. Sampling will occur bi-weekly from April through October, all samples will be analyzed for the nitrogen series; total Kjeldahl nitrogen, nitrate + nitrite nitrogen, ammonia nitrogen. Field measurements of pH, DO, and in-stream temperature are sometimes taken *in-situ* with YSI ion selective electrodes.

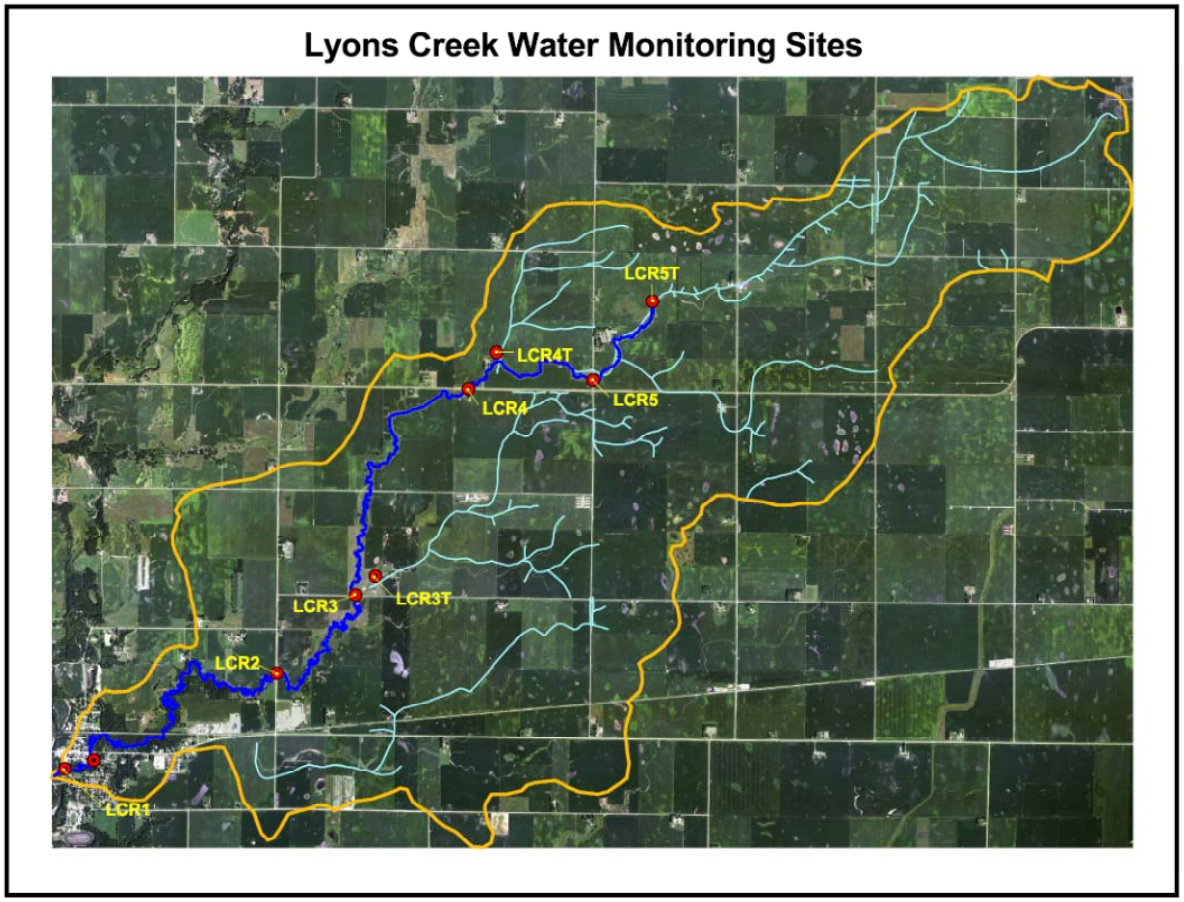


Figure 19. Water monitoring sites within Lyons Creek watershed.

6.2 Storm-Event Sampling

For storm event sampling, four ISCO automated sampling units have been deployed within Lyons Creek (at sites LRC1T, LCR3T, LCR4T, and LCR5T). All stations are recording continual stage, and three sites are at the mouth of individual drainage districts are measuring continual flow. All samples collected are analyzed by Des Moines Water Works for nutrients and bacteria. A separate monitoring contract with The Nature Conservancy is providing the funding for this data collection. The contract is in place through June 30, 2010. It is anticipated that additional funding will be provide via a new contract. To understanding loading rates and the effects of management change, event sampling should be continued.

6.3 Monitoring Cost Estimates (yearly)

Breakdown of expenses:

Grab Sampling: ~$8,630
Storm-Event Sampling: ~$9,720

Table 9 Grab sampling expenses.

Grab Sampling		
Sampling	*Rate*	*Amount*
18 trips x 6 hours	$50/hr	$5,400
Analysis		
90 samples	$10/sample – nutrients	$900
45 samples	$20/sample – bacteria	$900
30 samples	$5/sample – TSS	$150
Travel/Equipment		
18 trips x 120 miles/trip	$0.50/mile	$1,080
Bottles, etc.		$200
Total		**Approx. $8,630**

Table 10 Event sampling expenses.

Storm Event Sampling (4 sites * 6 events * 24 samples/event/site)		
Sampling	*Rate*	*Amount*
6 trips x 6 hours	$50/hr	$1,800
Analysis		
4 sites x 6 events x 18 samples/event	$10/sample - nutrients	$4,320
4 sites x 6 events x 6 samples/event	$20/sample - bacteria	$2,880
4 sites x 6 events x 3 samples/event	$5/sample – TSS	$360
Travel		
6 trips x 120 miles/trip	$0.50/mile	$360
Total		**Approx. $9,720**

6.4 Stalk sampling

The end-of-season stalk nitrate test is a tool that can be used to evaluate the availability of N 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 N availability to the plant. The corn plant will move available nitrogen to the grain first. By measuring the amount of N that was left after grain fill, a determination can be made as to how much excess or little N 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.

7. Phased Implementation Schedule

Below is a phased approach for implementing the Lyons Creek watershed management plan. This implementation schedule is intended to serve as a tool to recognize tasks that are scheduled for the upcoming year, and to help focus the necessary resources for the current phase of the project. The implementation schedule should be adaptable and updated on regular basis due to shifting priorities, new opportunities, and expected delays.

Table 10. Goals and objectives by phase.

Goal 1	Reduce nitrate-N loads leaving Lyons Creek Watershed by 34.4% or 80,720 pounds per year.	Goal	Units	Phase 1 Years 1-5	Phase 2 Years 5-10	Phases 3&4 Years 10-20
Obj. 1	**Implement Best Management Practices**					
Task 1	Plan NRCS Nutrient Mgmt. Standard (590).	4,000	Acres Enrolled	500	1000	2,500
Task 2	Install/construct twelve (12) bio-reactors in targeted areas within the watershed (747)	12	Number Installed	4	4	4
Task 3	Install/construct three (3) removal wetland in targeted areas within the watershed	3	Number Installed	1	1	1
Task 4	Plan/install cover crops to target acres (340)	3,000 ac	Acres Enrolled	800	800	1400
Task 5	Pasture Management (512,528, 382)	150	Acres Enrolled	60	45	45
Task 6	Install and construct riparian management systems including buffer and filter strips (393/CRP)	400	Acres Treated	50	75	75
Task 7	Enroll producers in residue and tillage management practices (329)	2,000	Acres Enrolled	600	700	700
Task 8	Restore 8 oxbow wetlands	8	Number Restored	3	3	2
Obj. 2	**Implement a coordinated monitoring and evaluation approach to measure water quality trends, management performance and progress on water quality improvements.**					
Task 1	Continue grab sampling and storm event sampling to monitor water quality in Lyons Creek.			Yearly	Yearly	Yearly

Task 2	When possible monitor effectiveness of best management practices.			TBD	TBD	TDB
Task 3	Conduct fall stalk nitrate testing.			Yearly	Yearly	Yearly

Obj. 3	**Inform the public on the benefits of improved resource management while sustaining the local economy and maintaining agricultural productivity.**					
Task 1	Field Days		Number	5	5	10
Task 2	Newsletters		Number	10	10	20
Task 3	Stakeholder Meetings		Number	10	10	20

Nitrate-N Reduction Targets by Phase

Nitrate-N reductions by phase have been calculated to allow project staff to tract progress towards reaching water quality targets.

Phase 1 Goal: 21,360 lbs nitrate-N removal

Phase 2 Goal: 23,445 lbs nitrate-N removal

Phase 3 & 4 Goal: 35,811 lbs nitrate-N removal

Nitrate-N Load Reduction Formula

As BMPs are installed in the Lyons Creek watershed the formula below should be used to calculated loading reductions.

Nitrate-N Load Reduction in Pounds = 20.44 x Acres Treated x BMP Reduction Efficiency

Note: 20.44 is the average nitrate-N load in pounds per acre within the Lyons Creek watershed.

Nitrate-N Concentrations by Phase

Using monitoring data from 2010-2011 in combination with modeled Nitrate-N load reductions the following targets have been established for in stream Nitrate-N concentrations. These targets will be measured against the season long average nitrate concentrations at monitoring site LCR1 (see Figure 19). These targets could be used to determine if watershed BMPs are achieving desired results. Caution should be used when comparing in-stream concentrations to these targets as weather patterns play a major role in nonpoint source pollution patterns.

Phase 1 Target: 8.8 mg/L

Phase 2 Target: 7.9 mg/L

Phase 3 & 4 Target: 6.3 mg/L

8. Information and Education

8.1 Lyons Creek Watershed Advisory Committee

In 2008, a Lyons Creek Watershed Advisory Committee was created for purposes of assisting in the development of a locally-based watershed plan. Comprised of local stakeholders representing farmers, agronomists, local cooperatives, banking, conservation, state/federal agencies, and local stakeholders, this group has met on a regular basis to discuss resource issues and concerns, watershed goals and objectives, and implementation strategies. Lyons Creek watershed is fortunate to have several innovative stakeholders and farmer leaders that are beginning to initiate grass-roots led efforts (e.g. – one area producer has promoted the use of strip tillage and has gotten six other producers to participate in testing the use of strip tillage on their farms).

Watershed advisory council meetings will be facilitated by the Hamilton SWCD, with assistance provided by NRCS, DNR, and affiliated partners. Two advisory council meetings will be held annually throughout the watershed project.

Table 11 Lyons Creek Watershed advisory council.

Name	Affiliation/Title	Subgroup
Tom Larson	Producer	Lyons Creek Advisory Committee
Brad Anderson	Producer	Lyons Creek Advisory Committee
Brent Lee Odland	Producer	Lyons Creek Advisory Committee
Randy Greufe	Producer	Lyons Creek Advisory Committee
Roger Tapper	Producer	Lyons Creek Advisory Committee
Noel Singer	Producer	Lyons Creek Advisory Committee
Tom Riemenschieder	Producer	Lyons Creek Advisory Committee
Kreg Kantak	Producer	Lyons Creek Advisory Committee; Boone River Watershed Assoc.
Arlo Van Diest	Producer	Lyons Creek Advisory Committee; Boone River Watershed Assoc.
Bruce Hinderks	Ag retailer/producer	Lyons Creek Advisory Committee
Tim Scott	Ag retailer	Lyons Creek Advisory Committee
Brian Stroner	Webster City	Lyons Creek Advisory Committee
Bill Walker	Producer	Lyons Creek Advisory Committee
Lynn Crystal	Producer	Lyons Creek Advisory Committee
Jeff / Mark Nelson	Producer	Lyons Creek Advisory Committee
Jen Filipiak	The Nature Conservancy	Boone River Watershed Assoc.
John Paulin	USDA-NRCS, RC&D	Boone River Watershed Assoc.
Marvin Hoffmann	USDA-NRCS	Lyons Creek Advisory Committee
John Thompson	Producer	Lyons Creek Advisory Committee
Larry Haren	Producer	Lyons Creek Advisory Committee
Tom Larson	Producer	Lyons Creek Advisory Committee
Adam Kiel	Basin Coordinator	Iowa DNR

8.2 Outreach/Education

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 facing Lyons 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. The following plan will guide public outreach activities in the Lyons Creek watershed.

The plan's education component is based on the community based outreach model that has been successfully utilized in other areas of environmental concern such as solid waste management. This model uses a wide variety of educational strategies on an ongoing basis to reinforce the core messages and support continuous improvements.

1. **Plan Goals and Objectives**

- Goal: Within 20 years of project start date reduce nitrate-N loads leaving the Lyons Creek watershed by 34% or 80,616 pounds per year while maintaining agricultural productivity.
    - *Objective 1*: Implement best management practices aimed at avoiding, trapping, and treating nitrate-N in surface water within the Lyons Creek watershed.
    - *Objective2*: Implement a coordinated monitoring and evaluation approach to measure baseline water quality trends, and management performance to determine whether progress is being made on water quality improvements.
    - *Objective 3*: Inform the public on the benefits of improved resource management while sustaining the local economy and maintaining agricultural productivity.

2. **Target Audiences**

Who will be needed in order to make changes to the land and water?

- Landowners (Agricultural)
- Tenants (Agricultural)
- Rural residents
- Managers of publically owned land
- Iowa NRCS
- Iowa Department of Natural Resources

Who will be depended upon to advance this project?

- Hamilton County Soil and Water Conservation District
- Hamilton County Conservation Board
- Hamilton County Board of Supervisors
- Iowa Department of Ag and Land Stewardship
- Iowa Department of Natural Resources

- Iowa NRCS
- Iowa Soybean Association (ISA)
- The Nature Conservancy (TNC)

Who will be needed to communicate plan goals to these people?

- Project partners, community leaders, and stakeholders
    - SWCD Commissioners
    - Hamilton County Supervisors
    - NRCS, County Conservation, and other agency personnel
    - Key landowners and agricultural producers
    - Iowa Department of Natural Resources
    - Iowa Department of Ag and Land Stewardship
    - Farm Service Agency (FSA)
    - Local agriculture and outdoor groups
        - Pheasants Forever
        - Ducks Unlimited
        - 4-H
        - FFA
        - Farm Bureau
        - Local sportsmen's clubs
- Newspapers
    - Daily Freeman Journal (Webster City)
    - Eagle Grove Eagle (Eagle Grove)
    - Des Moines Register
- Radio
    - KQWC 95.7 FM/1570 AM
    - KWMT 540 AM

3. Target Audience Outreach Strategy

The following section outlines assumptions regarding target audiences developed during public outreach efforts and input received from watershed stakeholders related to the development of this plan. This does not represent extensive research of the target audience however.

Potential Barriers to Participation

Agricultural landowners/operators/other stakeholders

- Possible reduction in productive agricultural land
- Loss of rental income from placing productive ground into conservation
- Cost of installing and maintaining practices
- Perception of yield loss when adopting new practices; producer takes on the risk
- Reluctant to change current practice implementation
- Concern of working with government employees and programs
- Those in targeted areas not participating in conservation programs
- Increasing commodity prices driving decisions
- Absentee land owner contact and education/outreach efforts

Potential Solutions, Motivators, Incentives or Benefits to Encourage Participation

- Increase cost share rates for targeted conservation practices; identify additional funding assistance programs to help offset costs.

- Educate landowners/producers on how best to minimize loss (e.g. – nutrient management strategies, tillage practices) while still maintaining yields.
- Increase one-to-one meetings with landowners/producers to discuss environmental and conservation issues and best management practices to address concerns.
- Utilize baseline line data gathered during the watershed planning process to target areas for appropriate land use and agriculture/conservation practices
- Utilize field days, demonstrations, and public meetings to encourage adoption of practices; enlist the support of "farmer leaders" in the watershed that are utilizing targeted conservation practices.

4. Use Research to Develop Outreach Strategy

With knowledge of potential barriers and motivators, education and outreach efforts can be developed around the target audiences' accepted means of receiving information and watershed management education. This includes demonstrations, field days, outreach workshops, one to one contacts, outdoor classrooms for school children, adult educational activities, and traditional media outlets.

Potential outreach strategies

- Develop a Watershed Advisory Committee to assist in plan implementation, outreach, and education efforts.
- Develop an annual outreach plan/schedule that coordinates with key seasons/dates (e.g. – spring planting season) to ensure messages and activities are received by the correct audience.
- Hold additional public meetings to educate stakeholders on status of watershed impairment and implementation efforts identified in the watershed management plan.
- Utilize internet resources to advance watershed plan implementation efforts; utilize internet for education and outreach efforts.
- Utilize producers and other landowners in the watershed that have implemented target practices to encourage adoption of others in the watershed.
- Arrange annual field days to increase awareness of watershed activities, and utilize to help show project progress.
- Identify/develop/seek to secure funding sources to offset the cost of installation practices.
- Identify opportunities to have direct exposure to members of the target audiences and/or one to one conversations with individuals to educate them on the watershed project, targeted areas of concern, cost share options, and other related activities.
- Develop watershed signage to promote activities in the watershed.

5. Evaluation and Measurement of Effectiveness

Annually, the Outreach/Education plan should be reviewed and evaluated to determine if specific activities listed above are being accomplished.

- Meeting attendance and participation (e.g. – Advisory committee, public meetings, other)
- Number of landowners/producers involved in project

- Attendance at field days, demonstration days, community-based outreach activities, other.
- Periodic surveys with landowners/producers; conduct on 5-year watershed plan update cycle.
- Follow-up with directs mailings; phone calls; one on one interviews.
- Copies of news articles published; internet content updated; dates/times of radio and television spots.
- Evaluation of practice implementation; water quality monitoring information.
- Surveys completed by participants after community-based outreach activities.

In fall of 2009, an extensive watershed resource management survey was mailed out to all landowners and operators in five sub-watersheds within the Raccoon and Boone River watersheds. This included the Lyons Creek watershed. The survey was conducted by J. Gordon Arbuckle, Assistant Professor, Department of Sociology at Iowa State University.

A summary report on the percent distribution of questions/answers has been tabulated and can be found in Appendix B.

The survey included general questions on the respondents knowledge of watershed issues, participation in watershed activities (e.g. – swimming, fishing, etc.), and demographics. A few results worth noting include 82% of respondents feel that farmers and other local residents should work together on water quality issues; 68% are concerned about agriculture's impact on water quality; and 66% feel more data needs to be collected to identify the major cause of water quality.

Respondents were also asked to select from a list of conservation practices, which practices have been established, or should be established, and those that are not needed. According to the survey, respondents replied that they have established or should establish: integrated pest management (57%); nutrient management (50%) reduced tillage (67%); grassed waterways (75%); and filter strips (63%). In comparison, respondents replied that practices not needed include: riparian forest buffers (80%); rotational grazing and fencing to keep livestock out of streams (88%); and grade stabilization structures.

According to the survey, 72% of respondents feel their overall farming activities do not harm the environment, and 67% feel they are reducing nitrogen and phosphorus into waterways. When asked for reasons for establishing conservation practices, 83% replied to increase long-term profitability, while 79% replied to reduce the environmental impact of my farming activities.

The survey helps to outline producers' current attitudes and behaviors, and potential barriers to the adoption of conservation practices. Results from this survey should be used to help direct the education and outreach plan to the target audience, along with long term management and implementation strategies. An increase in knowledge should help to motivate behavioral change.

9. Resource Needs

9.1 Costs

Below are cost estimates associated with project administration and best management practice (total cost) in 2011 dollars.

Table 12 Funding matrix.

Administration	Phase 1 Year 1-5	Phase 2 Year 5-10	Phase 3 & 4 Year 10-20	Total
Salary and Benefits	$150,000	$150,000	$300,000	**$600,000**
Equipment & Supplies	$2,500	$2,500	$5,000	**$10,000**
Travel & Training	$1,250	$1,250	$2,500	**$5,000**
Information & Education	$5,000	$5,000	$10,000	**$20,000**
Water Monitoring	$91,750	$91,750	$183,500	**$367,000**
Total	**$250,500**	**$250,500**	**$501,000**	**$1,002,000**

Best Management Practices	Phase 1 Year 1-5	Phase 2 Year 5-10	Phase 3 & 4 Year 10-20	Total
Nutrient Management Planning	$9,000	$18,000	$45,000	**$72,000**
Bio-Reactors	$30,000	$30,000	$30,000	**$90,000**
Nitrate Removal Wetlands	$325,000	$325,000	$325,000	**$975,000**
Cover Crops	$131,760	$131,760	$230,580	**$494,100**
Pasture Management	$17,640	$13,230	$13,230	**$44,100**
Buffers and Filter Strips	$132,500	$198,750	$198,750	**$530,000**
Residue & Tillage Management	$120,000	$140,000	$140,000	**$400,000**
Oxbow Wetland Restoration	$12,000	$12,000	$8,000	**$32,000**
Total	**$777,900**	**$868,740**	**$990,560**	**$2,637,200**

Appendix A

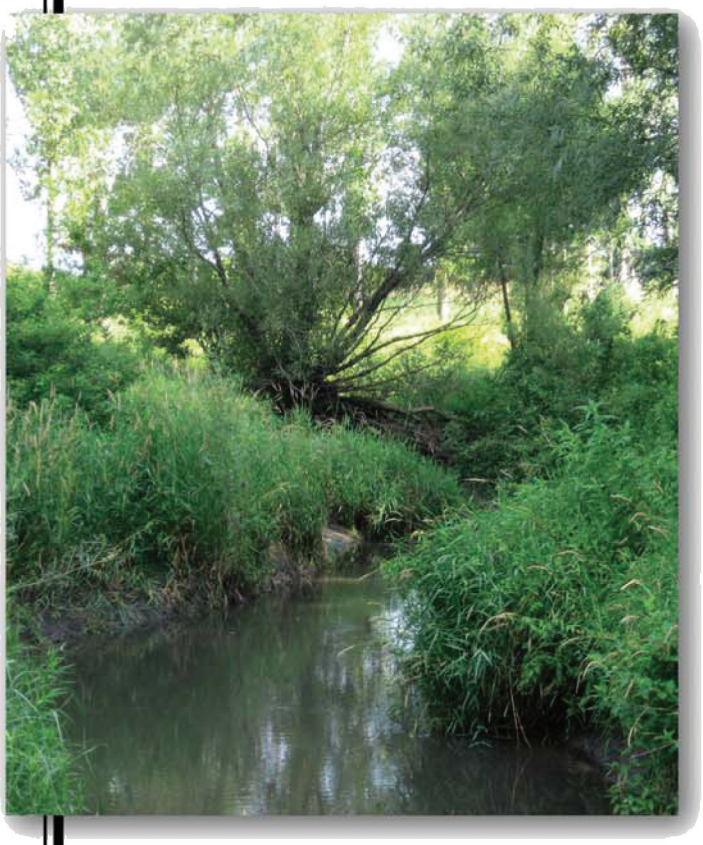
Water Monitoring Data

Lyons Creek Watershed
Monthly Average Nitrate Concentration

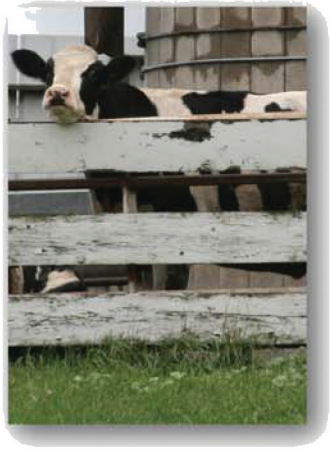
Type	Grab								
Average of Number		Site Name	Analyte						
		LCR1	LCR2	LCR3	LCR3T	LCR4	LCR4T	LCR5	LCR5T
Years	Date	Nitrate as N	Nitrate as N	Nitrate as N	Nitrate as N	Nitrate as N	Nitrate as N	Nitrate as N	Nitrate as N
2008	Aug	6.52	7.57				16.00		15.92
	Sep	1.22	2.49	4.28	13.70	6.00	14.87	8.25	15.09
	Oct	5.03	7.41	7.93	14.68	7.21	11.75	7.36	8.11
	Nov	8.73	9.86	10.63	14.28	10.41	13.72	10.64	12.36
	Dec	10.55	11.56	12.23	14.15	12.48	14.03	12.61	14.22
2009	Jan	9.61	10.57	11.55	16.00	11.74	17.50	11.87	16.82
	Feb	4.68	4.76	5.51	7.90	5.31	7.31	5.19	5.03
	Mar	8.52	9.13	9.28	12.78	8.72	8.87	8.82	9.17
	Apr	10.43	11.45	12.05	14.86	11.76	13.08	11.98	13.18
	May	12.19	13.38	13.65	16.17	13.84	13.89	13.85	15.05
	Jun	12.50	12.16	12.07	15.05	10.53	16.52	11.36	16.16
	Jul	12.35	12.40	12.53	17.53	12.82	14.91	11.99	16.60
	Aug	2.36	2.42	2.47	13.11	2.73	13.64	2.58	18.96
	Sep	0.03	0.30	2.22	7.77	1.99	13.44	4.61	17.19
	Oct	1.56	2.81	4.85	10.33	8.89	12.15	10.75	13.20
	Nov	11.13	12.21	12.87	14.31	13.69	12.08	13.93	15.13
	Dec	10.66	11.86	12.50	14.26	12.93	11.98	13.55	14.73
2010	Jan	9.26	9.88	10.46	13.17	10.85	11.67	11.48	12.47
	Feb	7.42	7.87	9.46	12.60	9.99	10.85	11.15	11.66

Appendix B

Stakeholder Survey



Informing the Cooperative Conservation Framework for Improving Watershed Health: Operator and Landowner Survey Results



IOWA STATE UNIVERSITY
University Extension

Iowa Soybean ASSOCIATION
EXPANDING OPPORTUNITIES. DELIVERING RESULTS.

Sociology Technical Report 1031
March 31, 2010

Introduction

The objective of this study was to provide social, economic, and behavioral data on farm operators and landowners to inform the Iowa Soybean Association's (ISA) effort to develop effective Cooperative Conservation systems in five HUC-12 watersheds in the larger Boone and Raccoon River Watersheds. Three of the watersheds are located in the Boone River watershed: Buck Creek, Lower Eagle, and Lyons Creek. The two watersheds selected from the larger Raccoon River watershed were Fanny's Branch and Willow Creek. A survey titled *Watershed Resource Management for Environmental and Economic Performance* was sent to all farm operators and non-operator landowners in the watersheds. The data collected through this survey effort and presented in this report represent baseline information that will guide ISA's technical assistance planning and adaptive management processes and facilitate measurement of changes in attitudes, values, and behaviors over time.

Survey Development

The survey was designed in collaboration with ISA staff to ensure that their data collection objectives were met. The survey collected data on the following general areas:

Socio-economic characteristics: Data on age, gender, education, life cycle stage, farm income, dependence on farm income, and other key variables.

Farm characteristics and farming practices: Data on owned and rented farmland, crop rotations and acreage planted, numbers and type of livestock, use of fertilizers and manures, and other variables of interest.

Knowledge, beliefs, and concern regarding local environmental conditions: Behavioral change is generally preceded by awareness of a problem. Questions examined levels of knowledge of and concern about environmental issues specific to the project watersheds.

Past and planned conservation behavior: Questions focused on several dimensions of conservation behavior, including 1) conservation practices currently in place 2) conservation practices that respondents believe they should establish, 3) use of management plans (i.e., RMS, nutrient management), and 4) beliefs about the environmental performance of farm operations.

Interest in technical assistance: One of ISA's primary objectives is to provide technical assistance to operators and landowners in the project areas. Survey questions measured potential interest in varied conservation and production-related technical assistance and assessed preferred delivery methods for different categories of technical assistance.

Survey Implementation

Survey implementation consisted of three steps. The first was the development of comprehensive lists of operators and landowners in the study areas. Because the HUC-12 watersheds are relatively small, the entire population of operators and landowners in the five watersheds were surveyed. Iowa Soybean Association staff worked with the USDA Farm Service Agency and the

Natural Resource Conservation Service to develop the lists from the agency databases. The final list contained 769 names and addresses,

The survey was conducted using a modified Dillman Tailored Design Method. A three-step process was followed consisting of 1) a first mailing of the survey and cover letter explaining the purpose of the survey, 2) a reminder postcard sent to non-respondents, and 3) a second mailing of the survey to remaining non-respondents.

Response Rate

Of the 769 surveys that were mailed, 71 were undeliverable, and 179 were completed and returned. As a result, the overall response rate was 26 percent. While this rate of response is lower than what was hoped for, the sample size is large enough to facilitate complex statistical analyses. Nevertheless, because such high rates of nonresponse result in risk of bias due to potential differences between respondents and nonrespondents, caution will be required when generalizing results to the larger population of farm operators and landowners in the watersheds.

Brief Summary of Results

The following section of this report presents a basic tabulation of the data. Several multiple-item question sets employed five-point scales that measured degree of disagreement or agreement, level of importance, level of interest, and so forth. For these questions sets, items are listed in order from strongest response to weakest. This section presents selected findings.

Socio-economic characteristics

- 52 percent were farm operators, 48 percent were non-operator landowners
- Average age was 63 years
- 63 percent had at least some college education

Farm characteristics and farming practices

- 26 percent reported gross farm income over $250,000
- 44 percent reported that over 50 percent of household income came from farming
- 57 percent reported that it is likely or very likely that a child or younger family member will take over management of their land in the future
- Respondents owned an average of 460 acres
- Of the 90 farm operators, 65 rent an average of 925 acres of farmland
- 82 non-operator landowners rented out an average of 196 acres of farmland

Knowledge, beliefs, and concern regarding local environmental conditions

- 86 and 78 percent indicated that they are at least somewhat familiar with the terms “watershed” and “watershed management,” respectively
- More than half did not know if there was an active watershed management group in their watershed
- 18 percent reported that they are involved in organized watershed management activities
- More than 50 percent believe that farmers in the watershed where their farm is located are performing above average on key conservation measures such as reducing soil erosion

- Much higher percentages rate their own performance on those same conservation measures as above average
- Nearly 70 percent were concerned about agriculture's impact on water quality
- Nearly 70 percent agreed that more data should be collected to pinpoint causes of water quality problems
- 52 percent reported uncertainty about the quality of water in their watersheds
- 48 percent agreed that non-farm sources are causing water quality problems
- 25 percent agreed that farming activities are causing water quality problems
- 17 percent agreed that tile drainage is causing water quality problems

Past and planned conservation behavior

- Large percentages had implemented numerous common conservation-oriented practices, such as soil testing (81 percent), grassed waterways (63 percent), and filter strips (56 percent).
- Far fewer saw the need to implement further conservation practices: only integrated pest management (22 percent) was cited by more than twenty percent of respondents as something they should do, but had not done so yet
- Respondents who had made investments in conservation over the previous 10 years cited productivity and profitability concerns among the most important drivers of those investments
- Other motivations for conservation practice establishment, in rough order of importance, included concerns about the environmental performance of operations, policy and regulatory factors, and social pressure

Interest in technical assistance

- The top five areas in which respondents expressed that they were interested or very interested in receiving more information, technical assistance, or other support were soil testing (64 percent), soil erosion control (61 percent), nutrient management (59 percent), energy efficiency (56 percent), and identification of true sources of water quality problems (53 percent)

Watershed Resource Management for Environmental and Economic Performance Survey
Percentage Distribution
(N=179/698, 26 percent response rate)

Response Distribution by Watershed

Buck Creek	17.3%
Fanny's Branch	19.6%
Lower Eagle	37.4%
Lyons Creek	9.5%
Willow Creek	16.2%

WATERSHEDS AND WATERSHED MANAGEMENT

A *watershed* is an area of land—often bordered by high ground such as hills and ridges—that drains into a common waterway or water body. Watersheds are often described as "nested" because smaller watersheds that drain into smaller waterways make up larger watersheds that drain into rivers and ultimately into the sea.

***Watershed management* refers to planning and action focused on maintaining clean water and general environmental quality within a watershed.**

1) Before reading the definitions above, how familiar were you with the following terms?

	Not at all familiar		*Percentage*		Very familiar
Watershed (n=178)	6.7	7.9	24.2	28.7	32.6
Watershed management (n=170)	11.8	10.0	27.1	28.2	22.9

2) Please answer the following questions about the watershed where your farm operation/farmland is located.

	Yes	No	Don't Know
	—Percentage—		
Is there an active watershed management group in the watershed? (n=176)	23.3	26.1	50.6
Are local farmers involved in organized watershed management activities? (n=175)	25.1	24.0	50.9
Are local non-farming residents involved in organized watershed management activities? (n=174)	14.4	25.3	60.3
Are you involved in organized watershed management activities? (n=176)	17.6	75.0	7.4

3) Do any of the following waterways run through or alongside your farm operation/farmland?

	Yes	No	Don't Know
	— Percentage —		
A drainage ditch (n=172)	53.5	43.6	2.9
A stream that starts on or near your land (n=165)	37.0	60.6	2.4
A stream that is formed by two or three smaller streams that come together upstream from your land (n=165)	22.4	72.7	4.8
A large stream that is formed by many smaller streams that come together upstream from your land (n=162)	13.6	80.9	5.6
A river (n=164)	14.0	82.3	3.7

4) On average, how many times per year do you do the following in *streams and rivers* in the watershed where your farm operation/farmland is located? (If none, write "0").

	Number
Swim	n=178 Range = 0-20; $\bar{x}$ = 0.3; Std. Dev. = 1.7
Fish	n=177 Range = 0-100; $\bar{x}$ = 1.2; Std. Dev. = 7.9
Boat	n=178 Range = 0-30; $\bar{x}$ = 0.3; Std. Dev. = 2.4

5) On average, how many times per year do you do the following in *lakes* in the watershed where your farm operation/farmland is located? (If none, please write "0").

	Number
Swim	n=178 Range = 0-5; $\bar{x}$ = 0.1; Std. Dev. = 0.6
Fish	n=177 Range = 0-100; $\bar{x}$ = 0.8; Std. Dev. = 7.6
Boat	n=176 Range = 0-25; $\bar{x}$ = 0.3; Std. Dev. = 2.2

6) Would you eat fish that were caught in waterways or lakes in the watershed where your farm operation/farmland is located?

	Yes	No
	— Percentage —	
Would you eat fish from local streams or rivers? (n=174)	64.4	35.6
Would you eat fish from local lakes? (n=173)	70.5	29.5

7) Thinking generally about farmers in the watershed where your farm operation/farmland is located, how well do you think they are performing in the following areas?

	Very Poorly	Poorly	Average	Well	Very Well	Don't Know
	Percentage					
Maintaining or enhancing soil productivity (n=174)	1.7	1.7	21.8	37.4	25.9	11.5
Reducing runoff of soils and sediments into waterways (n=174)	1.1	6.3	18.4	41.4	19.5	13.2
Improving fertilizer use efficiency (n=171)	0.6	4.1	23.4	33.9	25.1	12.9
Reducing soil erosion (n=172)	1.7	5.2	25.0	36.0	20.9	11.0
Ensuring that overall their farming activities do not harm the environment (n=173)	1.2	7.5	23.7	35.8	16.8	15.0
Reducing flow of nutrients such as nitrogen and phosphorous into waterways (n=175)	0.6	12.6	21.7	32.6	14.9	17.7
Reducing runoff of chemicals such as herbicides, insecticides, and fungicides into waterways (n=173)	1.2	8.7	26.6	30.6	16.2	16.8
Improving soil carbon (organic matter) levels (n=174)	0.6	7.5	26.4	28.7	13.2	23.6
Improving energy efficiency in their operations (n=174)	0.0	6.9	32.2	27.6	13.8	19.5
Providing habitat for game wildlife (n=172)	1.2	14.0	31.4	23.8	16.3	13.4
Providing habitat for non-game wildlife (n=173)	1.7	15.6	34.1	19.1	15.0	14.5

8) Thinking about *your* farm operation or farmland, how well do you think you are performing in these areas?

	Very Poorly	Poorly	Average	Well	Very Well	Don't Know
	Percentage					
Reducing soil erosion (n=175)	0.0	1.7	15.4	38.3	38.9	5.7
Reducing runoff of soils and sediments into waterways (n=173)	0.0	2.3	15.0	38.2	38.2	6.4
Improving fertilizer use efficiency (n=175)	0.0	1.7	15.4	34.9	40.0	8.0
Maintaining or enhancing soil productivity (n=176)	0.0	0.6	18.8	32.4	42.0	6.3
Ensuring that overall farming activities on your land do not harm the environment (n=173)	0.0	0.6	18.3	33.7	38.3	9.1
Reducing flow of chemicals such as herbicides, insecticides, and fungicides into waterways (n=173)	0.0	3.5	16.8	35.8	34.7	9.2
Reducing runoff of nutrients such as nitrogen and phosphorous into waterways (n=173)	0.0	5.2	16.2	37.0	30.1	11.6
Improving energy efficiency in your operations (n=172)	0.0	3.5	20.8	32.4	31.2	12.1
Improving soil carbon (organic matter) levels (n=172)	0.0	2.9	20.9	32.0	26.7	17.4
Providing habitat for game wildlife (n=174)	1.7	6.9	27.0	24.1	31.6	8.6
Providing habitat for non-game wildlife (n=174)	1.7	8.6	28.7	23.0	28.7	9.2

9) Thinking about the watershed where your farm operation/farmland is located, to what extent do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	Percentage				
Farmers and other local residents should work together on water quality issues (n=170)	0.6	1.8	15.9	74.1	7.6
I am concerned about agriculture's impact on water quality (n=174)	3.4	9.2	19.5	58.6	9.2
More data needs to be collected to identify exactly what the major causes (if any) of water quality problems are (n=170)	1.8	10.0	21.8	55.3	11.2
Non-farm sources (municipal wastewater, septic systems, lawn fertilizers) are causing water quality problems (n=174)	4.0	10.9	36.8	42.0	6.3
Water quality in waterways is steadily improving (n=170)	2.4	8.8	45.9	40.0	2.9
Farmers need more help to improve the environmental efficiency of their farms (n=172)	2.3	15.7	40.7	34.3	7.0
Streambank erosion is causing water quality problems (n=171)	9.4	26.3	32.7	26.3	5.3
I would be willing to get more involved in local watershed management efforts (n=170)	7.6	15.9	47.1	27.1	2.4
Water quality in waterways is just fine (n=172)	3.5	16.3	51.7	27.3	1.2
Farming activities are causing water quality problems (n=173)	10.4	30.1	34.1	23.1	2.3
Tile drainage is causing water quality problems (n=173)	12.7	35.3	35.3	15.6	1.2

10) Thinking about the following conservation practices, which practices 1) have you established or employed on your land over the last ten years (since 1999), 2) do you believe you should establish, but have not done so yet, or 3) are not needed on your land?

		Have established	Should establish	Practice not needed
		Percentage		
Soil testing	(n=161)	81.4	11.8	6.8
Yield monitoring	(n=158)	75.9	12.7	11.4
Grassed waterways	(n=164)	62.8	12.2	25.0
Systematic crop scouting	(n=152)	57.2	15.8	27.0
Filter strips (along waterways or water bodies)	(n=162)	56.2	6.8	37.0
Reduced tillage (example: ridge till, no-till)	(n=158)	50.0	17.1	32.9
Drainage water management	(n=149)	43.6	12.8	43.6
Wildlife habitat improvement	(n=159)	39.0	18.2	42.8
Nutrient management plan	(n=158)	37.3	12.7	50.0
Integrated pest management	(n=153)	36.6	21.6	41.8
Windbreak/shelterbelt	(n=159)	30.2	12.6	57.2
Wetland creation/restoration/enhancement	(n=157)	25.5	7.6	66.9
Field border	(n=151)	17.9	9.9	72.2
Streambank stabilization	(n=157)	17.8	18.5	63.7
Cover crops	(n=154)	17.5	9.7	72.7
Terraces	(n=161)	16.1	3.7	80.1
Integration of small grains or forage crops into rotation	(n=153)	15.0	11.1	73.9
Contour buffer strips	(n=159)	14.5	8.2	77.4
Riparian forest buffers (along waterways or water bodies)	(n=159)	14.5	5.7	79.9
Grade stabilization structure (example: pond)	(n=160)	11.9	3.8	84.4
Manure management plan	(n=158)	11.4	2.5	86.1
Water and sediment control basin	(n=158)	10.1	12.0	77.8
Fencing to keep livestock out of streams or wooded areas	(n=161)	8.7	3.1	88.2
Manure pit	(n=162)	6.8	0.0	93.2
Management-intensive rotational grazing	(n=158)	5.7	5.7	88.6
Solid settling basin	(n=156)	3.8	3.2	92.9
Deep-bedded barn	(n=159)	1.3	1.3	97.5
Lagoon	(n=161)	1.2	0.0	98.8

If you did not establish any of the conservation practices listed above since 1999, please skip to question 13

11) What is the approximate total cost of all of the conservation practices that you have established since 1999? Please include all expenses, including those covered by cost-share, loans, or other sources. (Round to the nearest dollar.)

(n=96) Range = $0-$2,000,000; $\bar{x}$ = $48,130.06; Std. Dev. = $211,998.87

12) The following are some reasons why people establish conservation practices. Please rate how important each reason was in your decision to establish conservation practices on your land.

	Not at All Important		*Percentage*		Very Important
Protect the land for the next generation ..... (n=138)	0.7	2.9	5.1	34.1	57.2
Protect my investment in the land..... (n=139)	1.4	1.4	7.2	33.1	56.8
Maintain or improve soil fertility..... (n=136)	0.7	0.7	11.0	37.5	50.0
Maintain or enhance productivity ..... (n=136)	2.9	4.4	8.1	37.5	47.1
Increase long-term profitability ..... (n=133)	3.8	3.0	9.8	39.1	44.4
Avoid polluting streams, rivers and lakes..... (n=136)	1.5	3.7	15.4	39.7	39.7
Reduce the environmental impact of my farming activities..... (n=135)	0.7	3.0	17.0	41.5	37.8
Increase the efficiency of my operation..... (n=136)	2.9	4.4	14.7	34.6	43.4
Keep chemicals and nutrients on the farm ..... (n=136)	1.5	2.9	17.6	43.4	34.6
Protect water quality downstream..... (n=137)	0.0	6.6	20.4	43.1	29.9
Feeling of responsibility to earlier generations.... (n=135)	5.2	5.9	18.5	37.8	32.6
Comply with Farm Bill requirements ..... (n=132)	9.8	12.1	14.4	37.9	25.8
Ensure eligibility for farm bill payments ..... (n=131)	6.9	9.9	20.6	36.6	26.0
Prepare for programs that reward conservation behavior ..... (n=133)	4.5	14.3	21.8	39.8	19.5
Improve habitat for game wildlife ..... (n=135)	2.2	11.9	31.9	32.6	21.5
Increase short-term profitability ..... (n=135)	9.6	13.3	23.7	28.9	24.4
Improve habitat for non-game wildlife..... (n=134)	3.0	11.9	32.8	32.1	20.1
Prepare for potential future regulations ..... (n=132)	8.3	18.9	22.0	34.8	15.9
Avoid problems with regulatory agencies ..... (n=131)	10.7	10.7	29.0	29.0	20.6
I felt embarrassed about a visible problem ..... (n=131)	36.6	20.6	25.2	13.0	4.6
Family member(s) encouraged me to do so..... (n=133)	28.6	28.6	27.8	12.0	3.0
My neighbors were doing it..... (n=133)	38.3	25.6	22.6	12.8	0.8
Neighbors encouraged me to do so..... (n=132)	38.6	34.1	22.0	5.3	0.0

13) 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.

	Not at All Interested	Somewhat Interested	Interested	Very Interested	Uncertain
			Percentage		
Soil testing (n=152)	19.7	14.5	31.6	32.2	2.0
Soil erosion control (n=154)	16.9	18.8	31.8	29.2	3.2
Nutrient management (n=147)	23.8	16.3	34.0	24.5	1.4
Energy efficiency (n=151)	23.2	17.9	31.8	23.8	3.3
Identification of true sources of water quality problems in your watershed (n=150)	22.7	20.7	29.3	24.0	3.3
Pest management (n=148)	21.6	23.3	32.4	20.3	2.7
Tillage and residue management (n=149)	24.8	26.2	32.2	15.4	1.3
Assessment of overall environmental performance of your farm (n=151)	23.8	26.5	25.2	21.2	3.3
Stalk sampling (n=149)	30.2	22.1	30.9	14.8	2.0
Water sampling and monitoring (n=150)	30.0	22.7	26.0	18.7	2.7
Wildlife habitat improvement (n=151)	25.8	27.2	30.5	13.9	2.6
Controlled drainage (n=148)	29.1	26.4	27.0	15.5	2.0
Assessment of overall environmental performance of all activities in watersheds (n=151)	23.2	32.5	22.5	17.2	4.6
Waste management (trash, used oil, hazardous materials) (n=148)	31.8	25.0	29.7	8.1	5.4
Legal/regulatory requirement review (n=147)	36.1	21.8	29.3	7.5	5.4
Carbon sequestration/greenhouse gas management (n=148)	37.8	20.3	23.0	13.5	5.4
Whole-farm resource management (n=145)	39.3	20.7	25.5	10.3	4.1
Streambank stabilization (n=149)	45.6	20.8	20.1	10.1	3.4
Construction of nutrient removal wetlands (n=146)	42.5	25.3	18.5	7.5	6.2
Facilitation of citizen-led watershed management planning and action (n=144)	50.7	20.8	19.4	5.6	3.5
Odor management (n=151)	54.3	16.6	17.9	6.6	4.6
Manure management (n=150)	59.3	14.0	15.3	8.7	2.7
Septic system evaluation (n=154)	53.2	22.1	15.6	5.2	3.9
Construction of bioreactors (n=150)	52.0	18.0	14.7	6.0	9.3
Grazing management (n=151)	69.5	11.3	9.9	5.3	4.0

14) 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	Demonstrations/ Field days	Mailings	Internet websites and email
	Percentage				
Soil erosion control ..... (n=144)	24.3	17.4	19.4	27.8	11.1
Water quality improvement..... (n=140)	11.4	30.0	15.0	30.0	13.6
Pest management..... (n=138)	10.9	29.0	14.5	31.9	13.8
Soil fertility improvement ..... (n=140)	20.7	20.7	16.4	27.9	14.3
Nutrient or manure management ..... (n=133)	14.3	27.8	15.0	26.3	16.5
Wildlife habitat improvement ..... (n=139)	14.4	20.1	18.0	33.1	14.4

GENERAL QUESTIONS

15) How many years has the farmland that your family has *owned the longest* been in the family?

(n=171) Range = 5-154 years; $\bar{x}$ = 75.6 years; Std. Dev. = 35.1 years

16) When you retire from farming or are no longer managing your land, how likely is it that one of your children or a younger family member (in-law, nephew, niece) will take over? (n=174)

33.3% Very likely
24.1% Likely
18.4% Unlikely
24.1% Very unlikely

17) Are you a… (n=175)

77.1% Male
22.9% Female

18) What is your age?

(n=171) Range = 23-95 years; $\bar{x}$ = 63.1 years; Std. Dev. = 13.3 years

19) What is the highest level of education you have completed? (n=174)

2.9% Some high school
26.4% High school graduate
8.0% Technical/vocational school
20.1% Some college
27.6% Bachelor's degree
5.2% Some graduate school
9.8% Graduate or professional degree

FARM CHARACTERISTICS

20) How many acres of farmland do you own?

(n=172) Range = 0-8,400 acres; $\bar{x}$ = 460.2 acres; Std. Dev. = 1,116.1 acres

21) How many acres of farmland did you rent or lease *from* others in 2009? (if none, please write "0")

(n=166) Range = 0-3,500 acres; $\bar{x}$ = 372.8 acres; Std. Dev. = 657.6 acres

22) How many acres of farmland did you rent or lease *to* others in 2009? (if none, please write "0")

(n=169) Range = 0-4,313 acres; $\bar{x}$ = 186.1 acres; Std. Dev. = 518.6 acres

23) Which category best represents your *gross* farm income for 2008? (n=152)

0.7%	Less than $2,500
5.9%	$2,500 to $9,999
11.8%	$10,000 to $24,999
23.7%	$25,000 to $49,999
15.1%	$50,000 to $99,999
17.1%	$100,000 to $249,999
11.2%	$250,000 to $499,999
14.5%	$500,000 or more

24) What percent of your 2008 net household income was from your farm operation or farmland? (n=160)

13.8%	0% to 10%
21.9%	11% to 25%
20.6%	26% to 50%
17.5%	51% to 75%
26.3%	76% to 100%

25) Are you a: (n=174)

48.3%	Non-operator farmland owner	***Thank you for your participation. You are finished with the survey.***
51.7%	Farm operator	***Please go to Q26***

26) Please indicate the number of acres of your land or land that you rented from someone else that are in the following crops/uses in 2009.

	Owned	Rented
Corn	(n=62) Range = 26-8,000; $\bar{x}$ = 373.4; Std. Dev. = 1,016.2	(n=63) Range = 30-2,200; $\bar{x}$ = 501.8; Std. Dev. = 468.9
Soybeans	(n=56) Range = 20-1,000; $\bar{x}$ = 191.1; Std. Dev. = 183.1	(n=58) Range = 15-1,800; $\bar{x}$ = 403.0; Std. Dev. = 350.2
Wheat	(n=0)	(n=0)
Oats	(n=0)	(n=0)
Sorghum	(n=0)	(n=0)
Hay or pasture	(n=8) Range = 1-35; $\bar{x}$ = 16.9; Std. Dev. = 10.7	(n=9) Range = 2-110; $\bar{x}$ = 26.8 Std. Dev. = 34.4
Vegetables or fruit	(n=0)	(n=0)
Conservation Reserve (CRP) ground	(n=17) Range = 3-106; $\bar{x}$ = 31.2; Std. Dev. = 35.3	(n=19) Range = 1-80; $\bar{x}$ = 16.6; Std. Dev. = 18.4
Other	(n=5) Range = 10-30; $\bar{x}$ = 16.8; Std. Dev. = 8.3	(n=1) $\bar{x}$ = 2

27) Please indicate the number of animals currently in your farm operation or on your land.

	Owned by You	Owned by Others
Beef cow-calf pairs	(n=9) Range = 3-170; $\bar{x}$ = 34.6; Std. Dev. = 52.5	(n=4) Range = 5-50; $\bar{x}$ = 18.2; Std. Dev. = 21.3
Cattle on feed	(n=5) Range = 4-850; $\bar{x}$ = 214.2; Std. Dev. = 357.6	(n=1) $\bar{x}$ = 1,600
Dairy cattle	(n=0)	(n=0)
Breeding hogs	(n=3) Range = 1-180; $\bar{x}$ = 62.3; Std. Dev. = 101.9	(n=0)
Market hogs, including feeder pigs	(n=3) Range = 300-1,500; $\bar{x}$ = 725.0; Std. Dev. = 672.2	(n=6) Range = 400-13,000; $\bar{x}$ = 3,850.0; Std. Dev. = 4,768.1
Laying hens and pullets	(n=1) $\bar{x}$ = 12	(n=0)
Broilers and other chickens	(n=0)	(n=0)
Turkeys	(n=1) $\bar{x}$ = 9	(n=0)
Other	(n=1) $\bar{x}$ = 14	(n=1) $\bar{x}$ = 100

FERTILIZER USE AND MANURE MANAGEMENT

28) In the last five years, have you made any regular reductions in the amount of nitrogen you apply to your cropland? (n=99)

59.6%	Yes	***Please continue to Question 29***
33.3%	No	***Please continue to Question 30***
7.1%	Don't know	***Please continue to Question 30***

29) If yes, why have you reduced the amount of nitrogen you apply? (n=59 for each statement)

% ✓'ed	
89.8	To reduce costs
52.5	Following new recommendations
27.1	Credit taken from manure/legumes
27.1	Concern over groundwater pollution
8.5	Concern over health effects
18.6	Concern over surface water pollution
16.9	Want my farm to become more sustainable

30) To what extent do you use the following practices to manage nitrogen?

	Do Not Use	Limited Use	Moderate Use	Heavy Use
	Percentage			
Crop rotations (n=94)	3.2	5.3	35.1	56.4
Soil testing (n=94)	9.6	9.6	48.9	31.9
Yield goals (n=93)	11.8	7.5	43.0	37.6
Variable fertilizer rates (n=92)	32.6	19.6	28.3	19.6
Animal manure (n=95)	49.5	10.5	25.3	14.7
Soil temperatures (n=90)	50.0	14.4	20.0	15.6
Plant legumes (n=92)	51.1	17.4	22.8	8.7
N-Serve or N-Stabilizer (n=91)	52.7	16.5	18.7	12.1
Controlled drainage (n=91)	59.3	11.0	22.0	7.7
Integrated Crop Management (ICM) (n=89)	46.1	24.7	25.8	3.4
Test strips (n=89)	55.2	20.2	18.0	5.6
Aerial photos or remote sensing (n=91)	74.7	8.8	11.0	5.5
Stalk N tests (n=88)	67.0	18.2	12.5	2.3
Late spring nitrogen test (n=88)	69.3	18.2	10.2	2.3
Wetlands (n=92)	72.8	17.4	6.5	3.3
SPAD (chlorophyll) meter (n=89)	94.4	3.4	2.2	0.0

31) Please indicate the number of acres that received the following forms of fertilizer and application rates over the 2008-2009 season (If none, write "0").

	Number of Acres	Application Rates	
Anhydrous Ammonia	(n=78) Range = 0-6,000; $\bar{x}$ = 463.9; Std. Dev. = 811.4	(n=62) Range = 0-300; $\bar{x}$ = 106.3; Std. Dev. = 68.0	lbs. N/acre
Liquid Nitrogen	(n=74) Range = 0-3,200; $\bar{x}$ = 296.2; Std. Dev. = 499.3	(n=55) Range = 0-180; $\bar{x}$ = 75.6; Std. Dev. = 62.8	lbs. N/acre
Dry (granular) Nitrogen	(n=64) Range = 0-1,700; $\bar{x}$ = 201.0; Std. Dev. = 361.1	(n=45) Range = 0-200; $\bar{x}$ = 23.9; Std. Dev. = 39.0	lbs. N/acre
Phosphorus	(n=68) Range = 0-8,000; $\bar{x}$ = 509.5; Std. Dev. = 1,055.3	(n=44) Range = 0-180; $\bar{x}$ = 56.4; Std. Dev. = 50.9	lbs. P/acre
Solid manure	(n=68) Range = 0-677; $\bar{x}$ = 86.4; Std. Dev. = 167.2	(n=48) Range = 0-3; $\bar{x}$ = 0.8; Std. Dev. = 1.1	Tons/acre
Liquid manure	(n=66) Range = 0-1,200; $\bar{x}$ = 65.9; Std. Dev. = 205.5	(n=44) Range = 0-20,000; $\bar{x}$ = 1,157.7; Std. Dev. = 3,361.0	Gallons/acre

32) Do you apply manure on your cropland? (n=101)

No	62.4%	***Thank you for your participation. You are finished with the survey***
Yes	37.6%	Go to question 33

33) Do you regularly apply manure prior to planting the following crops?

	Yes	No
	Percentage	
Corn (n=48)	75.0	25.0
Soybeans (n=44)	15.9	84.1
Alfalfa (n=41)	4.9	95.1
Small grain (n=40)	0.0	100.0
Other (n=37)	2.7	97.3

34) Please answer the following questions about manure management and application.

	Yes	No
	Percentage	
Have you tested manure for its nitrogen/phosphorus nutrient availability? (n=46)	65.2	34.8
Do you adjust commercial nitrogen rates to reflect the contribution from manure? (n=46)	76.1	23.9
Do you adjust commercial phosphorus rates to reflect the contribution from manure? (n=46)	69.6	30.4

35) How do you decide where to apply manure? (n=59 for each statement)

% ✓'ed	
15.3	According to my manure management plan
20.3	Systematically rotate applications depending upon soil nutrient needs
6.8	Apply mostly in fields near my livestock facilities
8.5	Apply manure evenly in most or all of my fields
3.4	Apply in most convenient locations
27.1	Apply according to schedule that involves rotation of fields
6.8	Consultant's recommendation

Thank you for your participation. Your input will help to improve outreach and extension support for Iowa farmers and landowners. Please return the survey in the envelope provided at your earliest convenience.

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jack M. Payne, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.