Indian Creek Watershed Management Plan

June 2015

ECICOG
EAST CENTRAL IOWA COUNCIL OF GOVERNMENTS
YOUR REGIONAL PLANNING AGENCY

Indian Creek Watershed Management Authority

Acknowledgements

This Indian Creek Watershed Management Plan (2015) is the culmination of a two year, collaborative planning process that involved local, state, and federal agencies; institutions of higher learning; consultants; and many engaged stakeholders that represented various groups in the watershed. Thank you to the Indian Creek Watershed Management Authority Board of Directors and the Technical Team for their dedication to this process. For many, the time dedicated to this project was voluntary or in addition to their normal job responsibilities. A special thanks to the many watershed stakeholders who participated in developing this plan to improve the Indian Creek Watershed for everyone who lives, works and plays there.

Funding for the Indian Creek Watershed Management Plan was provided through grants to the City of Marion serving as fiscal agent. The Iowa Economic Development Authority funded completion of a comprehensive watershed management plan through a Community Development Block Grant Program Disaster Recovery Contract. In addition, publication of this document was funded in part by the Iowa Department of Natural Resources through a grant from the U.S. Environmental Protection Agency under the Federal Nonpoint Source Management Program (Section 319 of the Clean Water Act).

Project Manager

Jennifer Fencl – East Central Iowa Council of Governments (ECICOG)

Editors & Contributors

Mary Beth Stevenson – IDNR
Martin St. Clair Ph.D. – Coe College
Jeff Tisl – IDALS-DSC
Mary Skopec Ph.D. – IDNR
Toby Hunemuller P.E. – US Army Corps of Engineers Rock Island District
Ryan Clark P.G. – Iowa Geological Survey
Chad Fields – Iowa Geological Survey
Tom Wilton – IDNR Biologist
Walt Stephenson – Retired UNI Professor

GIS Mapping & Analysis

Andy Asell – IDNR
Brock Grenis – ECICOG
Mary Beth Stevenson – IDNR
Alicia Presto – ECICOG

Design & Layout

Nicole Van Nelson – ECICOG

Photo Credits

Rick Sandstrom – Watershed Resident
Nicole Van Nelson – ECICOG
Martin St. Clair Ph. D. – Coe College
Christopher Emery – ECICOG Intern

Indian Creek Watershed Management Authority Board of Directors

Bruce Frana – Linn Soil & Water Conservation District
Craig Hanson – City of Cedar Rapids
Steve Cooper – City of Marion
Vince Bading – City of Robins
John Bender – City of Hiawatha
Les Beck – Linn County

Research Consultants

US Corps of Engineers Rock Island District
    Toby Hunemuller P.E. and Gregory Karlovits P.E.
Coe College Chemistry Department
    Martin St. Clair Ph.D. with students Laura Bybee, Maddy Jensen, Kelsey McKillip, and Kendra Miner
Coe College Anthropology Department
    Assistant Professor Julie Fairbanks with students Katelyn Leonardo and Matthew McNeil
Vernon Research Group
    Linda Kuster & staff
Iowa Department of Natural Resources
    Mary Beth Stevenson, Mary Skopec Ph.D., Andy Asell, Tom Wilton
Iowa Geological Survey
    Ryan Clark P.G. and Chad Fields
Iowa Department of Agriculture & Land Stewardship
    Jeff Tisl and Amy Bouska
Linn Soil & Water Conservation District
    John Bruene and Jon Gallagher
Environmental Working Group
    Soren Rundquist

Thank you to Todd Steigerwaldt, Marion Water Department, for making that phone call and to Mary Beth Stevenson, Iowa DNR, for insisting this could be done.

Here's to hoping the immortal words of Yogi Berra are true...
"the future ain't what it used to be."

Table of Contents

Documents Available on ICWMA Website at indiancreekwatershed.weebly.com/the-plan

ICWMA Formation Documents

Interagency Visioning Workshops Report 2012

Indian Creek Landcover Assessment Report

Indian Creek Water Quality Assessment Report 2013

Cedar River Tributary Study Summer 2014

Stream Habitat Improvements Recommendation Report 2015

Indian Creek Watershed RASCAL Report 2014

Indian Creek Watershed Cedar Rapids, Iowa Watershed Modeling and Mapping Report, May 2014

Indian Creek Watershed On-line Survey May 2014

Survey Outreach Methods

Survey Outreach to Farmers

Indian Creek User Survey

Indian Creek Watershed Survey Quantitative Findings Report September 2014

Summary of Stakeholder Input Report June 2015

Tables

Figures

Executive Summary

Persistent flooding and water quality concerns have led the governmental entities within the Indian Creek watershed to embrace a cooperative, multi-jurisdictional planning approach. The resulting Indian Creek Watershed Management Plan (Plan) details strategies and recommendations for watershed and stormwater management, water quality protection, and stormwater permit compliance. It includes specific implementation strategies and milestones for these recommendations for local governments as well as regional and state agencies.

The Indian Creek Watershed Management Authority (ICWMA) utilized a collaborative, adaptive management approach for the Plan, which incorporates and links knowledge and credible science with the experience and values of stakeholders for more effective decision-making. The Indian Creek Watershed Management Plan was completed by the ICWMA Board of Directors and planning staff from the East Central Iowa Council of Governments, with a great deal of input from a Technical Advisory Team (Tech Team), a Community Advisory Team, and technical consulting firms/institutions.

Watershed Characterization (Chapter 2)

The watershed characterization chapter includes a description of the watershed in terms of area, population, land use/land cover, climate, topography, geology, soils, and groundwater/drinking water sources. Overall, the Indian Creek watershed has experienced both growth in urban land use and the intensification of agricultural land uses. These land use pressures, along with the trend of more rainfall brought about by climate change, will continue to impact erosion rates and floodplain extents in the Indian, Dry and Squaw Creeks and their tributaries.

Water Quality (Chapter 3)

Water quality in a creek is highly influenced by the amount and quality of water that runs off the land within the watershed. Water that runs off agricultural fields or is conveyed through tile drainage can carry soil particles (sediment), fertilizers (nitrogen and phosphorus), pesticides and herbicides. In urban areas, water that is conveyed through storm sewer networks from parking lots, roads, rooftops, and urban lawns can carry heavy metals, oil and grease, pet waste, and lawn chemicals. This chapter summarizes the water quality of Indian Creek and its tributaries and compares this data to available stream water quality criteria. The levels of nitrogen and phosphorus in the water vary seasonally and are generally higher in the agricultural part (northern) of the watershed. A significant majority of the samples taken to measure bacteria levels (*E.Coli*) in the creeks exceeded the state standard for children's recreational use.

Stream Health (Chapter 4)

Two assessments were conducted to examine the overall health of the creeks in the watershed. First, the Iowa Department of Natural Resources provided an evaluation of stream habitat conditions using a model and biological samples collected at four stream locations between 2000 and 2013. The evaluation assessed the suitability of habitat in the creek for supporting a healthy aquatic community. In general, habitat would be improved by reducing the silt and sediment in the creeks and increasing the cobble and boulder make-up of the stream bed. The condition of the stream channel was assessed through the RASCAL (Rapid Assessment of Stream Condition Along Length) conducted by students from Coe College. The RASCAL assessment was completed on 35 miles of the stream network (61% of the total stream length) and found that only 9% of the assessed segments had stable stream banks. Stream bank erosion appears to be more problematic in the lower reaches of Indian Creek and Squaw Creek.

Hydrology (Chapter 5)

The hydrology of the Indian Creek watershed has long been described as "flashy" meaning that the water level in the creeks rise and fall rapidly in response to rain events. In an effort to better understand the hydrology of the watershed, a study was commissioned to add to the existing modeling work done by the US Army Corps of Engineers – Rock Island District. The results of the study are summarized in this chapter and illustrate that land use and climate, considered both separately and together, can significantly affect peak flows throughout the Indian Creek watershed. Peak flows will increase as urbanization increases with greater increases during more frequent, lower flood events than during less frequent, high flooding, intense rainfall events. The climate change analysis indicated that changes in weather patterns are likely to increase peak flows throughout the watershed as well. From a watershed management standpoint, these findings suggest that practices in urban areas to infiltrate stormwater from the majority of rainfall events, which tend to be small, could help to substantially mitigate the effects of urbanization in the watershed.

Social Assessment (Chapter 6)

Completing a social assessment of the Indian Creek watershed inhabitants was one of the priorities of the planning process. Vernon Research Group conducted a representative survey of watershed residents and farmers to capture attitudes, knowledge levels, and willingness to engage in watershed improvements. Results are presented in this chapter along with recommendations for developing an education plan. In general, residents and farmers viewed urban issues as the top contributors to water quality problems and residents scored nearly all of the contributing issues significantly more problematic than farmers. Flooding was the only condition rated as a moderate problem or above by both residents and farmers. Residents recognized the relationship between their lawn care practices and the health of local creeks, wanted to protect creeks, and are willing to be part of that effort. Farmers wanted to leave the land healthy, recognized that their practices have an impact, and voiced concern.

Watershed Action Plan (Chapter 7)

Goals, objectives, and implementation strategies for the Indian Creek Watershed Management Plan were developed through an iterative process involving watershed stakeholders, the ICWMA Board, and the Tech Team and related back to the watershed assessment. The Plan goals are:

1. Protect and improve surface water and groundwater in the watershed
2. Protect human life, property, and surface water systems that could be damaged by flood events in the watershed
3. Expand and enhance recreational opportunities and increase the quantity and quality of habitat in the watershed
4. Build community support for the protection & enhancement of land and water resources in the watershed
5. Work cooperatively with stakeholders to identify and establish partnerships, common polices, and shared resources to implement the Indian Creek Watershed Management Plan

Implementation Strategies

A detailed action plan was developed using the goal setting process and considerable time and effort from both the Tech Team and the ICWMA Board. The action plan identifies the Plan goals addressed by each strategy, adds activity milestones, recommends a group to take the lead, and lists possible technical resources and/or funding options. The action plan will be used by ICWMA member governments, watershed stakeholders, and other partners to make progress towards, and measure, watershed management goals.

Recommended Management Strategies

An important component of the watershed planning process is to identify watershed management strategies that will reduce, slow and filter runoff to receiving waterbodies. Part of this involves identifying critical areas in the watershed that contribute relatively higher pollutant loads or runoff volumes. These critical areas are high priorities for implementing Best Management Practices (BMPs). This chapter presents a map that combines key findings from the assessment data and shows recommended strategies for land management to improve water quality and reduce peak flows.

Funding Sources (Chapter 8)

This chapter lists and describes the available funding sources for watershed management efforts that were adapted from the Iowa Stormwater Education Program.

Education & Outreach Plan (Chapter 9)

Education and public awareness is essential to effective water resources management. Public education will raise awareness about the environmental impacts of daily activities and build support for watershed planning and projects. This chapter provides a framework for a detailed education and awareness program including a list of education activities identified as important in Phase 1 of Plan implementation, education messages, target audiences, and program delivery techniques.

Water Monitoring Plan (Chapter 10)

Water monitoring is an important part of establishing a baseline for both water quality and stream flows, and for documenting progress in achieving the goals of the Indian Creek Watershed Management Plan. This chapter outlines a water monitoring plan that includes an urban and agricultural monitoring component to add to existing data collection efforts.

Plan Evaluation (Chapter 11)

There will need to be an evaluation of the progress towards implementation of the specific actions identified in the Indian Creek Watershed Management Plan and towards meeting the long-term goal of a healthy watershed. The Plan will be evaluated through annual Plan reviews and Plan updates every 5 years. This chapter provides a framework for the annual review and 5 year update process.

Chapter 1 – Introduction

"The significant problems we face
cannot be solved at the same level of thinking
we were at when they were created."

Albert Einstein

1.1 The Indian Creek Watershed

The Indian Creek watershed is located entirely within Linn County in the Lower Cedar River sub-basin. The main branch of Indian Creek is fed by Dry Creek and Squaw Creek ultimately draining to the Cedar River near the intersection of Otis Road SE and Bertram Road south of Cedar Rapids, see Figure 2-1. Some of the notable characteristics of the watershed include:

- The watershed is 60,229 acres with a population of 63,569 residents, which is expected to increase to over 85,000 by 2040
- Oak savanna and prairie were the primary land cover types prior to the 1830s
- The dominant watershed land use types in 2013 were agricultural land (53%) and developed land (29%)
- Urban development pressures over the past forty years in the lower part of the watershed combined with intensive agricultural activities in the upper reaches has impacted water quantity and quality
- The watershed includes all of the municipalities of Marion and Alburnett and portions of Cedar Rapids, Hiawatha, and Robins
- Significant, reoccurring flash flood events are common throughout the watershed
- FEMA's 100-year floodplain covers 4,563 acres or 7.6% of the watershed
- Indian and Dry Creek are both listed on Iowa's 303(d) impaired waters list due to pathogens and degraded habitat for aquatic life
- Nine percent of the stream banks of Indian Creek and its tributaries exhibit bank erosion, 80% of the banks exhibit minor to moderate erosion, and 8% of the banks are severely eroded

1.2 Indian Creek Watershed Management Authority Formation

In 2010, Iowa lawmakers passed legislation authorizing the creation of Watershed Management Authorities (Iowa Code Chapter 466B). A Watershed Management Authority (WMA) is a mechanism for cities, counties, Soil & Water Conservation Districts (SWCDs) and stakeholders to cooperatively engage in watershed planning and management. Generally, the purpose of WMAs are to:

- Assess and reduce flood risk
- Assess and improve water quality
- Monitor federal flood risk planning and activities
- Educate residents of the watershed regarding flood risks and water quality
- Allocate moneys made available to the Authority for water quality and flood mitigation projects

Iowa Code specifies that WMAs do not have taxing authority or the right to acquire property through eminent domain.

In fall of 2011, the City of Marion obtained funding from the State of Iowa to form the Indian Creek Watershed Management Authority (ICWMA) in cooperation with other local governments and with assistance from the East Central Iowa Council of Governments (ECICOG). Membership in the ICWMA is based on the hydrologic boundary of the Indian Creek watershed which is shown in Figure 2-1. The participating local governments within the Indian Creek watershed include the cities of Marion, Cedar Rapids, Hiawatha, and Robins, Linn County, and the Linn Soil & Water Conservation District. The ICWMA was established as a cooperative organization through an agreement under Iowa Code 28E and 466B and filed with the Secretary of the State of Iowa in August 2012. The agreement and by-laws can be found in the ICWMA Formation Documents section of Appendix 2.

Vision Statement

The members of the ICWMA have agreed to engage in watershed level planning and management with a goal to support communication and coordination within the Indian Creek watershed to reduce flood risk and improve water quality.

Board of Directors

A Board of Directors representing all participating political subdivisions guides efforts to improve the watershed as outlined in the ICWMA by-laws. The ICWMA Board of Directors (ICWMA Board) meets quarterly on the second Wednesday of the months of February, May, August, and November. The ICWMA Board is responsible for the content of this comprehensive Indian Creek Watershed Management Plan (Plan) and its implementation and maintenance. The ICWMA Board also helped ensure that the Plan is in alignment with the Linn County Multi-jurisdictional Hazard Mitigation Plan and each political subdivision's comprehensive plan.

Table 1-1. ICWMA Board of Directors in 2015

	Board Member Name	Representing	Term Expires	Alternate Board Member
Chairperson	Bruce Frana	Linn SWCD	August 2016	Donna Walton
Vice-Chairperson	Craig Hanson	Cedar Rapids	August 2016	Mike Kuntz or Sandy Pumphrey
Secretary / Treasurer	Steve Cooper	Marion	February 2018	Darin Andresen
Director	Vince Bading	Robins	August 2016	Patrick Schwickerath
Director	John Bender	Hiawatha	January 2018	Patrick Parsley
Director	Les Beck	Linn County	September 2017	Dan Swartzendruber

Source: ICWMA meeting minutes

1.3 Plan Development

Resource Concerns

The ICWMA Board identified the primary resource concerns for establishing the ICWMA and completing the Indian Creek Watershed Management Plan. These resource concerns guided the entire planning process:

- Stormwater Discharge Permit Requirements (particularly as it relates to watershed assessment and public education)
- Flood mitigation
- Water quality concerns including Impaired Waters designation
- Improved aquatic recreation including fishing and paddling
- Public education and outreach/involvement

These resource concerns are also shared by the public, as confirmed in a series of workshops conducted early in the planning process by the Iowa-Cedar Watershed Interagency Coordination Team aimed at developing a collective vision for the Indian Creek watershed (Interagency Visioning Workshops Report 2012 included in Appendix 2).

Purpose of the Watershed Management Plan

Persistent flooding and water quality concerns have led the governmental entities within the Indian Creek watershed to embrace a cooperative, multi-jurisdictional planning approach. The resulting Indian Creek Watershed Management Plan details strategies and recommendations for watershed and stormwater management; water quality protection; and stormwater permit compliance. It includes specific implementation strategies and milestones for these recommendations for local governments as well as regional and state agencies. The Indian Creek Watershed Management Plan enables policy makers to:

- Prioritize resources to protect water quality
- Mitigate flood impacts that have plagued area residents
- Address resource concerns identified by the ICWMA Board and local stakeholders

Watershed Management Planning Process

Soon after the ICWMA was formed, funds were made available by the Iowa Economic Development Authority to complete comprehensive watershed management plans. The ICWMA was one of three Iowa WMAs that received that funding. At the outset, the ICWMA board of directors strongly believed that the planning process should utilize local resources and partnerships wherever possible and build the capacity within the watershed community to continue planning for the future.

The ICWMA utilized a collaborative, adaptive management approach for the Plan, which incorporates and links knowledge and credible science with the experience and values of stakeholders for more effective management decision-making. The resulting Plan is at the watershed scale, aligned with Iowa's Smart Planning Principles[1], and builds consensus for long-term watershed management solutions.

A watershed approach involves coordination with both public and private sectors focusing efforts to identify and address the highest priority challenges. The Indian Creek Watershed Management Plan is the result of a collaborative effort between the ICWMA's local jurisdictions and numerous stakeholders.

Planning Participants

The Indian Creek Watershed Management Plan was completed by the ICWMA Board of Directors and planning staff from the East Central Iowa Council of Governments, with a great deal of input and assistance from a Technical Advisory Team, a Community Advisory Team, and technical consulting firms/institutions.

Technical Advisory Team (Tech Team): The Tech Team is comprised primarily of state and local watershed planning and management

[1] Smart Planning in Iowa - A Guide to Principles, Strategies and Policy Tools, 2011

Technical Advisory Team

Andy Asell
DNR GIS Analyst

John Bruene
NRCS District Conservationist

Amy Bouska
Urban Conservationist, Johnson County

Ryan Clark P.G.
Geologist with Iowa Geological Survey

Chad Fields
Geologist with Iowa Geological Survey

Jon Gallagher
County Resource Conservationist, Linn County

Toby Hunemuller P.E.
US Army Corps of Engineers - Rock Island District

Mike Kuntz
Utilities Environmental Manager for CR Water Pollution Control

Mary Skopec Ph.D
DNR IOWATER & Stream Monitoring Coordinator

Marty St. Clair Ph.D.
Professor of Chemistry at Coe College

Mary Beth Stevenson
DNR Iowa-Cedar River Basin Coordinator

Jeff Tisl
IDALS-DSC Regional Coordinator

Tom Wilton
DNR Biologist

experts including local government stormwater and public works staff, the Linn Soil and Water Conservation District (Linn SWCD), the Iowa Department of Natural Resources (IDNR), the US Army Corps of Engineers – Rock Island District, and the Iowa Department of Agriculture and Land Stewardship (IDALS). The Tech Team provided planning and technical support in the areas of stormwater management, conservation practices, hydrology, soils, geology, water quality, habitat, recreation, and public education. The Tech Team was responsible for the data collection process and the interpretation of the watershed information gathered before and during the planning process. Their expertise was vital in terms of assessing the condition of the watershed and developing the plan.

Community Advisory Committee (CAC): The Community Advisory Committee was created by drawing on participants in the Inter-Agency Visioning workshops as well as other community leaders. CAC members included concerned citizens, flood impacted residents, local environmental interests, school districts, agricultural producers, local government, and business interests. The Community Advisory Committee assisted in the public outreach efforts during the planning process and was significantly involved in the goal setting process. The CAC kept watershed interests engaged throughout the entire planning process.

United States Army Corps of Engineers – Rock Island District (USACE): The US Army Corps of Engineers - Rock Island District completed a hydrologic assessment of the Indian Creek watershed by creating a hydrologic (HEC-HMS) model and a hydraulic model (HEC-RAS). The HEC-HMS model is used to identify opportunities for flood damage reduction and evaluate the impact of different floodplain regulations. The hydraulic model (HEC-RAS) is used to develop water surface profile and inundation extents along the stream during storm events of different magnitudes. Through this process, the 100-year and 500-year floodplain maps were redeveloped, and discharges for these events can now be modeled to show potential impacts on structures within the floodplain.

Coe College: The Coe College Water Quality Laboratory directed by Professor Martin St. Clair and staffed by undergraduate students provided valuable field measurements in the areas of water quality and stream condition to better understand the watershed. Field measurements include:

- A chemical assessment of the Indian Creek watershed was completed in 2013 and 2014. Samples and measurements were taken March through November for a total of 633 sampling events [6,963 data points] collected at 12 sites throughout the watershed.
- A physical assessment of creek sections was conducted using the Rapid Assessment of Stream Conditions Along Length (RASCAL) methodology. Students noted important stream parameters such as bank stability, canopy cover, and stream substrate condition.

The Anthropology Department at Coe College assisted with the social assessment of Indian Creek watershed residents. Julie Fairbanks, Assistant Professor of Anthropology, and her students completed 99 interview style surveys of individuals engaging in recreational activities at several locations near the creeks in the watershed. Surveys were gathered in the fall of 2013, winter of 2014 and spring of 2014.

Vernon Research Group: The Vernon Research Group is a local research and marketing firm that specializes in on-line surveys. Vernon was hired to conduct a representative survey of watershed residents to capture attitudes, knowledge levels, and willingness to engage in watershed improvements. Their compilation and analysis of the responses is summarized in a report with recommendations to develop an effective education and outreach plan addressing the issues identified in the social research.

Community Input & Plan Outreach

A variety of methods were used during the planning process to engage the watershed community and stakeholders. These efforts included:

- Establishment of an ICWMA website (www.indiancreekwatershed.weebly.com), a Friends of Indian Creek Facebook page, and an email address contact list of interested citizens
- A survey of residents and property owners in the watershed and creek users
- Three Lunch & Learn events conducted July – September 2014, presented watershed assessment results, gathered input on possible goals, and generated implementation strategies for the Plan
- Presentations to ICWMA member policy makers, local colleges, League of Women Voters chapter, Corridor Conservation Coalition, Pheasants Forever, and the annual banquet of the Linn Corn & Soybean Association and the Linn Cattlemen Association
- Hosted a Women Caring of the Land workshop in April 2015 to engage female owners of agricultural land
- Two Plan Open House events in June 2015 to gather feedback on the draft Plan

Prior Studies and Reports

Various studies and reports have been completed describing and analyzing conditions within the Indian Creek watershed. The Indian Creek Watershed Management Plan used existing data to analyze and summarize work that has been completed by others as well as integrating new data and information. A list of known studies and reports is summarized below.

Flood of June 4, 2002, in the Indian Creek Basin, Linn County, Iowa

Prepared by the US Department of the Interior and the US Geological Survey, in cooperation with the Iowa Department of Transportation and the Iowa Highway Research Board in 2004.

Section 205 – Initial Assessment for Flood Damage Reduction, May 2004

Prepared by the US Army Corps of Engineers – Rock Island District for Cedar Rapids. It is a study to identify economical flood damage reduction measures.

Embracing the River: Smart Growth Strategies for Assisting in Cedar Rapids' Recovery

Prepared by the US Environmental Protection Agency and the Federal Emergency Management Agency in cooperation with the City of Cedar Rapids; Rebuild Iowa Office; and the Iowa Department of Economic Development in 2010.

Interagency Visioning Workshops Report 2012

Prepared and facilitated by the Iowa-Cedar Basin Interagency Coordination Team, a group of state, federal, non-governmental organizations, and academic institutions that cooperate to support planning and watershed based decision making efforts in the Iowa-Cedar River Basin.

Conservation Reserve Program Flood Damage Reduction Benefits to Downstream Urban Areas

Prepared by the US Army Corps of Engineers - Rock Island District for the US Department of Agriculture Farm Service Agency in 2013. It is a study of the flood reduction benefits of Conservation Reserve Program (CRP) land using the Indian Creek Watershed as a model.

Iowa's Low Hanging Fruit: Stream Buffer Rule = Cleaner Water, Little Extra Cost Report

Prepared by the Environmental Working Group in January 2015. This study used high resolution aerial photography to assess the impact on Iowa's farms of implementing streamside buffer standards of varying widths in five counties including Linn County.

Plans in Alignment

State and local plans that align with the Indian Creek Watershed Management Plan are listed here.

Iowa's Nonpoint Source Management Plan

Prepared by the Iowa Department of Natural Resources in cooperation with other state agencies and a wide variety of stakeholder groups in 2012.

Iowa's Nutrient Reduction Strategy

Developed through a partnership of the College of Agriculture and Life Sciences at Iowa State University and the Iowa Department of Agriculture and Land Stewardship and released in August 2013. The Nutrient Reduction Strategy is a science and technology-based framework to assess and reduce nutrients to Iowa waters.

City of Cedar Rapids EnvisionCR Plan

Prepared by RDG Planning & Design and HR Green, Inc. and adopted in January 2015.

City of Hiawatha General Land Use Plan

Linn Soil & Water Conservation District 2012 -2020 Long-Range Plan

Developed by the District Commissioners and Linn Soil & Water Conservation District staff in 2012.

Linn County Comprehensive Plan: A Smarter Course

Prepared by Linn County Planning & Development and made effective in July 2013.

Linn County Multi-jurisdictional Hazard Mitigation Plan 2014 - 2019

Prepared by the East Central Iowa Council of Governments and approved in November 2014.

City of Marion Comprehensive Plan

Prepared by Houseal Lavigne Associates and adopted in July 2010.

Robins Comprehensive Plan

Prepared by the East Central Iowa Council of Governments and adopted in 2013.

Watershed Plans Referenced

Several watershed plans from other watershed groups in Iowa and outside the state provided useful general watershed information and ideas for organizing this Plan.

Catfish Creek Watershed Management Plan

Prepared by Applied Ecological Services, Inc. for the City of Dubuque in 2014.

Upper Cedar River Watershed Authority – Watershed Management Plan

Prepared by MSA Professional Services for the Upper Cedar River Authority in 2014.

Squaw Creek Watershed Management Plan

Prepared by EOR for the Squaw Creek Watershed Management Authority in 2014.

Red Cedar River Watershed Management Plan

Prepared by Tetra Tech for the Greater Lansing Regional Committee in 2006.

The Metropolitan North Georgia Water Planning District Watershed Management Plan

Prepared by AECOM and R2T, Inc. for the Metropolitan North Georgia Water Planning District in 2009.

Chapter 2 – Watershed Characterization

"Water is the most critical resource issue for our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land."

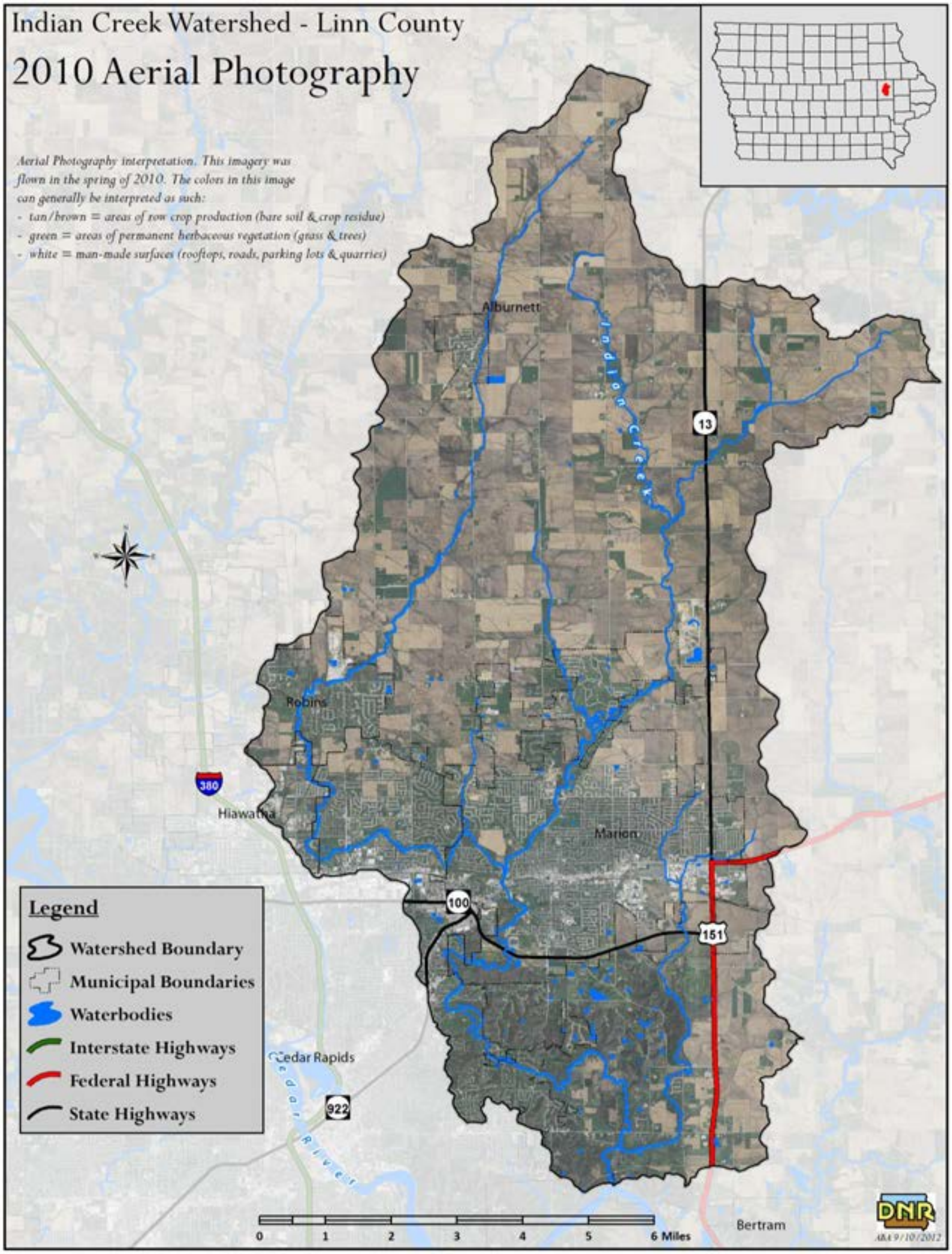
Luna Leopold

The watershed characterization chapter includes a description of the watershed in terms of area, population, land use/land cover, climate, topography, geology, soils, and groundwater/drinking water sources. Overall, the Indian Creek watershed has experienced both a growth in urban land use and the intensification of agricultural land uses. These land use pressures, along with the trend of more rainfall brought about by climate change, will continue to impact erosion rates and flood-plain extents in the Indian, Dry and Squaw creeks and their tributaries.

2.1 Watershed Location & Overview

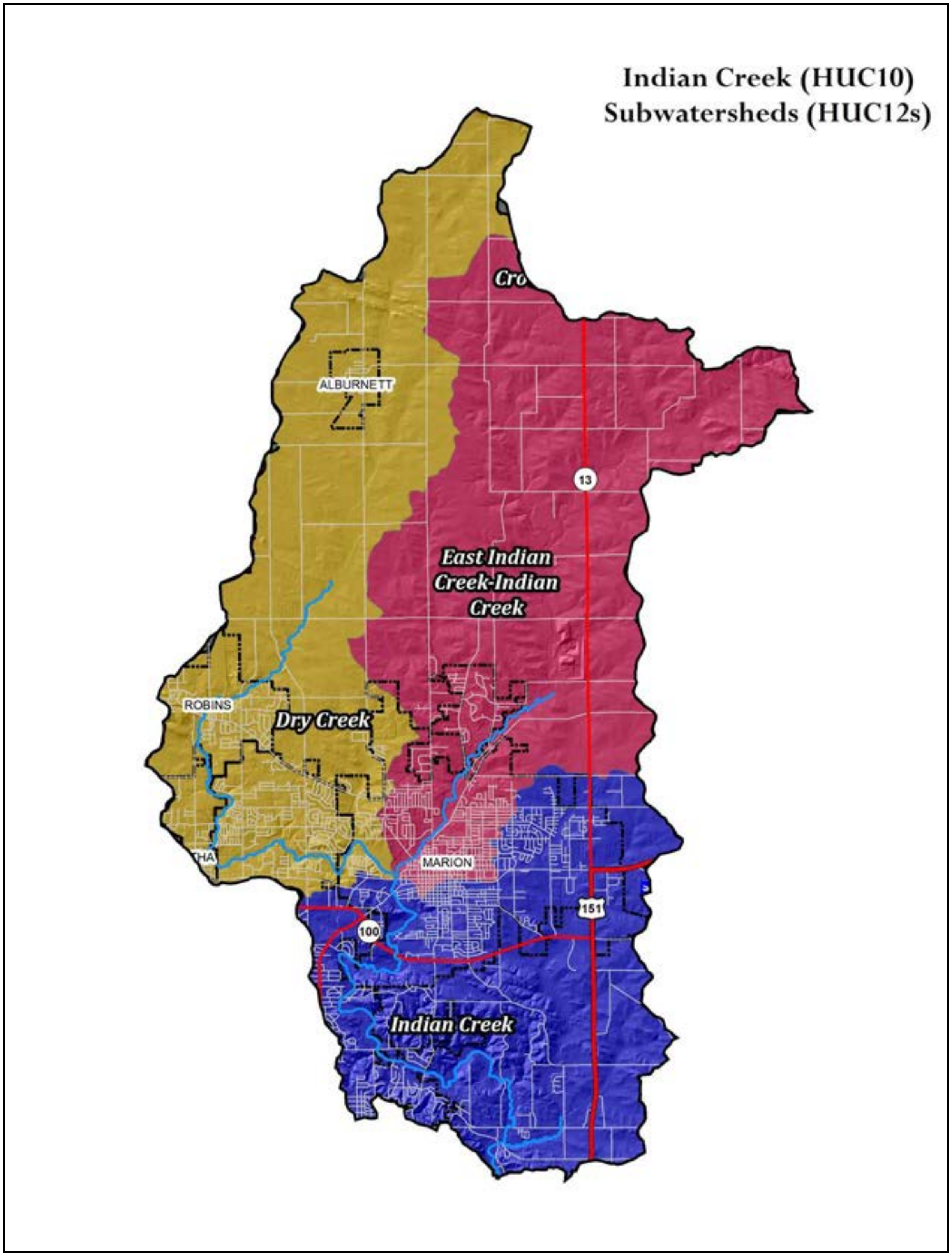
The boundaries of the Indian Creek watershed and its three subwatersheds are based on United States Geological Survey (USGS) defined boundaries. These boundaries, or Hydrologic Unit Codes (HUC), divide the United States into discrete, nested areas based on common drainage patterns. The Indian Creek watershed (HUC-10 0708020601) spans a 94-square mile area within Linn County, Iowa as shown in Figure 2-1. The watershed contains Marion, Alburnett, and portions of Cedar Rapids, Hiawatha, and Robins. Indian Creek is fed by Dry Creek, East Indian Creek, and Squaw Creek, and ultimately drains to the Cedar River near the intersection of Otis Road SE and Bertram Road, south of Mt. Vernon Road SE in Cedar Rapids. The map in Figure 2-2 depicts the subwatersheds.

Figure 2-1. Map of the Indian Creek Watershed



Source: Iowa Department of Natural Resources

Figure 2-2. Map of the Indian Creek Subwatersheds



Source: Army Corps of Engineers – Rock Island District

The subwatershed areas and stream lengths are listed in Table 2-1.

Table 2-1. Stream Lengths and Area in the Indian Creek Watershed

Watershed (HUC-12)	Stream Length in Miles	Acres (Square miles)
Dry Creek (070802060101)	22	20,167 (31.5)
East Indian - Indian Creek (070802060102)	26	23,178 (36.2)
Indian Creek (070802060103)	9	16,884 (26.4)
TOTAL	**57**	**60,229 (94.1)**

Source: US Army Corps of Engineers – Rock Island District

Land use and topography of the watershed can be segmented into three general regions. The western and northern region is mostly flat and agricultural and is drained by the upper reaches of Dry Creek and Indian Creek. The middle region is more hilly and urban and features the lower portion of Dry Creek, the middle portion of Indian Creek, and most of Squaw Creek. The steeply sloping forest in the southern region is drained by lower Squaw Creek and lower Indian Creek.

The headwaters area of the Indian Creek watershed is predominantly agricultural. Indian Creek itself originates north of the City of Marion near Burnett Station Road, and is joined by East Indian Creek near County Home Road. Indian Creek travels south to meet Dry Creek in Marion. Dry Creek originates north of Alburnett and travels through Robins, Hiawatha, and Cedar Rapids before draining to Indian Creek. Squaw Creek discharges into Indian Creek from the east at approximately 4,350 feet upstream of the confluence of the Indian Creek with the Cedar River. Below the Squaw Creek confluence, the Indian Creek floodplain is more susceptible to the backwater effects of the Cedar River.

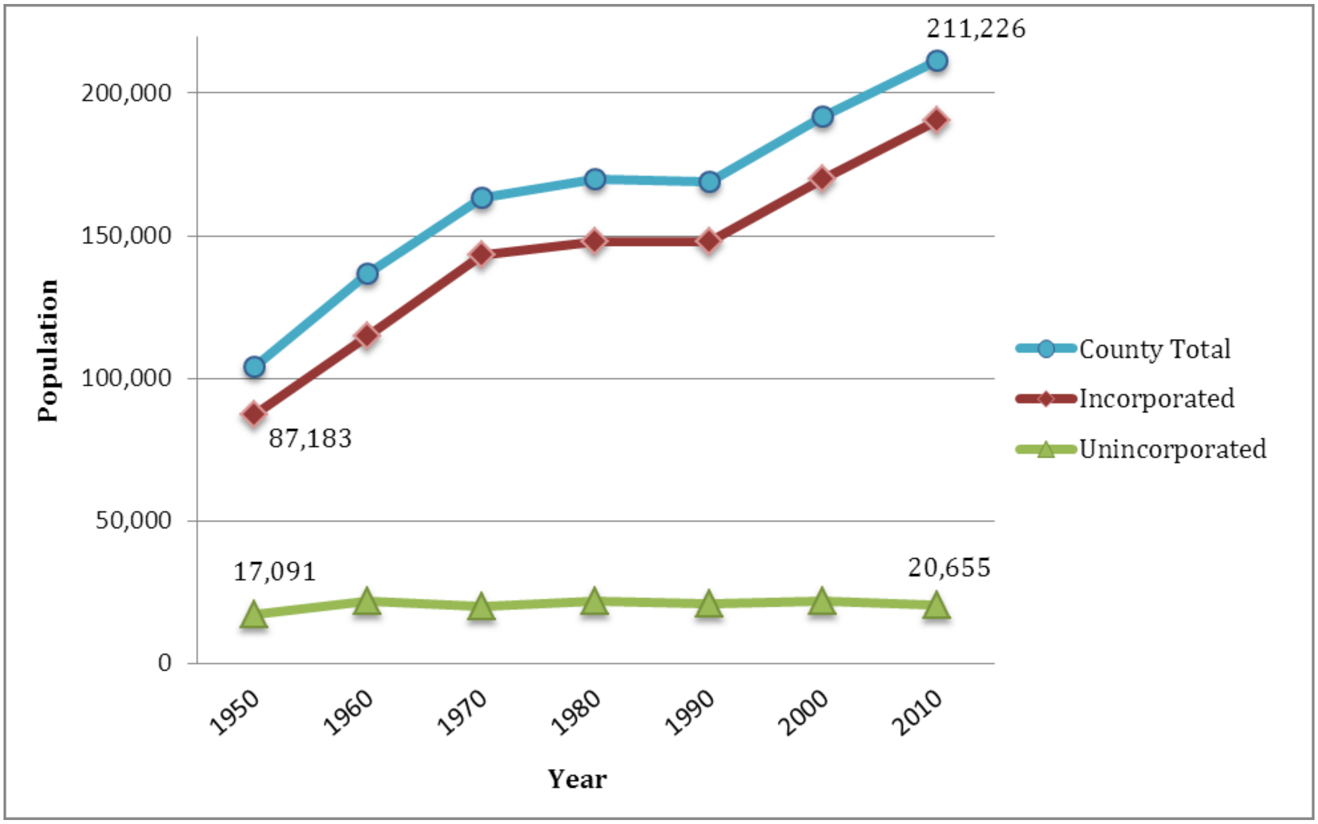
2.2 Political Jurisdictions & Population

The Indian Creek watershed lies entirely within Linn County, which is located in east-central Iowa. Linn County is the second most populous county in Iowa with a total population of 211,226[2] in 2010. Urban and suburban growth has been significant in the last few decades and is expected to continue. County-wide, 90% of the population lives in incorporated areas (190,571) and nearly 10% live in unincorporated areas (20,655). Similarly, the 63,569 residents in the Indian Creek watershed live mostly in the urban area.

As Figure 2-3 shows, the overall population of Linn County and the population in incorporated areas had very similar growth patterns since 1950. Population in the unincorporated areas increased only slightly between 1950 and 2010, while the total county population more than doubled. This is partly attributable to annexations of unincorporated land into incorporated communities of Linn County since 2000. Linn County's population is expected to increase by 10% each decade through 2040 adding another 65,000+ people to the county mostly in the incorporated areas.

[2] U.S. 2010 Census

Figure 2-3. Historical Population Change in Linn County 1950 - 2010



Source: Linn County Rural Land Use Plan 2013 and the 2010 U.S. Census

Linn County covers approximately 726 square miles and includes eighteen incorporated communities and eight unincorporated villages. The Indian Creek watershed spans 94 of those square miles and contains all or parts of five incorporated communities. Table 2-2 shows the number of acres that are in the watershed for each of these communities and the rural portions of Linn County, as well as the watershed coverage percentages. The figures used for acres and square miles differ slightly throughout the plan due to differences in data sources.

Table 2-2. Acres and Percentage of Each Jurisdiction in the Watershed 2014

Political Jurisdiction	Total Watershed	
	Acres	Percent of Watershed
Alburnett	487	0.81%
Cedar Rapids	5,018	8.33%
Hiawatha	689	1.14%
Marion	10,630	17.65%
Robins	1,894	3.14%
Linn County (unincorporated)	41,513	68.92%
TOTALS	60,231	100.00%

Source: Linn County Planning and Development Department

2.3 Land Use & Growth Trends

Urbanization and more intensive use of agricultural areas have altered the natural hydrology and impacted water quality of the Indian Creek watershed.

Urban Land Use

The Indian Creek watershed has experienced tremendous population growth and urban development over the last several decades resulting in significant land use and land cover changes within the watershed. There has been a shift of timber and agricultural lands to residential, commercial, and other urbanized land uses. Table 2-3 illustrates the changes in land cover that have occurred in the region from 1992 to 2013.

Table 2-3. Land Use Trends in the Watershed 1992 - 2013

Land Use Type	Acres in 1992	% of Watershed	Acres in 2013	% of Watershed
Barren (rock/sand/clay)	72	0%	251	0%
Row Crops	37,058	62%	31,748	53%
Pasture / Grasslands	7,525	13%	6,253	10%
Timber	5,348	9%	4,249	7%
Wetlands & Water	637	1%	133	0%
Urban / Developed	9,399	16%	17,568	29%

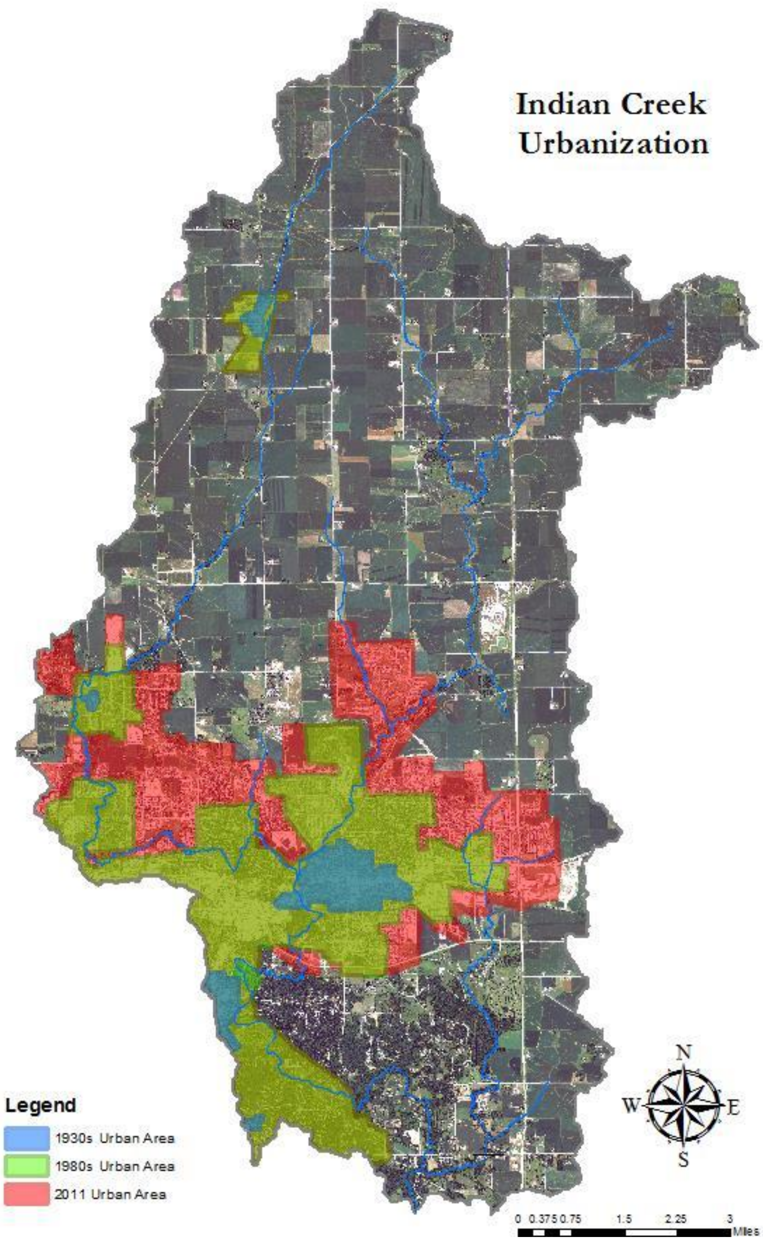
Source: US Army Corps of Engineers – Rock Island District and Iowa Department of Natural Resources

In 2013, urban and residential land uses (commercial, residential, industrial, or roads) comprised approximately 29% of the Indian Creek watershed, which is almost double the amount of developed land two decades ago. The urban land uses occur primarily in the southern half of the watershed.

Several major thoroughfares transect the watershed including US Highway 151, State Highway 13, and State Highway 100. Highway 13 parallels much of the eastern boundary of the watershed, while Highways 151 and 100 bisect the lower third of the watershed. There are also three county roads, E28 (Burnett Station Road), E34 (County Home Road), and E48 (Mt. Vernon Road) that cut across the watershed east-west and one north-south, W58 (Alburnett Road). These highways are crucial routes today for transporting people and goods throughout the state. Additionally, they play a role in directing future urbanization by opening up more rural areas and communities to convenient intra-state travel. Consequently, highway access becomes a hub for development. Two future road extension projects, Tower Terrance Road and East Post Road, will impact the watershed through future development.

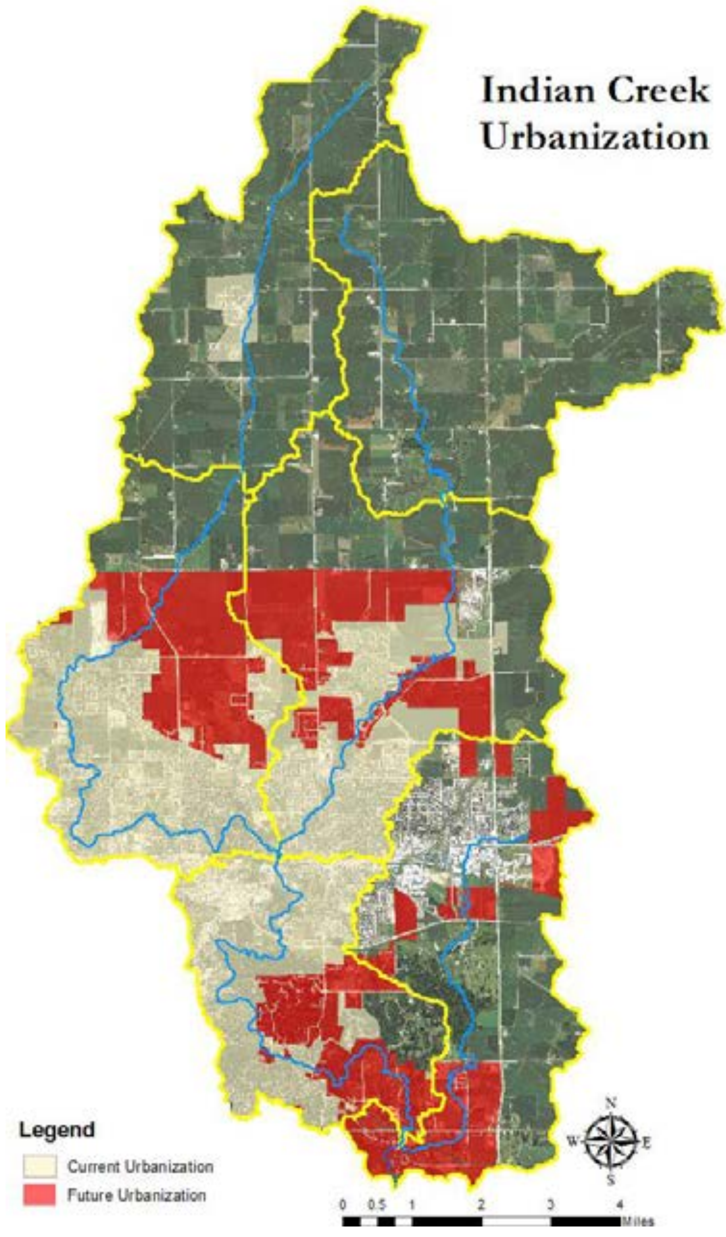
The past and possible future trends of urban land use can also be seen in Figure 2-4 representing the increase in urbanization from the 1930s to 2011 and Figure 2.5 representing the existing urbanization compared to probable areas of future development.

Figure 2-4. Historic and Existing Watershed Urbanization from 1930 - 2011



Source: USACE – Rock Island District

Figure 2-5. Existing and Future Watershed Urbanization



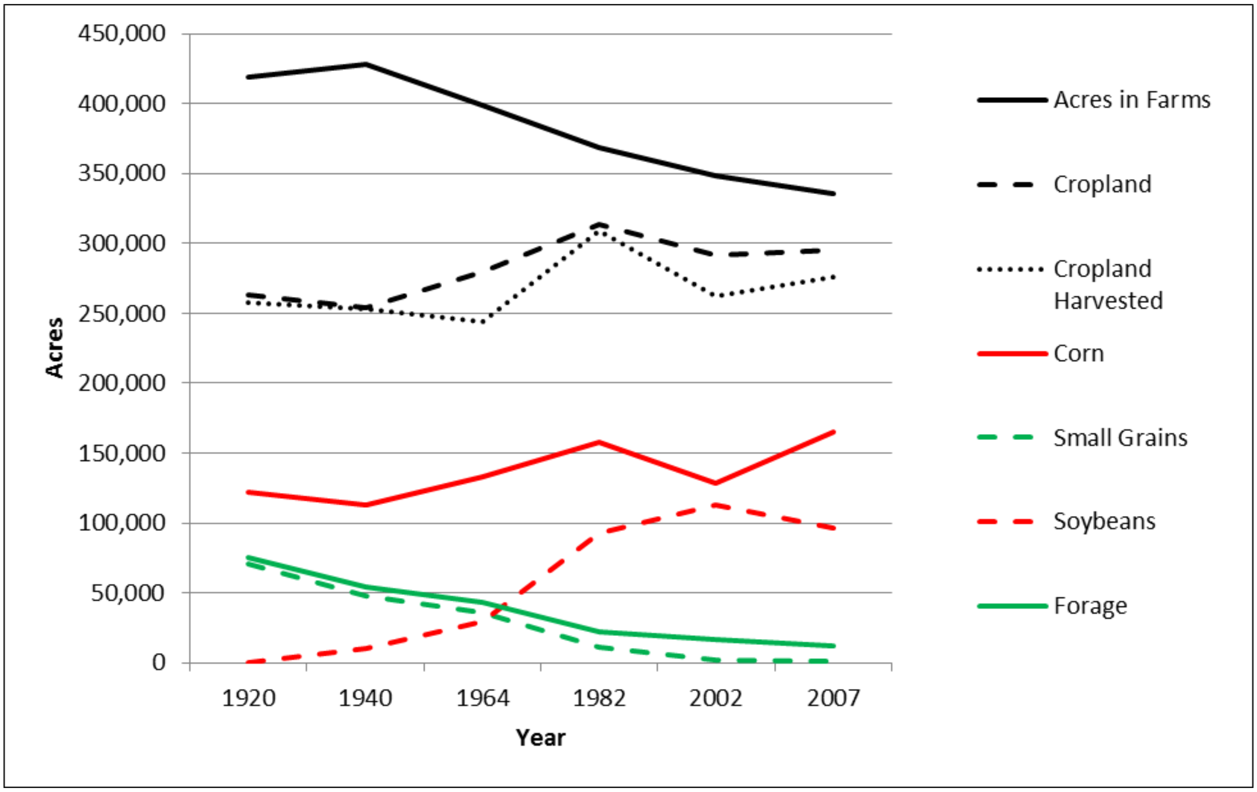
Source: USACE – Rock Island District

Agricultural Land Use

Agriculture has historically played an important role in the land use and economy of Linn County. In 2013, despite the significant growth of urban land uses, the majority of the watershed area (53%) is still in agricultural land uses (corn, soybeans, and alfalfa/hay), largely in the northern half and southeast.

Historical Agriculture Trends: The Indian Creek watershed has been impacted by advances in agriculture such as larger equipment, field tile, hybrid seeds, and fertilizers, which made it feasible to expand production to previously marginal land. A shift from the more diverse farm operations, which included livestock, to a focus on corn and soybean crops has meant fewer acres of hay in rotation and additional acres under cultivation, as well as additional acres receiving nutrients on an annual basis.

Figure 2-6. Historical Land Cover Trends in Linn County 1920 - 2007

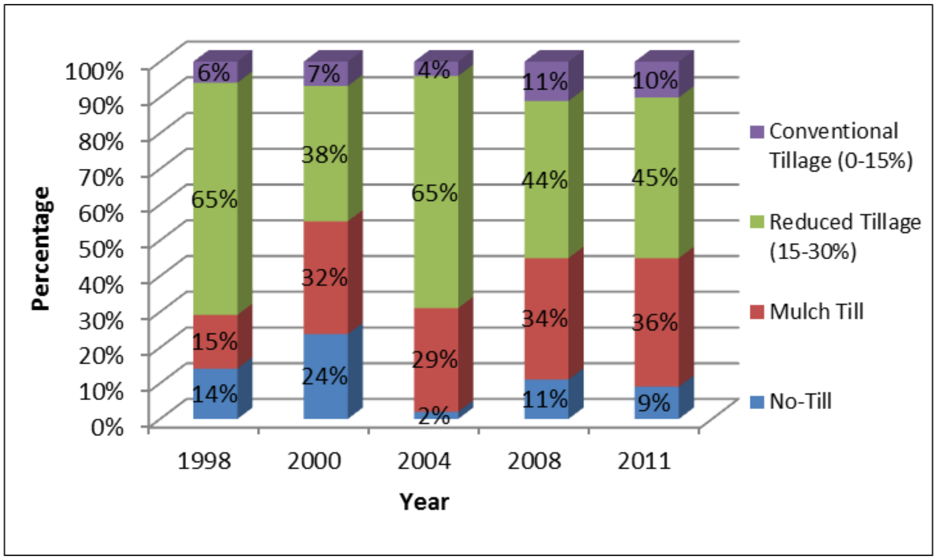


Source: Indian Creek Land Cover Assessment, Linn SWCD

The total number of cropland acres in Linn County has declined, primarily due to continued urban expansion. However, row crop acres, specifically corn and soybeans, have actually increased due to the loss of pasture and forage crop acres.

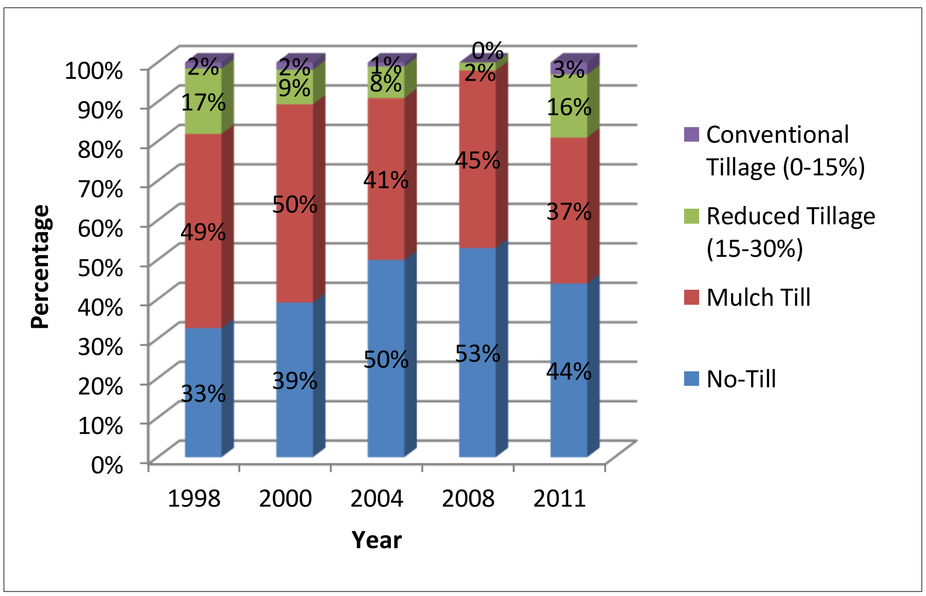
Tillage Trends: A comparison of tillage practices of farmers in Linn County is provided in Figures 2-7 and 2-8. As seen in Figure 2-7, the amount of no-till planted corn peaked in 2000 while the percentages of reduced and mulch till remained roughly the same since 2008. For soybeans, the amount planted into reduced and mulch till have remained steady as represented in Figure 2-8, while the adoption of no-till planted soybeans has increased over the past 15 years.

Figure 2-7. Corn Planted in Varying Levels of Crop Residue (Linn County)



Source: Indian Creek Land Cover Assessment, Linn SWCD

Figure 2-8. Soybeans Planted in Varying Levels of Crop Residue (Linn County)



Source: Indian Creek Land Cover Assessment, Linn SWCD

Conventional Tillage 0 – 15% residue

Reduced Tillage 15 – 30% residue

Mulch Till 40 – 60% residue

No-Till 60-70% residue

While there has been no data gathered since 2011, local SWCD officials are noticing that the amount of conventional and reduced tillage acres are increasing and the amount of mulch till and no-till acres are decreasing in the Indian Creek watershed.[3]

Tillage information was generated from surveys conducted by Linn SWCD staff. The tillage survey is conducted every other year in late May or early June by staff travelling the same route though the county. On a field-by-field basis, the staff documents the varying amounts of crop residue left on the surface after planting the current year's crop. The entire Indian Creek Land Cover Assessment report by the Linn SWCD is included in Appendix 2.

Public Areas: There are numerous and significant recreation resources and opportunities for residents within the Indian Creek watershed. The recreational opportunities are varied and provide people of all ages the chance to enjoy the outdoors. Some of these areas provide direct public access to Indian Creek or its tributaries, so people can enjoy interacting with the waterways. Other areas, while not directly adjacent to the stream, still provide valuable opportunities for recreation and open space.

Recreation areas within the watershed include:

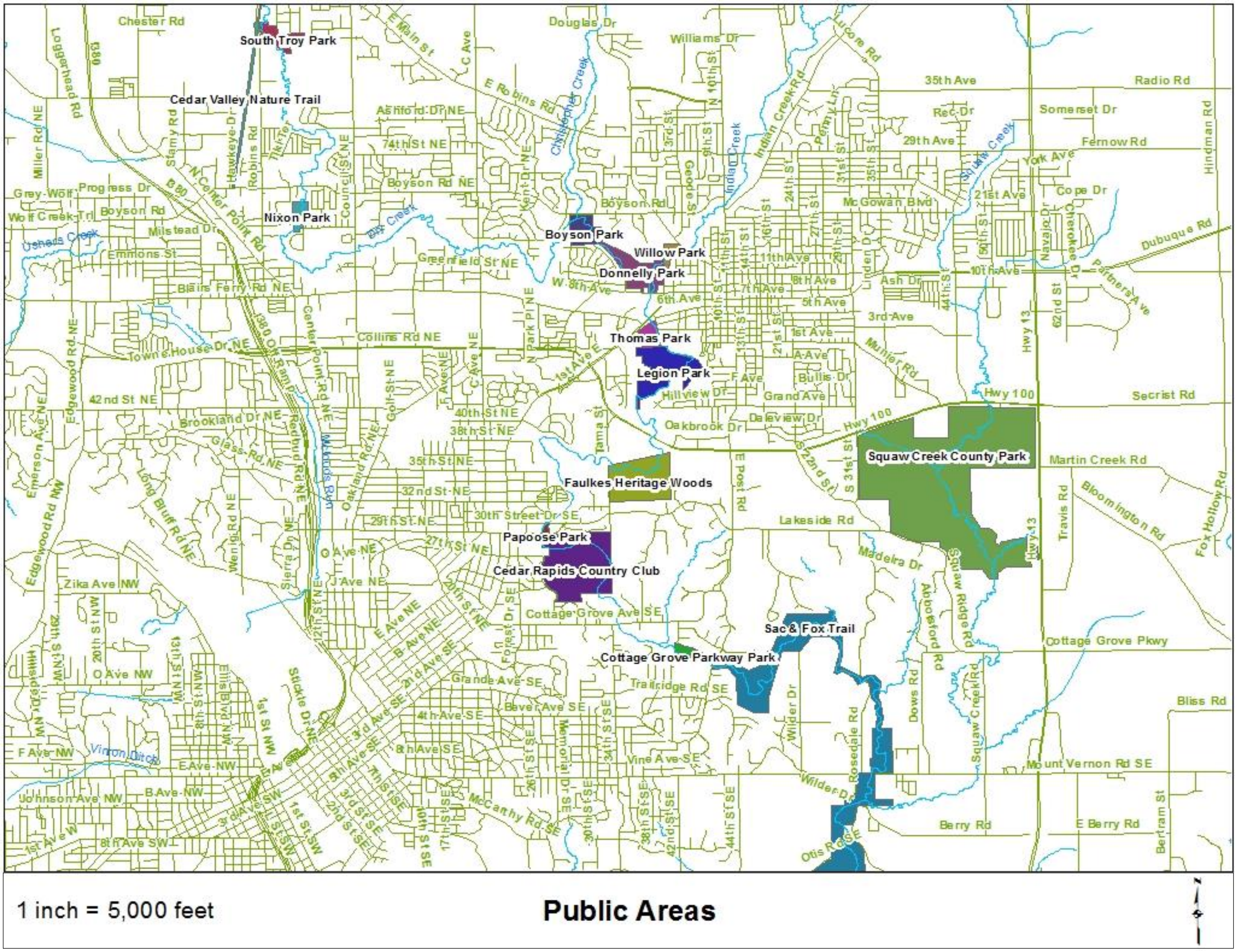
- 5 golf courses
- 6 sports complexes, ball fields and outdoor tracks
- 2 public swimming pools
- 22 public parks, natural areas and greenways

These areas provide opportunities for people to engage in activities ranging from splash pads and playgrounds, to quiet, natural places for nature study and relaxation. The public spaces vary in size from the 0.3 acre Elza Park in Marion to the 692 acre Squaw Creek Park in Linn County.

In addition to the recreation facilities and parks, there are five regionally significant trails in the watershed. These include the Boyson Trail, Cedar Valley Nature trail, Marion Trail, Lindale Trail and the Sac and Fox Trail. Also within the watershed are two centers providing educational opportunities for people interested in a variety of topics. These centers include the Prairiewoods Franciscan Spirituality Center and the Indian Creek Nature Center.

[3] Observation from Linn SWCD officials 2012 through 2014.

Figure 2-9. Public Recreation Areas in the Indian Creek Watershed

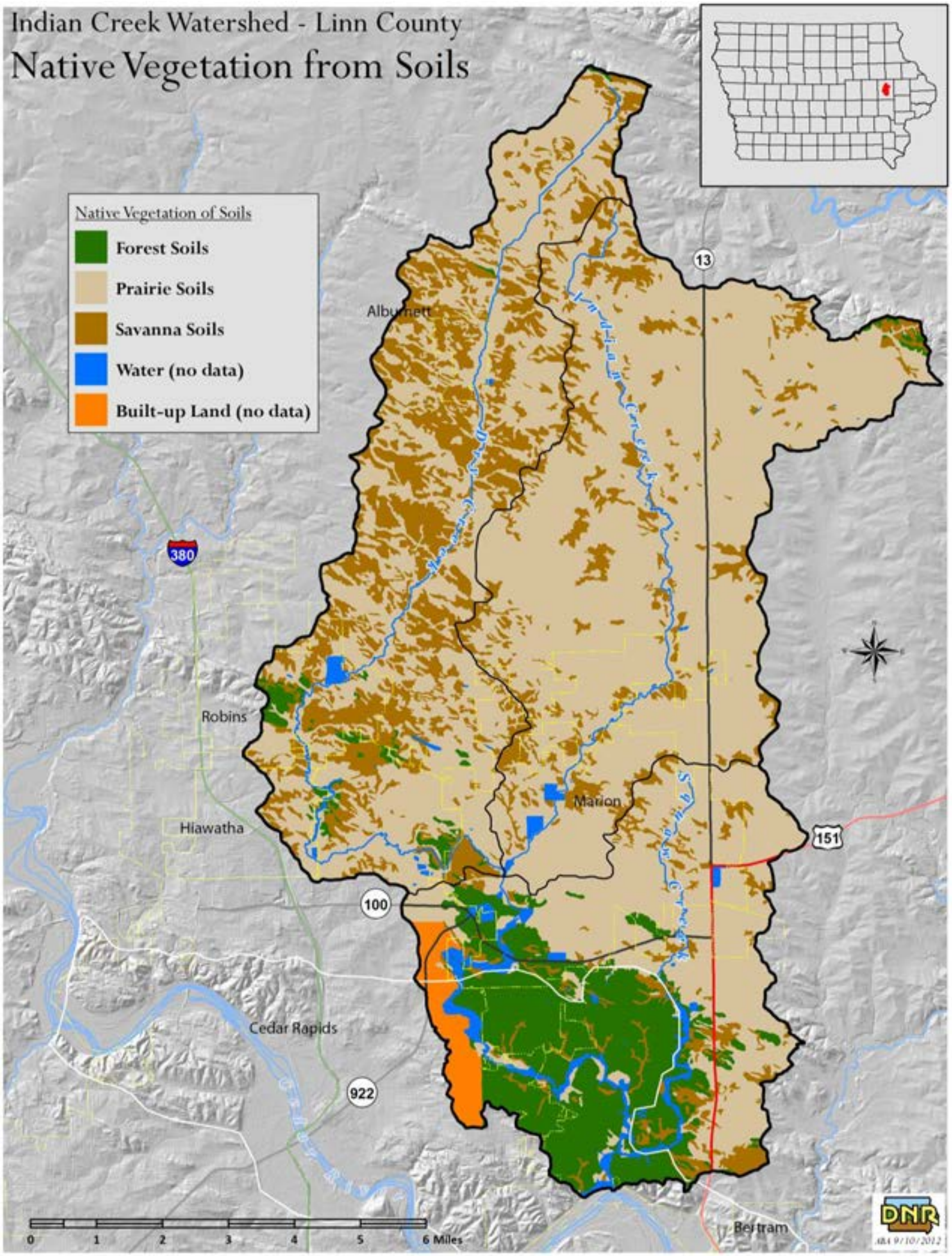


Source: Marion Engineering Department

2.4 Watershed Impacts of Land Use Changes

The Indian Creek watershed is a good example of a mixed use, rural and urban watershed. The landscape of the watershed has changed significantly from the pre-settlement era. Historically, the prairies, wetlands, timbered areas, and riparian corridors allowed rainwater to soak into the ground and percolate slowly through the soil profile. As land use changes from forest and grasslands to agricultural or suburban and urban uses, the natural cycle of water (hydrology) is disrupted and altered. Land development affects the physical, chemical, and biological conditions of waterways and water resources. Clearing removes the vegetation that intercepts, slows and returns rainfall to the air through evaporation and transpiration. The conversion of native ecosystems, as shown in Figure 2-10, to intensive agriculture and urban areas has dramatically changed how water moves across the Indian Creek watershed. Rainfall that once seeped into the soil and eventually became groundwater, now runs more quickly off the surface and into waterways.

Figure 2-10. Native Vegetation from Soils in Indian Creek Watershed



Source: Iowa Department of Natural Resources

Agriculture Land Use Impacts

As of 2013, row crop corn and soybeans make up 53% of the Indian Creek watershed's land use, primarily in the northern portion of the basin. While intensive agriculture has been an economic boon, row crop systems have altered the watershed's hydrology by increasing the rate and volume of water that reaches receiving surface waters. Agriculture has affected watershed hydrology in several ways, such as:

- The loss of deep-rooted native plants, which allowed water to soak into the ground by creating spongier soils with increased pore spaces and organic matter
- The degradation of soils through tillage, which increases bulk density of soils, making them less permeable to stormwater and reducing soil structure
- The loss of wetlands, which provided storage for runoff
- The loss of riparian areas along streams, which provided an opportunity for water to spread out in the floodplain during high flow events, thereby reducing downstream peak flows

Because row crop fields (particularly those that are conventionally-tilled) generate more surface runoff than native prairies or savannahs, increasing attention is being paid to maintaining high productivity of crops while maximizing conservation efforts. Management practices such as no-till (particularly permanent no-till) and cover crops are being promoted to help minimize runoff from farm fields. Incentivizing farmers to slow down or hold back water using methods such as wetlands, riparian buffers, or structural practices are other strategies for helping to reduce peak flows in downstream areas. These practices will be discussed in more detail in Chapter 7.

Another hydrologic impact of intensive agriculture is tile drainage, which is prevalent throughout Iowa's rural watersheds. The use of tile drainage in watersheds can increase usable farm land and yields by decreasing the moisture content in the soil. However, these practices also increase plant uptake of water throughout the growing season (April to October) which increases evapotranspiration (the loss of water through plant respiration). Tile drainage also:

- Heightens erosion potential from October to April
- Increases stream baseflow
- Creates sediment "hungry" flows at tile outlets that can cause stream incision/steep banks due to in-channel sediment generation
- Has not been shown to increase or decrease peak flood flows[4]

Urban Land Use Impacts

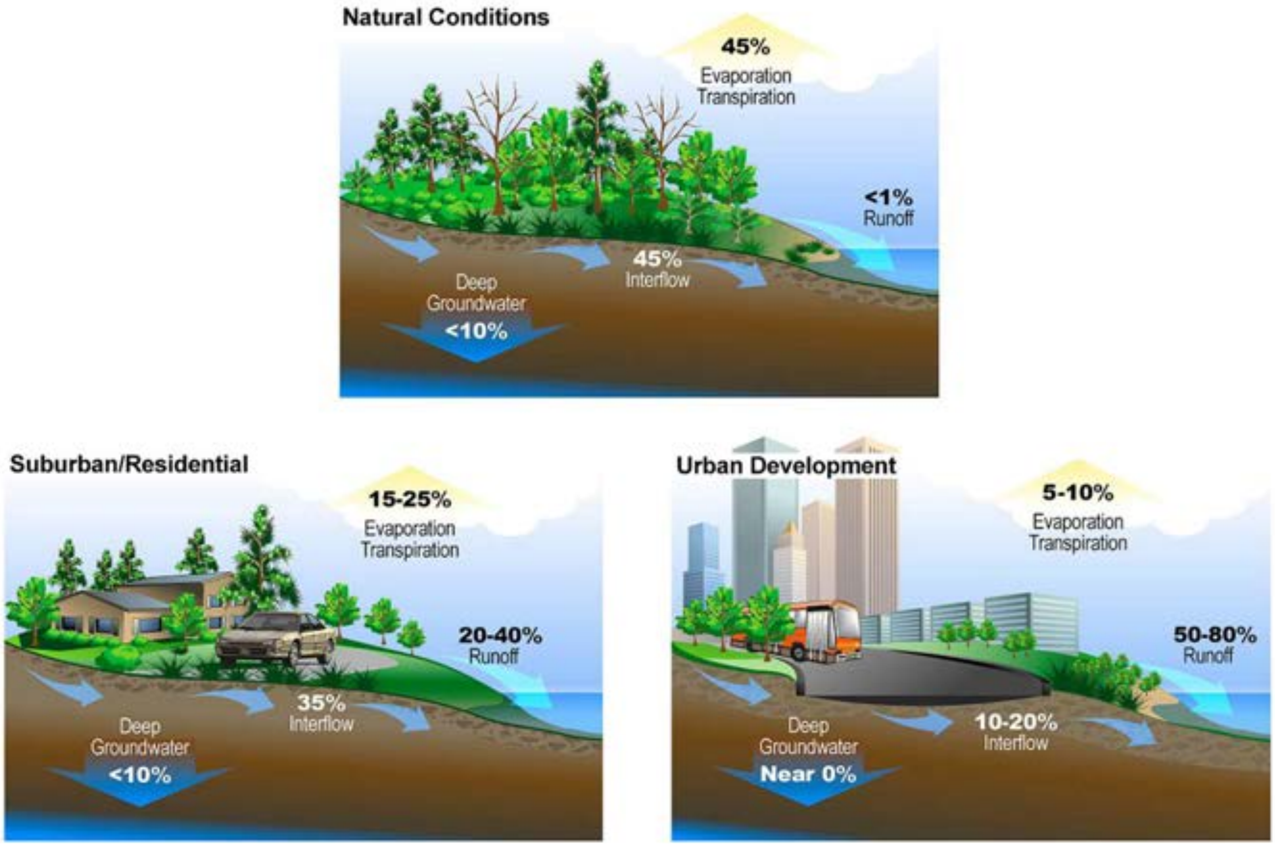
The central and southern portions of the Indian Creek watershed are primarily urban with the majority of surfaces consisting of impervious surfaces such as buildings, roads, and parking lots, and less impervious surfaces such as residential turf grass and low organic content soil. Urbanization has dramatically changed the flow of water across the land.

These changes begin with the construction phase. The process of developing land for subdivisions or commercial areas involves site preparation activities that reduce the ability of the land to soak in rainwater. Grading flattens hilly terrain and fills in natural depressions that slow and provide temporary storage for rainfall. The topsoil and sponge-like layers of humus are scraped and removed and the remaining subsoil is compacted. Moreover, the addition of surfaces that are impervious to rainfall further reduces infiltration and increases runoff.

[4] Schilling, K. E. and Helmers, M. (2008), Effects of subsurface drainage tiles on streamflow in Iowa agricultural watersheds. *Hydrological Processes Volume 22* (Issue 23)

Stormwater drainage systems such as ditches, curb and gutter, and storm drainage inlets and pipes further modify natural hydrology, which speeds stormwater runoff to the creeks and concentrate pollutants from human activities in the watershed. Figure 2-11 illustrates how the water balance changes when natural forest/grassland cover is cleared and replaced by suburban and urban development.

Figure 2-11. Impacts of Changes to Natural Hydrology



Source: Metropolitan North Georgia Water Planning District

The changes in watershed hydrology from land use changes such as urban development can have significant impacts on creek/stream conditions and the watershed including:

- Changes in Stream Flow – Increased runoff volumes, increased peak discharges, greater runoff velocities, increased flooding, and lower dry weather stream flows due to the loss of shallow groundwater as an input to streamflow
- Changes in Stream Geometry – Stream erosion (widening and down-cutting), loss of riparian tree cover, sedimentation in the channel, and increased flood elevations
- Degradation of Aquatic Habitat – Degradation of habitat structure, loss of pool-riffle structure, reduced stream base flows, increased temperatures, and reduced abundance and diversity of aquatic biota
- Water Quality Impacts – Reduced dissolved oxygen and increased suspended solids, nutrients (phosphorus and nitrogen compounds), hydrocarbons (oils and grease), organic contaminants, heavy metals, toxic chemicals, trash & debris, and microbial contamination (bacteria, viruses and other pathogens)

These creek/stream and watershed impacts can have dramatic physical, economic and aesthetic consequences to residents in the Indian Creek watershed, including:

- Losses and damages to private property and public infrastructure due to flooding and erosion
- Impairment of drinking water supplies
- Increased cost of water supply treatment and watershed protection
- Loss of recreational opportunities
- Declining value of waterfront property
- Reduction in quality of life

The focus of the Indian Creek Watershed Management Plan is to recommend watershed management strategies to help local communities to protect their watersheds from future impacts and to help effectively mitigate existing problems to the extent practical.

2.5 Climate

Temperature & Rainfall

The Indian Creek watershed has a continental climate with hot, moist summers and cold, generally dry winters; however conditions can vary widely from year to year. The spring and fall seasons are noted for rapid changes from one type of air mass to another. The average crop growing season is on the order of 180 to 190 days from early April to mid-October.

The winter months are cold averaging highs around 33°F while winter lows are around 16°F. Summers are warm with average highs around 83°F and summer lows around 62°F. The highest recorded temperature was 110°F in July 1911 while the lowest temperature was -28°F in both February 1996 and December 1924. Most of the annual precipitation falls in the warm months in the form of rain showers or thunderstorms. Winter often brings snowstorms, ice storms, and occasional blizzards. Total precipitation amounts during winter months are lower on average than in other seasons. Droughts severe enough to cause widespread crop losses occur about every 20 years. Fairly typical for the Midwest, the current climate of the Indian Creek watershed consists of an average rainfall of 37.63 inches and snowfall around 32 inches. Normal monthly temperatures and precipitation are summarized in Figure 2-12.

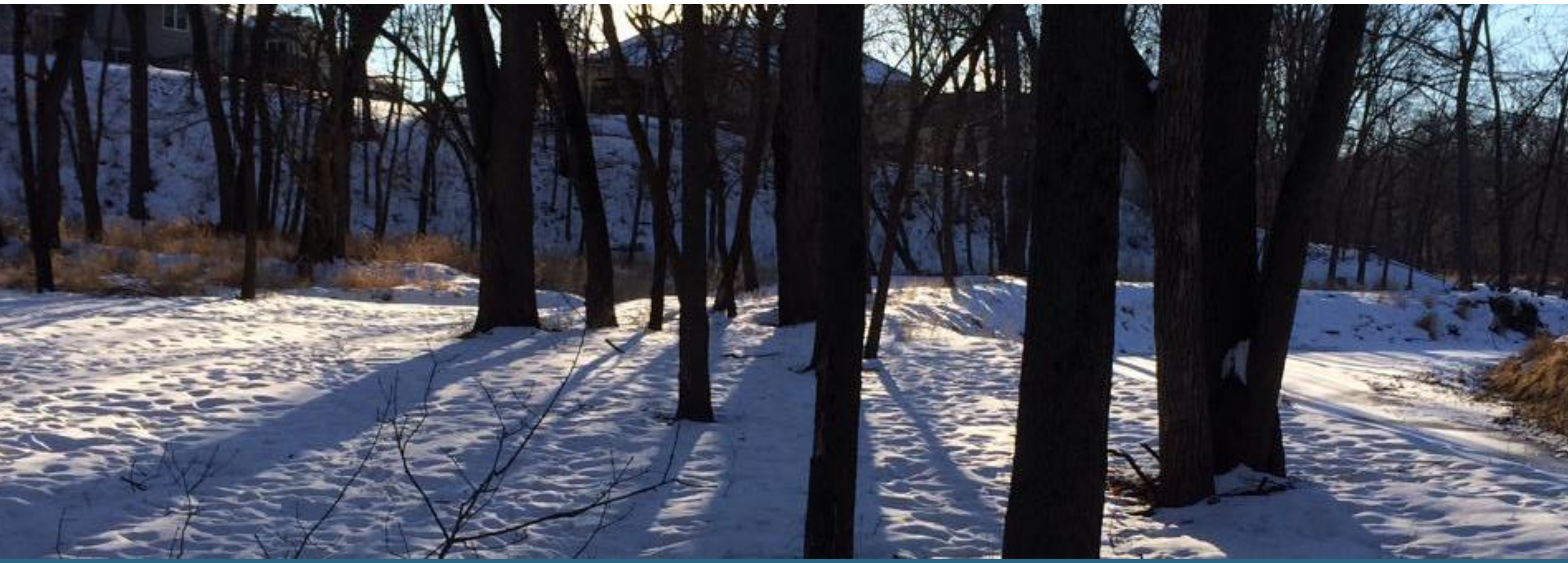
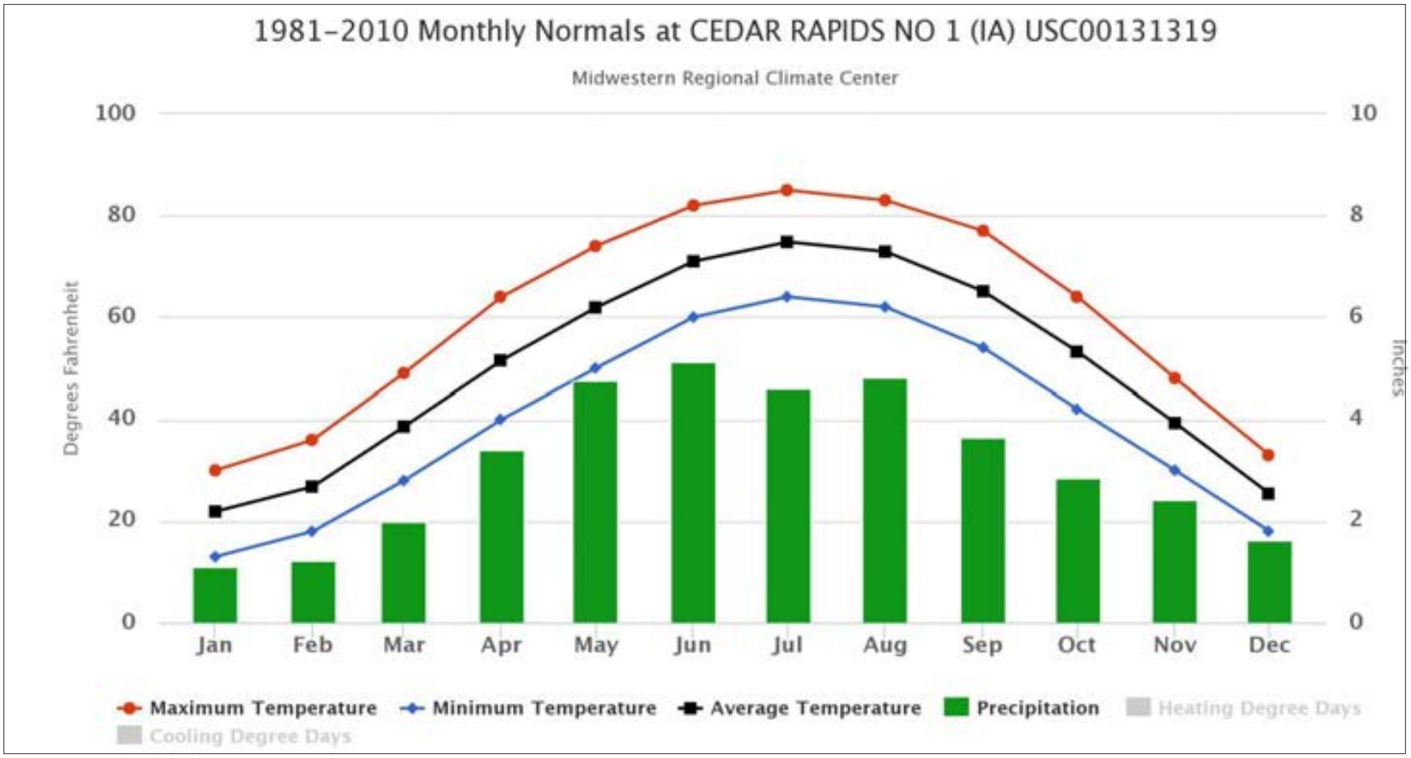


Figure 2-12. Normal Temperatures and Precipitation in Indian Creek Watershed 1981 - 2010



Source: NOAA's Midwestern Regional Climate Center

Climate Change

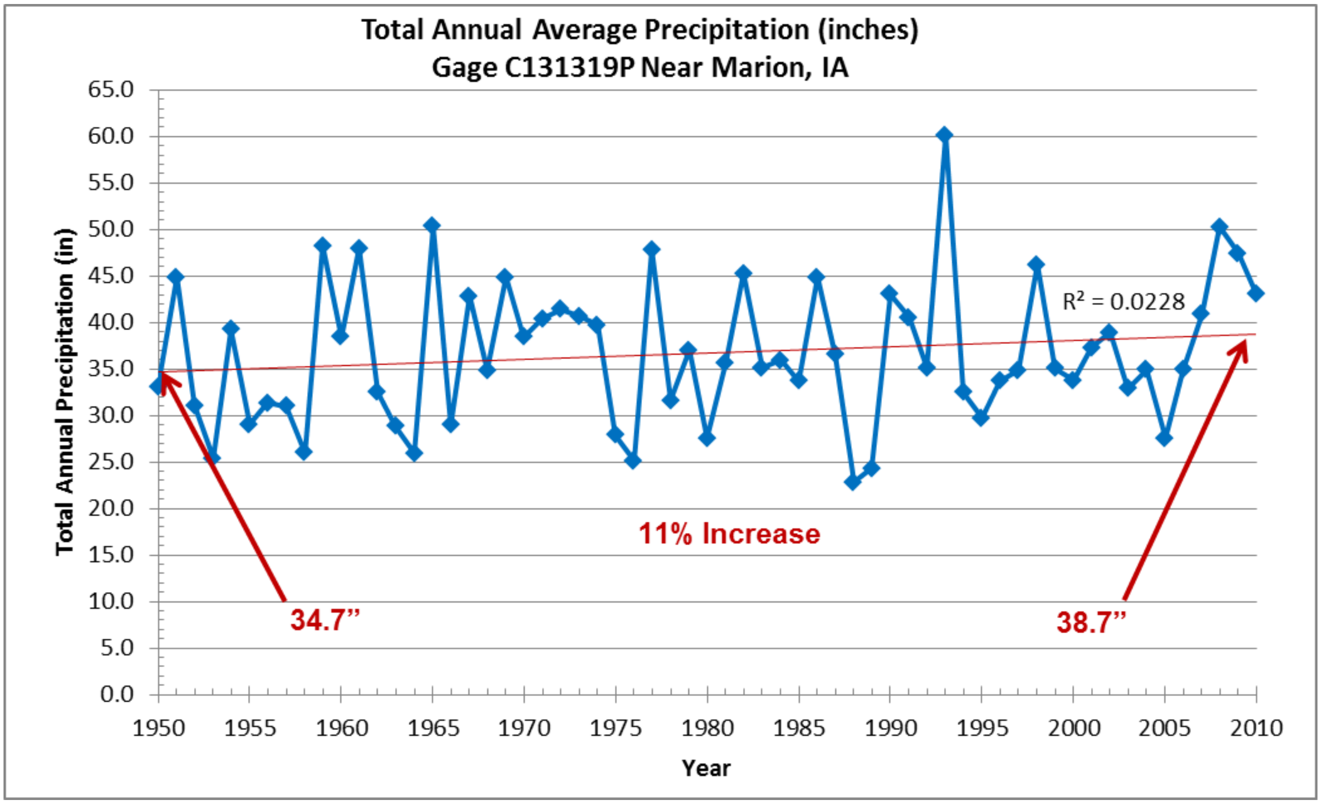
In Iowa, the average annual temperature, total annual precipitation, and the number of days per year with precipitation have been increasing from the early 20th to the early 21st century. Signs of these changes include:

- More days of rain
- More total rainfall (Figure 2-13)
- Significant changes in heavy precipitation
- Hotter nights
- Warmer winter temperatures
- More frequent extreme heat waves

Climate change is driven by how much greenhouse gas is released into the atmosphere. Changes in climate are a global phenomenon with local impacts. However, impacts can change from place to place and year to year. Climate models suggest:

- Several degree changes in temperature (higher highs and lower lows)
- Shifts toward more winter precipitation and spring storms
- Hotter summer weather with more extreme (high or low) rainfall
- Average annual precipitation increases; often made up of a few very large events
- Increased potential for flooding and drought

Figure 2-13. Total Annual Precipitation at Cedar Rapids Gage 1950 - 2010



Source: US Army Corps of Engineers – Rock Island District report [IEM Climodat]

Other potential consequences of climate change include less snow during the winter months, longer growing seasons, and an increase in climate variability, meaning each year is less predictable. In addition, increases in summertime heat means more crop stress and increased water demand along with the potential for larger, more intense thunderstorms. Climate change coupled with land use change in many watersheds makes their hydrology behave in a substantially unpredictable manner.

2.6 Flooding

Flooding is a natural part of the annual hydrologic cycle, and floods can actually be very beneficial to stream ecosystems in an undeveloped setting. However, the combined loss of floodplain areas and watershed-scale land use changes in addition to changes in annual rainfall patterns have resulted in increased flood peak flows and overall flood magnitudes.

Historical Flood Events

Flood events on Indian, Dry, and Squaw Creeks have caused significant damage to homes, businesses, and municipal infrastructure. This is a summary of flood events from the past four decades as reported in local newspapers:

- August 1969 – Indian Creek was described as a "raging torrent of water" during much of the summer of 1969. The Marion public swimming pool was inundated four times in a 45 day period
- August 1977 – Significant property damage and bridge washouts due to flooding in Marion and described as "the worst flood in Cedar Rapids in 20 years"
- July 1993 – Historic floods impacted crops, businesses, livestock, wildlife, and trees throughout the watershed. Water line reaches 6 feet on exterior of homes

- June 2002 -- Over 500 homes in Cedar Rapids and hundreds more in Marion, Hiawatha, and Robins were damaged by high water and sewer backups from flooding on Indian and Dry Creeks. More than 50 residents rescued from high water areas
- May 2004 – Flooding causes heavy property damage and firefighters rescued four teenagers stranded by fast moving water near Linn-Mar High School
- June 2008 – The 2008 flood has been described as a "watershed event." Damage costs were in the billions and the City of Cedar Rapids is still recovering
- August 2009 – Heavy rains cause flash flooding that requires motorists to be rescued and damages homes, bridges and parks along Indian Creek

Floodplain Management

Floodplains are a natural part of a stream corridor, and appropriate management is the first step in mitigating flood damage. Historically, river systems had broad, shallow floodplains that allowed the water to spread out during high flow events. This had an attenuating effect on peak flows, by slowing the rate of flow and even allowing additional space for water to soak into the ground. Now, the floodplain areas have been significantly narrowed, and water is forced to remain within the smaller confines of the stream channel. In addition, water is diverted more quickly to the stream channel through the stormwater system in urban areas or tile flow in agricultural areas.

Homes and other critical structures that are built in the floodplain are at greater risk of repeated damages from flood impacts. In agricultural areas, repetitive crop loss can be a problem when crops are planted in floodplains. Overall, strategies for reducing the risk to structures within the floodplain can range from restricting all development within the floodplain to elevating new structures that are built within the floodplain.

Currently, the following floodplain management measures are in place in the watershed:

City of Cedar Rapids: The City of Cedar Rapids has a floodplain ordinance in place. The city has a flood response plan located on the City of Cedar Rapids website[5], which includes both interim protection measures such as Tiger dams, HESCO barriers, and sandbags; as well as permanent protection projects in the Indian Creek watershed such as a berm along Cottage Grove Parkway and a planned berm west of Sundland Drive.

Linn County: Linn County has adopted floodplain management regulations as a part of its Unified Development Code (Article 7, Section 13), and participates in the Community Rating System. Floodplain information is also available on the county's website[6].

2.7 Topography, Geology & Soils

The Indian Creek watershed is a dynamic region where the interaction between surface water and groundwater is highly complex. Variability in the surface materials and their thicknesses are important factors in understanding how surface water is distributed throughout the watershed. Much of the watershed is underlain by bedrock that serves as an aquifer for municipal and private well users.

[5] http://www.cedar-rapids.org/government/departments/public-works/engineering/flood protection information

[6] www.linncounty.org/301/Floodplain-Information

Glacial Geology

The majority of Iowa's land surface has been covered by glaciers many times in the geologic past. As glaciers advanced and retreated they left behind distinct landscapes that are characterized by the environment in which they formed. The Indian Creek watershed lies almost entirely within the *Iowan Surface* with only the southwestern portion of the watershed lying within the *Southern Iowa Drift Plain*. The Iowan Surface is typified by a relatively flat landscape underlain by glacial till and elongated ridges of loess, known as *pahas*. Till is a general term for the dense mixture of clay, sand, and gravel deposited by glaciers over much of the state and can be up to 300 feet thick in the watershed. Loess refers to wind-blown silt that was deposited during the last ice age (10,000 – 30,000 years ago). The Southern Iowa Drift Plain is characterized by loess covering till to varying thicknesses and well developed drainage patterns, as seen in the more "wrinkled" topography in the southern part of the watershed (see Figure 2-15).

Topography

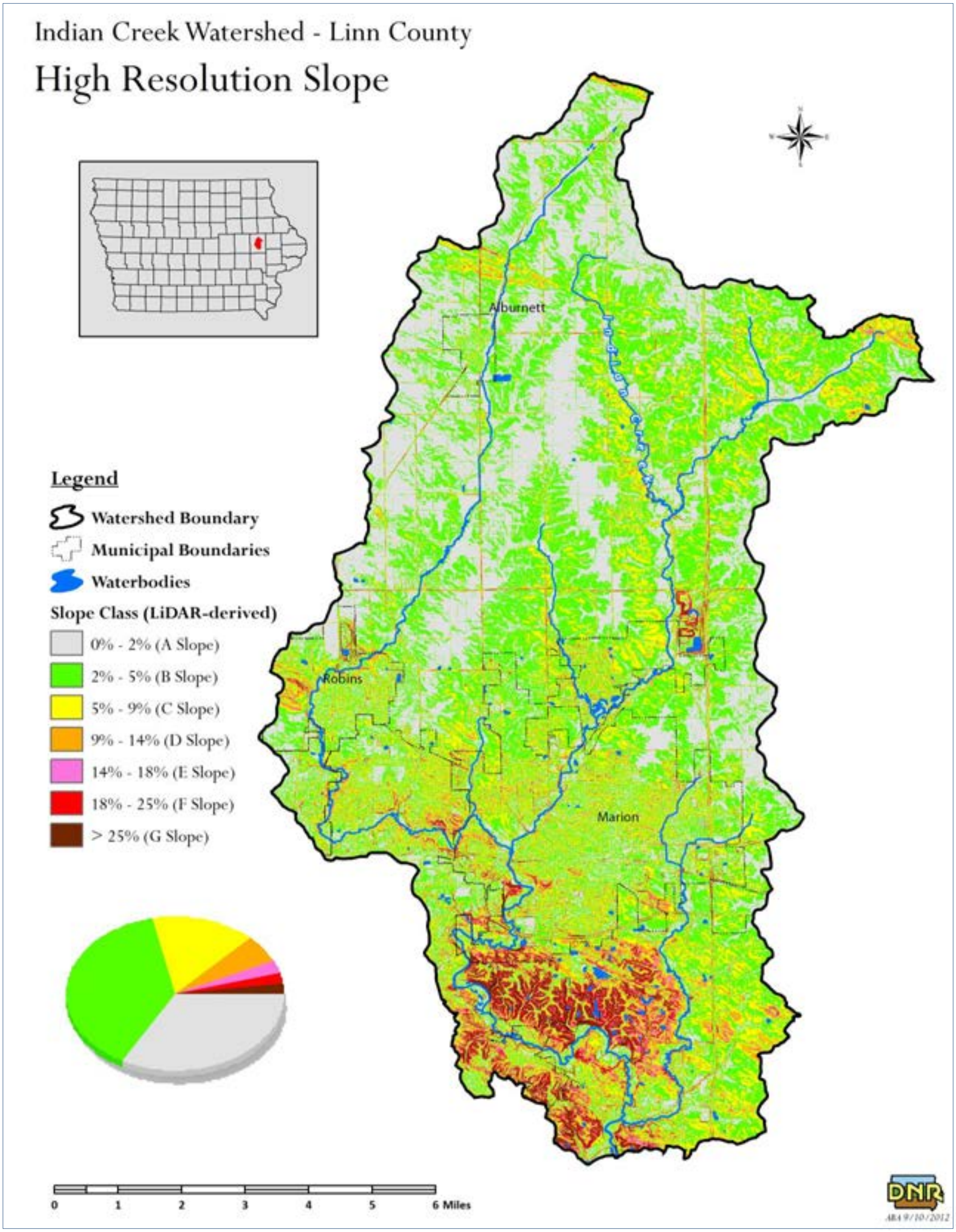
Topography or the land's surface features, is an important consideration of watershed management because it influences patterns of erosion and drainage, and determines what types of conservation practices are best suited to a particular landscape. In the Indian Creek watershed, 72% of the terrain is characterized as nearly level or gently sloping (either A or B slopes) and has an average slope of 3.2%. The vast majority of the watershed's agricultural activity occurs in these areas. C slopes are scattered throughout the watershed, and make up about 15% of the total area. Steeper slopes are much less common, occurring primarily in the southern quarter where the watershed transitions into the Southern Iowa Drift Plain. These steeper slopes (classes D – G) make up about 13% of the watershed. Urban and forested land uses are more prevalent in this portion of the watershed.

Table 2-4. Slopes in the Indian Creek Watershed

Slope Class	Percent Slope	Slope Description	Acres	Percent of watershed
A	0 – 2%	Nearly level	19,892	33%
B	3 – 6%	Gently sloping	23,257	39%
C	7-12%	Moderately sloping	9,284	15%
D	13 – 18%	Strongly sloping	3,535	6%
E	19 – 25%	Moderately steep	1,511	3%
F	26 – 35%	Steep	1,417	2%
G	>35%	Very Steep	1,306	2%

Source: Iowa Department of Natural Resources

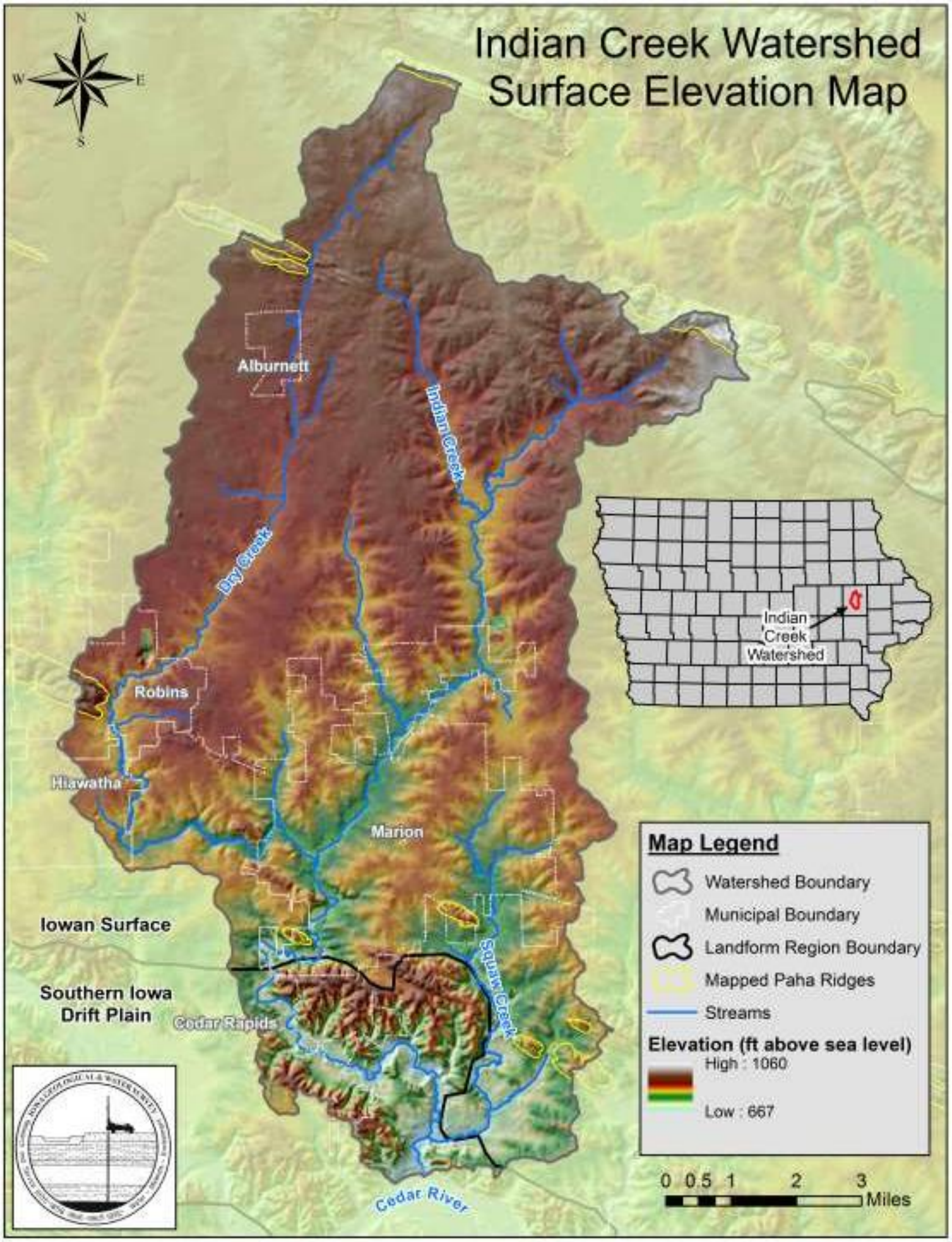
Figure 2-14. Slopes in Indian Creek Watershed



Source: Iowa Department of Natural Resources

Elevations of the Indian Creek Watershed are shown in figure 2-15 with *paha* ridges outlined in yellow. The black line in the extreme southwest shows the boundary between the Iowan Surface and the Southern Iowa Drift Plain landform regions.

Figure 2-15. Surface Elevation Map



Source: Ryan J. Clark, Iowa Department of Natural Resources, Iowa Geological & Water Survey. "Geology of the Indian Creek Watershed, Linn County, Iowa" January 2014

Soil Types

Soil generation is a complex process that incorporates many factors such as parent material, slope angle, vegetation, moisture content, and the degree to which it has been eroded. Soils are classified using these characteristics and are subdivided into association names, primarily from the sites where each one was initially identified. The following list describes the dominant soil associations[7] within the Indian Creek watershed based on the landform region in which they occur.

Iowan Surface soils:

- Kenyon-Clyde-Floyd: Nearly level to strongly sloping, dark-colored, moderately well drained to poorly drained soils formed in loamy material and glacial till; on uplands
- Readlyn-Oran-Tripoli: Nearly level, dark-colored to moderately dark-colored, somewhat poorly drained and poorly drained soils formed in loamy material and glacial till; on uplands
- Kenyon-Dinsdale: Gently sloping to strongly sloping, dark-colored, well drained and moderately well drained soils formed in loamy material and glacial till or in silty material and glacial till; on uplands
- Dinsdale-Klinger: Nearly level to moderately sloping, dark-colored, well drained to somewhat poorly drained soils formed in silty material and glacial till; on uplands
- Klinger-Franklin-Maxfield: Nearly level, dark-colored to moderately dark-colored, somewhat poorly drained and poorly drained soils formed in silty material and glacial till; on uplands

Southern Iowa Drift Plain soils:

- Tama-Colo-Ely: Nearly level to moderately sloping, dark-colored, well drained, somewhat poorly drained, and poorly drained soils formed in silty material; on uplands and in upland drainageways
- Fayette-Downs-Chelsea: Gently sloping to very steep, light-colored to moderately dark-colored, well drained and excessively drained soils formed in silty and sandy material; on uplands

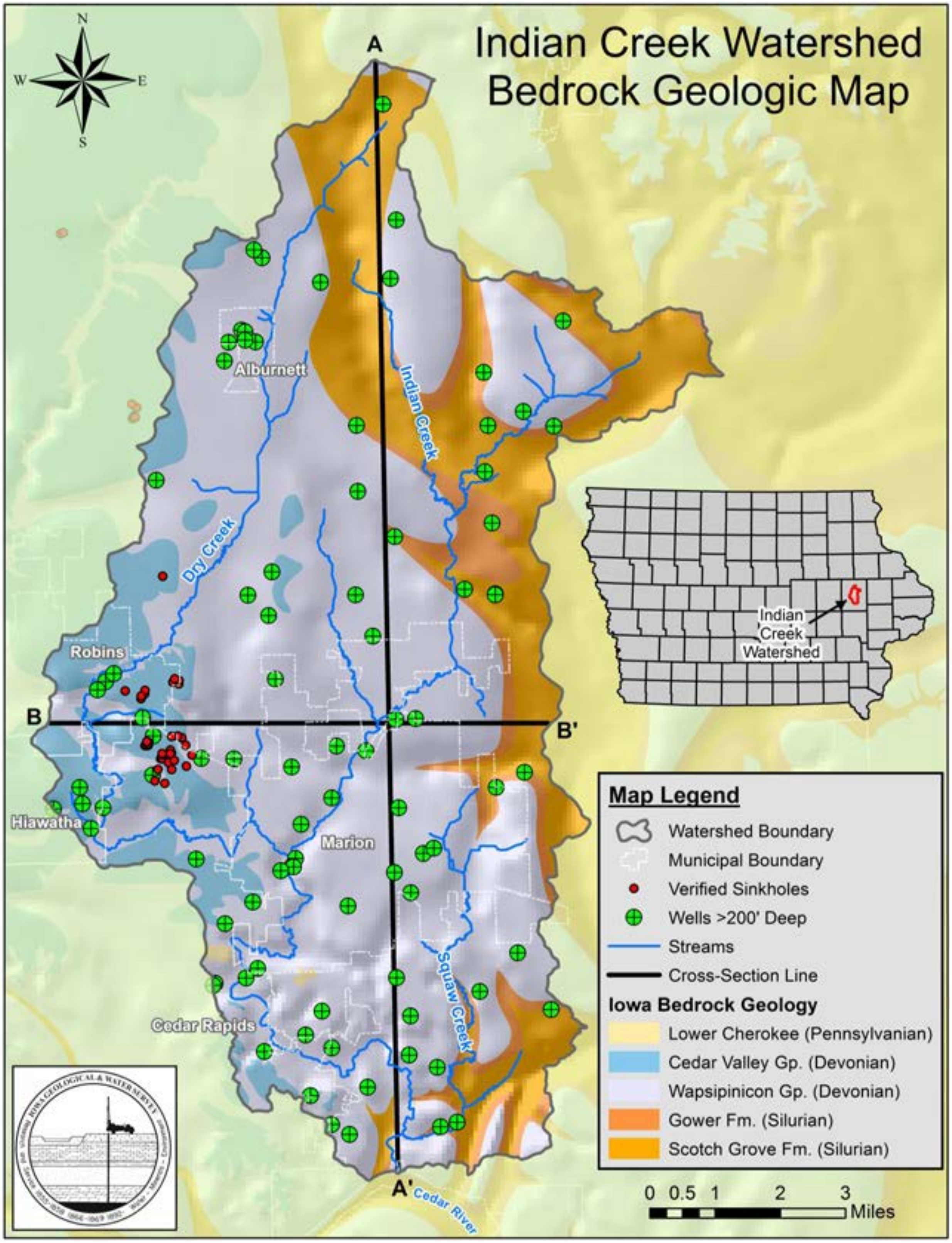
Bedrock Geology

The bedrock under the Indian Creek watershed consists primarily of limestone and dolomite, with lesser amounts of shale. Limestone and dolomite are commonly referred to as carbonate rocks, because they were formed by the accumulation of the calcareous remains of microscopic organisms that lived in ancient oceans that covered the state many times over the geologic past. Carbonate rocks are typically very good aquifers. Water supply wells completed in the carbonate rocks under the watershed can yield several hundred gallons of water per minute.

[7] Soil Survey of Linn County, Iowa: USDA Soil Conservation Service, 1975.

Figure 2-16. Groundwater Seeping out of Devonian Limestone in the Robins quarry

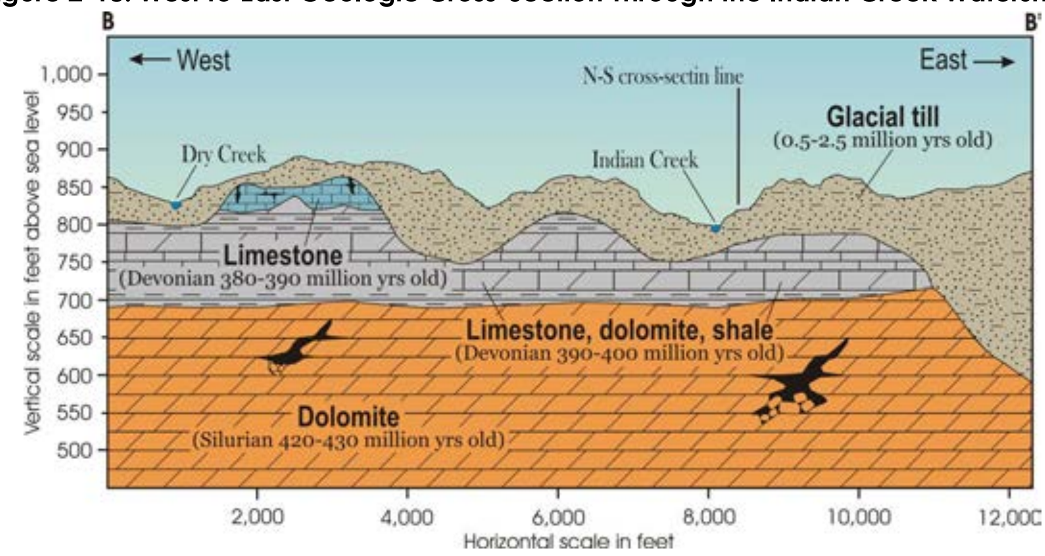
Figure 2-17. Bedrock Geologic Map of the Indian Creek Watershed



Source: Bedrock Geologic Map of Iowa, Open File Map OFM-10-1

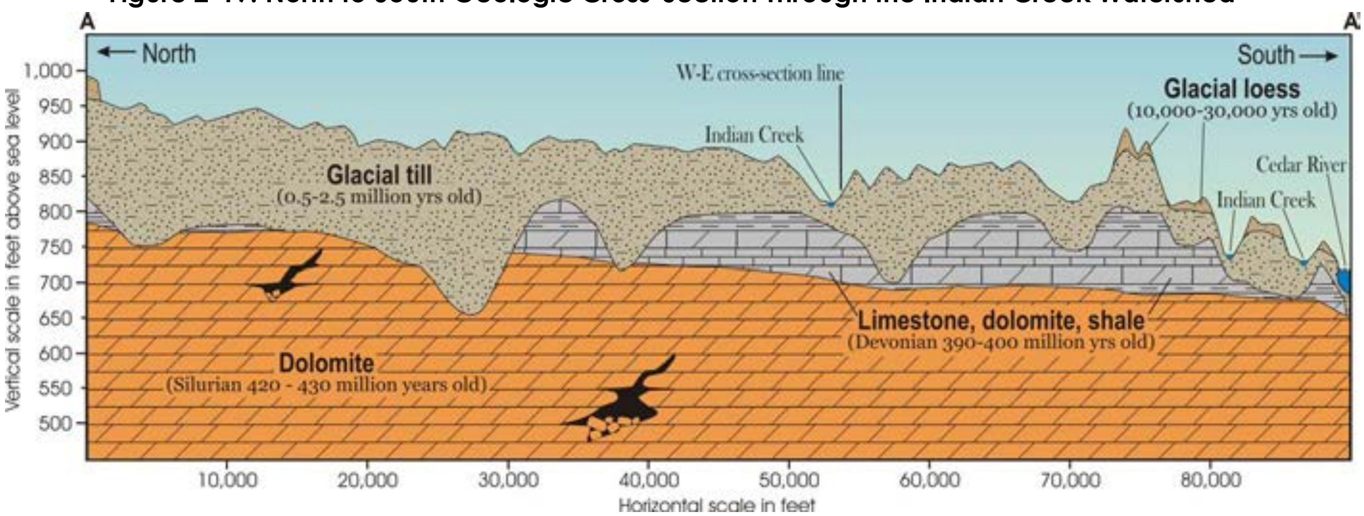
The map in Figure 2-17 shows the bedrock geology under the Indian Creek watershed along with two cross-section lines that correspond with Figures 2-18 and 2-19. The Devonian-age bedrock that underlies the majority of the watershed was formed approximately 380 to 400 million years ago and primarily consists of limestone, dolomite, and some shale. Where the Devonian-age rocks have been eroded away the bedrock surface is deeper and the older Silurian-age rocks are the first bedrock unit encountered below the glacial sediments. The Silurian-age bedrock under the watershed was formed approximately 420 to 430 million years ago and consists primarily of dolomite. Figures 2-18 and 2-19 show schematic cross-sections through the watershed and illustrate the estimated depth to bedrock, thickness of distinct units, and general rock types that exist beneath the watershed.

Figure 2-18. West to East Geologic Cross-Section Through the Indian Creek Watershed



Source: Ryan J. Clark, Iowa Department of Natural Resources, Iowa Geological & Water Survey. "Geology of the Indian Creek Watershed, Linn County, Iowa" January 2014

Figure 2-19. North to South Geologic Cross-Section Through the Indian Creek Watershed



Source: Ryan J. Clark, Iowa Department of Natural Resources, Iowa Geological & Water Survey. "Geology of the Indian Creek Watershed, Linn County, Iowa" January 2014

One of the biggest threats to groundwater quality is the presence of *karst*. Karst geology refers to the ability of groundwater to dissolve carbonate bedrock which can widen fractures and occasionally create open voids. When a bedrock opening or fracture occurs close to the surface the overlying sediments can essentially drain into it, which can cause a depression visible on the land surface. Several sinkholes have been identified in the Robins area, generally associated with Devonian-age Cedar Valley Group limestone, see Figure 2-17. These features indicate areas where surface water and potential contaminants may seep directly into the groundwater aquifer.

2.8 Regulations Related to Watershed Management

Amendments made to the Clean Water Act in 1987 required the U.S. Environmental Protection Agency (EPA) to address stormwater runoff in two phases. In 1990, the EPA implemented Phase I of the National Pollutant Discharge Elimination System (NPDES) permit program to control water pollution by regulating the discharge of pollutants into waters of the United States. The NPDES program covers several pollutant sources that are regulated by permits issued by the Iowa Department of Natural Resources (IDNR). There are three general classes of activities that must be covered by a NPDES permit. These general classes are:

- Construction activity that involves an acre or greater of land disturbance
- Ten categories of industrial activity
- Municipal Separate Storm Sewer Systems (MS4) for larger communities or those near larger communities

Table 2-5. NPDES Permits within the Indian Creek Watershed

EPA ID	Expire Date	Facility Name	Facility City	Permit Type
0024431	4/30/2016	Alburnett, City Of	Alburnett	Municipal/Sewer
0002437	12/31/2015	Kilborn, Inc.	Cedar Rapids	Industrial
0078689	9/23/2015	Marion, City Of	Marion	Stormwater/MS4
0080934	4/28/2013	Wendling Quarries - Robins Quarry	Robins	Industrial
0078743	9/27/2009	Hiawatha, City Of	Hiawatha	Stormwater/MS4
0075566	2/14/2016	Cedar Rapids, City Of	Cedar Rapids	Stormwater/MS4
0078816	1/16/2010	Robins, City Of	Robins	Stormwater/MS4

Source: EPA

NPDES Permit Program-Construction Runoff

Land disturbing activities that involve an acre or greater of land, including smaller sites that are part of a larger common plan of development, are required to obtain coverage under NPDES General Permit No. 2. General Permit No. 2 authorizes discharge of stormwater from construction sites, and requires that runoff control measures be implemented and maintained on site for the duration of a project.

Permittees must submit a Notice of Intent to the IDNR to obtain coverage under General Permit No. 2. In addition, erosion and sedimentation control plans detailing the runoff control measures to be implemented for the project are required by local authorities who review and approve these plans. Inspections and reporting are done by the local authorities to ensure that permittees are following the provisions of the approved plan. General Permit No. 2 coverage must be maintained until construction is completed and a site is fully stabilized.

NPDES Permit Program-Industrial Activity

The NPDES permit program requires that stormwater discharges associated with industrial activity obtain permit coverage under General Permit No. 1, which is issued by the IDNR. The EPA lists ten general categories of industrial activity requiring a permit. Publicly-owned treatment works, wastewater systems and facilities, sludge and bio-solids handling, and industrial users discharging into a municipal wastewater system are all required to obtain authorization under an NPDES industrial stormwater permit for discharging stormwater. NPDES permits typically establish specific discharge limits, and monitoring and reporting requirements.

NPDES Permit Program-Municipal Separate Storm Sewer Systems (MS4)

A municipal separate storm sewer system (MS4) is defined as a conveyance or system of conveyances that are publicly owned, designed for collecting or conveying stormwater, not part of a combined sewer, and not part of a publicly owned treatment works. These conveyances include sewer inlets and pipes, municipal streets, curbs, gutters, drainage ways, and ditches.

MS4s that discharge to surface waters are required to obtain a NPDES Stormwater Permit issued by the IDNR. A NPDES Stormwater Permit authorizes a municipality to operate and discharge from their MS4, in accordance with the provisions of the permit. Permittees are required to develop and implement a stormwater management program that includes six minimum control measures, all aimed at managing stormwater and reducing the quantity of pollutants that get delivered to waterways via the MS4.

Six Minimum Control Measures

1. Public Education and Outreach
2. Public Participation/Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention/Good Housekeeping

NPDES MS4 Program – Phase I & II

In 1990, the EPA established Phase I rules for the NPDES stormwater program. This phase incorporated cities whose MS4 served populations greater than 100,000, requiring them to implement a stormwater program. Phase II of the NPDES Stormwater Program was implemented in 2003 and extends the coverage of the program to smaller MS4s as well as MS4s that are located in what are considered "urbanized areas," as delineated by the Census Bureau. The IDNR bases designation of communities required to obtain a permit on a combination of population, proximity to urbanized areas, and receiving streams water quality.

The City of Cedar Rapids was incorporated into the Phase I NPDES Stormwater Program. Implementation of Phase II of the program extended coverage to additional communities in the watershed including Marion, Robins, and Hiawatha. Table 2-7 provides a current listing of communities within the Indian Creek Watershed by permit type.

Permittees are required to submit an annual report to the IDNR to demonstrate and outline compliance with permit requirements. In addition, permittees are subject to audits by both the IDNR and EPA to ensure that permit provisions are being adequately met. The City of Cedar Rapids was audited by both the IDNR and EPA in January 2015.

Federal Clean Water Act-Total Maximum Daily Loads

The Federal Clean Water Act requires that states develop a 303(d) Threatened and Impaired Waters List. A stream or lake is placed on Iowa's impaired waters list if they do not meet the state's designated water quality standards. Total Maximum Daily Load (TMDL) must then be developed for water bodies that are determined to be impaired. A TMDL includes calculations of the maximum pollutant loads that can enter a body of water and still result in the water body meeting water quality standards, as well as point and nonpoint-source load allocations from the various sources of the pollutant.

There are two segments of Indian Creek and one segment of Dry Creek included on the draft 2014 State 303(d) list. The TMDL status for all three segments is "TMDL needed."

Federal Safe Drinking Water Act

The Federal Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply as a response to outbreaks of waterborne diseases and increasing chemical contamination. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and ground water wells.

Wellhead protection requirements were also included in the 1986 amendments to the SDWA. Wellhead protection areas established around drinking water supply wells are based on the local geology, well depth, and pumping rate, among other factors. These wellhead protection areas help protect wells and springs used as sources of water supply for community public water systems owned by and/or serving municipalities and counties.

National Flood Insurance Act

The National Flood Insurance Act of 1968 led to the creation of the National Flood Insurance Program (NFIP) and offered new flood protection to homeowners. Participation in the NFIP is voluntary and based on an agreement between local communities and the federal government. A participating community must adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in "special flood hazard areas." The federal government will make flood insurance available within the community as a financial protection against flood losses.

In 2001 FEMA established the 10-step Community Rating System (CRS) process that identified four essential parts to mitigation planning and created a point-based evaluation system. The CRS rewards communities that undertake floodplain activities beyond the requirements with lower flood insurance premiums. A Class 1 rating requires the most credit points and gives the greatest premium reduction; Class 10 receives no premium reduction. A community that does not apply for the CRS, or does not obtain the minimum number of credit points is automatically categorized a Class 10 community.

Table 2-6. National Flood Insurance Program Participation

Jurisdiction	NPDES Permit Type	NFIP Participation	CRS Rating	Flood Insurance Discount
Cedar Rapids	MS4 Phase I	Yes	6	20%
Marion	MS4 Phase II	Yes	10	-
Hiawatha	MS4 Phase II	Yes	10	-
Robins	MS4 Phase II	Yes	10	-
Linn County	N/A	Yes	8	10%

Source: NFIP Community Status Book

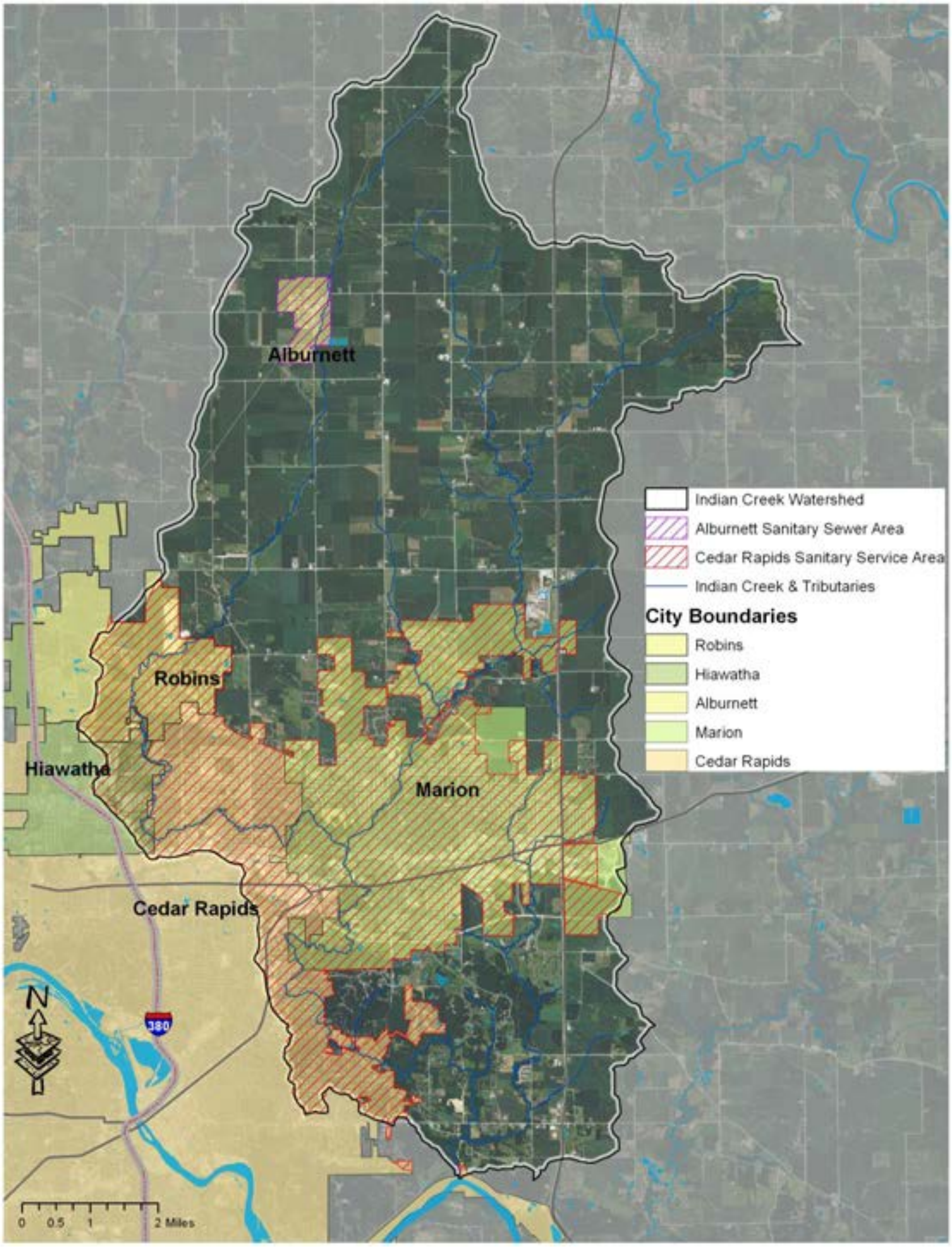
2.9 Sanitary Sewer Areas & Private Septic Systems

Sanitary sewer service is an important factor that has the potential to affect water quality in the watershed. Where this service does not exist, homes dispose of their waste through a private septic system. Collectively, private systems present a greater risk of pollutant discharge to waters as compared to a centralized treatment facility that is associated with a sanitary sewer system.

Sanitary sewer service coverage in the watershed is shown in Figure 2-20. Generally, the most populous areas of the watershed have sanitary sewer service. There are two systems that serve areas in the watershed. The City of

Alburnett has a wastewater treatment lagoon system serving the community. The City of Cedar Rapids operates the Water Pollution Control facility which serves the Cedar Rapids metro area including the other communities in the watershed. The Alburnett system discharges their effluent to Dry Creek. The Water Pollution Control facility discharges their effluent to the Cedar River below the Indian Creek outlet. The rest of the homes and businesses in the watershed have private septic systems.

Figure 2-20. Sanitary Sewer Service Area in Indian Creek Watershed



Source: Map by ECICOG with data from Cedar Rapids Water Pollution Control

2.10 Source Water

There are two major aquifers used by private and public water supplies in the Indian Creek watershed: the Silurian-Devonian bedrock aquifer and the Cambrian-Ordovician bedrock aquifer. These two aquifers are hydrologically separated by a shale unit called the Maquoketa Shale aquitard (confining layer). This unit inhibits water from moving vertically between the two aquifers.

The Silurian-Devonian aquifer provides drinking water to nine public water supplies within the Indian Creek watershed area (Table 2-8, Figure 2-21). The largest public users of the Silurian-Devonian aquifer are the cities of Marion, Hiawatha and Alburnett. Natural protection of the Silurian-Devonian aquifer varies greatly from point to point depending on the extent of erosional processes removing the glacial till overlying the aquifer. Communities like Vernon Heights Mobile Home have less than 25 ft. of glacial till protecting the aquifer and are considered to be 'Highly Susceptible' to surface pollution. Other communities using the Silurian-Devonian aquifer in the watershed have over 100 ft. of confining layer and are considered to have 'Low Susceptibility' to surface pollution (Figure 2-21, Table 2-8). Additionally, areas with less than 25 ft. of glacial till protecting the aquifer that also have karst development within the bedrock and sinkholes at the surface are more susceptible to surface pollution entering the aquifer.

The deeper Cambrian-Ordovician aquifer is only used by the City of Marion. Marion's Cambrian-Ordovician capture zone is within the Indian Creek watershed. However, the aquifer is at 1,100 ft. depth and separated from the land surface by the Maquoketa Shale aquitard. Therefore the Cambrian-Ordovician aquifer is considered to be hydrologically separated from both the land surface and Silurian-Devonian aquifer.

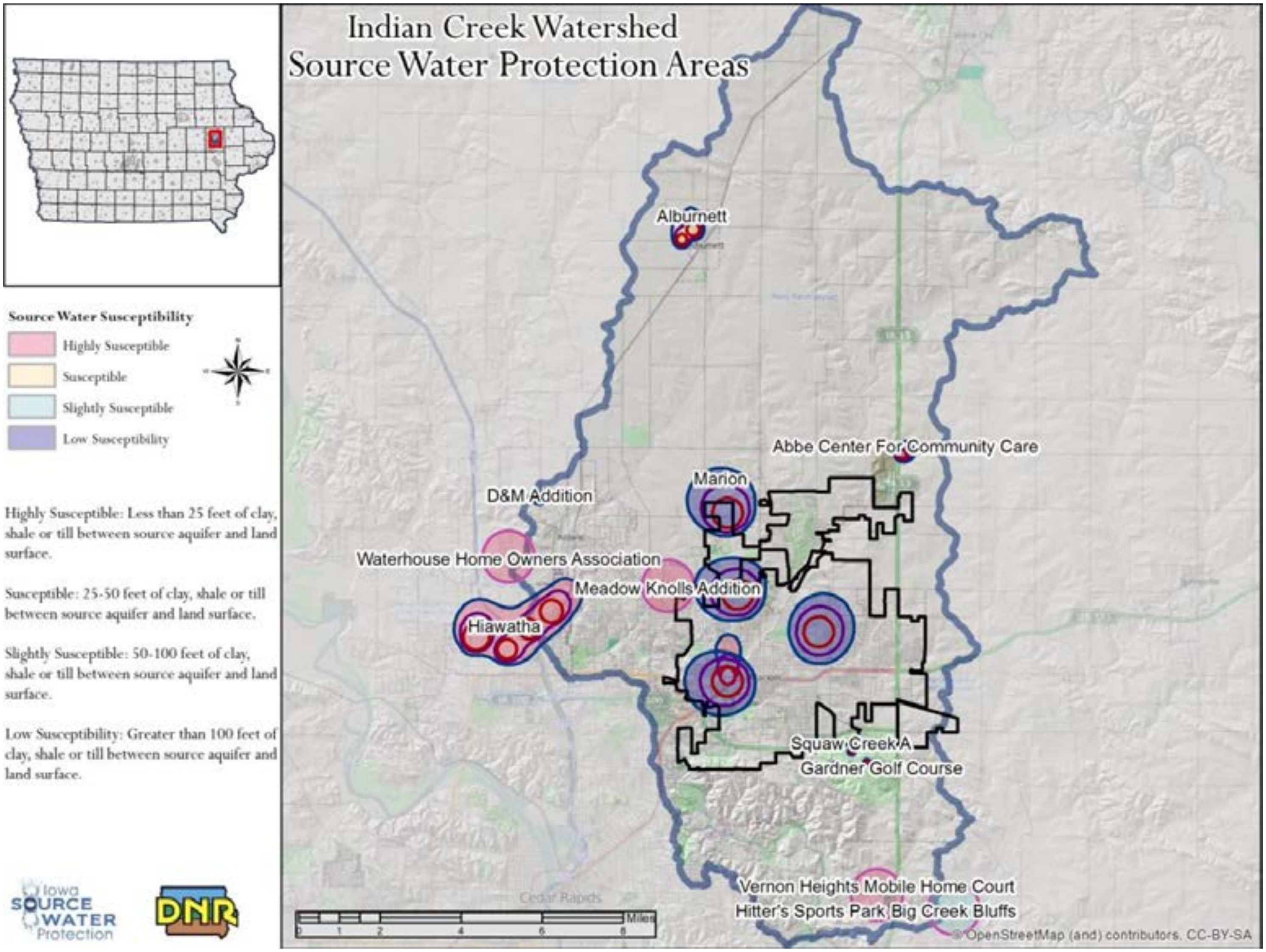
The Iowa Source Water Protection program has estimated the areas contributing groundwater to wells on all public water systems in the watershed. The Source Water Protection Areas that are Highly Susceptible in Figure 2-21 should be considered as having the most direct drinking water and surface water quality impact from land use changes.

Table 2-7. Public Water Supplies within the Indian Creek Watershed

System Name	Area Delineation	Pop.	Aquifer	Susceptibility to Surface Pollution
Marion	Time of Travel	25,984	Cambrian-Ordovician	Low Susceptibility
Vernon Heights Mobile Home	Setback Distance	120	Silurian	Highly Susceptible
Abbe Center For Community Care	Time of Travel	350	Silurian	Low Susceptibility
Hitter's Sports Park	Setback Distance	400	Silurian	Low Susceptibility
Big Creek Bluffs	Setback Distance	80	Silurian	Slightly Susceptible
D&M Addition	Setback Distance	80	Silurian	Highly Susceptible
Alburnett	Time of Travel	559	Silurian-Devonian	Susceptible
Squaw Creek A	Setback Distance	153	Silurian-Devonian	Low Susceptibility
Hiawatha	Time of Travel	6,480	Silurian-Devonian	Highly Susceptible
Marion	Time of Travel	25,984	Silurian-Devonian	Highly Susceptible
Meadow Knolls Addition	Setback Distance	59	Silurian-Devonian	Highly Susceptible
Waterhouse HOA	Setback Distance	unknown	Silurian-Devonian	Highly Susceptible
Gardner Golf Course	NC	206	Unknown	Highly Susceptible

Source: Chad L. Fields, Iowa Department of Natural Resources, Iowa Geological & Water Survey. "Groundwater in the Indian Creek Watershed, Linn County Iowa" January 2014

Figure 2-21. Source Water Capture Zones within the Indian Creek Watershed

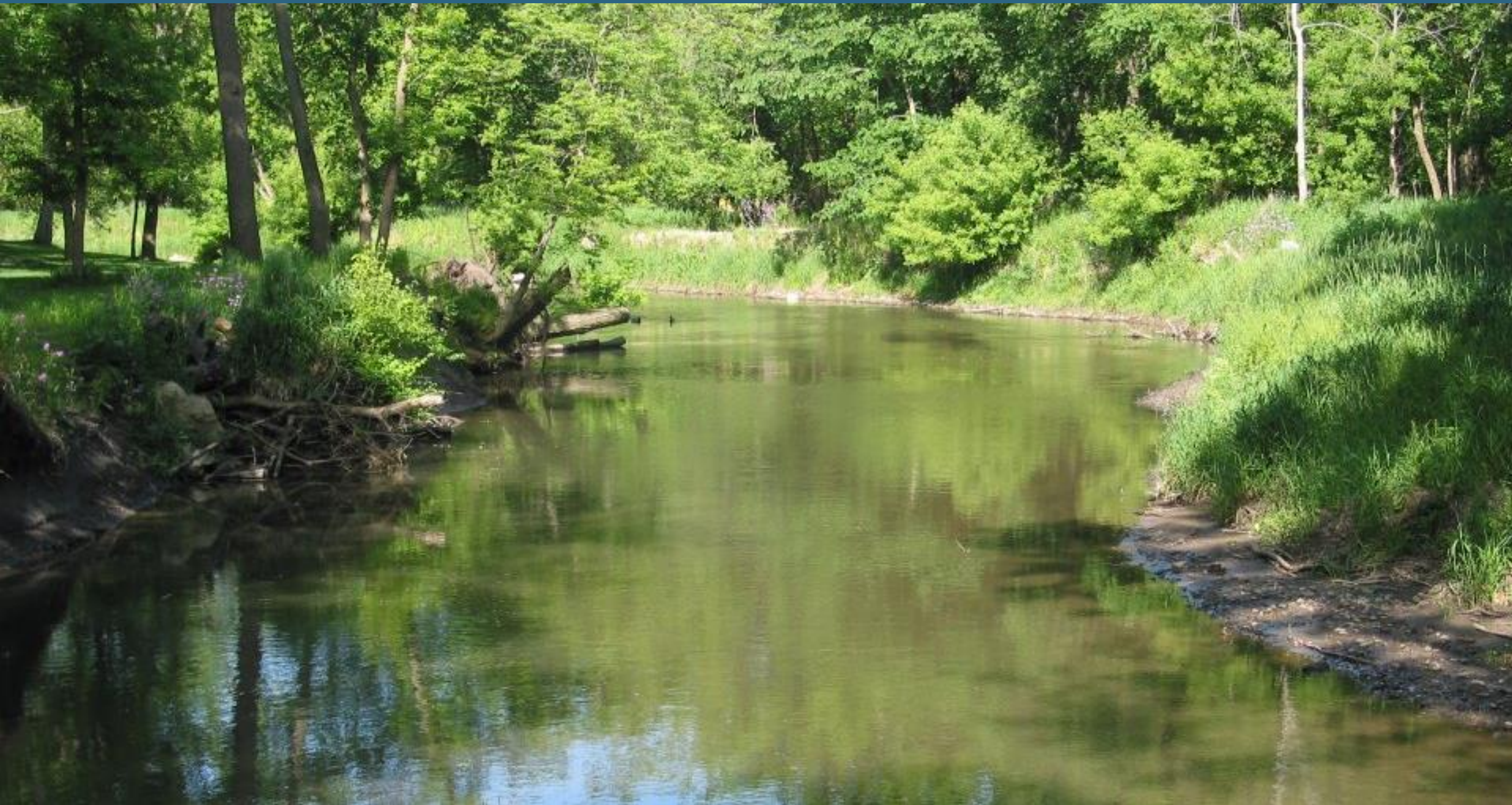


Source: Chad L. Fields, Iowa Department of Natural Resources, Iowa Geological & Water Survey. "Groundwater in the Indian Creek Watershed, Linn County Iowa" January 2014

Chapter 3 – Water Quality Assessment

"High quality water is more than the dream of the conservationists, more than a political slogan; high quality water, in the right quantity at the right place at the right time, is essential to health, recreation, and economic growth."

Edmund S. Muskie

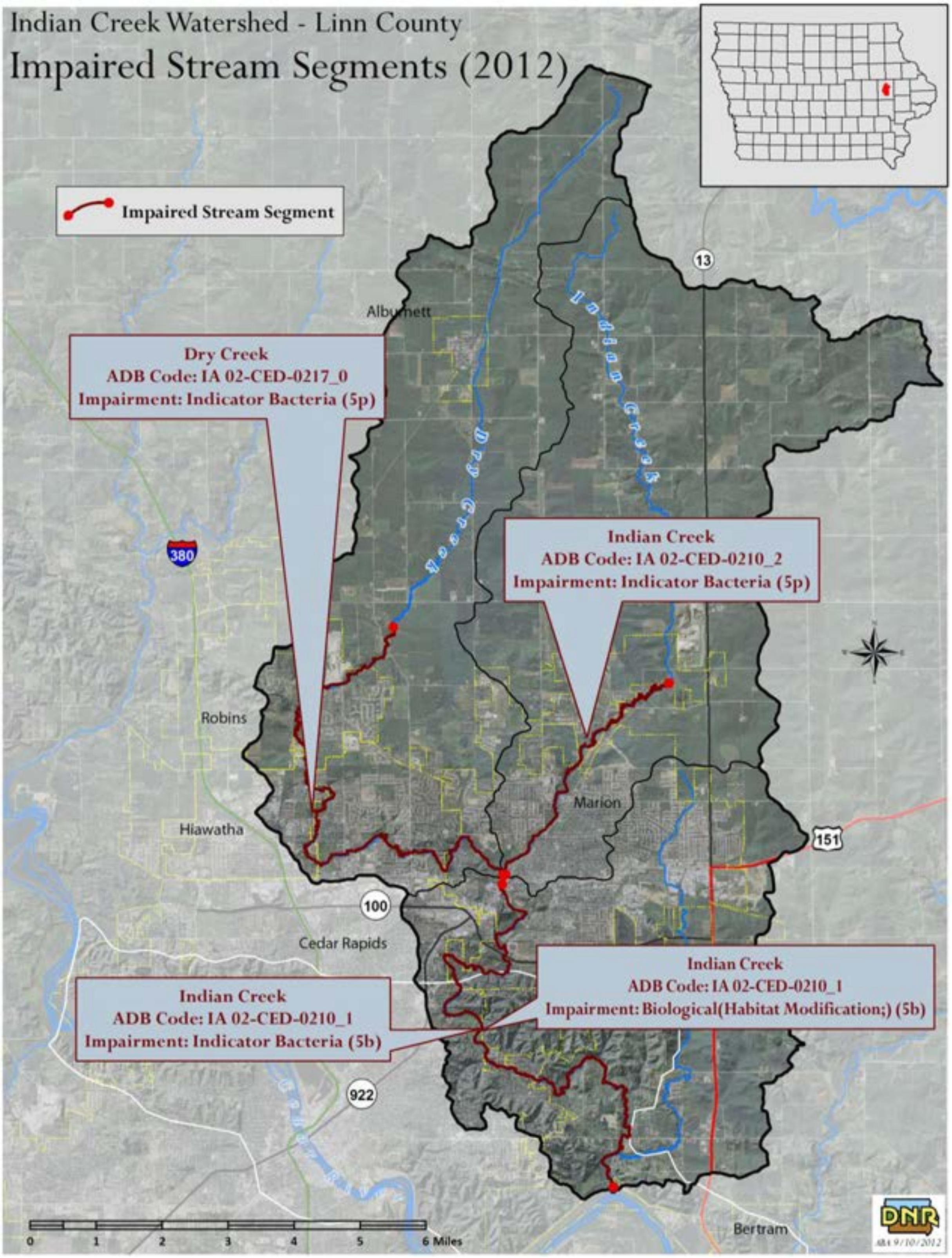


Water quality in a stream is highly influenced by the amount and quality of water that runs off the land within the watershed. Water that runs off from agricultural fields or is conveyed through tile drainage can carry soil particles (sediment), fertilizers (nitrogen and phosphorus), or pesticides and herbicides. In urban areas, water that is conveyed through storm sewer networks from parking lots, roads, rooftops, and urban lawns can carry heavy metals, oil and grease, pet waste, and lawn chemicals. This chapter summarizes the water quality of Indian Creek and its tributaries and compares this data to available stream water quality criteria. The levels of nitrogen and phosphorus in the water vary seasonally and are generally higher in the northern agricultural part of the watershed. A significant majority of the samples taken to measure indicator bacteria levels in the creeks exceeded the state standard for children's recreational use.

3.1 Designated Uses & Impaired Status

The State of Iowa has assigned two designated uses for Indian Creek, Dry Creek, and Squaw Creek: primary contact recreation (Class A1) and aquatic life (Class B WW2). These designated uses have been reported as impaired in three of the watershed's stream segments as shown in Figure 3-1. The "impaired" designation is given when water quality monitoring indicates a water body is not capable of supporting its designated use. The designated use and impaired status of each stream segment in the Indian Creek watershed is listed in Figure 3.1. It is important to note that five stream segments in the watershed have not been tested, and therefore no data is available for an impairment designation.

Figure 3-1. Water Bodies Listed as Impaired in the 2012 Section 303(d) Integrated Report



Source: Iowa Department of Natural Resources

Primary Contact Recreation – Class A1

Water quality monitoring data indicate that direct contact with the water through swimming in certain reaches of Indian and Dry Creeks could be unsafe due to elevated levels of indicator bacteria in the water. These are bacteria that are commonly found in the intestines of warm-blooded animals, and high levels of indicator bacteria confirms the presence of contamination from fecal material. While the indicator bacteria themselves are not harmful to human health, they can be associated with other types of disease-causing pathogens that are also found in fecal material.

Aquatic Life – Class B WW-2

One stream segment in Indian Creek is listed as impaired (partially supported) for aquatic life due to habitat alterations or other changes to the stream channel. This determination was made based on the results of fish and aquatic macroinvertebrate surveys, in which the number of species present in the stream was lower than expected.

3.2 Pollutants of Concern

Nitrogen

Nitrogen is a nutrient that is critically important for plant growth. Nitrate nitrogen is the dominant dissolved form with typically very small amounts of nitrite nitrogen present. While nitrate is one of the primary forms of nitrogen used by plants for growth, excess amounts in groundwater and streams can cause concerns for human health and aquatic life. At concentrations greater than 10 mg NO_3^--N/L, it has been linked to methemoglobinemia or "blue baby syndrome". Nitrogen is also one of the primary contributors to low oxygen areas resulting from algae blooms, such as the well-known Gulf of Mexico hypoxic zone. Sources of nitrogen to the environment in excess of natural, background levels include fertilizer, animal manure, and legumes such as soybeans. Monitoring in the Indian Creek watershed focused on the nitrate nitrogen (NO_3^--N) with concentrations that vary seasonally from biological activity and nutrient inputs like fertilizer, wastewater and urban runoff.

Phosphorus

Phosphorus is a primary nutrient for plant growth on the land and in the water. Reducing phosphorus loading to waterways is a primary focus of watershed management due to the role of this element in creating algae blooms. In severe cases, massive algal mats and scums can be generated by blue-green algae (cyanobacteria) that also can produce toxins such as microcystin that can affect wildlife and drinking water supplies. Phosphorus is typically monitored in two forms: dissolved phosphorus in forms most readily used by crops as well as aquatic plants resulting in increased productivity; and total phosphorus found in both dissolved and particulate forms. The primary sources of excess phosphorus in waterways include sediment from erosion, manure, sewage, and fertilizers.

Sediment / Suspended Solids

Turbidity is caused by materials suspended in water such as soil, algae, plankton, and microbes. As more material or sediment is suspended in the water, less light can pass through, making it less transparent. High turbidity is a condition that is rarely toxic to aquatic animals, but it indirectly harms them when solids settle out and clog gills, destroy habitat, and reduce the availability of food. Furthermore, suspended materials or sediment in streams magnify solar heat increasing water temperatures and reducing light penetration, which reduces photosynthesis, both of which contribute to lower dissolved oxygen. Suspended materials or sediment can also carry chemicals attached to the particles, which can have harmful environmental effects. Sources of suspended particles in the Indian Creek watershed may include soil erosion, sewer/septic discharge, manure, urban runoff, eroding stream banks, and excess algal growth.

E. coli Bacteria

Water-borne pathogens include a wide variety of bacteria, viruses, protozoa, and microorganisms such as Giardia and Cryptosporidium that are capable of producing gastro-intestinal illnesses and other symptoms that can be severe. Testing for all of the potential pathogens would be prohibitively expensive and therefore monitoring has focused on indicator organisms known as Escherichia coli (*E.coli*). Bacterial levels are affected by sunlight, nutrient levels, seasonal weather, stream flows, temperatures, and distance from pollution sources such as livestock manure practices, wildlife activity, and sewage overflows. Stream and pond sediments can harbor bacteria populations. These factors will vary spatially and temporally and, therefore, should be considered in sampling site selection and data interpretation. To compare values to the Iowa water quality geometric mean of 126 org/100mL, a minimum of five samples are required in a single year from March 15th to November 15th. However, stream reaches may also be listed on the 303(d) list as impaired if single samples exceed 235 org/100mL.

Chloride

Chloride is generally present as sodium chloride in all natural waters, although the concentration can vary from a few milligrams per liter or less, to several thousand milligrams per liter in some ground waters. Sources of excess chloride in waterways include industrial discharges, municipal wastewater, septic effluent and the use of deicers (road salts) applied to impervious surfaces for public safety. Concentrated animal operation wastes and some agricultural inorganic fertilizers also influence chloride concentrations.

Urban Runoff

Various pollutants collect on the surface of roads, parking lots, lawns, and other urban areas over time. During a rainstorm, these contaminants are washed into the nearest storm drain and discharged directly to a waterway such as Indian Creek. Forms of urban pollutants include:

- Oil and grease (hydrocarbons) from automobiles
- Heavy metals from roof shingles, automobiles, and other sources
- Nutrients from lawn fertilizers, failing sanitary / septic systems, and pet waste
- Bacteria / pathogens from pet waste and failing sanitary / septic systems
- Chlorides from road salt
- Thermal pollution: as water runs off hot surfaces such as asphalt, it can elevate the water temperature in urban streams

3.3 Water Quality Monitoring

The Indian Creek Watershed Management Authority contracted with Coe College to conduct a water quality assessment including sampling and analysis. Student researchers at Coe have been monitoring water quality in Indian Creek since 2002. Sampling sites were chosen to capture the influences of the various land uses and soil types on the creek. Samples were taken weekly from March through April, twice per week from May through August, and weekly from September through November of 2013. While not part of the ICWMA study, data from 2014 is included as well. Sampling took place at a subset of the sites from 2013 on a weekly schedule from May to August. A brief description of the sites is given in Table 3-1 progressing from rural upstream to urban downstream. The sampling sites are represented on the map in Figure 3-2. The Indian Creek Water Quality Assessment Report 2013 and the Cedar River Tributary Study Summer 2014 can be found in Appendix 2.

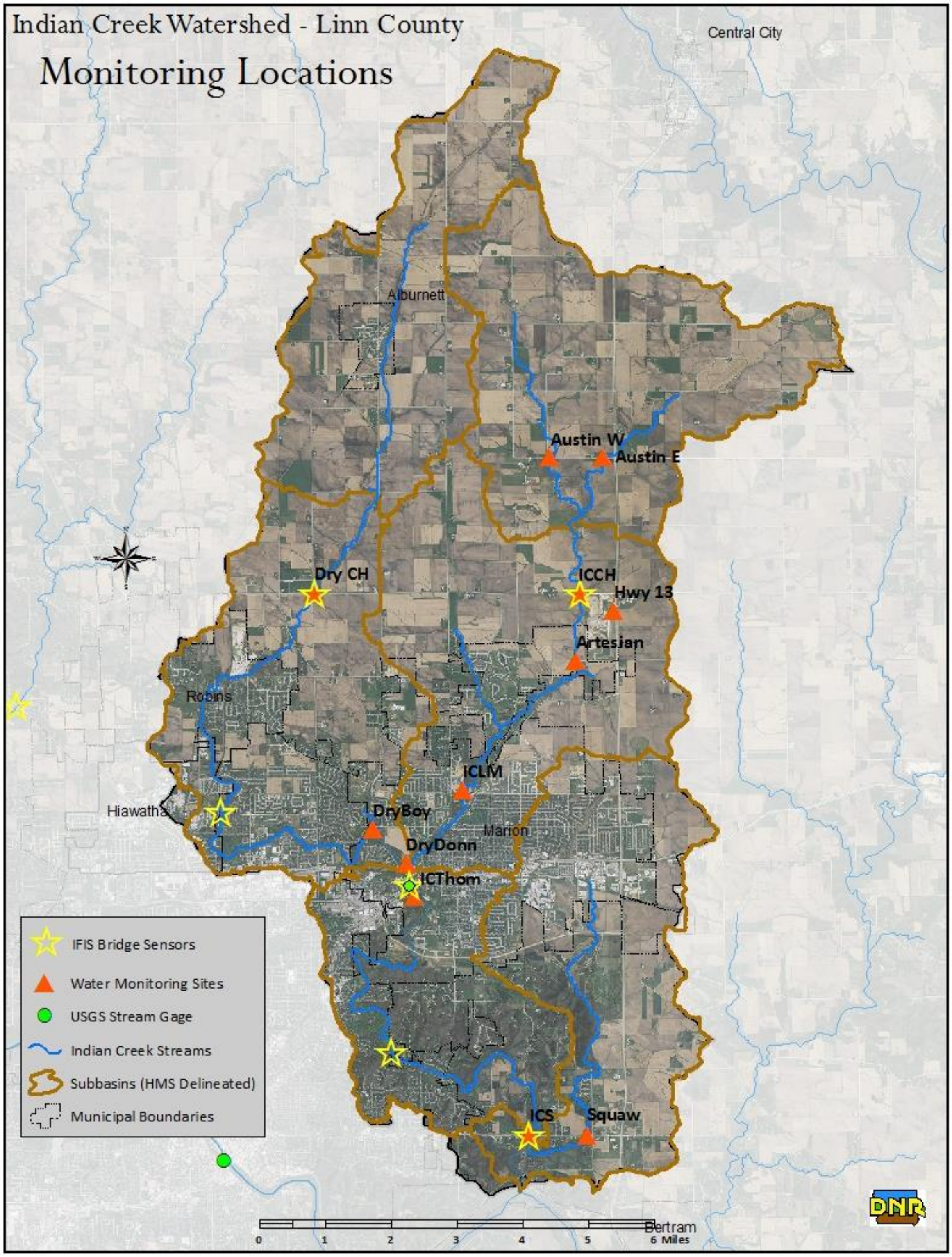
Table 3-1. Sampling Sites for the Water Quality Assessment

Sampling Site	Watershed Placement	Site Description
Austin W	High	Most upstream portion of Indian Creek
Austin E	High	Most upstream portion of Indian Creek
Dry CH	High	Most upstream portion of Dry Creek
ICCH (County Home Rd.)	High	Indian Creek upstream of landfill
Hwy 13	High	Very small stream entering landfill from east
Artesian	Middle	Downstream from landfill
ICLM (Linn Mar)	Middle	Agriculture upstream, suburban downstream
DryBoy (Boyson Park)	Middle	Dry Creek springs between this site & Dry Donnelly
DryDonn (Donnelly Park)	Middle	Most downstream site on Dry Creek
ICThom (Thomas Park)	Middle	Indian Creek after Dry Creek joins it
ICS (Mt. Vernon Rd.)	Low	Most downstream site on Indian Creek
Squaw (Mt. Vernon Rd.)	Low	Only site on Squaw Creek

Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013

Samples collected from these sites were analyzed for dissolved oxygen, turbidity, temperature, specific conductance, pH, total suspended solids, chloride, nitrate, sulfate, dissolved reactive phosphorus, and *E. coli.*

Figure 3-2. Sampling Sites for the Water Quality Assessment



Source: Iowa Department of Natural Resources with data from Iowa Flood Center / IFIS (IFIS Bridge Sensors), United States Geological Survey (USGS Stream Gage), and Dr. Martin St. Clair, Coe College Water Quality Laboratory (Water Monitoring Sites)

3.4 Water Quality Results

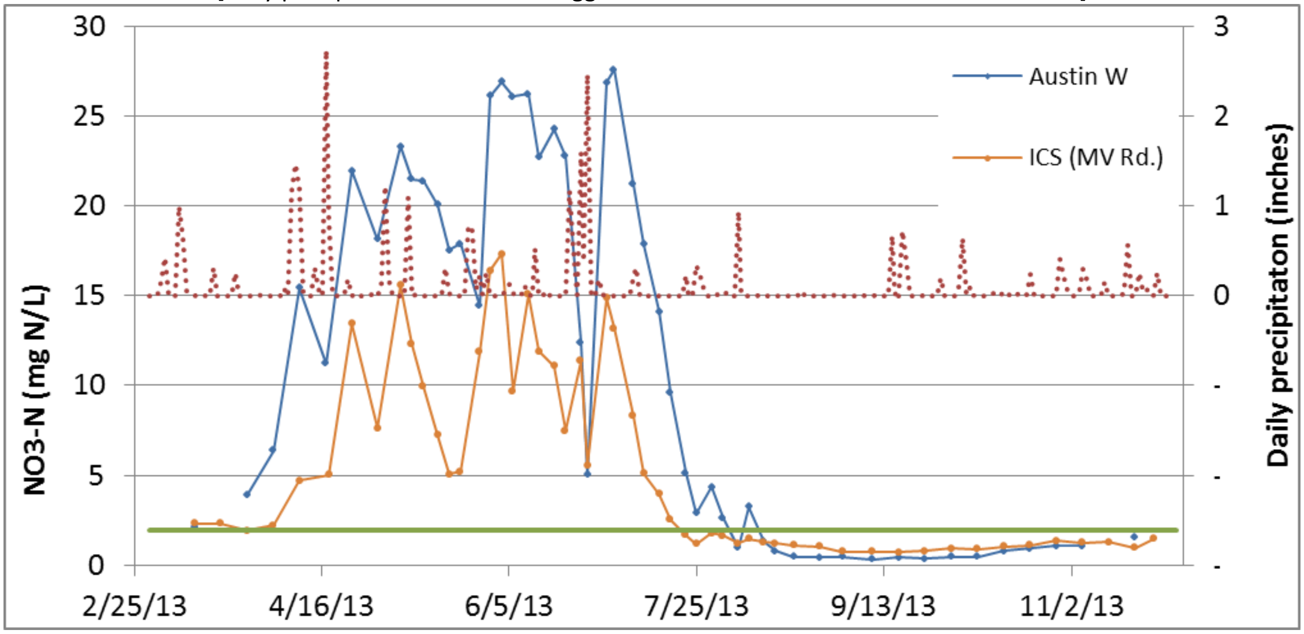
The Indian Creek watershed exemplifies water quality challenges facing many Iowa watersheds. Approximately half of the watershed is row crop agriculture, so excess levels of nutrients are typically found in the stream. On the other hand, suburban development continues to advance into rural areas, increasing the amount of impervious surface in the watershed resulting in flashier hydrology.

Nitrate

As shown in Figure 3-3, nitrate levels in 2013 started relatively low in early spring, but quickly rose to high levels. Other studies indicate that a considerable amount of the nitrate levels early in the spring originated from last year's fertilizer application. Drought conditions in 2012 left much applied nitrogen in the soil, and spring rains in 2013 flushed it from the soil. For comparison, the EPA's suggested total nitrogen criteria of 1.965 mg N/L is plotted in Figure 3.3. Nitrate concentrations remained high until mid-July and then dropped to a relatively constant value. The average value from August 1st to November 30th at Mt. Vernon Road was 1.11 mg NO_3^-- N/L. In general, nitrate levels were consistently higher upstream in the watershed and decreased moving toward the outlet into the Cedar River. The sampling point farthest upstream is Austin West and the farthest downstream sampling point is Mt. Vernon Road as shown in Figure 3-2.

Figure 3-3. Nitrate-N Levels Upstream (Austin West) and Downstream (ICS) in 2013

[daily precipitation[8] and EPA's suggested nutrient criteria[9] for total N are shown]



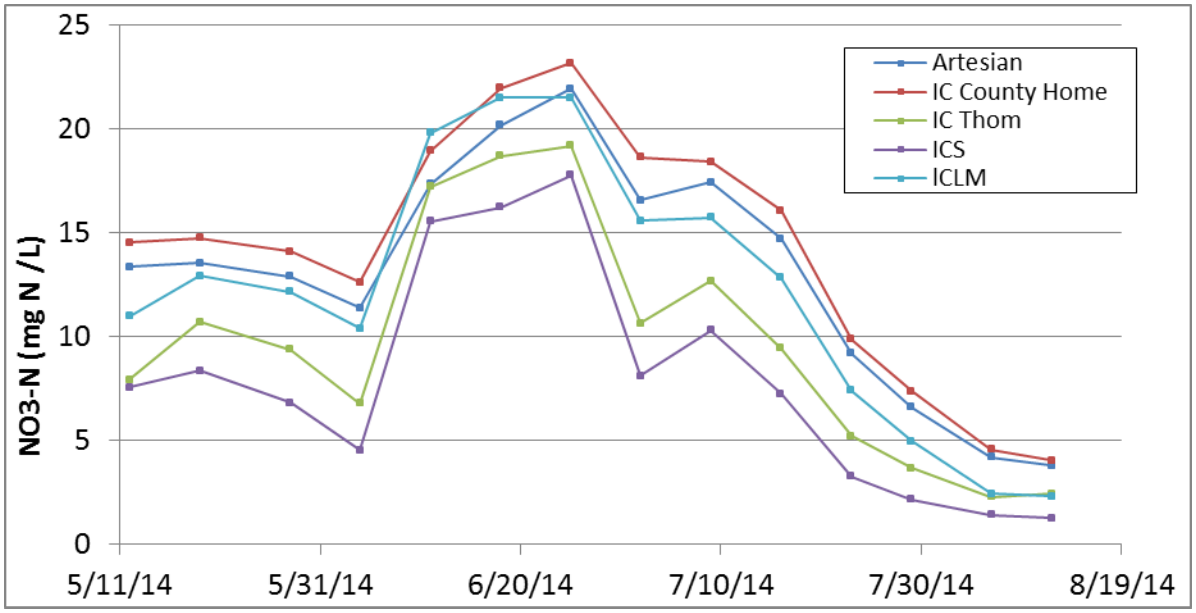
Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013

Nitrate concentrations followed similar trends in 2014, though the peak nitrate level occurred later in the season.

[8] Generated at http://mesonet.agron.iastate.edu/rainfall/ for 42 02 03.66 N, 91 36 41.31 W (intersection of Dry and Indian Creeks.)

[9] USEPA (2000), Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion VI. EPA 822-B-00-017

Figure 3-4. Nitrate Concentrations in the Indian Creek Watershed Summer 2014



Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Cedar River Tributary Study Summer 2014

Several sampling sites have been monitored for 10 years, which provides baseline data. Table 3-2 summarizes average nitrate concentrations from May through August 2014.

Table 3-2. Historic Nitrate Concentrations 2004 - 2014

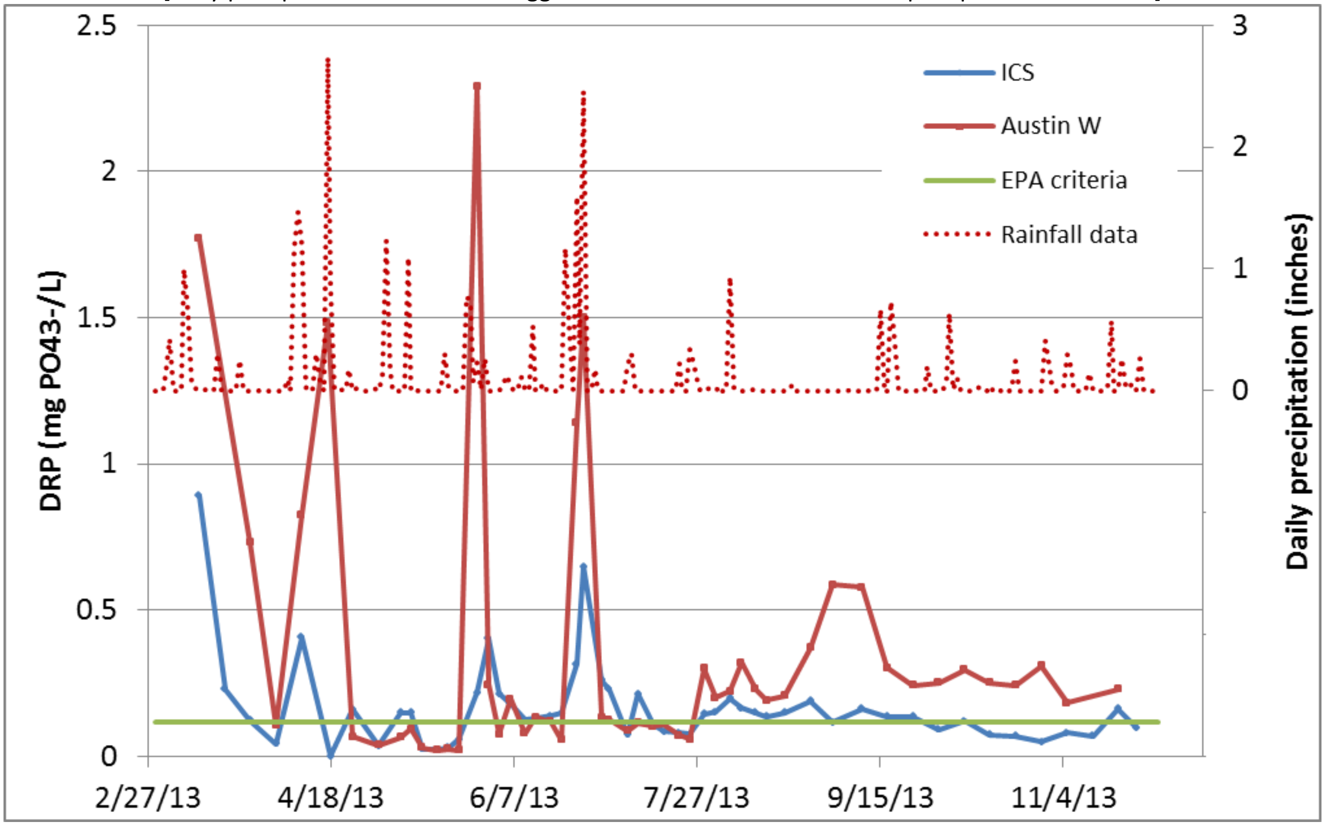
Year	Sampling Sites (north to south)			
	ICLM	IC Thomas	Dry Donn	ICS
2004	8.58	6.74	2.64	5.83
2005	4.57	3.96	3.18	2.49
2006	12.01	9.70	5.43	7.58
2007	10.50	8.17	5.32	6.17
2008	12.00	8.35	6.46	7.74
2009	7.44	5.94	NA	4.90
2010	8.95	7.28	5.83	6.02
2011	9.25	7.00	5.89	5.89
2012	3.89	3.52	2.85	2.72
2013	12.01	9.62	7.89	7.75
2014	12.93	10.28	7.59	8.40

Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory

Phosphorus

Phosphorus exhibits somewhat similar behavior, though transport occurs largely via attachment to soil particles and overland flow. Large precipitation events typically trigger increases both in total suspended solids and phosphorus in the stream. Again, concentrations decrease moving down the watershed, though the pattern is not as consistent as it is with nitrate. Monitoring in the Indian Creek watershed was focused on dissolved reactive phosphorus (DRP), which is the form that is more readily biologically available and therefore contributes to algae blooms.

Figure 3-5. DRP Concentrations Upstream (Austin West) and Downstream (ICS) in 2013
[daily precipitation[10] and EPA's suggested nutrient criteria[11] for total phosphorus are shown]



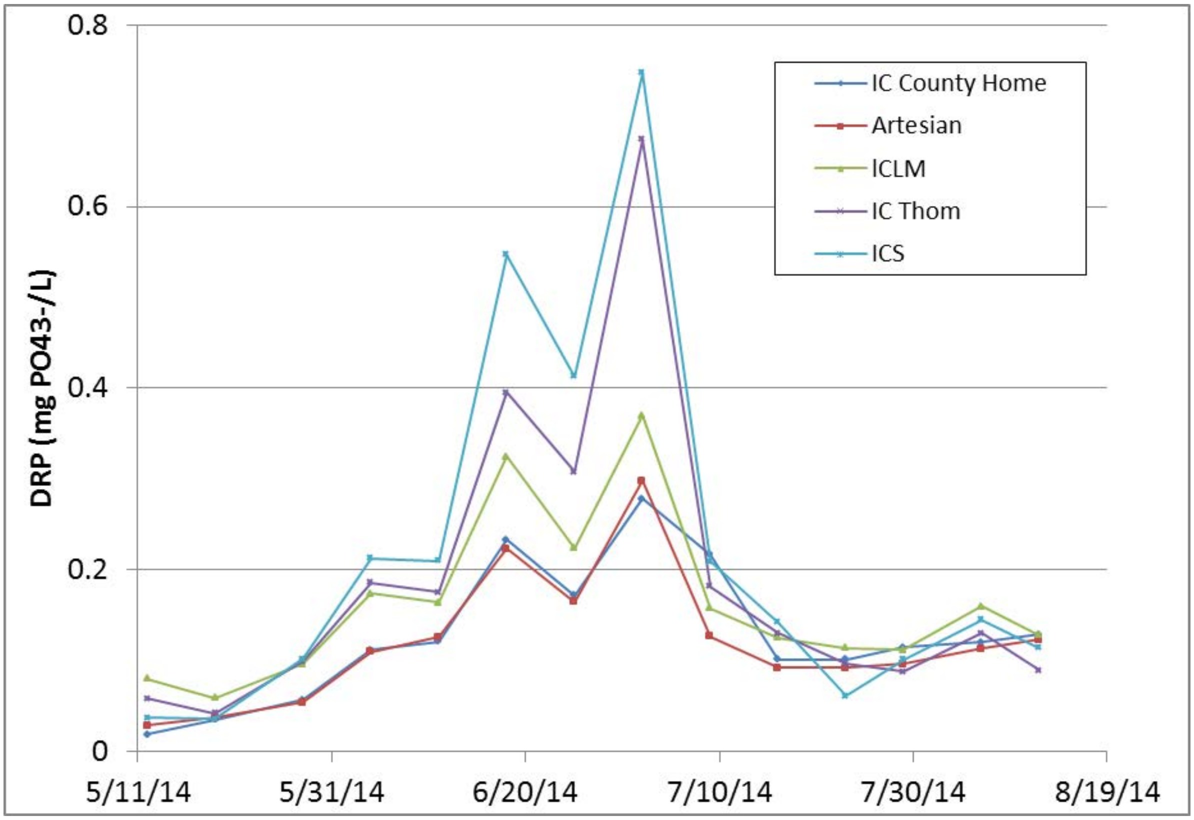
Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013

Interestingly, trends in DRP concentrations were different in 2014, with the highest concentrations observed at Indian Creek South. The highest concentrations, though were significantly lower than in the summer of 2013. Again, precipitation events are coupled strongly to DRP concentrations, but erosion sources and localized precipitation can also have a strong impact.

[10] Generated at http://mesonet.agron.iastate.edu/rainfall/ for 42 02 03.66 N, 91 36 41.31 W (intersection of Dry and Indian Creeks.)

[11] USEPA (2000), Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion VI. EPA 822-B-00-017

Figure 3-6. DRP Concentrations Upstream (Austin West) and Downstream (ICS) Summer 2014



Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Cedar River Tributary Study Summer 2014

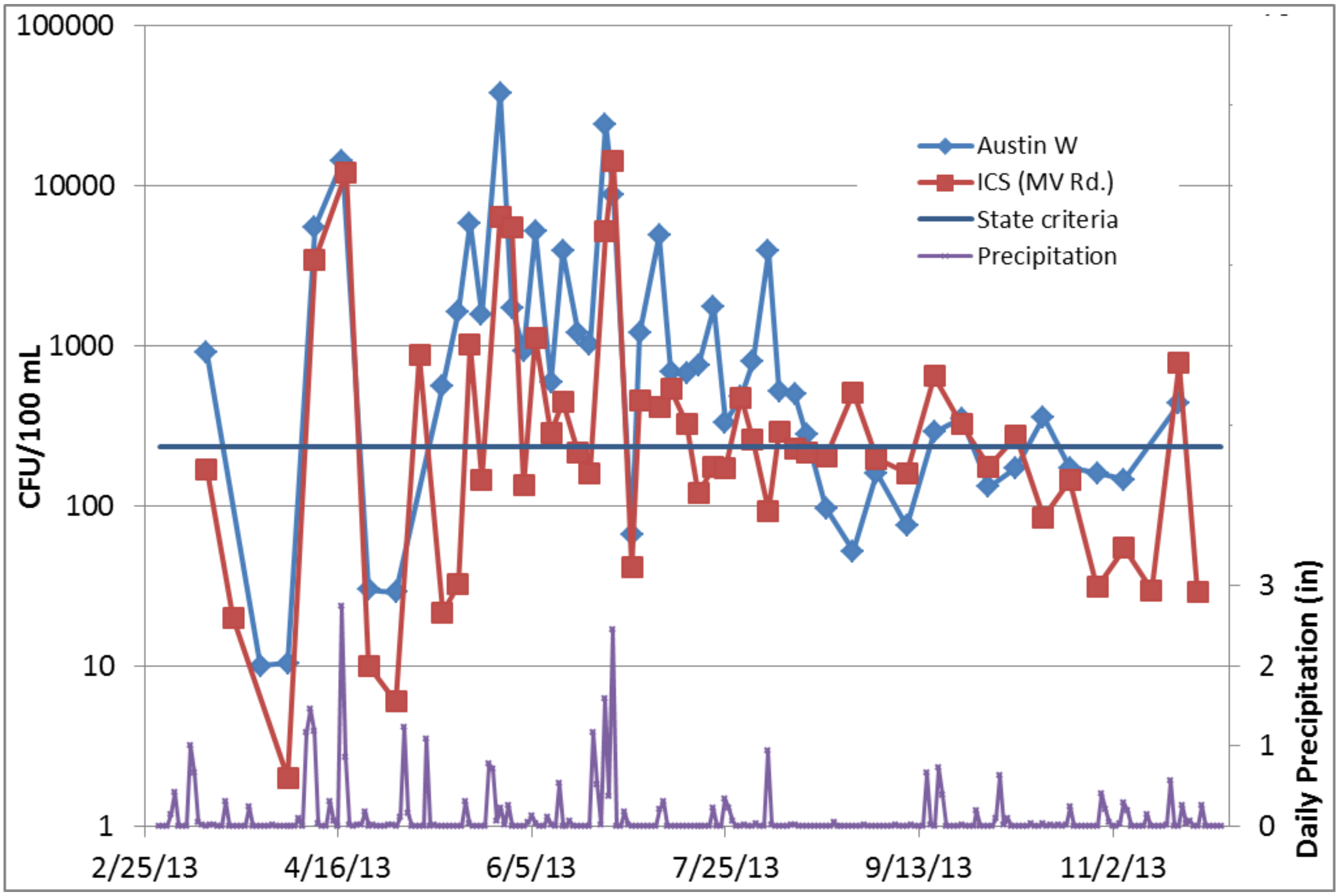
With respect to which nutrient is most responsible for excess biological activity, one common yardstick is the molar ratio of nitrogen to phosphorus often referred to as the Redfield ratio. While the rapid turnover of streams makes this ratio less useful in streams than in the ocean, it still provides a useful marker for assessing relative nutrient concentrations.[12] Phytoplankton typically exhibit an N/P ratio of 16:1. The average N/P ratio for all samples taken in the Indian Creek watershed was 833 (standard deviation of 2929) with a median value of 210. The maximum ratio was 65,905, while the minimum was 3. In the samples with high ratios, the dissolved reactive phosphorus was near detection limits. While it would be better to use total phosphorus, these ratios clearly indicate that nitrogen is in large excess in the Indian Creek watershed.

Bacteria

E. coli measurements provide an indication of bacterial contamination of a stream. While *E. coli* is not necessarily disease causing, it originates in the digestive tract of mammals and this indicates the possible presence of disease-causing organisms. Standards are based on the use of the stream, and Indian Creek is considered to be suitable for children's recreational use (A3). The State standard of 235 colony forming units (cfu) per 100 mL of sample is the appropriate comparison. Increases in *E. coli* concentrations are typically associated with precipitation events, which wash *E. coli* source material into streams.

[12] Green, M.B. & Finlay, J.C. (2010). Patterns of hydrologic control over stream water total nitrogen to total phosphorus ratios. Biogeochemistry 99:15-30.

Figure 3-7. *E. coli* Measurements (CFU/100 mL) Upstream (Austin West) and Downstream (ICS)



Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013

An alternative way to assess the *E. coli* situation is to examine each site to determine how often it exceeds the state standard of 235 cfu per 100mL. Table 3-3 contains this data, illustrating that the standard is more frequently exceeded higher in the watershed than downstream.

Table 3-3. Percent of Samples at Each Site Exceeding 235 cfu *E. coli*/100 mL

Site	% exceeding standard 2013	% exceeding standard 2014	Site	% exceeding standard 2013	% exceeding standard 2014
Artesian	77.6	100	Dry Donnelly	67.3	85.7
Austin E	81.3	NA	Hwy 13	53.2	78.6
Austin W	70.8	NA	IC Thomas	76.5	92.9
County Home Dry	66.7	NA	ICLM	67.3	92.9
County Home Indian	71.2	100	ICS (MV Rd.)	45.1	64.3
Dry Boyson	63.5	NA	Squaw	74.5	NA

Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013 & Cedar River Tributary Study Summer 2014

Synoptic Sampling

In an attempt to further define the spatial sources of nutrients and bacteria in the watershed, a one-day "snapshot" sampling was carried out on November 16, 2014. Thirty-two sites in the watershed were sampled between 9:30 AM and 2:00 PM. *E. coli,* in general, was low; only 3 of the samples exceeded the 235 cfu/100 mL standard. The highest value (1540 cfu/100 mL) was in the northern part of the watershed where there is cattle pasture on the creek. Nitrate was generally low (average value of 7.7 mg NO_3^--N/L), though values are still higher in the upper part of the watershed. The small tributary to Indian Creek that drains the Lindale Mall parking lot had a chloride concentration of 217 mg/L, which likely reflects salting of the lot to prevent icing. (It snowed approximately 2" the evening before sampling.) However, downstream of the tributary, Indian Creek chloride concentrations were within a normal range, reflecting the low flow of the tributary. Chloride concentrations of over 100 mg/L were also observed in Squaw Creek. DRP was generally low at all sites with an average value of 0.08 mg PO_4^{3-}/L.

Synthesis

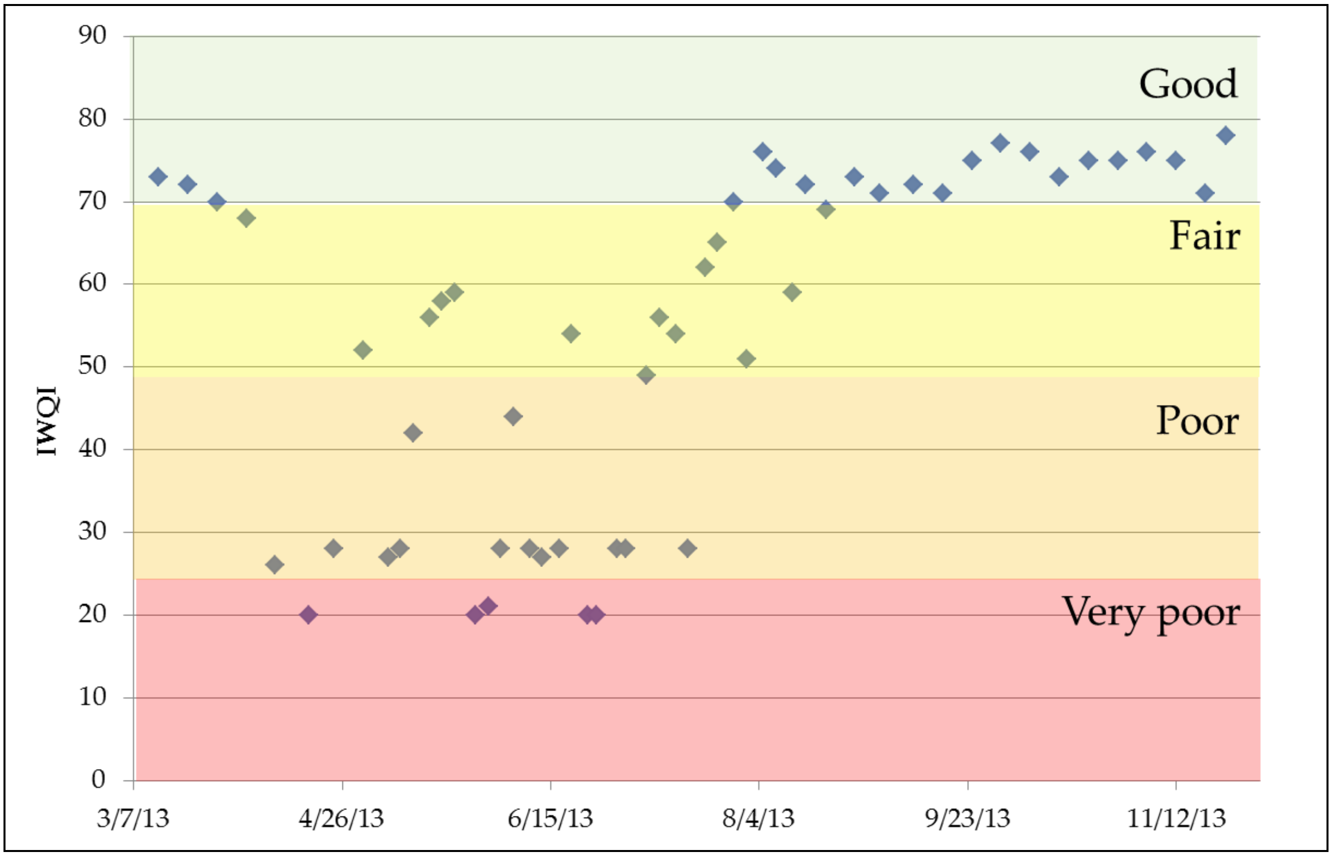
The Iowa Water Quality Index[13] (IWQI) offers a technique to integrate water quality parameters into a single index that provides an assessment of a water body's overall quality. The index includes biochemical oxygen demand, dissolved oxygen, nitrate, total phosphorus, total dissolved solids, total suspended solids, pH, *E. coli*, and total pesticides. IWQI was calculated[14] for samples taken from Indian Creek at Mt. Vernon Road, which is the site nearest the Cedar River and thus provides an integrated view of the watershed. As shown in Figure 3-8, water quality is best early (March-April) and late in the season (August –November). These times generally correspond to low flow, relatively low nitrate concentrations, and low phosphorus concentrations. Conversely, the periods of low water quality correspond to higher levels of nutrients. This trend was clearly seen in 2013, where samples mainly fell in the 'good' range in March – early April and August – November, while late April – July samples tested generally in the very poor to fair range.

[13] http://www.igsb.uiowa.edu/wqm/data/wqi/WqiMonthly.htm

[14] Since BOD and total pesticides were not measured, a value of 50 (out of a scale of 10-100) was used as specified in the index. Specific conductance was converted to TDS using a conversion factor of 0.67. Dissolved reactive phosphorus (DRP) was used instead of total phosphorus, and nitrate was used rather than nitrate+nitrite.

Figure 3-8. IWQ Index Calculated for Indian Creek Samples at Mt. Vernon Road in 2013

[Very poor (0-25), poor (25-50), fair (50-70), good (70-90), or excellent (90-100)]



Source: Dr. Martin St. Clair, Coe College Water Quality Laboratory, Indian Creek Water Quality Assessment Report 2013

Chapter 4 – Stream Health

"Plans to protect air and water, wilderness and wildlife are in fact plans to protect man."

Stewart Udall

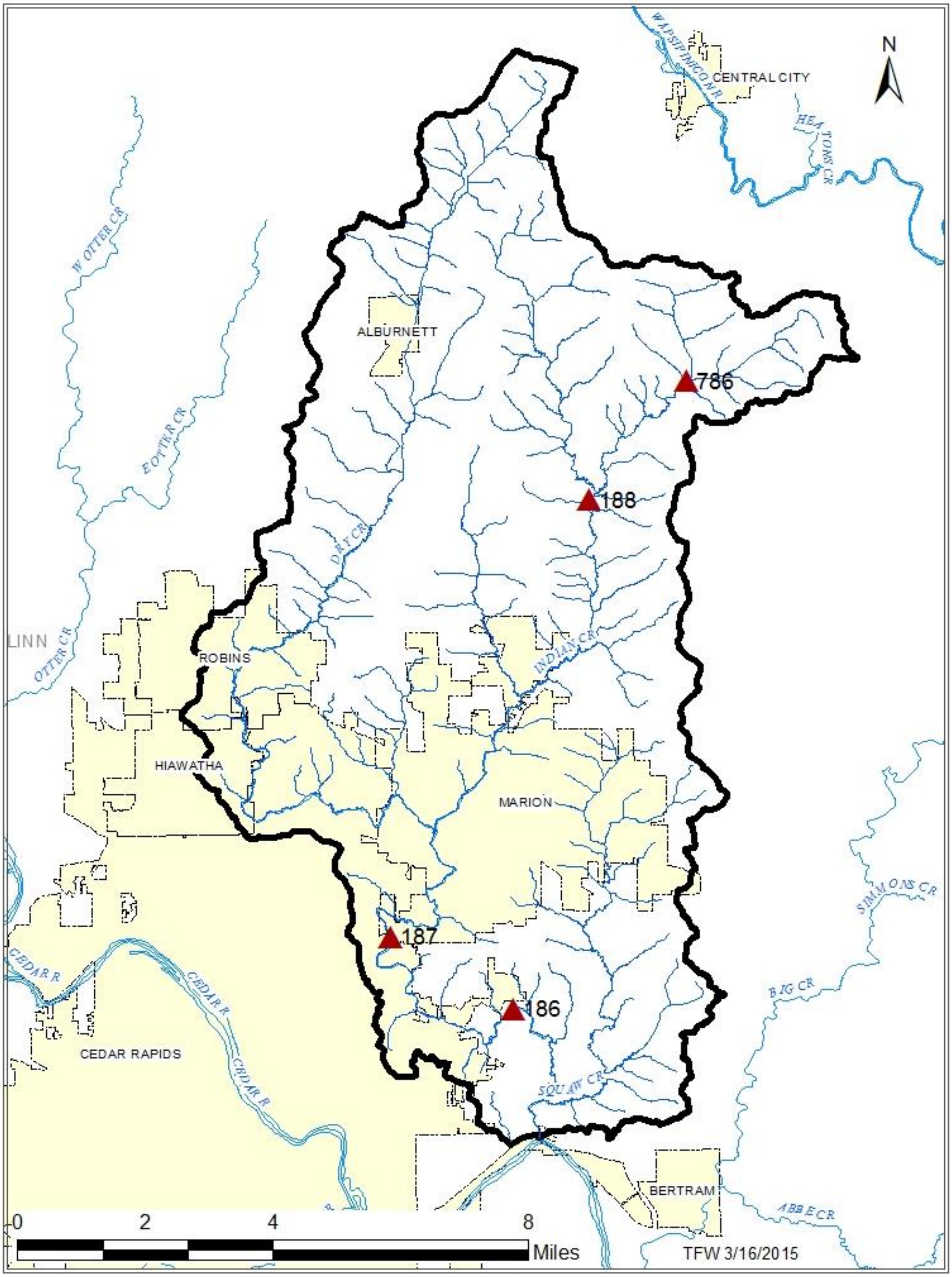
Two assessments were conducted to examine the overall health of the creeks in the watershed.

1. The Iowa DNR provided an evaluation of stream habitat conditions using a model and biological samples collected at four stream locations between 2000 and 2013. The evaluation assessed the suitability of habitat in the creek for supporting a healthy aquatic community. In general, habitat would be improved by reducing the silt and sediment in the creeks and increasing the cobble and boulder make-up of the stream bed.
2. The condition of the stream channel was assessed through the RASCAL (Rapid Assessment of Stream Condition Along Length) fieldwork conducted by students from Coe College. The RASCAL assessment was completed on 35 miles of the stream network (61% of the total stream length) and found that only 9% of the assessed segments had stable stream banks. Stream bank erosion appears to be more problematic in the lower reaches of Indian Creek and Squaw Creek.

4.1 Biological Assessment for Recreation & Habitat Assessment

The Iowa DNR provided an evaluation of stream habitat conditions in the Indian Creek watershed using a habitat index statistical model, a synopsis of which is provided here and the full Stream Habitat Improvement Recommendations report is available in Appendix 2. The analysis was based on biological samples (fish and benthic macroinvertebrates) collected in the Indian Creek watershed at four stream locations (bioassessment sites) as shown in Figure 4-1 between 2000 and 2013. The samples were used for the 2014 Aquatic Life Use Assessment summarized in Table 4-1.

Figure 4-1. Locations of IDNR Stream Biological & Habitat Monitoring Sites



Source: Tom Wilton, Iowa DNR, Indian Creek Stream Habitat Improvement Recommendations Report 2015

Table 4-1. Draft 2014 Aquatic Life Use Assessment Status for the Indian Creek Watershed

Stream - Location	BioNet SiteID	ADB SegID	RASCAL SegID[1]	Sample Date	BMIBI	B-BIC*	FIBI	F-BIC**	Draft 2014 Aquatic Life Use Assessment
Indian Creek – Cedar Rapids, Wilder Dr Trailhead	186	IA 02-CED-0210_1	8-9	8/27/2013	65	70 (NS)	68	65 (R)	Partial Support (Monitored)
				8/28/2012	62		69		
				9/18/2000	63	70 (NS)	66	65 (R)	
Indian Crk – Cedar Rapids, Mt Calvary Cemetery	187		10-11	9/19/2000	45	70 (NS)	36	44 (NR)	
Indian Creek – Cedar Rapids, Prairie Chapel Rd	188	IA 02-CED-0211_0	12-13	9/25/2000	79	70 (NS)	44	44 (NR)	Not Assessed
East Indian Crk – Marion (HW39)	786	IA 02-CED-0212_0	13-14	9/26/2013	64	70 (NS)	65	44 (NR)	Fully Supported (Evaluated)
				7/25/2012	73		59		

*BMIBI - Biological Impairment Criterion (B-BIC): 70 (NS) Natural Substrate (rock)
**FIBI - Biological Impairment Criterion (F-BIC): 65, Riffle Habitat (R); 44, Non-Riffle Habitat (NR)
Pass / Fail comparison to BIC
Source: Tom Wilton, Iowa DNR, Indian Creek Stream Habitat Improvement Recommendations Report 2015

The analysis assessed the suitability of habitat in the stream for supporting a healthy aquatic community, and to attain designated aquatic life uses. Levels of twenty-five stream habitat metrics measured at bioassessment sites in the Indian Creek watershed were compared against previously determined benchmarks representing conditions in higher quality streams. The results were used to identify habitat characteristics in need of improvement and for developing habitat target recommendations.

In general, the analysis found that improvement in stream sediment conditions are the most likely to generate a positive response in fish. Specifically, increases in the amounts of cobble and boulders on the stream bottom, coupled with reductions in silt coverage, would provide the most benefit for aquatic life, provided that water quality and other environmental factors are acceptable. Increasing cobble and boulder on the stream bottom is important because these substrates provide habitat for aquatic organisms. Decreasing siltation is important because too much silt in the stream can reduce the available habitat in the rocky portions of the stream. In addition, silt in the water can reduce water clarity and is detrimental to the health of aquatic organisms. Therefore, reducing sedimentation in the creek would benefit aquatic organisms such as fish, insects and native mussels.

The habitat analysis provided a list of recommended habitat conservation and improvement targets for the Indian Creek watershed, which are listed in Table 4-2. For the purpose of watershed planning, a first goal might be to ensure that habitat characteristics fall within the critical ranges listed in Table 4-2. Doing so will ensure that habitat by itself will not limit the stream from attaining good or excellent ratings.

Once critical habitat levels have been achieved to the maximum extent possible, improvement goals could be refined to match the habitat conditions of higher quality streams with similar channel and watershed characteristics (ie, DNR's bioassessment reference sites). In the table, target conditions are expressed as the interquartile ranges (i.e., 25th – 75th percentiles) of habitat metric values sampled from wadeable warmwater reference sites, and certain condition targets that are specific to stream reaches having stable riffle habitat and large rock substrates. The green highlighted metrics in Table 4-2 emphasize the most influential habitat metrics with respect to impacting Fish Index of Biotic Integrity (FIBI) levels.

In addition to improving stream sediment and substrate conditions, another complimentary goal would be to ensure that aspects of stream habitat, such as bank stability, canopy coverage, instream cover, and channel bedform/dimensions, are restored to or maintained within desirable levels as defined by data from least disturbed stream reference sites.

Development and implementation of a long-term monitoring and assessment plan is strongly recommended to provide a mechanism for tracking progress in habitat improvements and documenting the stream aquatic community response. The conclusions and recommendations from this analysis are based on limited data, some of which is outdated. The value of stream biological and habitat monitoring data collected at a limited number of fixed locations might be enhanced by careful integration and refinement of rapid visual assessments (such as RASCAL) that are capable of producing a more comprehensive assessment of habitat improvement needs throughout the watershed. Staff of the Iowa DNR stream bioassessment program can offer technical advice on developing an appropriate habitat and biological sampling design. Follow-up sampling at previously sampled bioassessment sites is logical to consider provided it matches with monitoring needs for the watershed.

Table 4-2. Stream Habitat Targets for the Indian Creek Watershed

Stream Habitat Category	Metric Description	Abbrv.	Critical Range (to stay within)	General Target Ranges Derived From Wadeable Warmwater Reference Site Interquartile Range	Specific Targets for Stream Reaches with Stable Riffle Habitat and Large Rock Substrate
Bank	% Horizontal (0-15 degrees)	bnkahz%	2.5-67.5	25 - 45	
Bank	% Moderate (20-50 degrees)	bnkamd%	>17.5	35 - 55	
Bank	% Vertical (55-110 degrees)	bnkavr%	<42.5	10 - 25	
Bank	Streambank - Average Percent Bare	bnkbare%	17.0-93.8	53 - 80	
Canopy/Shade	Average Percent of Channel Shaded	chshdav%	8.2-89.5	42.1 - 76.5	
Canopy/Shade	Standard Deviation - Percent of Channel Shaded	chshdsd%	>10.2	25.1 - 35.3	
Dimension	Transect Depth - Average (ft)	dpthav	<1.41	0.65 - 1.10	
Dimension	Transect Depth - Coefficient of Variation	dpthcv	>0.46	0.58 - 0.76	
Dimension	Maximum Depth (ft)	maxdep	>1.62	3.0 - 4.5	
Dimension	Stream Width - Average (ft)	strwdtav	>13.6	32.4 - 52.3	
Dimension	Stream Width - Standard Deviation	strwdtsd	>3.4	7.5 - 13.7	
Dimension	Thalweg Depth - Average (ft)	thwgdpav	>0.55	1.22 - 1.94	
Dimension	Thalweg Depth : Stream Width Ratio	thwgwdr	10.3-54.7	20.7 - 33.0	
Instream Cover	Depth/Pool - Average Percent - IDNR Method	cvrdpl%	<20.6	0.6 - 9.6	
Instream Cover	Total Proportional Areal Cover - EPA Method	cvrepa%	>13.25	17.3 - 30.1	
Instream Cover	Overhanging Vegetation - Average Percent	cvrovhg%	<10.4	1.1 - 3.5	
Instream Cover	Woody Debris - Average Percent	cvrwdbrs%	0.25-14	1.5 - 6.4	
Macrohabitat	% Reach Area as Dominant Macrohabitat Type	rchmxhb%	<90.3	53.6 - 76.8	
Macrohabitat	% Reach Area as Pool	rchpool%	5.4-84.8	18.3 - 51.4	
Macrohabitat	% Reach Area as Riffle	rchrffl%	na	0 - 10.7	> 10
Macrohabitat	% Reach Area as Run	rchrun%	na	40.2 - 75.0	
Substrate	Coarse Rock Embeddedness - Average Rating	embdrtg	<3.4	1.7 - 2.4	≤ 2
Substrate	% Cobble	subcbbl%	na	0 - 24	14 - 46
Substrate	% Clay	subclay%	<17	0 - 0	
Substrate	% Fines (Clay+Silt+Sand)	subfines%	<84.5	41.3 - 84.0	
Substrate	% Coarse Rock (Grvl+Cbbl+Bldr)	subrock%	>11.5	13.3 - 54.0	38 - 61
Substrate	% Silt	subsilt%	<38.5	5.3 - 25.6	3 - 16
Substrate	% Maximum Substrate Type	substrmx%	<82.5	38.0 - 60.8	
Composite	% Habitat Metrics as Suboptimal	PctSubOpt%	na	0 - 10	0

Source: Tom Wilton, Iowa DNR, Indian Creek Stream Habitat Improvement Recommendations Report 2015

4.2 Stream Condition

The Indian Creek Watershed Management Authority (ICWMA) partnered with Coe College to conduct a stream condition assessment along Indian, Dry, and Squaw Creeks during 2013 – 2014. The goal of the assessment was to provide an overall snapshot of the stream corridor with respect to erosion, sedimentation, riparian condition, and habitat quality. The survey team collected data by walking the length of the stream channel and evaluating indicators such as stream bank stability, adjacent land use, and in-stream habitat quality. For an overview of the procedure used for the stream assessment, also known as RASCAL (Rapid Assessment of Stream Condition Along Length), see the Indian Creek Watershed RASCAL Report 2014 in Appendix 2.

The RASCAL assessment was completed on 35 miles of the stream network in the watershed. Some portions in agricultural areas of the watershed were not assessed because permission from the landowners had not been granted. The ICWMA hopes to re-visit un-surveyed portions of the watershed in future years. The stream condition assessment collected data on a variety of stream health indicators. A summary of the conditions relating to sedimentation, streambank erosion, and riparian condition are provided in this section of the plan, as well as an overall description of conditions within each tributary.

Sediment & Erosion

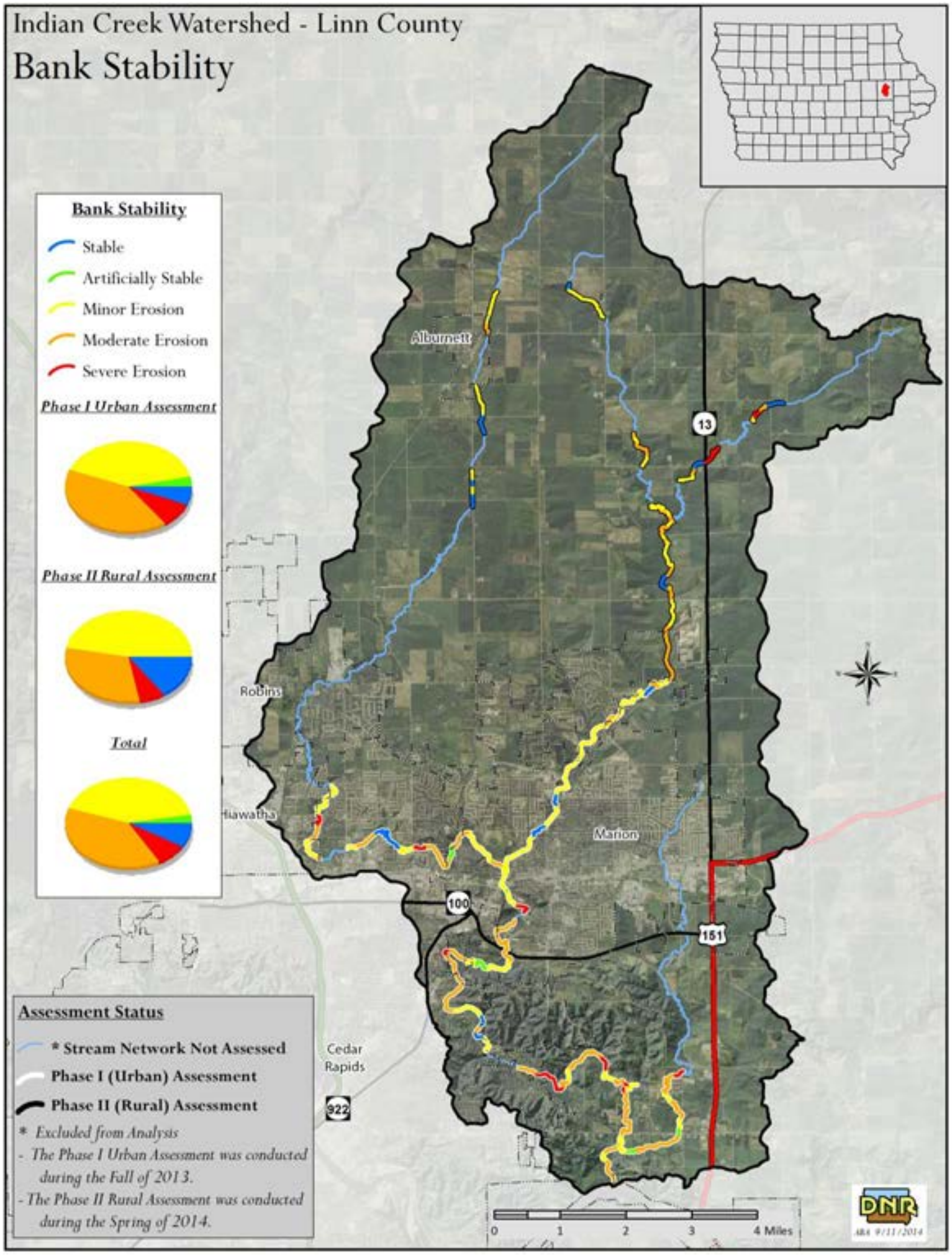
Stream bank erosion can be a significant contribution to the sediment load within a stream. Overall, 80% of the surveyed stream segments tended to exhibit signs of minor to moderate stream bank erosion, while only 9% were described as stable. The survey team noted signs of severe erosion on 8% of the surveyed stream segments, and 2.5% of the stream segments had been artificially stabilized using riprap or some other method. Figure 4-2 displays the segments surveyed in terms of bank stability. The estimated total sediment load from streambank erosion from the surveyed segments in the entire Indian Creek watershed is 9,950 tons per year. Areas of moderate erosion in the watershed contribute an estimated 45% of sediment load from streambank erosion, while areas of extreme erosion contribute 31% of the sediment load. Even areas with only minor erosion contribute up to 20% of the sediment load. This suggests that controlling minor to moderate erosion should be a priority for the Indian Creek watershed, even though at the site scale it may not seem to be a significant issue.

Minimal erosion

Moderate erosion

Severe erosion

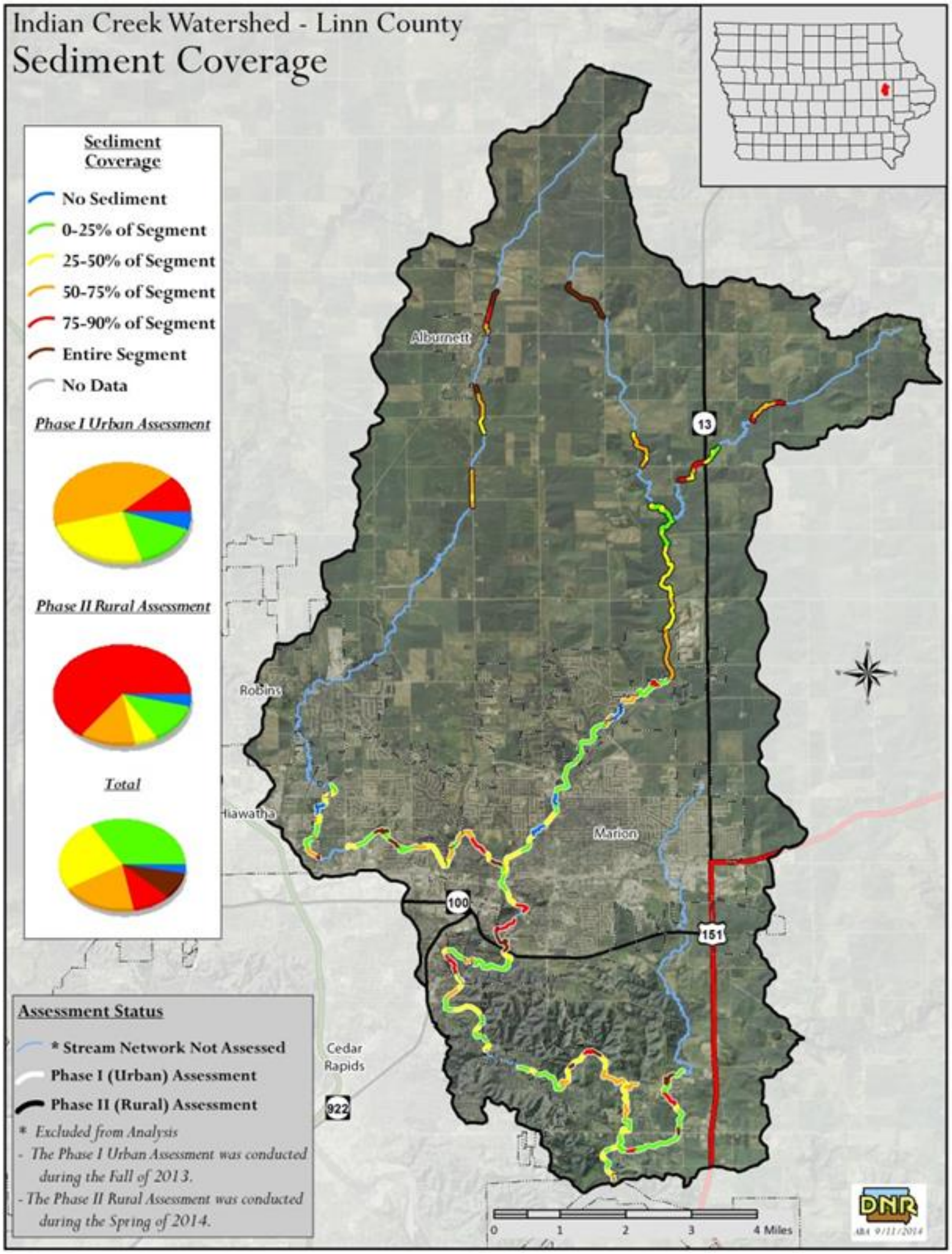
Figure 4-2. Bank Stability of RASCAL Surveyed Segments



Source: Iowa Department of Natural Resources with data from Coe College students

One of the parameters influencing in-channel conditions is stream gradient (slope). The steeper the channel grade, the faster water will move. As water moves faster, it becomes more erosive and is able to transport more sediment within suspension. Once sediment-laden water slows down sufficiently, the heaviest sediment particles will begin to settle out of the water to the stream bottom, followed by increasingly finer particles such as silts as the flow rates continue to slow. Figure 4-3 shows where sedimentation was observed to be problematic. About 19% of the surveyed segments were observed to have 75% - 100% of the stream bottom covered in sediment.

Figure 4-3. Sediment Coverage of RASCAL Surveyed Segments



Source: Iowa Department of Natural Resources with data from Coe College students

From the standpoint of sediment-related threats to water quality, the segments currently exhibiting the *worst* conditions are listed in Table 4-3. The stream segments listed in Tables 4-3 and 4-4 are represented on the map in Figure 4-4. The Best Management Practices (BMP) for these segments could include streambank stabilization, additional riparian plantings, sediment & runoff trapping structures in the adjoining gullies, infiltration practices to reduce stormwater runoff from urban areas, and fencing to restrict livestock access to the stream corridor.

Table 4-3. RASCAL Segments with Highest Streambank Erosion Rates

Stream	Segment	Channel Grade %	Grade Rank (1 = Steepest)	Streambank Erosion (tons/mile)	Streambank erosion rank (1=Highest Erosion Rates)
Indian Creek	8 to 9	0.12	17	449	1
Indian Creek	7 to 8	0.12	16	385	2
Indian Creek	13 to 14	0.19	9	360	3
Squaw Creek	3 to 4	0.23	7	333	4
Indian Creek	Confluence to 7	0.08	23	321	5
Squaw Creek	1 to 2	0.26	6	252	6
Dry Creek	15 to 16	0.14	11	239	7
Indian Creek	10 to 11	0.11	19	238	8

Source: Iowa Department of Natural Resources with data from Coe College students

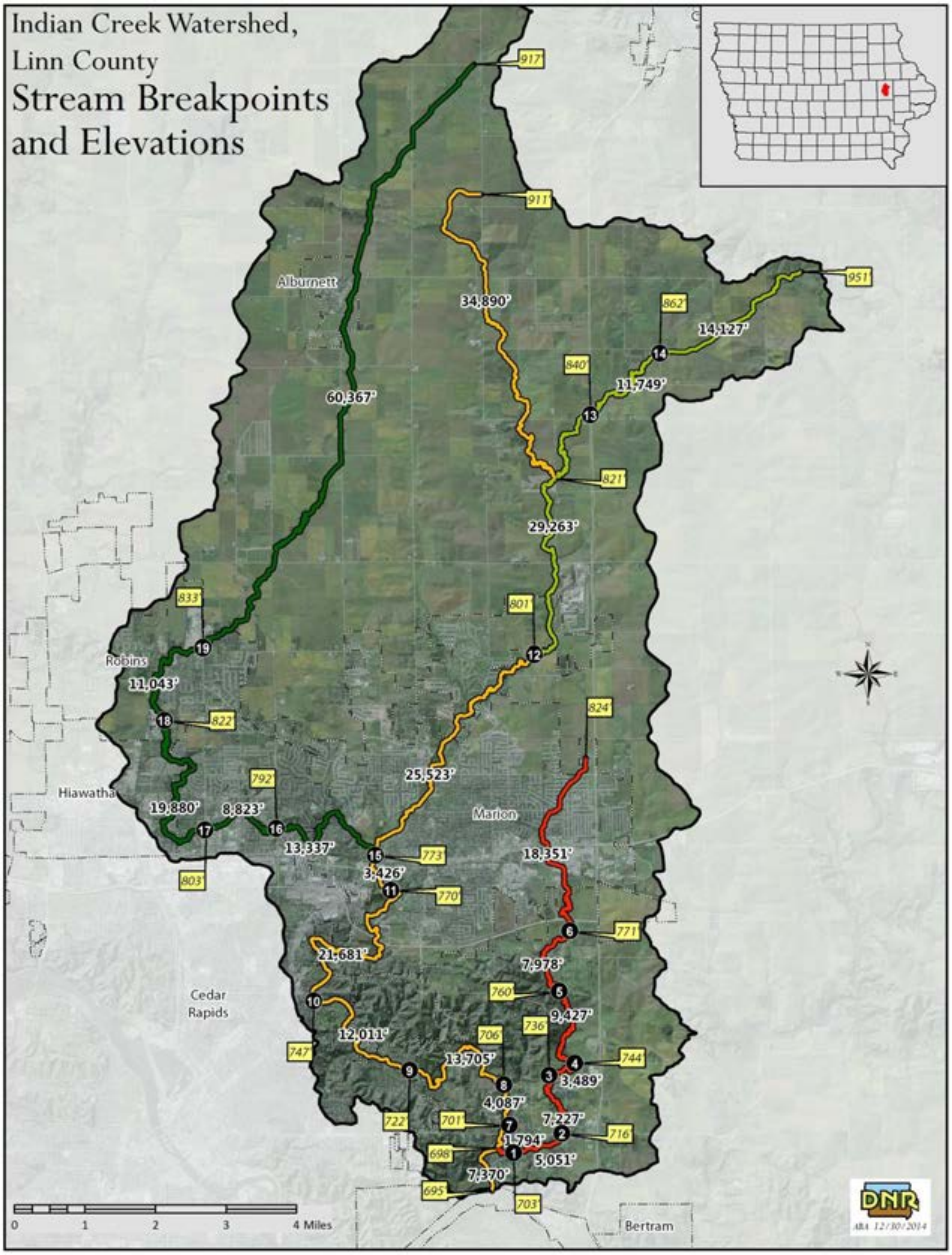
The segments of the stream exhibiting the *best* conditions are listed in Table 4-4. The BMP strategy for these segments should focus on protecting the existing riparian area and continuing to improve it, and addressing any concerns with streambank stability that may exist.

Table 4-4. RASCAL Segments with the Lowest Streambank Erosion Rates

Stream	Segment	Channel Grade %	Grade Rank (1 = Steepest)	Streambank Erosion (tons/mile)	Streambank erosion rank (1=Highest, 20 = Lowest Erosion Rates)
Indian Creek	14 to headwaters	0.63	1	17	20
Dry Creek	19 to headwaters	0.14	12	45	19
Dry Creek	16 to 17	0.13	15	106	17
W. Fork Indian	Confluence to headwaters	0.26	5	108	16
Indian Creek	9 to 10	0.21	8	121	15
Indian Creek	15 to 12	0.11	18	133	14
Indian Creek	11 to 15	0.09	22	164	13

Source: Iowa Department of Natural Resources with data from Coe College students

Figure 4-4. RASCAL Stream Segments and Elevations



Source: Iowa Department of Natural Resources and Iowa Department of Agriculture & Land Stewardship

The RASCAL stream assessment protocol was originally designed to identify threats to water quality, and primarily focuses on sediment-related threats. While it is the best available tool to use for this purpose, it falls short of properly evaluating potential water quality impacts from stormwater runoff and nutrient exports from both agricultural and urban areas. Additional tools, such as direct water monitoring or modeling, could be used in conjunction with this assessment to better understand the water quality and general hydrology of the watershed.

Riparian Width & Cover. The RASCAL also identified stream segments where the riparian area was lacking in width or in vegetation. Of the 35 stream miles assessed, just under half had riparian zones that were greater than 60' wide (42% of the right bank, 44% of the left bank). Another quarter had riparian zones of 30' – 60' wide (25% of the right bank, 27% of the left bank). However, about a third of the stream corridor had an inadequate riparian area of <30' on at least one side (29% of the left bank, and 33% of the right bank). The majority of the riparian area was either grass or trees (93% of the right bank, 95% of the left bank). The maps in the Indian Creek Watershed RASCAL Report 2014 in Appendix 2 illustrate the locations where improvements to the riparian zone could be made to benefit the stream corridor.

Tributary Conditions

Indian Creek. Problems with stream bank erosion and sediment deposition have been cited as an issue of concern by the public. Overall, conditions in the lower part of Indian Creek are the most concerning when compared to the watershed as a whole; four of the five segments of concern identified in Table 4-3 in the Indian Creek subwatershed are below the Dry Creek confluence. Sheet and rill erosion rates are higher in the areas adjacent to the lower reaches of Indian Creek (Segments 7 to 11) due to changes in the overall topography with the transition into the Southern Iowa Drift Plain in the lower parts of the watershed. This is where most of the watershed's Highly Erodible Land can be found, and unchecked gully erosion within the many timbered areas is likely an issue. This problem could increase as residential areas are developed, adding more impervious surfaces to the watershed. A gully assessment would be a good follow-up step for this portion of the watershed, particularly in Segment 8 to 9 to identify opportunities for stabilization. In the agricultural portions of the watershed, there are some concerns with stream bank stability and erosion in the reaches where livestock appear to have access to the stream. However, the segment that stretches between the Dry Creek confluence to just south of the landfill, is one of the better segments in the watershed. Along Indian Creek, total rates of stream bank erosion were estimated at 6,444 tons per year.

Dry Creek. Dry Creek lies entirely within the Iowan Surface landform region unlike Indian Creek and Squaw Creek, in which the lower portions are within the Southern Iowa Drift Plain region. In many ways, the characteristics of Dry Creek would suggest that of all the tributaries (including Indian Creek), this stream may be the most advanced, or hydrologically mature. The in-channel gradients are even and among the lowest in all the tributaries, posing less of a threat to channel degradation. The problem of channel incision does not appear to be a threat on Dry Creek. Therefore, more traditional forms of streambank stabilization should be acceptable. Total rates of streambank erosion in Dry Creek were estimated at 2,386 tons per year.

While the lower reaches of the stream exhibit various degrees of sand, gravel & cobble substrates, the lack of channel grade enables sediment to fall out of suspension. Compounding the problem, even though measures can be taken to reduce the generation of sediment along this tributary, there may not be sufficient stream energy to clean up the sediment that is already along the stream bottom, making in-stream aquatic habitat improvements difficult to achieve.

The lower reaches contain significant coldwater springs which can play a significant role in aquatic habitats. If significant enough, they can add diversity by hosting coldwater species while at the same time acting as a thermal barrier preventing warm water species from migrating further upstream. These types of discussions would be better served by aquatic biologist with the Iowa DNR or area academic specialists.

Squaw Creek. Hydrologically speaking, of all the tributaries of Indian Creek, Squaw may be the one undergoing the most change. Due in part to its younger age, the stream is still trying to cut its way through the landscape to reach a state of equilibrium. Three of the four and five of the top seven most steep channel gradients within the entire Indian Creek watershed can be found within Squaw Creek. Exacerbating this even further, the rapid rate of urban growth in this relatively small watershed means the stream is being asked to handle larger flows more frequently due to the increasing imperviousness of the subwatershed. However, since this stream enters Indian Creek so close to the outlet of Indian Creek into the Cedar River, the problems associated with this subwatershed pose little threat to the majority of the Indian Creek watershed.

Total rates of streambank erosion in Squaw Creek were estimated at 762 tons per year (not including erosion from the three segments of Squaw Creek that were not assessed). Due to the erosive nature of this stream, additional installation of bank stabilization will be recommended in several of the reaches. But it is important to note, that designers only use acceptable bank stabilization designs since this stream appears to be downcutting in several reaches. Using traditional riprap without first stabilizing the grade problems found within the channel may only lead to future failures. In certain highly volatile sites, it may be best to employ a pool & riffle restoration design using low stone weirs or even some form of sheet pile structure to solve the grade issues *prior* to treating the streambanks.

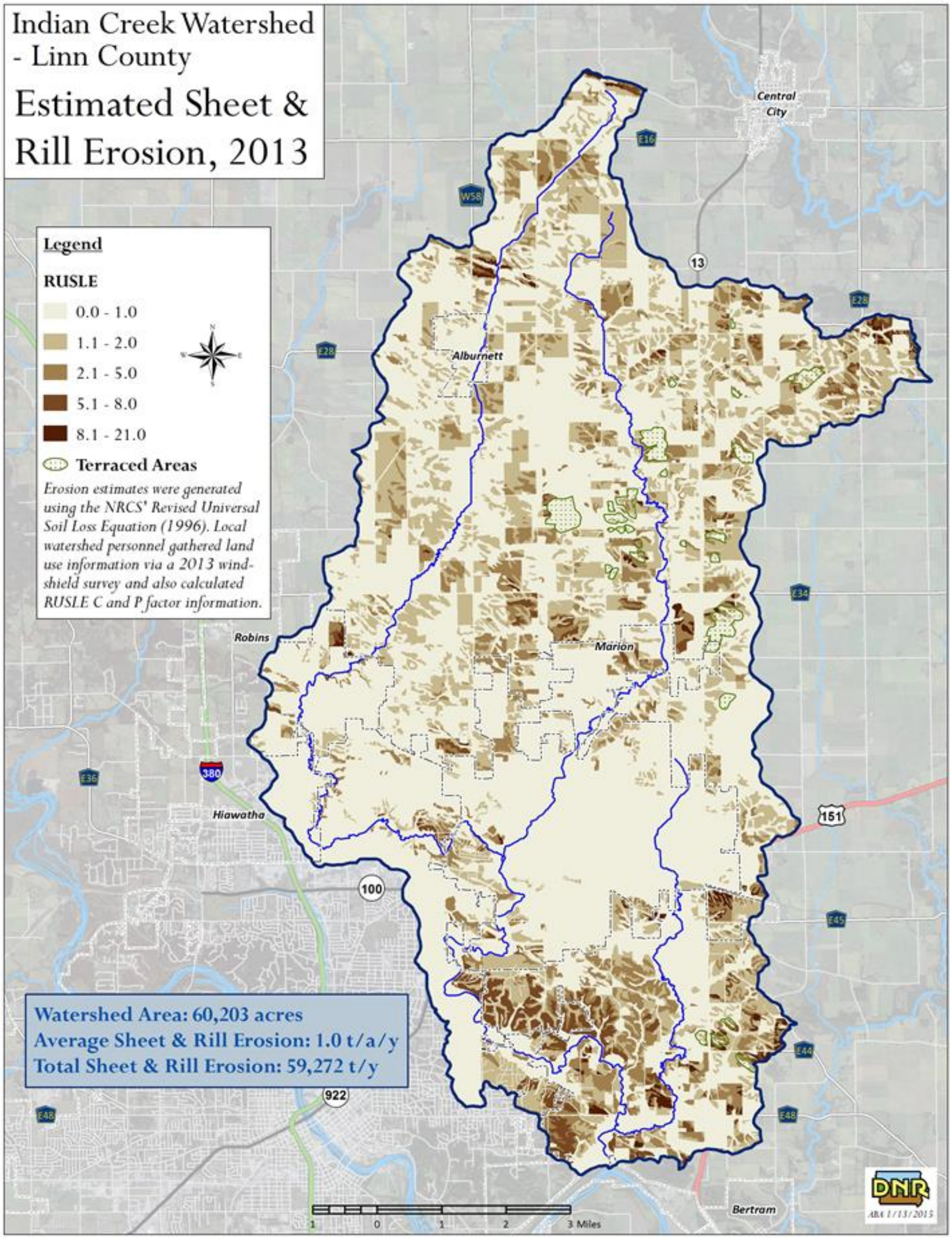
At the time of writing, only the lower half of the stream has been inventoried. Due to the rapid rate of land use changes occurring in this subwatershed, completing the assessment is an important action step.

The loss of wetlands and the conversion of significant acres of haying and grazing within the rural portions of the watershed to row crop production occurred in the 1970s to 1990s. Therefore, most of the negative changes within the rural areas that could increase runoff and sediment transport have most likely already taken place. So, the most likely threat to making the situation worse in the future is the continued expansion of impervious areas within the watershed. That said, there are strategies that can be employed in both urban and rural areas to reduce the quantity and improve the quality of runoff and therefore mitigate the impacts to the stream channel.

Watershed Sources of Sediment

The RASCAL assessment identified a number of stream segments where sedimentation is problematic due to streambank erosion. Another important source of sediment to a stream is sheet and rill erosion from the watershed. Erosion estimates for the Indian Creek watershed were determined using the Natural Resources Conservation Service (NRCS) Revised Universal Soil Loss Equation (RUSLE). This model utilizes data on land cover (such as corn, soybeans, hay, etc.), land management practices (such as cover crops) and tillage practices and estimates the rate of soil loss from the landscape. Average sheet and rill erosion for the entire 60,203 acre watershed is estimated at 1 ton per acre per year, and total sheet and rill erosion is estimated to be 59,272 tons per year. Figure 4-5 shows where sheet and rill erosion rates are higher in the watershed.

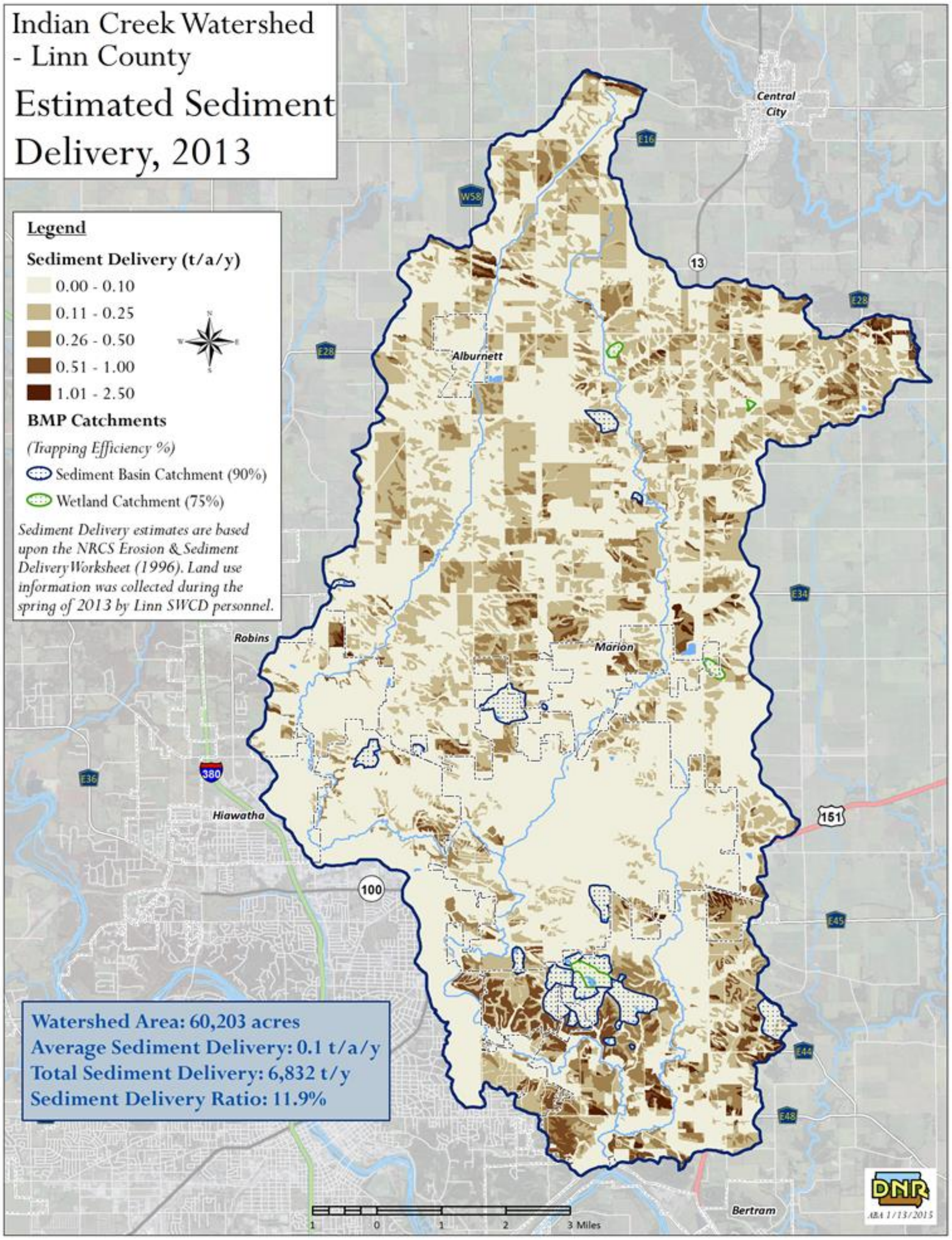
Figure 4-5. Sheet and Rill Erosion Rates



Source: Iowa Department of Natural Resources and Iowa Department of Agriculture & Land Stewardship

Not all of the sediment lost through sheet and rill erosion within the watershed ultimately ends up in the creek. Sediment delivery is influenced by a variety of factors such as watershed size, topography, and land use. At the watershed scale, sediment delivery is estimated to be 0.1 tons per acre per year or 6,832 total tons per year. Areas in the watershed that have a Sediment Delivery rate greater than 0.5 tons per acre per year have been designated as high priority for placement of sediment trapping BMPs.

Figure 4-6. Estimated Sediment Delivery Rates

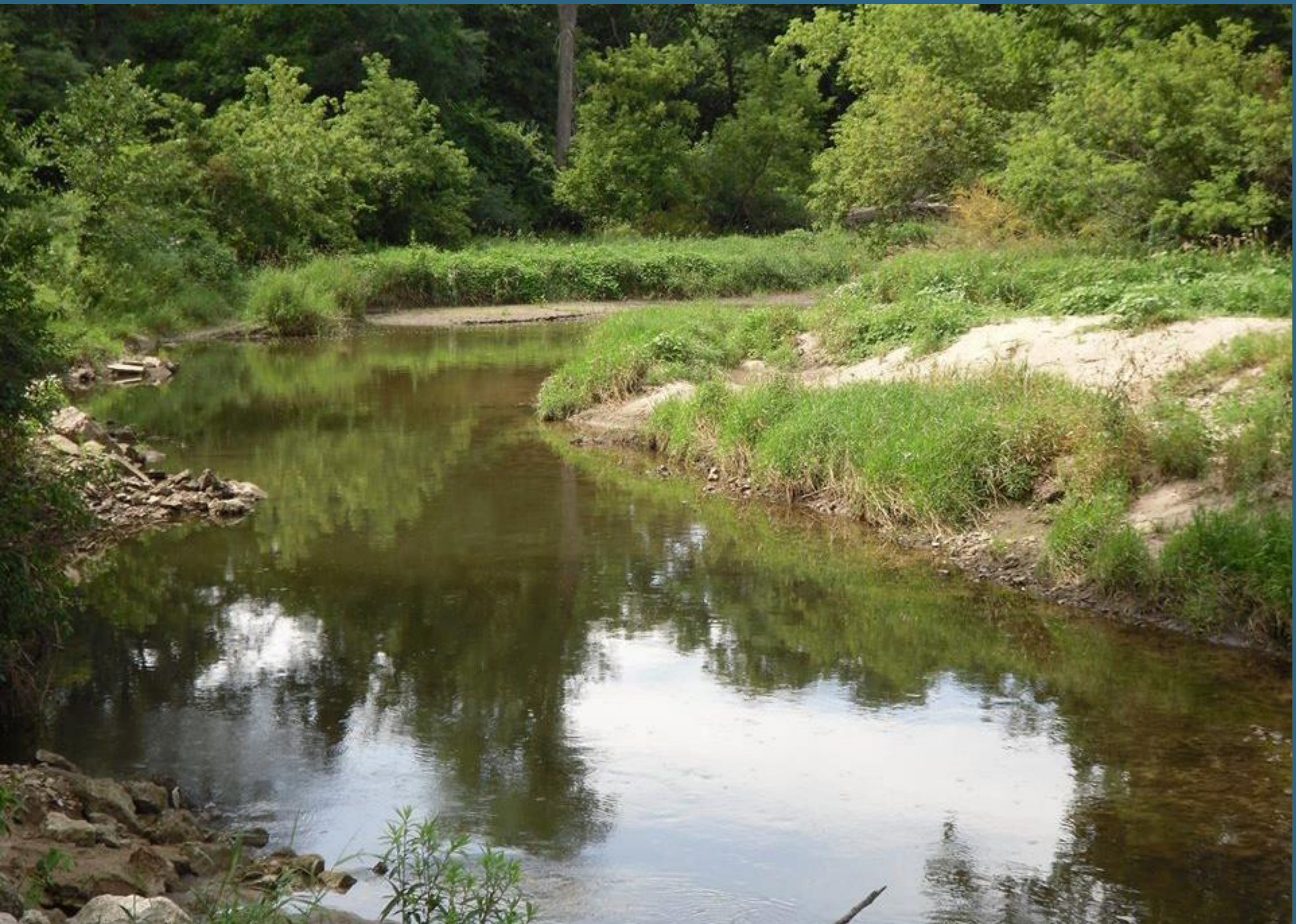


Source: Iowa Department of Natural Resources and Iowa Department of Agriculture & Land Stewardship

Chapter 5 – Hydrology

"When the well is dry, we know the worth of water."

Benjamin Franklin



The hydrology of the Indian Creek watershed has long been described as “flashy” meaning that the water level in the creeks rise and fall rapidly. Local officials have used a reliable, albeit unscientific, method to gage impending flood risk by observing the water level at Linn Mar High School. A visual cue of the water reaching a certain point at the High School on 29th Avenue in Marion means there are 3 hours before Cedar Rapids neighborhoods experience high water.

In general, a watershed’s hydrology is most readily seen in floodplain areas which are areas adjacent to rivers or streams that are likely to experience repeated flooding. Floodplains that are relatively undisturbed provide a wide range of benefits to both human and natural systems. These benefits can be both aesthetic and functional, such as filtering nutrients carried in sediment, providing habitat for wildlife, helping to prevent erosion, and minimizing future flood damage.

Floodplains were once classified as either 100-year or 500-year floodplains depending on how often future flood events are expected to occur. Areas with an annual 1 percent chance of experiencing flooding were referred to as 100-year floodplains or zones. Areas with an annual 0.2 percent chance of flooding were called 500-year floodplains or zones. Because of common misunderstandings from the use of these terms, these zones are now classified as 1 percent and 0.2 percent flood hazard areas, respectively.

In an effort to better understand the hydrology of the watershed, a study was commissioned to add to the existing modeling work done by the US Army Corps of Engineers – Rock Island District.

5.1 Hydrology Study

The US Army Corps of Engineers – Rock Island District (USACE) created planning-level hydrologic and hydraulic watershed models at the request of the Indian Creek Watershed Management Authority and the cities of Cedar Rapids and Marion. The USACE report titled Indian Creek Watershed Cedar Rapids, Iowa, Watershed Modeling and Mapping Report, dated May 2014 is included in Appendix 2. Various basin conditions were examined throughout the analysis including:

- Existing—Present day land use conditions
- Past—Land use as depicted by historical aerial photography; less development
- Future—Land use as projected by the 2013 Linn County Comprehensive Plan; more development

The first phase of the modeling was to create a HEC-HMS model (Hydrological Engineering Center-Hydrologic Modeling System) for the Indian Creek watershed, including its main tributaries: Dry Creek and Squaw Creek. This model was used to convert hydrologic inputs (precipitation data, land type and use, slope, storage, etc.) into flow frequency discharges for several points of interest throughout the watershed.

The HEC-HMS data was then entered into the HEC-RAS (Hydrological Engineering Center-River Analysis System) model for the second phase of the study. The HEC-RAS model analyzes properties such as channel width, slope, and velocity along with bridges, obstructions, etc. to translate the peak streamflows into water surface elevations. These elevations were then paired with area topography in the final phase to create updated floodplain extents.

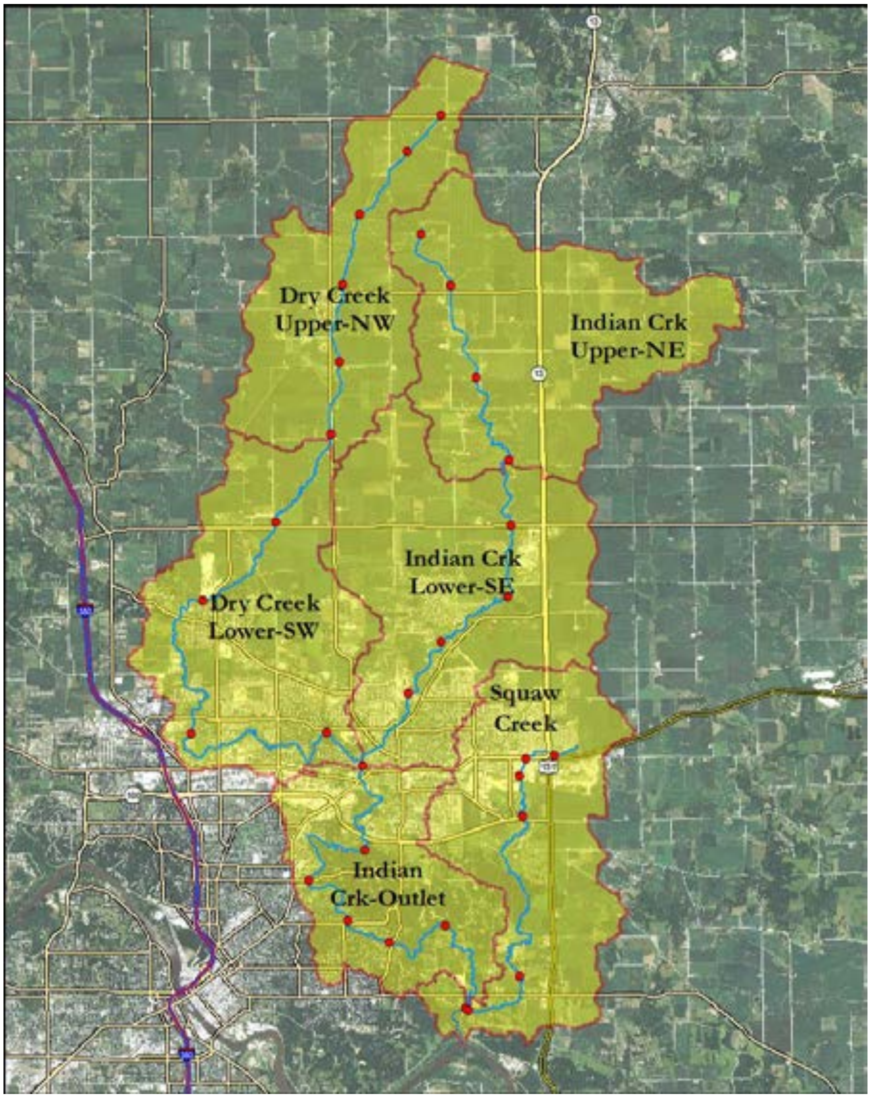
For the study, the watershed was divided into 6 sub-basins according to the hydraulic features of the area as displayed in Figure 5-1. Table 5-1 shows the area, stream length and number of bridges within each sub-basin. Flow frequency discharges with exceedance probabilities of 0.20, 0.10, 0.04, 0.02, 0.01, and 0.002 (5-year to 500-year events) were determined at various points throughout each sub-basin.

Table 5-1. Indian Creek Sub-Basin Data

Sub-basin	Area (mi²)	Stream Length	Number of Bridges
DRY CREEK UPPER-NW	14.05	21.87 miles (115,460 feet)	35
DRY CREEK LOWER-SW	16.60		
INDIAN CREEK LOWER-SE	18.44	25.89 miles (136,690 feet)	42
INDIAN CREEK UPPER-NE	17.62		
INDIAN CREEK OUTLET	10.86		
SQUAW CREEK	15.15	9.17 miles (48,399 feet)	11
Watershed Total	92.73	56.93 mi	88

Source: US Army Corps of Engineers – Rock Island District, May 2014 Report

Figure 5-1. Indian Creek Watershed Sub-Basins



Source: US Army Corps of Engineers – Rock Island District, May 2014 Report

Flow frequency locations are illustrated by the red points in Figure 5-1. Locations with the smallest contributing areas within each sub-basin are the furthest north, with the contributing areas increasing down the streams.

Several additional analyses were conducted in order to better understand how climate change and land use alterations affect hydrology in the watershed.

5.2 Hydrology & Land Use Analysis

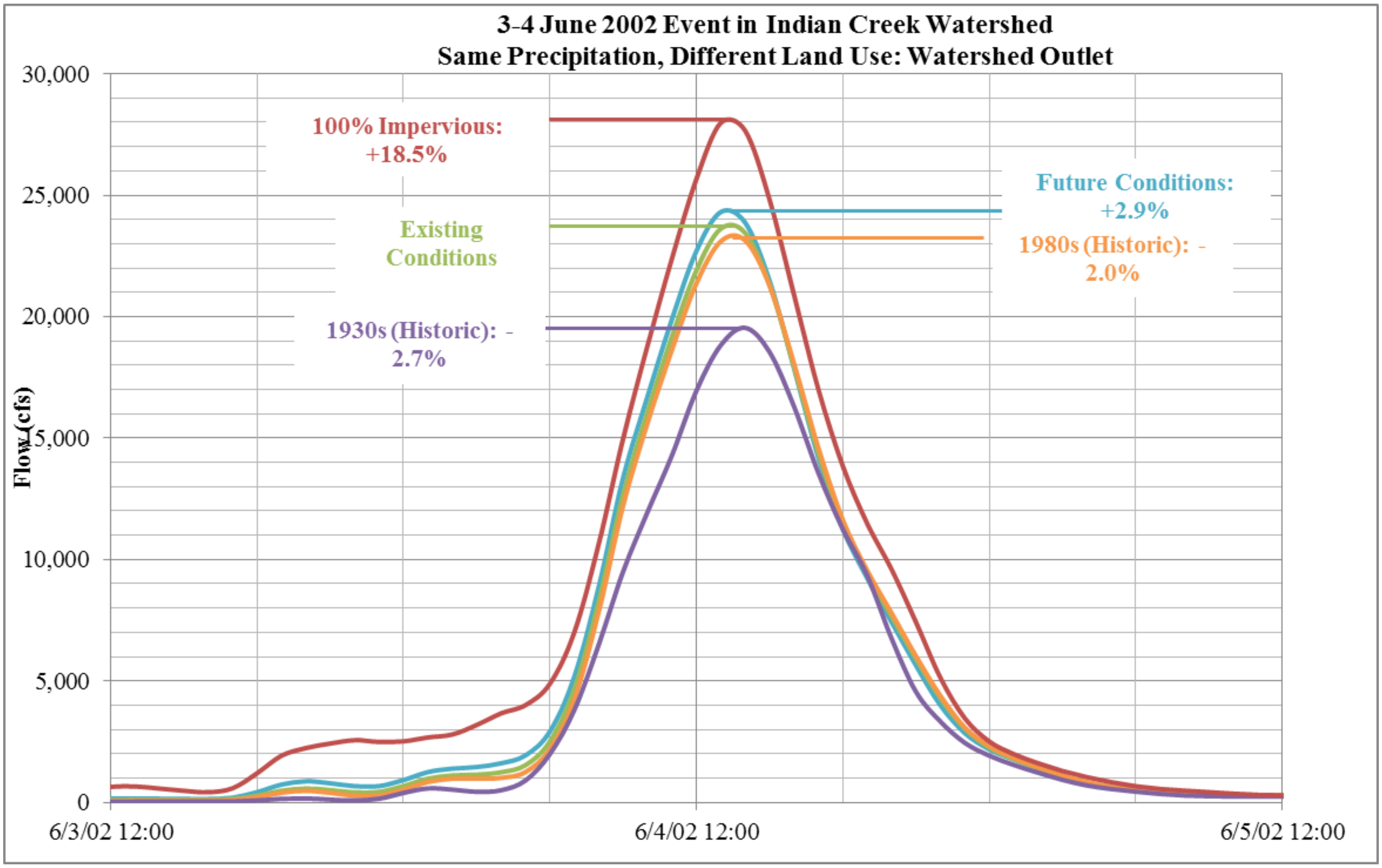
The effect of urbanization on watershed hydrology was modeled using aerial photos from the 1930s, 1980s, and 2011 (existing) to delineate areas of urbanization as seen in Figure 2-4 in Chapter 2. Future urbanized areas were determined from the 2013 Linn County Comprehensive Plan that depicts areas of expected future urbanization as seen in Figure 2-5 in Chapter 2. Hydrologic models were used to compare the effects of urbanization and land use for three historic storm events: 3-4 June 2002 (High Flow), 26-28 August 2009 (High Flow), and 24-26 May 2011 (Low Flow). The additional result of a "100% Impervious" Indian Creek watershed was also added for comparison (this condition could be seen when soils are frozen or completely saturated).

The model results indicate that urbanization dramatically influences the hydrology of the watershed. These effects are particularly evident during less intense rainfall events. During an intense rainfall event, the presence of permeable areas becomes less critical as rain falls so quickly there is not time for significant infiltration. In this situation, whether it is falling on a pasture or a parking lot, the majority of the rain will directly become runoff. During a less intense rainfall, however, there is more time for infiltration into permeable areas and the quantity of such areas becomes more critical in lower peak flows.

In smaller storms, peak flows have increased by an estimated 43% due to the urbanization that has occurred since the 1930s (Figure 2-4 & Figure 5-4). Low flow event peaks may increase by around 68.2% with future urbanization plans. In contrast, high flow event peaks in larger storms have increased around 2.7% with the urbanization that has occurred since the 1930s (Figure 2-4 & Figures 5-2 and 5-3). High flow peaks may increase by around 4% with future urbanization plans.

In a natural setting, less than 1% of the rainwater produced in a smaller storm runs off to a waterway; the rest is taken up by plants or soaks directly into the ground. However, in an urbanized landscape, up to 50% - 80% of the rainwater is quickly conveyed over impervious surfaces and through the stormwater infrastructure directly to the creek. In large storms, more runoff is produced even in natural settings once the soils become saturated and unable to absorb more stormwater. This explains why the hydrologic variation in urban vs. natural landscapes is more pronounced in a smaller storm.

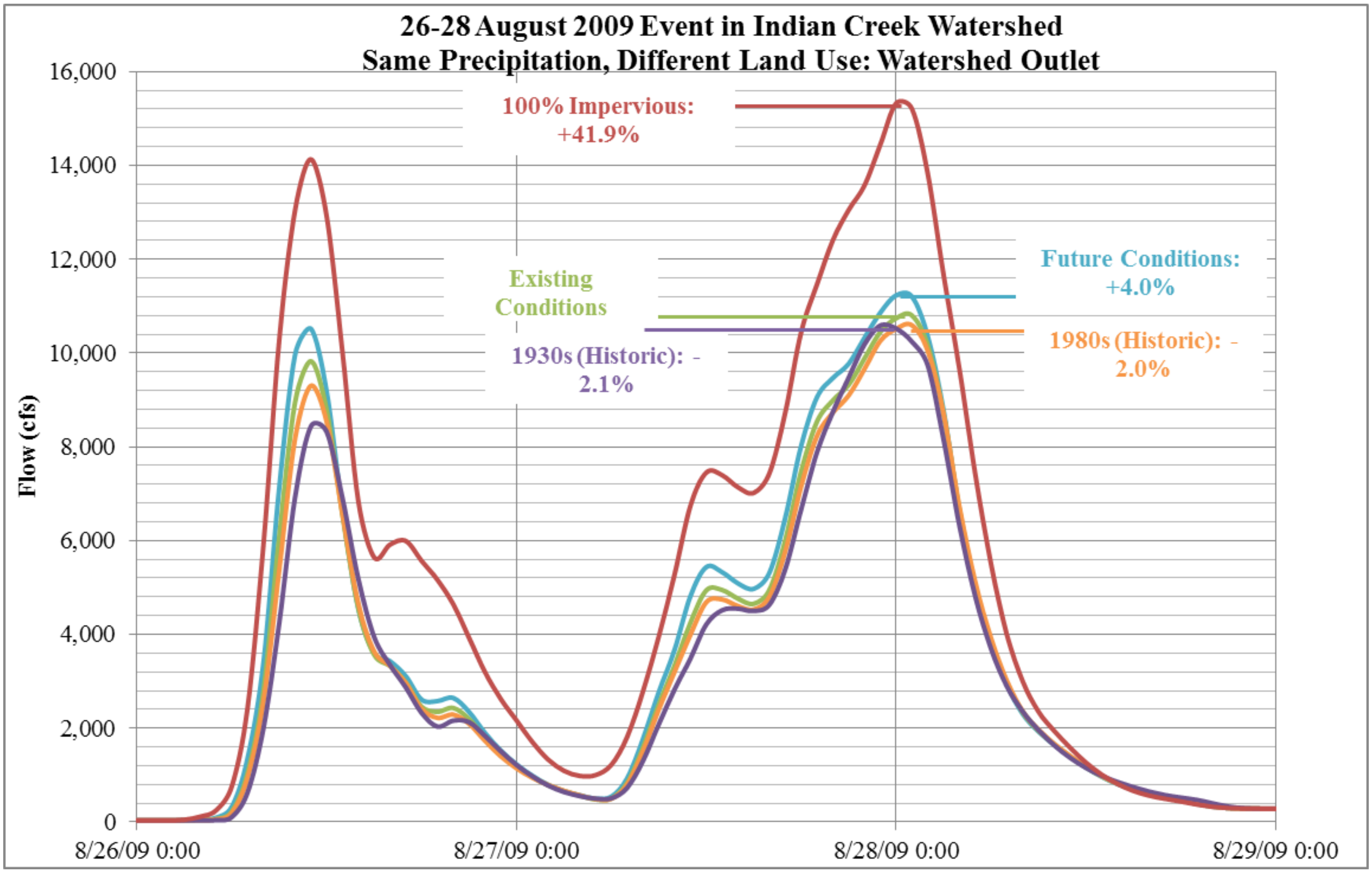
Figure 5-2. Land Use Results: June 2002 (High Flow)



Source: US Army Corps of Engineers – Rock Island District

Land use changes (from increasing urbanization of the basin) may marginally increase peak streamflows during high flow, out of bank events by around 2-4%. The above illustration shows how past, existing, potential future and 100% impervious conditions affect streamflow peaks during the June 2002 rainfall event where the basin received an average of 5.2 inches of rain.

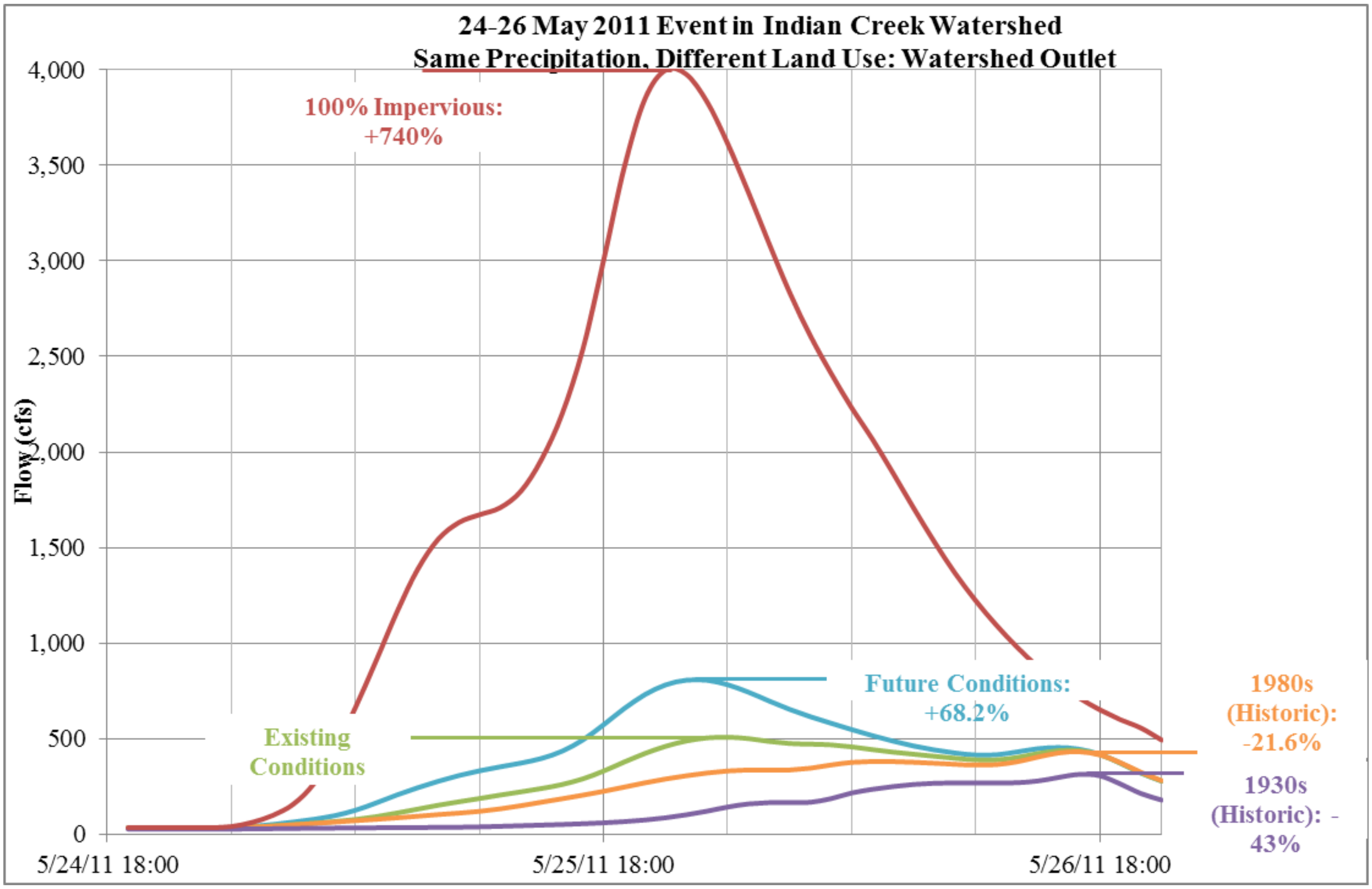
Figure 5-3. Land Use Results: August 2009 (High Flow)



Source: US Army Corps of Engineers – Rock Island District

Land use changes (from increasing urbanization of the basin) may marginally increase peak streamflows during high flow, out of bank events by around 2-4%. The above illustration shows how past, existing, potential future and 100% impervious conditions affect streamflow peaks during the August 2009 rainfall event where the basin received an average of 6.0 inches of rain.

Figure 5-4. Land Use Results: May 2011 (Low Flow)



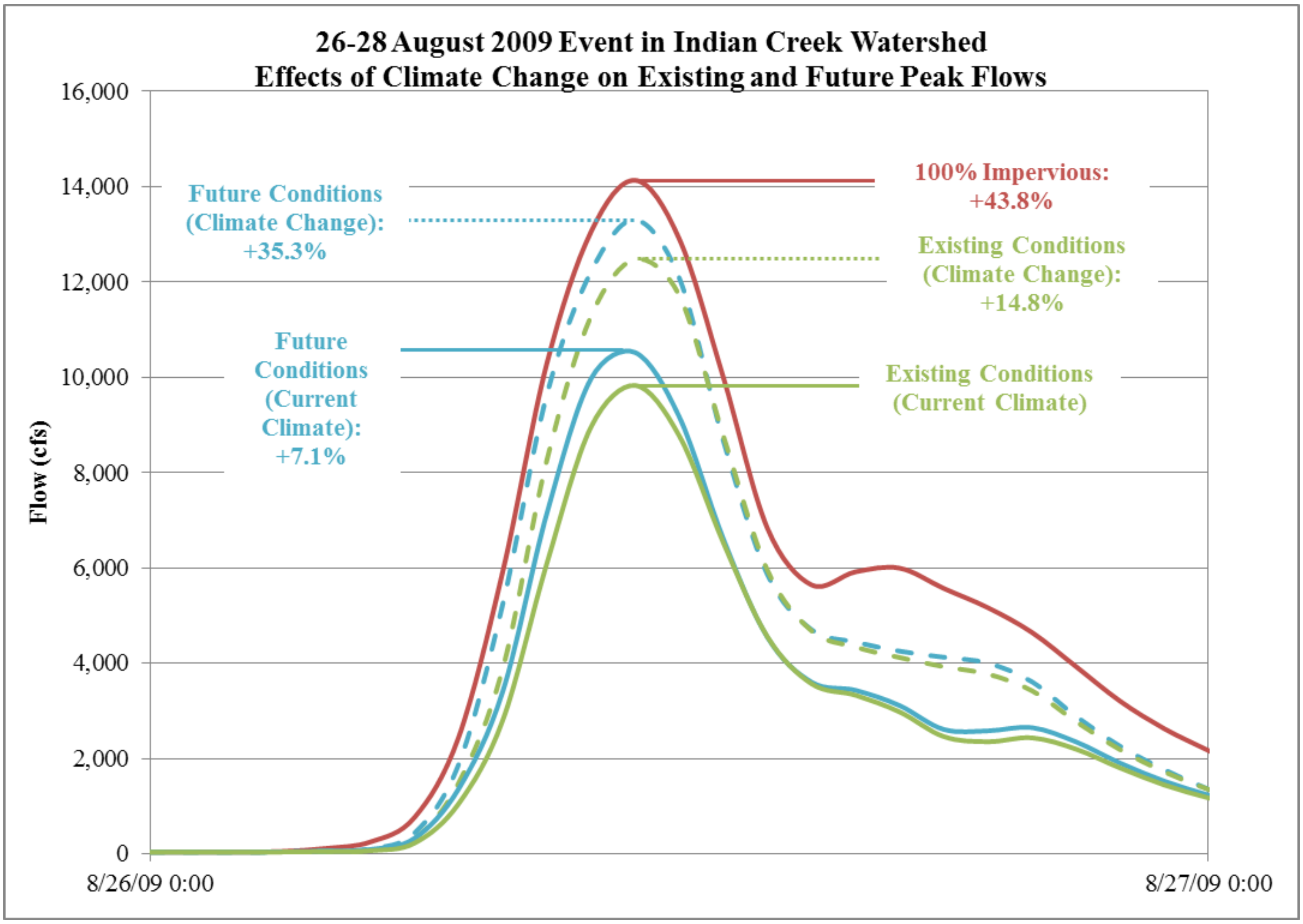
Source: US Army Corps of Engineers – Rock Island District

Land use changes (from increasing urbanization of the basin) may dramatically increase peak streamflows during low flow, within-bank events by around 21-68%. The above illustration shows how past, existing, potential future and 100% impervious conditions affect streamflow peaks during the May 2011 rainfall event where the basin received an average of 1.5 inches of rain.

5.3 Hydrology & Climate Change Analysis

To better understand how climate change may affect the Indian Creek watershed, USACE conducted an analysis of the August 2009 storm event using a regional climate model. This model provided a picture of how a similar storm would affect the watershed under different climate conditions. The local climate model predicted that precipitation would increase in the future, raising existing peak flows by 14.8% for this event. When future development is factored in to the model, it is estimated that the effects of climate change could raise existing peak flows by 35.3%.

Figure 5-5. Effects of Climate Change on High Flow Event Peaks



Source: US Army Corps of Engineers – Rock Island District

Model results indicate even greater increases in peak flows when comparing existing conditions with existing precipitation to existing and future land uses with increased precipitation levels due to climate change.

5.4 Management Implications

The US Army Corps of Engineers – Rock Island District study has illustrated that land use and climate, both considered separately and together, can significantly affect peak flows throughout the Indian Creek watershed. Peak flows will increase as urbanization increases with greater increases during more frequent, lower flood events than during less frequent, high flooding, intense rainfall events. From a watershed management standpoint, these findings suggest that practices in urban areas to infiltrate stormwater from the majority of rainfall events, which tend to be small, could help to substantially mitigate the effects of urbanization in the watershed. Encouraging new development and re-development to infiltrate up to 1.25” of rainfall would address roughly 90% of the rainfall events.

The climate change analysis indicated that changes in weather patterns are likely to increase peak flows throughout the basin as well. This increase in peak flows will likely translate to additional flood risk for structures located within or adjacent to the existing floodplain. Plans for future development within the floodplain should take this information into consideration.

Many factors that contribute to higher peak flows are uncontrollable, such as temperature, precipitation, soil type, and channel slope. However, there are still several factors such as land use practices, stormwater management, bridge locations and sizes, and zoning requirements that the ICWMA members and the community have influence on. The USACE report concludes that citizens have control over what is in the floodplain and possess the ability to be good stewards of the watershed. Implementing land use best management practices, providing proper stormwater drainage throughout the urban area, and zoning responsibly are only a few alternatives that aid in enhanced watershed drainage and contribute to lowering peak flows and reducing flood damage.

The complete USACE report includes a detailed discussion of the formulation, testing and modification of the Indian Creek watershed flooding model as well as the impact of climate change and land use. The report is included in its entirety in Appendix 2.

Chapter 6 – Social Assessment

"The environment is where we all meet; where all have a mutual interest; it is one thing all of us share."

Lady Bird Johnson

Completing a social assessment of the Indian Creek watershed inhabitants was one of the priorities of the planning process. When the planning process started, there had already been stakeholder engagement through the Iowa-Cedar Watershed Interagency Coordination Team visioning pilot process. The Iowa-Cedar Watershed Interagency Coordination Team is a group of state and federal agencies, non-profits, and universities in Iowa whose primary goal is to develop a comprehensive basin management plan for the Iowa-Cedar River basin. The Interagency Team developed the visioning pilot to focus on public engagement work at a smaller scale to ensure local concerns are integrated into management priorities at the basin scale.

The Indian Creek pilot involved a series of five workshops in 2012 resulting in the identification of high-priority resource concerns and actions for improving the watershed. Workshop participation was strong, averaging 25 – 30 local residents, public officials/staff, non-profit organizations, and academic institution staff interested in moving toward watershed improvement projects.

The ICWMA used the Interagency Visioning Workshops Report 2012 results as a starting point to complete a social assessment of the 63,569 residents in the watershed. Surveys were used to measure a variety of factors of key groups including:

- watershed awareness levels in urban and agricultural areas
- attitudes about the watershed in urban and agricultural areas
- personal sources of information
- interests for the watershed

The key groups were defined as rural landowners/farmers; urban/suburban residents; business owners; and recreation interests.

6.1 Survey Methods

Online Survey

The ICWMA selected Vernon Research Group (Vernon), a local research and marketing firm, to design and program an on-line survey capable of characterizing participants as an urban/suburban resident, a rural landowner/agricultural producer, or a business owner located in the Indian Creek watershed. The survey design allowed for common questions to be asked of all groups and specific questions tailored to each group. The survey went live in late April 2014. The final version of the survey is included in Appendix 2.

A variety of methods were used to promote the on-line survey to the three target audiences (urban, rural, businesses) including e-mail invitations, mailed postcards, city websites, and local newsletters. A detailed list of these efforts is included in Appendix 2. In general, the marketing materials encouraged people to visit the Linn Soil & Water Conservation District (SWCD) website that posted a prominent link to the survey.

Over 1,000 people attempted to complete the on-line survey which yielded 287 urban/suburban resident surveys; 12 business owner surveys; and 50 rural landowner/agricultural producer surveys from within the watershed. Initially, there was such a low response to the on-line survey from farmers that Vernon Research employed a variety of additional marketing methods to encourage participation. A summary of those efforts are also included in Appendix 2. The number of business owner responses was too small to analyze individually. Instead, they were grouped with the resident responses for a sample size of 299 residents.

In the end, there was a good mix of survey participants by age, gender, education, household income, employment status and children in the home. In the farmer sample: 57% own and manage their operation; 13% rent land from owner and manage the operation; and 30% rent land out to a tenant. In the resident sample: 93% own their home; 4% rent; and 3% live with family/friend.

Creek User Survey

The ICWMA partnered with the Anthropology Department at Coe College to measure the views and interests of those interacting with the creeks in the watershed. Coe College students completed 99 interview style surveys of individuals engaging in recreational activities at several locations near the creeks. Surveys were gathered in the fall of 2013, winter of 2014 and spring of 2014. The full creek user survey can be found in Appendix 2.

6.2 Survey Findings

All of the survey findings can be found in the Indian Creek Watershed Survey Quantitative Findings Report September 2014 from Vernon Research Group in Appendix 2. Highlights of the findings are summarized in this section.

Creek User Findings

A third of respondents visited local creeks during just one season and 22% visited local creeks year-round. Most people in the group used the creeks for multiple activities and 37% have used it for 5 or more activities. Nature enjoyment and running/jogging/walking were the most frequent activities at the creeks. Fishing/hunting, swimming/wading and kayaking/canoeing were all infrequent activities at the creeks.

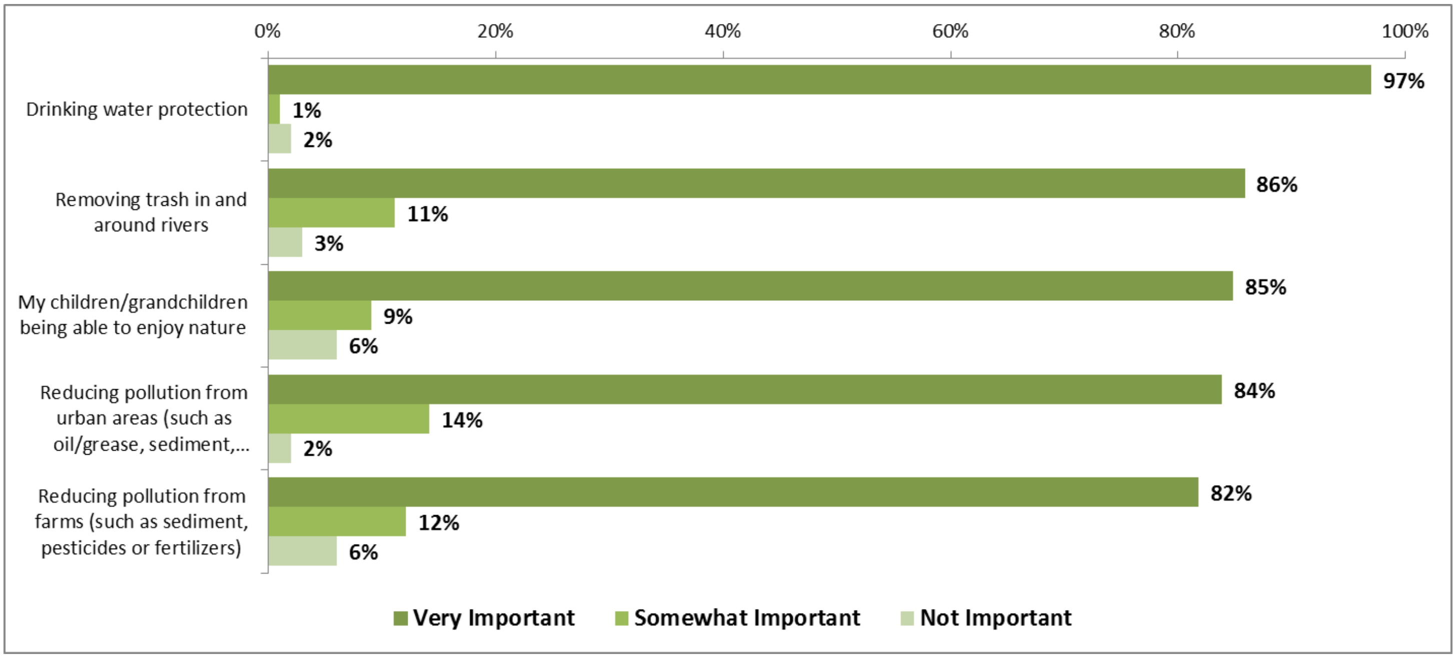
Figure 6-1. Activities Creek Users Engage in and How Often

	Frequently	Sometimes	Rarely	Never
Nature enjoyment	40%	29%	8%	22%
Running/jogging/ walking	38%	33%	12%	16%
Playgrounds/ picnics	28%	23%	7%	41%
Biking	24%	17%	15%	43%
Fishing/hunting	16%	7%	10%	67%
Swimming/wading	11%	8%	16%	65%
Kayaking/canoeing	9%	4%	8%	79%

Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

These five issues were rated the most important by respondents. Drinking water protection was unmistakably the most important issue to the overall group. Having nature areas that are free of pollution and trash were also highly important to the group.

Figure 6-2. Most Important Issues to Creek Users



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

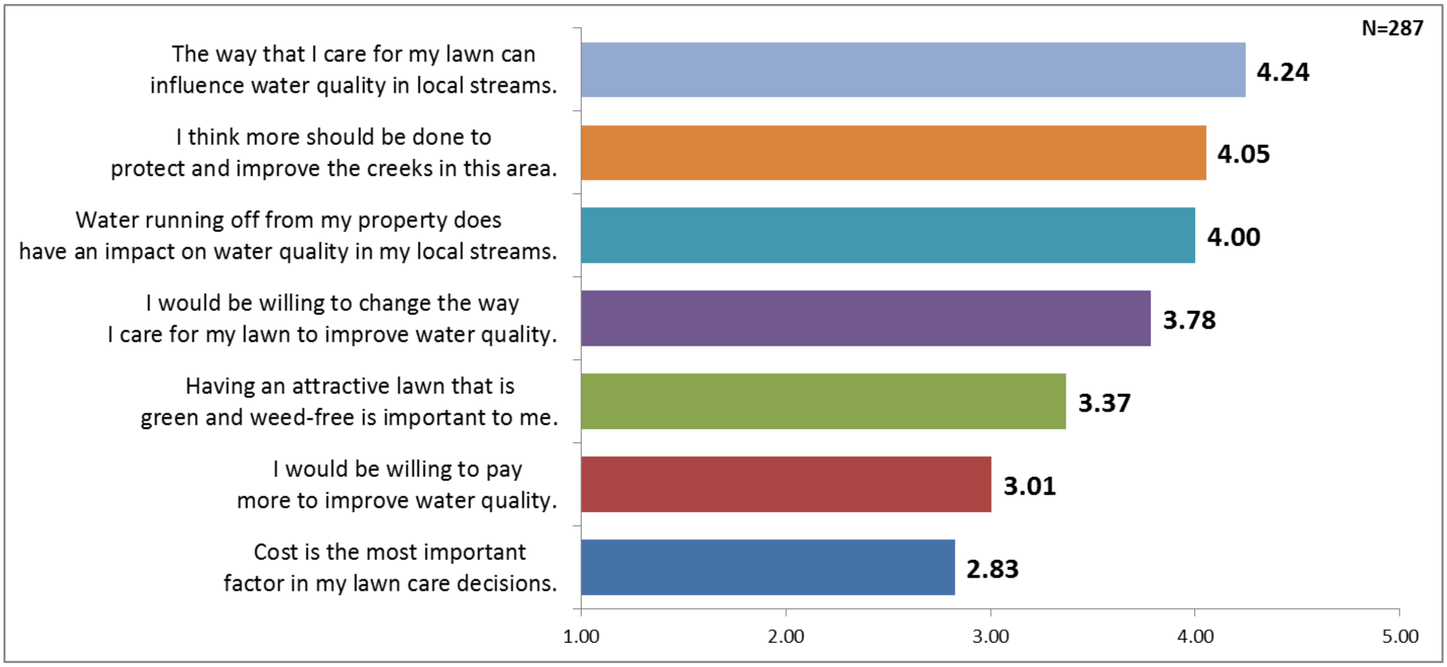
Resident Findings

Some general findings from the Resident respondents include:

- A majority of Residents indicated that they do know where rainwater goes when it runs off their properties. The two most common responses for where rainwater goes were Indian Creek and storm sewer/gutter
- Roughly half of Residents evaluated water quality positively for activities that do not require touching the water and negatively for activities that do require touching the water
- Residents scored stormwater runoff from hard surfaces, such as parking lots, streets and roofs as the most severe watershed issue. Waste material from pets was viewed as the least problematic
- Fully half of all Residents did not know about the issue of improperly maintained septic systems
- Flooding was the only ongoing problem that scored within the moderate-to-severe problem range

Residents recognized the relationship between their lawn care practices and the health of local creeks. Residents want to protect creeks and are willing to be part of that effort as seen in Figure 6-3.

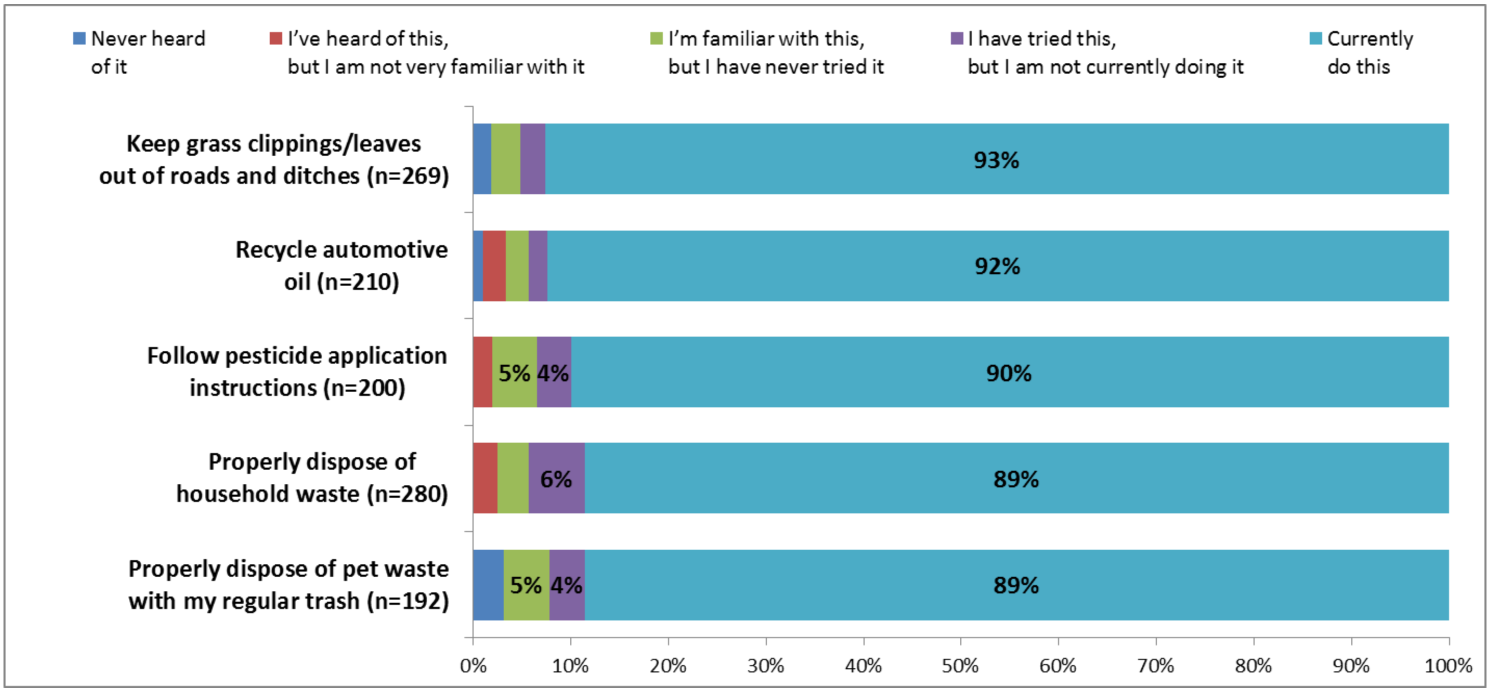
Figure 6-3. Most Agreed with Statements by Residents



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Large majorities of Residents currently practice helpful behaviors such as properly managing wastes and caring for their lawns as shown in Figure 6-4. Using rain barrels and having a rain garden are practices Residents were familiar with, but had never tried.

Figure 6-4. Awareness Levels and Participation in Helpful Watershed Practices by Residents



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Farmer Findings

Some general findings from the Farmer respondents include:

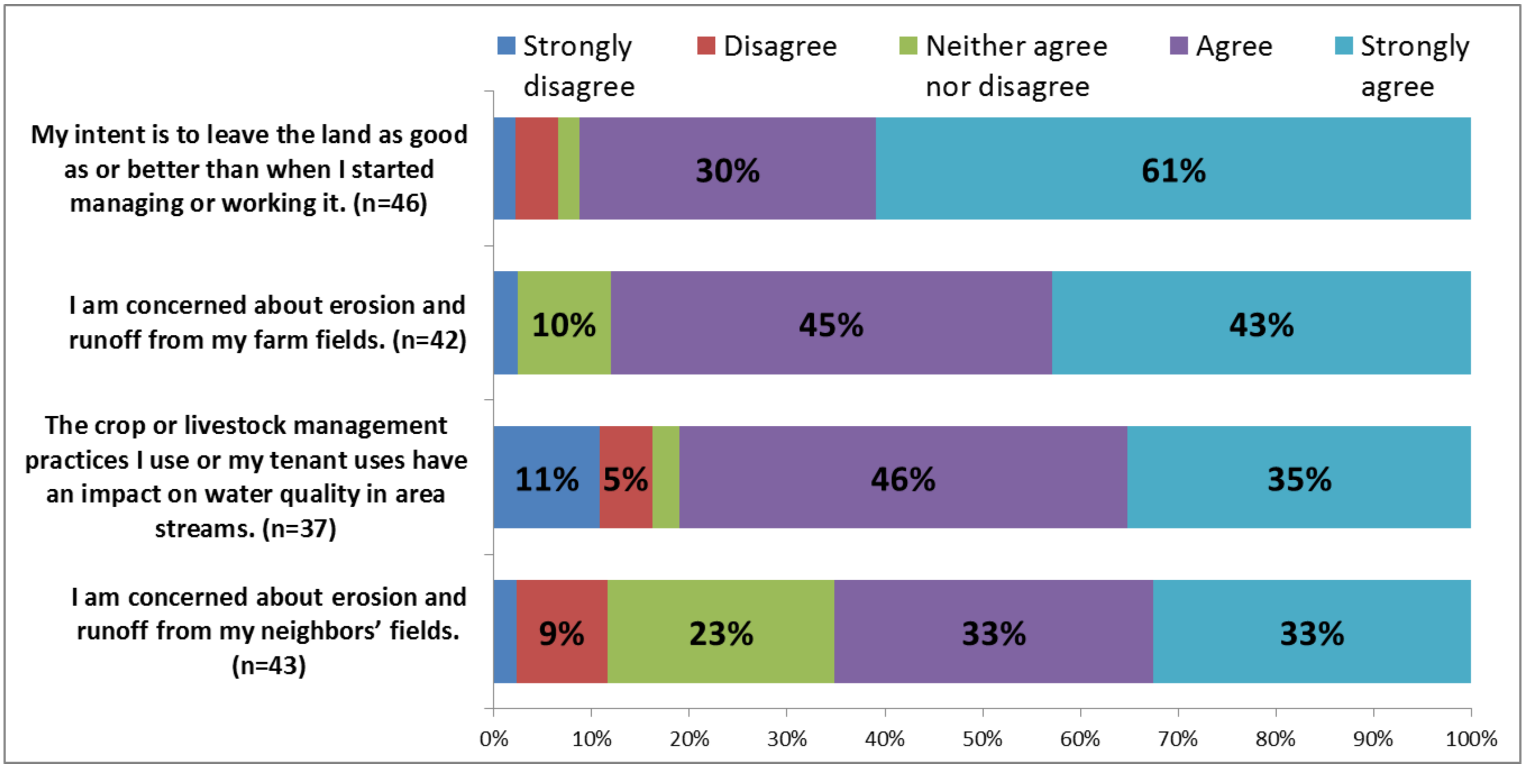
- Farmers evaluated water quality more positively for activities that do not require touching the water
- Farmers scored most contributing watershed issues as slight-to-moderate problems
    - the most severe problem was stormwater runoff from hard surfaces, such as streets and roofs
    - the least severe problem was waste material from pets
- Flooding was the only creek condition that scored within the slight-to-moderate problem range

Farmers prefer either web-based (email, specific website) or print (direct mail, print publications) formats to access information about soil and water resources. Linn Soil and Water Conservation District and County ISU Extension Office were the most highly-trusted sources of information about the quality of water resources.

- Non-profit groups and local media were the least-trusted sources of information about the quality of water resources
- 14% registered unfamiliarity with the Iowa Department of Agriculture and Land Stewardship

Farmers agreed most with the statement: "My intent is to leave the land as good as or better than when I started managing or working it." Farmers agreed least with the statement: "Management practices that improve water quality are too costly for my operation." Farmers wanted to leave the land healthy, recognized that their practices have an impact and voiced concern as shown in Figure 6-5.

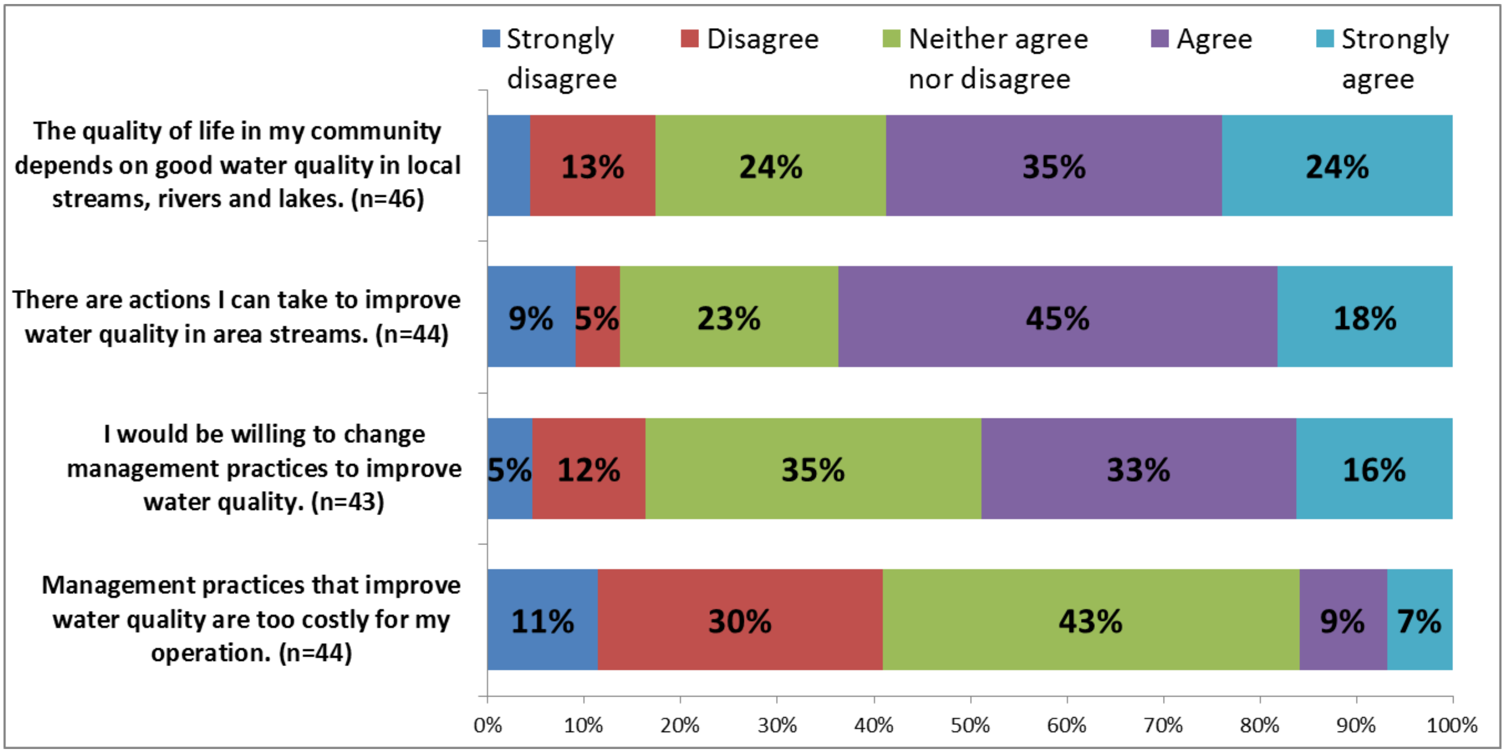
Figure 6-5. Most Agreed with Statements by Farmers



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

The majority of Farmers reported that they believe they can make a difference, are willing to change and do not think improvements are too costly as seen in Figure 6-6.

Figure 6-6. Least Agreed with Statements by Farmers



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Farmers reported using many traditional and new practices that directly or indirectly contribute to the protection of water quality.

- A substantial majority of respondent Farmers reported performing helpful practices listed in Figure 6-7
- More than half of the Farmers in the sample said they use practices listed in Figure 6-8 as well
- The practices listed in Figure 6-9 have NOT been adopted by Farmers yet, although cover crops is nearing a third
- The helpful practice with the lowest Farmer usage was living mulch (such as Kura clover)
- No Farmers have tried saturated buffers and only two have used bioreactors
- Some Farm Owners reported requiring (or encouraging) their tenant to use some of these helpful practices. For instance, a majority of Farm Owners required/encouraged the use of grassed waterways

Figure 6-7. Significant Levels of Participation in Helpful Watershed Practices by Farmers

PRACTICE	I currently do this
Rotate crops (n=31)	90%
Grassed waterway (n=30)	90%
Follow university recommendations for fertilization rates (n=29)	90%
Consider location and soil characteristics to minimize leaching or runoff (n=28)	89%
Maintain the calibration of fertilizer application equipment (n=22)	86%
Use variable rate application technology (n=28)	86%
Conduct regular soil tests for pH, phosphorus, nitrogen and potassium (n=29)	83%
Use nitrification inhibitor (n=26)	81%

Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Figure 6-8. Majority Levels of Participation in Helpful Watershed Practices by Farmers

PRACTICE	I currently do this
No-till (n=31)	74%
Buffers (n=26)	73%
Adjust crops or fertilization in high-risk areas of a field (e.g., sink holes, shallow soils over fractured bedrock) (n=18)	72%
Follow a comprehensive nutrient management plan (n=30)	70%
Use anti-backflow devices on hoses used for filling sprayer misters (n=20)	70%
Drainage management (n=30)	70%
Terraces (n=20)	70%
Avoid fall application of manure or nitrogen fertilizer (n=26)	69%
Stream bank stabilization (n=23)	57%
Timber stand improvements (n=17)	53%
Contour farming (n=21)	52%

Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

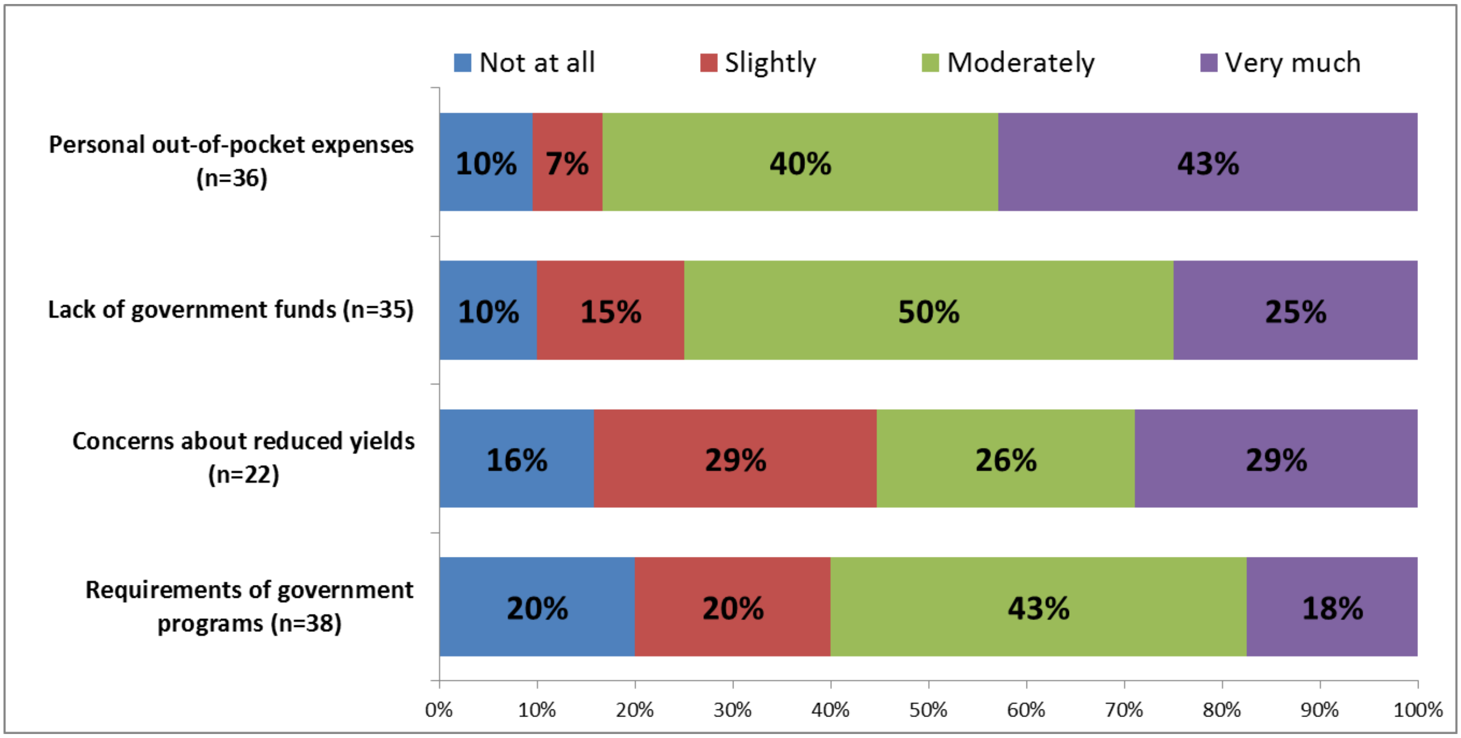
Figure 6-9. Practices Not Adopted by Farmers Yet

PRACTICE	I currently do this
Use cover crops (n=30)	30%
Long-term no-till (n=27)	26%
Herbaceous wind barriers (n=24)	21%
Cross-wind ridges, strip-cropping or trap strips (n=23)	17%
Bioreactors (n=26)	4%
Strip-till (n=27)	4%
Saturated buffers (n=27)	0%

Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Although most Farmers did not agree that improvements are too costly for their operation, cost *is* the highest-rated barrier, followed by lack of government funds. The *top* four barriers are shown in Figure 6-10. Farmers reported that personal, out-of-pocket expenses were the greatest barrier to changing management practices. Approval of neighbors was the lowest-rated barrier to changing management practices.

Figure 6-10. Barriers to Changing Management Practices



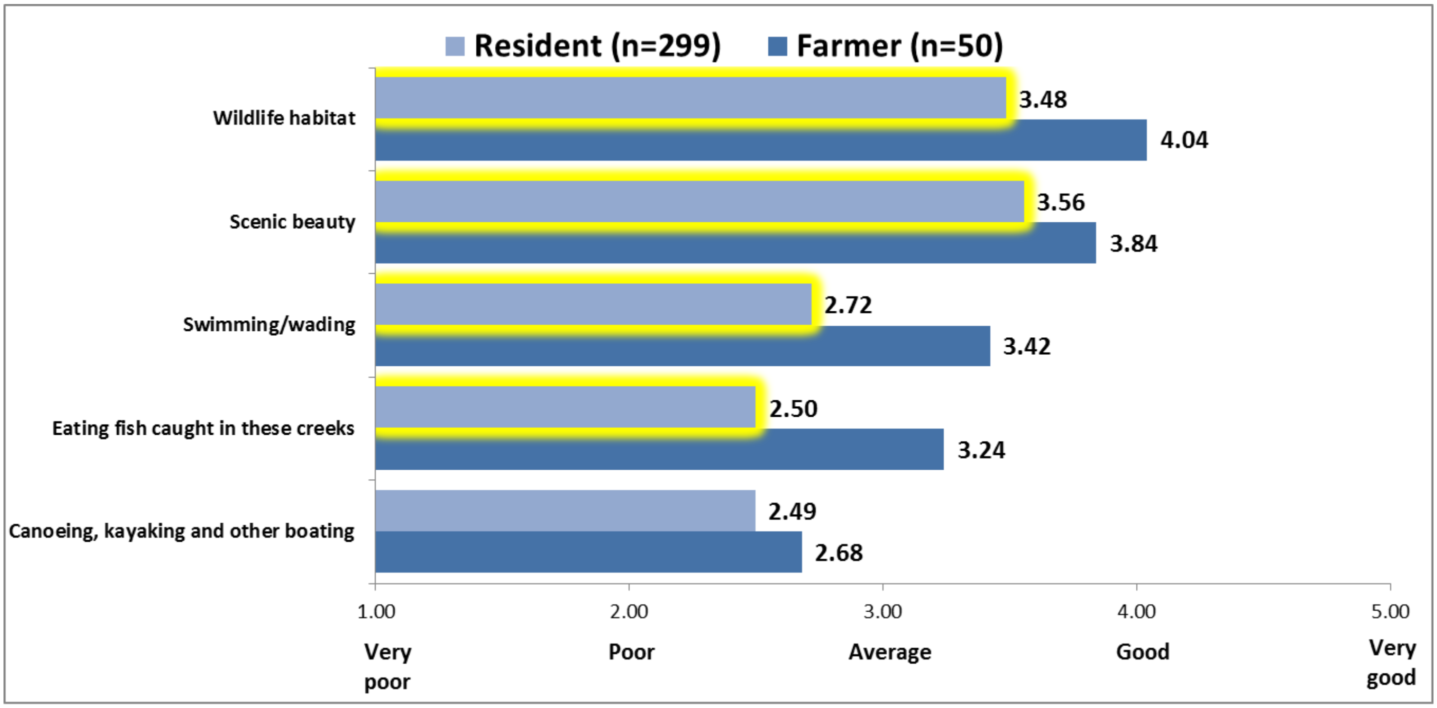
Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Comparison of Findings from Residents and Farmers

Vernon compared the data of the Resident respondents and the Farmer respondents to find commonalities and differences. In terms of understanding the respondents, a significantly greater percentage of Farmers lived on property that touches a creek or wetland than did Residents. Also, a significantly greater percentage of Residents answered that their property has ***not*** been affected by flooding from Indian, Squaw and/or Dry Creeks than did Farmers.

Overall, Residents scored most of the issues contributing to problems in local streams as more problematic than Farmers did. Farmers also evaluated water quality significantly more positive than Residents did for all activities except canoeing, kayaking and other boating as shown in Figure 6-11.

Figure 6-11. Comparing Evaluations of Water Quality for Certain Activities



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

The survey asked respondents to rate a list of specific issues that contribute to water quality as more or less problematic. Residents and Farmers viewed mostly urban issues as the top contributors to water quality problems as shown in Figure 6-12. Residents scored nearly all of the contributing issues significantly more problematic than Farmers did.

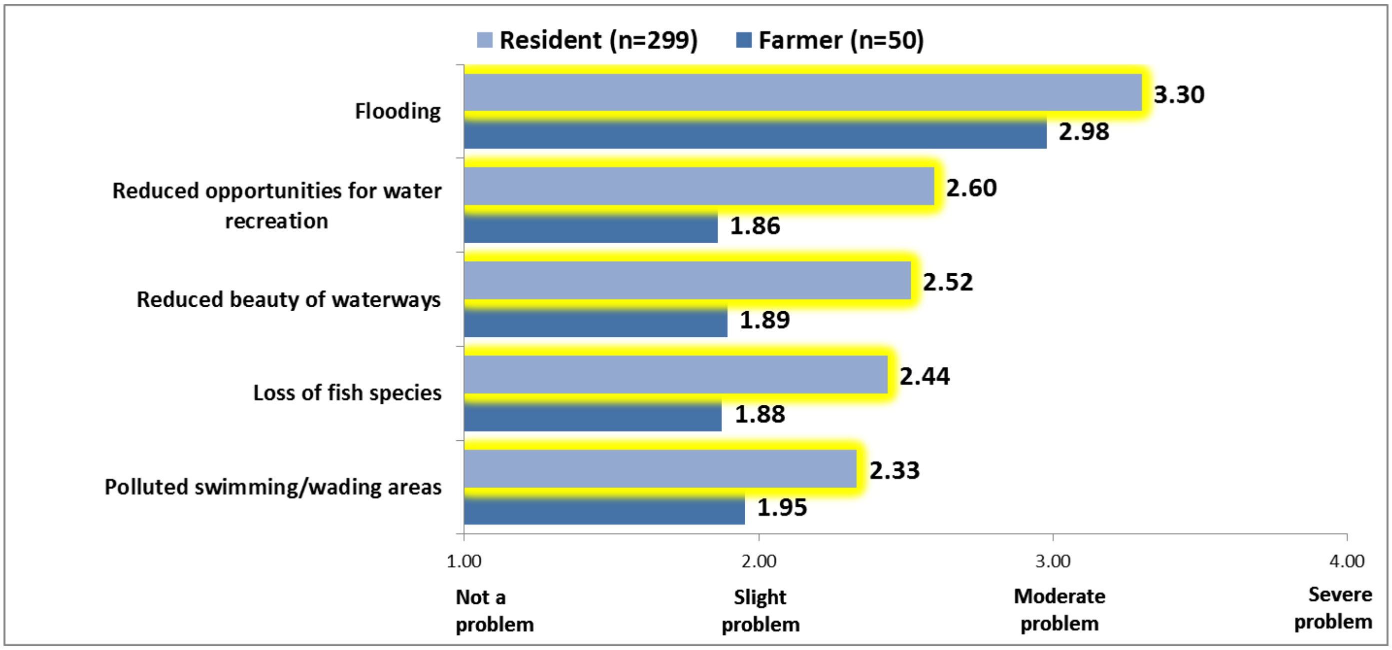
Figure 6-12. Summary of the Top Five Issues Contributing to Water Quality Problems

Resident Top Five	Farmer Top Five
Stormwater runoff from hard surfaces	Stormwater runoff from hard surfaces
Street salt and sand ending up in the water	New housing and commercial development
Excessive use of fertilizers/pesticides on lawns	Street salt and sand ending up in the water
New housing and commercial development	Presence of solid waste landfill along Indian Creek
Excessive use of fertilizers/herbicides/pesticides for crops	Excessive use of fertilizers/pesticides on lawns

Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

The survey also asked respondents to rate how much of a problem specific conditions were in the local creeks. Residents scored all of the conditions significantly more problematic than Farmers did as shown in Figure 6-13. Flooding was the only condition rated as a moderate problem or above by both Residents and Farmers. However, Residents rated many conditions greater in severity.

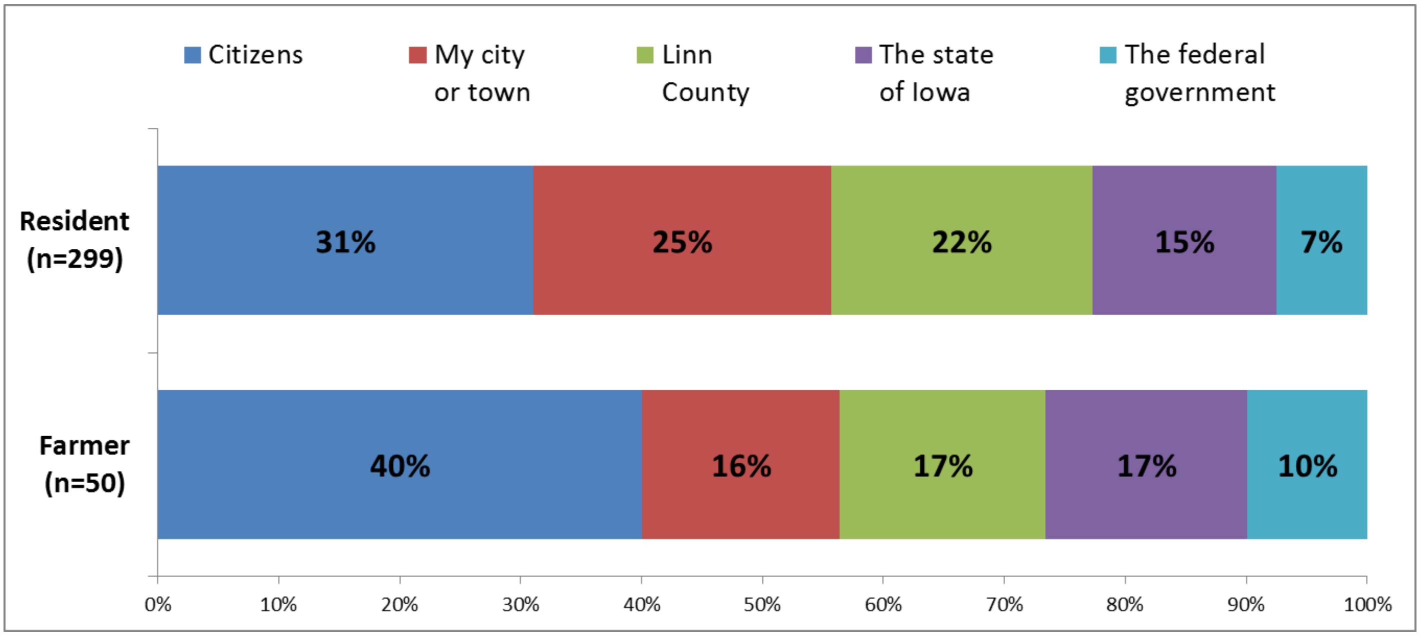
Figure 6-13. Creek Conditions Rated as the Most Problematic



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Both Residents and Farmers assigned responsibility for water quality to the people first, then local government. A significantly greater percentage of Farmers than Residents placed responsibility on citizens. A significantly greater percentage of Residents than Farmers placed responsibility on their city or town. Interestingly, both groups placed 56% total responsibility on citizens and their city or town.

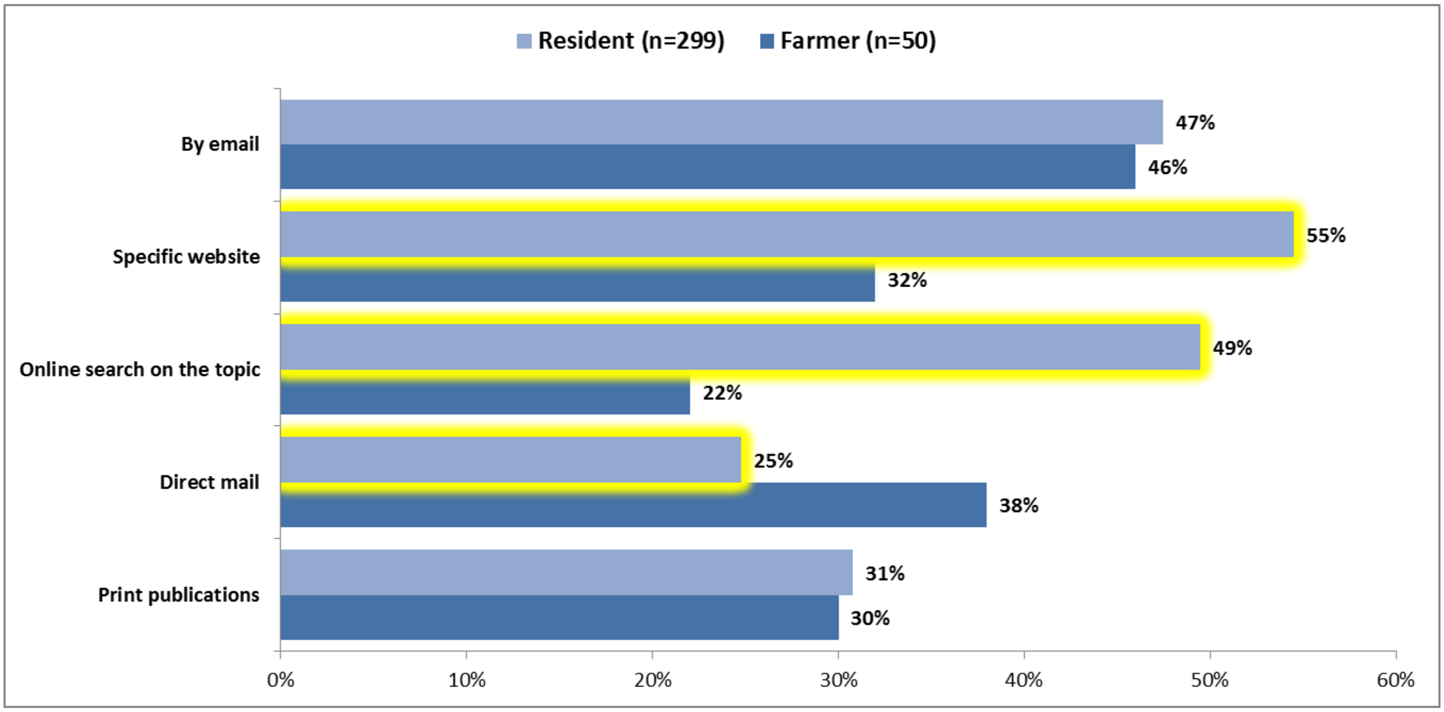
Figure 6-14. Assignment of Responsibility for Water Quality



Source: Indian Creek Watershed Survey Quantitative Findings Report, August 2014

In measuring the preferred methods of receiving information about the quality of water resources, e-mail was a leading preference for all participants. Residents also selected two other online resources and Farmers selected specific websites and direct mail. Residents preferred specific websites, online searches, TV programs, social media and videos significantly more than Farmers. Farmers preferred direct mail and communication in person significantly more than Residents.

Figure 6-15. Communication Preferences

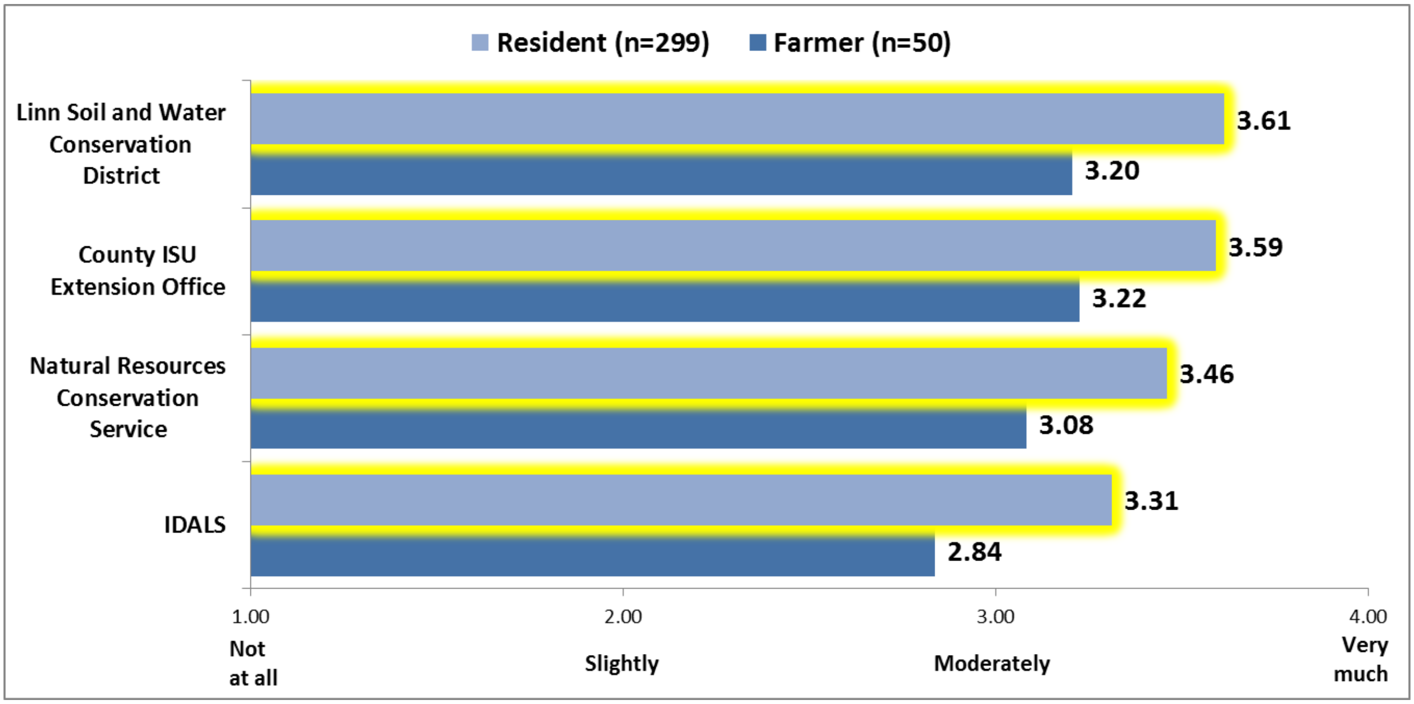


Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

Who did respondents say they trust? Overall, Residents were much more trusting of organizations than Farmers. The top two most-trusted organizations were identical for both groups. The Linn Soil and Water Conservation District and the County ISU Extension Office were the most highly-trusted sources of information about the quality of water resources.

- Local garden centers or lawn care companies were the least-trusted sources of information about the quality of water resources
- Over 40% of Residents registered unfamiliarity with local cooperatives or certified crop advisors and the Farm Service Agency
- There is a large and significant gap between Residents and Farmers regarding their trust for the Iowa DNR

Figure 6-16. Most Trustworthy Sources of Water Quality Information



Source: Indian Creek Watershed Survey Quantitative Findings Report September 2014

6.3 Social Assessment Recommendations

Vernon Research Group summarizes key findings from the survey data and makes recommendations to support the development of a public outreach plan, which can all be found in their full report included in Appendix 2. In this section, Vernon's recommendations are grouped as either a communication tip or a specific message and listed below. These recommendations will be incorporated into the Education and Outreach Plan section in this Plan.

Communication Tips

- Watershed programs will be most effective if they are more local in scope or origin and leverage local and trusted organizations
- Communication plans targeting residents should emphasize web-based channels, supplemented by TV and direct mail
- Communication plans targeting farmers or owners of agricultural land should be multi-faceted, using email, websites, direct mail/print and in-person presentations
- Identify opportunities to partner with local and youth agricultural groups
- Offering farmers and landowners monetary incentives or partial funding will boost participation in practices – remember to publicize existing programs and explain long-term return on investment
- Improvements and additional amenities to trails, paths, picnicking and observation areas within the watershed will be utilized
- Address concerns about contact with creeks – so from creek usage and perception data, it appears that people hesitate to engage in activities that involve contact with the water (e.g. wading, fishing and boating). Identify problems and work on solutions

Specific Messages

- Publicize & commend practitioners of helpful agricultural and urban landscape behaviors
- Emphasize that residents and farmers share many opinions and priorities
- Both Residents and Farmers valued water quality and believed their practices make a difference
- Any practices that can be correlated with the prevention or mitigation of flooding should be emphasized in programs and communications
- Consider special events or publicity tied to activities that have contact with the water (e.g., fishing, kayaking), if and/or when the water is safe for that activity
- More education is needed regarding the role and health of fish in the watershed's creeks
- Education efforts targeting residents of the watershed should focus on septic system issues, phosphate-free fertilizers and rain harvesting (barrels, gardens)
- Education is needed on the problem of pet waste and its effects on watershed creeks

Chapter 7 – Watershed Action Plan

"Anything else you're interested in is not going to happen if you can't breathe the air and drink the water.

Don't sit this one out.

Do something.

You are by accident of fate alive at an absolutely critical moment in the history of our planet."

Carl Sagan

7.1 Process to Develop Goals & Objectives

Goals, objectives, and implementation strategies for the Indian Creek Watershed Management Plan were developed through an iterative process involving watershed stakeholders, the ICWMA Board, and the Tech Team. The first step was a series of Lunch & Learn events that served two purposes. Stakeholders learned about research conducted and technical aspects of the watershed and participated in refining the proposed goals with locally driven objectives and implementation ideas. Three Lunch & Learn events were held, each with a specific watershed topic as summarized below. The Summary of Stakeholder Input Report June 2015 is included in Appendix 2.

Flooding Lunch & Learn

On July 30, 2014, watershed stakeholders were invited to a presentation of the hydrology modeling results given by Greg Karlovits, PE, with the US Army Corps of Engineers – Rock Island District. The event was designed to give an overview of hydrology and flooding in general and present the issues impacting flooding in the Indian Creek watershed. The event concluded with an exercise to gather input about flood mitigation strategies in the watershed. Participants were provided with worksheets and asked to provide their feedback on the draft goal and objectives presented. Feedback was requested on overall reactions, thoughts, ideas, suggested action steps, and questions relating to each of the objectives. The written responses from each participant were recorded as raw data into the Summary of Stakeholder Input Report June 2015 included in Appendix 2. A total of 40 stakeholders attended representing city & county public works and planning staff; state level staff; agriculture interests; property owners; local college students; conservation interests; civic organizations; development interests; and elected officials.

Water Quality Lunch & Learn

On August 13, 2014, watershed stakeholders were invited to a presentation of the water quality research results given by Dr. Martin St. Clair, Coe College Chemistry Professor. The event was structured to give an overview of factors impacting water quality and present the results of an extensive record of water samples analyzed from the Indian Creek watershed. The event concluded with a small group exercise to gather input about strategies to improve water quality in the watershed. Participants were asked to work in small groups and brainstorm strategies for one of the three draft goals presented. The small groups were encouraged to use the framework outlined later in this section as a way to group strategies. The small groups reported their ideas to the larger group and consensus formed around the strategies and ideas presented in the summary document included in Appendix 2. A total of 41 stakeholders attended representing city & county public works and planning staff; state level staff; agriculture interests; property owners; local college students; conservation interests; civic organizations; and development interests.

Public Outreach Lunch & Learn

On September 24, 2014, watershed stakeholders were invited to a presentation of the social assessment research results given by Linda Kuster with Vernon Research Group. The full results of the survey and an analysis of the data was presented. Participants were asked to respond to questions posed about the survey results. The whole group provided reactions and suggestions for the questions presented, which helped to form the education strategies in the Implementation Strategies section. A total of 20 stakeholders attended representing city & county public works and planning staff; state level staff; agriculture interests; property owners; local college students; conservation interests; civic organizations; and development interests.

A framework for organizing objectives and implementation strategies within each goal was agreed to during the Lunch & Learn events as follows:

- Education / Communication
- Policy Related
- Practices / Action Items
- Measuring / Monitoring

Some reoccurring themes emerged from the Lunch & Learn goal setting events that provided further direction for the implementation strategies:

1. Education and communication should be targeted to specific audiences
2. Policies should favor incentives over regulation whenever possible
3. Practices should be targeted to the best areas to achieve improvements
4. Establish benchmarks for monitoring & measuring improvements

Next, the input from the Lunch & Learn events was reviewed and discussed by both the ICWMA Board and the Tech Team over the course of several meetings and work sessions. The ICWMA Board provided some context from a local government perspective that helped to ground the input ideas and connect them to local physical and political conditions. The Tech Team divided into a Rural Subcommittee and an Urban Subcommittee to take a close look at the watershed assessment data and further refine the objectives and implementation strategies based on the assessment and the resource concerns identified at the start of the planning process as follows.

- Partnerships & Policy – Stormwater issues and NPDES MS4 Permit Requirements
- Flood Risk Management
- Water Quality

- Improved Recreation & Habitat
- Public Outreach & Education

After final ICWMA Board review and comments received from the two Plan open houses, a full listing of the goals, objectives and associated implementation strategies was developed.

7.2 Goals & Objectives

The overall goals for the Plan are presented in this section, along with the objectives and implementation strategies for each goal. The order of the goals and objectives presented here are arranged based on the priorities of participants in the Plan open houses, which included ICWMA Board members, Tech Team members, and 64 watershed stakeholders. A map displaying the important places identified by participants in the Plan open houses as well as a summary of participants' comments are included in Appendix 1. As noted previously, many of the Plan objectives align with existing ICWMA Member plans listed in Chapter 1.

Water Quality Goal

Protect and improve surface water and groundwater in the Indian Creek Watershed

Water Quality Goal

Protect and improve surface and ground water in the Indian Creek Watershed

Objectives	Results from Open Houses
1 Encourage & implement practices to reduce nutrient export (e.g. fertilizer runoff) from the Indian Creek Watershed	28
2 Encourage & implement stormwater management practices to hold water from a 2.5 inch or less rain event	25
3 Encourage & implement practices to reduce *E.coli* bacteria in the creeks	5
4 Encourage policies & practices to protect drinking water sources	9

Indian Creek Watershed Management Authority

Objective 1. Encourage & implement practices to reduce nutrient export from Indian Creek in line with the Iowa Nutrient Reduction Strategy

a. determine baseline Nitrogen and Phosphorus loads and 20-year load reduction goal
b. communicate and enforce existing and new rules regarding Nitrogen and Phosphorus sources

c. determine priority locations for Nutrient Reduction Strategy practices based on the watershed assessment data and modeling; identify locations on public land for demonstration purposes
    1. promote the use of nutrient management plans and/or whole farm conservation plans
    2. target tile-drained fields for edge-of-field practices such as wetlands, saturated buffers, and bioreactors
    3. target drainage water management practices in flatter areas of the watershed
    4. promote use of structural practices such as terraces and sediment basins on Highly Erodible Lands (HEL) to reduce soil loss
    5. promote use of management practices such as cover crops, no-till, and strip-till on all crop ground but especially HEL
    6. utilize inlet protection measures around tile drainage intakes
    7. erosion control practices on construction sites
d. conduct streambank stabilization & restoration at priority locations identified in the RASCAL stream assessment
e. promote Farm Bill and other programs for cost-sharing of practices
f. better characterize Phosphorus by developing a monitoring program for Total P and OrthoP
g. explore possibility of nutrient trading

Objective 2. Encourage and implement stormwater management practices that will infiltrate runoff from up to a 2.5 inch rain event as recommended in the Iowa Stormwater Management Manual

a. conduct a storm drain retrofitability assessment and identify low hanging fruit based on ease of retrofitability and willing municipal / homeowner interest
b. select priority subwatersheds and do modeling to target Best Management Practices (BMP) types and locations
c. encourage road salt storage & use improvements to decrease chloride loading
    1. assess containment and leaching to groundwater at road salt storage sites
    2. promote the use of road salt alternatives to non-municipal users
    3. implement metering of road salt application rates
d. focus on implementing green infrastructure practices as part of the capital improvements planned within the watershed over the next 10 years
e. track existing and new BMPs using GIS and encourage signage and promotion

Objective 3. Develop a 5 year water quality plan to measure progress toward objectives

a. partner with US Geological Survey (USGS) or the Iowa Flood Center to deploy real-time nitrate sensors at strategic locations
b. continue partnership with Coe College to monitor water quality & quantity
c. implement water monitoring plan to assess temperature and urban pollutants in priority subwatersheds
d. increase indicator bacteria monitoring in places where people recreate
e. conduct RASCAL assessment in locations that were not surveyed in 2013 - 2014

Objective 4. Encourage & implement practices that increase the percent of time creek water samples test below the state recreational standard (one-time sample maximum) for *E.coli* by 50%

a. better characterize bacteria timing and sources by developing a bacteria source testing plan that includes assessment of potential inputs from municipal sewer systems and/or septic systems (use optical brighteners for example)
b. encourage prescribed grazing in areas adjacent to the stream corridor
c. encourage and incentivize landowners to fence livestock out of stream channel
d. encourage tall grass plantings around ponds to deter Canada geese

Objective 5. Encourage policies & practices to protect drinking water sources

a. develop a subcommittee to determine how stormwater should be managed in source water protection areas

Flood Risk Management Goal

Protect human life, property, and surface water systems that could be damaged by flood events in the Indian Creek Watershed

Objective 1. Encourage & implement practices to reduce peak flows

a. promote the use of the Iowa Stormwater Management Manual criteria to reduce peak flows using overbank and stream channel protection guidelines
b. conduct an inventory of rural road culverts and bridges to identify opportunities for converting road ditches to bioswales and on-road structures to hold back water
c. inventory row crop encroachment in road right-of-ways and enforce existing laws throughout the watershed
d. use GIS aerial photography & anecdotal evidence to identify locations where repetitive crop losses due to flooding have occurred and promote the Conservation Reserve Program (CRP), the Wetland Reserve Program (WRP) and other relevant practices

Objective 2. Encourage cities to go beyond floodplain management requirements

a. Identify Community Rating System criteria that all communities should meet and determine improvements
b. identify areas of repetitive loss due to flooding

Objective 3. Coordinate flood risk management strategies among member communities

a. develop a uniform method among the ICWMA members to track public sector costs due to flooding
b. complete & install flood warning system as a special page on the Iowa Flood Information System (IFIS) website
c. update flood inundation maps when related plan updates occur

Objective 4. Update policies & strategies to minimize damage in the 500-year floodplain

a. Conduct a comprehensive inventory and risk based evaluation of the structures in the 500-year floodplain
b. develop or update policies to discourage new development in the 100 year & 500 year floodplain
c. utilize the HEC-HMS model to identify priority areas to reduce upstream peak flow to protect property in the 500-year floodplain

Recreation & Habitat Goal

Expand and enhance recreational opportunities and increase the quantity and quality of habitat in the Indian Creek watershed


Recreation & Habitat Goal

Expand & enhance recreational opportunities and increase the quantity & quality of habitat in the Indian Creek Watershed

Objectives	Results from Open Houses
1 Create a vision for what recreation could be in the Indian Creek Watershed	8
2 Protect, enhance, and extend recreational trail systems along stream corridors	6
3 Protect and enhance fisheries in suitable locations	4
4 Increase the quantity and quality of habitat (e.g. fish and birds) in the watershed	15

Objective 1. Increase the quantity and quality of habitat in the Indian Creek Watershed

a. develop criteria for identifying stream segments that are a higher priority for habitat restoration
b. conduct bio-assessment on Dry Creek and Squaw Creek to determine baseline conditions in high priority segments
c. identify locations suitable for restoring riffle habitat in priority segments, to achieve a riffle distance ratio of 5-7
d. in East Indian Creek, address issues with stream channel instability and active downcutting
e. reduce sediment loads so that sediment-related habitat metrics fall within critical levels

f. develop a local goal for buffer strip width within the watershed
g. eventually, restore high-priority stream segments to achieve habitat metric values characteristic of respective reference sites
h. refine habitat improvement goals to match similar stream reaches with stable riffle habitat and large rock substrate

Objective 2. Create a vision for what recreation could be in the Indian Creek watershed

a. partner with Iowa Water Trails Association and DNR Water Trails program to possibly develop a water trail on Indian Creek and tributaries
b. organize and promote creek cleanup events

Objective 3. Protect, enhance and extend recreational trail systems along stream corridors

a. identify opportunities to protect segments of trail from streambank erosion (e.g. Sac and Fox Trail at Wilder Drive)
b. establish user friendly comment submittal system on ICWMA website to communicate issues with the trails and stream conditions
c. enhance trail connectivity

Objective 4. Protect and enhance fisheries in suitable locations

a. conduct an assessment of fishery enhancement in Dry Creek and lower reaches of Indian Creek

Public Outreach & Education Goal

Build community support for the protection & enhancement of land and water resources in the Indian Creek Watershed

Public Outreach & Education Goal

Build community support for the protection & enhancement of land and water resources in the Indian Creek Watershed

Objectives	Results from Open Houses
1 Develop outreach campaigns to raise water quality and flood risk awareness	17
2 Increase opportunities to connect with those living, working or playing in the watershed	4
3 Create a program to recognize efforts to protect the watershed	2
4 Develop children's programs to raise awareness about protecting our land & water resources	7

Indian Creek Watershed Management Authority

Objective 1. Develop outreach campaign specific to identified audiences to raise water quality and flood risk awareness with individual calls to action

a. communicate with landowners about the Nutrient Reduction Strategy (NRS) recommended practices & foster general understanding about the NRS through workshops, demonstration videos, and implementation of more example projects in the watershed
b. communicate the results of water quality monitoring to educate about actual vs. perceived sources of pollution in the watershed
c. communicate with landowners about the multiple benefits of enrolling acres into the Conservation Reserve Program leveraging USACE/Farm Service Agency research
d. communicate steps anyone can take to protect the watershed - "You Pick Two" concept
e. communicate the importance of proper management of pet wastes to residents
f. develop a program and outreach materials to educate urban residents about agriculture
g. develop an annual State of Indian Creek report to highlight activities, water quality, steps toward progress
h. develop a collaborative communication & education plan between all ICWMA members using existing materials (such as County Conservation Board watershed public service announcements)
i. develop a brochure with color shaded map that explains future flood risk in terms of a 30-year mortgage for local realtors to distribute to potential homebuyers

j. develop a program and outreach materials to educate homeowners & potential homeowners about the hydrology of the watershed and the factors that influence it
k. communicate the comparison of repeated flood recovery costs to pro-active flood mitigation practices to policy makers and the general public

Objective 2. Develop children's programs to raise awareness about protecting our land & water resources

a. Coe College to develop a grade school curriculum aligned with the Common Core through their education department
b. host IOWATER training for children partnering with local schools and/or summer camps
c. partner with local Future Farmers of America (FFA) teachers to incorporate watershed issues into their classes
d. organize field trip and outdoor play opportunities

Objective 3. Increase opportunities to connect with those living, working or playing in the watershed to promote watershed protection and conservation practices

a. organize events to connect urban residents with the creek such as storm drain labeling, installing watershed signs, or festivals in parks with access to the creeks, etc
b. Continue to hold IOWATER workshops and engage trained volunteers in an active monitoring program in the watershed
c. organize Rainscaping workshops and urban Best Management Practices (BMPs) tours for homeowners, policy makers, or other interested stakeholders to communicate the purpose and attractiveness of BMPs
d. develop a self-guided podcast tour of green stormwater management practices with ideas for the listener to implement at home
e. partner with city & county planning departments to provide trainings, tours or lunch-n-learns to Planning & Zoning Committees, city staff, and other decision makers on stormwater management practices
f. partner with Iowa Storm Water Education Program (ISWEP) to hold workshops (with Continuing Education Units) for developers, builders, engineers, and inspectors about infiltration practices and Low Impact Development
g. continue to host Women Caring for the Land workshops
h. host field days, tours and other peer to peer events for farmers and other stakeholders

Objective 4. Create a program to recognize efforts to protect the watershed

a. partner with the Linn SWCD to develop an awards program such as a certificate or sign recognizing a "Friend of Indian Creek Watershed"
b. promote BMPs installed within the watershed as models through signage and/or inclusion in the self-guided podcast tour

Partnerships & Policy Goal

Work cooperatively with stakeholders to identify and establish partnerships; common policies; and shared resources to implement the Indian Creek Comprehensive Watershed Management Plan

Objective 1. Establish local funding mechanisms to implement the plan

a. recommend that ICWMA members fully leverage all grant opportunities to the greatest extent possible
b. recommend that ICWMA members set policies to dedicate funds collected through Stormwater Utilities to water quality practices
c. develop and/or promote the Urban BMP cost share programs in the metro area

Objective 2. Support the Indian Creek Watershed Management Authority as a leader in watershed management

a. complete & adopt a 20 year Comprehensive Watershed Management Plan with 5 year updates
b. recommend that ICWMA members financially support organizational management of the ICWMA, according to the contribution formula developed by the Board of Directors, to implement the Plan
c. establish sub-committees of the ICWMA that align with plan goals and report progress to the ICWMA Board on a regular basis (example committees include planning & infrastructure, agricultural, public outreach, habitat & recreation)
d. recommend that ICWMA members capitalize a cost share program, according to the contribution formula established by the Board of Directors, to implement practices or serve as matching funds for grant applications
e. establish public / private partnerships to implement demo BMP projects

f. develop HUC-12 scale watershed plans & projects and seek funding to advance implementation
g. consider amending the Articles of Agreement to establish ICWMA as a separate legal entity

Objective 3. Recommend policy changes that meet or exceed state & national model ordinances related to stormwater management

a. Develop model ordinance language for policies such as stormwater, floodplains, subdivisions, building site plans, and sensitive areas, based on existing examples in Iowa, and encourage adoption by ICWMA members
b. encourage ICWMA members to adopt the Iowa Stormwater Manual as the design standard with each stormwater or related ordinance
c. encourage the adoption of a minimum 35' vegetated buffer along the stream corridor for the purpose of protecting habitat and enhancing recreation
d. encourage ICWMA members to implement a rule of minimum 4" topsoil + additional organic profile on developed lots
e. encourage the development of policies to maximize the use of infiltration based practices in new construction or redevelopment

7.3 Implementation Strategies

The implementation strategies from the goals section are organized in this section into a detailed action plan that can be used by ICWMA member governments, watershed stakeholders, and other partners to make progress towards, and measure, watershed management goals. The action plan identifies the Plan goals addressed by each strategy, adds activity milestones, recommends a group to take the lead, and lists possible technical resources /funding options. The implementation strategies have been grouped by the action types identified in the framework (Section 7.1) established at the Lunch & Learn events and represented by color code in Tables 7-1 through 7-4.

- Education / Communication
- Policy Related
- Practices / Action Items
- Measuring / Monitoring

After organizing the implementation strategies as an education, policy, practice or measure activity, the ICWMA Board was asked to rank the importance of each strategy. Each ICWMA Board member selected the Plan Phase that they wanted to see a strategy completed in. The Plan Phases (Phase 1 – 4) correspond to the 5-year plan update schedule agreed to by the ICWMA Board for the 20-year Plan. The overall average rank for each strategy is listed in the tables in this section and the Appendix.

The rankings were based on existing conditions and resources. Changes to the implementation strategy rankings will likely be made as the Plan is reviewed annually and updated every five years. The Phase 1 (or first 5 years) implementation strategies are included in this section and the rest can be found in Appendix 1.

The ICWMA will begin implementing the action plan by establishing subcommittees and advisory groups that will identify projects and activities to take on first. The subcommittees to be established first will be:

- Agriculture Related Advisory Group – will include representatives from local farmers, local chapters of the Farm Bureau and commodity groups, ag industry, Iowa Department of Agriculture and Land Stewardship (IDALS), National Resource Conservation Service (NRCS), Farm Service Agency (FSA), Farm Managers, and certified crop advisors to advise on project development and education strategies

- Education & Outreach Subcommittee – will include representatives from city stormwater staff, Iowa Storm Water Education Program (ISWEP), schools, ICWMA Member communications staff, Corridor Conservation Coalition, and Soil & Water Conservation District to develop and implement education strategies
- Monitoring & Analysis Subcommittee – will include representatives from Coe College, DNR/IOWATER, Iowa Flood Center, Soybean Association, and the US Army Corps of Engineers – Rock Island District to develop and implement a long-term monitoring and data collection plan to evaluate progress toward Plan goals and objectives

Other subcommittees in future years will include a Policy & Ordinance Review Subcommittee and an Infrastructure Subcommittee.

Table 7-1. Indian Creek Watershed Action Plan – Education Strategies

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Goals Addressed: Water Quality	Goals Addressed: Public Outreach & Education	Goals Addressed: Partnerships & Policy	Goals Addressed: Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	1	partner with ISWEP to hold workshops (with CEUs) for developers, builders, engineers, and inspectors about infiltration practices and Low Impact Development (LID)	x	x	x	x	x	host two workshops per year reaching at least 10 participants	Phase 1	1.17	ISWEP & ICWMA Board	ICWMA Member communications & stormwater staff
Education	2	develop a collaborative communication & education plan between all ICWMA members using existing materials (such as the CCB watershed PSAs)			x	x		Subcommittee established & education plan developed	Phase 1	1.33	ICWMA Education Subcommittee	ICWMA Member communications & stormwater staff
Education	3	organize events to connect urban residents with the creek such as storm drain labeling, installing watershed signs, or festivals in parks with access to the creeks, etc.			x		x	host quarterly events	Phase 1	1.33	ICWMA Education Subcommittee	ICWMA Member communications & stormwater staff
Education	4	partner with city & county planning departments to provide trainings, tours or lunch-n-learns to Planning & Zoning Committees, city staff, and other decision makers on stormwater management practices	x	x	x	x	x	host quarterly events that increases the knowledge of 15 - 20 participants per year	Phase 1	1.39	ICWMA Education Subcommittee	Local
Education	5	communicate the importance of proper management of pet wastes to residents		x	x		x	Utilize existing materials in all communities	Phase 1	1.50	ICWMA Education Subcommittee	ICWMA Member communications & stormwater staff
Education	6	communicate with landowners about the Nutrient Reduction Strategy recommended practices & foster general understanding about the NRS through workshops, demonstration videos, and implementation of more example projects in the watershed		x	x			host one workshop per year; at least three videos created; complete at least one demo project	Phase 1	1.67	Linn SWCD & ICWMA Board	WQI

Table 7-1. Indian Creek Watershed Action Plan – Education Strategies Continued

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	7	communicate the results of water quality-monitoring to educate about actual vs. perceived sources of pollution in the watershed		x	x			report out results at annual watershed meeting; create water quality fact sheet & post to website	Phase 1	1.67	ICWMA Education Subcommittee	Coe College; IOWATER; ICWMA Member communications & stormwater staff
	8	develop an annual State of Indian Creek report to highlight activities, water quality, steps toward progress			x	x		annual report developed & posted to websites	Phase 1	1.67	ICWMA Board	ICWMA Tech Team; ICWMA Member communications & stormwater staff
	9	communicate the comparison of repeated flood recovery costs to pro-active flood mitigation practices to policy makers and the general public	x		x	x		include an economic analysis of Mitigation Strategies in the next Hazard Mitigation Plan update; create fact sheet	Phase 1	1.67	ICWMA Board	ICWMA Tech Team
	10	promote BMPs installed within the watershed as models through signage and/or inclusion in the self-guided podcast tour	x	x	x		x	create BMP map; install promo signs; develop podcast tour	Phase 1	1.67	ICWMA Education Subcommittee	REAP CEP
	11	establish user friendly comment submittal system on ICWMA website to communicate issues with the trails and stream conditions	x	x	x	x	x	comment submittal system established and put on website	Phase 1	1.67	ICWMA Board	
	12	organize Rainscaping workshops and urban BMP tours for homeowners, policy makers, or other interested stakeholders to communicate the purpose and attractiveness of BMPs	x	x	x	x	x	host quarterly workshops / tours	Phase 1	1.67	ICWMA Education Subcommittee	ICWMA Member communications & stormwater staff

Table 7-2. Indian Creek Watershed Action Plan – Policy Related Strategies

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	13	recommend that ICWMA members fully leverage all grant opportunities to the greatest extent possible				x		monitor funding opportunities; coordinate application development	Phase 1	1.50	ICWMA Members	ICWMA Tech Team
	14	Develop model ordinance language for policies such as stormwater, floodplains, subdivisions, building site plans, and sensitive areas, based on existing examples in Iowa, and encourage adoption by ICWMA members	x	x	x	x	x	model ordinance language drafted and presented to members	Phase 1	1.67	ICWMA Board & Members	ISWEP; ICWMA stormwater staff
	15	encourage ICWMA members to adopt the Iowa Stormwater Manual as the design standard with each stormwater or related ordinance	x	x		x	x	adoption by ICWMA Members	Phase 1	1.67	ICWMA Members	IDALS Urban Conservation Program; ICWMA stormwater staff
	16	encourage the development of policies to maximize the use of infiltration based practices in new construction or redevelopment	x	x		x	x	policy developed; number of members adopting the policies	Phase 1	1.67	ICWMA Members	IDALS Urban Conservation Program
	17	develop and/or promote the Urban BMP cost share programs in the metro area	x	x	x	x	x	at least 10 projects receiving cost-share	Phase 1	1.67	ICWMA Members	Local
	18	complete & adopt a 20 year Comprehensive Watershed Management Plan with 5 year updates	x	x	x	x	x	plan adopted by all ICWMA Members; 5 year updates completed	Phase 1	1.67	ICWMA Board & stakeholders	ICWMA Tech Team; ICWMA Members
	19	recommend that ICWMA members financially support organizational management of the ICWMA, according to the contribution formula developed by the Board of Directors, to implement the Plan	x	x	x	x	x	service agreement for organizational management in place & financially supported	Phase 1	1.67	ICWMA Board & Members	ICWMA Members

Table 7-2. Indian Creek Watershed Action Plan – Policy Related Strategies Continued

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	20	develop or update policies to discourage new development in the 100 year & 500 year floodplain	x		x	x		develop model ordinance language	Phase 1	1.67	ICWMA Members	IFSMA; ICWMA Member Engineering staff
Policy	21	focus on implementing green infrastructure practices as part of the capital improvements planned within the watershed over the next 10 years	x	x		x	x	implement at least 10 green infrastructure practices in upcoming projects	Phase 1	1.67	ICWMA Members	IDALS Urban Conservation Program

Table 7-3. Indian Creek Watershed Action Plan – Practices

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Practices	22	erosion control practices on construction sites		x			x	coordinate enforcement plans; standardize penalties across communities	Phase 1	1.17	ICWMA member cities	ISWEP; ICWMA stormwater staff
	23	Coordinate a stream corridor maintenance program to include bank stabilization, debris clean-out, & improvements to rock substrate	x	x		x	x	coordinate activities to maximize results	Phase 1	N/A	ICWMA member cities & County Road Dept.	ICWMA Members & ICWMA Tech Team
	24	select priority subwatersheds and do modeling to target BMP types and locations		x	x	x	x	modeling completed	Phase 1	1.50	ICWMA member cities	DNR GIS staff
	25	identify Community Rating System criteria that all communities should meet and determine low-hanging fruit	x		X	x		establish minimum criteria;	Phase 1	1.67	ICWMA Board	DNR Floodplains
	26	identify areas of repetitive loss due to flooding	x		x	x		map created; communicate findings to the public	Phase 1	1.67	ICWMA Board & IDNR & Linn SWCD	DNR Floodplains
	27	target tile-drained fields for edge-of-field practices such as wetlands, saturated buffers, and bioreactors		x			x	install demonstration sites: two bioreactors, two saturated buffers, one wetland; outreach to landowners	Phase 1	1.67	Linn SWCD & ICWMA Board	Pheasants Forever; WQI
	28	organize and promote creek cleanup events		x	x		x	host two events per year removing at least 5 tons of trash	Phase 1	1.67	ICWMA Board & Members	Iowa Waste Exchange; DNR Water Trails

Table 7-4. Indian Creek Watershed Action Plan – Monitoring & Measuring Strategies

			Goals Addressed									
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation & Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Monitor & Measure	29	continue partnership with Coe College to monitor water quality & quantity	x	x	x	x	x	samples collected & analyzed	Phase 1	1.50	ICWMA Board & Members & Coe College	ICWMA Member stormwater staff; Cedar Rapids Utilities Director
	30	track existing and new Best Management Practices (BMPs) using GIS and encourage signage and promotion		x	x	x		tracking method established	Phase 1	1.67	ICWMA Board & Members	IDALS Urban Conservationist; ICWMA Member stormwater coordinators
	31	implement water monitoring plan to assess temperature and urban pollutants in priority subwatersheds		x			x	urban pollutants monitoring plan developed	Phase 1	1.67	ICWMA Member cities	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators

7.4 Recommended Management Strategies

An important component of the watershed planning process is to identify watershed management strategies that will reduce, slow and filter runoff to receiving waterbodies. Part of this involves identifying critical areas in the watershed that contribute relatively higher pollutant loads or runoff volumes. These critical areas are high priorities for implementing Best Management Practices (BMPs). Ultimately, placing BMPs in high priority locations may help to achieve greater environmental benefit with limited resources.

The previous sections described the various watershed-based assessments that were completed during the planning process in order to identify critical areas and BMP opportunities. Figure 7.1 combines key findings from the assessment data into one map, showing recommended strategies to improve water quality and reduce peak flows. The map breaks the watershed into five overall management zones, using data derived from several watershed assessments.

- Inadequate Riparian Buffer: The Environmental Working Group (EWG) released a study in February 2015 entitled "Iowa's Low-Hanging Fruit: Stream Buffer Rule = Cleaner Water, Little Cost." The study analyzed the agricultural portions of Linn County to determine where riparian buffers were either missing or inadequate. EWG provided the Indian Creek WMA with the GIS data developed in the analysis, and locations with less than 35' of riparian buffer are illustrated in the map as priority locations for buffer establishment.
- Stream Corridor Restoration: Based on the RASCAL assessment conducted by Coe College students, the stream segments determined to be exhibiting the worst condition in terms of sediment-related threats to water quality are labelled on the map.
- Livestock Management: The locations identified in the map as potential locations for livestock management strategies were identified either in the RASCAL assessment or in the most recent land use map developed by Iowa DNR in 2015.
- Sediment Control: The areas colored red in the map are areas with relatively higher sediment delivery rates (0.5 tons/acre/year). Sediment delivery estimates are based upon the Natural Resources Conservation Service (NRCS) Erosion and Sediment Delivery Worksheet (1996). Land use information used in the analysis was collected during the spring of 2013 by Linn Soil & Water Conservation District (SWCD) personnel.
- Agricultural Conservation: This is a broad category that includes all acres that were in row crop production as of 2013.
- Urban Best Management Practices: All urban / residential / commercial areas were identified as potential locations for 'green' stormwater infrastructure projects, including both infiltration and detention BMPs.
- Existing Natural Areas: For reference, all natural areas (e.g. timber, grassland, parkland) were also highlighted in the map. Preserving these natural areas in permanent vegetative cover should be a priority for the watershed.

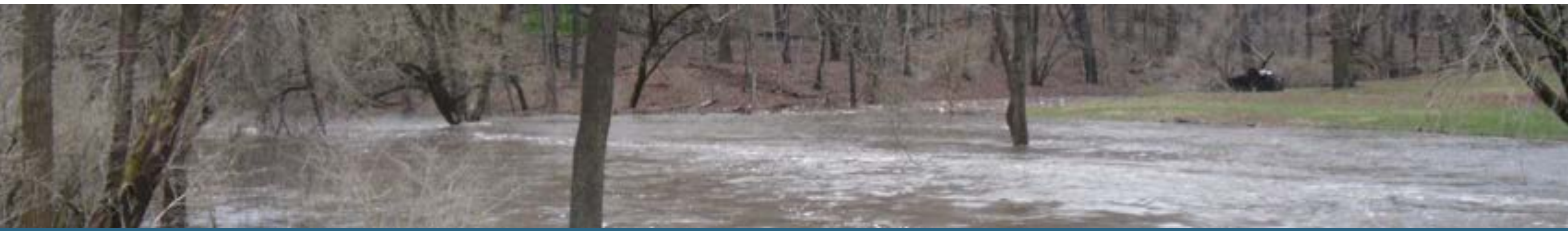
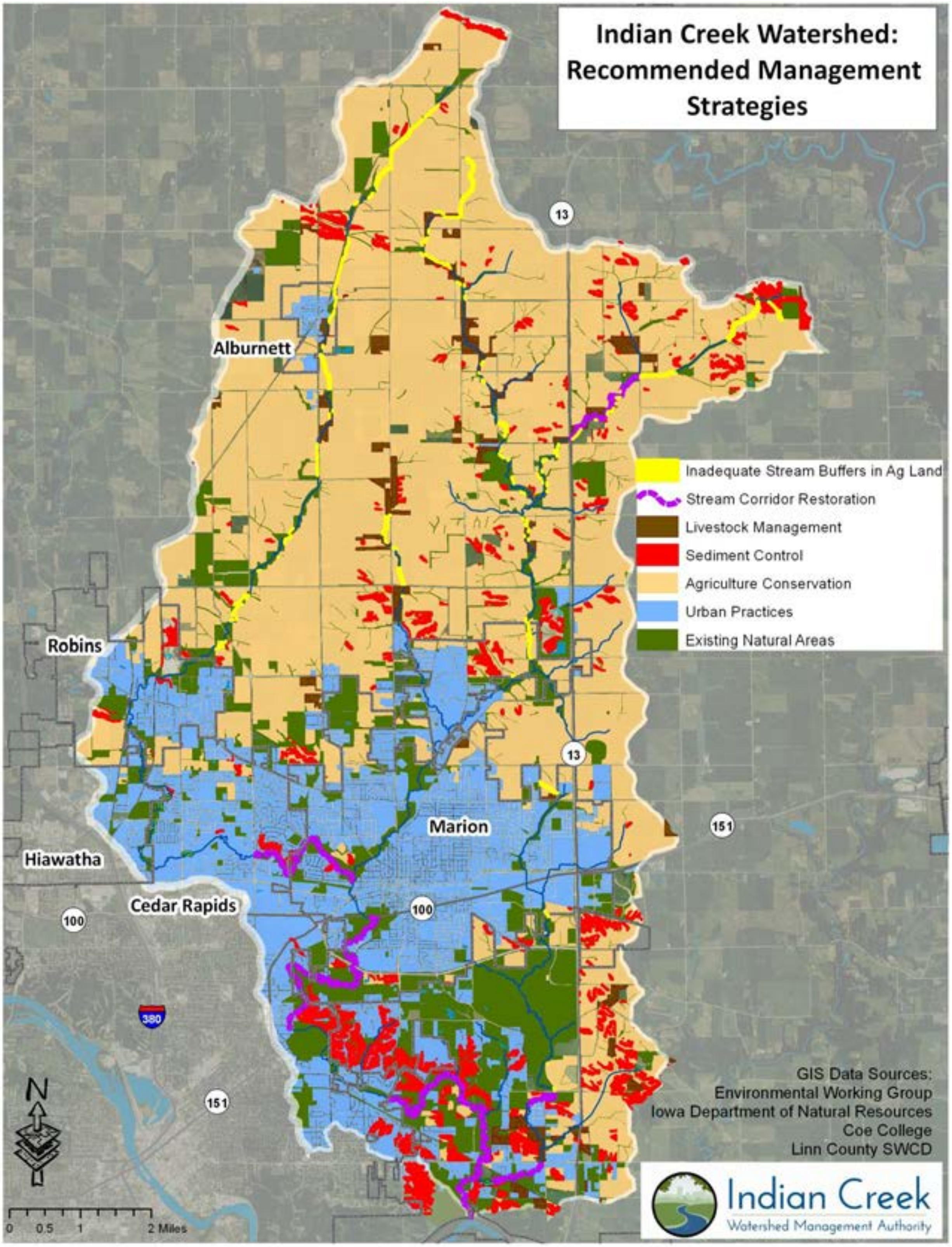


Figure 7-1. Zones for Recommended Management Strategies in Indian Creek Watershed



Source: ECICOG and Iowa Department of Natural Resources

Management Strategy Zones

Riparian Buffers

Riparian buffers are vegetated zones immediately adjacent to a stream. They can be extremely beneficial for trapping sediment and nutrients, and can provide water storage during flood events, which may reduce downstream peak flows.

Additional BMP strategies in these locations could include sediment and runoff trapping structures in the adjoining gullies, infiltration practices to reduce stormwater runoff from urban areas, and fencing to restrict livestock access to the stream corridor.

Stream Corridor Restoration

Several of the assessments identified areas where work in or along the stream corridor would be beneficial. These activities are grouped together here, though more details on the practices that are needed within specific segments can be found in the related appendices.

Streambank Stabilization is used to stabilize and protect banks of streams or constructed channels. It uses a combination of bioengineering with native vegetation, hard armoring with rock if needed, and adjacent riparian area improvements via removal of non-native vegetation and replacement with native species. Streambank stabilization prevents the loss of land or damage to land uses or other facilities adjacent to the banks. ICWMA members have identified several projects related to streambank stabilization that are high local priorities listed here with cost estimates.

- Bank stabilization on Indian Creek at 40th Street Drive SE -- $100,000
- Bank stabilization on Indian Creek along the Sac & Fox Trail near Rosedale Road -- $50,000
- Bank stabilization on Dry Creek through South Troy park -- $150,000
- Clear out debris on Dry Creek through South Troy park
- Clear out debris on Dry Creek west of C Avenue NE -- $40,000
- Clear out debris on Indian Creek north of Cottage Grove -- $30,000
- Clear out debris on Dry Creek from Northwood Drive to Tucker Park -- $40,000
- Repair or replace bridge on Bertram Road crossing Indian Creek -- $750,000
- Build access to Dry Creek at C Avenue NE -- $10,000
- Expand & improve recreational access to Indian Creek by extending & raising the CEMAR trail next to Indian Creek between Hwy 100 and 30th St Drive -- $1 million

Artificial Pool-Riffle Complexes help to restore the natural hydrology of the stream. They can also provide habitat for aquatic organisms such as fish and insects.

Livestock Management

The RASCAL and land use assessments identified areas in the watershed where livestock management practices could be implemented. Limiting livestock access to streams can reduce streambank erosion, and facilitates growth of riparian vegetation to help stabilize streambanks and filter nutrients and pathogens from animal waste. Livestock management practices include:

Access Control involves either temporary or permanent exclusion of animals or vehicles from streambanks.

Stream Crossings help control streambank erosion by creating stabilized areas for both animal and vehicle traffic to cross streams.

Heavy Use Area Protection involves stabilizing land in areas that are heavily impacted by livestock, such as outdoor paddocks or near feeding troughs, to control erosion and soil disturbance.

Planned (Prescribed) Grazing System divides pasture into two or more paddocks with fencing. Cattle are moved from paddock to paddock on a pre-arranged schedule based on forage availability and livestock nutrition needs.

Sediment Control

The land use assessment identified areas in the watershed with greater than 0.5 tons per acre per year sediment delivered to Indian Creek and its tributaries. These areas are high priority locations for sediment-trapping practices, on farmed ground as well as other areas in the watershed.

Vegetated filter strips or buffer strips are shallowly sloped vegetated surfaces that remove suspended sediment and nutrients from water runoff. When installed and functioning properly, the EPA has documented that filter strips can reduce total suspended solids (sediment) by 73%, total phosphorus by 45%, and total nitrogen by 40%.

Grade Stabilization Structure is a dam, embankment or other structure built across a grassed waterway or existing gully control to reduce water flow. The structure drops water from one stabilized grade to another and prevents over-fall gullies from advancing up a slope.

Contour Farming involves tilling and planting on the land contour to create hundreds of small ridges or dams. These ridges or dams slow water flow and increase infiltration which reduces erosion.

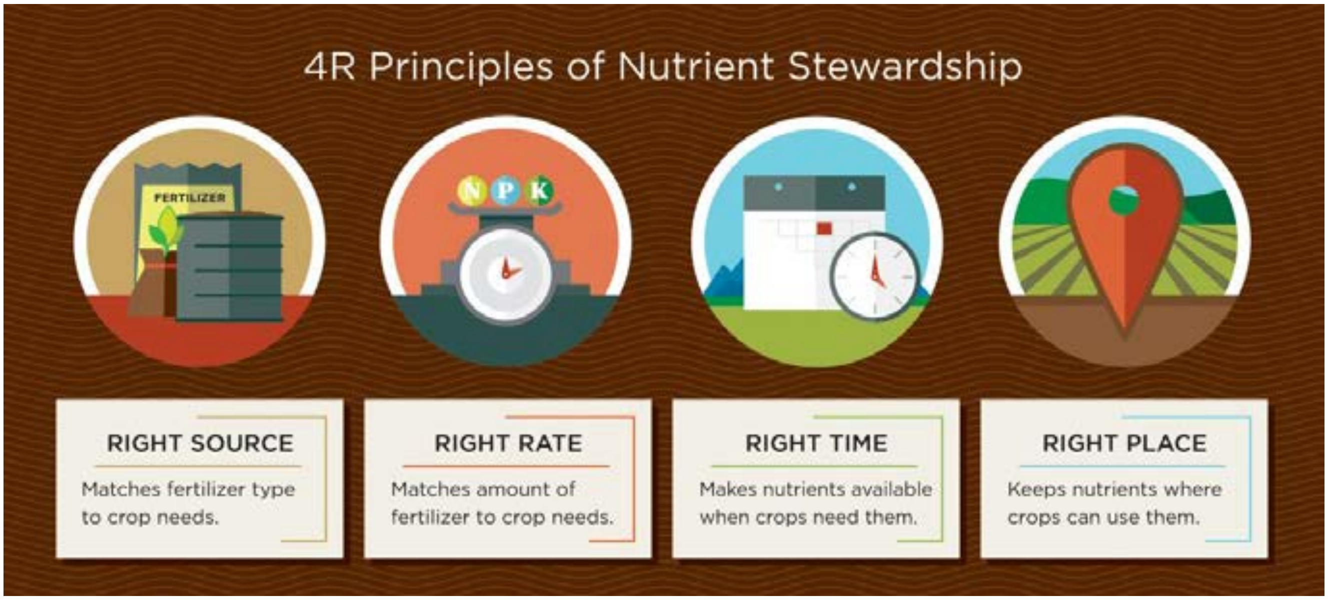
Grassed Waterway is a natural drainage way graded and shaped to form a smooth, bowl-shaped channel. This area is seeded to sod-forming grasses. Runoff flows across the grass rather than tearing away soil and forming a gully. An outlet is often installed at the base of the drainage way to stabilize the waterway and prevent any new gullies from forming.

Water and Sediment Control Basins are small earthen embankments built across an area of concentrated flow within a field. They are designed to reduce the amount of runoff and sediment leaving the field.

Agricultural Conservation

Agricultural conservation encompasses a broad array of practices and strategies. Due to the geographic scope of the Indian Creek HUC-10 watershed, this plan does not aim to provide specific field-scale recommendations for agricultural BMPs, but identifies the suite of practices that could be implemented in the areas used for row-crop production identified in the land use assessment. Specific strategies will be developed through working one-on-one with farm owners or operators to identify the practices that meet their agronomic and conservation goals. The Indian Creek WMA will work with partners such as the Linn SWCD, NRCS, ISU Extension, and crop consultants / advisors to promote a balanced strategy of managing natural resources while maintaining agricultural productivity.

In-field (Cultural) Management Strategies address resource concerns such as soil erosion and nutrient loading at the source. Building soil health and reducing soil bulk density, as well as increasing residue on crop fields, are key elements of in-field conservation management. Nutrient management is another aspect of this, focusing on the 4 Rs of nutrient application: the Right Time, Right Place, Right Amount, Right Source.



Source: www.nutrientstewardship.com/what-are-4rs

Nutrient management practices include:

- Reduce nitrogen application rate to the MRTN: Reduce the nitrogen application to the level which maximizes yield vs. fertilizer costs.
- Use a nitrification inhibitor to slow the microbial conversion of ammonium-nitrogen to nitrate-nitrogen. The practice specifically uses nitrapyrin and applies only to fall application of anhydrous ammonia.
- Eliminate fall anhydrous nitrogen application involves moving fall anhydrous N fertilizer application to spring pre-plant. It prevents denitrification and leaching during late fall, winter and spring.
- Side-dress all spring applied nitrogen during the periods of plant demand (late spring/early summer) rather than the spring which reduces the risk of loss from early spring rainfall/leaching events.
- Reduce phosphorus application rates in fields that have high to very high soil test phosphorus content. This practice minimizes phosphorus fertilizer over-application.
- Manure injection/ Phosphorus banding involves injecting liquid manure and banding solid inorganic fertilizers within all no-till acres. Placing phosphorus at the root zone can increase phosphorus availability and allow for reduced application rates.

Other in-field management practices include:

- Conservation Tillage includes a range of practices from permanent no-till to strip-till to reduced tillage. The overall goal is to preserve some degree of crop residue on the soil surface to reduce erosion. A primary benefit of no-till is the resulting increase in soil health. Tillage negatively impacts soil microorganisms and earthworms, reduces the organic matter within the soil, and increases soil bulk density. Healthy soils are spongier, with increased pore spaces, which can help to infiltrate water more quickly. Along with soil conservation benefits, high fuel prices are driving a switch to conservation tillage for many farmers. Eliminating tillage passes reduces both fuel and labor expenses.
- Cover Crops include any number of plants that are sown following the growing season of corn / beans, such as oats or cereal rye. Cover crop varieties include those that are winter-killed or those that are winter-hardy. Both types have specific benefits for reducing erosion, nutrient uptake, nitrogen-fixation, or

adding organic material to the soil. The varieties selected in any situation depend upon the specific agronomic goals and the experience level of the grower.

- Increasing organic matter provides both greater water and nutrient retention, preventing leaching, and increasing soil fertility. Currently, the primary practices for building soil organic matter are planting cover crops, reducing tillage and applying manure rather than commercial fertilizer.
- Extended Rotation is a rotation of corn, soybean, and at least three years of alfalfa or legume-grass mixtures managed for hay harvest. These crops provide soil cover, reduce soil erosion, and reduce phosphorus loss.
- Pasture/Land Retirement removes land from agricultural production and converts it perennial vegetation to limit soil erosion. This is a long-term CRP program (10-15 year). The established vegetation is a near natural system that has animal habitat and soil improvement benefits.
- Terraces break long slopes into shorter ones. They usually follow the contour. As water makes its way down a hill, terraces serve as small dams to intercept water and guide it to an outlet.

Edge-of-field or structural practices provide an additional line of defense to trap pollutants and infiltrate runoff before it reaches a waterway. These practices can significantly reduce pollutant loads, especially when used in conjunction with appropriate in-field management practices as part of a whole-farm conservation plan.

Controlled Drainage (Drainage Water Management) describes the practice of installing water level control structures within the tile system. This practice reduces nitrogen loads by raising the water table during part of the year, thereby reducing overall tile drainage volume and nitrate load. The water table is controlled through the use of gate structures that are adjusted at different times during the year. When field access is needed for planting, harvest or other operations, the gate can be opened fully to allow unrestricted drainage. When the gate is used to raise the water table level after spring planting, it may allow more plant water uptake during dry periods, which can increase crop yields. Controlled drainage may be used on fields with flat topography, typically one percent or less slope.

Nutrient Removal Wetlands are shallow depressions created in the landscape where aquatic vegetation is typically established. Nutrient removal wetlands can be a cost-effective approach to reducing nitrogen loadings in watersheds dominated by agriculture and tile drainage. Wetlands and surrounding grassland buffers also provide environmental benefits beyond water quality improvement such as increases in wildlife habitat, carbon sequestration, and flood water retention.

Denitrification bioreactors are trenches in the ground packed with carbonaceous material such as wood chips that allow colonization of soil bacteria that convert nitrate in drainage water to nitrogen gas. Installed at the outlet of tile drainage systems, bioreactors usually treat 40-60 acres of farmland.

Saturated Buffers are designed to treat tile runoff, which otherwise bypasses riparian vegetation to discharge directly to the ditch or stream. Field tiles are intercepted and routed into a new tile pipe that runs parallel to the ditch or stream. The tile water is allowed to exfiltrate and saturate the buffer area. The contact with soil and vegetation results in significant denitrification.

Urban Practices

Urbanization has added vast amounts of impervious surface to the watershed dramatically altering the hydrology of the Indian Creek watershed. A variety of infiltration-based practices can be employed in the urban / residential areas of the watershed to help mitigate the effect of impervious surface. The implementation of BMPs will depend upon the individual homeowners, business owners, and communities willingness to implement 'green infrastructure' strategies instead of traditional stormwater conveyance systems. Examples of urban practices include:

- Native Plantings are low maintenance areas that provide habitat for insects and birds. Their deep root system increase soil organic matter, builds soil quality, and helps retain and infiltrate storm water.
- Bioswales are engineered and vegetated storm water conveyance systems that provide an alternative to storm sewers. They absorb runoff from a light rain and carry runoff from heavy rains to storm sewer inlets or directly to surface waters. Bioswales improve water quality by infiltrating the first flush of storm water runoff and filtering the large storm flows they convey. According to EPA, vegetated swales reduce sediment by 65%, total phosphorus by 25%, and total nitrogen by 10%.
- Pervious Paving allows water to infiltrate into layers of limestone placed below the paving and then into the soil and groundwater below. By infiltrating most of the storm water on-site, the amount of water and pollution flowing into storm sewers and streams is reduced. This helps protect water quality, maintains more stable base flows to streams, reduces flood peaks, and reduces stream bank erosion. Studies documented by the EPA show that properly designed and maintained pervious pavement can reduce sediment by 90%, total phosphorus by 65%, and total nitrogen by 85%.
- Rain Gardens are depressional areas landscaped with perennial flowers and native vegetation that soak up rainwater. They are strategically located to capture runoff from impervious surfaces, such as roofs and streets.
- Green Roofs help to mitigate the effects of urbanization on water quality by filtering, absorbing or detaining rainfall. They are constructed of a lightweight soil media, underlain by a drainage layer, and a high quality impermeable membrane that protects the building structure. The specialized mix of plants on green roofs thrives in the harsh, dry, high temperature condition of the roof and tolerates short periods of inundation from storm events.
- Street Sweeping gathers and properly disposes of common urban pollutants such as sediment, trash, road salt, oils, nutrients, and metals. These materials would otherwise wash into storm sewers and streams following rain events. The EPA reports that weekly street sweeping can remove up to 16% of sediment and up to 6% of nitrogen and phosphorus.
- Detention Basins can be either wet or dry detention basins used to reduce peak discharge and detain runoff for a specified short period of time. A wet detention basin is a constructed stormwater detention basin that has a permanent pool of water. Runoff from each rain event is detained and treated in the pool primarily through settling and biological uptake mechanisms. Wet ponds are among the most widely used stormwater practices. A dry detention or extended dry detention basin is a surface storage basin or facility designed to provide water quantity control through detention and/or extended detention of stormwater runoff. ICWMA members have identified two detention basin projects as listed here with cost estimates.
    - Regional detention basin west of Alburnett Rd & north of Dawn Dr: $900,000
    - Regional detention basin west of Alburnett Rd & north of the future Tower Terrace Rd: $700,000

Chapter 8 – Funding Section

"The only way forward, if we are going to improve the quality of the environment, is to get everybody involved."

Richard Rogers

The following is a description of available funding sources for watershed management efforts that was adapted from the Iowa Stormwater Education Program.

8.1 Iowa Department of Agriculture and Land Stewardship

Water Quality Initiative accepts applications on an annual basis for projects focused on improving water quality in urban areas. Preference points are given to projects within nine priority watersheds and the projects selected will be announced in March.

Watershed Development and Planning Grants are issued by the Division of Soil Conservation for Districts and watershed partners to complete projects such as watershed assessment, problem source identification, partnerships, and landowner support.

Water Protection Fund and/or Watershed Protection Fund offers financial assistance to SWCDs interested in watershed implementation grants and those interested are encouraged to contact Iowa DNR.

Watershed Improvement Review Board - The Board awards grants to improve water quality and flood prevention. Eligible applicants are local watershed improvement committees, soil and water conservation districts, counties, county conservation boards, public water supply utilities and cities. The Iowa Legislature makes annual appropriations to the Watershed Improvement Fund, which the WIRB administers.

8.2 Iowa Economic Development Authority

Vision Iowa - River Enhancement Community Attraction and Tourism Program was created to assist projects that will provide recreational, cultural, entertainment and educational attractions.

Community Development Block Grants can be used to fund water and sewer facilities and must comply with the Green Streets criteria. Applications are guided by the CDBG annual application workshop, which is held in conjunction with the Water and Wastewater Infrastructure Funding Summit.

8.3 Iowa Department of Natural Resources

Grant Programs

319 Watershed Planning Grant is designed to assist interested groups in developing a Watershed Management Plan, which identifies problems in the watershed and proposes solutions for better water quality. Applicants are encouraged to contact their Iowa DNR Basin Coordinator.

319 Watershed Implementation Grant is designed to assist interested groups in putting their Watershed Management Plan into action. Applicants are encouraged to contact their IDNR Basin Coordinator.

Land and Water Conservation Fund (LWCF) is a competitive, federally funded grant program that provides match funds of 50% for outdoor recreation area development and acquisition. All Iowa's cities and counties are eligible to participate and the deadline is in March each year.

Resource Enhancement and Protection (REAP) funding is appropriated by the Iowa Legislature and signed into law by the Governor. The program is divided into three categories.

- City Park & Open Space: Grant amount dependent on city size and is specifically for parkland expansion and multi-purpose recreation development.
- County Conservation: Thirty percent of this fund is automatically and equally allocated to all 99 counties to be used for easements or acquisition, capital improvements, stabilization and protection of resources, repair and upgrading of facilities, environmental education, and equipment. Another thirty percent is allocated based on population and the remaining forty percent is available through competitive grants.
- Conservation Education Program (CEP): An annual amount of $350,000 is administered by a five-member board of landowners, naturalists, and educators. Funds are divided according to a standard application and mini-grants.

Loan Programs

Clean Water State Revolving Fund is jointly administered by the Iowa Finance Authority (IFA) and Iowa DNR Clean Water Program is designed for publicly owned wastewater treatment works and non-point source project (both public and private entities). A list of priority projects is outlined by the Intended Use Plan on a quarterly basis.

Storm Water Loan Program is available at 3% interest for municipalities that are required to have an MS4 permit.

Water Resource Restoration Sponsored Projects Program reduces the overall interest rates on loans for projects designed to improve water quality where the wastewater treatment facility is located. Applications are approved by the Environmental Protection Commission on an annual basis.

8.4 Federal Agricultural Programs

Environmental Quality Incentive Program (EQIP)

The NRCS's Environmental Quality Incentive Program is a voluntary conservation program that provides financial assistance to individuals/entities to address soil, water, air, plant, animal and other related natural resource concerns on their land. EQIP offers financial and technical assistance to install or implement structural and management practices on eligible agricultural land.

Conservation Reserve Program (CRP)

The Conservation Reserve Program is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species such as native prairie grasses that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length.

Wetland Reserve Program (WRP)

The Wetlands Reserve Program is a voluntary program offering farmers the opportunity to protect, restore, enhance, and protect wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. Landowners who choose to participate in WRP may sell a conservation easement or enter into a cost-share restoration agreement with NRCS to restore and protect wetlands. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum 10-year duration. Landowners and NRCS then develop a plan for the restoration and maintenance of the wetland. As a requirement of the program, landowners voluntarily limit future use of the land, yet retain private ownership.

Grassland Reserve Program (GRP)

The Grassland Reserve Program is a voluntary conservation program that emphasizes support for working grazing operations, enhancement of plant and animal biodiversity, and protection of grassland under threat of conversion to other uses. Participating farmers voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seeding, subject to certain restrictions during nesting seasons of bird species that are in significant decline or are protected under Federal or State law. A grazing management plan is required for participants.

Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program is a voluntary program that provides financial and technical assistance to help conserve agricultural lands and wetlands and their associated benefits through Agricultural Land Easements. ACEP is a new program designed to consolidate the WRP, GRP, and Farm and Ranch Land Protection Program. Land eligible for agricultural easements includes cropland, rangeland, grassland, pastureland, and nonindustrial private forest land, while farmed or converted wetland that can be successfully and cost-effectively restored is eligible for wetland reserve easements. These programs require agricultural land easement or wetland reserve restoration easement plans to protect the land over the long-term.

Wildlife Habitat Incentive Program (WHIP)

The Wildlife Habitat Incentive Program is a voluntary program for landowners who want to develop and improve wildlife habitat primarily on private lands. It provides both technical assistance and cost share payments to help native fish and wildlife species, reduce impacts of invasive species, and improve aquatic wildlife habitat. Participants work with NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the participant's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. NRCS and the participant enter into a cost-share agreement for wildlife habitat development that lasts from 5 to 10 years.

Chapter 9 – Education & Outreach Plan

"Never doubt that a small group of thoughtful, committed citiznes can change the world; indeed, it's the only thing that ever has."

Margaret Mead

Education and public awareness is essential to effective water resources management. Public education will raise awareness about the environmental impacts of daily activities and build support for watershed planning and projects. This Plan includes the framework for a detailed education and awareness program specifically designed to:

- Raise public awareness of water issues and needs to foster support for solutions
- Educate the public and other identified target groups in order to increase awareness and encourage behavioral changes
- Coordinate with other public as well as private entities to maximize the visibility of the Indian Creek Watershed Management Authority and its messages

One of the highest ranked implementation strategies in the Plan is to "develop a collaborative communication & education plan between all ICWMA members using existing materials." This section will outline how the education and public awareness program can be organized as both a watershed-wide program managed by the ICWMA and education activities undertaken by member local governments.

An Education & Outreach Subcommittee of the ICWMA will be established to coordinate the education messages, materials and methods used among ICWMA Members. A variety of resources including State agencies, the Iowa Storm Water Education Program (ISWEP), and the County Conservation Boards (CCB) have already created educational tools such as mass media content, brochures/factsheets and presentation materials. Coordinating education and outreach efforts will have many benefits including reducing duplication of effort, improving cost effectiveness by sharing costs, and expanding the size and scale of education efforts to include mass media such as television and radio advertising.

The goal of the ICWMA Education & Outreach Subcommittee will be to develop a watershed level public education program that raises awareness of local water resource protection issues. An informed public will be more likely to support local activities as well as change behaviors that will lead to the long-term protection of our water resources. Involving the public in local watershed protection efforts is crucial because it promotes broader public support, helps create an ethic of stewardship and community service and enables the public to make informed choices about water resources management.

The following education strategies were identified as priorities for the first 5-year phase of the Plan and will guide the efforts of the Education & Outreach Subcommittee in the near term.

- partner with ISWEP to hold workshops (with CEUs) for developers, builders, engineers, and inspectors about infiltration practices and Low Impact Development (LID)
- develop a collaborative communication & education plan between all ICWMA members using existing materials (such as the CCB watershed PSAs)
- organize events to connect urban residents with the creek such as storm drain labeling, installing watershed signs, or festivals in parks with access to the creeks, etc
- partner with city & county planning departments to provide trainings, tours or lunch-n-learns to Planning & Zoning Committees, city staff, and other decision makers on stormwater management practices
- communicate the importance of proper management of pet wastes to residents
- communicate with landowners about the Nutrient Reduction Strategy (NRS) recommended practices & foster general understanding about the NRS through workshops, demonstration videos, and implementation of more example projects in the watershed
- communicate the results of water quality monitoring to educate about actual vs. perceived sources of pollution in the watershed
- develop an annual State of Indian Creek report to highlight activities, water quality, steps toward progress

- communicate the comparison of repeated flood recovery costs to pro-active flood mitigation practices to policy makers and the general public
- promote BMPs installed within the watershed as models through signage and/or inclusion in the self-guided podcast tour
- establish user friendly comment submittal system on ICWMA website to communicate issues with the trails and stream conditions
- organize Rainscaping workshops and urban BMP tours for homeowners, policy makers, or other interested stakeholders to communicate the purpose and attractiveness of BMPs

The ICWMA Education & Outreach Subcommittee will consider the following program framework as a starting point to building a watershed level public awareness and education program.

9.1 Program Elements

The watershed level public awareness and education program should include both public education and outreach and public participation and involvement activities defined as:

Education and outreach activities are designed to distribute education materials and messages, and perform outreach to inform citizens and target audiences.

Public participation and involvement activities provide opportunities for citizens to participate in programs and become active in implementing watershed protection programs.

Table 9-1. Example Activities

Education / Outreach Programs	Public Involvement / Participation Programs
Bill inserts or newsletters	Creek water quality monitoring program
Brochures at local government facilities	Watershed festival
Website with watershed education information	Creek clean-up events
Speakers bureau presentations	Storm drain stenciling events
Event displays and/or kiosks	Watershed citizen advisory group
Press releases	Rainscaping workshops
School classroom education	Agriculture stakeholder group

9.2 Watershed Public Education Messages

The ICWMA Education & Outreach Subcommittee will consider incorporating these central messages for the watershed level education and public awareness program as well as incorporating the Social Assessment recommendations (see Chapter 6).

- Everything we do, where we work, live or play can impact our water resources
- We are all part of the solution to stormwater pollution / we are in this together
- Clean water for drinking, recreation and economic benefits need to be protected for future generations
- Watershed stewardship: It is the responsibility of everyone to protect our water resources
- We all live downstream

9.3 Education Focus for Target Audiences

The ICWMA Education & Outreach Subcommittee will tailor the messages for the target audiences identified in the Lunch & Learn events as summarized below.

General Public

Basic concepts of stormwater runoff and non-point source pollution including how their actions can impact water quality.

Students / Schools

Work with Coe College to distribute their newly developed curriculum to school systems to incorporate water resource protection lesson plans into current curriculum.

Homeowners / Urban Agriculture / Golf Courses

Best practices for fertilizer and pesticide use on gardens and landscapes as well as proper disposal of grass clippings and leaves in order to protect nearby water sources. Using low impact development practices to mitigate runoff such as rain gardens, rain barrels, and permeable paving.

Builders / Developers / Design Professionals

Best management practices on proper disposal of construction materials, erosion and sedimentation control, low impact development and buffer protection.

Realtors / Floodplain Residents

Explain long term flood risk to potential home buyers.

Local Government Staff

Educate local government staff such as public works, parks and recreation, code enforcement, planning and zoning, etc. on best management practices that affect water quality.

Local Elected Officials / Governing Boards

Importance of promoting and sufficiently funding the implementation of best management practices in order to protect local water resources.

9.4 Education Program Delivery Techniques

There are a number of ways to reach target audiences in a public education effort both at a local and watershed level. Some examples of these delivery methods are outlined below.

Internet

- Website – An internet site or page can provide an inexpensive way to foster awareness and education of stormwater management and watershed protection issues at the community or regional level. A website can also serve as an information clearinghouse for other educational materials, and provide resources and additional links for target groups such as the general public, the development communities, and various industries.
- Email – Email newsletters can provide information on upcoming outreach events as well as tips on nonpoint source pollution control for targeted audiences and the general public. Email is often the least expensive way to reach a larger number of individuals and entities.

- Streaming media – Tools such as streaming audio and video, webcasts, online training workshops, and other interactive electronic media tools can provide additional opportunities for reaching target audiences.

Printed Materials

- Brochures & Fact Sheets – Brochures, fact sheets and other literature can be for general information or provide messages and tips specific to a particular topic or target group. Printed materials often complement other education and public awareness activities such as public outreach events and workshops.
- Bill Inserts – Printed materials can be designed to accompany utility bills or other correspondence to local citizens and businesses. Inserts can include brochures, newsletters, tips on best management practices and event notices. Bill inserts are an excellent way to distribute educational materials without additional postage expenses.
- CD / DVDs and DVD-ROMs are mediums for providing interactive educational material and are especially well-suited for youth and classroom education. In addition, video DVD's can be used to distribute content such as public service announcements (PSAs), video programs, and instructional/training videos.
- Posters – Wall posters provide a great deal of information quickly to the target audience at a stationary location and can be displayed at locations such as libraries, schools, and other public locations.

Mass Media

- Press Relations – Both local communities and the ICWMA can work with the media to ensure coverage of stormwater and watershed protection issues and activities. This can include both articles and event listings in general circulation newspapers, specialty papers, and regional magazines; radio and television interviews; features on radio and television news and public affairs programming; and coverage of events such as watershed fairs and creek cleanups.
- Television Public Service Announcements – Television advertising using PSAs provide an immediate impact with a visual message. Broadcast channels reach a wide audience but are high-priced. Cable television offers local communities the ability to target their citizens and even tailor advertising to specific channels and audiences.
- Radio Public Service Announcements – Radio PSAs are an alternative to television and provide a less expensive way to reach a large number of individuals with messages and nonpoint source pollution tips.
- Outdoor Advertising – Billboards and other outdoor advertising such as bus shelter ads can be a way to reach audiences through a different medium. These outdoors ads are well suited to short theme messages and specific tips on stormwater pollution prevention.
- Other Advertising – Other advertising methods that may be considered include movie theater PSAs, paid ads in newspapers and print magazines, and sponsorship of traffic and/or weather spots on radio.

Outreach and Involvement

- Workshops – Workshops and seminars are opportunities to provide more detailed information and training to citizens, businesses and public sector groups.
- Speakers Bureau – A speakers bureau provides an opportunity for government staff and other professionals to address community organizations, business groups, homeowners' associations, church groups and educational institutions on issues related to stormwater and watershed management.

- Events – Hosting or participation in community events provides an opportunity for the distribution of information and resources directly to target communities. In addition, topic specific events such as watershed fairs, stream cleanups and storm drain stenciling are an important way to involve citizens directly in watershed management efforts.
- Event Display – An event display provides a way to present information and educational messages at workshops and other events. Exhibits may be permanent or portable and can have static displays, videos, or interactive features. Portable display boards are often effective for use at events or workshops.
- Promotional Items – Promotional giveaways such as magnets, pencils and bumper stickers can be imprinted with pollution prevention messages and tips and distributed at community events, schools and workshops.

Chapter 10 – Water Monitoring Plan

"Not everything that can be counted counts, and not everything that counts can be counted."

Albert Einstein

Water monitoring is an important part of establishing a baseline for both water quality and stream flows, and for documenting progress in achieving the goals of the Indian Creek Watershed Management Plan. Due to the nature of the watershed, the monitoring plan should have both an urban and agricultural monitoring component, in which the parameters being monitored may differ according to the land uses.

Currently in the Indian Creek watershed, several groups are conducting water monitoring, including:

- Coe College: Water quality monitoring at 7 sites (Martin St. Clair Ph.D.)
- USGS: Discharge, gage height, precipitation at Thomas Park in Marion
- Iowa Flood Center: Bridge sensors at 6 locations
- Iowa DNR: Biological monitoring
- IOWATER: Volunteer water quality monitoring

Building off the existing monitoring activities will provide a wealth of information about conditions in the Indian Creek watershed that can help to inform management decisions. A framework for an on-going monitoring program in the Indian Creek watershed is provided below.

Generally speaking, an intense monitoring effort over several years is recommended to adequately assess pollutant loading and to detect trends. Trend monitoring should be conducted at the USGS flow gauging station at Thomas Park as the long-term primary site. Upstream secondary stations can be added over time in a leap-frog method of identifying priority areas or areas of relatively good water quality.

10.1 Flows

Monitoring flows in Indian Creek, Dry Creek, and Squaw Creek over time - how much water flows each day, month and year - is important both for understanding the nature of flooding, as well as for documenting pollutant loads from the Indian Creek watershed to the Cedar River. Pollutant loads (such as pounds of sediment or phosphorus per year) are calculated by multiplying stream flows by sampled pollutant concentrations, which requires measuring continuous stream flows. This is done by use of computerized flow gauging stations that record the depth of the stream every 15 minutes or so. The depth of the stream is converted into stream flows based upon mathematical relationships derived from numerous measurements of flows and depths across the stream channel each year. Flow monitoring is currently conducted at the USGS stream gage site at Thomas Park (Station 05464695), just downstream of the confluence with Dry Creek. Additional stations could include:

- Dry Creek, potentially at Donnelly Park, to document flow and pollutant load contributions to Indian Creek
- Squaw Creek at Mount Vernon Road, to document flow and pollutant load contributions to Indian Creek
- Indian Creek upstream of the Dry Creek Confluence (potentially at County Home Road), to document the agricultural contributions
- Indian Creek near the outlet to the Cedar River, at Indian Creek Nature Center

10.2 Pollutant Concentrations

The Indian Creek WMA benefits greatly from the partnership with Coe College in collecting water quality data. It is hoped that this partnership will continue into the future, at a minimum collecting the same basic suite of data: dissolved oxygen, turbidity, temperature, specific conductance, pH, total suspended solids, chloride, nitrate, sulfate, dissolved reactive phosphorus, and *E. coli.* Additional resources should also be sought to allow for enhanced monitoring efforts, as determined by the specific phase of the watershed plan being implemented.

- Urban Constituents Monitoring should be conducted in the lower half of the watershed to assess the impact of urban land uses on the watershed's creeks. The effects of urbanization can vary from increasing the temperature of a receiving water body (thermal loading), the amount of runoff contaminated with urban pollutants such as oil and grease or heavy metals, and the rate / volume of runoff reaching the creeks. Parameters could include oil and grease, heavy metals, chloride, temperature, and TSS.
- Tile Outlet Monitoring would be a useful addition to the existing data set. Monitoring the quality of water from agricultural tile outflows is beneficial from the standpoint of the Indian Creek watershed, in terms of understanding field-scale contributions of nitrates and dissolved orthophosphate to the watershed. In addition, tile outlet monitoring has been useful to producers in terms of helping them to understand the patterns of nitrate leaching from their fields, which has a direct economic component. It should be noted that tile outlet monitoring results are never published publicly to protect the privacy of the landowner. However, publishing aggregated tile outlet monitoring data at the watershed scale is acceptable as long as individual data collection points are not listed.
- Storm Event Sampling is useful for characterizing the 'first flush' of contaminants reaching Indian Creek following a rain event. Automatic flow-paced sampling should be used, which will allow for sampling of each storm event's rising and declining limbs of the storm hydrograph (peak and recession of flows). Rising water levels at the beginning of a storm typically have higher pollutant concentrations that decline with receding water levels. If funding is not available (or until funding becomes available) grab sampling could be done at the USGS station with recording of instantaneous river gauge height, date and time noted for each sample. Multiple grab samples would need to be taken over the course of a storm event. Monitored pollutants should include; total phosphorus, soluble reactive phosphorus, total suspended solids, nitrate-nitrogen.
- IOWATER Monitoring should be promoted in the watershed to add to the existing network of data collection. A Volunteer Monitoring Program could be developed to encourage IOWATER-trained volunteers to collect data on a pre-determined day and time (such as 1st and 3rd Saturdays from 7:00 am – 9:00 am). This type of 'snapshot' monitoring would serve the dual purpose of providing beneficial data on trends at multiple locations, while providing a volunteer opportunity to help get people involved and aware of the watershed improvement effort.

10.3 Bacteria (*E.coli*) Monitoring

Bacteria monitoring should also be continued in the Indian Creek watershed, ideally including the USGS Station to determine bacteria loads. For comparison to standards, sampling should occur at least 5 times per month per site, from April through October, to obtain geometric mean concentrations for comparison to Iowa *E.coli* standards. Standardized sampling protocols have been established for monitoring *E. coli* in streams.

10.4 Biological Monitoring

Development and implementation of a long-term biological monitoring and assessment plan is strongly recommended to provide a mechanism for tracking progress in habitat improvements and documenting the stream aquatic community response. The conclusions and recommendations made in the stream habitat condition assessment (Chapter 4) were based on limited data, some of which is outdated. The value of stream biological and habitat monitoring data collected at a limited number of fixed locations might be enhanced by careful integration and refinement of rapid visual assessments (such as RASCAL) that are capable of producing a more comprehensive assessment of habitat improvement needs throughout the watershed. Staff with the Iowa DNR stream bio-assessment program has offered to provide technical advice on developing an appropriate habitat and biological sampling design. At a minimum, follow-up sampling at previously sampled bio-assessment sites is a logical first step.

10.5 Compiling the Data and Calculating Loads

The end result of the intensive monitoring is the calculation of water flows and nutrient/sediment losses from the land expressed as loads or pounds of phosphorus or sediment per acre per year. Wet years can have larger losses that may need to be adjusted for rainfall for inter-year comparisons (pounds P /acre/inch of precipitation). Very large storms can be expected to produce large amounts of runoff and associated pollutants and hence, the emphasis should be on evaluating average values for more typical years.

In addition to calculating loads based on field measurements, the Iowa DNR's Pollutant Load Reduction calculator should be used to document load reductions resulting from the implementation of specific Best Management Practices in the watershed. The Iowa DNR or Iowa DALS Basin Coordinators can assist with setting up an account for the Indian Creek watershed once the project has reached the stage of BMP implementation.

The data collected through the various programs should be compiled into an annual monitoring report that summarizes the monitoring results in straightforward language, with clear conclusions and recommendations for watershed management. If possible, the monitoring report should be presented to the public (or at minimum, a ICWMA Board meeting) with responsible agencies providing an overview of their key findings. Keeping the public apprised of water monitoring data is a public outreach tool that can help to build awareness of the need for continued watershed improvement efforts.

Chapter 11 – Plan Evaluation

"This planet came with a set of instructions, but we seem to have misplaced them. Civilization needs a new operating system."

Paul Hawken

There will need to be evaluation of the progress towards implementation of the specific actions identified in the Indian Creek Watershed Management Plan and towards meeting the long-term goal of a healthy watershed. It is recommended that evaluation be completed through annual plan reviews and plan updates that occur every five years. The reviews and updates are an important component of the adaptive management approach.

> *Adaptive management is a type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices. (USGS)*

This adaptive management approach recognizes the limitations of current knowledge regarding future situations, and the inevitability of change. This Plan provides a big-picture context for specific actions based on best available data, and will need to be adjusted as better information or new conditions arise. By design, the short-term action steps are outlined in greater detail than the long-term action steps. Recommendations for the first 5 years are reasonably firm, whereas those beyond 20 years are expected to be refined several times before they are implemented.

11.1 Implementation

The ICWMA will begin Plan implementation by establishing subcommittees and advisory groups:

- Agriculture Related Advisory Group to advise project development and education strategies
- Education & Outreach Subcommittee to develop and implement education strategies
- Monitoring & Analysis Subcommittee to develop and implement a long-term monitoring and data collection plan
- Policy & Ordinance Review Subcommittee to promote adoption of model ordinances to protect the watershed
- Infrastructure Subcommittee to incorporate low impact development and best management practices into capital improvement projects

11.2 Annual Reviews

The purpose of the annual plan review is to identify and discuss implementation challenges to determine if there is a need for plan amendments. The evaluation process provides stakeholders an opportunity to discuss concerns about a particular element of the Indian Creek Watershed Management Plan. The annual reviews are a reminder that the Plan is adaptable, dynamic and flexible. Information that will be collected as part of the annual survey and evaluation of progress will include:

- Education Activities – Reporting of education and outreach efforts
- Alignment of policies– Status of adopting model ordinances
- Watershed Improvement Projects – Track implementation of projects and locations, provide watershed-wide summary with a map
- Watershed Conditions Assessment – Update and summarize monitoring program data

As additional metrics for measuring progress are developed by the ICWMA they will be included in the annual survey and progress report.

11.3 Plan Updates

Plan updates occur every 5 years and take a more holistic look at changed conditions and implementation actions since the last Plan Update. Evaluations of changed conditions for Plan Updates may include:

- Population and land use forecasts and trends

- Water quality trends using the 303(d) list and available watershed assessment data
- Social assessment changes
- Tracking of BMPs
- Flood risk modeling for future land use projections

Undoubtedly, other issues will emerge that merit in-depth consideration in the future. As with existing efforts, future planning work should be open and inclusive, involving all ICWMA members and stakeholders.

11.4 Conclusions

While the performance will be reported annually by the ICWMA members, the final measure of implementation success will be the longer term, demonstrable trends of:

- Ongoing implementation of model ordinances
- Watershed planning and greater local coordination on land use and watershed health
- The progression of communities towards proactive programs
- Proactive detection of potential pollutant sources
- Collection of better watershed conditions data
- Heightened public awareness and community support through an effective public education and awareness program
- Progress on improving surface water quality and reducing the risk of flood impacts

Appendix 1

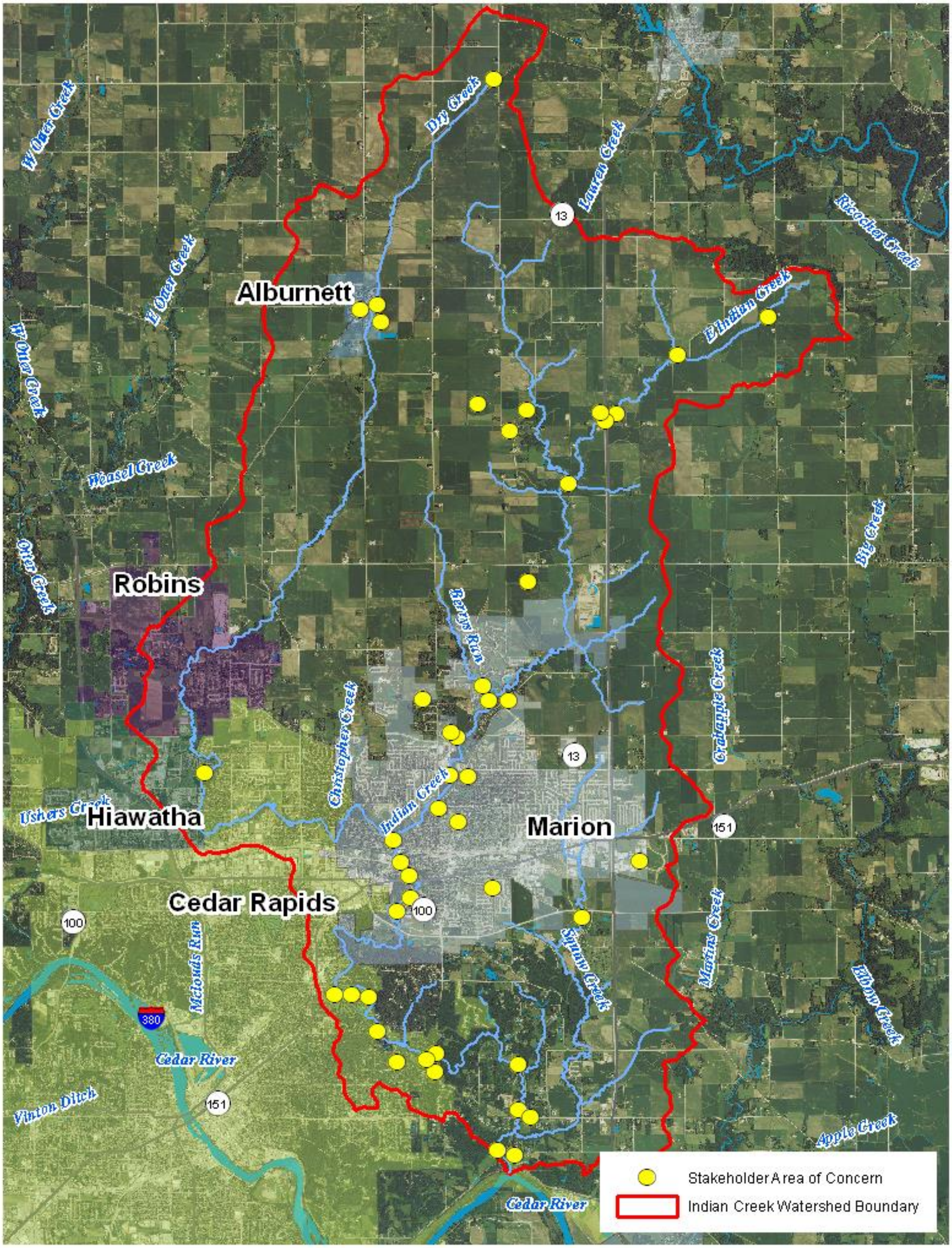
Stakeholder Input Gathered from the Two Plan Open House events on June 2nd and 3rd

- Map of Areas of Concern
- Map of Areas of Concern with Comments
- Summary of All Comments from Open House Participants

Implementation Strategies

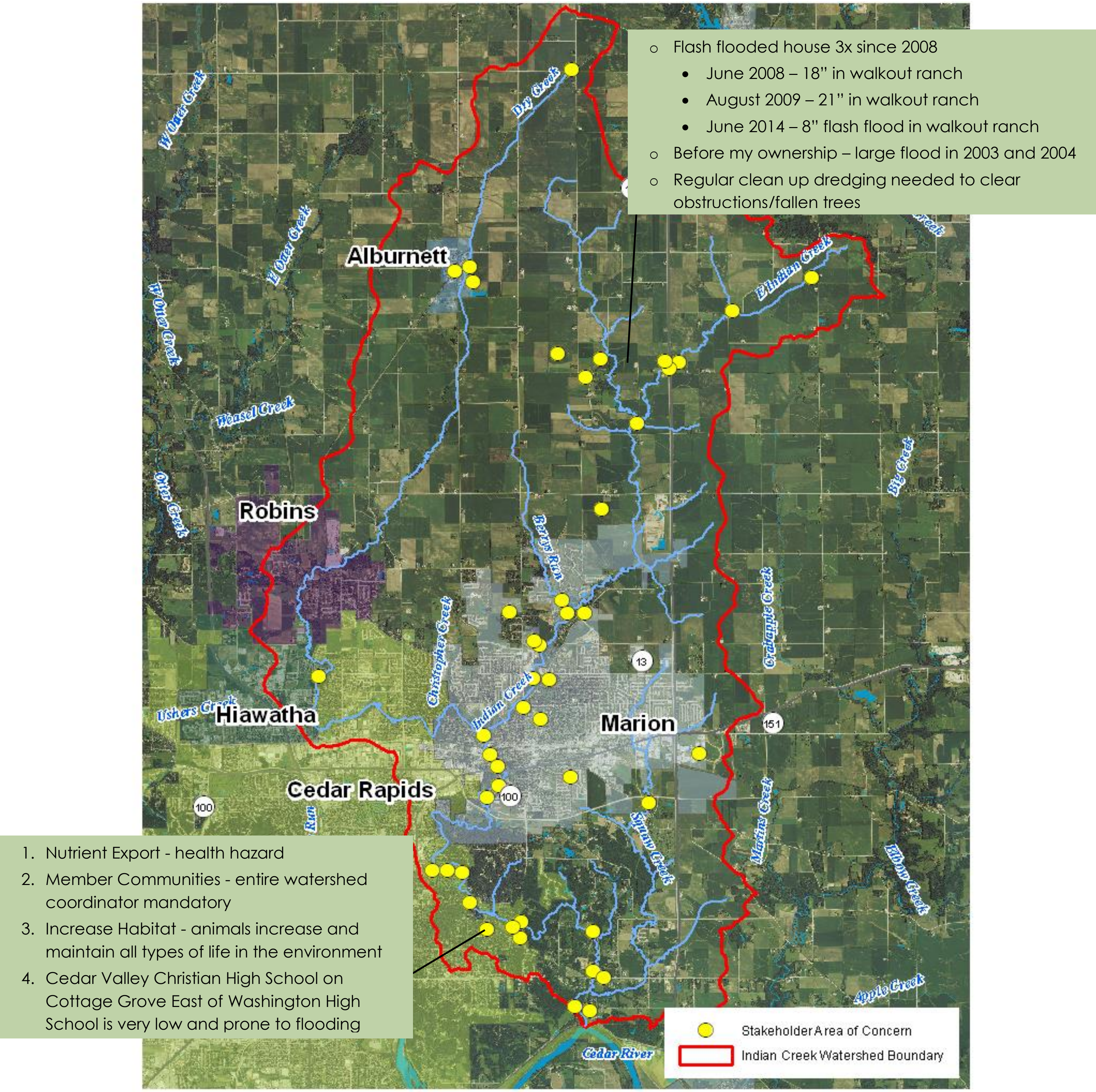
- Phase 2 (6-10 years out)
- Phase 3 (11-15 years out)
- Phase 4 (16-20 years out)

Stakeholder Areas of Concern



Map Source: Created by ECICOG with data from the open house events

Stakeholder Areas of Concern with Comments



Map Source: Created by ECICOG with data from the open house events

Comments Shared Publicly at the Open House Events June 2nd and June 3rd

- My family loves Thomas Park
- Align funding priorities with measurable improvement goals
- More roadside habitat
- Is a watershed curriculum available in Iowa Public School systems
- Could Iowa tourism fund water sustainability as it impacts revenues
- Copper Properties LLC, family owned – We love Indian Creek and grew up on it
- …because this is where it all begins.
- Promote and stress local benefits (flood mitigation, water quality, recreation) to local organizations to try and establish local funding.
- We believe in doing our best in preserving our land we farm!
- This site is important to me because it is:
    - Close to my house
    - Crossed by East Post Rd and tremendous amount of traffic
    - Is along the Sac Fox Trail
    - Visible to the community
    - Has pocketbook mussels
- Steve Cooper needs more summer help. To aide him in the difficult time of the year.
- Monitor water contaminants past *e.coli*-nitrates-phosphates since a landfill exists practically on the banks of the creek
- I work here!
- Flash flooded house 3x since 2008
    - June 2008 – 18" in walkout ranch
    - August 2009 – 21" in walkout ranch
    - June 2014 – 8" flash flood in walkout ranch
    - Before my ownership – large flood in 2003 or 2004
    - Regular clean up or dredging needed to clear obstructions/fallen trees
- Comments
  1. Publicize the water quality readings – bad news spurs attention
  2. Organize action days for the public to help clean streams, stabilize bands…think INHF volunteer days

Comments Shared Anonymously at the Open House Events June 2nd and June 3rd

- Presently, stormwater basins are designed to let all the water go through them until the 100-year frequency is reached. This must be changed
- Continue to engage the public on the value and importance of watershed management
- Provide landowners with funding source for improvements including ponds
- Improve fishing
- Detention of runoff w/20-30 small basins was a suggestion of the [the Army Corps of Engineers] several years ago. Local commitment to dedicate to a long term program and funding were hurdles not overcome to this point to get much done beyond development effort to no make 100 [year] frequency event any worse
- New development in the 35th Street extension (Corin roundabout) needs to shield rainwater runoff from downslope properties along Indian Creek. 4409 Lucore Road for example
- Agriculture is a significant aspect of our economy and helps feed the world, but do not believe enough is being done in regards to watershed management. I would like you to look into policies for stream buffering… Also concerned with pattern tiling and effects on stream flow rates and stream bed erosion
- Steve Cooper needs a personal summer help to improve the watershed
- In 1.3.4 2nd [paragraph] should read… "Tech team comprises state and…"
- Somewhere in goals, I think erosion prevention should be explicit. While it is necessary to all water quality improvement, the goals on posters do not say erosion (nor sediment transport)
- Monitor nutrient runoff and use prairie strips/buffer strips to reduce nutrients from farm fields

- I live in the Creekview Coves development which enjoys a wide valley to absorb flood water. I am concerned that channel projects downstream in Cedar Rapids may make our situation worse
- Partnerships
- It's good to see so many people, organizations and agencies involved. Question—how can farmers, landowners and city residences become motivated to solve the problems you have identified?
- Water Quality Goal: Who will provide on farm assistance to farms and land owners?
- I applaud this effort. Who will work on urban efforts to reduce nutrient pollution from lawns? Scott's says to use 4 applications of nitrogen fertilizer. Two applications is plenty
- Comments
    1. Nutrient Export – health hazard
    2. Member Communities – entire watershed coordinator mandatory
    3. Increase Habitat – animals increase and maintain all types of life in the environment
    4. Around Cedar Valley Christian School on Cottage Grove east of Washington [High School], it is very low and prone to flooding
- I would like to see more organized opportunities to clean Indian Creek for recreational kayak/boating use. Just like the bike trails business is starting to locate around outdoor recreation that is also close. Indian Creek is very [navigable] but also very dirty

Phase 2 Implementation Strategies

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	32	encourage tall grass plantings around ponds to deter Canada geese		x				x	identify ponds where geese are a problem; complete at least five projects	Phase 2	1.83	ICWMA Members	Pheasants Forever; SWCD; CTA
Education	33	communicate steps anyone can take to protect the watershed - "You Pick Two" concept	x	x	x				develop media campaign; create a fact sheet	Phase 2	1.83	ICWMA Board & Members	Water Quality Initiative; ICWMA Member communications & stormwater staff
Education	34	develop a program and outreach materials to educate homeowners & potential homeowners about the hydrology of the watershed and the factors that influence it	x		x				create fact sheet; distribute to realtors	Phase 2	1.83	ICWMA Board	ICWMA Member communications & stormwater staff
Education	35	continue to hold IOWATER workshops and engage trained volunteers in an active monitoring program in the watershed		x	x				host at least one event per year training 15 - 20 active monitoring volunteers	Phase 2	1.83	IDNR & ICWMA Board	ICWMA Member communications & stormwater staff

Phase 2 Implementation Strategies Continued

			Goals Addressed										
Education	36	develop a self-guided podcast tour of green stormwater management practices with ideas for the listener to implement at home	x	x	x			x	pod cast developed; downloaded 25 times	Phase 2	1.83	ICWMA Board & Members	REAP CEP
	37	host field days, tours and other peer to peer events for farmers and other interested stakeholders	x	x	x			x	host one event per year reaching at least 25 participants	Phase 2	1.83	Linn SWCD & ICWMA Board	Local
	38	host IOWATER training for children partnering with local schools and/or summer camps		x	x				host one training per year reaching at least 25 participants	Phase 2	1.83	IDNR & ICWMA	ICWMA Member communications & stormwater staff
	39	partner with local FFA teachers to incorporate watershed issues into their classes		x	x				students to help create videos; invite WMA related speakers	Phase 2	1.83	ICWMA Board & Members	Water Rocks Educational Materials
	40	partner with the Linn SWCD to develop an awards program such as a certificate or sign recognizing a "Friend of Indian Creek Watershed"	x	x	x			x	awards program developed; recipients announced each year at annual meeting	Phase 2	1.92	Linn SWCD & ICWMA Board	ICWMA Member communications & stormwater staff

Phase 2 Implementation Strategies Continued

Action Type	Strategy #	Implementation Strategies	Goals Addressed: Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	41	promote Farm Bill and other programs for cost-sharing of practices	x	x		x	x	x	increase number of cost-share practices implemented by 20%	Phase 2	2.00	Linn SWCD	EQIP; CSP; State Cost Share
	42	encourage implementation of salt storage improvements to decrease chloride loading		x		x			all storage locations identified and covered	Phase 2	2.00	ICWMA Board; ISWEP	State and local
	43	develop a brochure with color shaded map that explains future flood risk in terms of a 30-year mortgage for local realtors to disbribute to potential homebuyers	x		x	x			brochure developed; distribute to realtors	Phase 2	2.00	ICWMA Board	FEMA - RiskMap; ICWMA stormwater staff
	44	continue to host Women Caring for the Land workshops	x	x	x			x	host one workshop per year reaching 10 - 15 participants	Phase 2	2.00	ICWMA Board & Members	WFAN; local

Phase 2 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	45	recommend that ICWMA members set policies to dedicate funds collected through Stormwater Utilities to water quality practices				x			policy developed; members adopt the policy	Phase 2	1.83	ICWMA Members	Local
Policy	46	recommend that ICWMA members capitalize a cost share program, according to the contribution formula established by the Board of Directors, to implement practices or serve as matching funds for grant applications	x	x	x	x	x	x	cost share program established	Phase 2	1.83	ICWMA Board & Members	Local
Policy	47	develop a task force to determine how stormwater should be managed in source water protection areas		x		x			task force established & functioning	Phase 2	1.83	ICWMA Members & IDNR	IDALS Urban Conservation Program
Policy	48	encourage the adoption of a minimum 35' vegetated buffer along the stream corridor for the purpose of protecting habitat and enhancing recreation	x	x		x	x	x	adoption by ICWMA Members	Phase 2	2.00	ICWMA Members	Environmental Working Group; NRCS

Phase 2 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	49	establish sub-committees of the ICWMA that align with plan goals and report progress to the ICWMA Board on a regular basis (example committees include planning & infrastructure, agricultural, public outreach, habitat & recreation)	x	x	x	x	x	x	sub-committees established; develop goals/tasks for each sub-committee	Phase 2	2.00	ICWMA Board & Members	Local
Policy	50	promote the use of the Iowa Stormwater Management Manual criteria to reduce peak flows using overbank and stream channel protection guidelines	x			x		x	adoption of the Iowa Stormwater Management Manual	Phase 2	2.00	ICWMA Board & Members	IDALS Urban Conservation Program; ICWMA stormwater staff
Policy	51	develop a uniform method among the ICWMA members to track public sector costs due to flooding	x			x			develop spreadsheet tool for inputting costs; report out at annual meeting	Phase 2	2.00	ICWMA Board	FEMA - RiskMap; Iowa HSEMD

Phase 2 Implementation Strategies Continued

Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
			Goals Addressed										
Practices	52	promote use of management practices such as cover crops, no-till, and strip-till on all crop ground but especially HEL	x	x	x			x	locations identified; outreach to landowners	Phase 2	1.83	Linn SWCD & ICWMA Board	WQI
	53	utilize inlet protection measures around tile drainage intakes		x				x	locations identified; outreach to landowners	Phase 2	1.83	Linn SWCD & ICWMA Board	
	54	establish public / private partnerships to implement demo BMP projects		x		x			complete 5 projects	Phase 2	1.83	ICWMA Board	ICWMA stormwater staff
	55	utilize the HEC-HMS model to identify priority areas to reduce upstream peak flow to protect property in the 500-year floodplain	x			x			priority areas mapped; consider plans for detention pond north of County Home Road	Phase 2	2.00	USACE & ICWMA Board & IDNR & Linn SWCD	USACE; engineering staff and consultants
	56	determine priority locations for NRS practices based on the watershed assessment data and modeling; identify locations on public land for demonstration purposes		x				x	map created; possible locations identified	Phase 2	2.00	Linn SWCD & ICWMA Board	DNR GIS; NRCS

Phase 2 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Measure	57	better characterize bacteria timing and sources by developing a bacteria source testing plan that includes assessment of potential inputs from municipal sewer systems and/or septic systems (use optical brighteners for example)		x			x		testing plan developed	Phase 2	1.92	Technical Team	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators
	58	conduct RASCAL assessment in locations that were not surveyed in 2013 - 2014		x				x	RASCAL completed	Phase 2	2.00	ICWMA & Technical Team	ICWMA Members; Coe College

Phase 3 Implementation Strategies

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	59	promote the use of nutrient management plans and/or whole farm conservation plans		x	x		x	x	complete 6 whole farm plans in the watershed	Phase 3	2.17	Linn SWCD	EQIP; CTA
	60	communicate with landowners about the multiple benefits of enrolling acres into the Conservation Reserve Program leveraging USACE/FSA research	x	x	x			x	create a fact sheet; distribute to landowners	Phase 3	2.17	Linn SWCD	Pheasants Forever
	61	Coe College to develop a grade school curriculum aligned with the Common Core through their education department			x				curriculum developed; implemented in at least one school	Phase 3	2.17	Coe College	IOWATER program materials
	62	encourage presribed grazing in areas adjacent to the stream corridor		x				x	at least two projects completed	Phase 3	2.33	Linn SWCD	EQIP; CTA

Phase 3 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	63	develop HUC-12 scale watershed plans that include ArcSLAMM analysis, agricultural management practices by parcel, gully assessment, and monitors habitat improvements	x	x	x	x	x	x	prioritize HUC-12s for plan completion; one plan completed per phase; 3 plans completed	Phase 3	2.17	ICWMA Board & stakeholders	WSPF; WIRB; WQI; EPA 319
	64	communicate and enforce existing and new rules regarding N and P sources		x		x		x	identify existing rules and create a fact sheet distributed to landowners	Phase 3	2.17		ICWMA Member communications & stormwater staff
	65	implement metering of road salt application rates		x		x		x	application rates metered	Phase 3	2.17	ICWMA Members	DOT
	66	create a vision for what recreation could be in the Indian Creek Watershed	x	x	x	x	x	x	vision statement & associated recreation plan created	Phase 3	2.33	ICWMA Board & stakeholders	DNR Water Trails Funding

Phase 3 Implementation Strategies Continued

Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
			Goals Addressed										
Practices	67	conduct a comprehensive inventory and risk based evaluation of the structures in the 500-year floodplain	x			x			inventory & map created; develop risk reduction strategies as necessary	Phase 3	2.17	USACE & ICWMA Board & IDNR & Linn SWCD	USACE
Practices	68	use GIS aerial photography & anecdotal evidence to identify locations where repetitive crop losses due to flooding have occurred and promote CRP, WRP and other relevant practices	x	x	x	x		x	map created & used in promoting programs	Phase 3	2.17	USACE & ICWMA Board & IDNR & Linn SWCD	DNR GIS staff; Agren
Practices	69	complete & install flood warning system as a special page on the IFIS website	x			x			IFIS page created & launched	Phase 3	2.17	USACE & Iowa Flood Center	USACE & IFC; ICWMA stormwater staff
Practices	70	identify opportunities to protect segments of trail from streambank erosion (e.g. Sac and Fox Trail at Wilder Drive)		x			x	x	map created	Phase 3	2.17	ICWMA Board & Members	DNR River Programs
Practices	71	promote use of structural practices such as terraces and sediment basins on Highly Erodible Lands (HEL) to reduce soil loss		x	x			x	locations identified; outreach to landowners	Phase 3	2.33	Linn SWCD & ICWMA Board	WQI

Phase 3 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Practices	72	conduct streambank stabilization & restoration at priorty locations identified in the RASCAL stream assessment		x				x	22,000 linear feet of restoration in high-priority RASCAL segments	Phase 3	2.33	ICWMA Board & Members	State cost-share
Practices	73	conduct a storm drain retrofitability assessment and identify low hanging fruit based on ease of retrofitability and willing municipal / homeowner interest		x		x			assessment completed	Phase 3	2.33	ICWMA member cities	IDALS urban conservationists
Measure	74	partner with USGS or the Iowa Flood Center to deploy real-time nitrate sensors at strategic locations		x				x	install 2 sensors; 1 at urban/rural fringe and 1 at outlet	Phase 3	2.17	ICWMA & Technical Team	ICWMA Member stormwater coordinators
Measure	75	increase indicator bacteria monitoring in places where people recreate		x			x		monitoring sites identified & sampled	Phase 3	2.17	ICWMA & Technical Team	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators
Measure	76	update flood inundation maps when related plan updates occur	x			x			maps updated; Submit LOMR package to FEMA	Phase 3	2.33	ICWMA Board & Members	USACE; FEMA; DNR Floodplains; IFC

Phase 4 Implementation Strategies

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Education	77	encourage and incentivize landowners to fence livestock out of stream channel		x				x	implement at least two fence projects; especially in RASCAL segment 13 - 14	Phase 4	2.50	Linn SWCD	EQIP; CTA
Education	78	develop a program and outreach materials to educate urban residents about agriculture			x				promote field days to urban & ag audiences; create a fact sheet	Phase 4	2.50	Linn SWCD; Cedar River Watershed Coalition	ISWEP; IDALS Urban Conservation Porgram; ICWMA Member communications & stormwater staff
Education	79	promote the use of salt alternatives to non-municipal users		x				x	education materials developed & distributed	Phase 4	2.67	ICWMA Board; ISWEP	local
Education	80	organize field trip and outdoor play opportunities			x		x		host quarterly events each year	Phase 4	2.67	ICWMA Board & Members	Linn CCB
Policy	81	encourage ICWMA members to implement a rule of minimum 4" topsoil + additional organic profile on developed lots	x	x	x	x		x	rule developed; number of members adopting the rule	Phase 4	2.50	ICWMA Members	ICWMA stormwater staff
Policy	82	consider amending the Articles of Agreement to establish ICWMA as a separate legal entity				x			changes made after consideration	Phase 4	2.67	ICWMA Board	Other WMAs

Phase 4 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Policy	83	inventory row crop encroachment in road right-of-ways and enforce existing laws throughout the watershed	x	x		x			inventory completed; enforcement plan developed	Phase 4	3.00	Linn Co. Secondary Roads	Local
	84	explore possibility of nutrient trading		x		x			research nutrient trading examples	Phase 4	3.17	ICWMA Members	League of Cities
Practices	85	enhance trail connectivity			x	x	x		watershed trail plan completed	Phase 4	2.50	ICWMA Board & Members	Cedar Rapids Traffic Engineering; MPO Multi-modal staff
	86	assess containment and leaching to groundwater at road salt storage sites		x				x	assessment completed	Phase 4	2.67	ICWMA members	Local; DOT
	87	target tile drainage water management practices in flatter areas of the watershed	x	x				x	treat 30% of agricultural areas using edge-of-field practices; outreach to landowners	Phase 4	2.83	Linn SWCD & ICWMA Board	WQI
	88	conduct an assessment of fishery enhancement in Dry Creek and lower reaches of Indian Creek		x			x	x	assessment completed	Phase 4	2.83	ICWMA Board & Members	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators

Phase 4 Implementation Strategies Continued

			Goals Addressed										
Action Type	Strategy #	Implementation Strategies	Flood Risk Management	Water Quality	Public Outreach & Education	Partnerships & Policy	Recreation	Habitat	Milestone(s)	5-year Plan Phase	Average Rank	Responsible Entity(s)	Technical Resources / Funding Options
Practices	89	conduct an inventory of rural road culverts and bridges to identify opportunities for converting road ditches to bioswales and on-road structures to hold back water	x	x		x			inventory & map created; projects added to the their 5-year program	Phase 4	3.17	Linn Co. Secondary Roads	DNR GIS staff
Measure	90	better characterize P by developing a monitoring program for Total P and OrthoP		x					monitoring program established	Phase 4	2.67	Technical Team	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators
Measure	91	determine baseline N and P loads and 20-year load reduction goal		x				x	baseline established	Phase 4	3.00	Technical Team	IOWATER/DNR Water Monitoring Program; ICWMA Member stormwater coordinators