CLEAR CREEK WATERSHED MANAGEMENT PLAN

Prepared by:

East Central Iowa Council of Governments in cooperation with

Clear Creek Watershed Coalition & funded by the

Iowa Department of Natural Resources & the

Iowa Watershed Approach

September 28, 2020

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"THE SIGNIFICANT PROBLEMS WE FACE CANNOT BE SOLVED AT THE SAME LEVEL OF THINKING WE WERE AT WHEN THEY WERE CREATED.

ALBERT EINSTEIN

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Chapter 1

INTRODUCTION

1.1 The Clear Creek Watershed

The Clear Creek watershed is located in East-Central Iowa within Iowa and Johnson counties in the Lower Iowa River sub-basin. The main branch of Clear Creek is fed by Rhine Creek, Buffalo Creek and Deer Creek ultimately draining to the Iowa River near the intersection of 1st Avenue and US Highway 6 in Coralville approximately four miles upstream from the University of Iowa water intake. The watershed includes 514 farming units, the towns of Oxford and Tiffin, and 82% of urban Coralville. Stormwater and wastewater effluent from these communities and rural mobile home parks are discharged into the creek. During the floods of 1990 and 1993 these three communities were severely impacted, and Interstate 80 was closed by floodwaters from Clear Creek.

Some of the notable characteristics of the watershed include:

- The watershed is 66,136 acres (101 sq. mi.) with a population of 29,862 residents, which is expected to increase significantly with two of the fastest growing cities in Iowa (North Liberty and Tiffin) in the watershed.
- Oak savanna and prairie were the primary land cover types prior to the 1830s.
- The dominant watershed land use types in 2017 are agricultural crop land (58%), pasture / grassland (20%) and developed land (14%).
- Urban development pressures over the past fifty years in the lower part of the watershed combined with intensive agricultural activities in the upper reaches has impacted water quantity and quality.
- 84% of the watershed in considered Highly Erodible Land.
- The watershed includes the entire municipalities of Oxford and Tiffin and portions of Coralville, North Liberty and Iowa City.
- Significant, reoccurring flash flood events are common throughout the watershed.
- FEMA's 100-year floodplain covers 5,247 acres or 7.9% of the watershed.
- Kent Park Lake and Rhine Creek are both listed on the State's 303(d) impaired waters list. The Kent Park Lake watershed in Johnson County is impaired for primary contact due to elevated indicator bacteria levels and aesthetically objectionable conditions due to algae blooms. Rhine Creek, from the mouth to Clear Creek to the headwaters in Johnson County, is listed as impaired for general use due to a fish kill resulting from a pesticide spill.
- Lower Clear Creek is dominated by sandy soils and in places downstream of previously straightened areas, bank migration can be as much as 10 feet per year.

Clear Creek East of Camp Cardinal Road

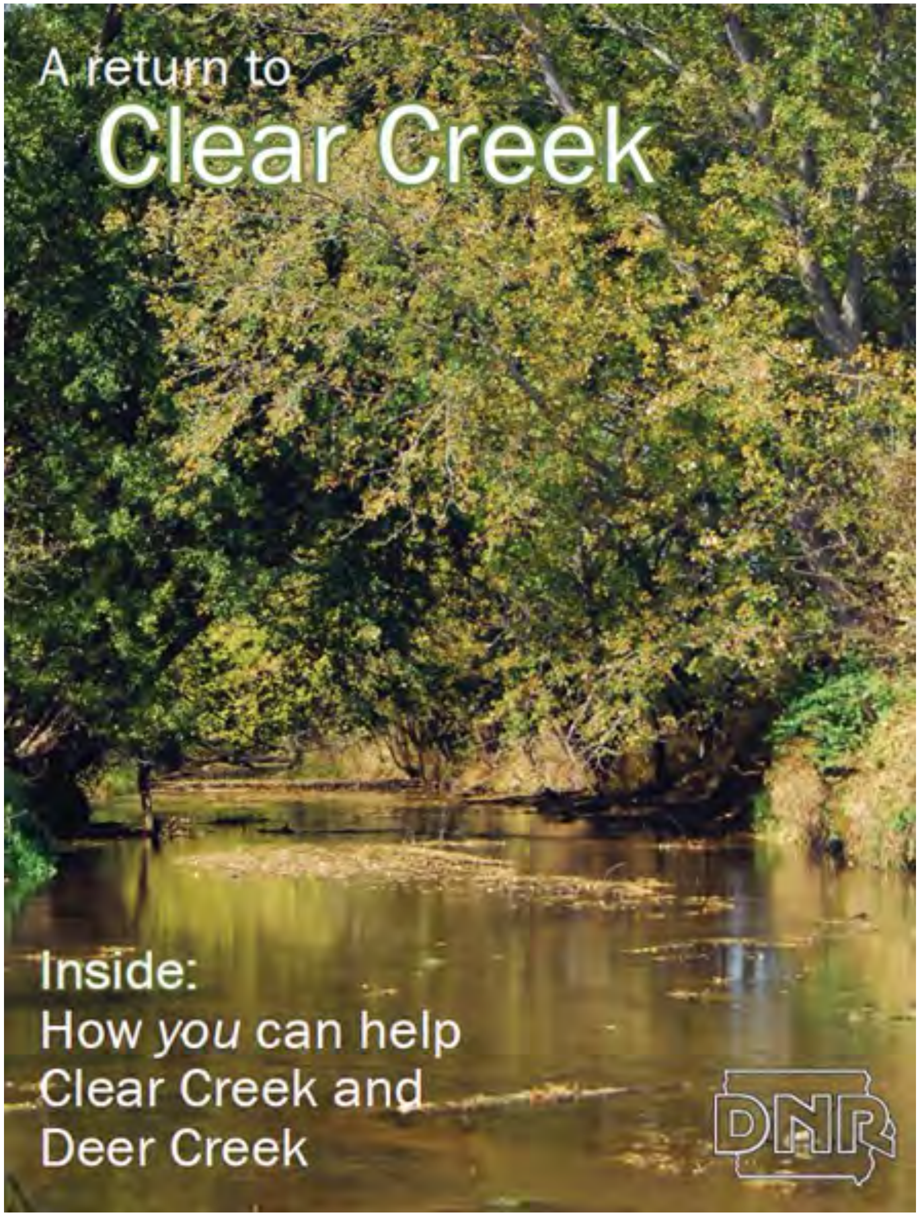
Photo Credit: John Rathbun, Clear Creek Watershed Coordinator

1.2 History of the Clear Creek Community

The History of Johnson County, Iowa 1836-1882, notes that a Native American chief said of the Clear Creek Valley, there was no more beautiful place this side of the Happy Hunting Ground. In the 1840's the creek was named Clear Creek by Sheriff Trowbridge because of its then clear flowing water. A historian of the late 1800's noted, "Since its naming, the creek has been beset by the herds of cattle tramping, and the droves of swine routing and wallowing in its banks, marshes and tributary brooklets. The original clearness of the creek has been swapped for fresh meat."
A later historian reflects that, in the middle of the twentieth century, dredging and straightening of creeks was in style. As a result, the natural meanders are absent from stretches of the creek making it possible for planters to set in their blades up to the very edge of the streambank. Development pressures accelerated in the 1970s and 1980s leading to more changes to the floodplain as wetland areas were filled and drained. In the late 1990's, a straight-line wind roared through the valley one June afternoon, wreaking havoc with upland tree stands and riparian areas along the creek's floodplain.

In more recent years, flooding has been a major concern because Clear Creek is located at the intersection of historic expansion of agriculture and increasing urbanization. Urban development along Clear Creek is particularly vulnerable to flooding with valuable infrastructure such as schools, sewage treatment plants and local business and industry located on the floodplain. In the last few decades flooding has increased substantially in the Clear Creek watershed with at least three floods greater than a 50-Year flood level occurring since 1990. The City of Coralville located near the outlet of Clear Creek has sustained millions of dollars in economic damages due to the flooding. Associated with the frequent flooding, erosion of sediment and topsoil has been exacerbated. The estimated amount of eroded topsoil for the entire watershed is 181,399 tons of fertile soil loss per year.

CCWEB Outreach Flyer



Source: 2006 EPA 319 Grant Report
Photo Credit: Clay Smith, Iowa DNR

1.2.1 Clear Creek Watershed Enhancement Board

The Clear Creek Watershed Enhancement Board (CCWEB) was established in 1998 as a grassroots organization to pro-actively bring partners and resources together to improve the watershed. The group relied on dozens of diverse stakeholders representing the District Commissioners and Assistant Commissioners, the cities of Coralville and Tiffin, the University of Iowa, Clear Creek Amana Community Schools, County Conservation Board, business leaders, farmers and residents to carry out its mission to make Clear Creek run clear once again. In 2004, the CCWEB received a Development Grant to determine priority areas, identify cropping practices and other impact factors, and make connections with operators and landowners about conservation. Clear Creek received an EPA 319 grant in 2006 to install agricultural conservation practices that reduced sediment loads in the agricultural section of the watershed by over 40%. In 2008, the Clear Creek watershed received a Watershed Improvement Review Board (WIRB) Grant to assist the unsewered community of Conroy to treat its wastewater.

1.2.2 Clear Creek Conservation Leaders

Clear Creek Watershed Enhancement Board

- Mary Somerville, of rural Oxford, was inspired by the 1990 flooding to use the knowledge she gained as a schoolgirl to good use. Elected in the fall of 1990 as a Soil & Water Conservation District Commissioner in Johnson County, Mary was especially interested in educating farmers and non-farmers alike about conservation efforts. Another interest was to name all the creeks to engender a sense of community and concern for those creeks. She was awarded the Johnson County Heritage Trust Conservation Award in 2001 for that work. Mary was the first Chair of the CCWEB and believed strongly that everyone had a role and a responsibility to control flooding and protect soil and water.
- Larry Wilson represented the University of Iowa on the Clear Creek Watershed Enhancement Board and was one of the most active members. Larry's steadfast attendance and commitment to Clear Creek watershed activities led to him succeed Mary Somerville as Chair of the CCWEB.
- Robert Meade farms in the Clear Creek watershed and over the years, installed many conservation practices on his farm. He played a key role as a role model for other farmers and talked with many of them about conservation. Robert served on the CCWEB.
- Gene Kasper was a Johnson County Soil and Water Conservation District Commissioner and farmer in the Clear Creek watershed. Gene was a leader in installing conservation practices on his farm, especially those related to livestock. He always attended local events and meetings and was a member of the CCWEB. He had a quiet voice that everyone listened to.
- Ellen Hartz was a local schoolteacher who taught at the Alternative High School in Tiffin. Ellen was a dedicated teacher who loved getting her students outside exploring the Clear Creek watershed. Ellen served on the CCWEB.
- Staff from the Johnson County Conservation Board (especially Harry Graves) and Coralville Parks and Recreation (first Julie Seydell Johnson and later Sherri Proud) were devoted CCWEB members as well. Numerous urban and rural residents also played an important role serving on the CCWEB over the years.

Robert Meade

Photo Credit: Clay Smith, Iowa DNR

State & Local Agencies

- Wayne Petersen, now retired from both the Iowa Department of Agricultural and Land Stewardship and Natural Resources Conservation Service, worked tirelessly as a District Conservationist to get efforts going in the Clear Creek Watershed. Wayne worked for over 40 years in the field of soil and water conservation and was instrumental in shaping early efforts in Clear Creek. He played a key role in creating the locally supported grass roots effort that led to the development of the Clear Creek Watershed Enhancement Board.
- Ruth Izer also played a key role when she was a Soil Conservationist at the Johnson County Natural Resources Conservation Service office. Ruth was instrumental in collecting data for the watershed assessment and assisting with grant writing to secure watershed funds.
- Steve Johnston and Al Rudin led efforts in the upper parts of the Clear Creek watershed in Iowa County. Steve was the District Conservationist for the Natural Resources Conservation Service and Al Rudin was a long-time Iowa County Soil & Water Conservation District Commissioner.
- Lynette Seigley and Mary Skopec played key roles in guiding water quality monitoring efforts and providing sampling materials through IOWATER, a program of the Department of Natural Resources.
- Dave Ratliff was instrumental in leading efforts to collect water samples in the Clear Creek watershed. High water sampling results led to the identification and implementation of targeted water quality practice implementation. He created and adhered to a Quality Assurance Project Plan that ensured that monitoring samples were collected and interpreted in a credible manner.
- Stewart Maas is a landowner in the Clear Creek watershed that has implemented terraces, water and sediment control basins, grassed waterways, wetlands, and filter strips. Stewart participated in every research project / demonstration evaluation conducted by University of Iowa staff and students. Stewart is a current Commissioner for the Iowa County Soil & Water Conservation District Commissioner.

James Martin, Clear Creek Coordinator 2004 – 2011

Photo Credit: Clay Smith, Iowa DNR

Coordinators

- Dale Shires was the first coordinator for the Clear Creek watershed who volunteered to get efforts underway for the Johnson Soil and Water Conservation District. Dale was instrumental in helping to initiate watershed activities in the early years. Dale was well respected in the agricultural community joining the watershed efforts after working 33 years for the Agricultural Extension Service.
- James Martin was the first watershed coordinator hired to implement Clear Creek watershed efforts. James worked from 2004 to 2011 building relationships with landowners and getting conservation practices on the land. James also played a key role in obtaining grant funds through the years to continue watershed efforts. James currently serves on the Clear Creek Watershed Coalition’s Technical Team in his role as Regional Basin Coordinator for the Iowa Department of Agriculture and Land Stewardship.
- John Rathbun is the current watershed coordinator supported through the Iowa Watershed Approach (IWA). John is building relationships and implementing the flood first IWA strategy in the watershed.

Coralville

- Dan Holderness is the City Engineer for the City of Coralville. Dan has worked on stormwater and flood related issues within the City of Coralville since 1986. In 2008, Dan was instrumental in helping the City recover from a 500-year flood event. Dan's foresight to collect data and his rapid response to deploy multiple teams to collect the high-water data during the 2008 Iowa River flood crest would later be used to accurately model needs for the City's Flood Protection Systems. His approach was visionary, innovative and allowed for a high level of precision within future flood mitigation efforts. Over the next 10 years, Dan implemented more that $63 million in flood control infrastructure. Dan sits on the Clear Creek Watershed Coalition's Technical Team and serves as our urban flood control expert.
- Amy Foster is the Stormwater Coordinator for the City of Coralville. Amy is involved in the water quality aspects of urban runoff and the health of local receiving streams. Amy was instrumental in developing the City of Coralville's Post Construction Stormwater Ordinance in 2014. This ordinance changed how private development and public infrastructure are designed, by requiring the installation of green infrastructure into every project. Amy sits on the Clear Creek Watershed Coalition's Technical Team and assists with urban stormwater runoff solutions.
- John Lundell is the Mayor of the City of Coralville and a huge supporter of local water quality. Mayor Lundell was the first Coralville resident to install a porous paving driveway at his home. This driveway has been used in ongoing water quality research with the University of Iowa. John was elected to the position of Mayor in 2013. Prior to serving as the Mayor of Coralville, John was a City Council member elected in 2002. John has also served on the Iowa League of Cities Executive Board as the President and President-elect from 2013-2017.

1.3 Clear Creek Watershed Coalition 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 is 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; and
- Allocate moneys made available to the Authority for purposes of water quality and flood mitigation.

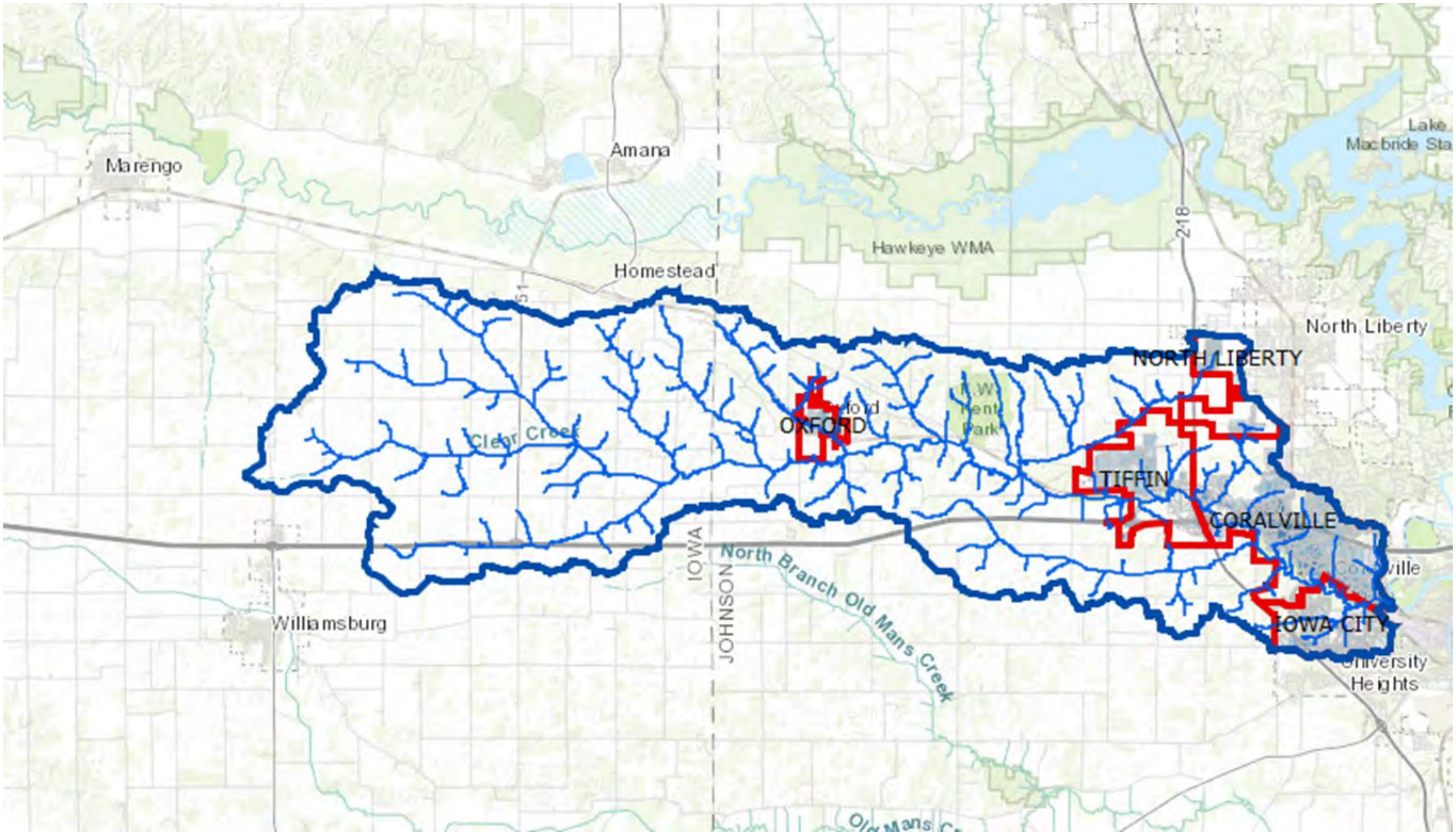
Iowa Code specifies that WMAs do not have taxing authority or the right to acquire property through eminent domain. In the summer of 2015, the City of Coralville provided funding to form a Watershed Management Authority in the Clear Creek watershed in cooperation with other local governments and with assistance from the East Central Iowa Council of Governments.

Clear Creek Watershed Coalition 2015 Kick-off Meeting

Photo Credit: Kate Giannini, Iowa Flood Center

Membership in the WMA is based on the hydrologic boundary of the Clear Creek watershed shown in Figure 1-1. The participating local governments within the Clear Creek watershed include Coralville, Iowa City, North Liberty, Tiffin, Oxford, Iowa County, Johnson County and the Soil & Water Conservation Districts in Iowa and Johnson counties.

Figure 1-1. Clear Creek Hydrologic Boundary and Member Entities



Source: East Central Iowa Council of Governments

The Clear Creek Watershed Coalition (CCWC) was established as a WMA cooperative organization through an agreement under Iowa Code 28E and 466B and filed with the Secretary of the State of Iowa in August 2015. The agreement and by-laws can be found in Appendix A.

1.3.1 Board of Directors

A Board of Directors representing all participating political subdivisions guides efforts to improve the watershed as outlined in the CCWC by-laws (found in Appendix A). The CCWC Board of Directors (CCWC Board) meets quarterly on the third Wednesday of the months of January, April, July, and October. The CCWC Board is responsible for the content of this comprehensive Clear Creek Watershed Management Plan (Plan) and its implementation and maintenance. The CCWC Board also helped ensure that the Plan is in alignment with the Multi-jurisdictional Hazard Mitigation Plan for Johnson and Iowa counties and each political subdivision's comprehensive plan.

Structure of CCWC Board of Directors

Source: East Central Iowa Council of Governments

Table 1-1. CCWC Board of Directors in 2019

	Board Member Name	Representing	Term Expires	Alternate Board Member
Chairperson	John Lundell	Coralville	October 2022	Dan Holderness
Vice-Chairperson	John Gahring	Iowa County	October 2021	
Secretary / Treasurer	Tracey Mulcahey	North Liberty	October 2022	Tom Palmer
	Kasey Hutchinson	Johnson County	October 2021	Brad Freidhof
	Ben Clark	Iowa City	October 2022	
		Oxford	October 2021	
	Al Havens	Tiffin	October 2020	
	Jody Bailey	Johnson Co. SWCD	October 2020	
	Stewart Maas	Iowa Co. SWCD	October 2020	Bob Faber

Source: CCWC meeting minutes

1.4 Plan Development

1.4.1 Purpose of the Watershed Management Plan

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

1. prioritize resources to protect water quality
2. mitigate flood impacts that have plagued area residents
3. address resource concerns identified by the CCWC Board and local stakeholders

Table 1-2. Summary of EPA's Nine Elements for Watershed Plans

EPA Nine Elements	Where in Plan
Identify the causes and sources of pollution	Chapter 3 & 6
Estimate pollutant loading into the watershed and the expected load reductions	Chapter 3 & 8
Describe management measures that will achieve load reductions and targeted critical areas	Chapter 6 & 8
Estimate the amounts of technical and financial assistance and the relevant authorities needed to implement the plan	Chapter 8 & 9
Develop an information/education component	Chapter 8 & 10
Develop a project schedule	Chapter 8 & 9
Develop the interim, measurable milestones	Chapter 8
Identify indicators to measure progress and make adjustments	Chapter 8 & 11
Develop a monitoring component	Chapter 11

Source: EPA Handbook for Developing Watershed Plans to Restore and Protect our Waters

1.4.2 Funding Sources for the Watershed Management Plan

The Clear Creek Watershed Management Plan was completed using funding from:

- Iowa's Nonpoint Source Pollution program through the Department of Natural Resources, also known as Section 319 planning grants
- National Disaster Resilience Competition – Iowa Watershed Approach, a grant through US Housing and Urban Development's Community Development Block Grant program

EPA Section 319 Watershed Plan: The US Environmental Protection Agency (EPA) Section 319 Watershed Plan funding program is designed to help states reduce nonpoint source pollution (pollution caused by rainfall running over the ground and carrying pollutants including trash, oil and grease, and fertilizers into nearby waterways). The program was authorized by Section 319 of the Clean Water Act, which requires states to adopt a nonpoint source management program and assess nonpoint source pollution responsible for water quality impairments. EPA provides funding to states under Section 319, and states give sub grants to local governments.

Development of watershed plans funded with Section 319 funds must be consistent with EPA's nine elements [PDF] that provide a framework for improving water quality in a holistic manner. The nine elements help assess the contributing causes and sources of nonpoint source pollution and involve key stakeholders to prioritize restoration and protection strategies to address water quality problems. The first three elements characterize and set goals to address pollution sources. The remaining six elements determine specific resources and criteria to implement and evaluate the plan. Table 1-2 identifies the nine elements and where they are addressed in the Clear Creek Watershed Management Plan.

Iowa Watershed Approach: In January 2016, the U.S. Department of Housing and Urban Development (HUD) announced an award of nearly $97M to the state of Iowa for its proposal titled, The Iowa Watershed Approach for Urban and Rural Resilience. The award was made under HUD's National Disaster Resilience Competition designed to fund cutting-edge projects that address unmet needs from past disasters while addressing the vulnerabilities that could put Americans in harm's way during future disasters. The Clear Creek watershed was one of the eight watersheds selected for funding receiving $4,423,346 for planning, hydrologic modeling and construction of practices to reduce flood impacts.

1.4.3 Resource Concerns

According to assessments done in the past and for this plan, sediment, bacteria, and flooding are the three primary watershed concerns in the Clear Creek watershed. As part of this plan, the CCWC Board identified their primary resource concerns for establishing the CCWC and completing the Clear Creek Watershed Management Plan. A combination of these resource concerns guided the entire planning process:

- Water quality – improve water quality and soil health in the watershed
- Flood mitigation – reduce the impacts of flooding in the watershed
- Building community – increase collaboration, cooperation and resiliency in the watershed
- Education – increase public awareness and public involvement in the watershed
- Recreation – promote & improve access to recreation activities in the watershed
- Planning & Assessment – engage in watershed level assessment and planning

These resource concerns are also shared by the public, as confirmed in a series of Planning Sessions conducted in late 2018 and early 2019 to receive feedback from stakeholders. Summaries of the public input are included in Appendix B.

1.4.4 Watershed Management Planning Process

Soon after the CCWC was formed, ECICOG secured a watershed planning grant from the Iowa Department of Natural Resources. At the outset, the CCWC Board 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 into the future.

The CCWC utilized a collaborative, adaptive management approach for the Clear Creek Watershed Management Plan (Plan), which incorporates and links knowledge and credible science with the experience and values of stakeholders and local officials for more effective management decision-making. The resulting Plan is at the watershed scale, aligned with Iowa's Smart Planning Principles and local Hazard Mitigation plans, 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 Plan is the result of a collaborative effort between the CCWC's local jurisdictions and numerous stakeholders.

1.4.5 Planning Participants

The Clear Creek Watershed Management Plan was completed by the CCWC 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 and technical consulting firms/ institutions.

Technical Advisory Team (Tech Team): The Tech Team is comprised primarily of state and local watershed planning and management experts including local government stormwater & public works staff, the Soil & Water Conservation Districts in Johnson and Iowa counties (SWCDs), the Iowa Department of Natural Resources (IDNR), the University of Iowa, the University of Northern Iowa, Iowa Geological Survey, United States Geological Service (USGS), and the Iowa Department of Agriculture & 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 assessing the condition of the watershed and developing the plan.

University of Iowa

- Iowa Iowa Flood Center: The Iowa Flood Center was tasked with developing a hydrologic assessment of the Clear Creek watershed as part of the Iowa Watershed Approach. The full Clear Creek Hydrologic Assessment can be found in Appendix C. The Iowa Flood Center also aided in summarizing the water quality data gathered for this plan.
- Department of Earth & Environmental Sciences: Dr. Art Bettis and his graduate students collected water samples and participated in the Rapid Assessment of Stream Conditions Along Length (RASCAL) assessment and the development of the Clear Creek Watershed Coalition Monitoring Plan (2016 - 2017) found in Appendix D.

University of Northern Iowa

- Geoinformatics Training, Research, Education and Extension Center (GeoTREE Center): The GeoTREE Center created 830 detailed sub-watersheds for all urban areas in the Clear Creek watershed to model runoff and pollutant loads using the ArcSLAMM/WinSLAMM urban stormwater modeling system. The full report is in Appendix E.

Technical Advisory Team

Mary Beth Stevenson, *DNR Iowa-Cedar River Basin Coordinator*

James Martin, *IDALS-DSC Regional Coordinator*

Andy Asell, *DNR GIS Analyst*

Amy Foster, *Coralville Stormwater Coordinator*

Mike Wolf, *North Liberty Stormwater Coordinator*

Ben Clark, *Iowa City Public Works*

Kasey Hutchinson, *Johnson County Planning*

Darice Baxter, *University of Iowa*

John Rathbun, *Clear Creek Watershed Coordinator*

Brad Freidhof, *Johnson County Conservation*

Travis Beckman, *Johnson County Emergency Management*

Antonio Arenas Amado, *Iowa Flood Center*

Kate Giannini, *Iowa Watershed Approach*

Art Bettis Ph.D., *Professor of Chemistry at University of Iowa*

Ryan Clark P.G., *Geologist with Iowa Geological Survey*

Daniel Christiansen, *USGS Surface Water Hydrology & Hydraulics Chief*

Joe Dixon, *NRCS District Conservationist*

Kate Timmerman, *NRCS District Conservationist*

Amy Bouska, *Urban Conservationist, Johnson County*

- Center for Social and Behavioral Research: The Center for Social and Behavioral Research is an academic social science research organization that specializes in survey work. The Center for Social and Behavioral Research was hired to conduct a representative survey of watershed landowners and residents to capture attitudes, knowledge levels, and willingness to engage in watershed improvements. A compilation and analysis of the responses is summarized in the Clear Creek Watershed Social Assessment: Urban Survey and Landowner Survey in Appendix F. *Survey* in Appendix F.

Clear Creek West of Camp Cardinal Road

Source: HR Green, Lower Clear Creek Stream Assessment

HR Green & Applied Eco Services: HR Green and Applied Ecological Services were asked to assess the lower six miles of Clear Creek, within the City limits of Coralville, for factors such as fluvial geomorphic character, riparian vegetation community, current risks to infrastructure and stream function, and opportunities for restoration. In addition, the team was asked to look at issues of floodplain connection, hydraulic function, and high-level recreation and habitat issues. The report, Lower Clear Creek Stream Assessment can be found in Appendix G-1.

1.4.6 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 a CCWC website www.clearcreekwatershedcoalition.org, a Clear Creek Facebook page, and an email address contact list of interested citizens.
- A survey was conducted of urban / suburban residents and agricultural property owners in the watershed. (example in Figure 1-9)
- Three Clear Creek Watershed Planning Sessions were held in August and September 2018 and in January 2019 to present watershed assessment results and gather input on possible goals and generate implementation strategies for the Plan.
- Presentations to CCWC member policy makers, county Farm Bureau groups, students from elementary school to college age, local League of Women Voters chapter, and a booth at the Johnson County Fair.
- Annual Clear Creek Watershed Picnics were held on August 25, 2018 and September 21, 2019.
- Hosted a Women Caring for the Land workshop May 1, 2019 in Iowa City to engage female owners of agricultural land.

Flood Resilience Planning Session

Photo Credit: Kate Giannini, Iowa Flood Center

1.5 Prior Studies & Reports

Various studies and reports have been completed describing and analyzing conditions within the Clear Creek watershed. The Clear 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 17,1990, in the Clear Creek Basin, East-Central Iowa, prepared by United States Geologic Service, Kimberlee K. Barnes and David A. Eash, Open-File Report 94-78

Coralville 2008 Flood Mitigation Study, prepared by HR Green

Intensively Managed Landscape – Critical Zone Observatory Clear Creek Watershed Study Summary, prepared by Abaci O. and A.N. Papanicolaou in 2009, Intensively Managed Landscape - Critical Zone Observatory Clear Creek

Deer Creek & North Branch Sub-sheds of Clear Creek, Water Quality Final Report, prepared by James Martin in May 2012

1.5.1 Academic Research

"The Clear Creek Eco-Hydrologic Observatory: From Vision toward Reality" by Muste, M., Kim, D., and Bennett, D., at the 7th International Conference on Hydroscience and Engineering, Philadelphia, September 10-13, 2006

"Biogeochemical Analyses of Soils in Clear Creek, Iowa" by Papanicolaou, A.N., at the 7th International Hydroscience and Engineering, Philadelphia, September 10-13, 2006

"Clear Creek Environmental Hydrologic Observatory: Adaptive Sensor Network" by Just, C. L., Muste, M., Kruger, A., and Kim, D., at the ASCE World Environmental and Water Resources Congress, Tampa, Florida, May 15-19, 2007

"Near Real-Time Sensing of Clear Creek Water Quality" by Loperfido, J.V., Schnoor, J.L., and Just, C.L., at the ASCE World Environmental and Water Resources Congress, Tampa, Florida, May 15-19, 2007

"The Clear Creek Hydrologic/Environmental Observatory" by Papanicolaou, A.N., at the ASCE World Environmental and Water Resources Congress, Tampa, Florida, May 15-19, 2007

"A Comparison of Watershed Models in the Clear Creek, IA Watershed" by Wilson, C.G., Papanicolaou, A.N., and Abaci, O., at the ASCE World Environmental and Water Resources Congress, Tampa, Florida, May 15-19, 2007

"The Clear Creek Eco-Hydrologic Observatory: From Vision toward Reality" by Muste, M., Kim, D., and Bennett, D., at the AWRA Summer Specialty Conference, Missoula, Montana, June 26-28, 2006

"Observations of Soils at the Hillslope Scale in the Clear Creek Watershed in Iowa, USA" by Papanicolaou, A.N., Elhakeem, M., Wilson, C., Burras, C.L., and Oneal, B., published in *Soil Survey Horizons*, Soil Science Society of America, Vol. 49, p. 83–86, Winter 2008

"SOM Dynamics and Erosion in an Agricultural Test Field of the Clear Creek, Iowa, Watershed" by Wilson, C.G., Papanicolaou, A.N.T., and Abaci, O., published in the Hydrology and Earth System Sciences Discussions, 6, pp. 1581-1619, 2009

"In Situ Sensing to Understand Diel Turbidity Cycles, Suspended Solids, and Nutrient Transport in Clear Creek, Iowa" by Loperfido, J.V.; Just, C.L.; and Papanicolaou, A.N., published in *Water Resources Research*, 46, W06525, June 30, 2010

"SOM Loss and Soil Quality in the Clear Creek, Iowa" by Papanicolaou, A.N.; Wilson, C.G.; Abaci, O.; Elhakeem, M.; and Skopec, M., published in the *Journal of the Iowa Academy of Science*, 116, 1–4, p. 14, 2009

"Watershed as Common-Place: Communicating for Conservation at the Watershed Scale" by Caroline Gottschalk Druschke, published in Environmental Communication: A Journal of Nature and Culture, 7:1, 80-96, 2013

1.6 Plans in Alignment

State and local plans that align with the Clear 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.

Future Forward 2045 Long Range Transportation Plan

Developed by the Metropolitan Planning Organization of Johnson County in 2017

Johnson County 2018 Comprehensive Plan

Developed by JEO Consulting Group Inc. and Confluence in May 2018

Johnson County, IA Countywide Hazard Mitigation Plan

Developed by Two Rivers Emergency Management, LLC in June 2019

Iowa County Multi-Jurisdictional Hazard Mitigation Plan 2020-2025

Developed by East Central Iowa Council of Governments in February 2020

Kent Park Lake Watershed Assessment and Management Plan

Developed by Johnson County Conservation Board in partnership with several local and state agencies in 2015

Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster Resilient Communities

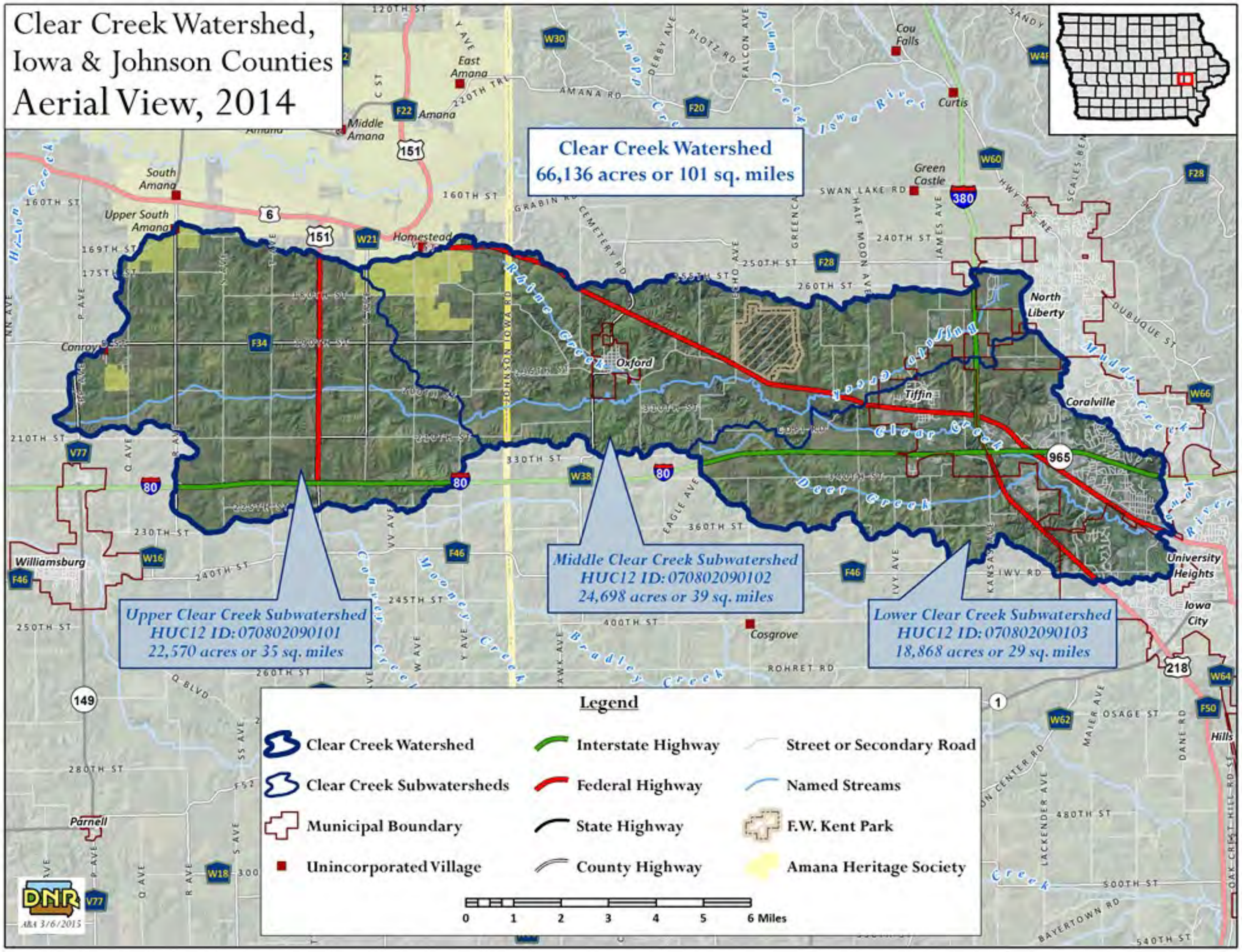
Developed by the US Environmental Protection Agency, EPA 231-R-14-003, July 2014

Chapter 2

WATERSHED CHARACTERIZATION

The watershed characterization chapter includes a description of the watershed in terms of area, population, land use/land cover, climate, topography, geology, and soils. Overall, the Clear 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 floodplain extents in Clear Creek and its tributaries.

Figure 2-1. Map of the Clear Creek Watershed



Source: Iowa Department of Natural Resources

2.1 Watershed Location

Table 2-1. Stream Lengths & Area in the Clear Creek Watershed

Watershed (HUC-12)	Stream Length (miles)	Acres (sq. miles)
Upper Clear Creek (070802090101)	21	22,570 (35)
Middle Clear Creek (070802090102)	35.7	24,698 (39)
Lower Clear Creek (070802090103)	12.4	18,868 (29)
TOTAL	69.1	66,136 (103)

Source: Iowa Department of Natural Resources

The Clear Creek watershed is located in East-Central Iowa in the Lower Iowa River sub-basin. The main branch of Clear Creek is fed by Rhine Creek, Buffalo Creek and Deer Creek ultimately draining to the Iowa River. The boundaries of the Clear Creek watershed and its three sub-watersheds are based on United States Geological Survey (USGS) defined boundaries (See Figure 2-1). These boundaries, or Hydrologic Unit Codes (HUC), divide the United States into discrete, nested areas based on common drainage patterns. The Clear Creek watershed (HUC-10 0708020904) spans a 101-square mile area within Iowa and Johnson counties in Iowa. The watershed is further divided into three HUC-12 sub-watersheds with attributes as shown in Figure 2-1 and Table 2-1.

2.2 Surface Water

The Iowa Department of Natural Resources maintains an online database to track Iowa's water quality assessments known as ADBNet. These assessments are prepared using US EPA guidance under Section 305b of the Clean Water Act to estimate the extent to which Iowa's waterbodies meet the goals of the Clean Water Act and attain state water quality standards. The surface water in the ADBNet database for the Clear Creek watershed are the main stem of Clear Creek, Rhine Creek and Kent Park Lake. These waterbodies have use designations including primary contact recreation, warm aquatic life, and human health/fish consumption and their attainment is shown in Table 2-2 using the 2018 assessment cycle.

Table 2-2. Surface Water Tracked in ADBNet in the Clear Creek Watershed

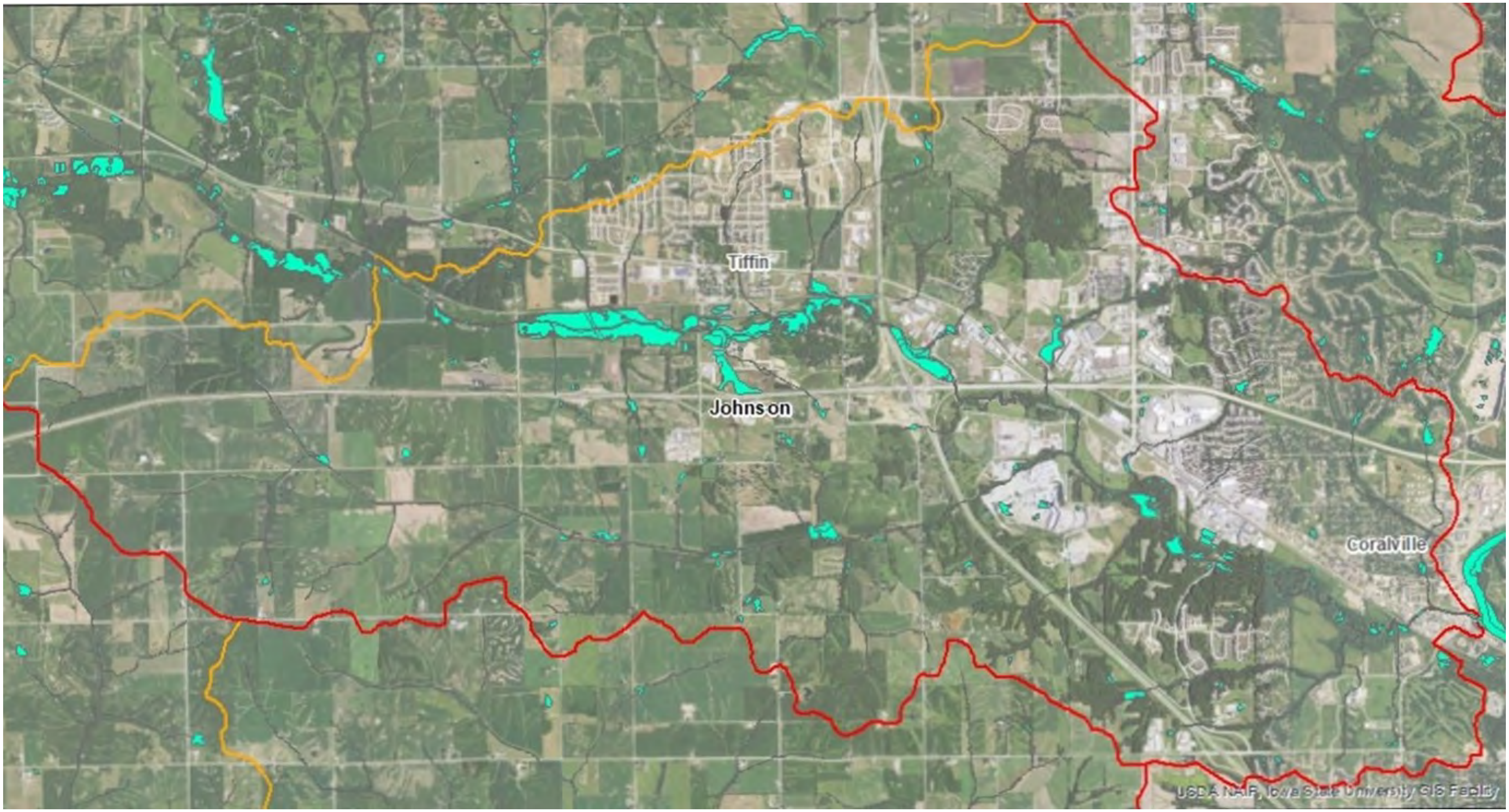
Waterbody	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Rhine Creek	Kent Park Lake
ADB Code	IA 02-IOW-690	IA-02-IOW-691	IA 02-IOW-692	IA-02-IOW-1937	IA-02-IOW-6412	IA 02-IOW-694
Legacy Code	IA 02-IOW-0160_1	IA-02-IOW-0160_2	IA 02-IOW-0160_3	IA-02-IOW-0161_0	IA-02-IOW-01608-0	IA 02-IOW-01630-L_0
Segment Size	2.86 miles	13.54 miles	7.52 miles	7.22 miles	4.44 miles	26 acres
Use Designations	A1, BWW-2	A1, BWW-2	A1, BWW-2	A1, BWW-1	A1, BWW-1	A1, BLW, HH
Use Support	Not Assessed	Not Assessed	Not Assessed	A-1 Fully Support BWW-1 Not Assessed	A1 Not Assessed BWW-1 Partially Supporting (5b & 3b)	A1 Partially Supporting (4a & 5a) BLW Fully Supporting HH Fully Supporting
Other Tributaries	Deer Creek, Buffalo Creek, Cardinal Creek, Biscuit creek, Oakdale Creek, Unnamed Tributaries					
Total Length	61.58 miles					

Source: Iowa Department of Natural Resources ADBNet Database – 2018 Assessment Cycle

2.2.1 Wetlands

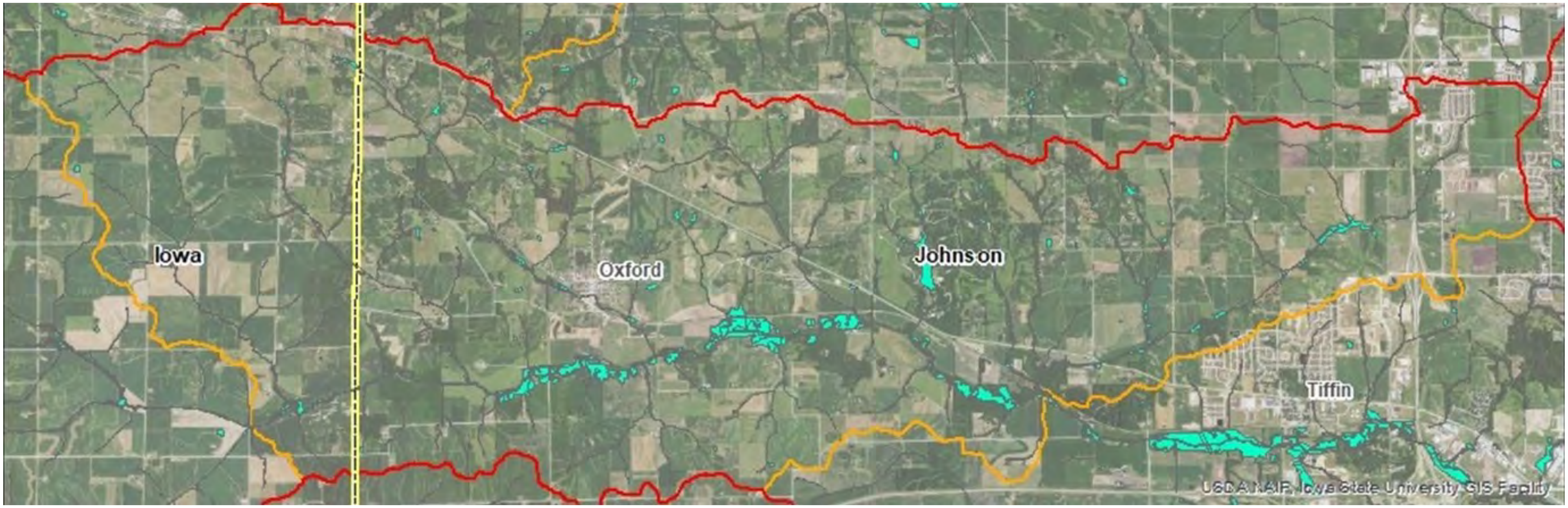
According to the National Wetlands inventory, there are 728 acres of wetlands in the watershed, which includes areas that are flooded or exposed intermittently, temporarily or seasonally. The maps in Figures 2-2 (Lower Clear Creek), Figure 2-3 (Middle Clear Creek) and 2-4 (Upper Clear Creek) display the watershed HUC-10 boundary in red, the HUC-12 boundaries in yellow and all types of wetlands identified in the National Wetlands Inventory as blue-green shaded areas.

Figure 2-2. Wetlands in the Lower Clear Creek Sub-Watershed



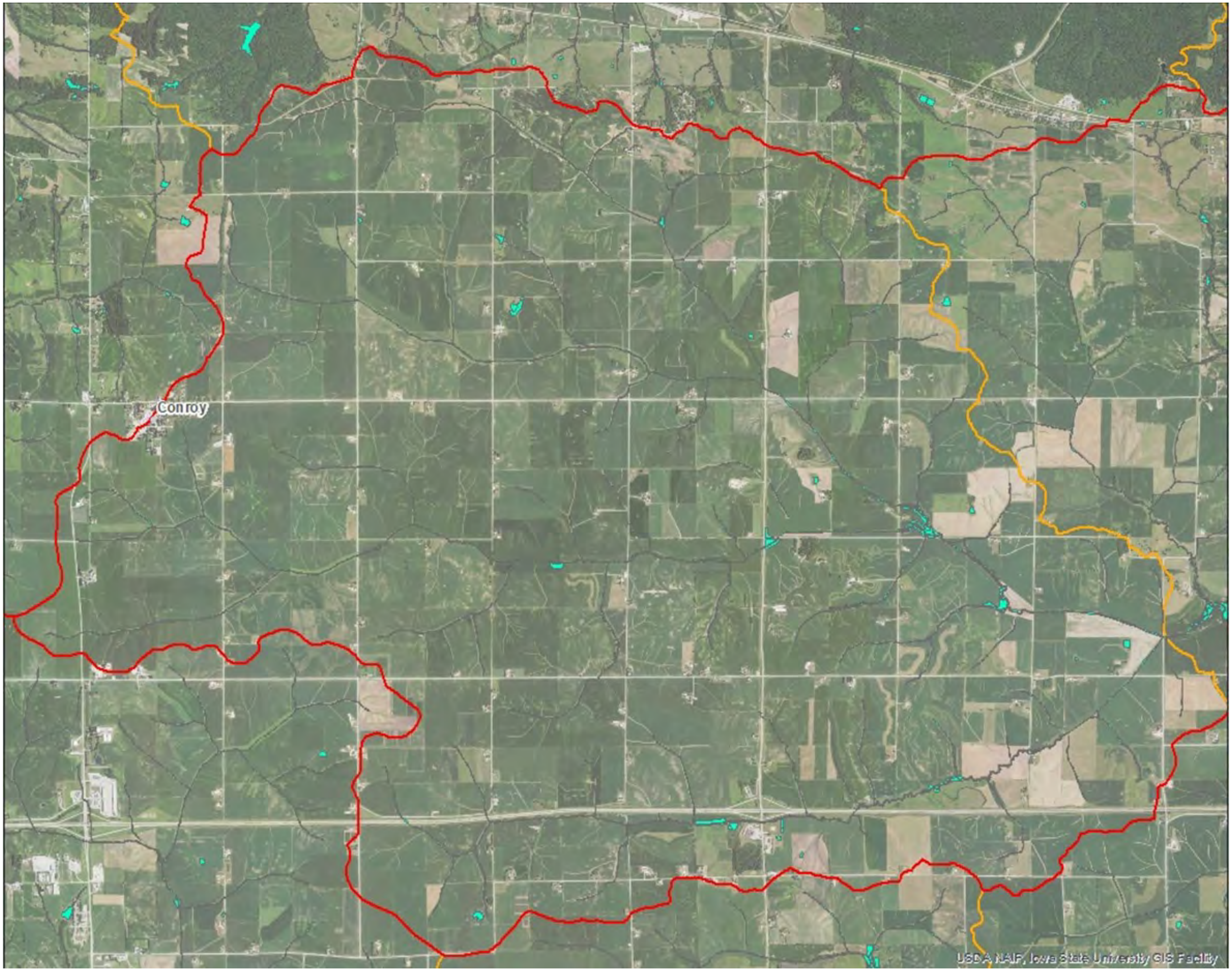
Source: Department of Natural Resources using National Wetlands Inventory Wetlands Mapper June 2020

Figure 2-3. Wetlands in the Middle Clear Creek Sub-Watershed



Source: Department of Natural Resources using National Wetlands Inventory Wetlands Mapper June 2020

Figure 2-4. Wetlands in the Upper Clear Creek Sub-Watershed



Source: Department of Natural Resources using National Wetlands Inventory Wetlands Mapper June 2020

2.3 Political Jurisdictions & Population

The Clear Creek watershed contains all or parts of five incorporated communities. Table 2-3 shows the number of acres that are in the watershed for each of these communities and the rural portions of Iowa and Johnson counties, as well as the watershed coverage percentages. The figures used for acres and square miles differ slightly throughout the plan due to differences in the data sources used.

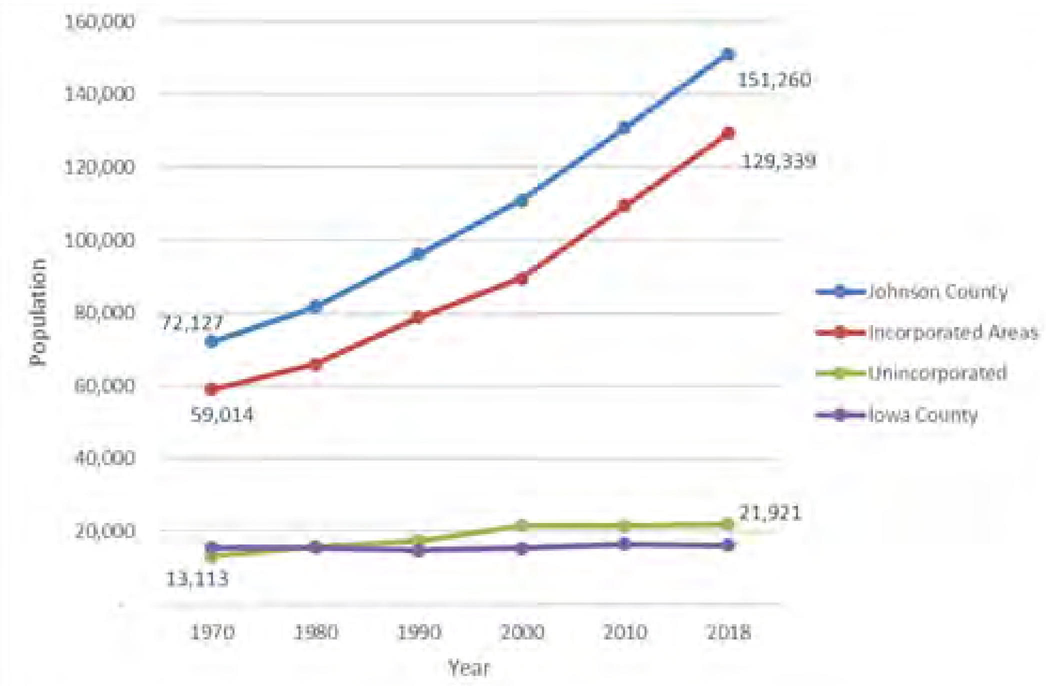
The Clear Creek watershed is in Iowa and Johnson counties in east-central Iowa. Johnson County is the fourth most populous county in Iowa with a total population of 151,260 in 2018 and is the second fasting growing county in the state. Iowa County is in the statistical middle of the list of counties by population

Table 2-3. Jurisdictions in the Watershed

Political Jurisdiction	Total Watershed	
	Acres	Percent of Watershed
Coralville	5,357	8%
Iowa City	1,720	2.6%
North Liberty	1,323	2%
Oxford	595	0.9%
Tiffin	2,645	4%
Iowa County (unincorporated)	27,976	42.3%
Johnson County (unincorporated)	26,521	40.1%
TOTALS	*66,136*	*100.00%*

Source: Iowa Department of Natural Resources

Figure 2-5. Population Change in Johnson County 1970 to 2018



Source: 2010 U.S. Census

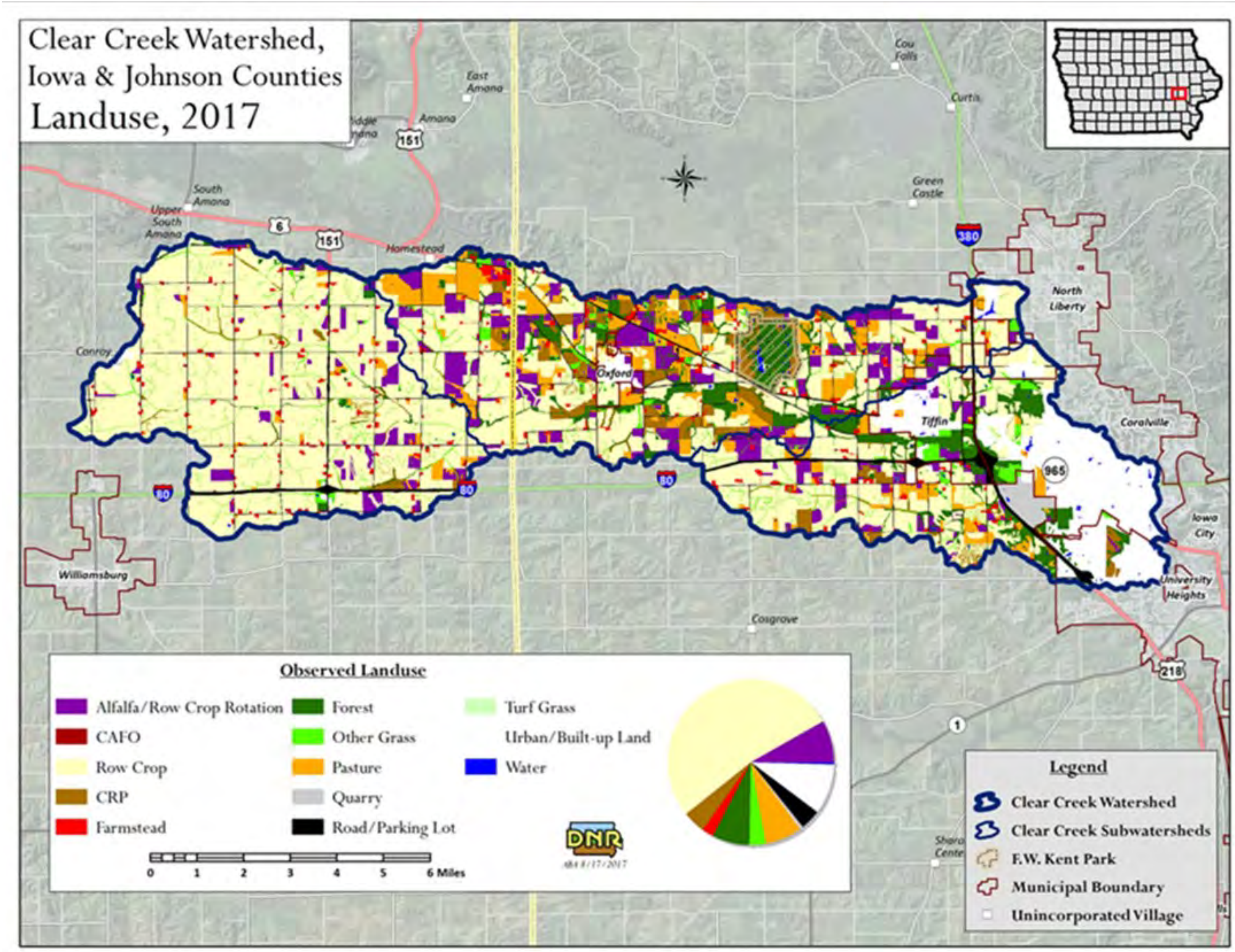
There are 16,141 people in the mostly rural county that has generally lost population since 2000. The 29,862 residents in the Clear Creek watershed live mostly in the urban areas.

As Figure 2-5 shows, the overall population of Johnson County and the population in incorporated areas have had very similar growth patterns since 1970. Population in the unincorporated areas increased only slightly between 1970 and 2010, while the total county population more than doubled. This is partly attributable to annexations of unincorporated land into incorporated communities of Johnson County since 2000. Johnson County's population is expected to increase by 20 percent each decade through 2040 adding another 60,500 people to the county, mostly in incorporated areas.

2.4 Land Use & Growth Trends

Urbanization and more intensive use of agricultural areas have altered the natural hydrology and impacted water quality of the Clear Creek watershed. Figure 2-6 is the land use map from 2017 representing the land use types in the watershed.

Figure 2-6. Clear Creek Land Use in 2017



Source: Iowa Department of Natural Resources

2.4.1 Urban Land Use

The lower portions of the Clear Creek watershed have experienced growth and development over the last several decades resulting in significant land use and land cover changes within the watershed. There has been a shift of grasslands and alfalfa/hay lands to residential, commercial, and other urbanized land uses. Table 2-4 illustrates the changes in land cover that have occurred in the region from 1985 to 2017.

Table 2-4. Land Use Trends in the Watershed

	1985*		1990*		2002*		2010**		2017***	
Landuse/Landcover	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Water	110	0.2%	129	0.2%	217	0.3%	413	0.6%	253	0.4%
Forest	3,722	5.6%	5,909	8.9%	5,371	8.1%	4,271	6.5%	4,821	7.3%
Grassland	19,132	28.9%	22,833	34.5%	20,688	31.3%	16,706	25.3%	8,639	13.1%
Alfalfa/Hay	2,473	3.7%	5,756	8.7%	1,878	2.8%	765	1.2%	1,113	1.7%
Row Crop	37,471	56.7%	27,813	42.1%	33,666	50.9%	36,002	54.5%	40,088	60.6%
Artificial	3,136	4.7%	3,598	5.4%	4,033	6.1%	7,833	11.8%	10,741	16.2%
Barren	55	0.1%	63	0.1%	237	0.4%	119	0.2%	446	0.7%
Totals	66,099	100.0%	66,101	100.0%	66,090	100.0%	66,109	100.0%	66,101	100.0%

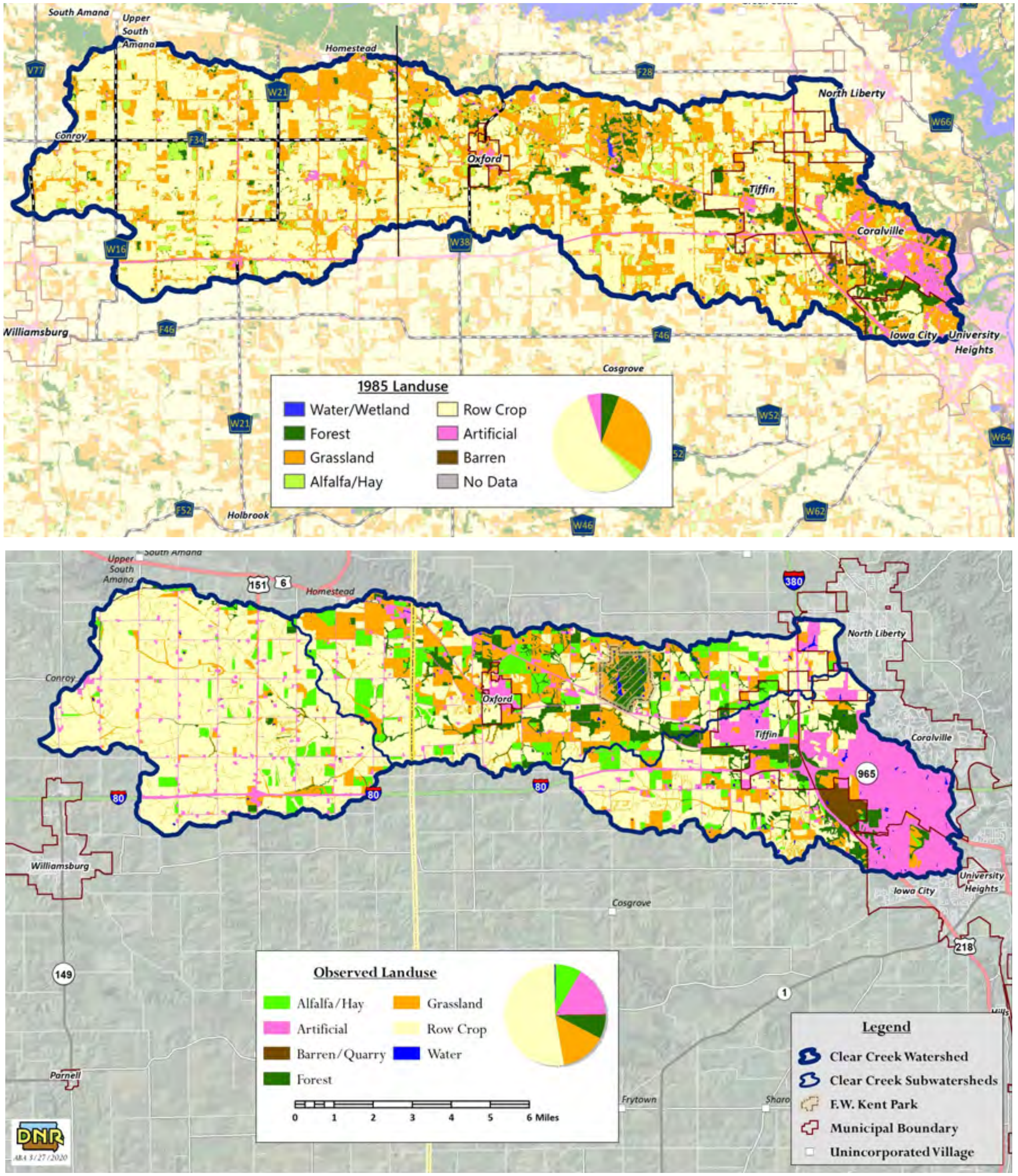
Source: Iowa Department of Natural Resources
* Land use Analysis originally compiled by the Iowa DNR GIS Section utilizing Landsat 5 & Imagery
** Land use Analysis compiled by USDA National Agricultural Statistical Service (2010 Cropland Data Layer)
*** Land use numbers compiled from results of CCWC Land use and Tillage Survey

In 2017, urban and residential land uses (commercial, residential, industrial, or roads) comprised approximately 16% of the Clear Creek watershed, which is four times the amount of developed land three decades ago. The urban land uses occur primarily in the eastern part of the watershed.

Several major thoroughfares transect the watershed including US Interstate 80 (I-80), US Intrastate 380 (I-380), US Highway 218, US Highway 6, US Highway 151, and State Highway 965. US I-80 parallels the much of the southern boundary of the watershed, while Highway 6 follows the northern boundary before bisecting to the southeast across the eastern third of the watershed. US Highway 151 cuts the western part of the watershed from I80 north to US Highway 6. US I-380 connects with US I-80 in the lower part of the watershed. All of these highways are crucial routes for transporting people and goods throughout the region and the state. Additionally, they play a role in directing future urbanization by opening more rural areas and communities to convenient intra-state travel. Consequently, highway accesses become hubs for development. Significant road construction projects are impacting the stream corridor including the reconstruction of I-80 and I-380 system interchange and the addition of the I-380 / Forevergreen Road interchange that will impact future development.

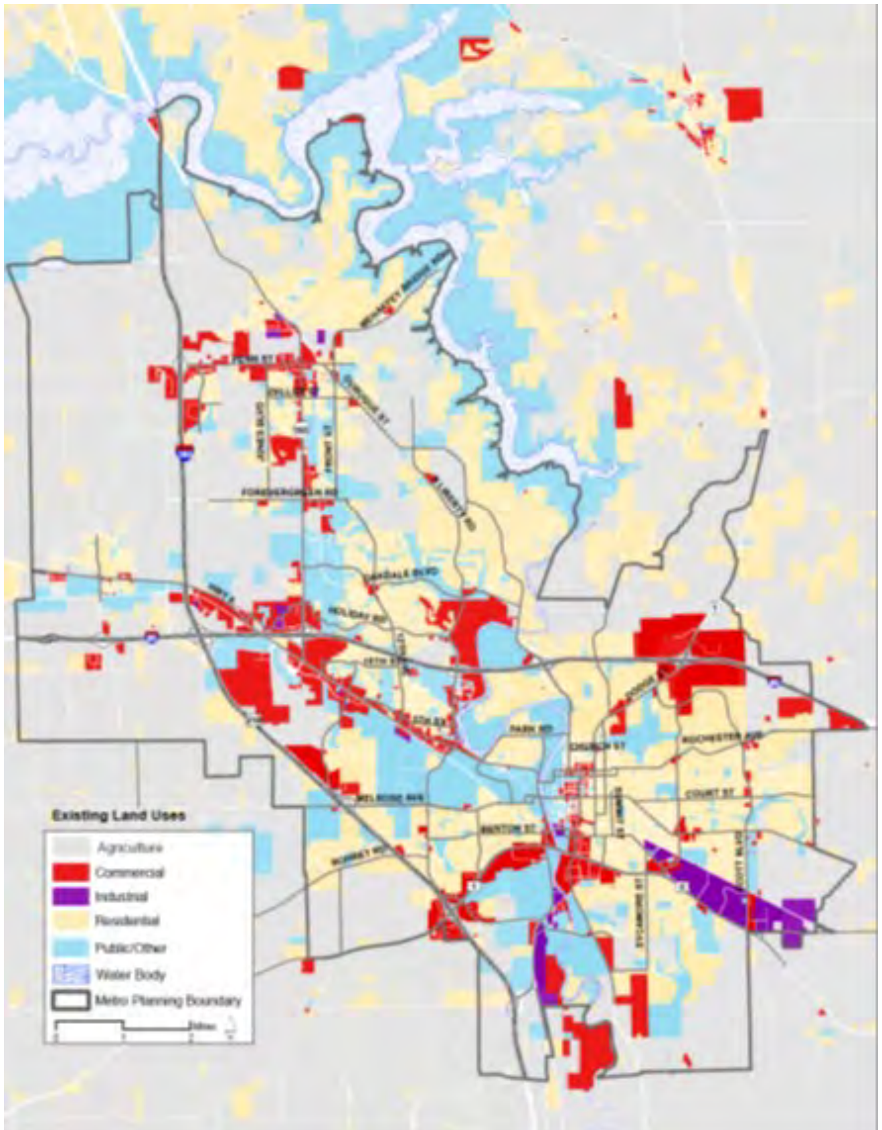
The past and possible future trends of urban land use can also be seen in Figure 2-7 representing the increase in urbanization from 1985 to 2017 and Figure 2-8 and 2-9 representing the existing urbanization compared to probable areas of future development.

Figure 2-7. Land Use Change from 1985 to 2017 (lower image)



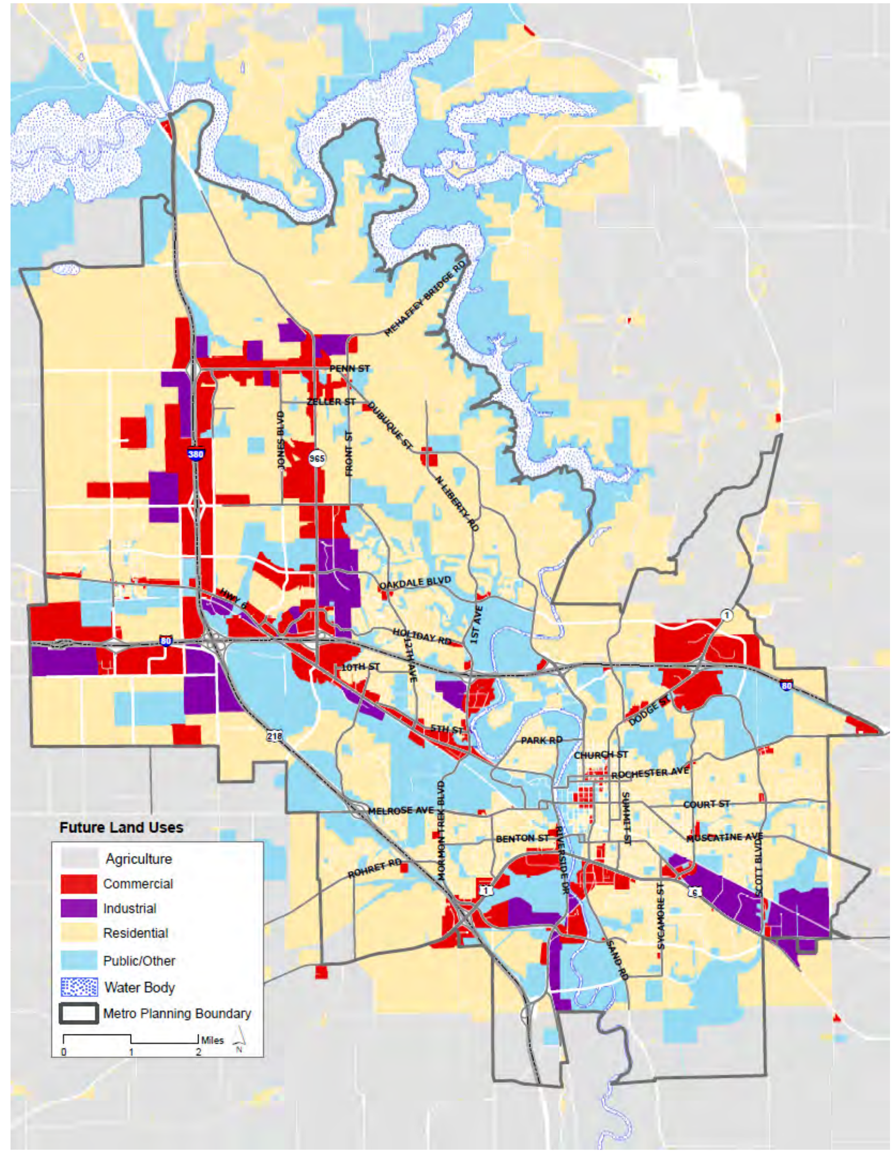
Source: Iowa Department of Natural Resources

Figure 2-8. Existing Urbanization



Source: Johnson County Metro Planning Organization Transportation Plan

Figure 2-9. Future Urbanization



Source: Johnson County Metro Planning Organization Transportation Plan

2.4.2 Agricultural Land Use

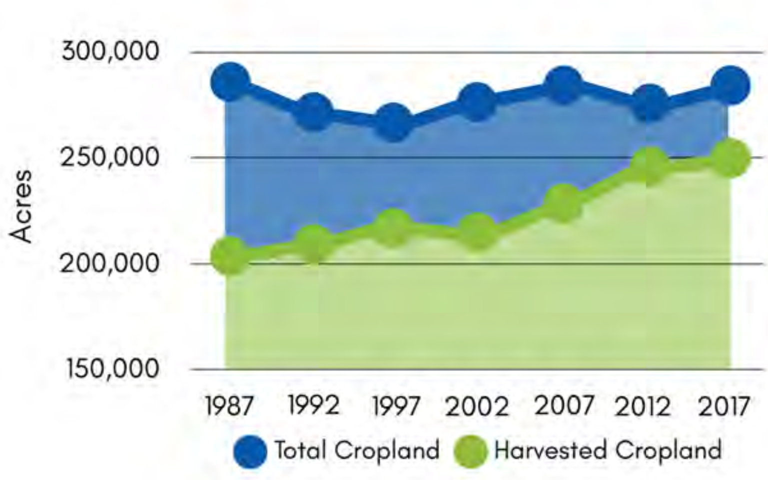
Agriculture has historically played an important role in the land use and economy of Iowa and Johnson counties. In 2017, despite the significant growth of urban land uses, most of the watershed area (55%) is still agricultural land uses (corn, soybeans, and alfalfa/hay).

Historical Agriculture Trends: Agriculture in the Clear 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.

Cropland: Figures 2-7 and 2-8 compares the acres of harvested cropland versus the total cropland available in Iowa and Johnson countities since the 1987 USDA Five-Year Census. Overall, the share of harvested cropland has increased over the past three decades with an increased level of production in Iowa County from 71% in 1987 to 87% in 2017 and in Johnson County from 75% in 1987 to 92% in 2017. It is important to note that a wide range of factors impact the amount of harvested cropland in any given year, such as weather, so numbers tend to fluctuate.

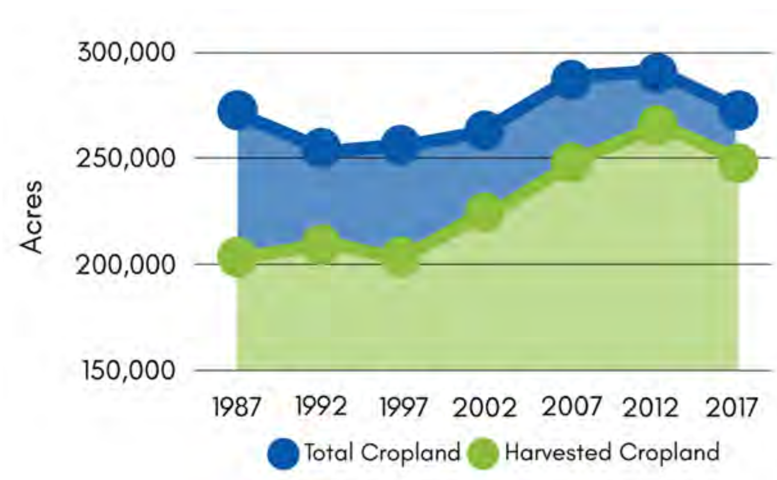
The growth of the ethanol industry and international demand for commodities, especially soybeans and corn, helped bring about a resurgence of the agriculture economy in 2007 only to slump again more recently due to trade tensions with China. The growth of these markets has led to an increase in the acres harvested of corn and soybeans for grain production.

Figure 2-10. Agricultural Cropland Trends in Iowa County



Source: USDA Five-Year Census (1987–2017)

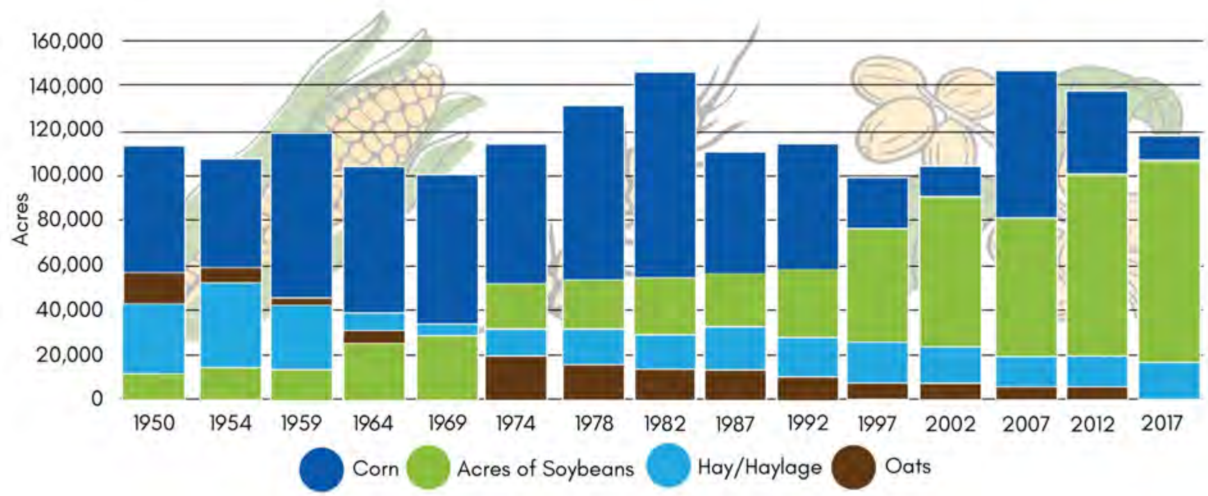
Figure 2-11. Agricultural Cropland Trends in Johnson County



Source: USDA Five-Year Census (1987–2017)

Crops Harvested: Figures 2-12 and 2-13 display the nearly 60-year trend for corn, soybean, hay and forage. Corn and soybeans have continued to dominate the market with fluctuations, but overall growth of acres planted, while acres of hay and forage have declined during this period.

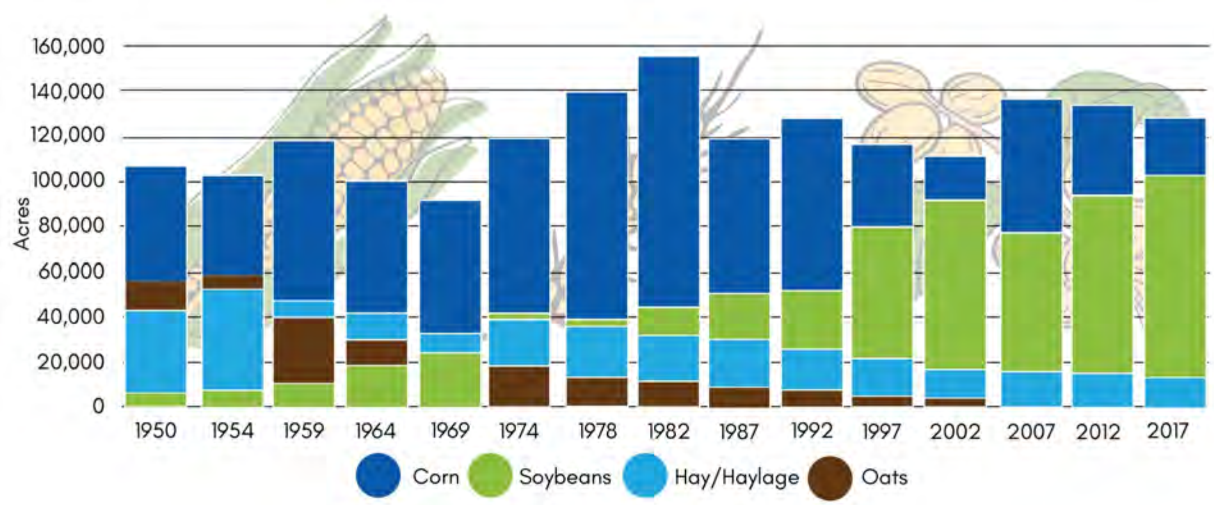
Figure 2.12. Crop Trends in Iowa County (1987–2017)



Source: USDA Five-Year Census (1987–2017)

Tillage: Tillage information was generated from surveys conducted by Johnson County SWCD staff. On a field-by-field basis, the staff documented the varying amounts of crop residue left on the surface after planting the current year's crop. In general, row crops are prevalent in the Upper Clear Creek watershed and more grazing takes place in the Middle Clear Creek watershed.

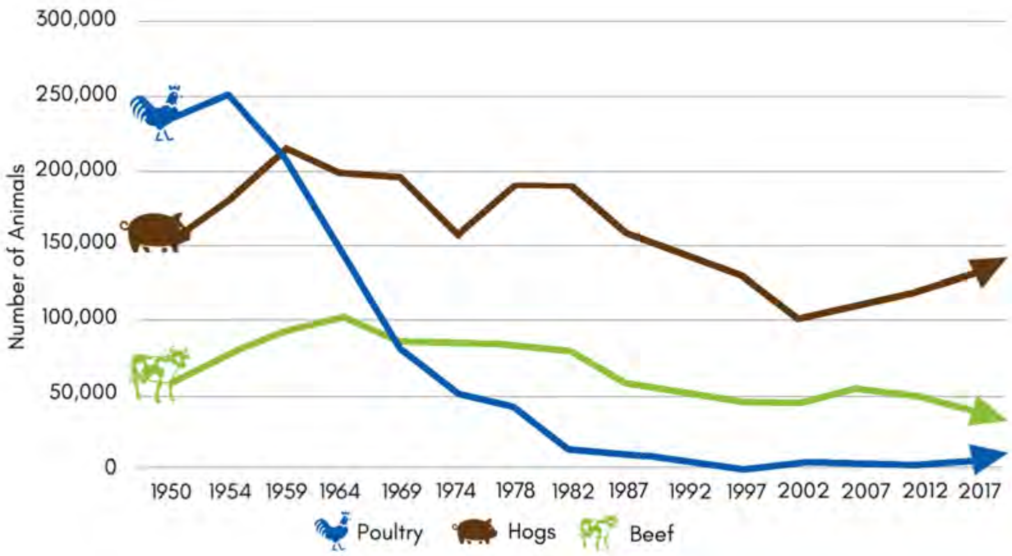
Figure 2.13. Crop Trends in Johnson County (1987–2017)



Source: USDA Five-Year Census (1987–2017)

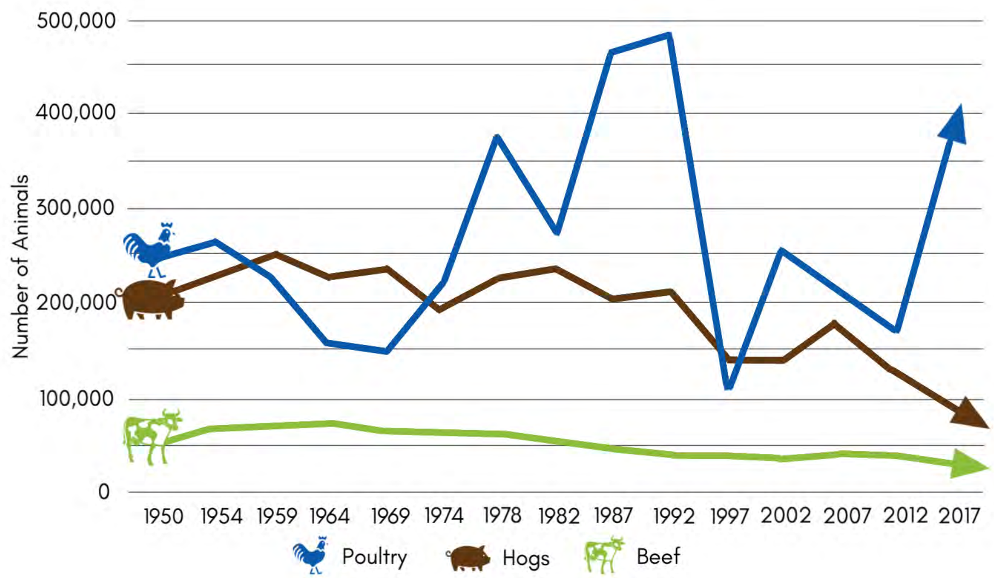
Livestock. Livestock trends are represented in Figures 2-14 and 2-15 for Iowa and Johnson counties over the past sixty years. Poultry (layers and broilers), hogs, and cattle and calves (beef and dairy) are the primary livestock raised in the area. Poultry has fluctuated the most, experiencing an 80.1% decline between 1954 and 1997 with a slight rebound since then. Hog inventory has experienced a similar but more steady decline, from 206,249 head in 1992 to 127,168 in 2012. Overall, cattle and calves have remained relatively steady throughout these five-year census estimates.

Figure 2-14. Livestock Trends in Iowa County (1950–2017)



Source: USDA Five-Year Census (1950–2017)

Figure 2-15. Livestock Trends in Johnson County (1950–2017)

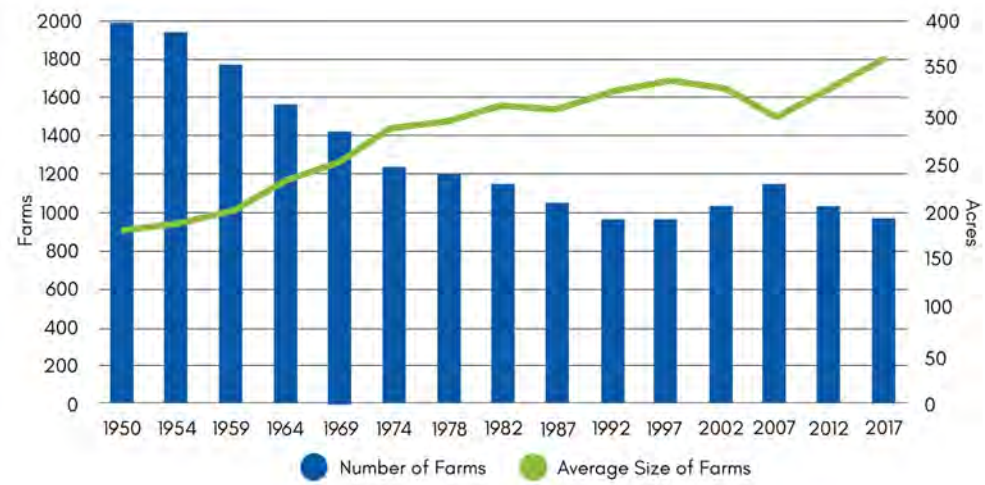


Source: USDA Five-Year Census (1950–2017)

Farm Operations: Although the number of farm operations has been declining since 1950, the average size of farm operations has increased as seen in Figures 2-16 and 2-17.

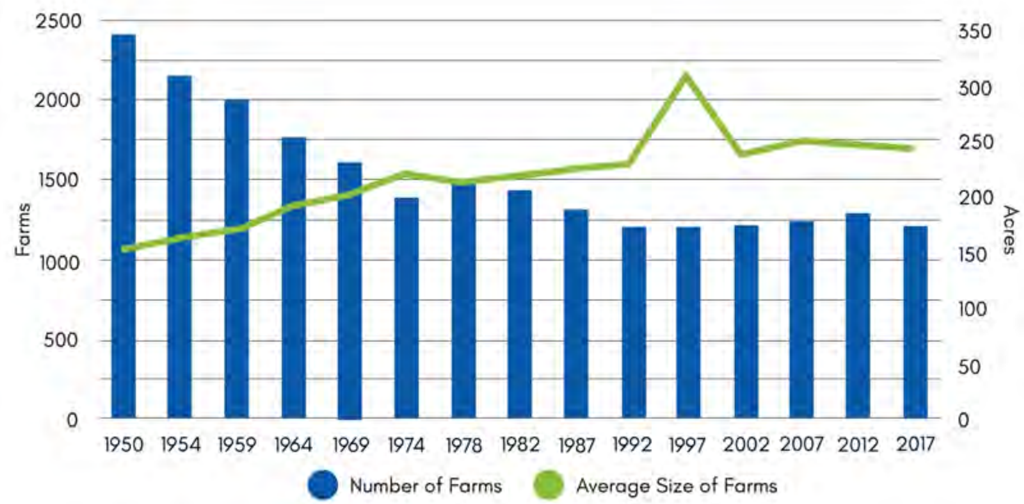
Advances in technology and farm practices, along with land costs, contribute to this trend. In general, fewer farmers are needed to produce higher yields of certain crops.

Figure 2-16. Number of Farms & Average Size in Iowa County 1950–2017



Source: USDA Five-Year Census (1992–2017)

Figure 2-17. Number of Farms & Average Size in Johnson County 1950–2017



Source: USDA Five-Year Census (1992–2017)

2.4.3 Public Areas

Public lands (Figure 2-18) and open space are important resources for recreation and to provide opportunities for residents to interact with the streams in the Clear Creek watershed. The recreational opportunities are varied and encourage people of all ages the chance to enjoy the outdoors.

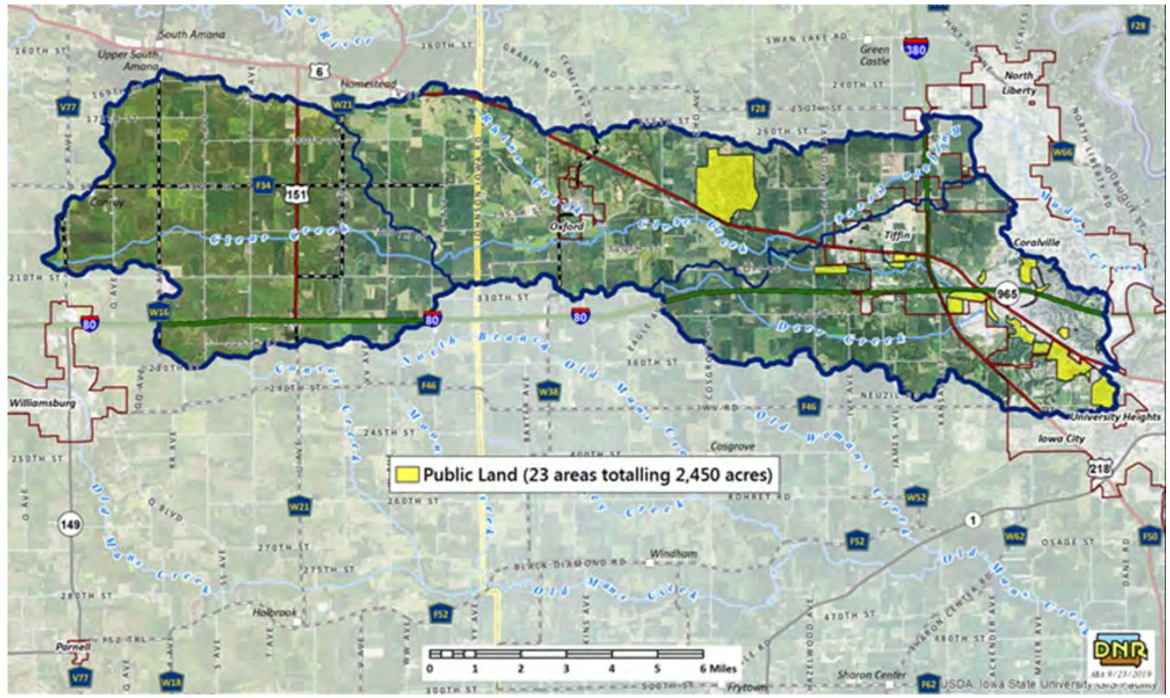
Some of these areas provide direct public access to Clear Creek or its tributaries for activities such as fishing or paddling. Other areas, while not directly adjacent to the stream, still provide valuable opportunities for recreation and open space. Recreation areas within the watershed include:

- 1 golf course
- 1 disc-golf course
- 3 sports complexes
- 4 trails
- 2 public swimming pools
- 25 public parks, natural areas and greenways

Disc Golf Course in the Clear Creek Watershed

Source: Sherri Proud, Coralville Parks Director

Figure 2-18. Public Lands in the Clear Creek Watershed



Source: Iowa Department of Natural Resources

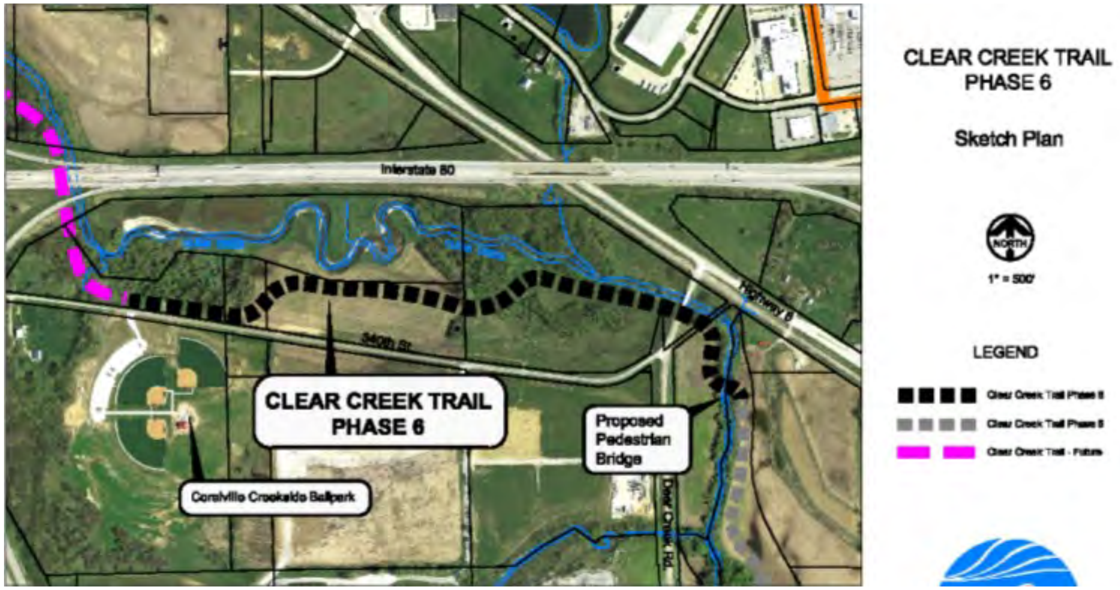
The public spaces in the watershed vary in size from the 2-acre Old City hall/Fire Station Park in Tiffin to the 1,052-acre F.W. Kent Park Lake in Johnson County.

In addition to the recreation facilities and parks, there are four regionally significant trails in the watershed. These include the Clear Creek Trail and North Ridge Trail that are multi-use and the Clear Creek Cross bike trail and the Woodpecker trails for mountain bikes. Figure 2-19 shows one of the trail expansion projects planned in the watershed. Coralville's Clear Creek Trail Phases 6 and 7 (to Creekside Ballpark and Tiffin) have been completed apart from the sections under the I-80 and I-380 Bridges. These sections of trail will be completed by the Iowa Department of Transportation with the I-80/I-380 Systems Interchange Improvements Project.

Part of the Clear Creek Trail in Coralville

Source: Sherri Proud, Coralville Parks Director

Figure 2-19. Clear Creek Trail Expansion Project



Source: Sherri Proud, Coralville Parks Director

F.W. Kent Park Lake

Source: Johnson County Conservation Board

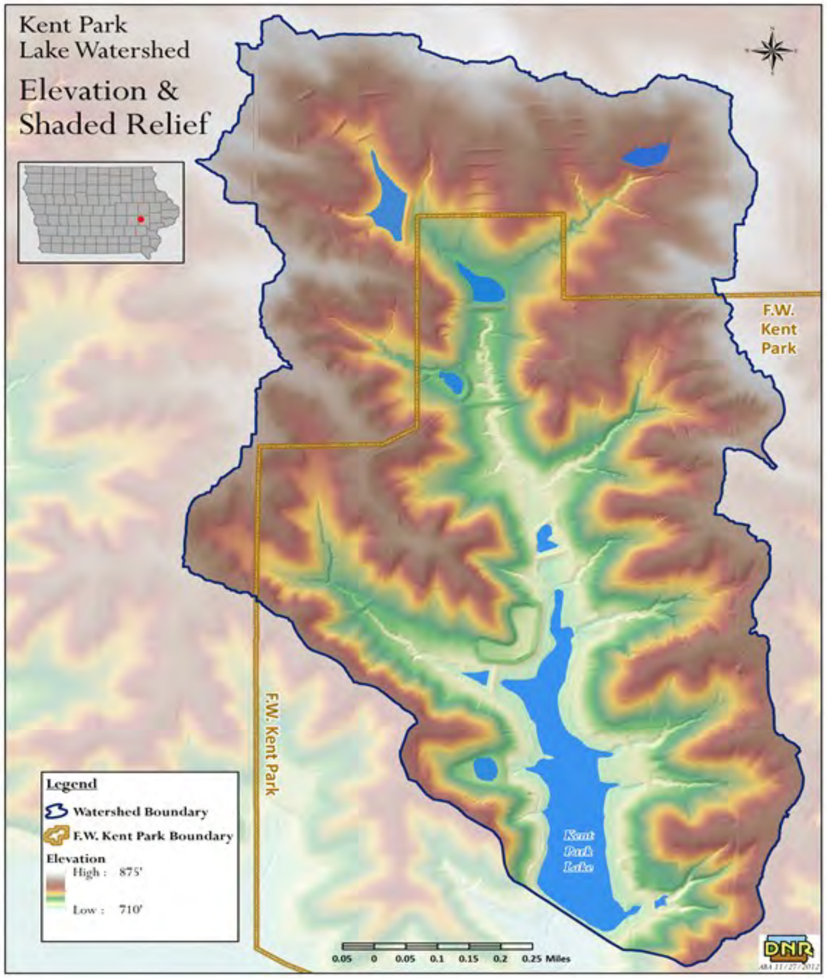
The Lake is a 26.5-acre lake built in the early 1970s as a recreation area. The watershed for the lake is 687 acres and is mostly within F.W. Kent Park (Figure 2-20). The lake provides 224-acre feet of storage and has had high levels of phosphorus and bacteria impacting water quality. There were seven beach closures from 2014 to 2016 and the lake aesthetics were objectionable from July through September those same years (Figure 2-21). In 2014, the Johnson County Conservation Board commissioned the development of the Kent Park Lake Watershed Assessment and Management Plan to find and address the underlying issues. Water monitoring, a gully assessment and an impervious surface report were completed for the plan and recommendations made for improving water quality in the lake including:

- Dredge existing catch basins to restore function.
- Construct 6 new basins and bio-cells
- Implement Timber Stand Improvements to promote herbaceous plant growth in forested areas.
- Dredge main lake to increase average depth to 9 feet or more
- Reduce mowing in turf areas and replace with prairie
- Beach renovation to reduce direct runoff into the lake

Figure 2-21. F.W. Kent Park Lake Sampling

Source: Johnson County Conservation Board

Figure 2-20. Kent Park Lake in the Clear Creek Watershed



Source: Iowa Department of Natural Resources

F.W. Kent Park is also home to the Johnson County Conservation Education Center providing a prairie diorama, a 200 year old oak cross section, a bird and wildlife viewing station, a live animal display featuring reptiles and amphibians that inhabit the park and an aquarium featuring representative fish from Kent Park Lake.

2.5 Watershed Impacts of Land Use Changes

The Clear 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 forested 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 to intensive agriculture and urban areas has dramatically changed how water moves across the Clear Creek watershed. Rainfall that once seeped into the soil and eventually became groundwater, now runs more quickly off the surface.

2.5.1 Agriculture Land Use Impacts

As of 2017, row crop corn and soybeans make up 55% of the Clear Creek watershed's land use, primarily in the western 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:

- **Changes in Soil Health --** 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 and the degradation of soils through tillage, which increases bulk density of soils, making them less permeable to stormwater and reducing soil structure and organic matter.
- **Changes in Riparian Corridor --** the loss of wetlands, which provided storage for runoff and 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.
- **Degradation of Habitat --** loss of habitat for plants and animals that depend on open prairie, woodlands and wetland areas.
- **Water Quality Impacts --** increase in nutrients (phosphorus and nitrogen compounds), reduced dissolved oxygen and increased suspended solids and microbial contamination (bacteria, viruses and other pathogens).

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 6.

2.5.2 Agriculture Land Use Impacts

In 2016, Iowa State University undertook the Iowa BMP (Best Management Practices) Mapping Project that set out to provide a complete baseline of BMPs dating from the 2007-2010 timeframe for use in watershed modeling, historic occurrence, and future practice tracking. The BMPs being mapped for the project are terraces, water and sediment control basins (WASCOB), grassed waterways, pond dams/farm ponds, strip cropping and contour buffer strips. For the Clear Creek watershed planning process, the Department of Natural Resources compiled the existing BMPs identified by the Iowa BMP Mapping Project presented in Table 2-5 and Figure 2-22. It is important to note that mapped practices may not meet NRCS standards or are actually the indicated practice since no ground truthing is being performed. The data does, however, provide a general baseline to begin tracking improvements.

Table 2-5. Existing Agricultural Practices in the Clear Creek Watershed

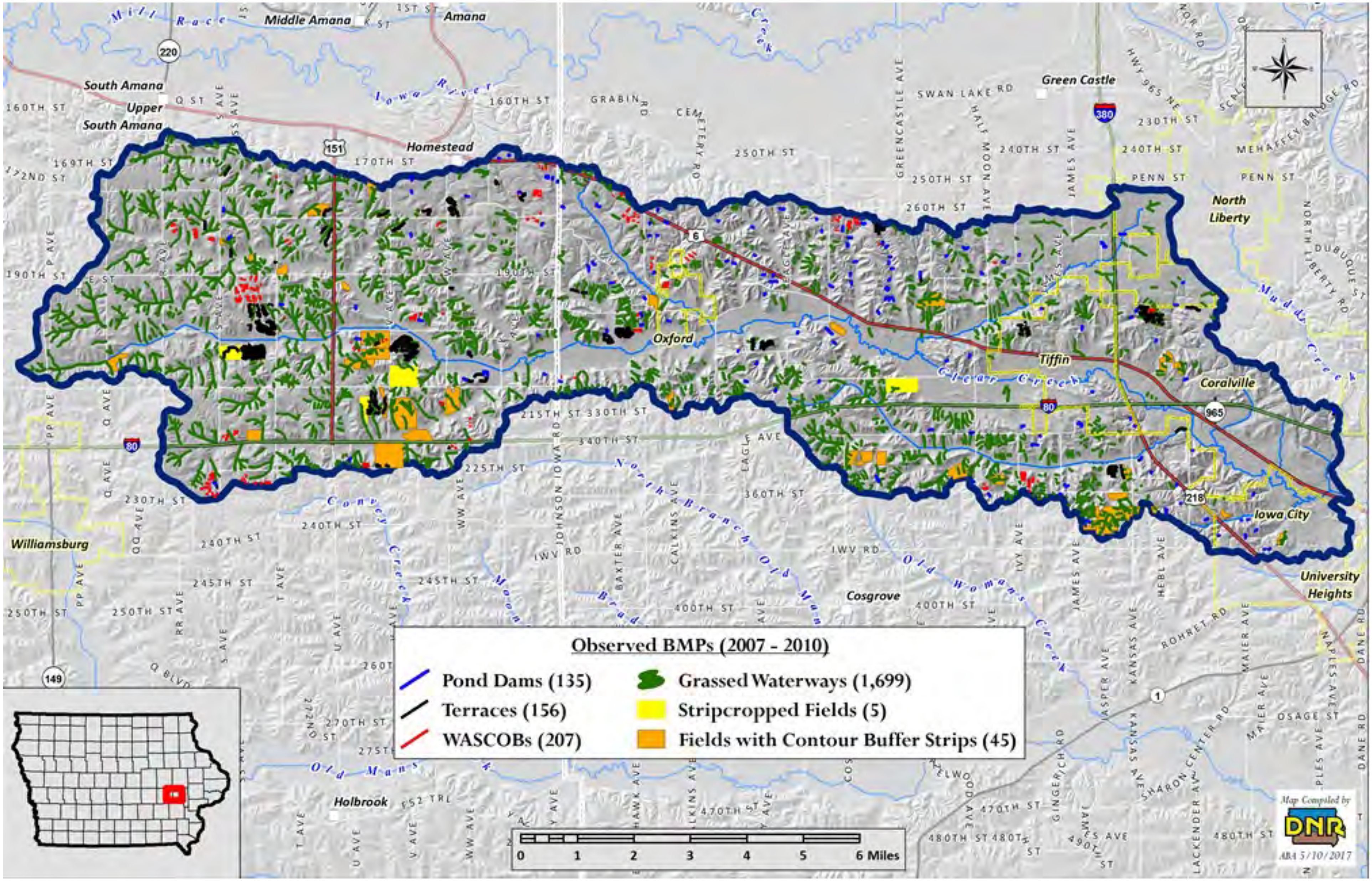
HUC-12	Farm Ponds (number)	Grassed Waterways (acres)	Terraces (miles)	WASCOBs (miles)	Contour Buffer Strips (acres)	Stripcropping (acres)
Upper Clear Creek	10	564.9	16.1	5.3	763.2	291.2
Middle Clear Creek	80	253.7	7.0	3.4	111.6	77.2
Lower Clear Creek	45	190.1	4.3	1.2	432.5	0.0
Totals	135	1,008.7	27.4	9.9	1,307.3	368.5

Source: Iowa Department of Natural Resources

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 farmland 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:

- 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

Figure 2-22. Existing Agricultural Practices



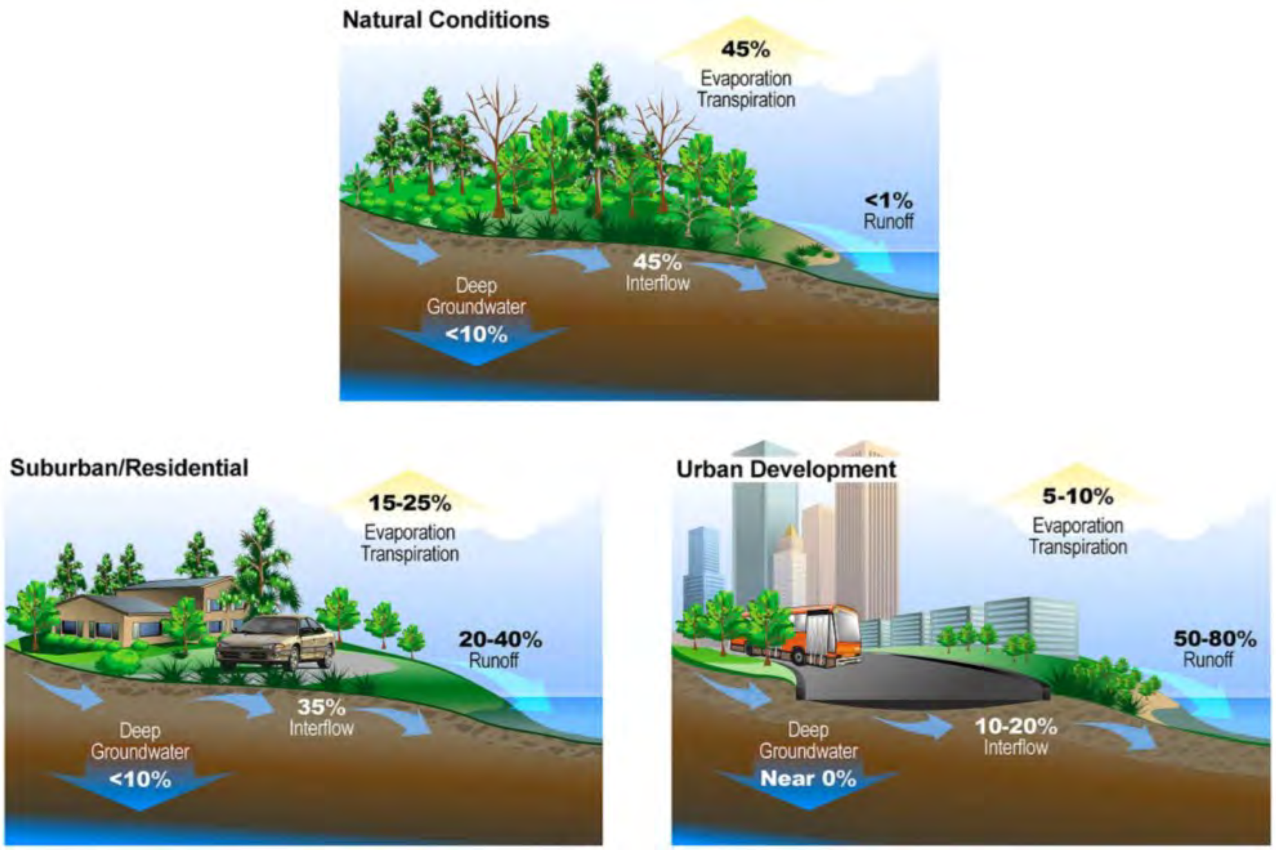
Source: Iowa Department of Natural Resources

2.5.3 Urban Land Use Impacts

The eastern portion of the Clear Creek watershed is primarily urban with most 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. The addition of surfaces that are impervious to rainfall further reduces infiltration and increases runoff.

Stormwater drainage systems such as ditches, curb and gutter, and storm drainage inlets and pipes further modify the natural hydrology which speeds stormwater runoff to the creeks. Runoff from urban areas can increase the temperature of the receiving stream, which impacts aquatic life. Urban runoff can also concentrate pollutants coming from human activities in the watershed. Figure 2-23 illustrates how the water balance changes when natural forest/ grassland cover is cleared and replaced by suburban and urban development.

Figure 2-23. Impacts of Changes to Natural Hydrology



Source: Iowa Department of Natural Resources

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 Clear Creek watershed, including:

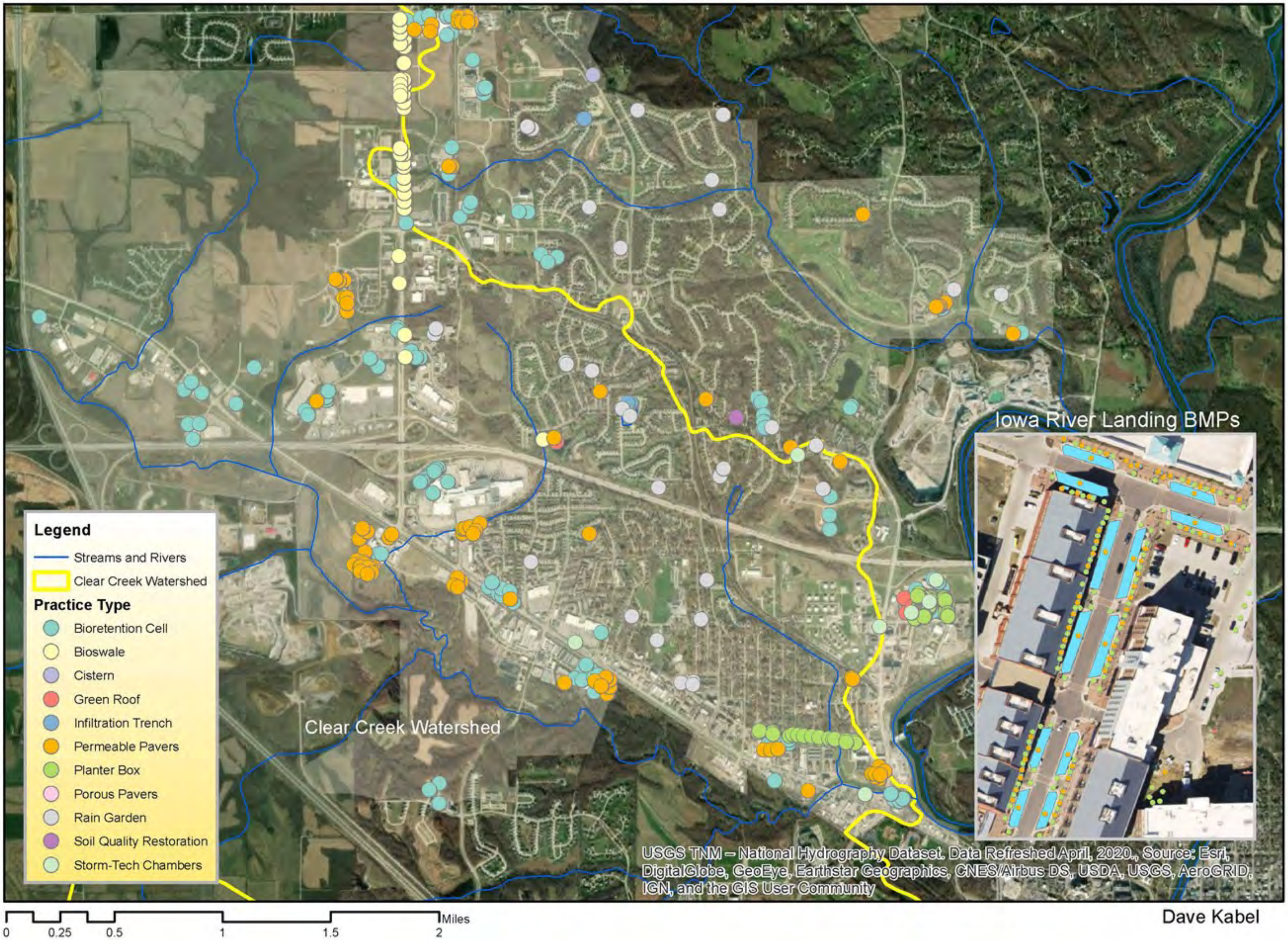
- Losses and damages to private & public property and infrastructure due to flooding & erosion
- Impairment of drinking water supplies
- Increased cost of water supply treatment and watershed protection
- Loss of recreational opportunities
- Declining value of flood prone property
- Reduction in quality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

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

2.5.4 Urban Best Management Practices (BMP)

The focus of the Clear Creek Watershed Management Plan is to recommend watershed management strategies to help communities protect residents and their property from future flood impacts and to help effectively mitigate existing problems to the extent practical. Urban BMPs (Best Management Practices) already in the City of Coralville were documented by Coralville Stormwater staff and the DNR for the planning process to provide a similar baseline for improvements (Figure 2-24).

Figure 2-24. Coralville Existing Urban BMPs



Source: Dave Kabel, City of Coralville Engineering Stormwater Technician

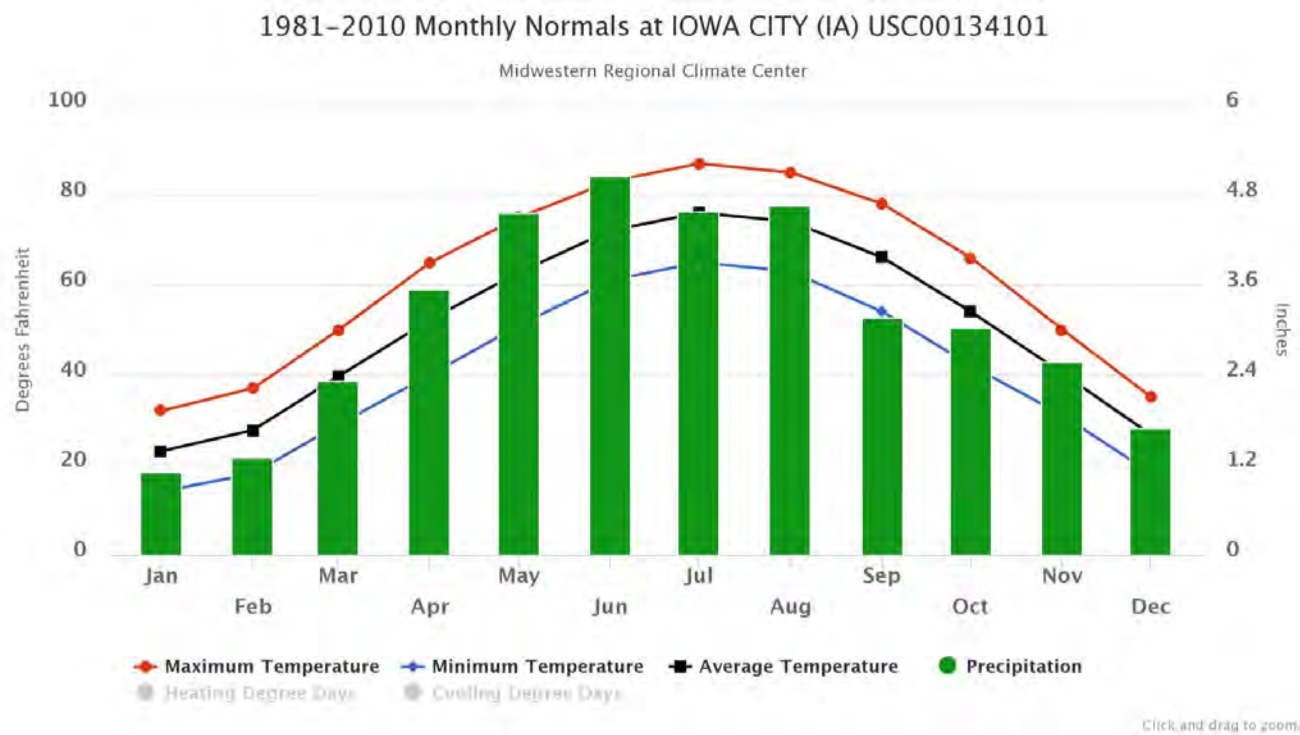
2.6 Climate

2.6.1 Temperature & Rainfall

The Clear 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. 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 Clear Creek watershed consists of an average precipitation of 37. Normal monthly temperatures and precipitation are summarized in Figure 2-22.

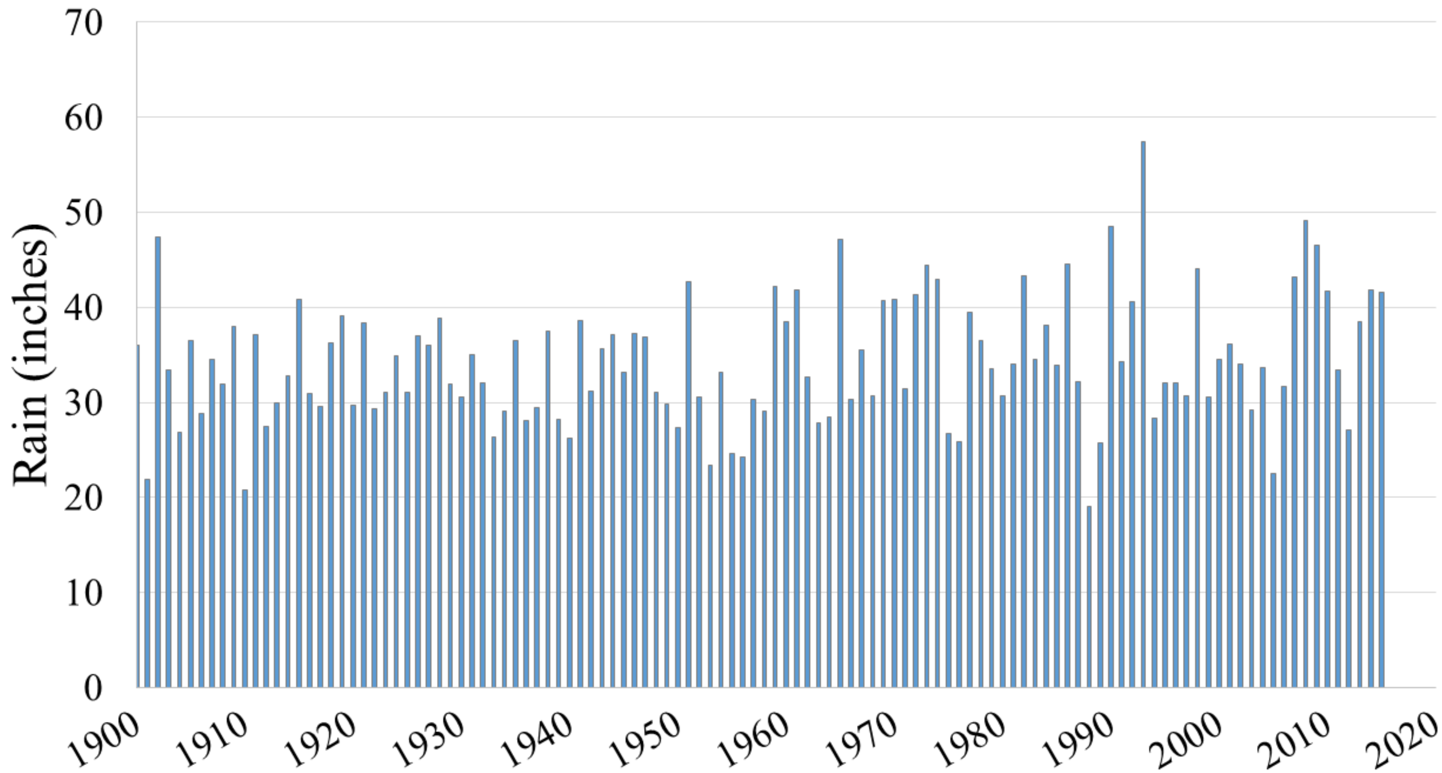
Figure 2-25. Normal Temperatures and Precipitation in Clear Creek Watershed



Source: NOAA's Midwestern Regional Climate Center

Figure 2-26 shows a stark change in the frequency of heavy precipitation years in the Clear Creek watershed. Before 1960, there were three years exceeding 40 inches of annual precipitation. Since 1960, there have been twenty years exceeding 40 inches of annual precipitation.

Figure 2-26. Annual Precipitation in the Clear Creek Watershed



Source: Clear Creek Watershed Hydrologic Assessment Report, Iowa Flood Center / IIHR Hydroscience & Engineering

2.6.2 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:

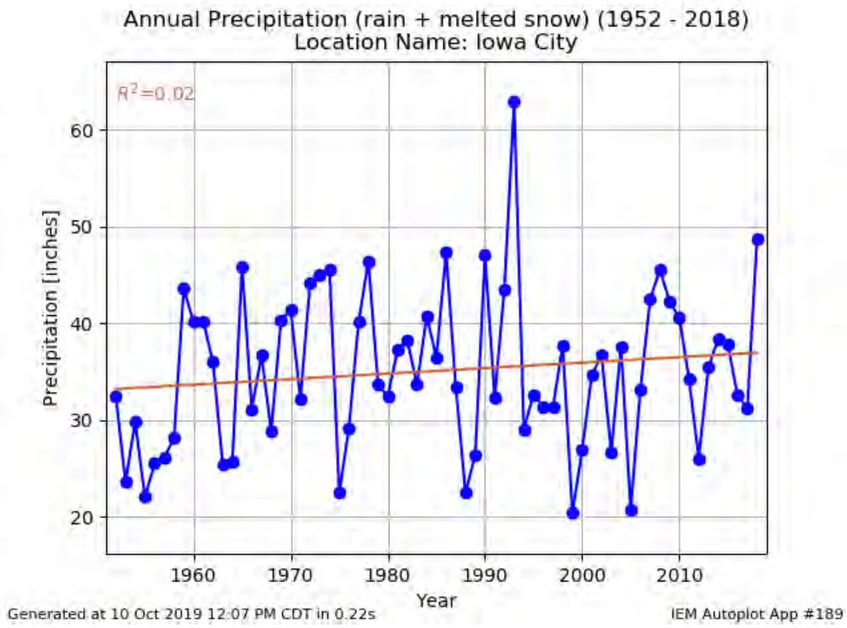
- More days of rain
- More total rainfall
- Significant changes in heavy precipitation
- Hotter nights
- Warmer winter temperatures
- More frequent extreme heat waves

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

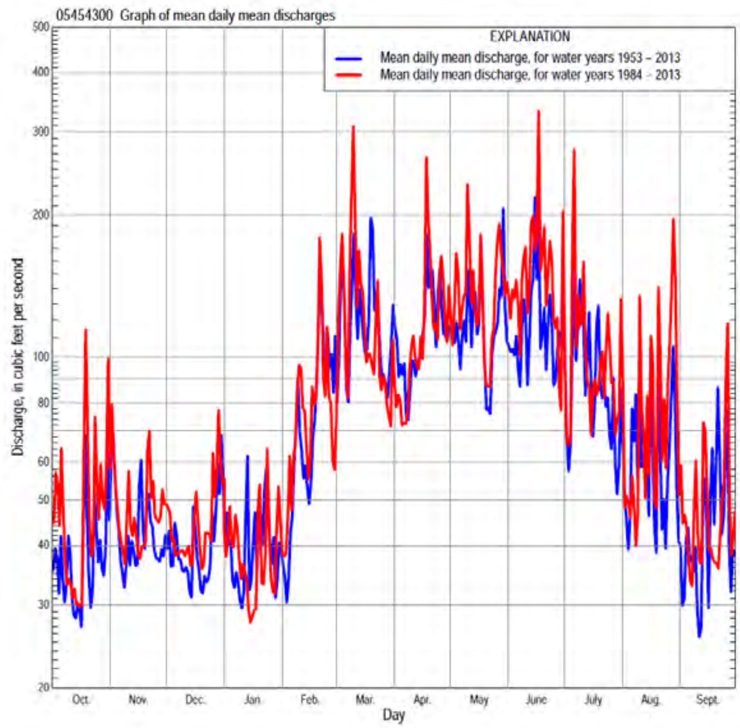
Other potential consequences of climate change include less snow during the winter months, longer growing seasons, and an increase in climate variability (i.e. each year is less predictable). In addition, increases in summertime heat means more crop stress and increased water demand along with the potential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

Figure 2-27. Total Annual Precipitation at Iowa City Gage



Source: IEM Climodat

Figure 2-28. Mean Daily Mean Discharge for Water Years 1953 – 2013 and 1984 – 2013



Source: Clear Creek Watershed Hydrologic Assessment Report, Iowa Flood Center / IIHR Hydroscience & Engineering

2.7 Flooding

Flooding is a natural part of the annual hydrologic cycle, and floods can 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. Another factor impacting the Clear Creek watershed is the US Army Corps of Engineers Dam creating the Coralville Reservoir 5 miles upstream from the outlet of Clear Creek into the Iowa River. Built in 1958 to control flooding on the Iowa and Cedar Rivers, it has had two instances of water going over the spillway impacting the Clear Creek watershed in 1993 and 2008.

2.7.1 Historical Flood Events

Clear Creek flooding has repeatedly impacted Iowa and Johnson counties damaging businesses, crop land, parks, utilities, and residential properties. Basements flooded with water, which often crept up to the main floors; impacts to transportation requiring longer, alternate travel routes; closed schools and unanticipated childcare needs; and missed workdays due to closure or recovery activities. These impacts burden all residents in a community. The largest flood events recorded by the US Geological Service (USGS) for Clear Creek at the gaging stations near Oxford and Coralville are shown in Table 2-6.

Table 2-6. Discharge from USGS Gaging Stations in the Clear Creek Watershed

Clear Creek near Oxford USGS 05454220 (since 1994)	Cubic Feet per Second (cfs)	Clear Creek near Coralville USGS 05454300 (since 1953)	Cubic Feet per Second (cfs)
April 18, 2013	6,000	June 17,1990	10,200
July 1, 2014	4,630	July 6, 1993	6,760
May 10, 1996	4,230	June 15, 1982	6,520
June 20, 2009	3,390	April 18, 2013	6,480
February 21, 1997	3,240	May 29, 1962	5,390
June 23, 2007	3,140	May 17, 1974	5,380

Source: Clear Creek Watershed Hydrologic Assessment Report, Iowa Flood Center / IIHR Hydroscience & Engineering

June 17, 1990 with a flow of 10,200 cubic feet per second (cfs) – In Tiffin, about one-third of the homes had flooded basements, and residents of a south-side neighborhood had to be evacuated when their trailer homes were threatened by the rising water of Clear Creek (Des Moines Register, June 18, 1990). A 2-mi stretch of Interstate 80 near Coralville was closed for about 14 hours because of inundation by Clear Creek floodwaters. Traffic was detoured for 5 miles until Interstate 80 was reopened on the afternoon of June 17. At the Clear Creek USGS gaging station at Coralville, the peak discharge recorded on June 17, 1990 is the maximum discharge for the period of record.

Press Coverage of Clear Creek Flooding in 1990


Metro editor
Joe Levy, 335-6063

Metro/Iowa

Page 3A

Summer showers pour into local city

Flood waters rise and fall over Tiffin

Source: *Iowa City Daily Iowan*, June 18, 1990

July 6, 1993 with a flow of 6,760 cfs – From mid-June through early August 1993, severe flooding in a nine-state area in the upper Mississippi River Basin followed intense and persistent rain from January through July. There was water in the streets of Coralville from July 5th to September 18th causing an estimated $3.5 million in damages. The underground water pressure was so high it forced live minnows out of street paving joints 250 feet from Clear Creek. On July 6, 1993, floodwaters from Clear Creek again inundated Interstate 80 near Coralville. At the Clear Creek gaging station near Coralville, the peak discharge is the second largest on record.

Coralville Flood Waters in 2008

Photo Credit: Scott Larson, Coralville Assistance City Engineer

June 2008 brought historic flooding to the Iowa River valley again. The crest saw water levels 4.2 feet over the Coralville Dam spillway flooding the streets of Coralville for 3 weeks at an elevation of 4.5 feet higher than in 1993.

April 18, 2013 with a flow of 6,480 cfs – Following Iowa's wettest spring on record, storms hit the City of Coralville with six inches of rain in 24 hours creating significant runoff causing several washouts and loss of roadways. More severe weather hit the area in June 2013 and the community braced for potential historic flooding. Clear Creek in Coralville experienced backwater effects as the Iowa River reached its fourth highest crest in history. The Iowa Department of Agriculture and Land Stewardship estimated it would cost over $4.6 million to repair damage from soil loss for this flood event alone.

2.7.2 Repetitive Loss Properties

In the Clear Creek Watershed, 40 properties have endured Repetitive Loss (RL). Each property has experienced damages of $1,000 or more at least twice in the past 10 years. These properties are classified as single family residential, multiplex residential, and businesses, and are in Iowa and Johnson Counties. The total of loss to the buildings and their contents was $2.1 million. See Table 2-6 for more information about RL structures in this watershed. The RL information is current as of December 2019. No properties in the Clear Creek Watershed have experienced Severe Repetitive Loss (SRL). For present-day information, contact the Iowa Department of Natural Resources.

Table 2-7: Repetitive Loss Properties in the Clear Creek Watershed

City/County	Total Buildings	Commercial	Residential	Total Building Payments	Total Contents Payment	Total Payments
Iowa County	4	-	4	$25,058	$0	$25,058
Johnson County	17	-	17	$404,288	$78,697	$482,982
Coralville	13	13	-	$1,246,888	$367,879	$1,614,767
Iowa City	2	-	2	$4,441	$0	$4,441
North Liberty	2	-	2	$11,335	$0	$11,335
Total	40	-		$1,692,010	$446,576	$2,138,583

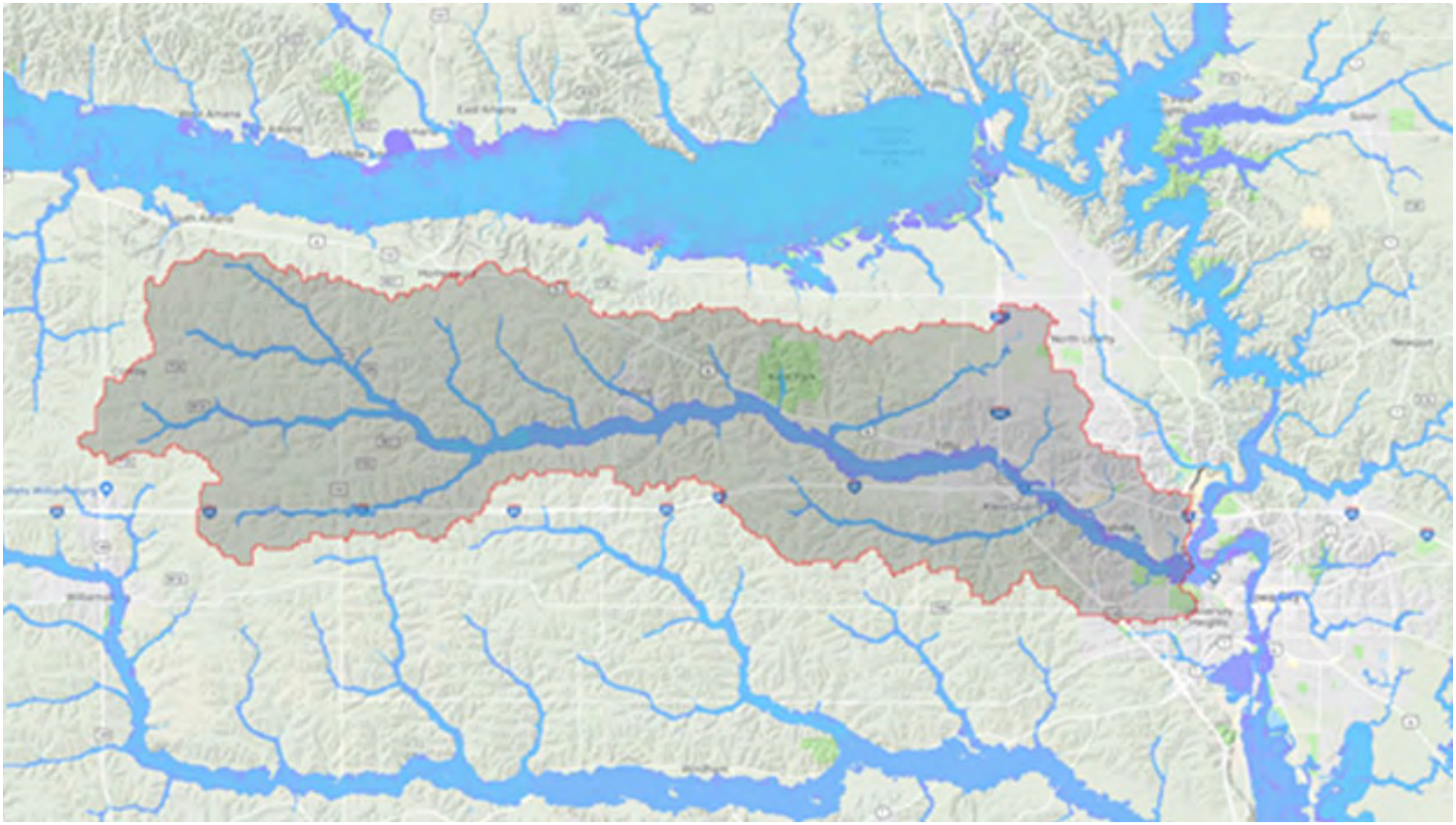
Source: Flood Mitigation Planning for the Clear Creek Watershed, Iowa Flood Center / IIHR Hydroscience & Engineering
Data current as of December 2018
**Commercial represents businesses and other non-residential buildings*
***Residential represents single and 2-4 family households*

2.7.3 Location and Extent of Flooding and Future Probability

Information on the probability, location, and extent of future floods and their impacts on populations and built environments are available on the Iowa Watershed Approach Information System (IWAIS). Researchers from Iowa Department of Natural Resources, Iowa Flood Center, and U.S. Army Corp of Engineers have modeled inundation depths for the 1% annual chance flood (the so-called “100-year” flood), as well as for flood events with an annual chance of 50% (2-year), 20% (5-year), 10% (10-year), 4% (25-year), 2% (50-year), 0.5% (200-year), and 0.2% (500-year) for the state of Iowa.

The 0.2% annual flood risk inundation depth is shown in Figure 2-29 for the entire Clear Creek watershed. Areas of high inundation in the Clear Creek watershed include Coralville, Tiffin, and Oxford. Areas of flood risk within the Clear Creek watershed are illustrated on the mapping application at http://iwa.iowawis.org/app/#clear_creek.

Figure 2-29. Clear Creek Watershed 0.2% Flood Risk Inundation Depth



Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

For select Iowa towns, IWAIS community scenario maps have multiple features, including detailed river stage (every half-foot), annual chance flood event, flow discharge and water depth.

The property at risk in Coralville and Iowa City from a 0.2% annual chance flood event is depicted in Figure 2-30. Inundation maps like this are valuable tools to illustrate the extent and depth of flood risks and can be accessed at iwa.iwais.org.

Figure 2-30. Coralville and Iowa City 0.2% Flood Risk Water Depth

Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

The flood maps can be layered with other data features that identify potential flood outcomes in their communities. This includes population vulnerability and the percentage of individuals impacted by floods. Figure 2-31 depicts the 0.2% annual flood risk inundation area layered with 2010 Census Tract 2 social vulnerability data including the percentage of female head of households, renters and disabled residents.

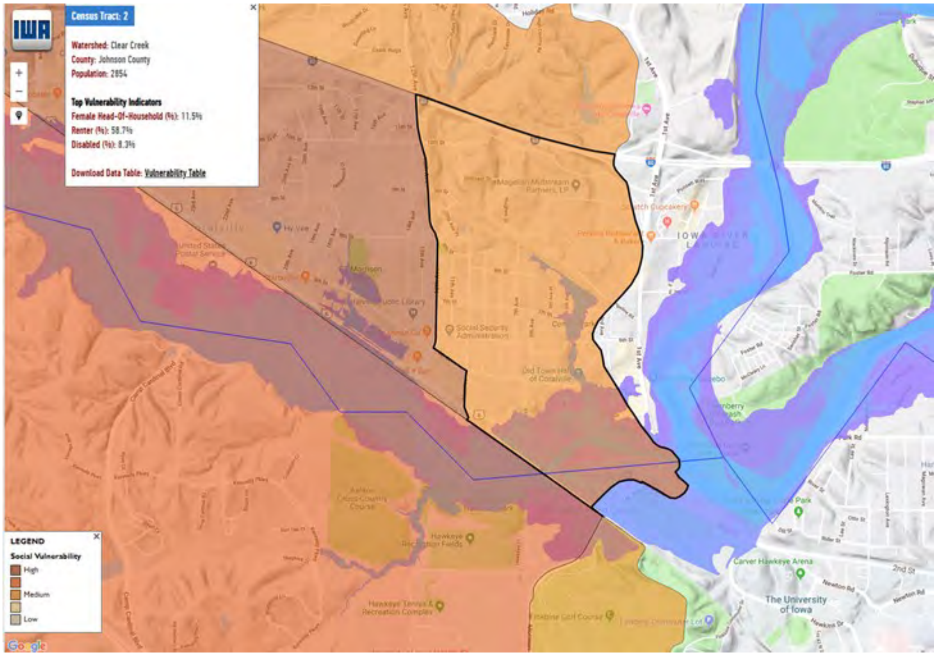
The boundary of the Clear Creek watershed intersects two counties, Johnson and Iowa, that each have a local hazard mitigation plan :

Iowa County Multi-Jurisdictional Hazard Mitigation Plan 2020-2025

Johnson County, IA Countywide Hazard Mitigation Plan 2019

The Clear Creek Watershed Management Plan includes information related to flooding disasters in these counties. The two local hazard mitigation plans may incorporate components of the Clear Creek Watershed Management Plan, including goals and actions, during future updates (5-year cycles). Some local staff will likely participate in both the watershed planning process and the hazard mitigation plan updates further integrating the plans.

Figure 2-31. Coralville Community Scenario Map



Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

Table 2-8. FEMA Hazard Mitigation Assistance Grant Programs

Grant Program	Community Eligibility	Award Cycle
Hazard Mitigation Grant Program (HMGP)	Statewide availability post-disaster declaration to all communities with a FEMA-approved hazard mitigation plan and active participation in the NFIP for SFHA areas	Only active post-presidential disaster declaration
Pre-Disaster Mitigation Program (PDM)	All states, U.S. territories, and federally-recognized tribes, and local communities with a FEMA-approved hazard mitigation plan active participation in the NFIP for SFHA areas	Annual basis
Flood Mitigation Assistance (FMA)	All states, U.S. territories, and federally-recognized tribes, and local communities with a FEMA-approved hazard mitigation plan and active participation in the NFIP	Annual basis

Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

Integrating local planning efforts allows for more cohesive and comprehensive goals and actions towards mitigating flood disaster impacts. This also enhances the competitiveness of watershed communities for Hazard Mitigation Assistance (HMA) through the Federal Emergency Management Agency (FEMA) and other potential funding sources. Further information about the HMA grant programs is listed in Table 2-8.

2.7.4 Potential Impacts of Flooding on Communities

Parcel level data for each of the counties in the Clear Creek watershed was obtained to identify the number of structures and associated value costs that are at risk of flooding. The parcel data was entered into FEMA's Hazus modeling tool to identify potential flood loss estimations on an annual basis, 1% annual chance (100-year flood), and 0.2% annual chance (500-year flood). The results are listed by county in Table 2-9, Table 2-10, and Table 2-11.

Table 2-9. Average Annual Flood Loss by County

County	Structures	Estimated Building Cost ($)	Estimated Content Cost ($)	Estimated Building Damage ($)	Estimated Content Damage ($)	Combined Estimated Loss ($)
Iowa	20	$1,374,100	$1,000,000	$2,921	$1,379	$4,300
Johnson	869	$545,699,992	$454,337,469	$898,243	$1,274,983	$2,173,226
Total	889	$547,074,092	$455,337,469	$901,164	$1,276,362	$2,177,527

Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

Table 2-10. Average Loss for 1% chance (100-Year Flood)

County	Structures	Estimated Building Cost ($)	Estimated Content Cost ($)	Estimated Building Damage ($)	Estimated Content Damage ($)	Combined Estimated Loss ($)
Iowa	10	$1,002,150	$814,025	$82,247	$35,148	$117,396
Johnson	676	$332,604,186	$197,084,527	$27,148,204	$24,077,294	$51,225,499
Total	686	$333,606,336	$197,898,552	$27,230,452	$24,112,442	$51,342,895

Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

Table 2-11. Average Loss for 0.2% annual chance (500-Year Flood)

County	Structures	Estimated Building Cost ($)	Estimated Content Cost ($)	Estimated Building Damage ($)	Estimated Content Damage ($)	Combined Estimated Loss ($)
Iowa	20	$1,374,100	$1,000,000	$183,064	$100,204	$283,268
Johnson	864	$533,688,752	$452,318,379	$79,451,770	$142,036,928	$221,488,698
Total	884	$ 535,062,852	$453,318,379	$79,634,835	$142,137,132	$221,771,967

Source: Flood Mitigation Planning for the Clear Creek Watershed, IIHR

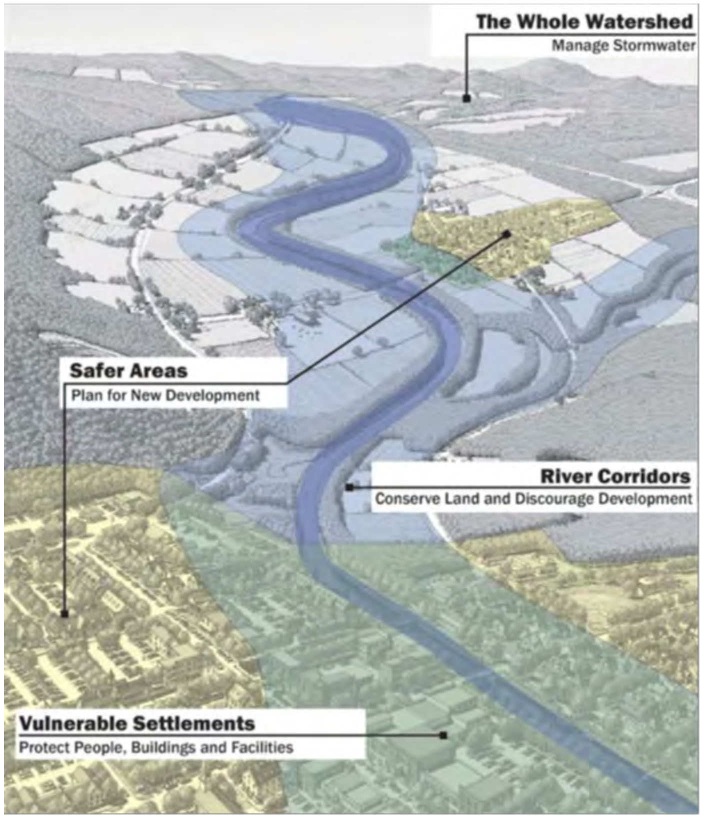
2.7.5 Floodplain Management for Resilience

Floodplains are a natural part of a stream corridor, and appropriate management is a 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. Over the past 40 years, the floodplain areas have been significantly narrowed, and water is forced to remain within 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.

To better withstand and recover from flood-related disasters in the future, the EPA recommends that communities consider updating, integrating, and revising their plans, policies, and regulations to ensure that they are consistent with their resilience goals and objectives. The following are basic steps to help communities get started on their road to resilience:

1. Update and integrate comprehensive plans and Hazard Mitigation Plans
2. Conduct thorough policy and regulatory audits
3. Amend zoning, subdivision, and stormwater policies and regulations to match plans
4. Consider participating in the National Flood Insurance Program Community Rating System

Figure 2-32. Approaches to Enhance Resilience to Future Floods



Source: *Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities,* US EPA, July 2014 Credit: Vermont Agency of Commerce and Community Development

To further increase flood resilience, there are several policy options communities could implement as outlined in the 2014 EPA report, "Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster Resilient Communities." The policy options described in the report are organized into four categories also shown in Figure 2-32.

1. River Corridors -- conserve land and discourage development in vulnerable areas along stream corridors such as flood plains and wetlands
2. Vulnerable Settlements – where development already exists, protect people, buildings, and facilities to reduce future flooding risk
3. Safer Areas – plan for and encourage new development in areas that are less vulnerable to future floods
4. The Whole Watershed -- implement enhanced stormwater management techniques to slow, spread, and infiltrate floodwater

The four categories describe different geographic areas within a watershed and offer the type of policy options and strategies most effective at enhancing flood resilience for that place. There are more specific descriptions of the polices and strategies in the EPA report. For example, in stream corridors, communities might focus on acquiring or protecting land in flood prone locations, while in the whole watershed, they might take a regional, watershed-wide approach to stormwater management.

The specific policy options under the four categories described in the EPA report, offer multiple and interrelated benefits. For example, directing development out of flood plains not only keeps people and property safe, it also protects the ability of flood plains to hold and slow down flood water before it reaches downstream development. Ultimately, it is up to the state and communities to select the appropriate policies, adjust them to meet their specific context, and allocate resources accordingly. Each jurisdiction can weigh their resilience goals with other community priorities to determine the best policies and approaches for flood resilience.

Farm Inundated by 2008 Flood of the Iowa River

Source: Iowa Flood Center

Intersection of Highway 6 and First Avenue in Coralville in 2008

Source: City of Coralville

2.7 Topography, Geology & Soils

The Clear Creek Watershed is located almost entirely within the Southern Iowa Drift Plain landform region (Figure 2-33). There is a very small area in the northeastern portion of the watershed that is part of the Iowan Surface landform region. The characteristics of each landform region have an influence on the rainfall-runoff potential and hydrologic properties of the watershed.

Figure 2-33. Landform Regions of Iowa

Source: Clear Creek Watershed Hydrologic Assessment Report, Iowa Flood Center / IIHR Hydroscience & Engineering

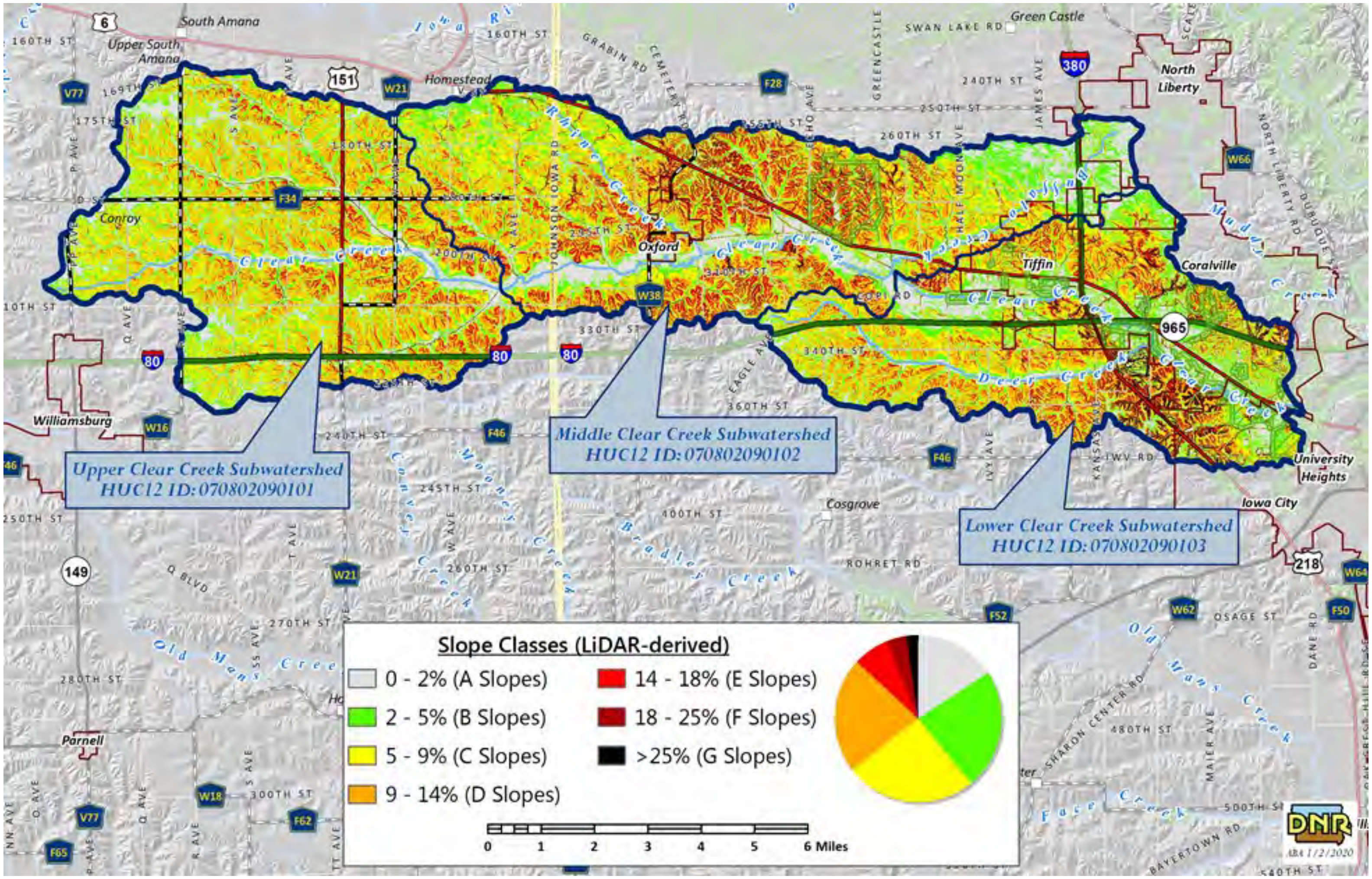
The Southern Iowa Drift Plain includes most of southern Iowa. This region was subjected to numerous episodes of glaciation between 500,000 and 2.6 million years ago. Since that time, periods of relative landscape stability and soil formation have alternated with episodes of erosion, shaping the land surface we see today (Prior, 1991). The landscape is characterized by steeply rolling topography and well-developed drainage divides (Figure 2-34). Glacial till deposits provide a thick confining unit on top of the bedrock surface and are generally mantled with a relatively thick package of loess (wind-blown silt). Glacial till and associated deposits may be greater than 400 feet thick in portions of the Clear Creek watershed. Limited areas of shallow bedrock may be present.

2.8.1 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 modern landscape of the Clear Creek watershed formed as the drainage network expanded and slopes evolved over at least two glacial-interglacial cycles during the past half-million years. Although the area remained unglaciated during the last two glacial periods (the Illinois and Wisconsin episodes), climatic changes during those glaciations significantly affected local and regional geologic processes that influenced development of the regional drainage system, local landscapes, and the environment.

Drainage divides, upland ridges, drainage lines, and most slope elements of the modern landscape, and a well-developed soil cover were in place at the close of the last interglacial period (Sangamon Episode) about 85,000 years ago. The most recent (Wisconsin) glaciation was unique in midcontinent North America because of the magnitude and extent of wind-blown silt (loess) deposited near the end of the glacial period (Bettis et al., 2003; Mason et al., 2007). Beyond the late-glacial ice margins, loess accumulated in boreal forests and parklands between 22,000 and 12,000 years ago and buried the pre-loess landscape and last interglacial soils with silty wind-blown loess and local eolian sand. In the Clear Creek watershed 10-25 feet (3-7m) of loess mantled the uplands and old terraces, burying the last interglacial landscape and clayey paleosols.

Figure 2-34. High Resolution Slope in Clear Creek Watershed



Source: Iowa Department of Natural Resources

2.8.2 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 Clear Creek watershed, 65% of the terrain is characterized as nearly level to moderately sloping (either A, B or C slopes). Most of the watershed's agricultural activity occurs in these areas. D slopes are scattered throughout the watershed and make up about 22% of the total area. Steeper slopes are much less common, occurring primarily in the middle and lower sub-basins. These steeper slopes (classes E – G) make up about 13% of the watershed. Urban and forested land uses are more prevalent in this portion of the watershed.

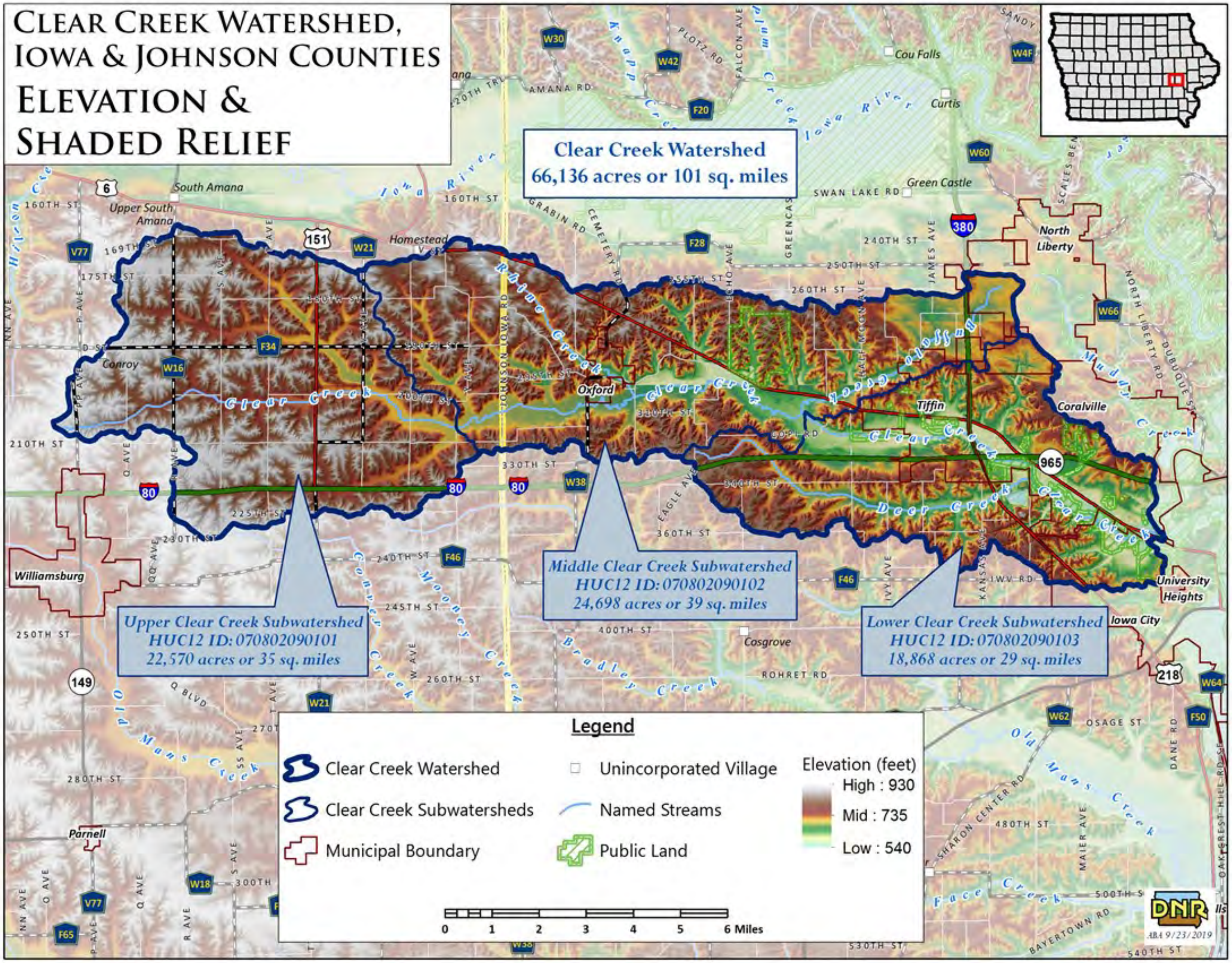
Table 2-12. Slopes in the Clear Creek Watershed

Slope Class	Percent Slope	Slope Description	Acres	Percent of watershed
A	0 – 2%	Nearly level	10,321	15.6
B	2 – 5%	Gently sloping	15,420	23.4
C	5 - 9%	Moderately sloping	16,883	25.6
D	9 – 14%	Strongly sloping	14,738	22.3
E	14 – 18%	Moderately steep	4,638	7.0
F	18 – 25%	Steep	2,457	3.7
G	>25%	Very Steep	1,569	2.4

Source: Iowa Department of Natural Resources using LiDAR elevation models

Figure 2-35 shows the topography of the Clear Creek Watershed. Elevations range from approximately 900 feet above sea level in the upstream and western part of the watershed to 650 feet above sea level in the downstream portion of the watershed in Coralville.

Figure 2-35. Surface Elevation Map



Source: Iowa Department of Natural Resources

2.8.3 Soils

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.

Credit: Wilson Brothers Garden Website

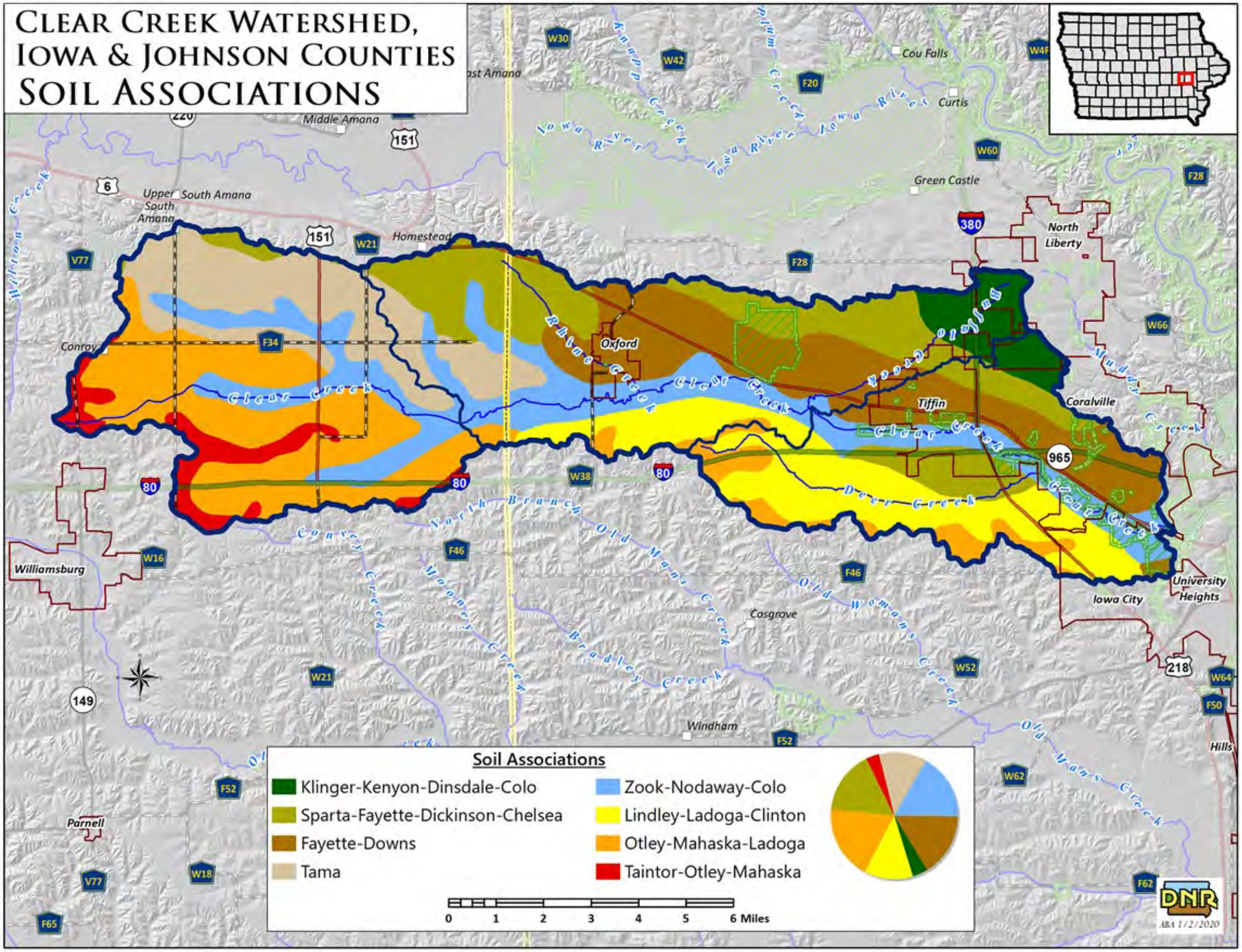
Soil Associations: Soils are classified using their characteristics and are subdivided into association names, primarily from the sites where each one was initially identified. Table 2-13 summarizes the dominant soil associations within the Clear Creek watershed and Figure 2-36 shows the distribution.

Table 2-13. Soil Associations in the Clear Creek Watershed

Map Unit Symbol	Association	Acres	Percent of Watershed	Description	Characteristics
s1695	Fayette-Downs	10,786	16.3%	Gently sloping to very steep, well drained soils formed in loess (connected ridgetops & side slopes)	Silty Material on Uplands
s1706	Tama	7,965	12.1%	Gently sloping to very steep, well drained soils formed in loess (side slopes on uplands and on stream terraces)	Silty clay loam on Uplands
s1708	Klinger-Kenyon-Dinsdale-Colo	2,695	4.1%	Gently sloping to strongly sloping, moderately well drained and well drained soils formed in loamy or silty materials and in the underlying glacial till	Loess or loamy surficial materials and in Underlying Glacial Till
s1710	Taintor-Otley-Mahaska	2,281	3.5%	Nearly level to moderately sloping, poorly drained to moderately well drained soils formed in loess (elongated areas which are the divides between streams)	Silty clay loam on Lowlands
s1711	Otley-Mahaska-Ladoga	12,523	18.9%	Nearly level to moderately sloping, moderately well drained to poorly drained soils formed in loess (broad upland flats and on ridges/side slopes)	Silty Material on Uplands
s1713	Lindley-Ladoga-Clinton	8,234	12.5%	Moderately sloping to strongly sloping, moderatedly well drained soils formed in loess (side slopes)	Silty Material on Uplands
s1723	Zook-Nodaway-Colo	11,131	16.8%	Nearly level, moderately well drained to poorly drained soils from silty and clayey alluvium on floodplains and low terraces	Silty clay loam on Lowlands
s1763	Sparta-Fayette-Dickinson-Chelsea	10,485	15.9%	Nearly level to very steep, well drained or somewhat excessively drained and excessively drained sandy and loamy soils (uplands)	Sandy and loamy on Uplands

Source: Andy Asell, Iowa Department of Natural Resources

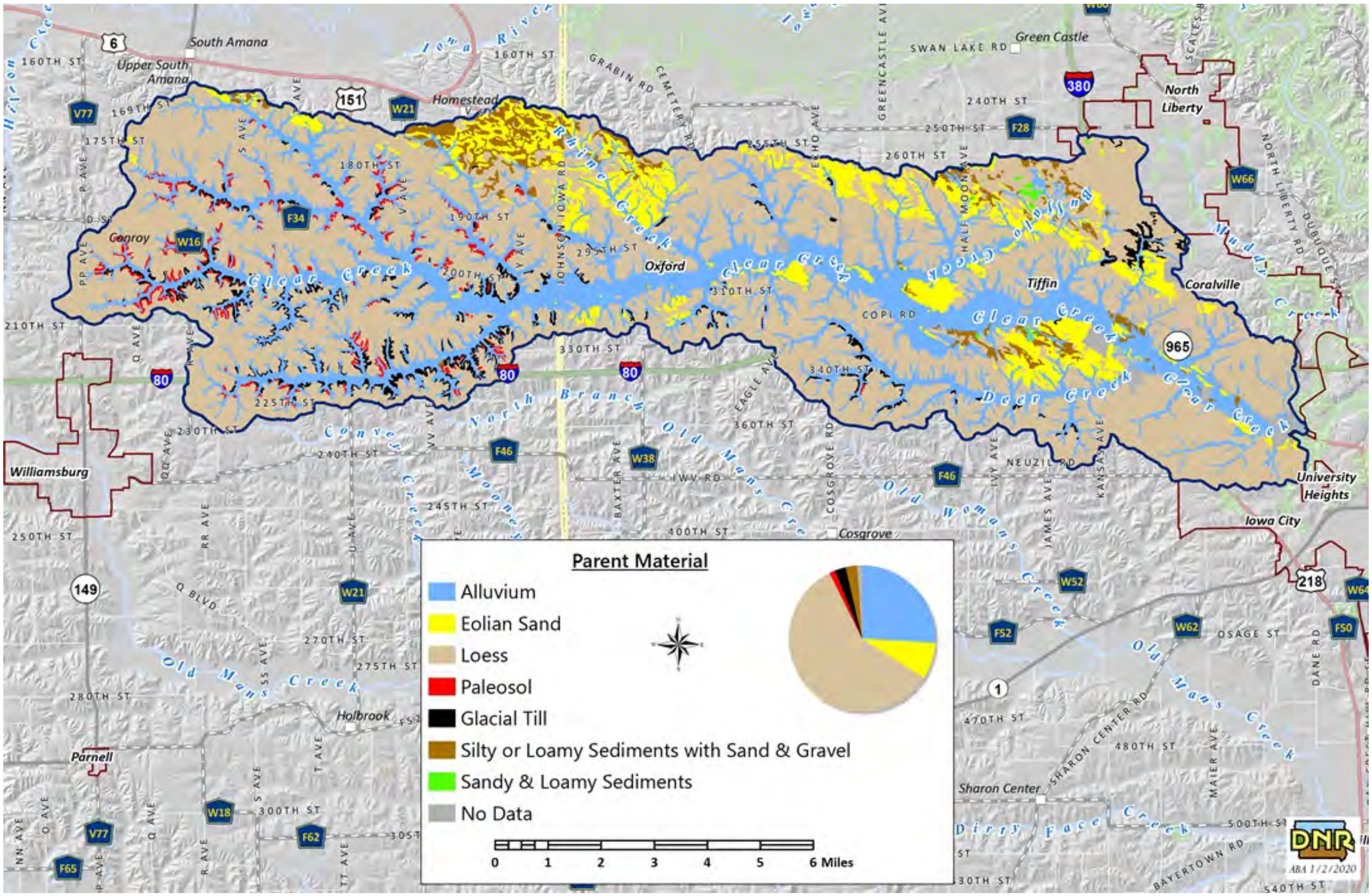
Figure 2-36. Soil Associations in the Clear Creek Watershed



Source: Andy Asell, Iowa Department of Natural Resources

Parent Material: Parent material, shown in Figure 2-37, is the underlying geological material (generally bedrock or a superficial or drift deposit) in which soil horizons form. Soils typically inherit a great deal of structure and minerals from their parent material. They are often classified based upon their contents of consolidated or unconsolidated mineral material that has undergone some degree of physical or chemical weathering and the mode by which the materials were most recently transported. [*Barnes, Burton; Zak, Donald; Denton, Shirley; Spurr, Stephen (1980). Forest Ecology. New York, NY*]

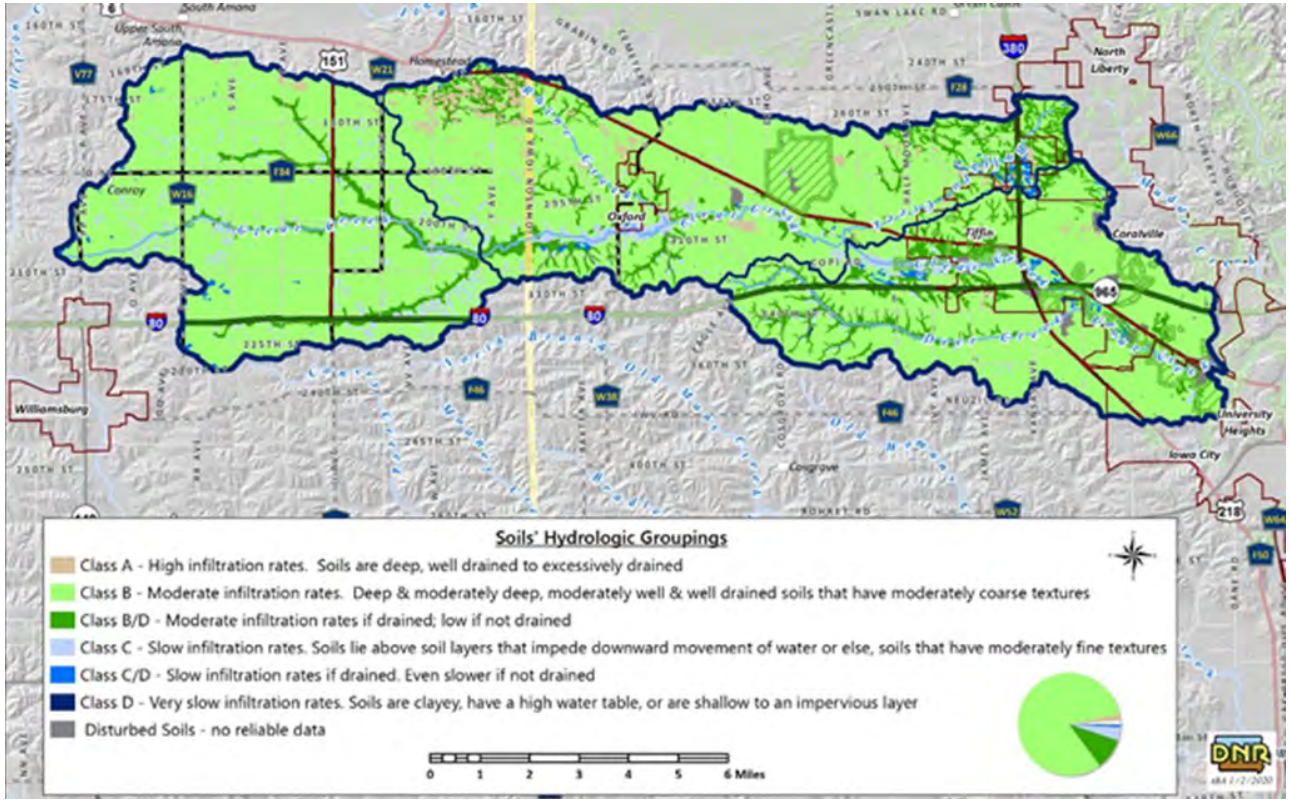
Figure 2-37. Parent Material of Soils in the Clear Creek Watershed



Source: Iowa Department of Natural Resources

Hydrologic Soil Groups: Soils are classified into four Hydrologic Soil Groups (HSG) by the Natural Resources Conservation Service (NRCS) based on the soil's runoff potential. The four HSG's are A, B, C, and D, where A-type soils have the lowest runoff potential and D-type have the highest. In addition, there are dual code soil classes A/D, B/D, and C/D that are assigned to certain wet soils. In the case of these soil groups, even though the soil properties may be favorable to allow infiltration (water passing from the surface into the ground), a shallow groundwater table (within 24 inches of the surface) typically prevents much infiltration from occurring. For example, a B/D soil will have the runoff potential of a B-type soil if the shallow water table were to be drained away, but the higher runoff potential of a D-type soil if it is not.

Figure 2-38. Hydrologic Soil Groups in the Clear Creek Watershed



Source: Andy Asell, Iowa Department of Natural Resources

Table 2-14. Hydrologic Soil Groups

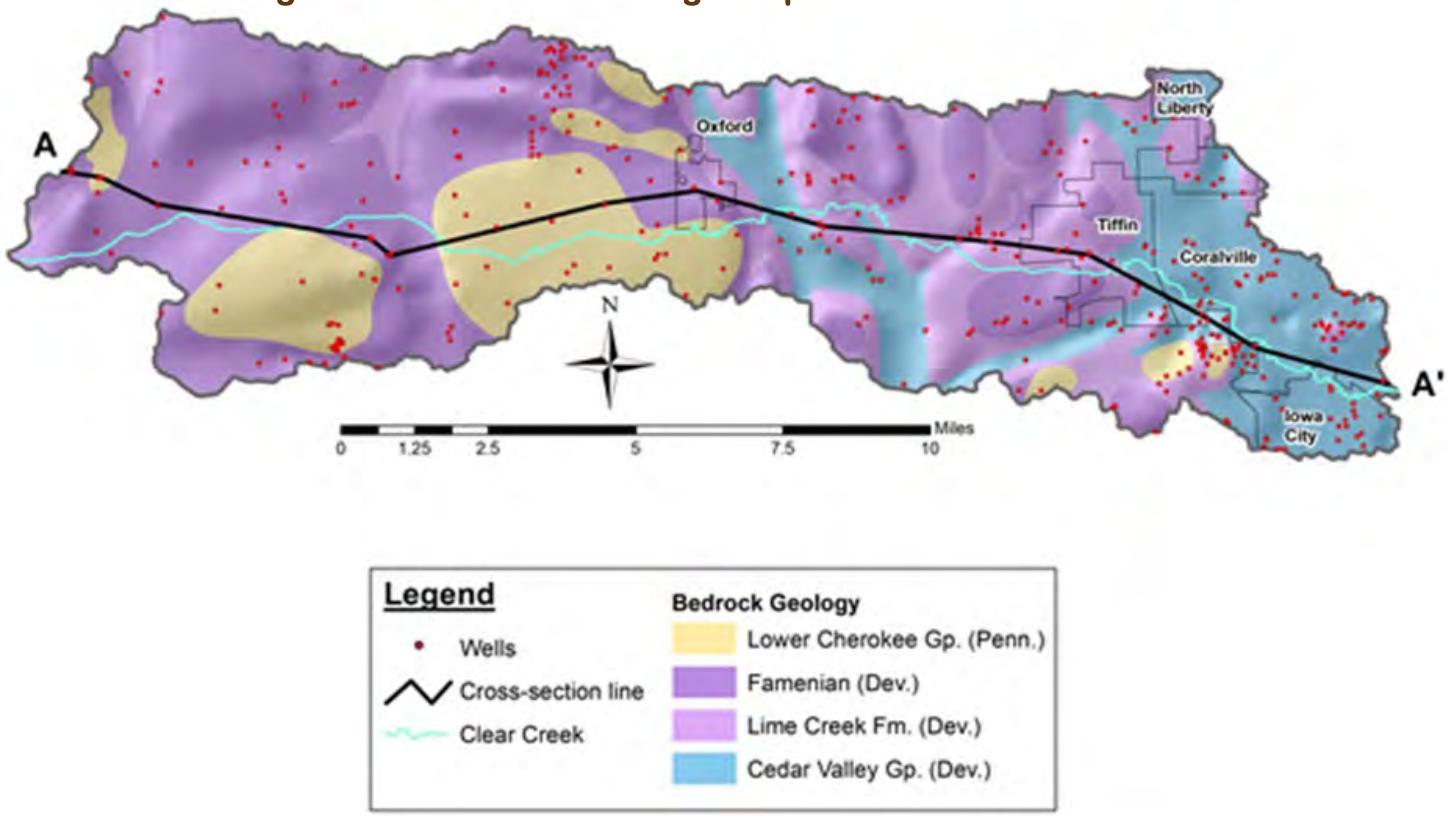
Type	Area (acres)	Coverage (%)
A - High Infiltration	1,501	2.3
B - Moderate Infiltration	54,067	82.7
B/D - Medium/Very Slow Infiltration	6,431	9.8
C - Slow Infiltration	2,769	4.2
C/D - Medium/Very Slow Infiltration	596	0.9
D - Very Slow Infiltration	5	0.0
Disturbed Land – No Data	732	1.1
Totals	66,101	101

Source: Andy Asell, Iowa Department of Natural Resources

Table 2-14 shows the approximate percentages by area of each HSG for the Southern Iowa Drift Plain in the Clear Creek Watershed. The Clear Creek Watershed consists primarily of HSG B type soils (82.7%), which have a moderate runoff potential when saturated. Relatively small components of type B/D (9.8%) soils are present, occurring in the adjacent valleys. The remaining classes each comprise 4% or less of the total. (Figure 2-38)

2.8.4 Bedrock Geology

Figure 2-39. Bedrock Geologic Map of the Clear Creek Watershed

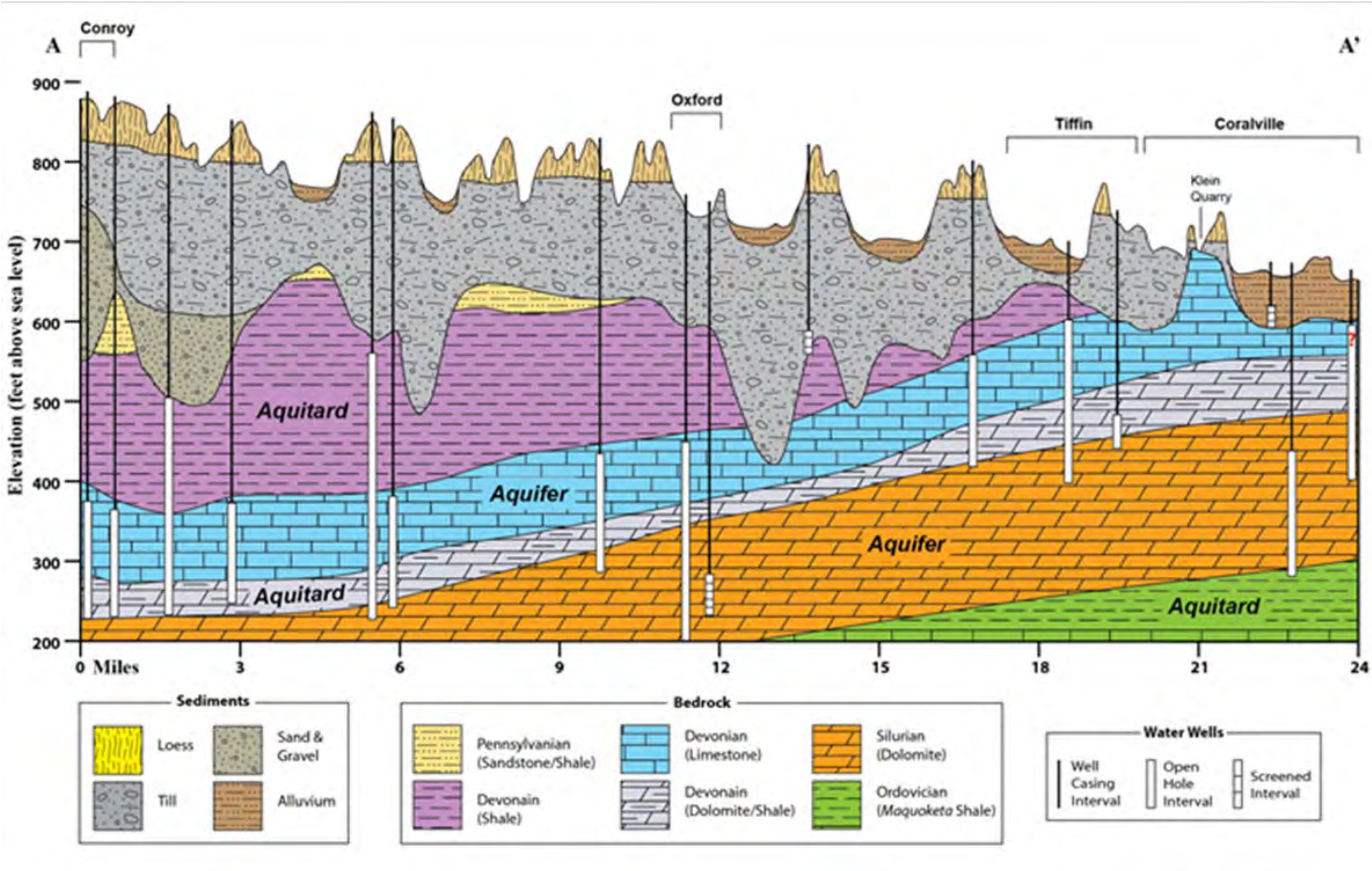


Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

Although patches of Pennsylvanian age (310-315 million years old (Ma)) sandstone and shale bedrock exist, the Clear Creek watershed is dominated by Devonian age (360-390 Ma) shale and limestone (Witzke et al., 2010). Devonian shales of the "Maple Mill" and Lime Creek formations can be up to 300 feet (90 m) thick and serve as a regional aquitard separating the unconsolidated sediments from the underlying limestone bedrock aquifer of the Cedar Valley Group. However, in places where the shales have been eroded away, the Cedar Valley limestone aquifer is in direct contact with the overlying unconsolidated sediments. In these cases, the groundwater in those sediments is likely mixing with, and percolating down into, the Cedar Valley limestone aquifer. Beneath the Cedar Valley Group is the Wapsipinicon Group which consists of a mixture of limestone, dolomite, and shale. The Wapsipinicon Group serves a moderate aquitard separating the Cedar Valley aquifer from the underlying Silurian age (420-440 Ma) dolomite aquifer. The Silurian dolomite aquifer is a widespread regional aquifer that is heavily utilized by many of the municipalities, industries, and private wells within the watershed and surrounding areas.

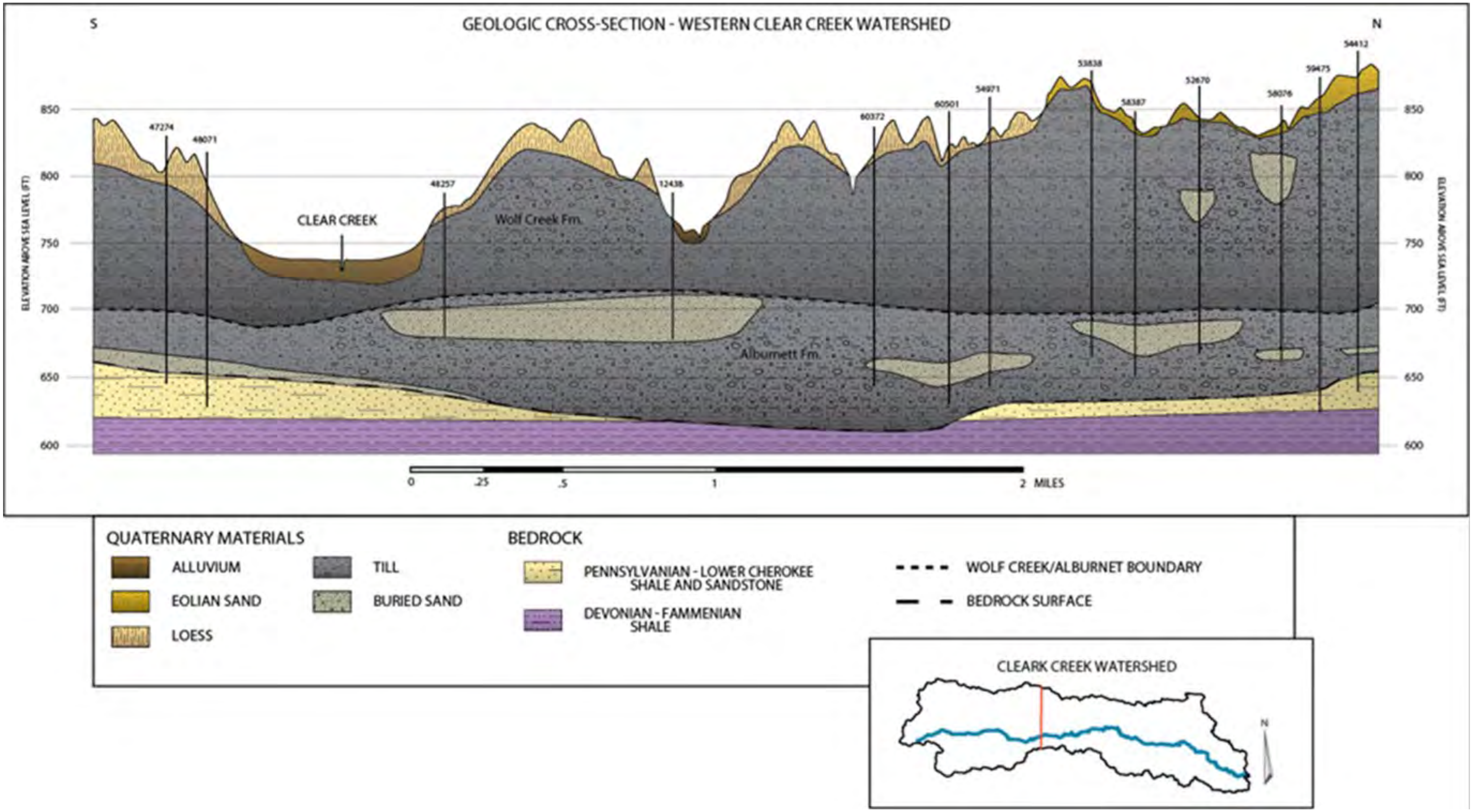
The map in Figure 2-39 shows the bedrock geology under the Clear Creek watershed along with a cross-section line that corresponds with Figure 2-40. The Devonian-age bedrock that underlies the majority of the watershed was formed approximately 360 to 390 million years ago and primarily consists of limestone, dolomite, and some shale. The Silurian-age bedrock under the watershed was formed approximately 420 to 430 million years ago and consists primarily of dolomite. Figures 2-41, Figure 2-42 and Figure 2-43 show schematic north to south cross-sections through the watershed and illustrate the estimated depth to bedrock, thickness of distinct units, and the different glacially derived sediments that exist beneath the watershed.

Figure 2-40. West to East Geologic Cross-Section Through the Clear Creek Watershed



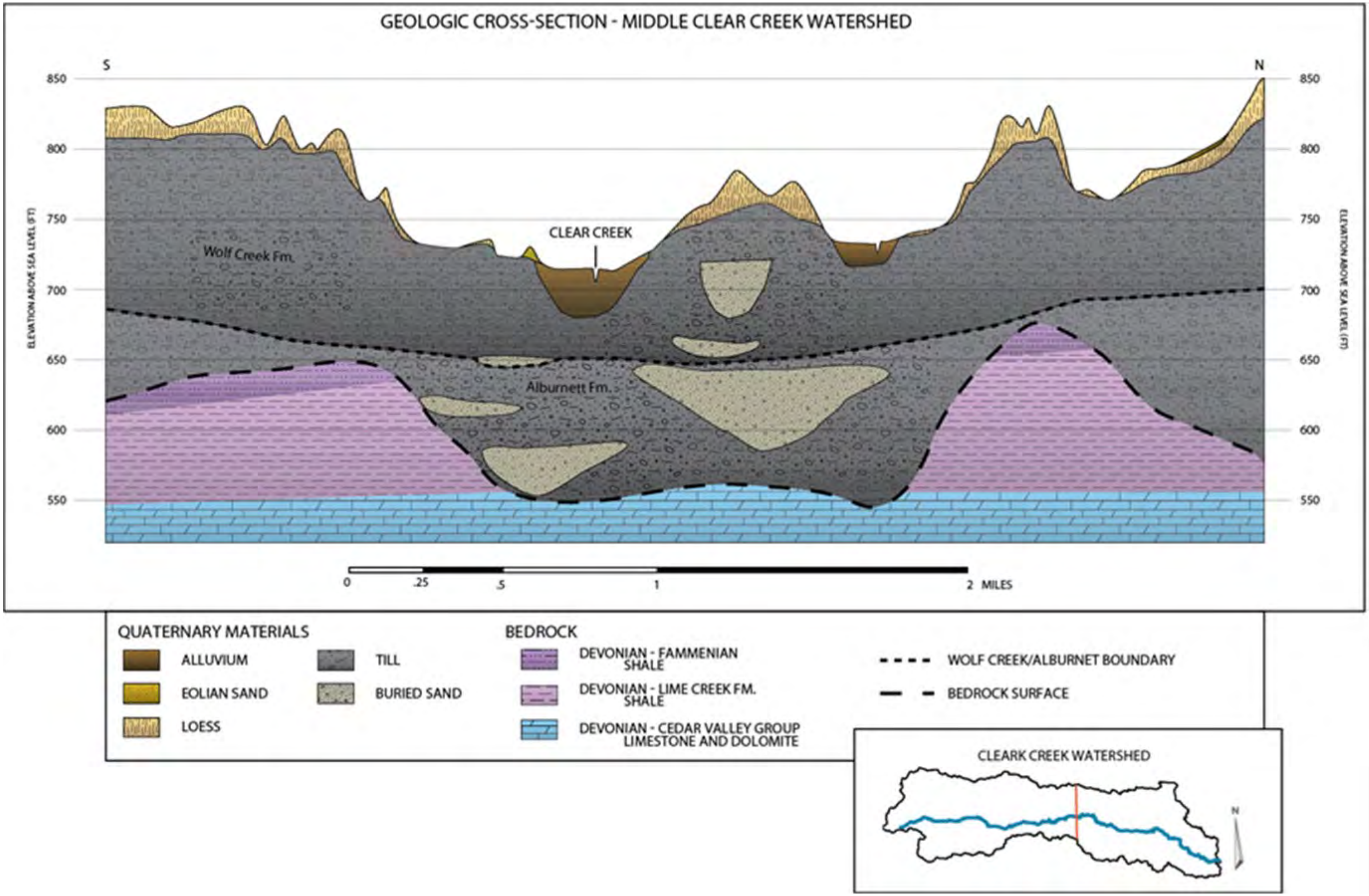
Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

Figure 2-41. North to South Geologic Cross-Section Through the Western Section of Clear Creek Watershed



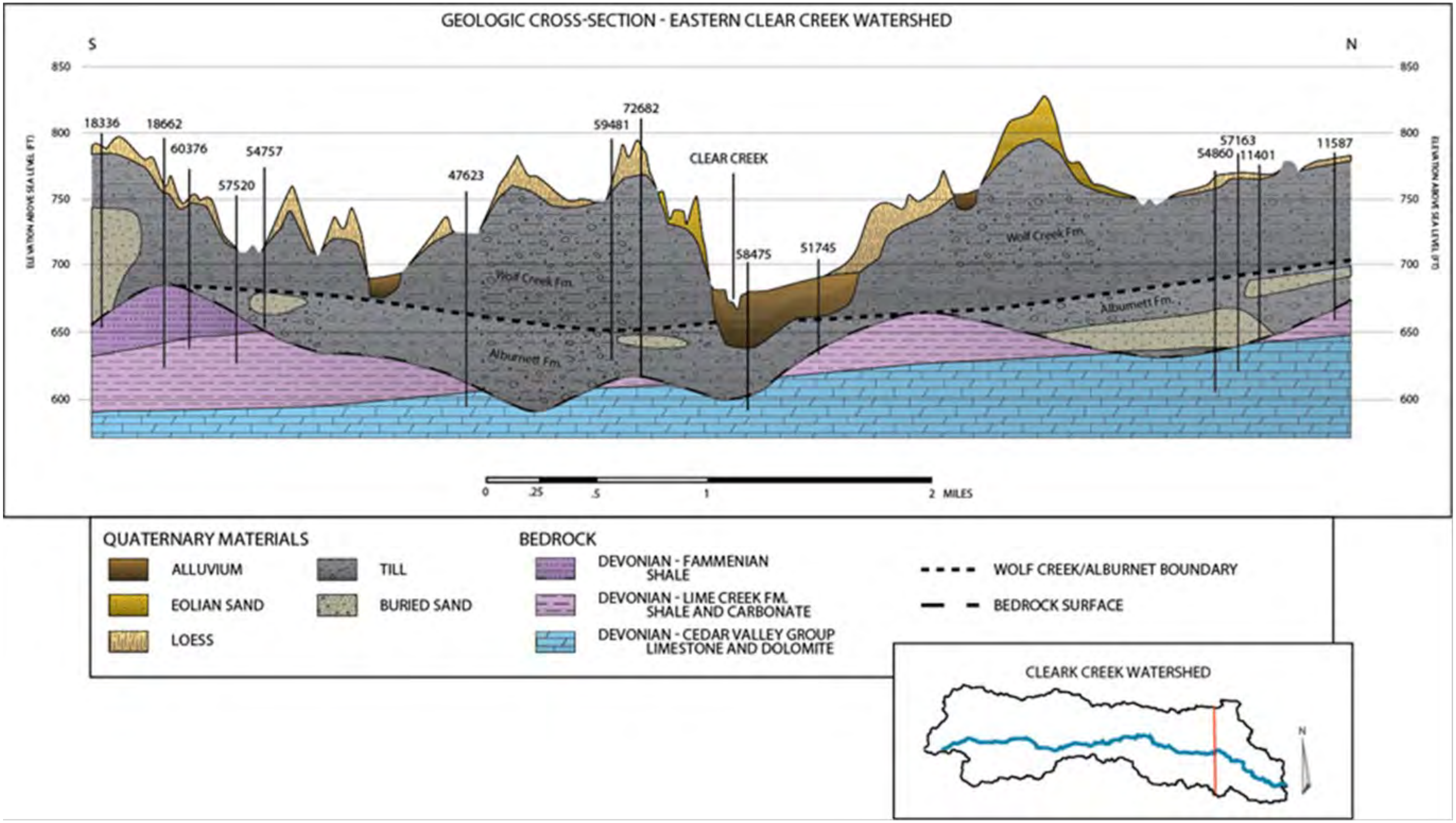
Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

Figure 2-42. North to South Geologic Cross-Section Through the Middle Section of Clear Creek Watershed



Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

Figure 2-43. North to South Geologic Cross-Section Through the Eastern Section of Clear Creek Watershed



Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

2.9 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 for larger communities or those near larger communities.

2.9.1 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 (NOI) 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 will 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.

2.9.2 NPDES Permit Program-Industrial Activity

The NPDES permit program requires that stormwater discharges that are associated with industrial activity obtain permit coverage under General Permit No. 1, issued by the IDNR. The EPA lists ten general categories of industrial activity for which permit requirements apply. 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.

2.9.3 NPDES Permit Program-Municipal Separate Stormwater 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.

2.9.4 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 Bureau of the Census. 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.

NPDES - 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

The cities of Coralville and Iowa City have been incorporated into the Phase I NPDES Stormwater Program. Implementation of Phase II of the program extended coverage to North Liberty. Table 2-15 provides a current listing of communities within the Clear Creek Watershed by permit type.

Table 2-15. NPDES permits within the Clear Creek Watershed

Permit #	EPA ID	Expire Date	Facility Name	Facility City	Permit Type	Class	Treatment Type
4800201	0069035	12/31/2022	Colony Village Restaurant	Williamsburg	Semi-Public	Minor	Aerated Lagoon
5208001	0020788	5/31/2020	Coralville, City of -- STP	Coralville	Municipal	Major	Sequencing Batch Reactor
5208002	0078646	8/31/2024	Coralville, City of -- Ms4	Coralville	Stormwater	Minor	No Treatment
4800205	0074225	3/31/2023	Heritage Inn Amana Colonies	Williamsburg	Semi-Public	Minor	Activated Sludge
5260001	0032531	5/31/2020	Oxford, City of -- STP	Oxford	Municipal	Minor	Sequencing Batch Reactor
5200603	0068349	5/31/2015	Parkview Mobile Home Court	Oxford	Semi-Public	Minor	Waste Stabilization Lagoon
4800705	0066265	12/31/2022	Ramada Inn	Williamsburg	Semi-Public	Minor	Aerated Lagoon
5288001	0036617	4/30/2020	Tiffin, City of -- STP	Tiffin	Municipal	Minor	Activated Sludge
5252003	0078794	8/31/2024	North Liberty, City of -- MS4	North Liberty	Stormwater	Minor	No Treatment
5225005	0078298	5/31/2024	Iowa City, City of -- MS4	Iowa City	Stormwater	Minor	No Treatment

Source: Iowa Department of Natural Resources
(https://www.iowadnr.gov/Environmental-Protection/Water-Quality/NPDES-Wastewater-Permitting/Current-NPDES-Permits)

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.

2.9.5 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 is one segment of Rhine Creek and Kent Park Lake included on the draft 2018 State 303(d) list with a TMDL status of "TMDL needed" for both.

2.9.6 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, counties, and authorities from nearby pollution sources.

2.9.7 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, based on an agreement between local communities and the federal government which states that if a community will 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.

Table 2-16. National Flood Insurance Program Participation

Jurisdiction	NPDES Permit Type	NFIP Participation	CRS Rating	Flood Insurance Discount
Coralville	MS4 Phase II	Yes	7	15%
Iowa City	MS4 Phase I	Yes	6	20%
North Liberty	MS4 Phase II	Yes	N/A	-
Oxford		Yes	N/A	-
Tiffin		Yes	N/A	-
Iowa County	N/A			
Johnson County	N/A			

Source: CCWC Members

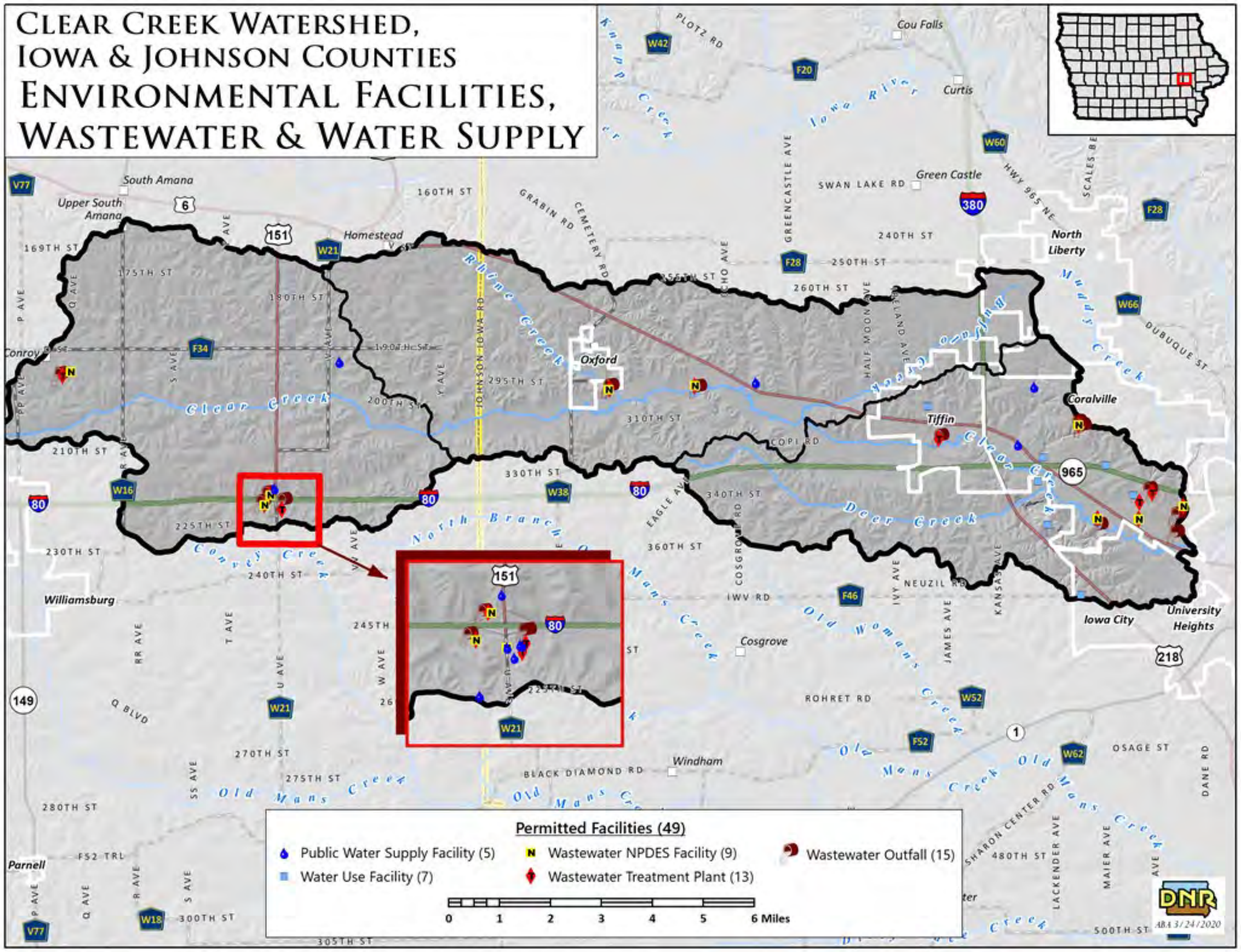
In 2001, FEMA promulgated hazard mitigation planning regulations pursuant to the Disaster Mitigation Act of 2000. FEMA established the 10-step Community Rating System (CRS) process that identified four essential parts to mitigation planning and created a point-based evaluation system. The CRS rewards 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.

2.10 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 wastewater 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 (wastewater) treatment plants and outfalls in relation to public water supply facilities in the watershed are shown in Figure 2-44. Generally, the more populous areas of the watershed are those that have sanitary sewer service. There are 13 systems that treat wastewater for hotels, businesses, mobile home parks and urban areas in the watershed. The rest of the homes and businesses in the watershed have private septic systems.

Figure 2-44. Environmental Facilities

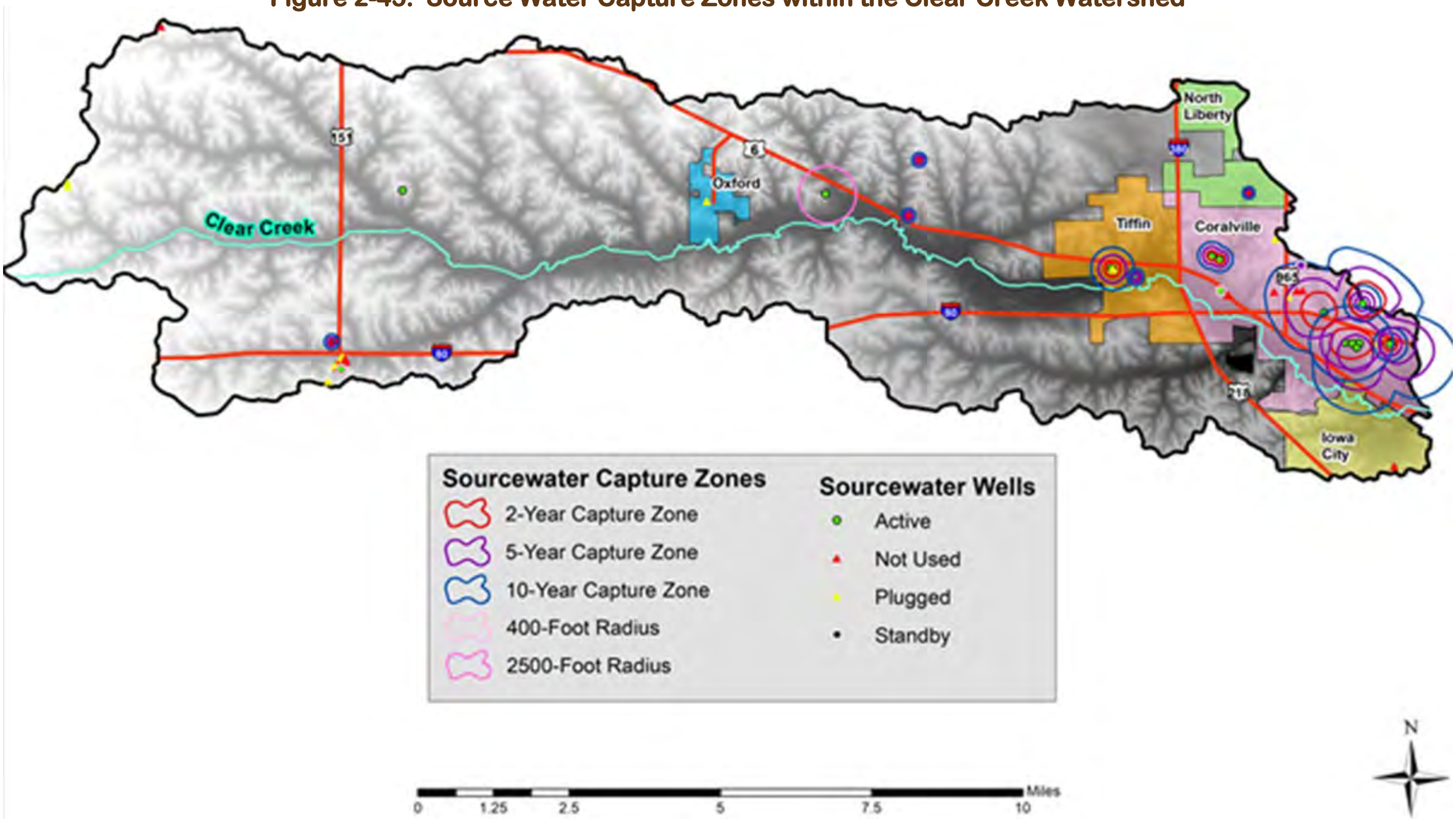


Source: Iowa Department of Natural Resources

2.11 Source Water

The Iowa Source Water Protection program has estimated the areas contributing groundwater to wells on all public water systems in the watershed. There are no Source Water Protection Areas that are considered Highly Susceptible in the Clear Creek watershed. Figure 2-45 shows the capture zones for the source water wells in the watershed.

Figure 2-45. Source Water Capture Zones within the Clear Creek Watershed



Source: Ryan J. Clark, Iowa Geological Survey.
"Geology of the Clear Creek Watershed, Iowa/Johnson County, Iowa" January 2019

Chapter 3

WATER QUALITY ASSESSMENT

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 Clear 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 (eastern) 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.

3.1 Source Water

3.1.1 Primary Contact Recreation – Class A1

Each of the Class A1 use designations in the Clear Creek watershed are 'fully supporting' or 'not assessed.' However, water quality monitoring data collected as part of this watershed management planning process suggest that direct contact with the water through swimming in certain reaches of Clear Creek 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 can indicate 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 matter. Professional monitoring by Iowa DNR is needed in the Clear Creek watershed to provide up-to-date information on Class A1 status, in order to ensure protection of public health.

Clear Creek at Johnson Iowa Road

Photo Credit: Mary Beth Stevenson, IDNR

3.1.2 Aquatic Life – Class B (WW-2)

One stream segment in Rhine Creek is listed as impaired (partially supported) for aquatic life due to a fish kill. Approximately 2,190 fish were killed in over one mile of stream. The value of the fish was reported as $213.60. The cause of the kill was identified as a pesticide spill. The following is from the DNR fish kill investigation:

"The source [of the pesticide(s) that caused the kill] originated from corn and soybean rinsate tanks. The valves apparently had been tampered with and released several hundred gallons of mixture that entered Rhine Creek. Johnson County, Oxford Township, Sec 21 T80N, R8W. The kill started in section 21 (UTM X = 600495, Y = 4619636) and extended approximately 1.0 miles to the confluence with Clear Creek in Sec 28 (UTM X = 601528, Y = 4618729).

3.2 Designated Uses & Impaired Status

The State of Iowa's use designations for streams in the Clear Creek watershed are summarized in Table 3-1 and represented in Figure 3-1. These designated uses have been reported as 'fully supporting' or 'not assessed' in most of the stream segments. However, it should be noted that no recent assessments have been conducted by Iowa DNR upon which to base impairment status, and most of the segment use designations are 'not assessed.'

Table 3-1. Use designations and impairment status for streams in the Clear Creek watershed

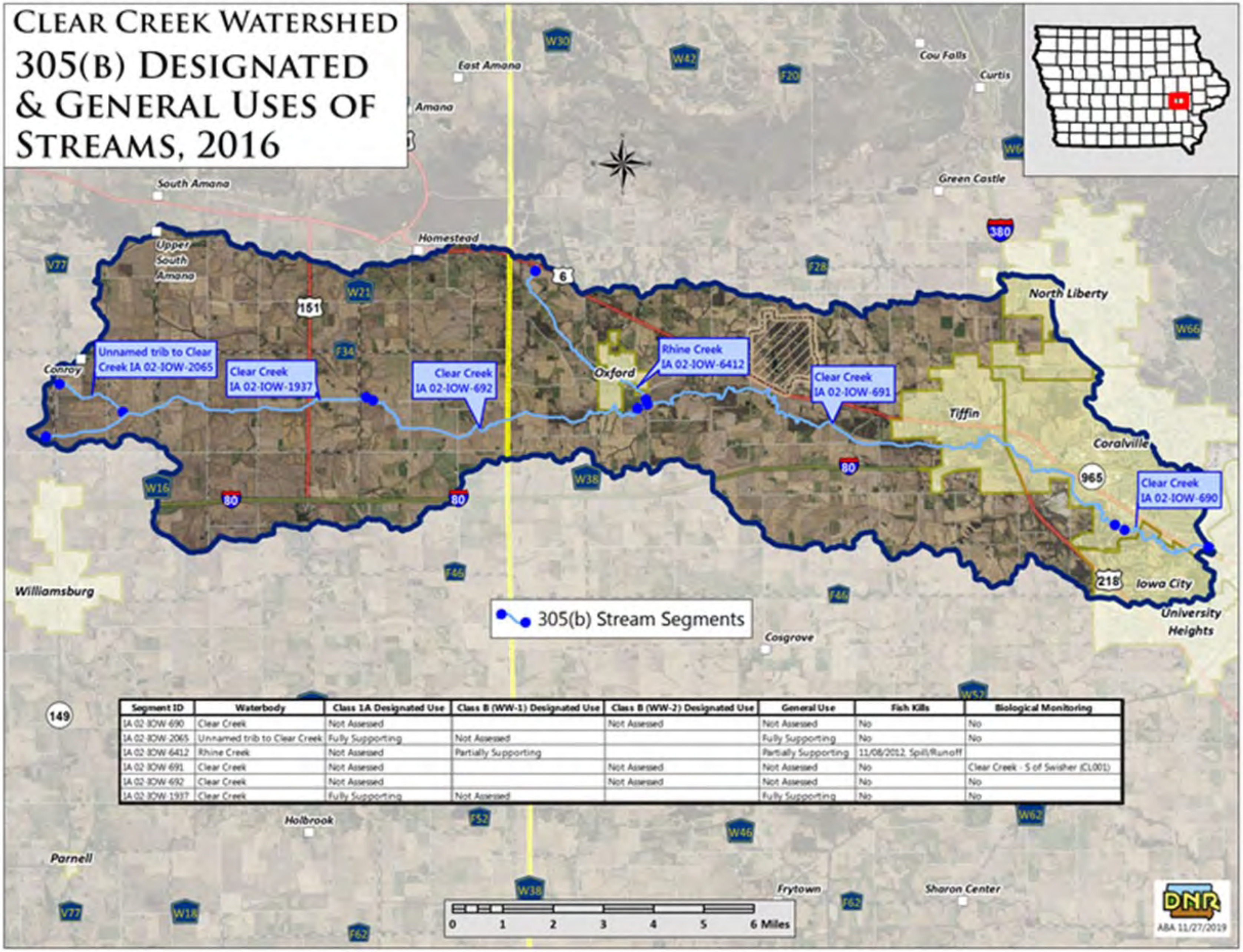
Segment ID	Waterbody	Use Designation				Fish Kills	Bio Monitoring	Notes
		Class A1	Class B (WW-1)	Class B (WW -2)	General			
IA 02-IOW-1937	Clear Creek	fully supporting	not assessed		fully supporting	no	no	Last actual field assessment is from 2009.
IA 02-IOW-690	Clear Creek	not assessed		not assessed	not assessed	no	no	
IA 02-IOW-691	Clear Creek	not assessed		not assessed	not assessed	no	Clear Creek - S of Swisher (CL001)	fish data from 1997
IA 02-IOW-692	Clear Creek	not assessed		not assessed	not assessed	no	no	
IA 02-IOW-2065	Unnamed trib to Clear Creek	fully supporting	not assessed		fully supporting	no	no	Last actual field assessment is from 2009.
IA 02-IOW-6412	Rhine Creek	not assessed	partially supporting		partially supporting	11/08/2012 Spill/Runoff		5b: fish kill caused by pesticide; 3b: wastewater from municipal WWTP

Department of Natural Resources

Rhine Creek is reported as 'partially supporting' for the Class B (WW-2) and General Use categories. A fish-kill in 2012 from a pesticide spill led to the Class B (WW-2) aquatic life designation of 'partially supporting.' Observations and biologic monitoring as part of a use attainability analysis (UAA) conducted in 2005 by DNR staff near the outfall of the Oxford Wastewater Treatment Plant (WWTP) led to a 'potential' impairment of the general uses of the stream due to the 'potential' water quality impacts of inadequately-treated domestic sewage. More detail on this impairment status can be found in DNR's assessment database (https://programs.iowadnr.gov/adbnet/Assessments/4616).

Impairments of the Primary Contact Recreation (Class A1) and Aquatic Life Uses (Class B WW1) were in place between the 2004 – 2008 listing cycles. These impairments were due to sewage contamination of Clear Creek near Conroy in the uppermost reaches of the watershed, which was discovered by volunteer water monitors conducting a snapshot monitoring event under the IOWATER program. Iowa DNR staff later confirmed the presence of sewage contamination. In a follow-up investigation, Iowa DNR staff from Field Office 6 found no further evidence of sewage contamination and the segment was de-listed in the 2010 reporting cycle. More detail on this impairment status can be found in DNR's assessment database (https://programs.iowadnr.gov/adbnet/Assessments/4730).

Figure 3-1. Water bodies listed as impaired in the 2016 Section 303(d) Integrated Report



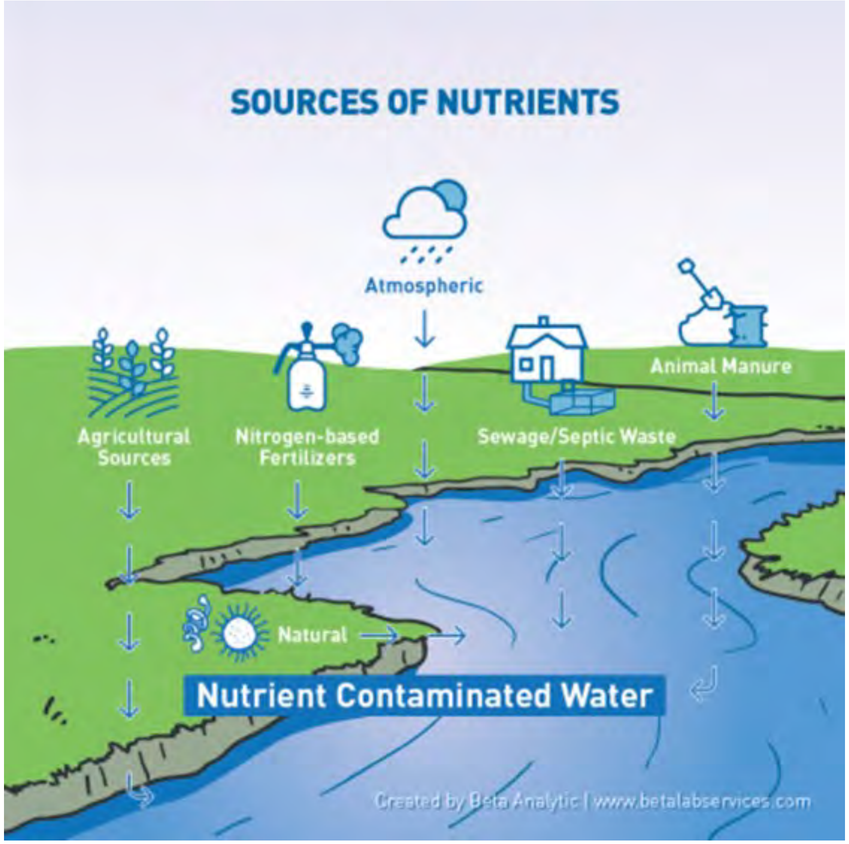
Segment ID	Waterbody	Class 1A Designated Use	Class B (WW-1) Designated Use	Class B (WW-2) Designated Use	General Use	Fish Kills	Biological Monitoring
IA 02-IOW-690	Clear Creek	Not Assessed		Not Assessed	Not Assessed	No	No
IA 02-IOW-2065	Unnamed trib to Clear Creek	Fully Supporting	Not Assessed		Fully Supporting	No	No
IA 02-IOW-6412	Rhine Creek	Not Assessed	Partially Supporting		Partially Supporting	11/08/2012, Spill/Runoff	
IA 02-IOW-691	Clear Creek	Not Assessed		Not Assessed	Not Assessed	No	Clear Creek - S of Swisher (CL001)
IA 02-IOW-692	Clear Creek	Not Assessed		Not Assessed	Not Assessed	No	No
IA 02-IOW-1937	Clear Creek	Fully Supporting	Not Assessed		Fully Supporting	No	No

Source: Iowa Department of Natural Resources

3.3 Designated Uses & Impaired Status

3.3.1 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 ("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 Clear Creek watershed focused on the nitrate nitrogen (NO_3-N) with concentrations that vary seasonally from biological activity and nutrient inputs (fertilizer, wastewater and urban runoff).



Source: www.betalabservices.com/nitrate-test

3.3.2 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 (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.

3.3.3 Sediment / Suspended Solids

Turbidity is caused by materials suspended in the 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 promote solar heating 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 Clear Creek watershed may include soil erosion, sewer/septic/manure discharge, urban runoff, eroding stream banks, and excess algal growth.

3.3.4 *E. coli* Bacteria

Water-borne pathogens include a wide variety of bacteria, viruses, protozoa, and micro-organisms such as Giardia and Cryptosporidium that can produce gastro-intestinal illnesses and other symptoms that can be severe. Testing for all 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.

3.3.5 Chloride

Chloride is present (generally as sodium chloride) in all natural sources of 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 concerns. Concentrated animal operation wastes and some agricultural inorganic fertilizers also influence chloride concentrations.

Sources of Pollutants

Source: http://www.filterwater.com/t-articles.water-pollution.aspx

3.3.6 Urban Runoff

Various pollutants collect on the surfaces 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 Clear 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

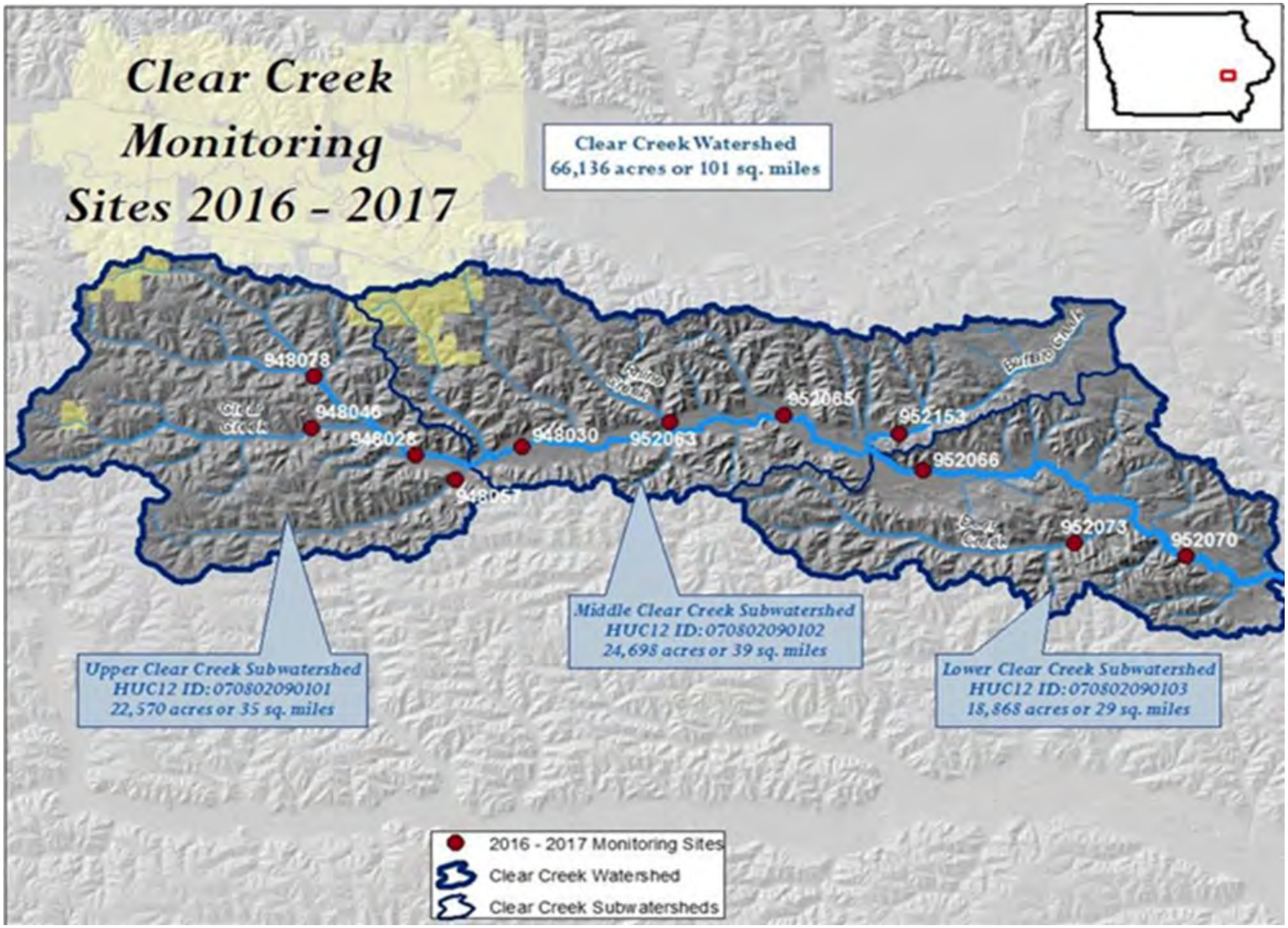
3.4 Designated Uses & Impaired Status

3.4.1 Monthly Monitoring

Monthly monitoring was conducted at 11 sites in the Clear Creek watershed between July and December of 2016, and between March and October of 2017, for a total of fourteen sampling events (Figure 3-2). This monitoring was conducted by University of Iowa students and by the Clear Creek Watershed Coordinator. Monitoring was conducted according to the procedures outlined in the Clear Creek 2016 – 2017 Water Monitoring Plan (Appendix D).

Each sampling event included field parameters (dissolved oxygen, pH, temperature, and turbidity) and grab samples included (Nitrate+Nitrite, total phosphorus, dissolved phosphorus, and E.coli). Water samples were analyzed at the State Hygienic Laboratory in Iowa City.

Figure 3-2. 2016-2017 Monitoring Sites in Clear Creek Watershed



Source: http://www.filterwater.com/t-articles.water-pollution.aspx

3.4.2 Continuous Monitoring

University of Iowa – IIHR deploys continuous water quality monitoring sensors at three sites (948078, 952065, and 952070) in the Clear Creek watershed each year. These sensors record dissolved oxygen, Nitrate+Nitrite, pH, conductance, temperature, Chlorophyll a, and Chlorophyll b. Two of these sensors are co-located with USGS discharge gage stations. Monthly monitoring (described above) was not conducted for parameters already being documented by continuous monitoring sensors.

Table 3-2. Monitoring Sites for Water Quality

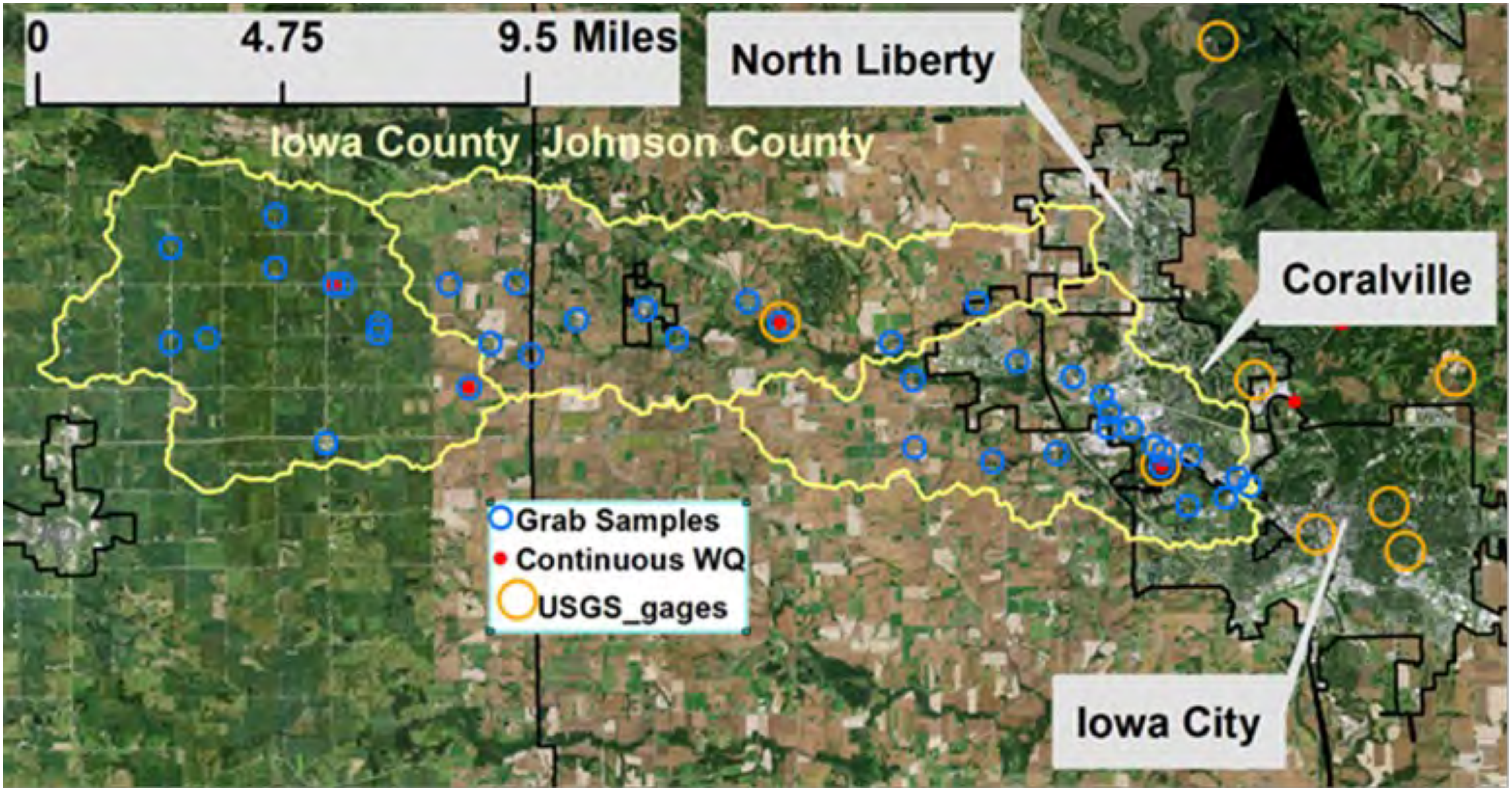
Sampling Site	Monthly Monitoring	Continuous Monitoring	USGS Gage	Watershed Placement	Elevated Pollutant Rank	Site Description
Site ID# 948078	X	X		Upper Clear Creek		190th & U Ave
Site ID# 948046	X			Upper Clear Creek	5th	Clear Creek @ 200th
Site ID# 948028	X			Upper Clear Creek		Clear Creek @ W Ave
Site ID# 948057	X			Upper Clear Creek		210th Bridge between W Ave & Y Ave
Site ID# 948030	X			Middle Clear Creek		Clear Creek @ Johnson & Iowa Roads
Site ID# 952063	X			Middle Clear Creek	1st	Rhine Creek @ 295th St
Site ID# 952065	X	X	X	Middle Clear Creek	3rd	Clear Creek @ Eagle Ave
Site ID# 952074	X			Middle Clear Creek		Buffalo Creek @ NW Half Moon
Site ID# 952068	X			Lower Clear Creek	2nd	Clear Creek @ Jasper Ave
Site ID# 952073	X			Lower Clear Creek		Deer Creek @ Kansas
Site ID# 952070	X	X	X	Lower Clear Creek	4th	Clear Creek @ Camp Cardinal

Source: Iowa Department of Natural Resources

3.4.3 Additional Synoptic Monitoring

Five monitoring events were also conducted by a University of Iowa researcher in order to correlate nitrate concentration and load with hydrologic conditions. Grab samples were collected on five different days (June 22, July 6, July 18, July 31, and August 17) in 2017 before conditions became extremely dry towards the end of the year.

Figure 3-3. Synoptic Nitrate Water Quality Assessment Sampling Sites



Source: University of Iowa – IIHR

3.5 Water Monitoring Results

3.5.1 Total Phosphorus – Monthly Monitoring

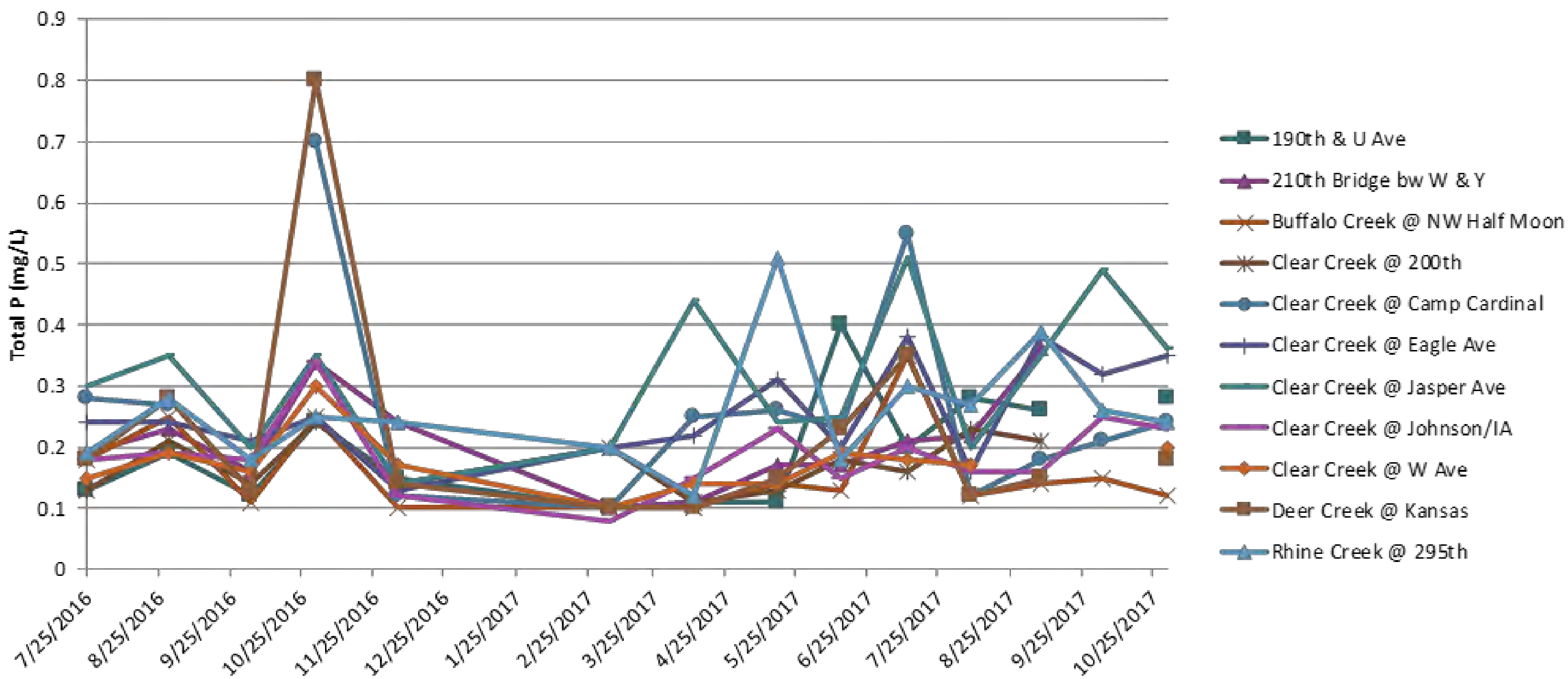
Total phosphorus is a measure of all forms of phosphorus (dissolved and particulate) that can come from sources such as sediment, sewage / livestock manure, fertilizers and decaying plant / animal material. Figure 3-4 depicts the individual sample results at the 11 sites.

Because there is no statewide water quality standard for total phosphorus, median values from Iowa DNR ambient stream sampling for both the entire state and Southern Iowa Drift Plain landform region (0.19 mg/L and 0.21 mg/L, respectively) are used as relative water quality benchmarks in this report. Of the 11 sites sampled, only four sites tested above the statewide median (0.19 mg/L) most of the time. The median value at only a single site, Clear Creek at Jasper Ave, was higher than the landform region median value of 0.21 mg/L. This suggests that in general, total phosphorus levels are slightly better than samples collected from other sites both in the Southern Iowa Drift Plain and across Iowa.

The four sites that tested above the statewide median for total phosphorus most of the time are:

- Rhine Creek @ 295th Ave
- Clear Creek @ Eagle Ave
- Clear Creek @ Jasper Ave (which also tested above the landform region median)
- Clear Creek @ Camp Cardinal

Figure 3-4. Total Phosphorus Concentration (mg/L) Results for 2016 – 2017 Monthly Sampling



Source: Iowa Department of Natural Resources

Three of these sites (Rhine Creek @ 295th, Clear Creek @ Eagle Ave, and Clear Creek @ Jasper Ave) were also among the top *E. coli* hot spots.

3.5.2 Dissolved Phosphorus – Monthly Monitoring

As with total phosphorus, there is no statewide water quality standard for dissolved phosphorus. Again, the statewide and Southern Iowa Drift Plain landform region median value is used as a benchmark (both have a median value of 0.1 mg/L). Median values for most of the Clear Creek monitoring sites were also 0.1 mg/L, except for Buffalo Creek which was below 0.1 mg/L. Individual samples from only two sites exceeded the statewide / landform region median value most of the time: Rhine Creek at 295th and Clear Creek at Jasper Ave (which had the most exceedances of the statewide median, as it did for total phosphorus). Clear Creek at Camp Cardinal Road tested above the statewide median half the time and had the highest single sample maximum value of all the sites (0.6 mg/L).

3.5.3 *E. coli* – Monthly Monitoring

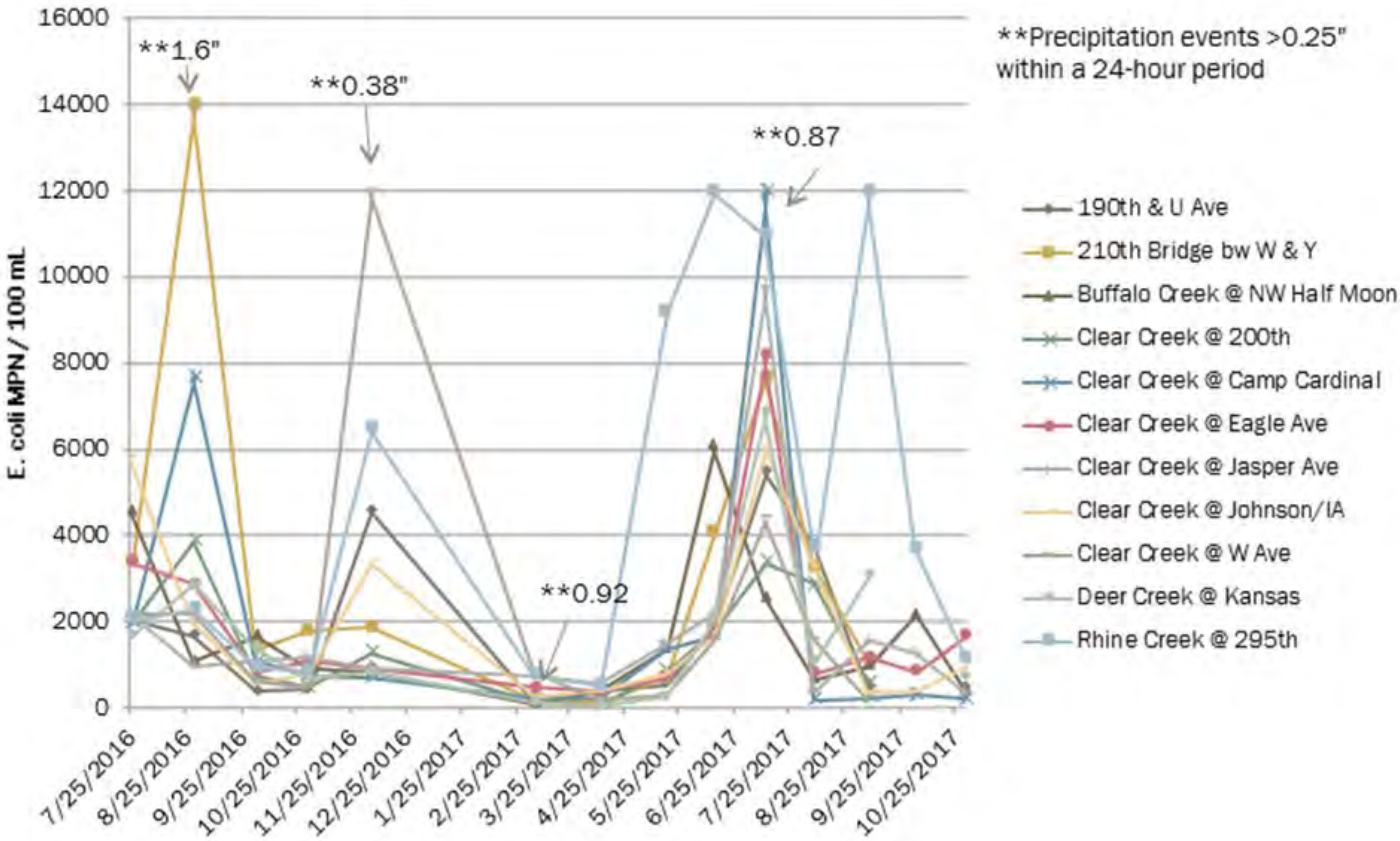
E. coli measurements provide an indication of bacterial contamination of a stream. While *E. coli* themselves are not necessarily disease causing, they originate in the digestive tract of mammals and this provides an indication of the possible presence of disease-causing organisms. Standards are based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

E. coli values were consistently elevated throughout the watershed. Four of the eleven sites tested above the water quality standard (single sample maximum, 235 MPN / 100 mL in every sampling event. As can be seen in Figure 3-5, spikes in *E. coli* values generally, but not always, were associated with rainfall events within a 24-hour period. Rhine Creek generally showed the most concerning *E. coli* trends, including spikes in values above 10,000 MPN / 100 mL that were not associated with a rain event. The Rhine Creek sampling location is immediately downstream of the Oxford municipal wastewater treatment plant, as well as the Oxford Sale Barn, both of which are potential sources of bacteria loading. The four sites that consistently tested above the *E. Coli* water quality standard of 235 MPN/100 mL were:

- Clear Creek @ Johnson/Iowa
- Rhine Creek @ 295th (which had the most elevated samples of them all)
- Clear Creek @ Eagle Ave
- Clear Creek @ Jasper Ave

As can be seen in Figure 3-5, spikes in E. coli values generally, but not always, were associated with rainfall events within a 24-hour period. Rhine Creek generally showed the most concerning E. coli trends, including spikes in values above 10,000 cfu/100 mL that were not associated with a rain event. The Rhine Creek sampling location is immediately downstream of the Oxford municipal wastewater treatment plant, as well as the Oxford Sale Barn, both of which are potential sources of bacteria loading.

Figure 3-5. E. coli Results for 2016 – 2017 Monthly Sampling



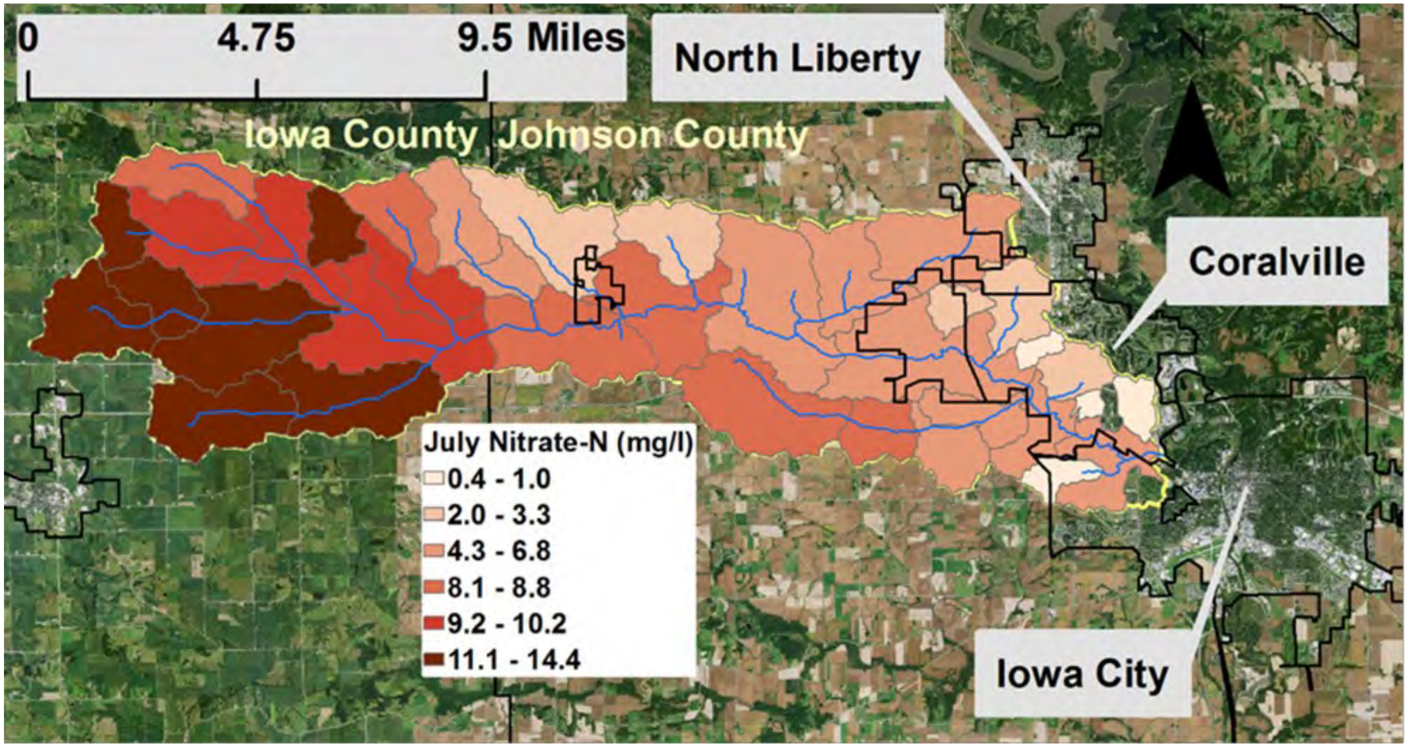
Source: Iowa Department of Natural Resources

3.5.4 Nitrogen (Nitrate + Nitrite) – Monthly Monitoring, Continuous Monitoring, Synoptic Monitoring

Nitrogen is a measure of the amount of nitrate + nitrite in the water and is naturally abundant in soils but is also introduced to the environment through fertilizers and sewage. In Iowa, nitrates threaten drinking water supplies and the Gulf of Mexico hypoxia (Dead Zone) is triggered by excess nitrate from the Mississippi River watershed.

There is a water quality standard for nitrate which applies to drinking water sources, which is 10 mg/L (milligrams per liter of sample). This value is commonly used as a benchmark for water quality, although the regulatory standard does not apply to Clear Creek, as it is not a drinking water source. The median concentration for nitrogen samples collected in the Southern Iowa Drift Plain is 4.5 mg/L. In general, nitrogen samples from the Clear Creek watershed were well below the 10 mg/L drinking water benchmark. However, seven of the eight sites where grab samples were collected had median values above the landform region median of 4.5 mg/L. In some cases, particularly in the lower reaches of the watershed, median values were only slightly higher than the landform region median. However, values were significantly higher than the landform region median in the Upper Clear creek sub-watershed.

Figure 3-6. Average Nitrate Concentrations in July 2017



Source: University of Iowa – IIHR

Generally speaking, there is a clear downward trend in nitrate concentrations progressing downstream from Upper to Lower Clear Creek. This could in part be due to a higher proportion of row-cropped acres in Upper Clear Creek, which is a proven source of nitrate. All four of the sampling sites in the Upper Clear Creek watershed most frequently tested above the 10 mg/L drinking water standard.

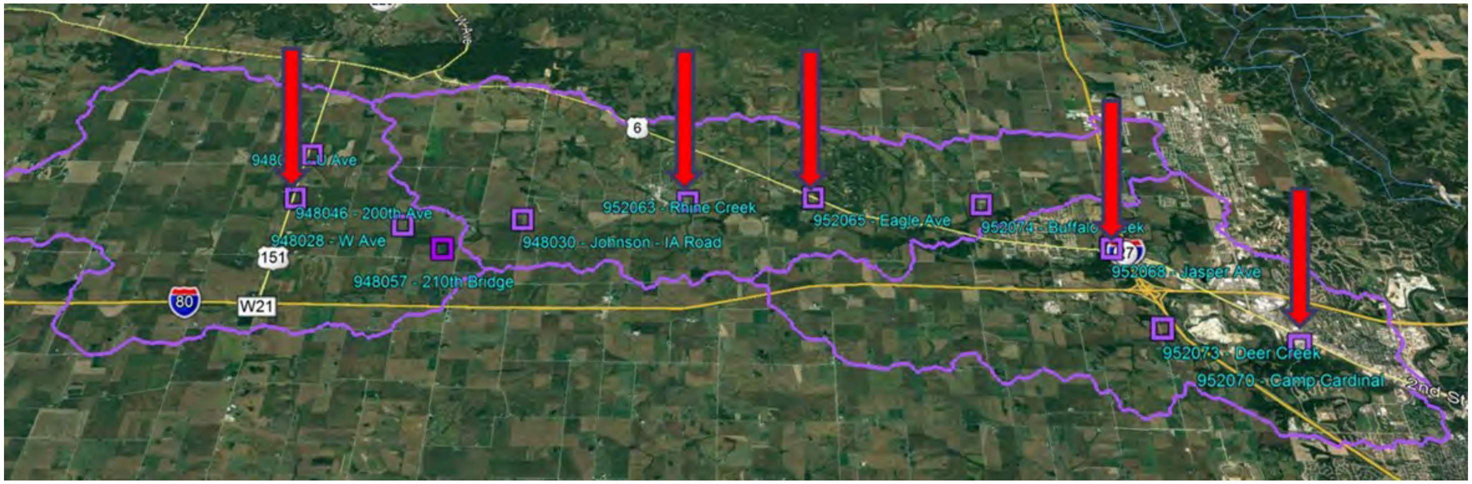
Interestingly, Rhine Creek exhibited the lowest nitrate concentrations of all the sites, even though it was among the sites with the most elevated concentrations for E. coli, total phosphorus, and dissolved phosphorus. Streams receiving water from the smallest drainage areas showed higher nitrate-N concentration as displayed in Figure 3-6.

3.6 Water Monitoring Conclusions

Several sites consistently show up as problematic for elevated pollutant levels. The top 5 sites are depicted in Figure 3-7 and listed here, ranked based on the number of pollutants of concern for each site.

1. Rhine Creek:
   - *E. coli*: Had the highest median and tested above the water quality standard 100% of the time
   - Total P: Tested above the statewide median value 64% of the time
   - Dissolved phosphorus: Tested above the statewide / landform region value 57% of the time
2. Clear Creek @ Jasper Ave:
   - *E. coli*: Tested above the water quality standard 100% of the time
   - Total P: Had the highest median value; tested above the statewide median value 93% of the time
   - Dissolved phosphorus: Tested above the statewide / landform region value 64% of the time, the most of all the sites
   - Turbidity: Tested above the statewide median 79% of the time
3. Clear Creek at Eagle Ave:
   - *E. coli*: Tested above the water quality standard 100% of the time
   - Total P: Tested above the statewide median value 86% of the time
4. Clear Creek at Camp Cardinal
   - Total P: Tested above the statewide median 69% of the time
   - Dissolved phosphorus: Tested above the state & landform region median 50% of the time
5. Clear Creek at 200th
   - Nitrogen: Tested above the 10 mg/L nitrate standard 50% of the time, and mean value is above the standard as well

Figure 3-7. Top 5 Sites of Concern



Source: Iowa Department of Natural Resources

3.7 Nitrogen Loss Analysis

An analysis developed by the Clear Creek Watershed Coordinator using local data illustrates another way to measure nitrogen in the stream and its impact. In addition to contributing to the entire Iowa River basin's nitrogen leaving the state, the question is how much lost nitrogen costs local farmers. The results indicate that while nitrogen levels in Clear Creek may not be high relative to other creeks in Iowa, losing nutrients to waterways comes with a significant cost.

The analysis used the 2015 to 2018 growing season rainfall data and estimates of nitrogen loss and cost per pound from Iowa State University and the University of Iowa to provide the results in Table 3-3. Nitrogen loss from row crop fields per month is estimated and nitrogen's value is assigned as an agricultural input. In general, the amount of nitrogen lost is dependent on rainfall and ranges from 342 tons to 488 tons per year. The value of that nitrogen is costing farmers in the Clear Creek watershed between $260,000 and $372,000 per year.

Table 3-3. Nitrogen Loss in Clear Creek Watershed

	2018		2017		2016		2015	
Month	Rain (inches)	N Lost per Month (pounds)	Rain (inches)	N Lost per Month (pounds)	Rain (inches)	N Lost per Month (pounds)	Rain (inches)	N Lost per Month (pounds)
March	3.02	21,802	1.66	15,300	0.58	23,800	0.35	8,482
April	0.68	11,614	4.76	158,100	2.17	56,300	3.1	20,155
May	3.77	8,098	3.5	330,100	3.61	121,000	4.64	192,200
June	7.69	54,900	4.21	122,600	6.62	137,415	5.88	299,550
July	2.52	24,321	6.48	47,934	3.32	93,300	2.68	97,500
August	8.18	13,877	1.12	5,625	6.15	69,395	3.59	38,300
September	7.05	196,158	0.49	698	2.83	84,599	3.63	11,611
October	7.22	341,700	3.73	2,348	2.16	65,000	3.8	19,867
November	2.65	106,500	0.83	1,856	0.14	58,600	4.81	122,400
December	2.38	83,100	0.2	389	0	0	1.94	166,400
Annual Totals	**45.16**	862,069	**26.98**	684,950	**27.58**	709,409	**34.42**	976,465
Tons of N lost per year		431		342		355		488
Value of N lost ($0.38/lbs)		$ 327,586		$ 260,281		$ 269,575		$ 371,057

Source: John Rathbun, Clear Creek Watershed Coordinator and James Martin, Iowa Department of Agriculture and Land Stewardship
* Numbers in red denote incomplete data for that month or day * Rainfall data from ISU Iowa Environmental Mesonet
* N Load info from IIHR IWQIS * Cost per lbs N from ISU "Estimated Costs of Crop Production 2019"

3.8 Urban Water Quality Modeling

An important part of the water quality assessment is to characterize pollutant sources and estimated loads, and to identify drainage areas where Best Management Practices (BMPs) should be prioritized in urban areas. The Source Loading and Management Model (SLAMM) was initially developed to evaluate stormwater BMPs. It soon became evident that in order to accurately evaluate the effectiveness of stormwater controls at an outfall, the sources of the pollutants or problem water flows must be known. As a Windows based program, WinSLAMM has evolved to include a variety of source area and end-of-pipe controls and the ability to predict the concentrations and loadings of many different pollutants from many potential source areas. WinSLAMM calculates mass balances for both particulate and dissolved pollutants and runoff flow volumes for different development characteristics and rainfalls. It was designed to give relatively simple answers such as pollutant mass discharges and control measure effects for a large variety of potential conditions. ArcSLAMM is a set of ArcGIS script tools designed to allow users to utilize widely available GIS land use/land cover datasets to automatically generate WinSLAMM models. Together, the ArcSLAMM/ WINSLAMM urban stormwater modeling system provides a mechanism for quantifying urban runoff and pollutant loads to gain a better understanding of urban area contributions.

The Clear Creek Watershed Coalition partnered with the Geoinformatics Training, Research, Education and Extension Center (GeoTREE Center) at the University of Northern Iowa to complete the work summarized in this section using the ArcSLAMM/WinSLAMM system to model runoff and pollutant loads in the Clear Creek watershed. The complete report is included as Appendix E.

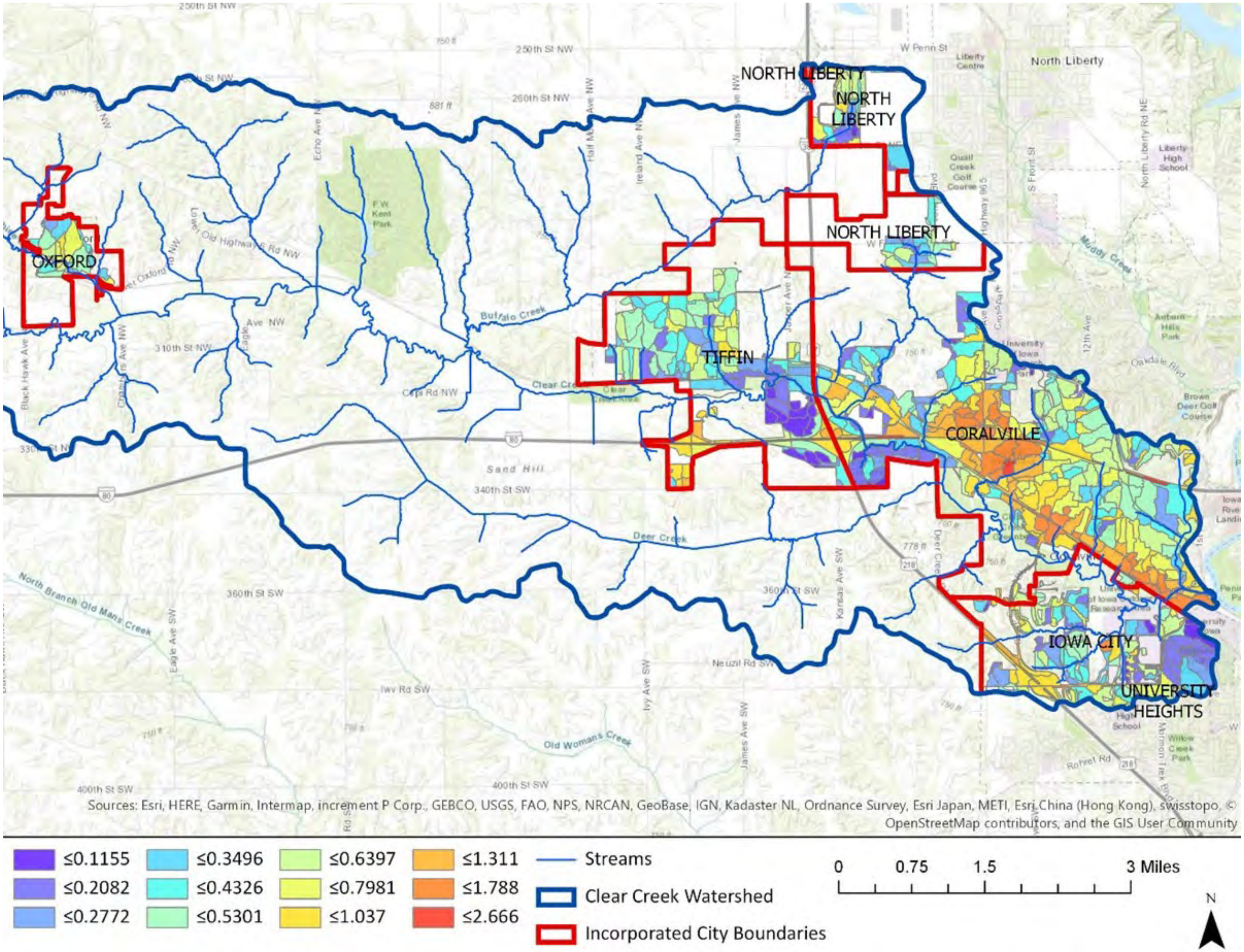
The GeoTREE Center used the ArcSLAMM/WinSLAMM system to characterize detailed urban land use in the watershed and then model urban runoff and pollutant loads for 830 separate sub-watersheds. All urban areas in the Clear Creek watershed were modeled including portions of Iowa City, Coralville, and North Liberty as well as all of Tiffin and Oxford. The basic idea is that each roof, driveway, street, sidewalk and other areas are created as a polygon with attributes such as connectivity (e.g. draining to storm sewers), soil type, and general land use. The model identified 1,922 acres of impervious surface in the urban areas of the watershed. The development of the detailed polygons allows for modeling sub-watersheds to develop simulations for existing BMPs or for potential “what-if” BMP simulations. The results are useful in providing a quantified database of modeled runoff conditions as well as estimated pollutant loads in locating future BMPs.

The maps in Figures 3-8 and 3-9 show the modeled sub-watershed results using data files for average rainfall, typical runoff, particulate concentrations and pollutant loads. There are more detailed maps for each urban area in the full report “Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas” in Appendix E.

In Figure 3-8, the color scale on the map represents the pounds of nitrate expected per acre in that sub-watershed each year. The range is from approximately one-tenth of a pound (dark blue) to about two and a half pounds (red). The red and orange sub-watersheds are areas to target for nitrate reducing BMPs.

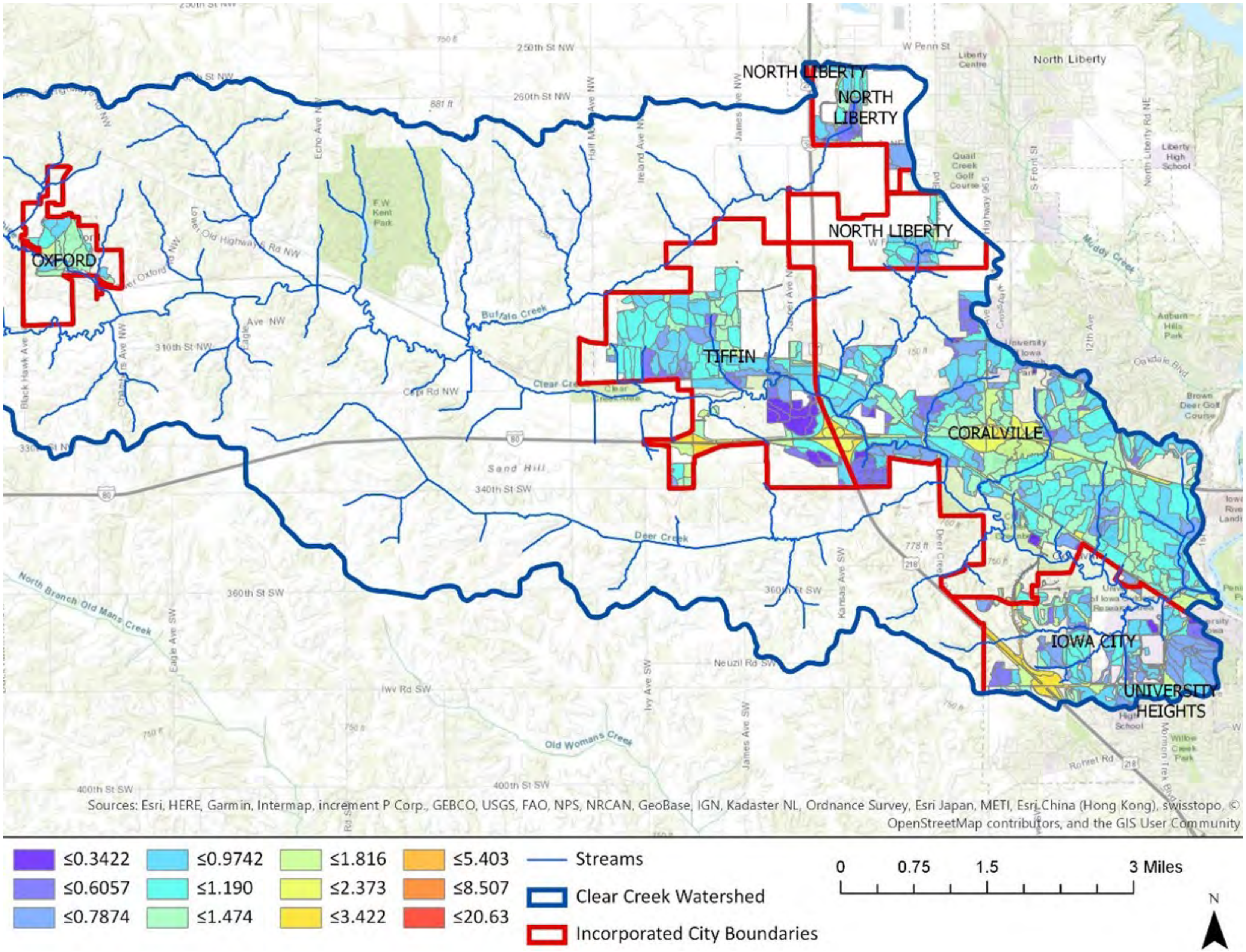
In Figure 3-9, the color scale on the map represents the pounds of total phosphorus expected per acre in that sub-watershed each year. The range is from approximately one-third of a pound (dark blue) to up to twenty pounds (red). The yellow and orange sub-watersheds are areas to target for phosphorus reducing BMPs.

Figure 3-8. Modeled Total Nitrate Load (pounds/acre/year) Normalized by Area



Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

Figure 3-9. Modeled Total Phosphorus Load (pounds/acre/year) Normalized by Area



Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

3.9 Water Quality Load Reductions

The Department of Natural Resources (DNR) Water Quality section developed water quality target load reductions based on the water qualtiy sampling conducted as part of the planning process. DNR staff member, Andrew Frana, Environmental Engineer and Total Maximum Daily Load (TMDL) Modeler, authored this section.

3.9.1 Reduce in-stream nitrogen levels by 41% (4,961 lbs / day) to be in line with Iowa Nutrient Reduction Strategy statewide goal

Technical Rationale: Clear Creek does not have a water quality standard for nitrogen. It is common in Iowa to use 10 mg/L as a relative benchmark for water quality, which is the water quality standard for water bodies used as source water. Modeling was completed by Iowa DNR for Clear Creek using nitrate data from the University of Iowa's continuous monitoring stations, in conjunction with USGS stream gage data, to determine daily loads at low, mid, and high flows. A target load was established for each flow condition based on the 10 mg/L benchmark. Clear Creek loads did not exceed the target in any flow condition. However, the Iowa Nutrient Reduction Strategy calls for a general 41% reduction in nonpoint source nitrogen levels, regardless of local baseline or flow conditions. The technical committee expressed commitment to the state nutrient reduction strategy in setting the nitrogen reduction goal at 41%, equivalent to 4,961 lbs / day, at the Camp Cardinal monitoring station.

Basic Explanation: The Clear Creek Technical Team recommends adopting the Iowa Nutrient Reduction Strategy goal of reducing nitrogen levels by 41% (4,961 lbs / day) in Clear Creek.

3.9.2 Reduce in-stream phosphorus levels by 86% (1,065 lbs/day) in average flow conditions to meet benchmark indicators for aquatic life

Technical Rationale: Clear Creek does not have a water quality standard for phosphorus, and there is no common benchmark for stream phosphorus levels. The Iowa DNR modeled phosphorus loads using USGS stream gage data and results from samples collected by the project coordinator and analyzed at the State Hygienic Lab. Iowa DNR used Carlson's Trophic State Index phosphorus target of 65 for lakes as a relative benchmark for Clear Creek, which equates to a concentration of 0.0682 mg/L. Of 13 samples collected at Camp Cardinal, none were below 0.1 mg/L, and the mean concentration was 0.3 mg/L. Phosphorus loads were modeled for wet, dry, and average flow conditions. A target load was established for each flow condition using the Trophic State Index target of 65. Clear Creek phosphorus loads exceeded the target in every flow condition, at each monitoring station. The recommended water quality goal is a reduction of 86% (1,065 lbs / day) at Camp Cardinal in average flow conditions (48 cubic feet/second). This goal is significantly higher than the Iowa Nutrient Reduction strategy statewide goal of 29% phosphorus reduction. The Clear Creek technical committee recommends adopting the more stringent water quality goal, as it reflects actual water quality conditions, and would result in more meaningful improvements to aquatic life.

Basic Explanation: The Clear Creek Technical Team recommends using the Trophic State Index as a benchmark to establish a goal of reducing phosphorus levels by 86% in average flow conditions.

3.9.3 Reduce in-stream nitrogen levels by 41% (4,961 lbs / day) to be in line with Iowa Nutrient Reduction Strategy statewide goal

Technical Rationale: The geometric mean water quality standard for Clear Creek is 126 colony forming units (cfu) / 100 mL. Modeling was completed by Iowa DNR for Clear Creek using E. coli data from samples collected by the project coordinator and analyzed at the State Hygienic Lab, in conjunction with USGS stream gage data, to determine daily loads at low, mid, and high flows. A target load was established for each flow condition based on the geometric mean water quality standard.

Basic Explanation: The water quality goal in order for Clear Creek to meet state standards is a reduction of 94% (2.26E+12 cfu / day) in average flow conditions.

Table 3-4. Target Load Reductions at Upper Clear Creek monitoring station (WQS011, near 190th and U Ave)

Mid-range flows = 8 cubic feet/second

Water Quality Indicator	Existing Load (Mid-Range Flows)	Target Load (Mid-Range Flows)	Targeted % Reduction to achieve benchmark	Targeted Nutrient Reduction Strategy % Reduction
Nitrogen	No data	No data	No data	41%
Phosphorus	90.7 lbs / day	29.7 lbs / day	67%	29%
E. coli	1.45E+11 cfu / day	2.50E+10 cfu / day	83%	Not Applicable

Table 3-5. Target Load Reductions at Middle Clear Creek monitoring station (WQS0003, Eagle Ave near Oxford)

Mid-range flows = 29 cubic feet / second

Water Quality Indicator	Existing Load (Mid-Range Flows)	Target Load (Mid-Range Flows)	Targeted % Reduction to achieve benchmark	Targeted Nutrient Reduction Strategy % Reduction
Nitrogen	12,100 lbs/day	15,300 lbs/day	0%	41%
Phosphorus	423 lbs / day	104 lbs/day	75%	29%
E. coli	1.24E+12 cfu / day	8.85E+10 cfu / day	92.8%	Not Applicable

Table 3-6. Target Load Reductions at Lower Clear Creek monitoring station (WQS0002, Camp Cardinal)

Mid-range flows = 48 cubic feet/second

Water Quality Indicator	Existing Load (Mid-Range Flows)	Target Load (Mid-Range Flows)	Targeted % Reduction to achieve benchmark	Targeted Nutrient Reduction Strategy % Reduction
Nitrogen	14,800 lbs/day	25,700 lbs/day	0%	41%
Phosphorus	1240 lbs / day	175 lbs / day	86%	29%
E. coli	2.41E+12 cfu / day	1.47E+11 cfu / day	94%	Not Applicable

Source: Andrew Frana, Iowa Department of Natural Resources

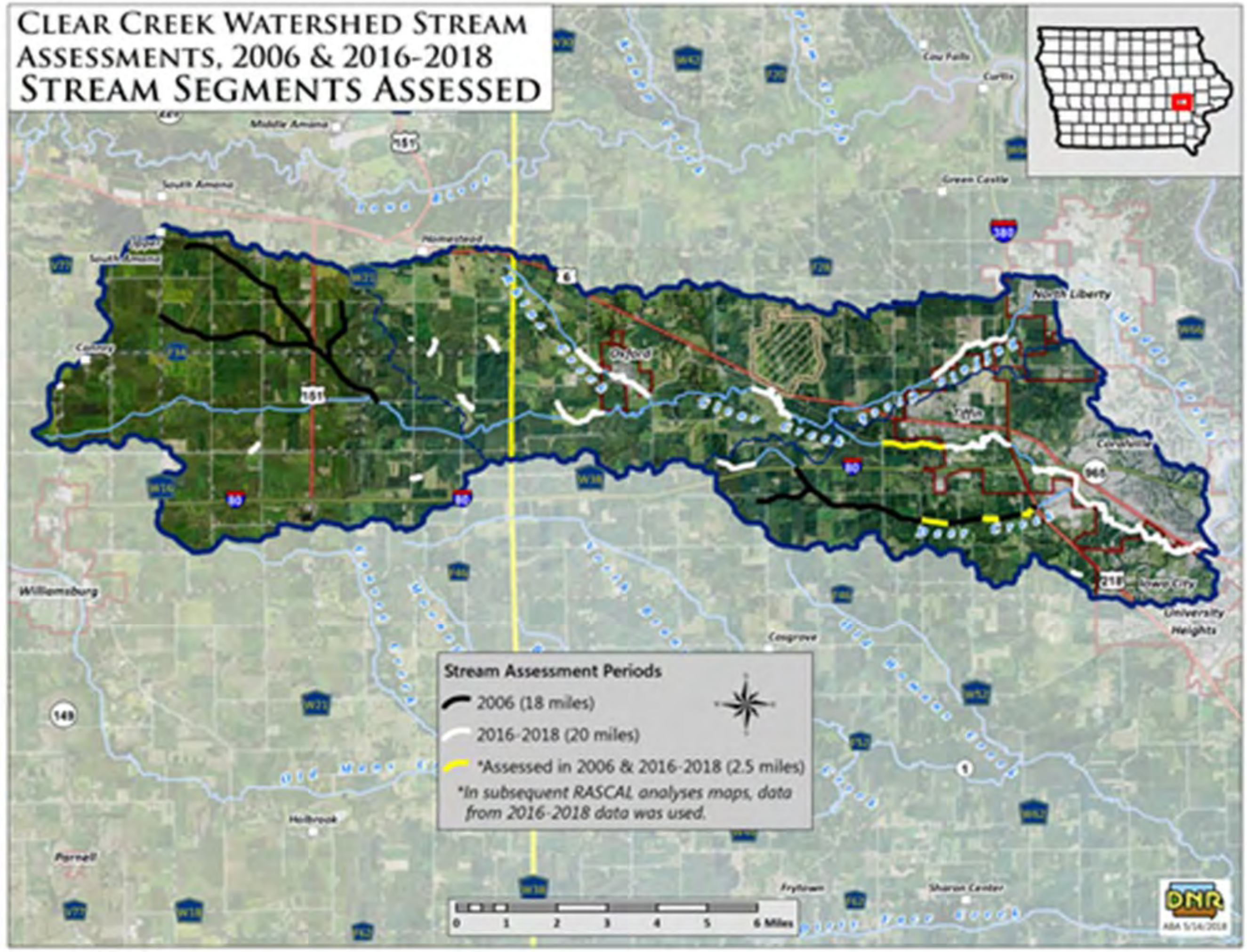
Chapter 4

STREAM HEALTH

4.1 Stream Condition

The Clear Creek Watershed Coalition (CCWC) partnered with the University of Iowa and the Johnson County Soil & Water Conservation District to conduct a stream condition assessment along Clear, Rhine, and Deer Creeks during 2016 – 2018. The goal of the 2016 – 2018 assessment was to provide an overall snapshot of the stream corridor with respect to erosion, sedimentation, riparian condition, and habitat quality. The 2016 – 2018 assessment was completed on 22.5 miles of the Clear Creek watershed stream network. Some reaches in the agricultural parts of the watershed were not assessed because permission from adjacent landowners had not been granted. The CCWC hopes to re-visit un-surveyed portions of the watershed in future years. A summary of the conditions relating to streambank condition, sedimentation and the riparian corridor are provided in this section of the Plan. It is important to note that because this was a rapid stream assessment, critical areas should be revisited for a more detailed analysis to determine suitability for bank stabilization and streambank restoration.

Figure 4-1. RASCAL Stream Segments Assessed



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

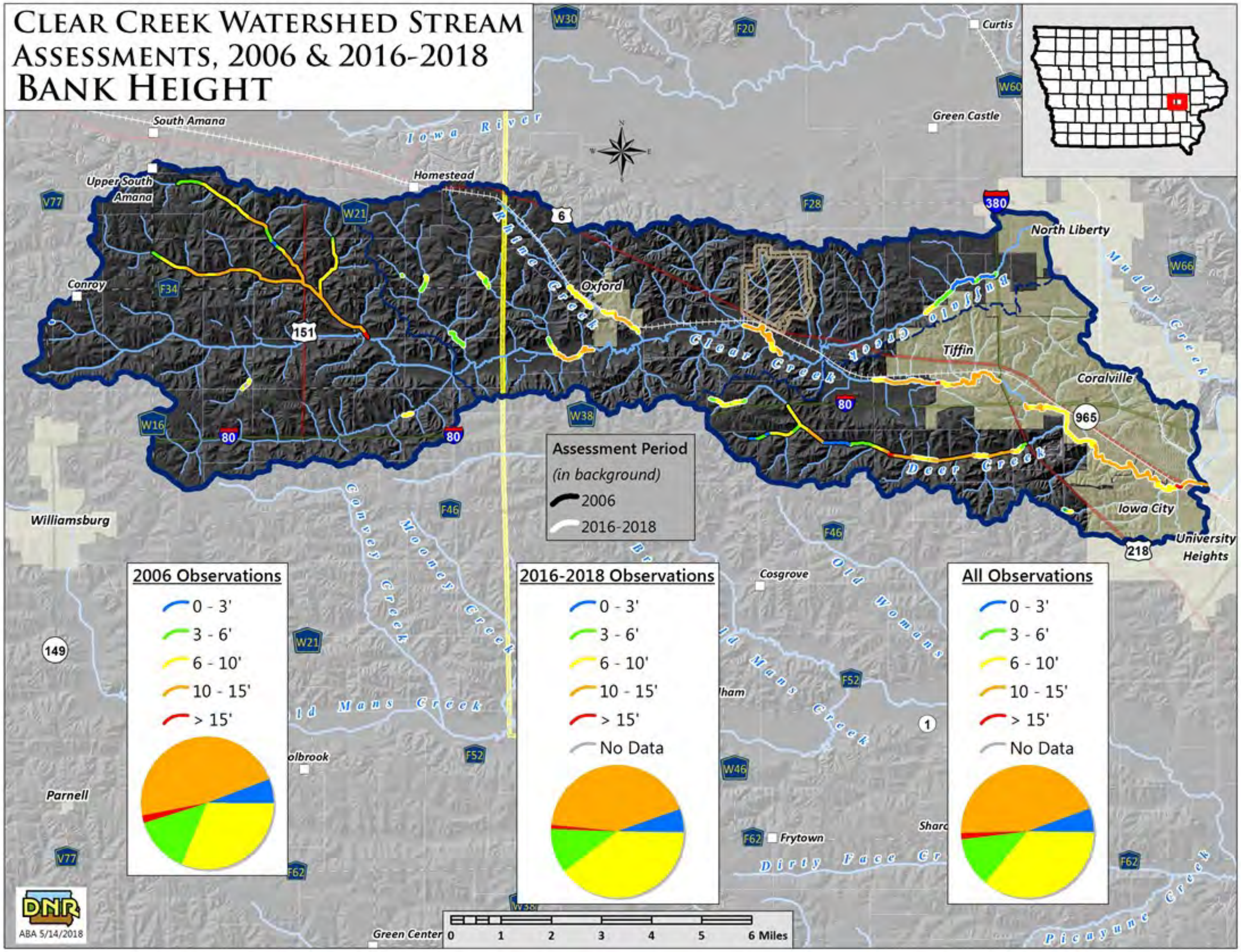
The survey team collected data by walking the length of the stream channel and evaluating indicators such as stream bank stability, adjacent land use, and in-stream habitat quality. For an overview of the procedure used for the stream assessment and a complete set of maps of the parameters assessed, see Appendix H, Protocol for RASCAL (Rapid Assessment of Stream Condition Along Length). The results from the 2016 – 2018 stream assessment were combined with results from a similar assessment completed in 2006 as part of an EPA 319 grant. The areas assessed for each are represented in Figure 4-1.

4.1.1 Streambank Condition

Streambank conditions were evaluated based on several indicators, including bank height, bank stability, and the erosion / sediment cycle. Evaluating streambank condition is important in prioritizing watershed improvements for increasing flood storage and protecting infrastructure as well as enhancing water quality and habitat.

Bank Height. Streams with high banks suffer from a lack of connectivity to the floodplain, causing loss of valuable storage during flood events. Bank heights of more than 10 feet (Figure 4-2) can create issues with overall bank instability.

Figure 4-2. RASCAL Stream Bank Heights

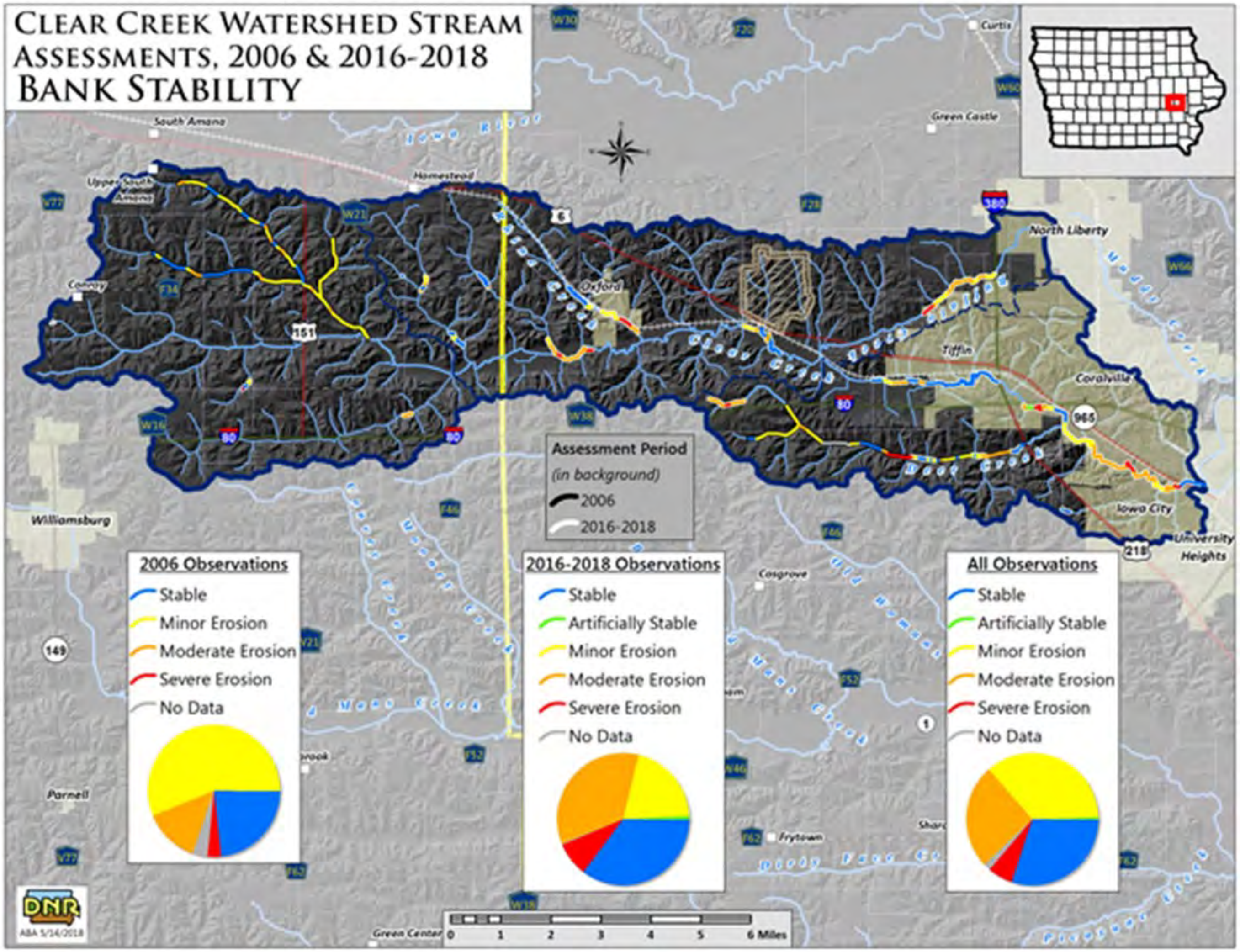


Source: Iowa Department of Natural Resources and Iowa Department of Agriculture & Land Stewardship

Bank Stability: Failing banks deposit excessive sediment to the stream, which increases stream bottom sedimentation and degrades habitat quality in the creek. Steep banks can also be a signal of stream incision, where the stream bottom is eroding / downcutting continually. In addition, streambank erosion can threaten existing infrastructure, such as pipes, trails, and bridges.

Critical areas of the assessed reaches are where moderate to severe erosion was observed as indicated in Figure 4-3, and in some cases, these areas overlap the areas where bank heights exceed 10 feet as indicated in Figure 4-2.

Figure 4-3. Bank Stability of RASCAL Surveyed Segments

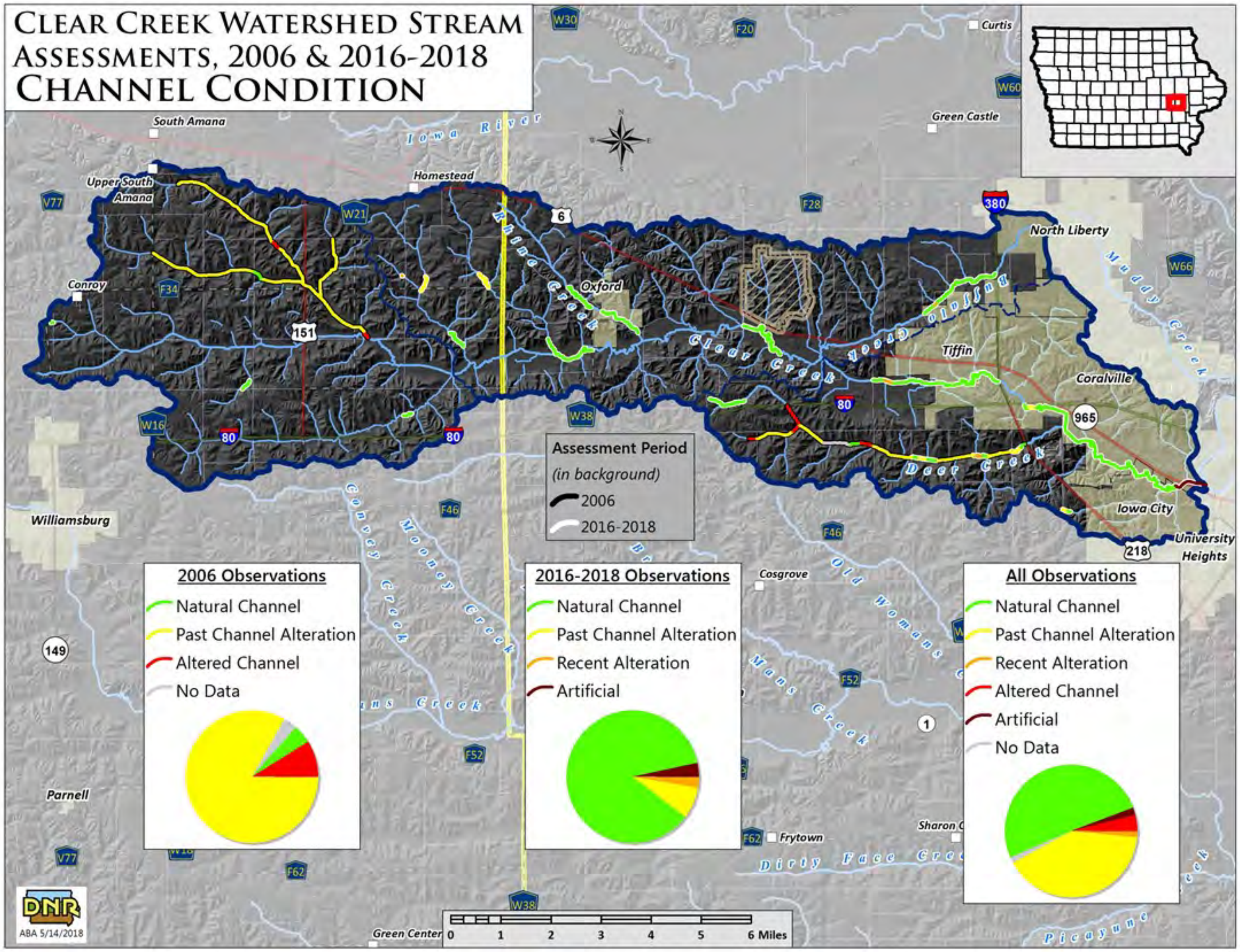


Source: Iowa Department of Natural Resources with data from University of Iowa students

4.1.2 Channel Condition

Many of the assessed sections of the stream were noted to have been previously straightened or artificially stabilized as represented in Figure 4-4. Stream channelization is a lesser known cause of serious issues downstream. Stream channelization removes the meanders from the stream corridor, reducing the overall length of a particular reach. This leads to higher flow velocities, which can cause downstream erosion, headcutting, and ultimately a loss of floodplain connectivity.

Figure 4-4. Channel Condition of RASCAL Surveyed Segments



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

4.2 Lower Clear Creek Stream Assessment

HR Green and Applied Ecological Services were tasked to assess the lower six miles of Clear Creek for factors such as fluvial geomorphic character, riparian vegetation community, current risks to infrastructure and stream function, and opportunities for restoration to be included in the watershed plan. The complete study, Lower Clear Creek Stream Assessment Within Coralville, Aaron Gwinnup PE, April 2019, can be found in Appendix G-1 with specific excerpts provided in this section.

4.2.1 Assessment Observations

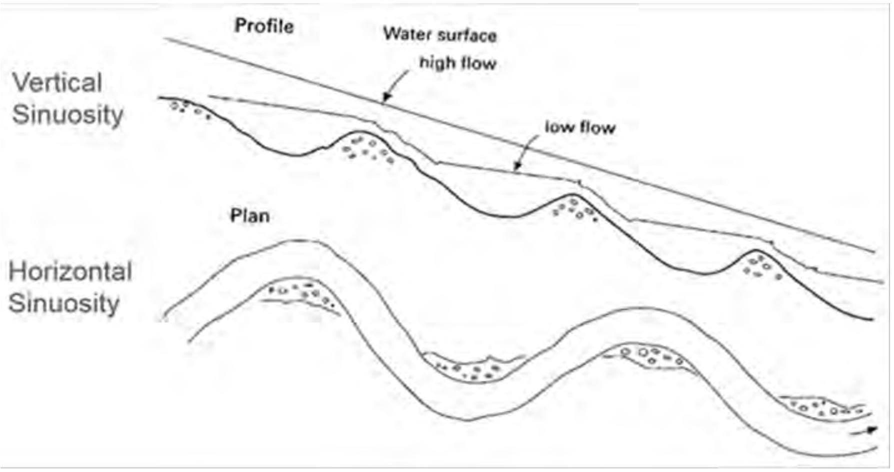
Lower Clear Creek is an evolving stream in an active floodplain consisting of very sandy soil with occasional clay deposits (and very rare bedrock). Because of the loose, highly erodible nature of the bank material, stream meandering and deposition are part of its natural development. The channel will rapidly respond to any alterations in plan, profile, or cross section. Future designers should consider this context when designing projects in lower Clear Creek to avoid unintentional effects adjacent to project areas. For example, erosion of sandy banks downstream of straightened reaches with oversized rip rap is a common issue in stream restoration (Figure 4-5).

The overall geomorphic characterization of Clear Creek within the Coralville City limits is a Rosgen type C5c-stream. This is a low-slope, sandy, meandering stream with frequent sandbars. The "typical" cross section includes steep, often eroding banks on the outside bends, and sandy point bars on inside bends. Both the bars and the channel bed are highly "transient" sand (constantly moving in larger flow events), and there is very little "riffle-run-pool" profile; most of the length is "run" with frequent scour pools at the toe of outside bends. Broadly, the most sustainable constructed channel and bank dimensions will match these existing parameters and characteristics. There are locations where the Rosgen type more closely matches an "F" or "E" type cross section, but these tend to be the more unstable sections suffering rapid lateral migration.

Figure 4-5. Large rip rap armoring a bank with instability immediately downstream

Source: Lower Clear Creek Stream Assessment Within Coralville, Aaron Gwinnup PE, April 2019

Figure 4-6. Natural Sinuosity



Source: *Lower Clear Creek Stream Assessment Within Coralville* Aaron Gwinnup PE, April 2019

While the system is low in slope (and therefore low in typical velocity and shear stress), most banks have little resistance strength, especially when vegetated. System-wide bank stability here is best achieved by striking a balance between radius of curvature (as large as possible) and high total sinuosity (which requires frequent bends). While the two may seem at odds, the existing planform (where natural and relatively stable) provides a good template. Where radius is too small, the “near bank shear stress” tends to erode the outer toe rapidly. Where sinuosity is too low, energy is not dissipated rapidly enough, and the next downstream bends tend to be unstable. Template parameters are provided for providing consistent and uniform balance between these forces.

Five locations were identified as having relatively stable cross-sections that are representative of the most likely “natural state” of lower Clear Creek (in the current modified context). These cross sections, termed “Reference,” provide a range of geomorphic observations that exhibit increased natural stability. Values for “Non-Reference” sections (i.e., sections not recommended as representative) are included for comparison in the full report. Note that for some metrics, there is an overlap in the range of values, possibly indicating that these metrics are not key drivers of instability. Future designs should consider the range of Reference conditions as recommended values for a basis of design (Table 4-1).

Table 4-1. Selected geomorphic metrics for representative “reference” conditions in lower Clear Creek

Parameter	min	mean	max	se	n
Avg Bankfull Height (ft)	3.88	**4.6**	5.17	0.219	5
Max Bankfull Height (ft)	6.24	**7.69**	8.77	0.419	5
Low Bank Height (ft)	10.4	**13.6**	18.4	1.53	5
Bankfull Width (ft)	35.8	**64.2**	102	10.7	5
Wetted Perimeter (ft)	40.8	**68.7**	105	10.4	5
Floodprone Width (ft)	218	**826**	1320	195	5
Bank Height Ratio	1.38	**1.76**	2.24	0.176	5
Entrenchment Ratio	6.09	**12.7**	20.5	2.71	5
Width/Depth Ratio	9.22	**13.8**	21.1	2.02	5
Slope	0	**0.000516**	0.001	0.000214	5
Bankfull Area (sq ft)	139	**301**	496	57.2	5
Hydraulic Radius (ft)	3.4	**4.27**	4.73	0.25	5

Note the following definitions hold for all tables in this report:
min = minimum of n values, mean = average of n values, max = maximum of n values, se = standard error of the mean, and n = number of observed cross-sections
Average bankfull height is the bankfull width divided by the bankfull area.
Max bankfull height is the height of the bankfull level above the thalweg.
Low bank height is the height above the thalweg of the lower the lowest of the two banks (right or left).
Bankfull width is the width of the channel at bankfull.
Wetted perimeter is the surface length along the cross-section from left bankfull to right bankfull.
Floodprone width is the channel width at twice the max bankfull height.
Bank height ratio is the ratio of the low bank height to the max bankfull height.
Entrenchment ratio is the ratio of floodprone width to bankfull width.
Width/depth ratio is the ratio of the bankfull width to the average bankfull depth.
Slope is the distance along the stream divided by the change in elevation of the stream bed.
Bankfull area is the area of the cross-section between the stream bed and the bankfull height. Hydraulic radius is the bankfull area divided by the wetted perimeter.
Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

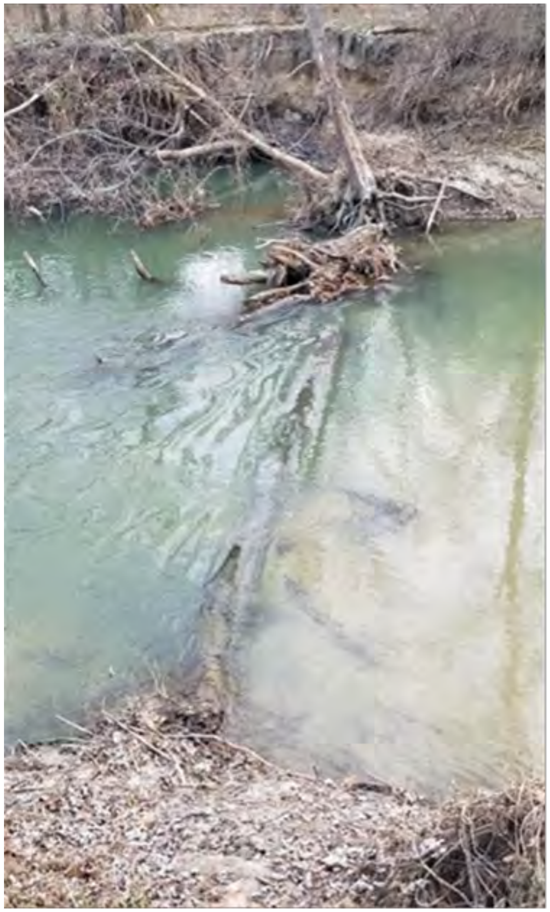
Lower Clear Creek is vertically constrained (can't really incise downward much) by grade controls both natural and man-made, but it is classically entrenched as the typical "low bank height" is around the 5-year stage. The system seems to "self-maintain" this entrenchment, though, as low areas adjacent to the channel are very rapidly buried by sandy sediment deposition up to this stage consistently along the length of the study area.

The predominant mode of failure in lower Clear Creek is a mix of fluvial erosion of the toe, and mass saturated-block failure - large chunks of non-cohesive sandy bank that slump down into the channel during high water events, or immediately after the high water goes down (Figure 4-7). Some reaches displayed mass failure blocks as large as 10 feet wide (perpendicular to the channel) and over 100 feet long (as a continuous block – general failure areas of multiple blocks can stretch for hundreds of feet).

Figure 4-7. Sandy-Bank Block Failure Along Clear Creek

Source*: Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

Figure 4-8. Natural & Stable Log Riffle



Source*: Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

As a sand bed stream, woody debris (either fallen on-site or transported from upstream) can provide much needed structure, habitat, and can often contribute to bank stabilization (Figure 4-8); without woody debris, this stream ecosystem would suffer. For all the benefits, in-stream woody structure can create risks to canoers and kayakers on the water trail. Fallen trees often require canoers and kayakers to portage around the fallen trees, or risk entrapment, drowning and other safety concerns. Additionally, fallen trees and woody structure comprised of highly biodegradable tree species (i.e. cottonwoods) do not provide long-term habitat or stream structure, and in certain cases may pose more risk than benefit.

4.2.2 Historical Evolution of Clear Creek

In the 1930's, lower Clear Creek was largely unconstrained by infrastructure and for the most part meandered naturally from Tiffin to the Iowa River. Between 1930 and 1980, various sections of Clear Creek were straightened and constrained by armoring and infrastructure (Figure 4-9). Straightening projects on lower Clear Creek ended in the 1980s, and the stream channel has subsequently begun to respond geomorphically to those changes (figure 4-10).

Straightening of streams generally leads to decreases in stream length (length along the channel) and sinuosity (proportion of stream length to valley length) and increases in long slope (upstream to downstream slope). Increases in long slope, coupled with associated shortening of stream length, lead to increases in stream power or energy of the water in the stream. This can lead to increased flow velocities and increased shear stresses for the same discharge, both of which have implications for stability of the stream channel.

From 1980 to 2017, portions of lower Clear Creek began to re-meander to dissipate the increased energy, thereby generally increasing stream length and sinuosity and generally reducing stream slope (Figure 4-10).

Figure 4-9. Clear Creek Centerlines in 1930 & 1980 with 2017 Aerial Imagery

Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

Figure 4-10. Geomorphic Response to Decades of Previous Straightening

Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

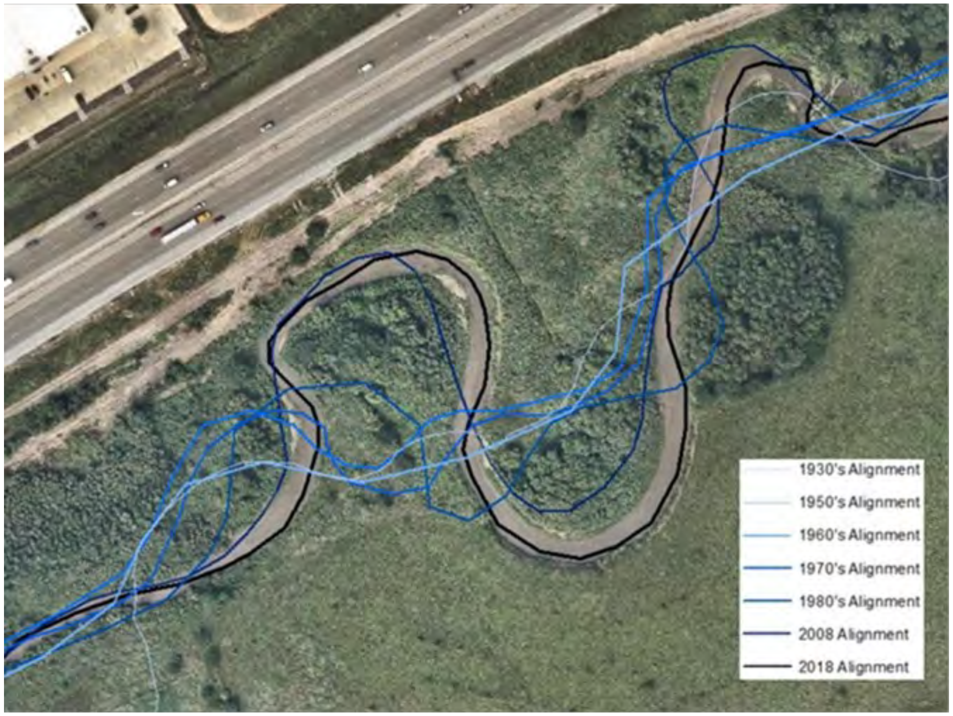
The current state of lower Clear Creek reflects the trend of geomorphic response from the peak of channelization in the 1980s. Previously straightened sections have typically developed more unstable sections downstream, characterized by highly unstable banks and increased rates of lateral bank migration.

The prime example of this response to previous channelization is the meander evolution (development and movement of meanders in a stream channel over time) area in the section between I-80 and Deer Creek Road (Figure 4-11). Water traveling though the heavily channelized portions of Clear Creek between I -380 and I-80, then around an armored bend and through an armored channel has relatively high energy. In the absence of vertical grade controls or horizontal sinuosity to reduce slope and energy at the downstream end of that section, the resulting stream power is dissipated by natural evolution of meanders once the banks are no longer fixed laterally.

Figure 4-12. Migration Rates of Dynamic Bends in Lower Clear Creek

Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

Figure 4-11. Meander evolution of lower Clear Creek



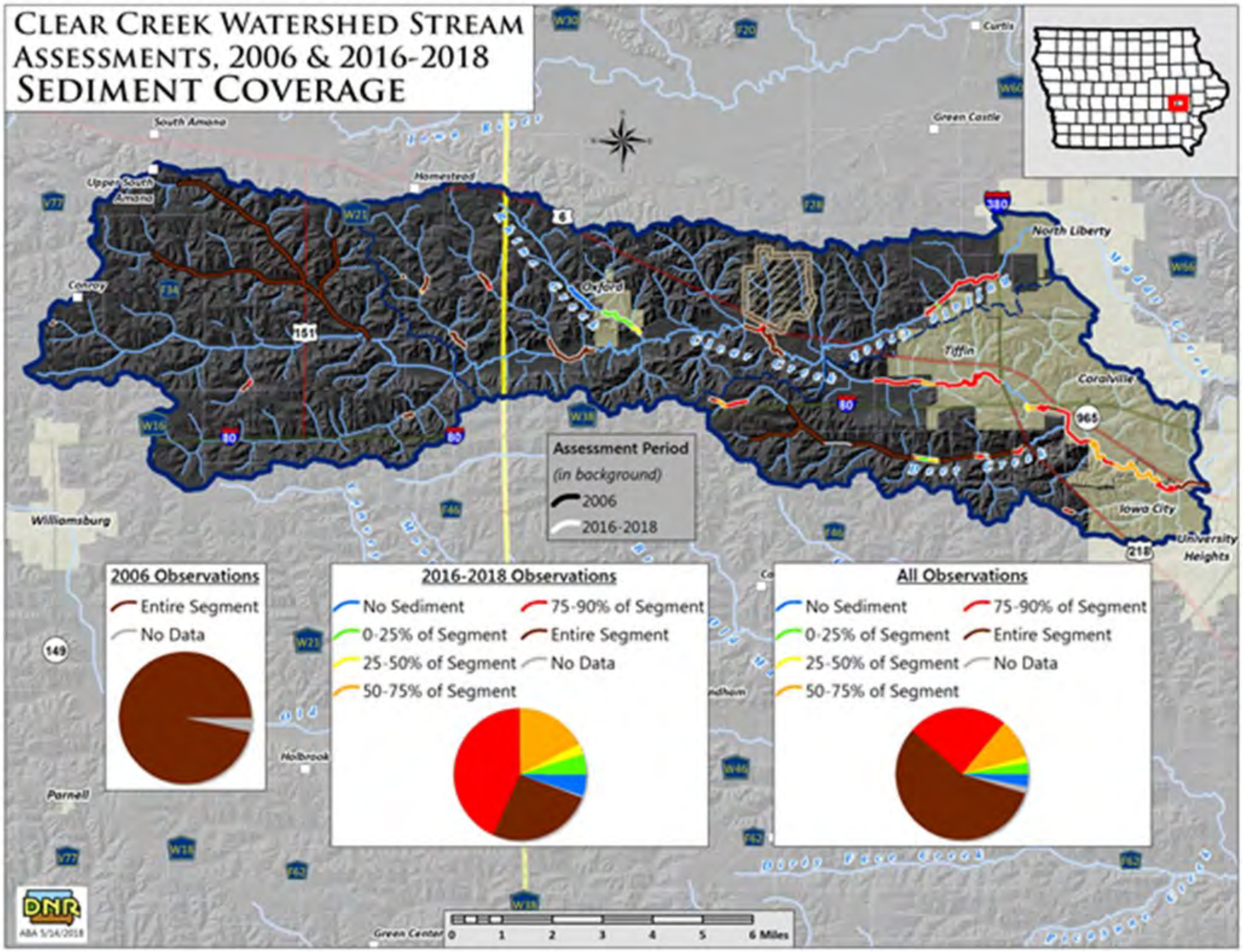
Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April 2019

The lateral migration of Clear Creek is quite rapid in reaches just downstream of less sinuous reaches, and especially downstream of previously straightened areas as the stream attempts to adjust to the increased energy created by reducing the channel length and effectively increasing the slope. Figure 4-12 shows a complex of bends that has migrated on average 10 feet per year (from about 80 to 135 feet per decade). The red arrows indicate the average direction of migration (typically downstream). The pink X's highlight a surveyed depression with flattened vegetation from a recent high flow event that may foretell the location of a future avulsion (complete bank erosion resulting in oxbow cutoff and abandonment). The orange arrow indicates the location of an avulsion that occurred between 1980 and 2008.

4.3 Sediment

Sediment deposition is a concern throughout the Clear Creek watershed. Many of the surveyed segments were observed to have 75% - 100% of the stream bottom covered in sediment (Figure 4-13). Sediment deposition is problematic in streams as it degrades water quality for aquatic life and reduces habitat availability for fish and macroinvertebrates.

Figure 4-13. Sediment Coverage of RASCAL Surveyed Segments

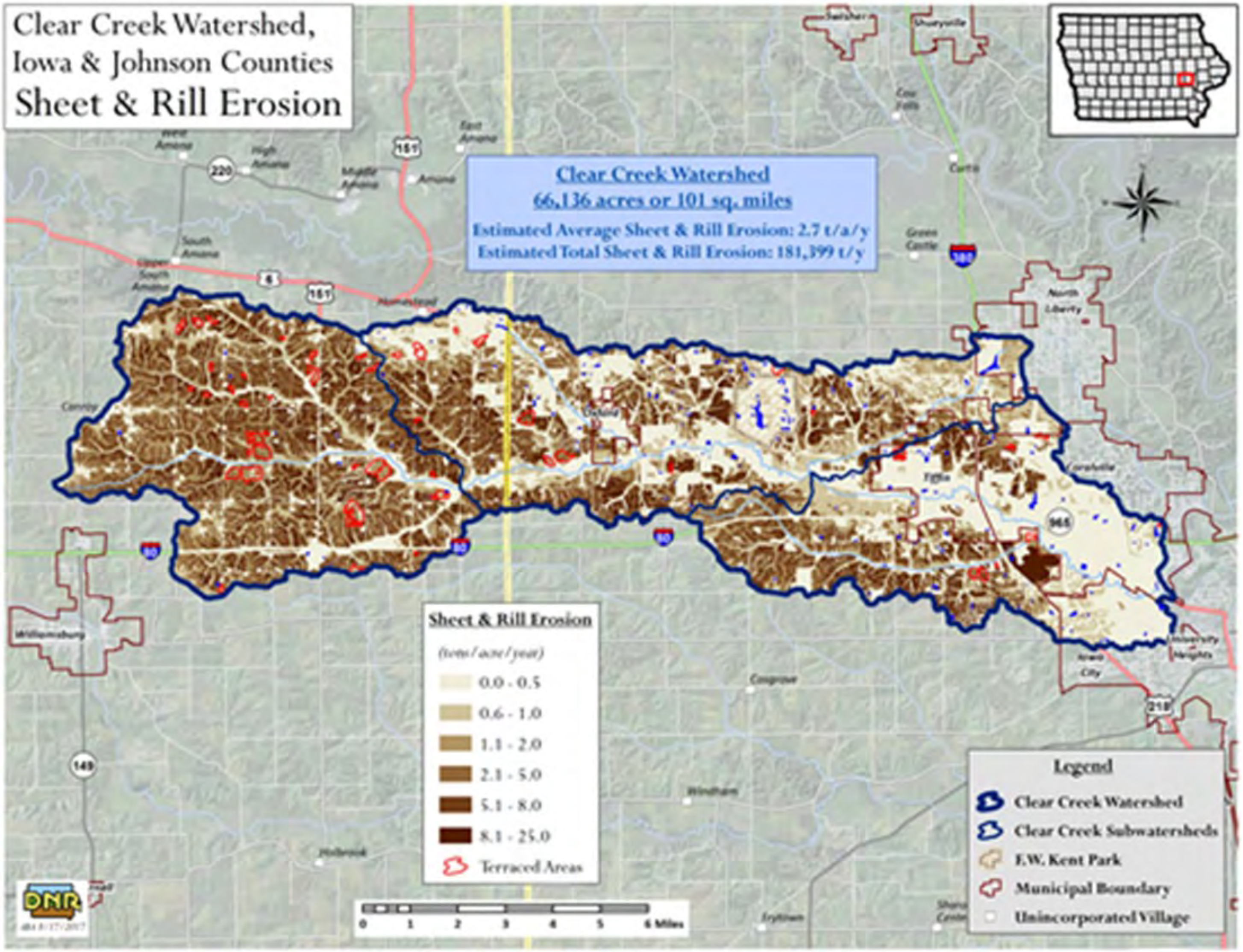


Source: Iowa Department of Natural Resources with data from University of Iowa students

4.3.1 Watershed Sources of Sediment

The RASCAL assessment identifies several stream segments where sedimentation is problematic. In addition to streambank erosion, another important source of sediment to a stream is sheet and rill erosion from the watershed. Erosion estimates for the Clear Creek watershed were determined using the 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 66,136-acre watershed is estimated at 2.7 tons per acre per year, and total sheet and rill erosion is estimated to be 181,399 tons per year. Figure 4-14 shows where sheet and rill erosion rates are higher in the watershed.

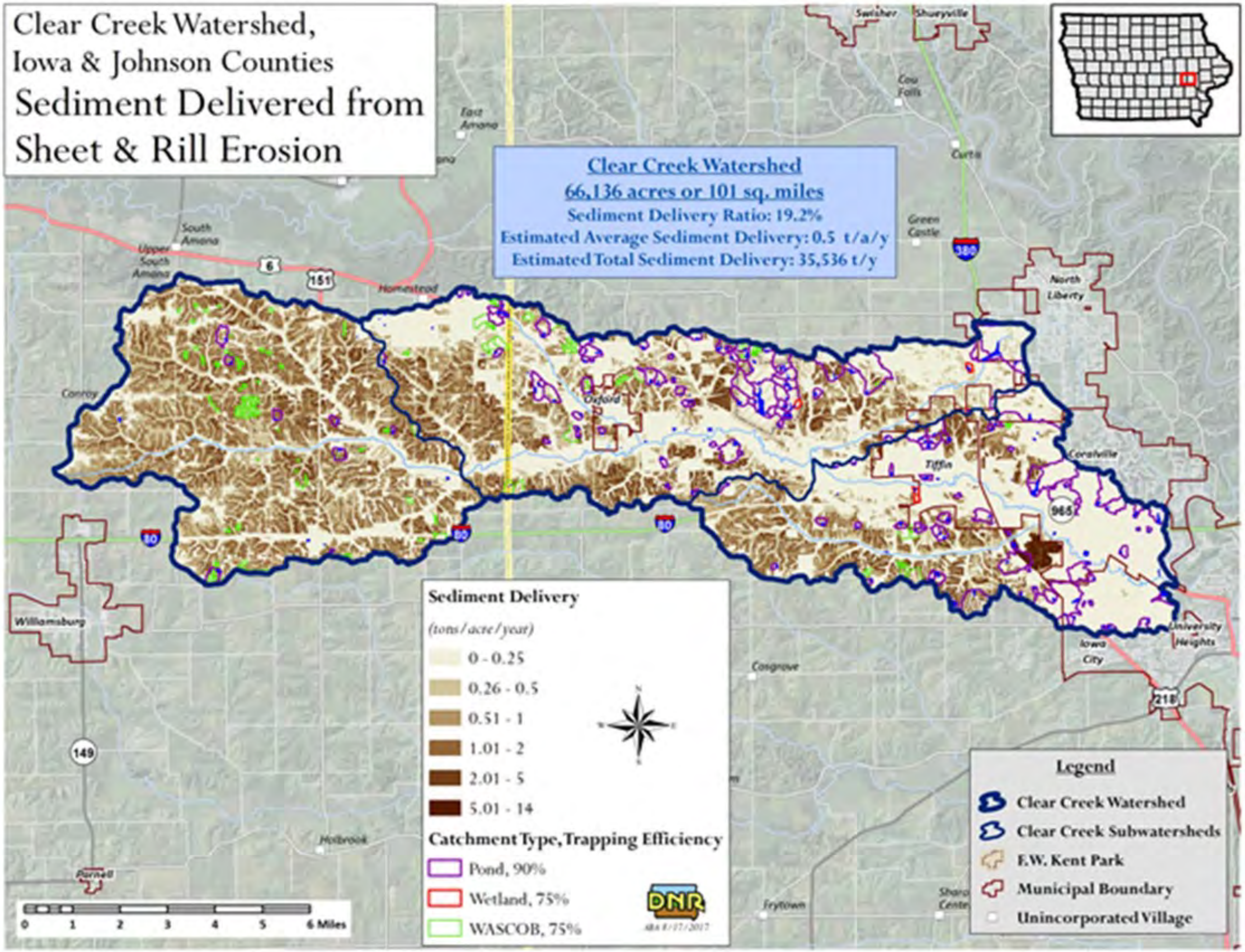
Figure 4-14. Sheet and Rill Erosion Rates



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

Not all 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, total sediment delivery is estimated to be 35,536 tons per year. Areas in the watershed that have a Sediment Delivery rate greater than 1 ton per acre per year (Figure 4-15) have been designated as high priority for placement of sediment trapping BMPs.

Figure 4-15. Estimated Sediment Delivery Rates

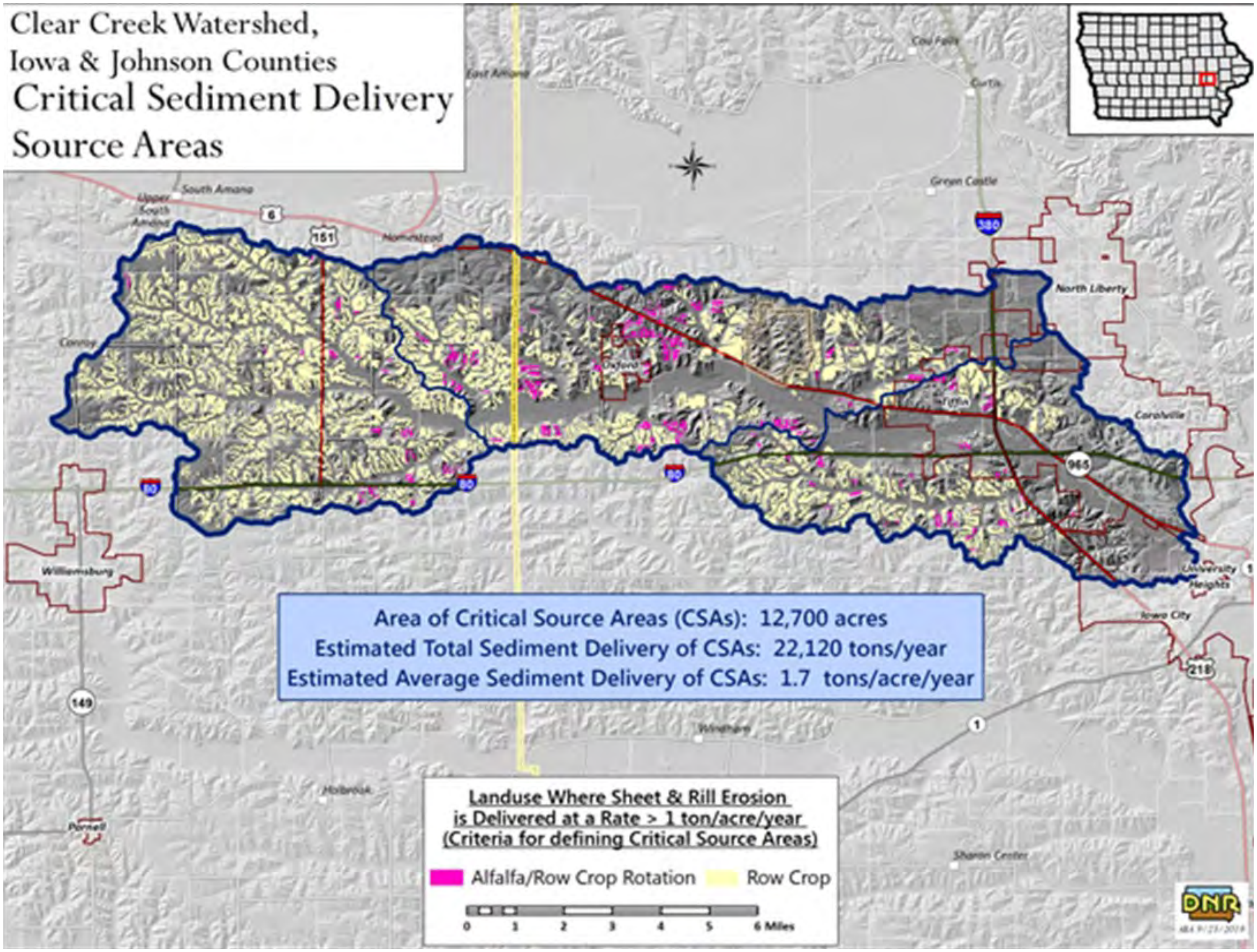


Source: Iowa Department of Natural Resources and Iowa Department of Agriculture & Land Stewardship

4.3.2 Sediment Control

The watershed assessment identified areas in the watershed with greater than 1 ton per acre per year sediment delivered to Clear Creek and its tributaries. These areas seen here in Figure 4-16 and in Chapter 8, Figure 8-8 are high priority locations for sediment-trapping practices, on farmed ground as well as other areas in the watershed.

Figure 4-16. Priority Areas for Erosion Control Practices

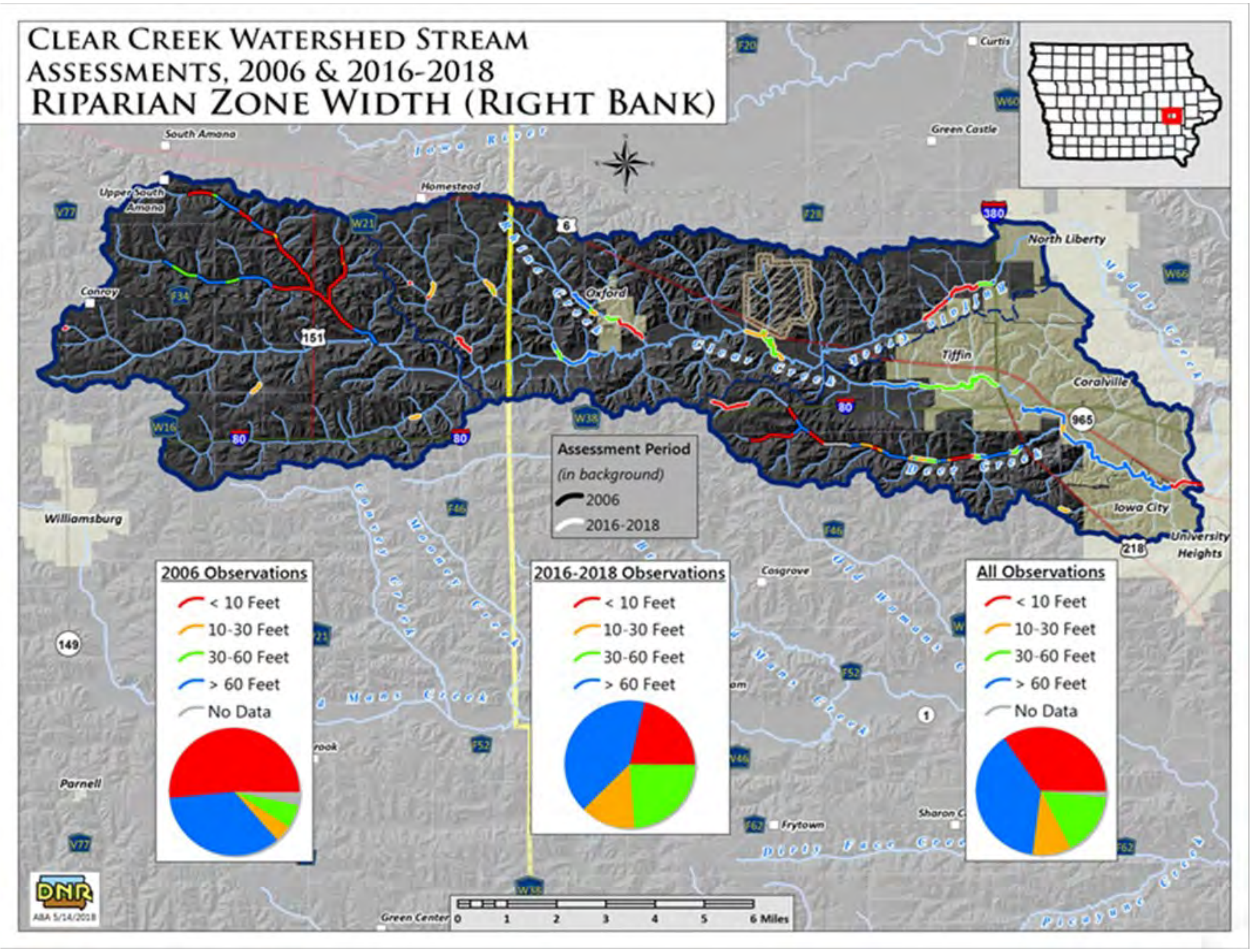


Source: Iowa Department of Natural Resources

4.4 Riparian Corridor

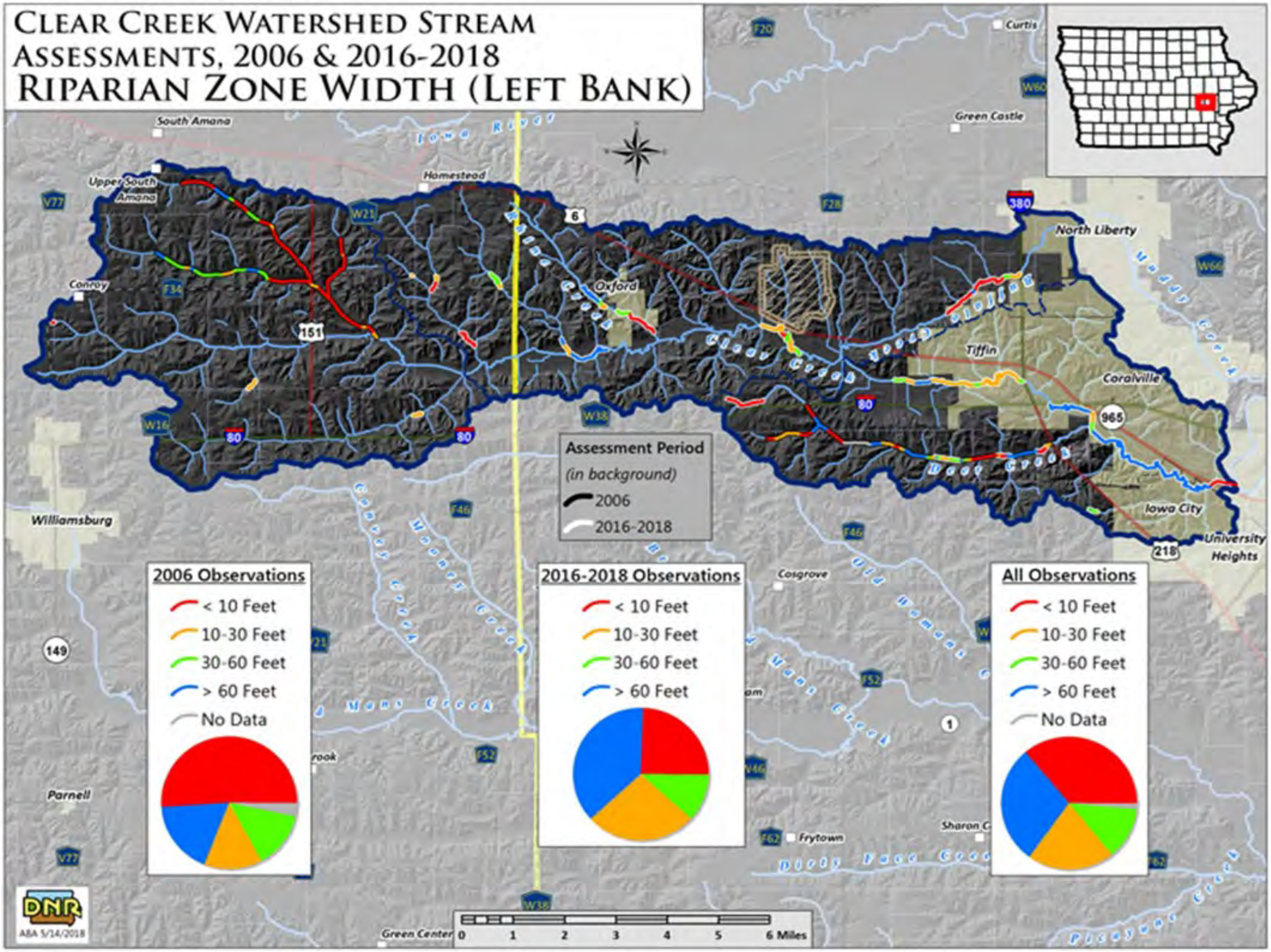
The width of the riparian zone was observed to be inadequate throughout most of the survey reaches as represented in Figure 4-17 and Figure 4-18. A riparian zone width of greater than 30' is ideal, as it allows for the growth of deep-rooted vegetation that can protect streambanks from erosion and is a valuable source of habitat. Stream reaches with less than 30' wide buffers are considered critical areas.

Figure 4-17. Riparian Zone Width on the Right Bank of RASCAL Surveyed Segments



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

Figure 4-18. Riparian Zone Width on the Left Bank of RASCAL Surveyed Segments



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

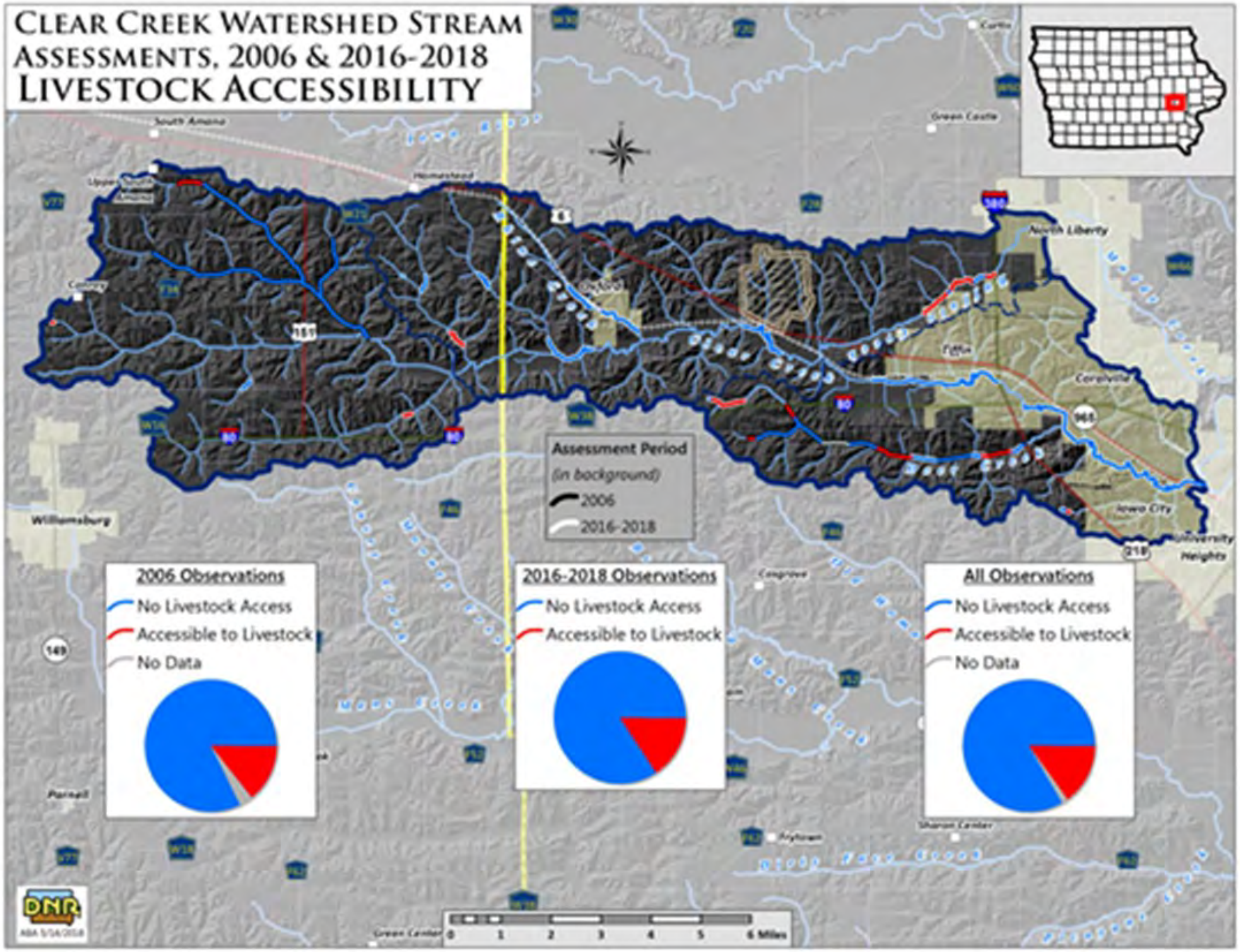
4.5 Livestock Access

Several sections of the surveyed stream reaches were accessible to livestock (Figure 4-19). Allowing livestock to access the stream can lead to streambank erosion, and direct inputs of manure are a source of nutrients and *E. coli.*

Where possible, livestock exclusion practices should be implemented along Clear Creek and its tributaries. All areas where livestock have access to the stream are considered critical areas.

Credit: Pixabay

Figure 4-19. Livestock Accessibility to RASCAL Surveyed Segments



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

Chapter 5

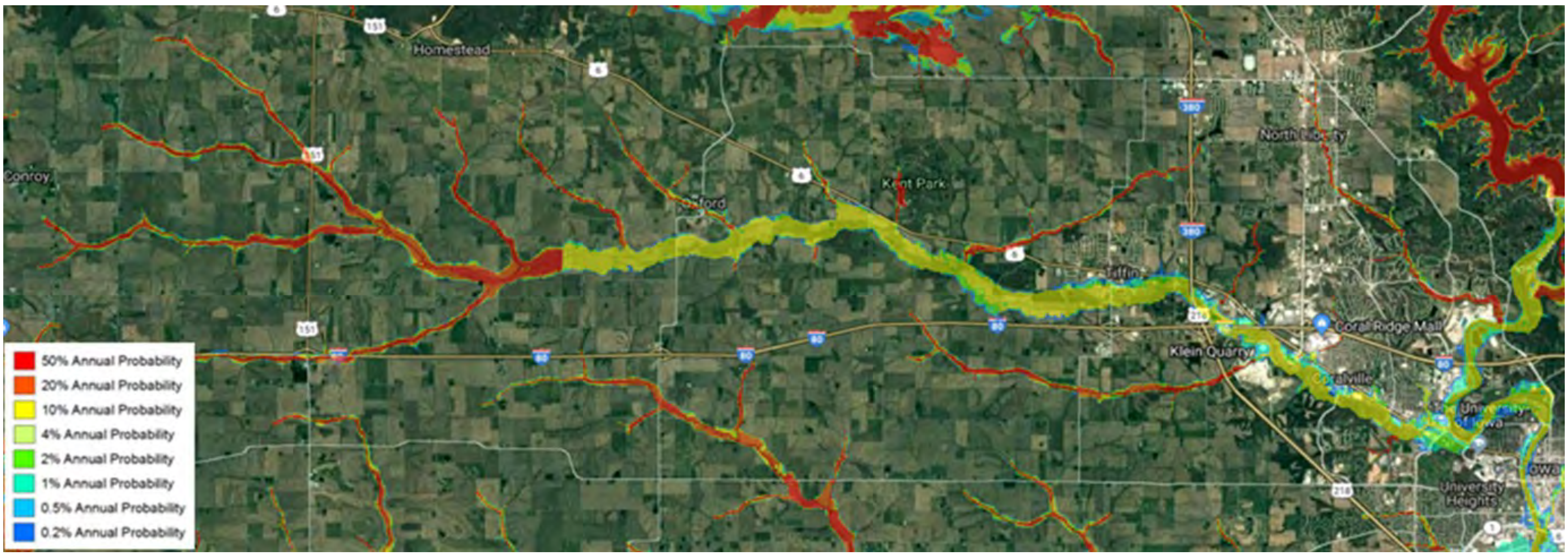
HYDROLOGY

As one of the eight Iowa watersheds participating in the Iowa Watershed Approach (IWA) program, a hydrologic report was developed for the Clear Creek watershed by the Iowa Flood Center/IIHR – Hydroscience & Engineering at the University of Iowa. Excerpts of the Clear Creek Watershed Hydrologic Assessment Report are included in this chapter and the whole report can be found in Appendix C. The purpose of the hydrologic assessment report is to provide an understanding of the watershed hydrology in the Clear Creek watershed and the potential of various hypothetical flood mitigation strategies that may be leveraged to accomplish the six goals of the IWA: (1) reduce flood risk; (2) improve water quality; (3) increase flood resilience; (4) engage stakeholders through collaboration and outreach/education; (5) improve quality of life and health, especially for vulnerable populations; and (6) develop a program that is scalable and replicable throughout the Midwest and the United States.

5.1 Floodplains

The hydrology of the Clear Creek watershed has long been described as “flashy” meaning that the water level in the creeks rise and fall rapidly. In general, a watershed’s hydrology is most readily seen in floodplain areas which are areas adjacent to creeks 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.

Figure 5-1. Iowa Flood Maps - Flood Inundation Risk Gradients



Source: Iowa Flood Center & Iowa Department of Natural Resources Statewide Floodplain Map at http://www.iowafloodmaps.org/

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.

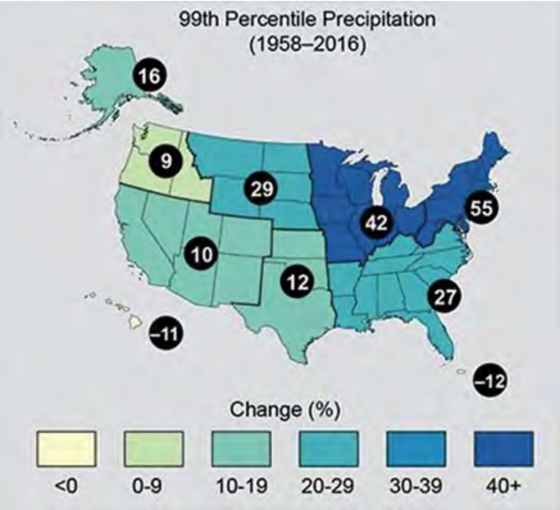
In partnership with the Iowa Department of Natural Resources, the Iowa Flood Center created statewide floodplain maps that estimate flood hazard extents and depths for every stream in the state of Iowa draining greater than one square mile. The maps depict flood boundaries and depths for eight different annual probabilities of occurrence: 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-%, allowing Iowans to better understand their flood risks and make informed land management decisions. Figure 5-1 is a map of the Clear Creek watershed with the annual probabilities of occurrence to show how floods of different magnitudes will impact floodplain areas.

The Iowa Flood Maps are part of the Iowa Flood Information System (IFIS), which is a one-stop web-platform to access community- based flood conditions, forecasts, visualizations, inundation maps, and flood-related information, visualizations, and applications.
IFIS can be accessed using this URL: http://ifis.iowafloodcenter.org/ifis/.

5.2 Hydrological Alterations Induced by Climate Change

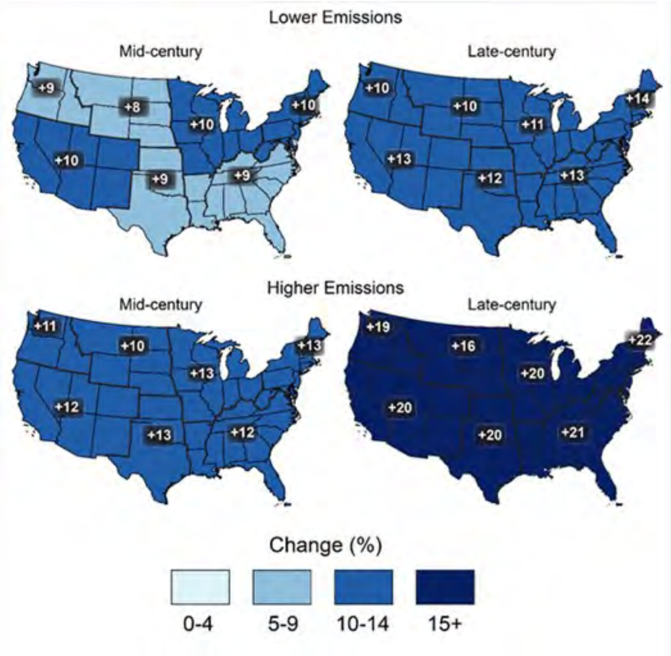
The U.S. government released The Climate Science Special Report (Wuebbles et al., 2017) summarizing the state-of-the-art science on climate change and its physical effects. The 2017 report was designed to be an authoritative assessment of the science of climate change, with a focus on the United States, to serve as the foundation for efforts to assess climate-related risks and inform decision-making about responses. Heavy rainfall is increasing in intensity and frequency across the United States (Figure 5-2) and globally and is expected to continue to increase over the next few decades (Figure 5-3). The Clear Creek watershed has already experienced a 40% increase in precipitation and could see as much as 20% more in the next 50 years.

Figure 5-2. Observed Change in Heavy Precipitation Between 1958 & 2016



Source: The Climate Science Special Report (Easterling et. al. 2017)

Figure 5-3. Projected Change in Heavy Precipitation due to Climate Change

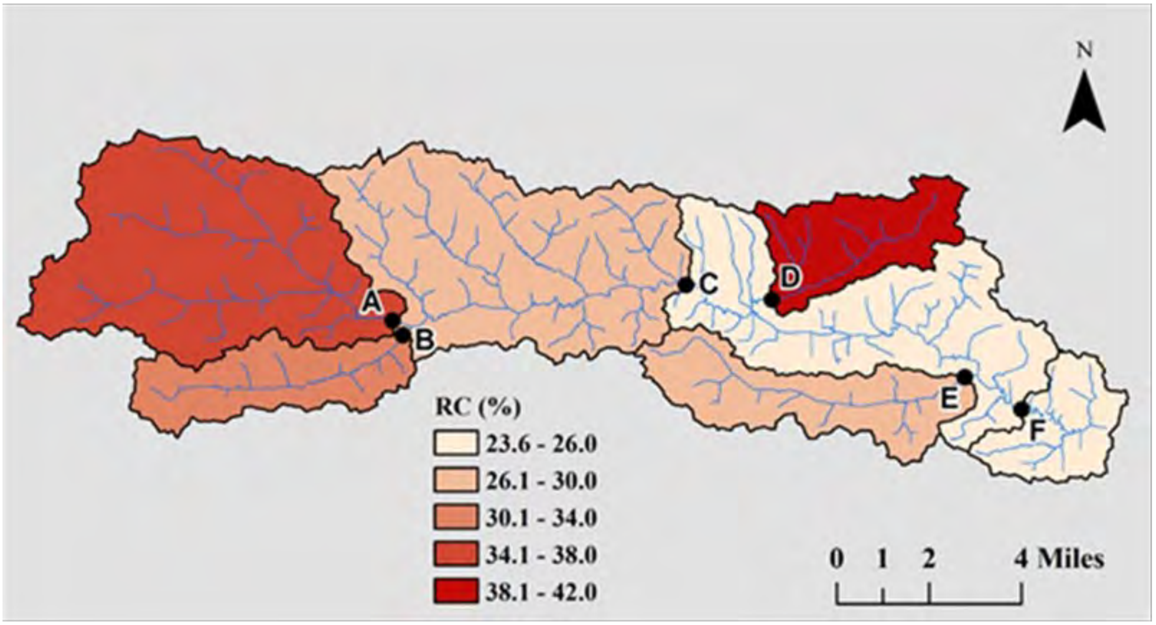


Source: The Climate Science Special Report (Easterling et. al. 2017)

5.3 Hydrology Modelling

The modeling activities described in the Plan were performed using the physically based integrated model GHOST developed at the University of Iowa IIHR – Hydroscience & Engineering to simulate the hydrologic response in watersheds ranging from 100 to 2,500 square miles over longer periods of time. GHOST stands for Generic Hydrologic Overland-Subsurface Toolkit. IIHR researchers determined model baseline conditions using a 15-year continuous simulation with hourly climatological data and accounted for Iowa's varied topography, soils and land use. Model parameters were then modified to simulate the implementation of cover crops and native vegetation (e.g., tall-grass prairie) in the study area. In addition, the watershed model evaluated the flood reduction benefits associated to a system of distributed storage built with ponds located in the watershed's headwater catchments. Details of this hydrological modeling are available on the Iowa Watershed Approach website.

Figure 5-4. Runoff Coefficient Analysis for the Clear Creek Watershed for the Simulation Period (2002 – 2016)



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

The GHOST model was used in the Clear Creek watershed to identify areas with high runoff potential and run simulations to help understand the impact of alternative flood mitigation strategies as well as the consequences of projected increases in heavy downpours in Iowa described in the Climate Science Special report (see Figure 5-3). The scenarios presented in the Clear Creek Watershed Hydrologic Assessment Report, focused on understanding the impacts of (1) increasing infiltration in the watershed and (2) implementing a system of distributed storage projects (ponds) across the landscape. Later in this chapter, a Flood Risk Reduction Conservation Scenario is described as a combination of practices to achieve the flood risk management goal proposed in the Plan.

5.4 High Runoff Potential Areas

Identifying areas of the watershed with higher runoff potential is the first step in selecting mitigation project sites. High runoff areas offer the greatest opportunity for retaining more water from large rainstorms on the landscape and reducing downstream flood peaks.

Figure 5-4 shows the runoff coefficient as a percentage (from 0% for no runoff to 100% when all rainfall is converted to runoff). Areas in the Clear Creek watershed with the highest runoff potential are primarily located upstream from the index points A, B, and D. Runoff coefficients mostly exceed 34% in these areas. Agricultural land use dominates these areas; however, this is not the sole reason they might produce higher runoff. From a hydrologic perspective, flood mitigation projects that can reduce runoff from these high runoff areas would be a priority.

High runoff potential is but one factor in selecting locations for potential flood mitigation strategies. There are many factors to consider in site selection. Landowner willingness to participate is essential. Locations may have existing conservation practices in place or areas such as timber that should not be disturbed. Stakeholder knowledge of places with repetitive loss of crops or road structures is also valuable in selecting locations. Lastly, the geology of the area may limit the effectiveness or even prohibit application of certain mitigation projects.

5.4.1 Mitigating the Effects of High Runoff with Increased Infiltration

Changes in a watershed that increase infiltration will reduce the volume of water leaving that drainage area during a storm event and for days thereafter. The increased water that passes from the surface into the ground may later evaporate or travel through the soil, either seeping deeper becoming groundwater or travel beneath the surface towards a stream. The rate of travel of water beneath the surface is much slower than if it were running across the surface. While much of this water may eventually make it to a stream, it will be much later than if it were surface runoff.

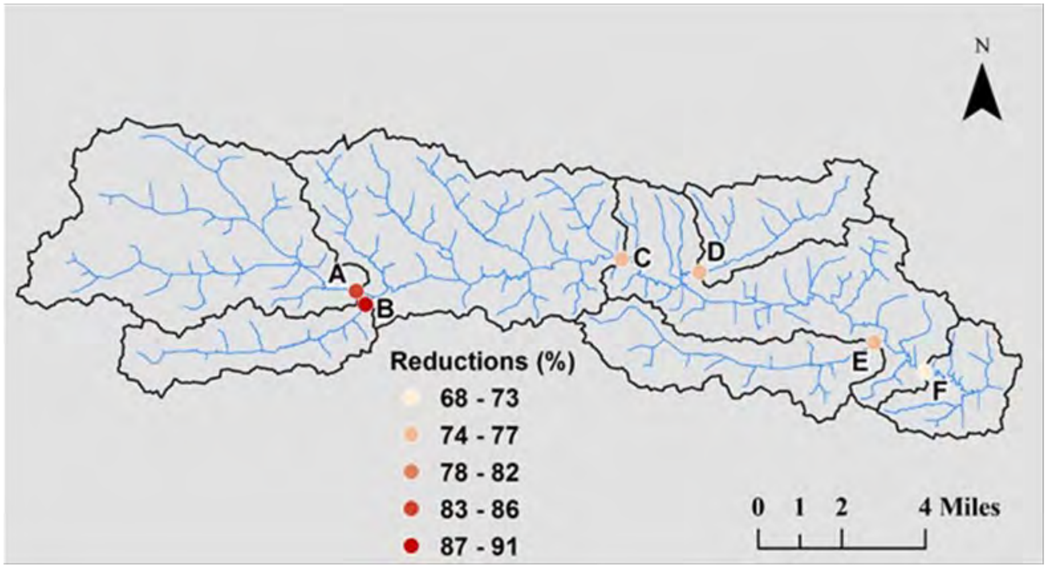
In this section, two different alternatives are examined to reduce runoff through land use changes and soil quality improvements. One possible land use change would be the conversion of row crop agriculture back to native tall-grass prairie. Another possible land use change would be improvements to agricultural conditions from planting cover crops during the dormant season and adoption of no-till in 100% of the row crop acres. These are hypothetical examples and only meant to illustrate the potential effects on flood risk reduction. The examples are also not project proposals; they are economically undesirable and/or not practically feasible. Still, the hypothetical examples do provide valuable benchmarks on the limits of flood risk reduction that are physically possible with broad-scale land cover changes.

Modifications to baseline model parameters to represent land use changes (e.g. native vegetation and cover crops/no-till) were based on information reported by several studies: Baschle, (2017); Mohamoud, (1991); VanLoocke et al., (2012); Kang et al. (2003); Baron et al. (1993), Bharati et al. (2002); Yimam et al. (2015), and Cronshey, (1986).

5.4.2 Mitigating the Effects of High Runoff with Native Vegetation

Much has been documented about the historical hydrology of native tall-grass prairie of the Midwestern states, with evidence suggesting tall-grass prairie could handle up to six inches of rain without having significant runoff. This is a result of the deep, loosely packed soils and the deep root systems of the prairie plants allowing a high volume of the rainfall to infiltrate into the ground. The water is retained across the landscape in the soil pores or it slowly flowed through the soil beneath the surface instead of finding a rapid course to a nearby stream as surface flow. Much of the water once in the subsurface was taken up by the root systems of the prairie grasses and returned to the atmosphere via transpiration.

Figure 5-5. Average peak discharge reduction (%) for index points in the Clear Creek Watershed - Baseline vs. Native Vegetation (historic precipitation)

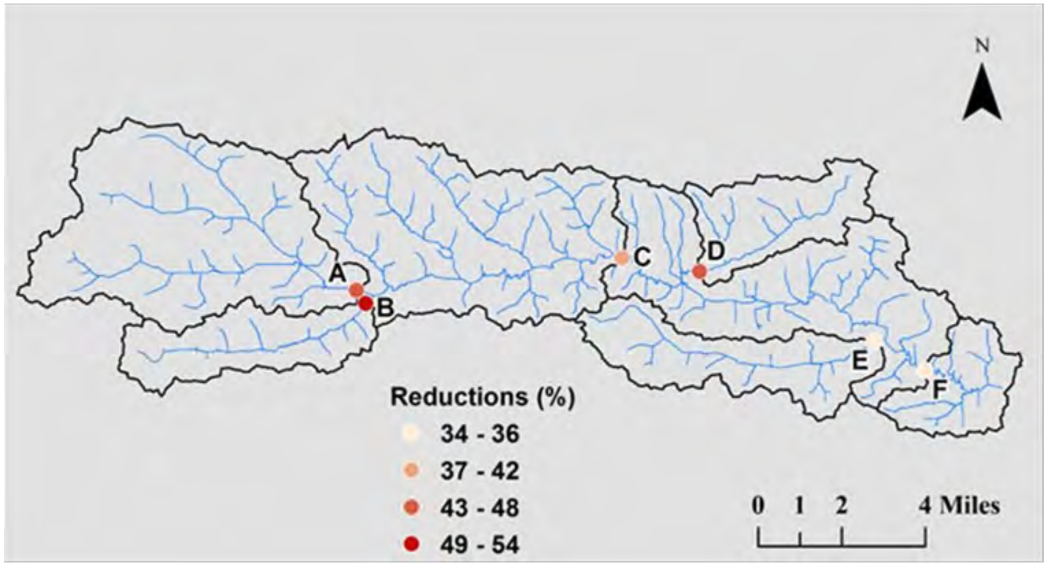


Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

This is an analysis proposing a scenario where all current row crop acres are converted back to native tall-grass prairie with its much higher infiltration characteristics within the Clear Creek watershed. The goal of the Iowa Watershed Approach (IWA) project is to sustain Iowa's valuable agricultural economy while protecting vulnerable residents and communities from flooding. Therefore, the simulation results from a scenario that assumes massive implementation of native vegetation is not intended to be a recommended flood mitigation strategy. Rather, these results are meant to provide a theoretical maximum of the flood reduction benefits that can be expected from land use changes.

Modelled results show that the adoption of native vegetation significantly reduces peak discharges at all six basin discharge points (Figure 5-5) and under both historic and increased precipitation conditions. Peak flow reduction decreases as one moves downstream. The highest average peak flow reductions were found at the index point B and the lowest at point F. Under historic precipitation conditions, the average peak flow reduction at Coralville (point F) is 68% whereas that value for the increased precipitation simulations is reduced to 58%.

Figure 5-6. Average peak discharge reduction (%) for index points in the Clear Creek Watershed - Baseline vs. Cover Crop/No-Till (historic precipitation)



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

5.4.3 Mitigating the Effects of High Runoff with Cover Crops/Soil Health/No-Till

Cover crops are an effective agricultural conservation practice and are typically planted following the harvest of cash crops to "cover" the ground through winter until the next growing season. The cover crop is killed off in the spring by rolling it; grazing it with livestock; or most often with Roundup (Glyphosate). Afterwards, row crops are planted directly into the remaining cover crop residue. Cover crops provide a variety of benefits including improved soil quality and fertility, increased organic matter content, increased infiltration and percolation, reduced soil compaction and reduced erosion and soil loss. They also retain soil moisture and enhance biodiversity (Mutch, 2010). One source suggests that for every one percent increase in soil organic matter (e.g. from 2% to 3%), the soil can retain 0.62 to 0.92 inches of rainfall or an additional 17,000- 25,000 gallons of water per acre (Archuleta, 2014). Examples of cover crops include clovers, annual and cereal rye grasses, winter wheat, and oilseed radish (Mutch, 2010).

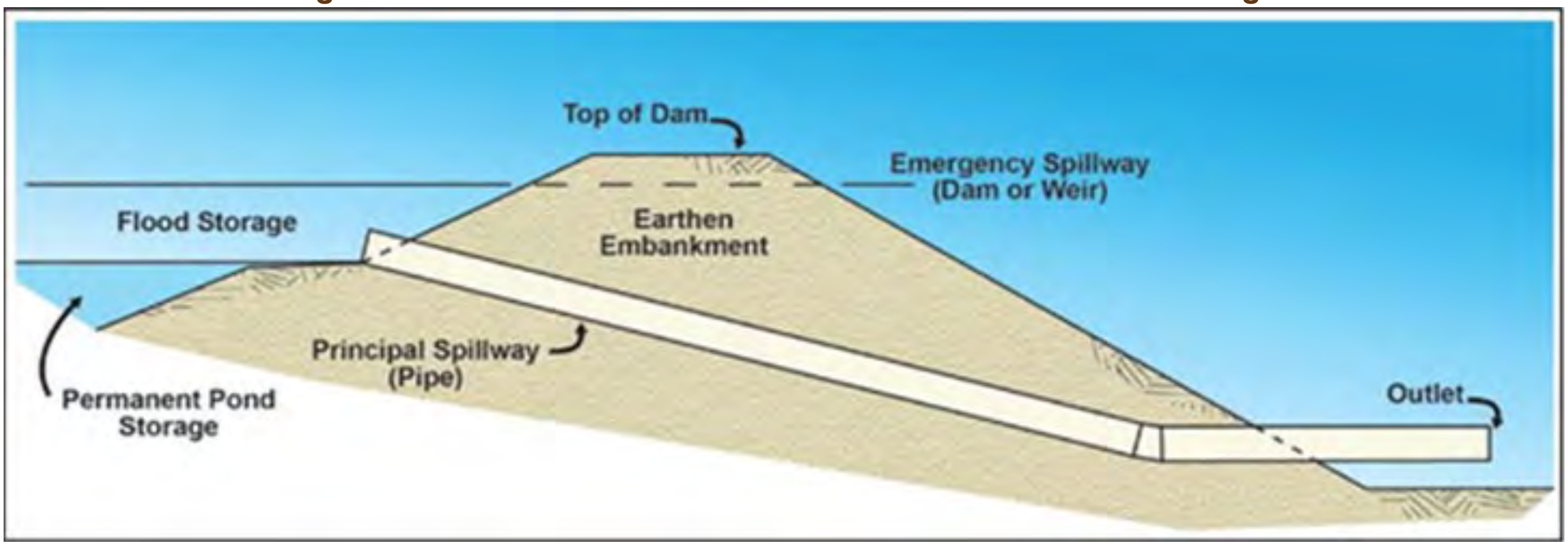
Based on model results, adoption of cover crops/no-till practices reduce peak discharges at all six basin discharge points under historic precipitation (Figure 5.6). This is largely true for cover crops/no-till plus increased precipitation, but there are a few instances with peak discharge values larger than the baseline condition. For the largest floods (exceedance probability < 20%), model results show that cover crops/no-till practices reduce peak discharges at all index points for both historic and increased precipitation scenarios. The largest and the smallest average peak flow reductions were found at points B & F, respectively. Under historic precipitation conditions, the average peak flow reduction at Coralville (point F) is 34% whereas the value for the increased precipitation scenario reduces to 20%.

The purpose of this hypothetical example is to investigate the impact of improved agricultural management practices on reducing flood peak discharges throughout the watershed. Planting cover crops across all agricultural areas in the watershed during the dormant (winter) season is hypothesized to lower the runoff potential of these same areas during the growing season (spring and summer) due to increased soil health and fertility. To be clear, this scenario does not represent the conversion of the existing agricultural landscape to cover crops. Rather, the existing agricultural landscape is kept intact, but its runoff potential during the growing season has been reduced by planting cover crops, in all row crop acres, during the dormant season.

5.4.4 Mitigating the Effects of High Runoff with Distributed Storage

Storage ponds hold floodwater temporarily and gradually release it at a slower rate. Therefore, the peak flood discharge downstream of the storage pond is lowered. The effectiveness of any one storage pond depends on its size (storage volume) and how quickly water is released. By adjusting the size and the pond outlets, storage ponds can be engineered to efficiently utilize their available storage for large floods. Generally, these ponds have a permanent pond storage area holding water all the time. This is done by constructing an earthen embankment across a stream and setting an outlet pipe, called the principal spillway, at some elevation above the floor of the pond. During a storm event, runoff enters and stays in the pond until the elevation of the water surface is greater than the pipe inlet. Water above the inlet pipe will pass through and leave the pond, but at a controlled rate. Additionally, the earthen dam is built higher than the pipe, allowing for more storage capacity within the pond. An emergency spillway set at an elevation higher than the pipe, will discharge water at a much faster rate. The emergency spillway is designed to release rapidly rising waters in the pond to protect the earthen embankment. The volume of water stored between the principal spillway and the emergency spillway is called the flood storage (Figure 5-7).

Figure 5-7. Schematic of a Pond Constructed to Provide Flood Storage



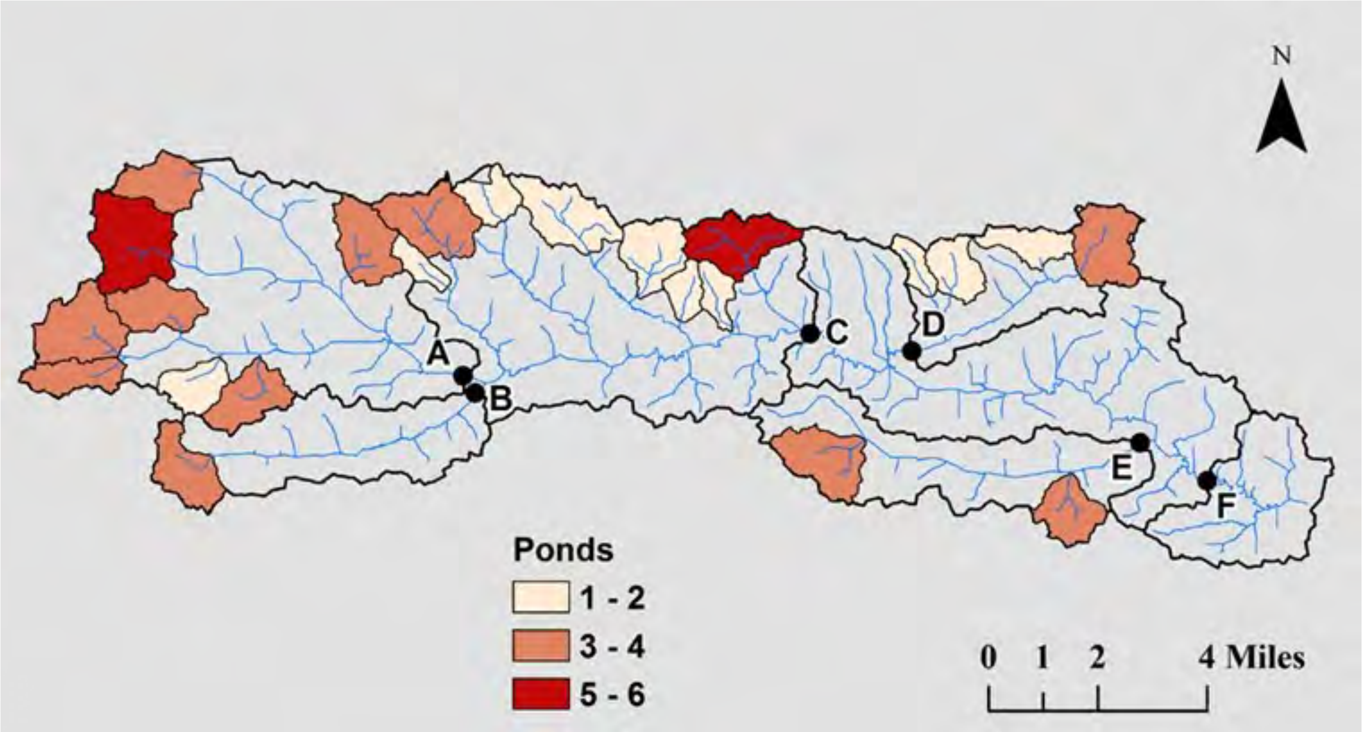
Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

The hypothetical distributed storage analysis performed using the Clear Creek GHOST model was based on potential project locations developed from the outputs of the Agricultural Conservation Planning Framework (ACPF) tool (see Figure 5-8) within the Clear Creek watershed and the distributed storage concept developed by the Soap Creek watershed. The Soap Creek watershed is in southeast Iowa approximately 100 miles south of Clear Creek near the Missouri/Iowa boarder. Soap Creek is also in the Southern Iowa Drift Plain landform, but in the Des Moines River watershed rather than the Iowa River watershed. The Soap Creek Watershed Board was formed in the 1980's as a result of the watershed's landowners coming together to do something to reduce flood damage and erosion within their watershed. They adopted a plan identifying the locations of 154 distributed storage structures (mainly ponds) that could be built within the watershed. As of 2018, 135 of these structures have been built (Stolze, 2018).

Soap Creek watershed drains approximately 250 square miles, equaling an average density of 1 built pond for every 1.9 square miles of drainage area. Further analysis of the Soap Creek structures shows that most of these structures are constructed in the headwater areas of the watershed, which allows for smaller structures, rather than having large, high-hazard class structures on the main rivers.

For the analysis, 65 ponds were simulated in the Clear Creek watershed (Figure 5-8) assuming a "typical" pond that was developed using the existing Soap Creek ponds and NRCS Technical References as guidance. The geometry of this "typical" pond consists of a 12-inch pipe outlet as the principal spillway with a 10-foot wide emergency spillway set at an elevation above the pipe to provide a flood storage of 20 acre-feet. The stage-storage relationship of any pond depends on local topography and is highly variable from site to site. There are opportunities to design and construct ponds at locations in sub basins that have not been used in this analysis. Therefore, flood reductions presented do not represent the theoretical maximum of the flood reduction benefits that can be expected from massive construction of ponds throughout the watershed.

Figure 5-8. Ponds (65) placement in Clear Creek



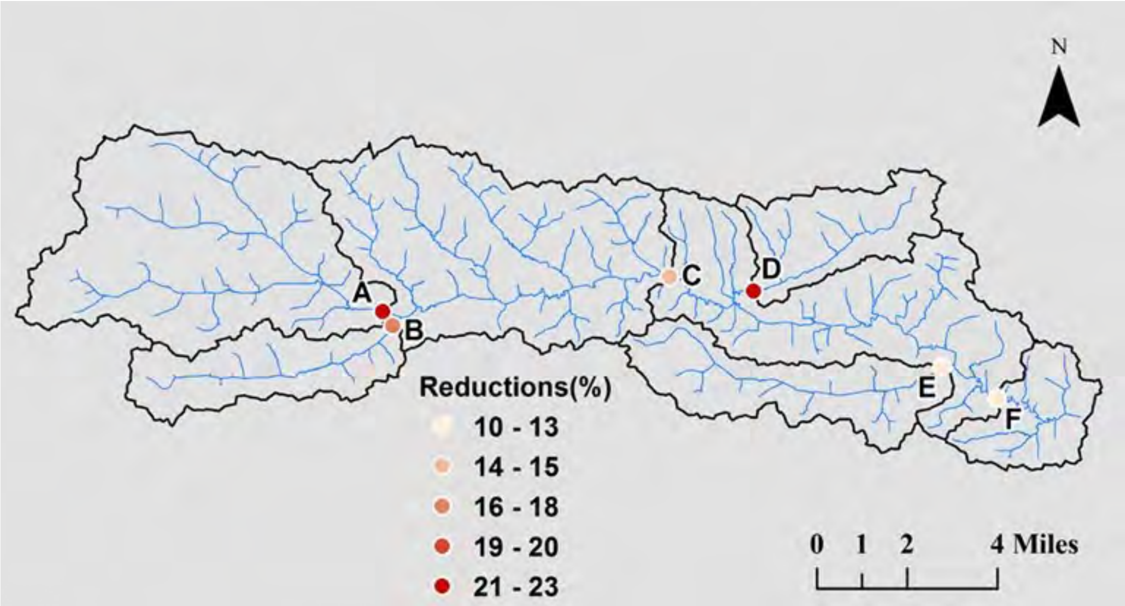
Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

Model results show that the system of 65 ponds provides flood attenuation benefits while increasing the less severe flow values. After precipitation events, surface runoff from the areas regulated by the ponds passes downstream through either the pipe (principal spillway) or the emergency spillway which creates a less severe peak flow but an extended period of relatively high flows. Furthermore, the ponds incorporated in the model result in enhanced infiltration leading to higher medium and low flows.

It is important to mention that in both the native vegetation and cover crops/no-till simulations more water was being removed from the watershed via transpiration than in the baseline case. In contrast, the 65 pond scenario does not have different transpiration parameters than the baseline case.

Information on annual peak discharge reduction is presented in Table 5-1 with index points represented in Figure 5-9. The 65 ponds result in average peak flow reductions from 10% to 23% at all index points under historic precipitation conditions. However, these reductions are smaller than those of the cover crops/no-till and native vegetation scenarios. As expected, reductions are greater at the index points with a larger percent of the drainage area regulated by the ponds (points A and D). Simulation results with increased precipitation conditions show that at some index points the ponds are insufficient to keep the predicted flows below the baseline conditions (points B, C, E, and F) with results for index points A and D showing positive average peak reductions.

Figure 5-9. Average peak discharge reduction (%) for index points in the Clear Creek Watershed - Baseline vs. Distributed Storage (historic precipitation)



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

Table 5-1. Average peak flow reduction at the index points

Index Point	Drainage Area	Number of Ponds	Ave Peak Reduction (%)	Ave Peak Reduction under IP (%)
A	26.5	26	23	8
B	8.3	3	17	-1
C	58.4	50	14	-2
D	7.6	8	23	8
E	10.1	7	11	-12
F	98.1	65	10	-6

Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

5.5 Watershed Scenarios for the Clear Creek Watershed

The GHOST model was used to better understand the flood hydrology of the Clear Creek watershed and to evaluate potential flood mitigation strategies. We first assessed the runoff potential throughout the basin identifying locations with the highest runoff potential; mitigating the effects of high runoff from these areas should be a priority for flood mitigation planning.

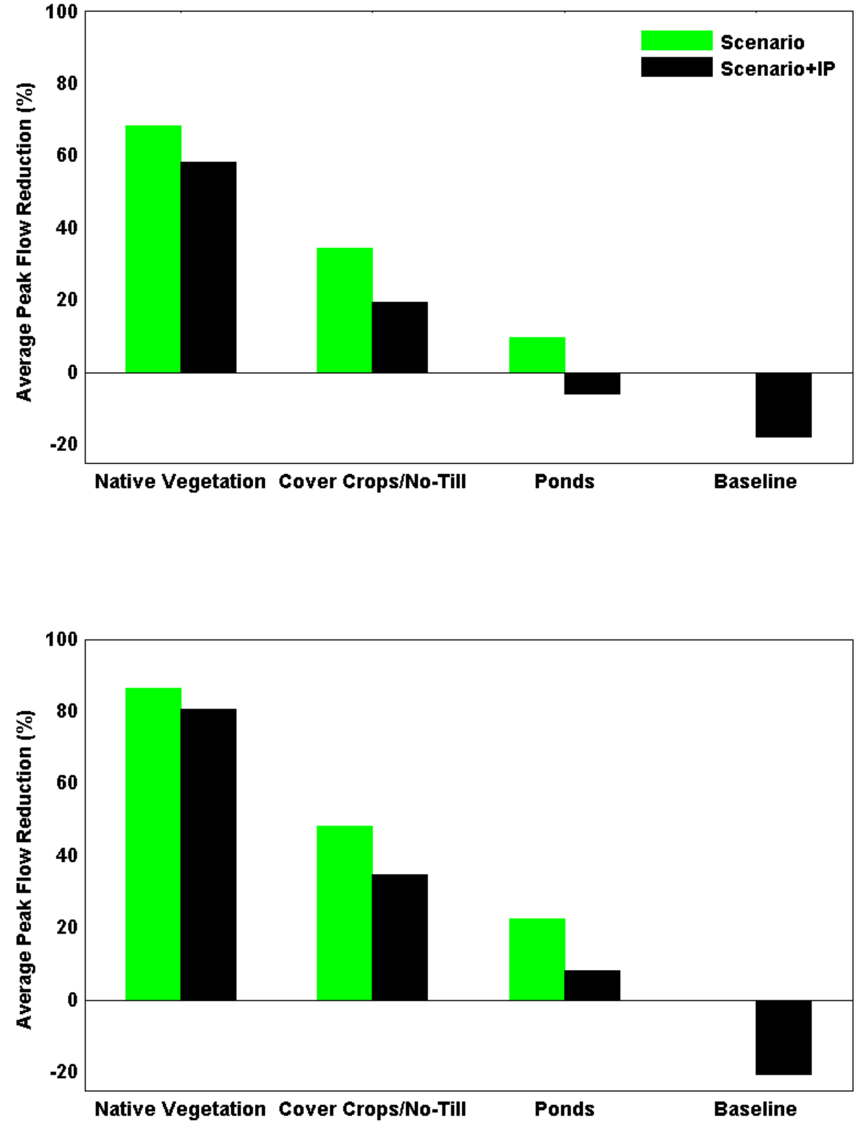
The GHOST model was used to quantify the potential effects of three different flood mitigation strategies applied throughout the Clear Creek watershed:

1. conversion of 100% of the row crop acres to native vegetation
2. adoption of both no-till and cover crops in 100% of the row crop acres
3. a distributed storage system built with ponds located in the headwater catchments

The results for these strategies were compared to simulations of flows for the existing watershed condition using both historical and increased precipitation values. Although each scenario simulated is hypothetical and simplified, the results provide valuable insights on the relative performance of each strategy for flood mitigation planning.

Figure 5-10 presents average peak flow reductions at index points F and A. All the reductions were estimated in reference to the baseline simulation with historic precipitation. The native vegetation scenario results reveal the enormous flood reduction potential of this practice and highlights why this land use change should be considered when evaluating flood reduction alternatives. Cover Crops/No-Till is a management practice that when implemented throughout agricultural watersheds has the potential to lead to important flood reduction benefits. Based on the Clear Creek model results, this practice shows average peak flood reduction of 38% and 20% near the outlet of the watershed for the simulations with historic rain and increased precipitation. The 65 ponds provide peak flow reductions of 10% with historic rain at point F but when increased precipitation conditions were simulated model results show higher peak flows than those of the baseline (with historic rain).

Figure 5-10. Average Peak Flow Reductions for all Simulations at Coralville (Point F) on top and Upper Clear Creek (Point A) on bottom



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR
Note: IP stands for increased precipitation. Peak flow reduction was estimated in reference to the baseline conditions with historic precipitation.

In contrast the ponds regulating runoff upstream from point A show that under both historic and increased precipitation conditions the ponds provide peak flood reduction.

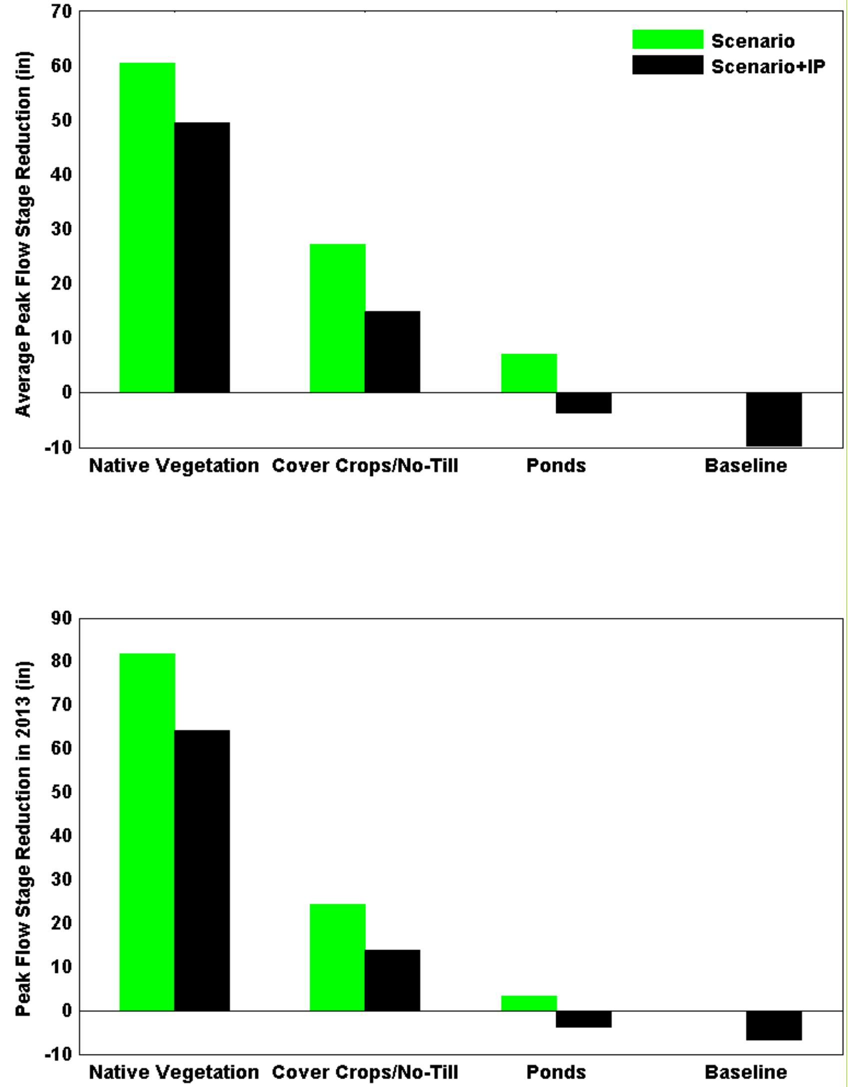
Flood stage reductions at Coralville are presented in Figure 5-11. Under historic precipitation conditions average values range between 5 and 0.75 feet for the native vegetation and pond scenarios. The largest flow for the analyzed window (2002-2016) was recorded at Coralville in April 2013. Predicted flood stage reductions for this event are between approximately 80 and 3 inches (historic precipitation).

As a final note, it is important to recognize that the modeling scenarios evaluate the *hydrologic effectiveness* of the flood mitigation strategies, and not their effectiveness in other ways. For instance, while certain strategies are more effective from a hydrologic point of view, they may not be more effective economically. As part of the flood mitigation planning process, factors such as the cost and benefits of alternatives, landowner willingness to participate, and more need to be considered in addition to the hydrology.

5.6 Connecting to Goals for the Clear Creek Watershed

The further analysis was performed by IIHR – Hydroscience & Engineering using the GHOST model to create a practice implementation scenario for achieving a specific peak flow reduction identified in the Plan's goals. The Flood Risk Reduction Conservation Scenario is a combination of native vegetation, cover crops/no-till and ponds to reduce the peak flow observed at the Camp Cardinal Road USGS gage on Clear Creek in April 2013 by 25%. The April 2013 flood event recorded a peak flow of 6,480 cubic feet per second. The Flood Risk Reduction Conservation Scenario assumes that all row crop acres in the watershed have adopted the Prairie STRIPS project recommendation of 10% native vegetation and calculates the level of cover crops/no-till and distributed storage implementation that is needed to reduce the April 2013 peak flow by 1,620 cubic feet per second. Implementation in the urban area will focus on reducing stormwater from impervious areas and protecting local floodplains by encouraging infiltration practices, undertaking flood mitigation projects to protect critical infrastructure and participate in the National Flood Insurance Program (NFIP) and its Community Rating System (CRS).

Figure 5-11. Average and Maximum Peak Flow Stage Reductions for all Simulations at Coralville (Point F)



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR
Note: IP stands for increased precipitation. Peak flow reduction was estimated in reference to the baseline conditions with historic precipitation.

Chapter 6

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 will achieve greater environmental benefit with limited resources.

The previous Chapters described the various watershed-based assessments that were completed during the planning process in order to identify critical areas and BMP opportunities. This section outlines the key findings from the assessment data and the recommended strategies to reduce peak flows and improve water quality.

6.1 Connecting to Goals for the Clear Creek Watershed

Flood mitigation approaches fall into two categories - structural and nonstructural. Structural forms mitigate harm by reconstructing landscapes. They include floodwalls, levees, and evacuation routes. Nonstructural measures reduce damage by removing people and property out of risk areas. They include elevated structures, property buyouts, permanent relocation, zoning, subdivision, and building codes. This section outlines the approaches to mitigate flood impacts and draws on watershed assessment data to make recommendations for projects in the Clear Creek watershed.

In 2017, FEMA released the report "Innovative Drought and Flood Mitigation Projects" that evaluates disaster mitigation approaches - Aquifer Storage and Recovery, Floodwater Diversion and Storage, Floodplain and Stream Restoration, and Low Impact Development (LID)/Green Infrastructure (GI). The report assesses each approach based on cost, efficacy, feasibility and fulfillment of Hazard Mitigation Assistance (HMA) requirements. The report finds that all options are consistent with HMA's requirements and guidelines and will effectively mitigate the impact of climate disasters, including floods. The following descriptions focus on the three flood related recommendations.

- **Floodwater Diversion and Storage** - Diverting floodwaters into ponds, wetlands, floodplains, detention/retention basins, or other structures to help mitigate flooding by allowing for a controlled release of water outside of developed areas.
- **Floodplain and Stream Restoration** – Floodplains and stream corridor restoration not only mitigate the risk of floods but can also mitigate bank erosion and benefit local ecosystems. Floodplains store stormwater runoff, reducing the number of floods and their severity.
- **Low Impact Development (LID)/Green Infrastructure (GI)** – LIDs and GIs mitigate the risk of floods by storing water. They tend to mimic natural hydrology and include innovations such as green roofs and permeable pavement.

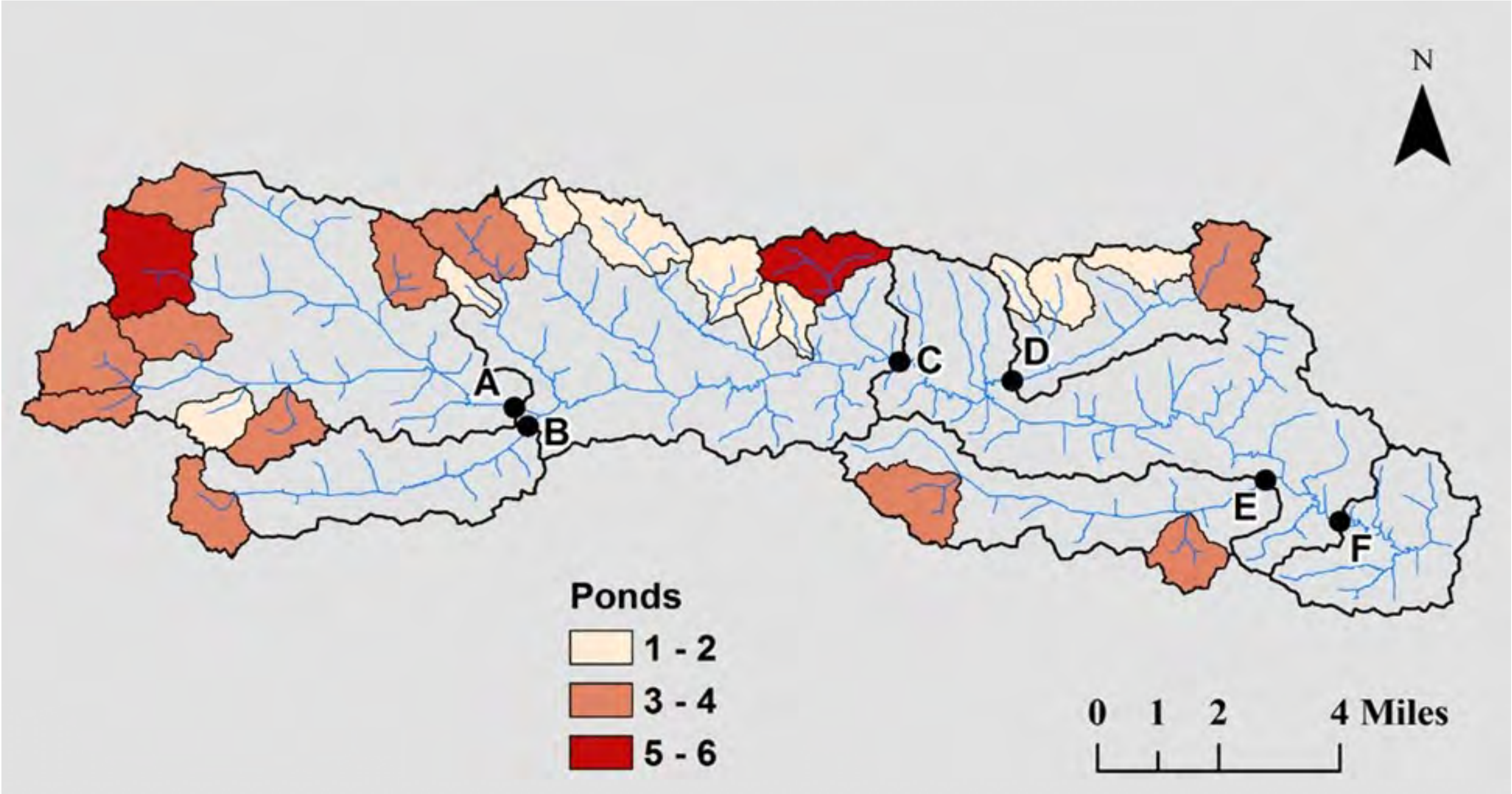
6.1.1 Floodwater Diversion and Storage

Distributed Storage

The Iowa Watershed Approach is based on a distributed storage model that is focused on investment in structural best management practices such as ponds, wetlands and control basins to reduce the magnitude of downstream flooding and improve water quality during and after flood events.

For the Clear Creek watershed planning process, several analyses were conducted to help prioritize areas for those structural practices. As discussed in Chapter 5, the Iowa Flood Center - IIHR simulated the placement of 65 ponds in priority sub-basins, shown in Figure 6-1, to measure the impact on peak flows. The modeled results indicated an average reduction of peak flows between 10% and 23%.

Figure 6-1. Ponds (65) placement in Clear Creek



Source: Clear Creek Watershed Hydrologic Assessment Report, UI-IIHR

Flood Risk Reduction Conservation Scenario

The Flood Risk Reduction Conservation Scenario is a combination of native vegetation, cover crops and structural practices like ponds or terraces to reduce the peak flow observed at the Clear Creek USGS gage (Camp Cardinal Road) in April 2013 by 25%. The 2013 flood event recorded a peak flow of 6,480 cubic feet per second at the Camp Cardinal Road USGS gage. The Flood Risk Reduction Conservation Scenario assumes that all row crop acres in the watershed have adopted the Prairie STRIPS Project recommendation of 10% native vegetation and calculates the level of cover crops/no-till and distributed storage implementation that is needed to reduce the April 2013 peak flow by 1,620 cubic feet per second.

On-Road Structures Analysis

Another analysis of practices that would reduce peak flows was conducted by John Rathbun, Clear Creek Watershed Coordinator with the assistance of James Martin, IDALS Regional Basin Coordinator. The analysis used GIS-based data to locate potential sites for On-Road Structures on county level roadways in the watershed.

On-Road Structures use the road embankment as a dam and modifies the existing culvert to hold back water during rain events. These structures are effective in holding back water and dropping out pollutants and sediment. For these projects to be constructed, flood easements would have to be acquired on private property in most cases. This will add time and cost to the projects.

The eleven locations listed in Tables 6-1 and 6-2 are assigned reference numbers used in Figures 6-2 and 6-3. Figure 6-2 shows the locations and Table 6-1 has more location detail and associated design specifications. All of the locations are suitable for an On-Road Structure and would add more than 422 acre-feet of storage for flood mitigation contingent on interest and willingness by County government. Properly engineered On-Road Structures have an added water quality benefit and are estimated to reduce sediment and phosphorous as seen in Figure 6-3 and Table 6-2.

Table 6-1. On-Road Structure Descriptions

Reference # on Maps	County	Road	Sub Watershed	Drainage Area Acres	Permanent Storage Acre Ft.	Temporary Storage Acre Ft.
1	Iowa	R Ave.	Upper	220	8	34
2	Iowa	180th St.	Upper	198	3	16
3	Iowa	S Ave.	Upper	440	5	32
4	Iowa	Q Ave.	Upper	824	26	108
5	Iowa	Q Ave.	Upper	461	23	71
6	Iowa	220th St.	Upper	140	4	20
7	Iowa	T Ave.	Upper	238	11	35
8	Iowa	190th St.	Middle	297	14	36
9	Iowa	200th St.	Middle	177	2	12
10	Johnson	Lower Oxford Rd.	Middle	312	4	22
11	Johnson	Cosgrove	Lower	372	4	36
			Totals	3,679	104	422

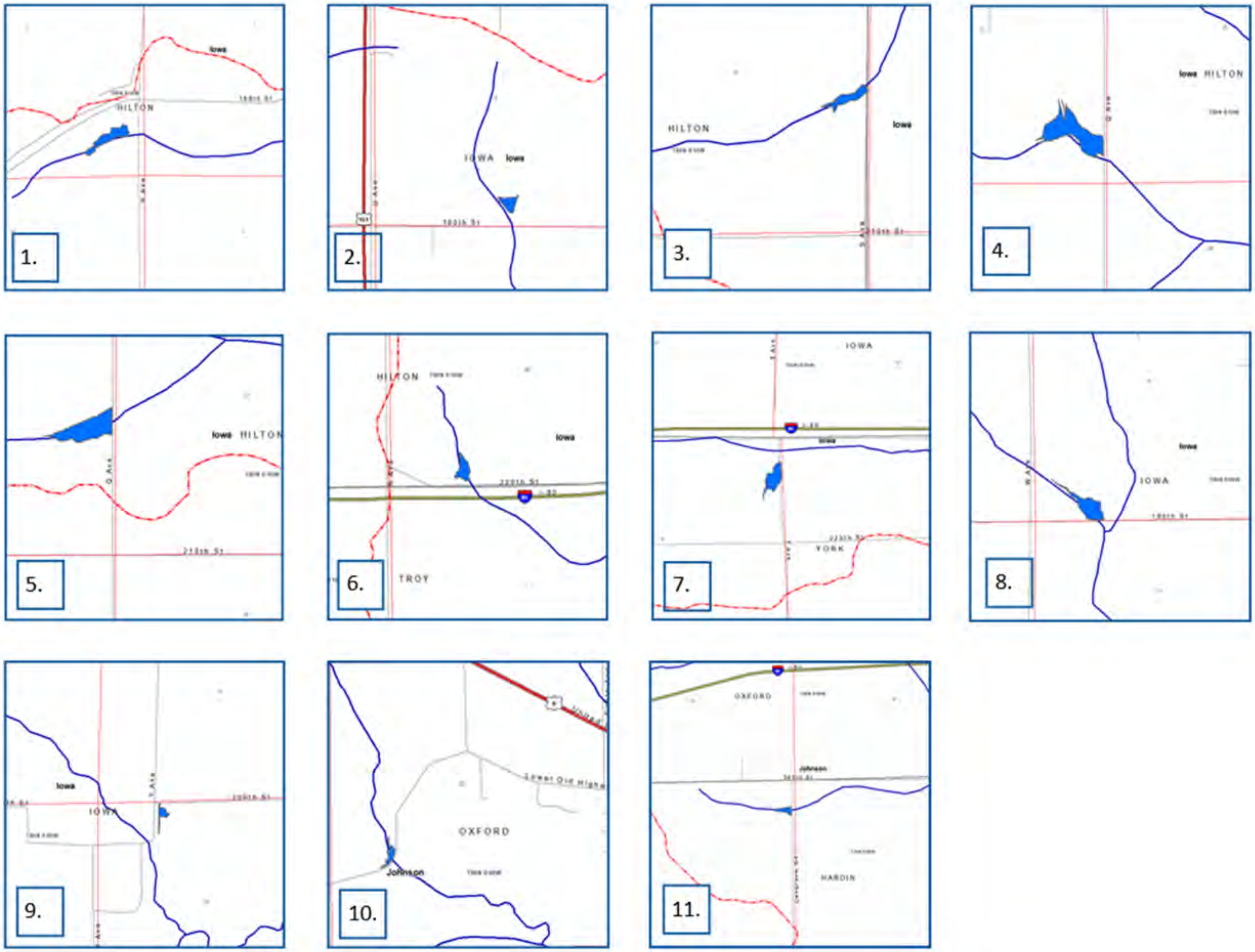
Coordinator and James Martin, NRCS

Table 6-2. Potential Reduction in Sediment and Phosphorous via On-Road Structures

Reference # on Maps	County	Road	Sub Watershed	Drainage Area in Acres	Sediment Delivered ton/yr.	CSD Source Area Acres Treated	Sediment Reduced ton/yr.	P Reduced pounds
1	Iowa	R Ave.	Upper	220	162	63	32	42
2	Iowa	180th St.	Upper	198	206	75	41	54
3	Iowa	S Ave.	Upper	440	408	132	82	106
4	Iowa	Q Ave.	Upper	824	568	195	114	148
5	Iowa	Q Ave.	Upper	461	254	45	51	66
6	Iowa	220th St.	Upper	140	72	15	14	19
7	Iowa	T Ave.	Upper	238	184	45	37	48
8	Iowa	190th St.	Middle	297	371	115	74	96
9	Iowa	200th St.	Middle	177	269	96	54	70
10	Johnson	Lower Oxford Rd.	Middle	312	189	68	38	49
11	Johnson	Cosgrove	Lower	372	302	108	60	79
			Totals	3,679	2,985	957	597	777

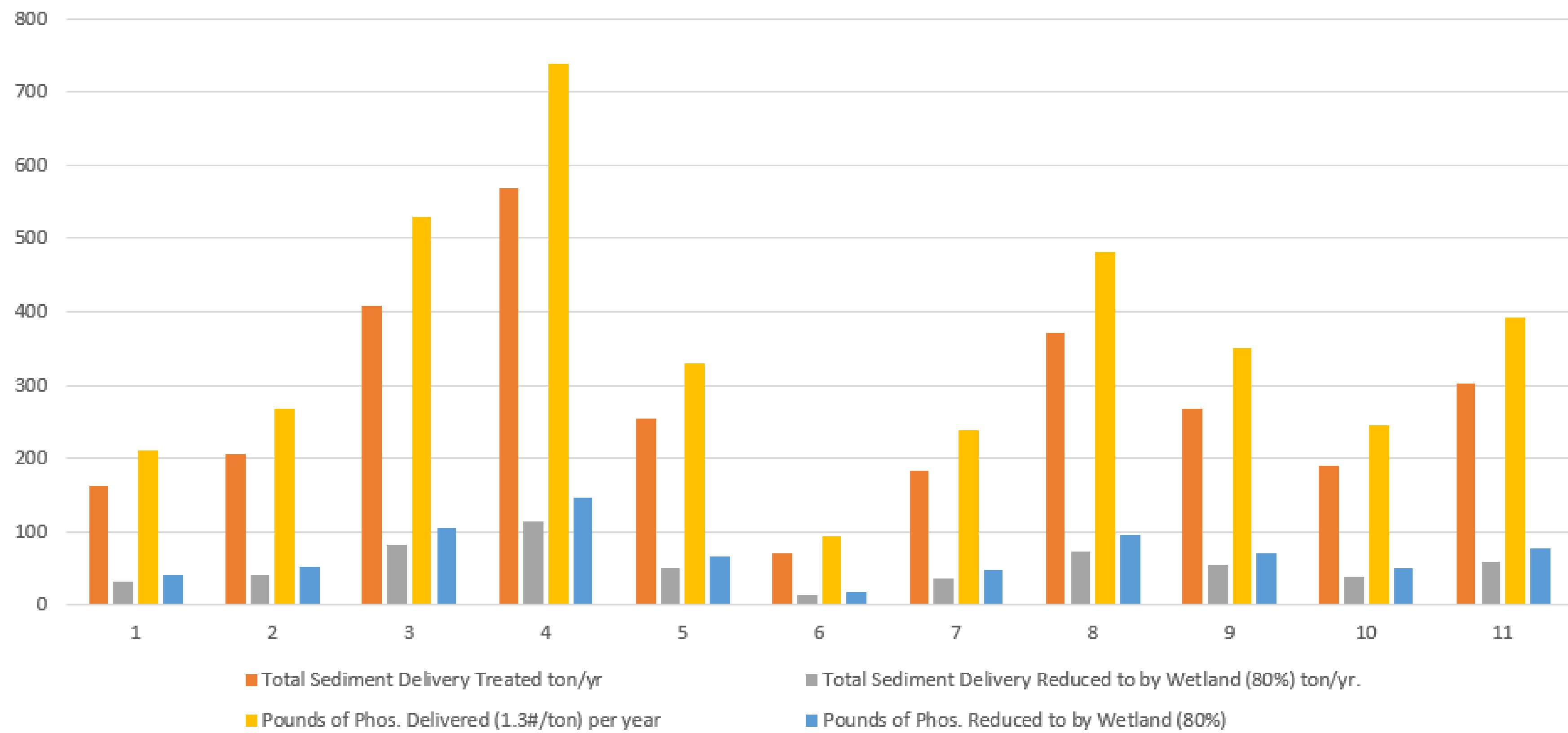
Source: John Rathbun, Clear Creek Watershed Coordinator and James Martin, NRCS
Note: CSD = Critical Sediment Delivery and P = phosphorous

Figure 6-2. Ponds (65) placement in Clear Creek



Source: John Rathbun, Clear Creek Watershed Coordinator and James Martin, NRCS

Figure 6-3. Potential Sediment & Phosphorus Reductions



Source: John Rathbun, Clear Creek Watershed Coordinator and James Martin, NRCS

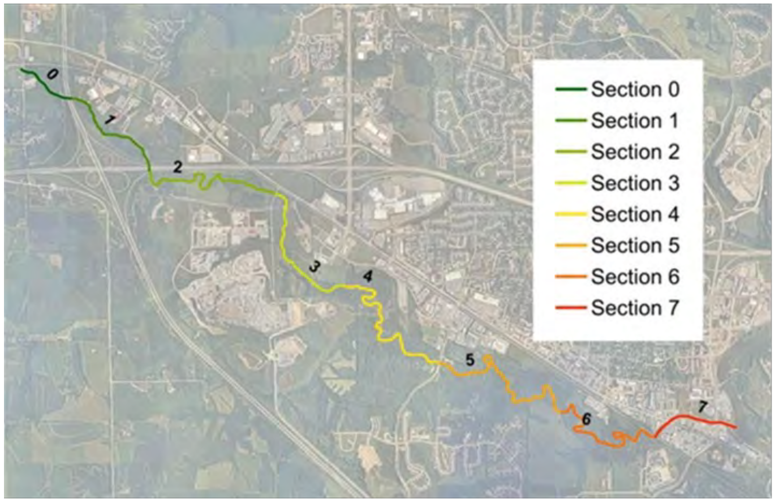
6.1.2 Floodplain and Stream Restoration

As described in Chapter 4, the Clear Creek Watershed Coalition (CCWC) partnered with the University of Iowa and the Johnson County Soil & Water Conservation District to conduct a stream condition assessment along Clear, Rhine, and Deer Creeks during 2016 – 2018. The stream condition assessments collected data on a variety of stream health indicators relating to streambank condition and the riparian corridor summarized in Chapter 4. Areas identified in the stream condition assessment should be revisited for more detailed analysis to determine suitability for streambank restoration.

Streambank Restoration

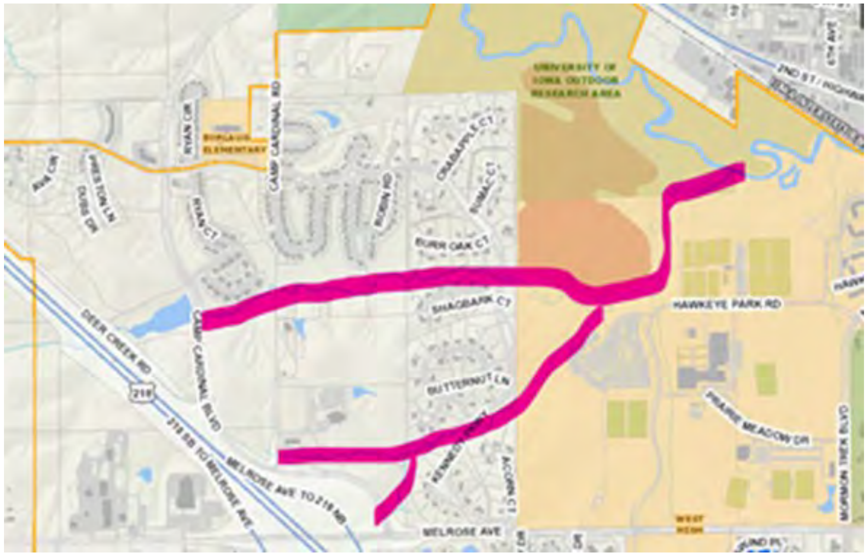
- CCWC members identified priority streambank restoration projects listed here with cost estimates in 2020 dollars:
- Restore Camp Cardinal Creek through Iowa City and University of Iowa Campus (Figure 6-4) converting sections to stormwater management facilities. Restore 12,000 linear feet at a cost of $4 million
- Restoration of Oakdale Creek near Coral Ridge Mall costing ~$2 million
- Restoration of pond at Ewalt Recreation Area costing ~$3 million
- Restoration of Biscuit Creek costing ~$1.7 million

Figure 6-5. Lower six miles of Clear Creek with enumerated study sections



Source: Lower Clear Creek Stream Assessment Within Coralville, Aaron Gwinnup PE, April 2019

Figure 6-4. Potential Site for Stream Restoration Work



Source: Ben Clark, Iowa City Stormwater Coordinator

Identifying areas for possible streambank restoration was a high priority in the planning process. In fact, the City of Coralville contributed resources supporting a stream restoration assessment in the Lower Clear Creek watershed. The study area begins at the Intrastate 380 corridor and continues through unincorporated Johnson County to the outlet in Coralville. The assessment examined fluvial geomorphic character, riparian vegetation community, current risks to infrastructure and stream function, and opportunities for restoration.

The *Lower Clear Creek Stream Assessment Within Coralville* report, completed by HR Green and Applied Ecological Services, is described in more detail in Chapter 4. The study area is divided into seven sections (1 – 7) as shown in Figure 6-5. Divisions were based on geomorphic similarity and recognizable geographic boundaries. Recommendations will refer to these sections.

Specific High-Risk Areas and Potential Solutions

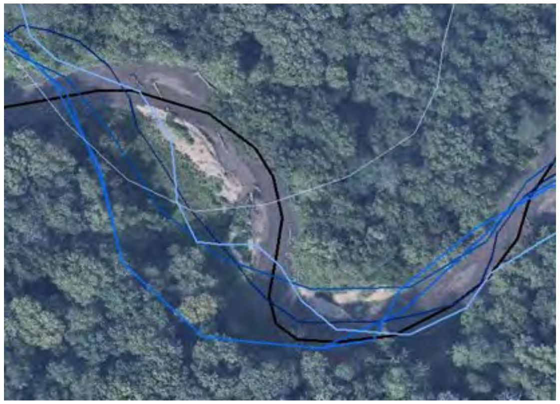
Several areas of potentially high risk were identified by the assessment and are discussed in Table 6-3. All risks and recommendations including those below and areas of lower general risk are shown in tabulations in Appendix G-2 and associated maps in Appendix G-3. The map numbers in Table 6-3 correspond to the maps in Appendix G-3. Approximate project costs are provided for most options in the full *Lower Clear Creek Stream Assessment Within Coralville* report.

Table 6-3. High-Risk Areas and Potential Stream Restoration Solutions in Lower Clear Creek Watershed

Map #	Risk Type / Severity	Description	Recommendation (costs in 2020 $)	Potential Stream Practices	Photo
3	Public Safety -- Extreme	Bank erosion and geotechnical separation were observed at top of bank ~6' from recreational trail. Relatively narrow section with minimal meander history, so if toe armor is installed the opposite bank should be widened to maintain cross sectional area	Move trail or armor toe / move thalweg, and widen section on opposite bank if reduced by practice at an estimated cost of $28,000 to $50,000	Toe Wood, Soil choked Riprap, Log Vane, J-hooks	
5	Stream Function -- Significant	Historic meander migration, impingement vectors, high energy, and vegetation lay-down from recent high flow event suggest this low, narrow peninsula may soon avulse similar to downstream bends. This would significantly increase energy and instability downstream and also cut off a known mussel bed (adult and juvenile observed)	Increase sinuosity upstream, protect toe and move thalweg, consider raising grade in low area about 1' (would also help RCG infestation) at an estimated cost of $175,000 to $192,000	Toe Wood, Log Vanes, Floodplain Bench, Native Vegetation	
6	Public Safety/ Sediment -- Extreme	Meander migration averaging ~10 ft/ year, impingement vectors and high energy from historic straightening upstream causing rapid bank failure on two bends. A primitive mountain bike trail follows the top of bank, otherwise general public risk is low. Sediment yield is approx. 1,700 tons / year. The downstream bend is migrating a bit slower, but toward an underground pipeline	Increase sinuosity upstream, protect toe (combine project with #5 above)	Remeander Upstream, Toe Wood, Cedar Tree Revetment, Log Vanes, Floodplain Bench, Native Vegetation	

Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April

Table 6-3 continued. High-Risk Areas and Potential Stream Restoration Solutions in Lower Clear Creek Watershed

Map #	Risk Type & Severity	Description	Recommendation (cost in 2020 $)	Potential Stream Practices	Photo
7	Public Safety/ Sediment -- Extreme	Recent meander migration (~4 ft/ year), impingement vectors, vertical bank, clay channel bottom and tight radius of curvature combined to topple a massive cottonwood during October 5, 2018 flood, partially blocking the channel and producing large root crater in vertical outside bank. Primitive mountain bike trail and wooden bridges near top of bank. Further rapid bank erosion expected	Increase sinuosity upstream, protect toe, increase radius (room exists upstream), re- shape outer bank to reduce shear stress at toe, control thalweg at an estimated cost of $82,000 to $115,000	Remeander, Toe Wood, Longitudinal Peaked Stone, Bendway Wiers, Bank Shaping	
8	Public Safety -- Extreme	~40' tall bank is short (~230'), nearly vertical & unvegetated (north-facing). Aesthetically dramatic, but erosion risk at base is low due to clay bank extending up to low bank height. Overlying sandy silt is unstable resulting in tree loss from top of bank. Potential public safety risk due to paved trail ~34 feet from top of bank. Equipment access is not great.	Protect / warn public at top of bank, protect toe, control thalweg, increase radius at an estimated cost of $229,000 to $679,000 combined with map project number 11	Remeander, Toe Wood, Log Vanes, J-Hooks, Longitudinal Peaked Stone Toe, Bendway Wiers, Bank Shaping	
11	Sediment/ Function -- Extreme	Bank rapidly eroding due to bar push because of sediment from recent avulsion upstream. The thalweg moved very little from 1930 to 2008, then shifted from inflection to outside bend by moving 80' in 10 years. Continuing serious erosion is expected, which will reduce the radius of curvature and increase impingement on #8 above. Equipment access is not great	Relocate thalweg, protect toe, increase sediment competence, reshape bank (combine project with #8 above)	Remeander, Toe Wood, Longitudinal Peaked Stone, Bendway Wiers, Bank Shaping	

Source: *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April

Table 6-3 continued. High-Risk Areas and Potential Stream Restoration Solutions in Lower Clear Creek Watershed

Map #	Risk Type & Severity	Description	Recommendation (cost in 2020 $)	Potential Stream Practices	Photo
12	Sediment / Safety -- Extreme	Extremely dynamic series of two wavelengths formed immediately at the downstream end of a long, straightened and armored section through I-80 / 380 ROW. High energy discharge causing rapid bend migration (~10 ft/year) and belt-width expansion as stream naturally re-meanders. A log jam has formed at downstream end acting as natural grade control however it will be flanked by lateral bank expansion. Sediment yield is ~4500 tons/yr. Upstream energy reduction is critical.	Remeander and widen upstream section, control thalweg, control grade, protect toe, reshape banks, increase radius, improve vegetation at an estimated cost of $970,000	**Remeander,** Low Head Grade Control, Longitudinal Peaked Stone, Bendway Wiers, J-hooks, Bank Shaping, Native Vegetation	 
22	Infrastructure -- Extreme	Historical bend migration suggests bend will continue northward toward sanitary sewer pipe (within feet of eroding vertical bank). Fortunately, this bank is one of few composed of stiff grey clay, so erosion rate is relatively slow. Migration rate has varied from 0 to7 ft/year. Bar push (upstream & at this bend) is reducing radius of curvature, increasing impingement vectors & generally increasing near bank stress to critical levels (extremely deep scour vortex pool formed at apex of the bend).	Increase radius (space exists), protect toe, reshape bank at an estimated cost of $140,000 to $245,000	Remeander, toe wood, soil -choked rip rap, cedar tree revetment	

Source*:* *Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April

Specific Non-Risk Areas and Potential Solutions

Table 6-4 lists several non-risk-related areas with potential for some form of enhancement (typically ecological restoration). These areas include abandoned oxbows, wetlands, and potential re-meander sites. Map numbers in Table 6-4 correspond to maps in Appendix G-3.

Table 6-4. List of Potential Non-Risk Restoration Areas in the Lower Clear Creek Watershed

Map #	Description	Ranking
101	Oxbow area abandoned between 80's and 2008, potential avulsion risk, low lying, sediment risk if excavated, needs veg improvement, medium access	High
102	Historic oxbow (abandoned prior to 50's), bisected by small stream (and also an area cleared for "cultural uses"), situated higher so less sediment risk	Med
103	Recent oxbow (abandoned between 2008 and 2017), excellent practice template to monitor for elevation versus sedimentation, intact ephemeral pool at apex	Med
104	Very nice perched forested wetland in high visibility area, great veg restoration site	High
105	Good Re-meander site to reduce downstream energy (1930's stream area), west end is slated for IDOT wetland mitigation, east end has RCG infestation (good area for stripping, excavating to eliminate)	Med
106	Low quality floodplain forest (east end has RCG infestation), area bisected by small stream, possible remeander or wetland / created oxbow site, pending IDOT project along channel	Low
107	Good Re-meander site to reduce downstream energy (1930's stream oxbow), channel bank is slated for IDOT project, east end has some RCG	High
108	1950's Stream alignment visible in floodplain forest floor, could be good wetland site, but difficult access	low
109	Recommend adding canoe / kayak access point adjacent to 1st Avenue bridge to improve exit / entry (this site is frequently used by paddlers despite awkward bank access), good parking in lot south of Clear Creek, but best access is on north bank	High
110	Low floodplain forest in fair condition, decent access but low public visibility, could use TSI / potential wetland improvements	Med
111	Very nice floodplain forest area in fair condition, no stream activity since 1930's, but abundant historical meander scars and pocket wetlands, needs TSI / veg improvement	Med
112	Historic oxbow (abandoned prior to 50's), bisected by small stream (and also an area cleared for "cultural uses"), situated higher so less sediment risk	Med
113	Good re-meander site to reduce downstream energy (also area to north of trail, but would require moving trail), possible shallow bedrock, also good potential for wetland / created oxbow, good visibility along trail, park setting	High

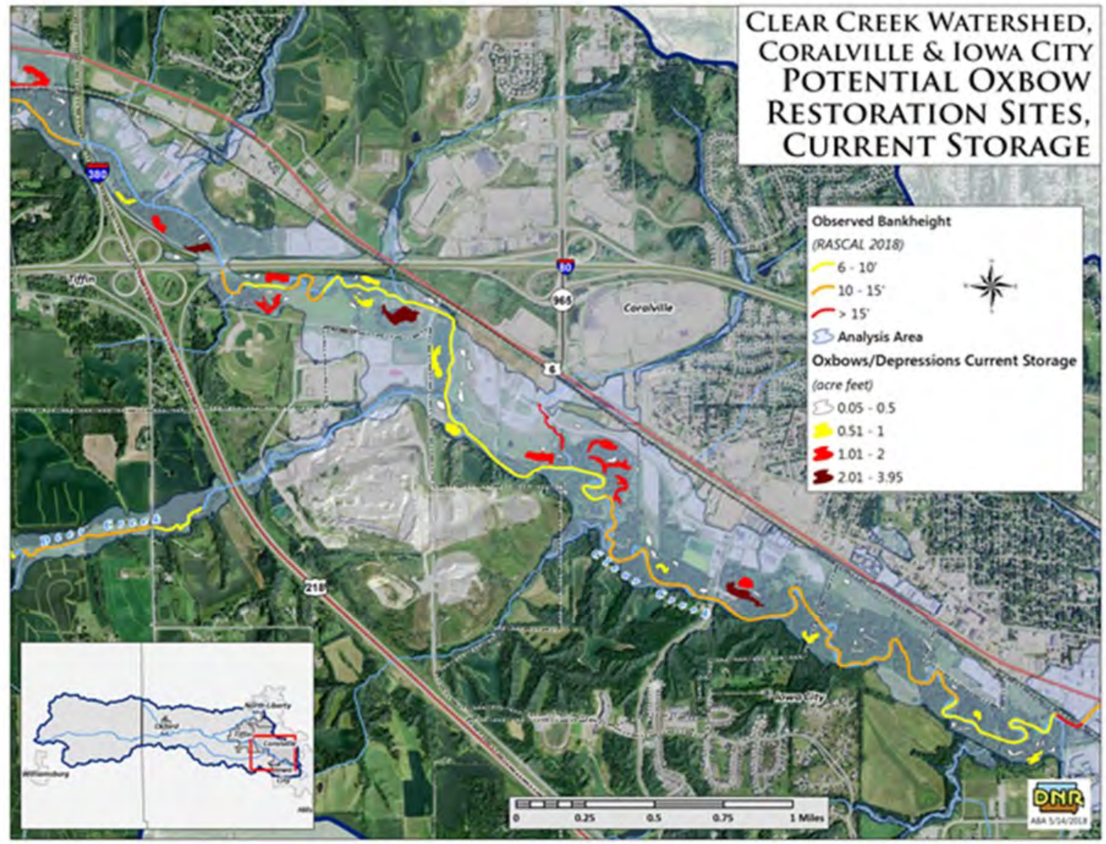
Source*: Lower Clear Creek Stream Assessment Within Coralville*, Aaron Gwinnup PE, April

General Design Recommendations

The Lower Clear Creek Stream Assessment Within Coralville, HR Green, Aaron Gwinnup, PE, (Appendix G-1) identified some general practices and recommendations to consider when designing projects specifically in the Lower Clear Creek study area. The following recommendations apply throughout the Lower Clear Creek sub-basin:

- Consider the geometric parameters observed at reference reaches, provided in the *Lower Clear Creek Stream Assessment Within Coralville,* as a basis of design.
- Match the existing local character of the channel when designing modifications. Embed revetment into the banks and bed to avoid constricting flow or inducing scour erosion downstream.
- Avoid large, open void rip rap. Instead, use smaller rip rap with sizing based on local shear stress calculations. Rip rap should be embedded into surrounding banks without producing constriction of the channel and should be soil choked and vegetated to blend with surroundings.
- Use wood-based practices where possible (like existing formations). Well-designed wood practices should last decades and be naturally replaced over time with stable vegetated banks.
- Avoid confining the toe of banks extensively, especially on both sides of the channel simultaneously.
- Allow the channel the space and ability to adjust naturally where possible.
- Include pool forming features to help dissipate energy and provide needed habitat.

Figure 6-6. Potential Oxbow Restoration Sites



Source: Iowa Department of Natural Resources

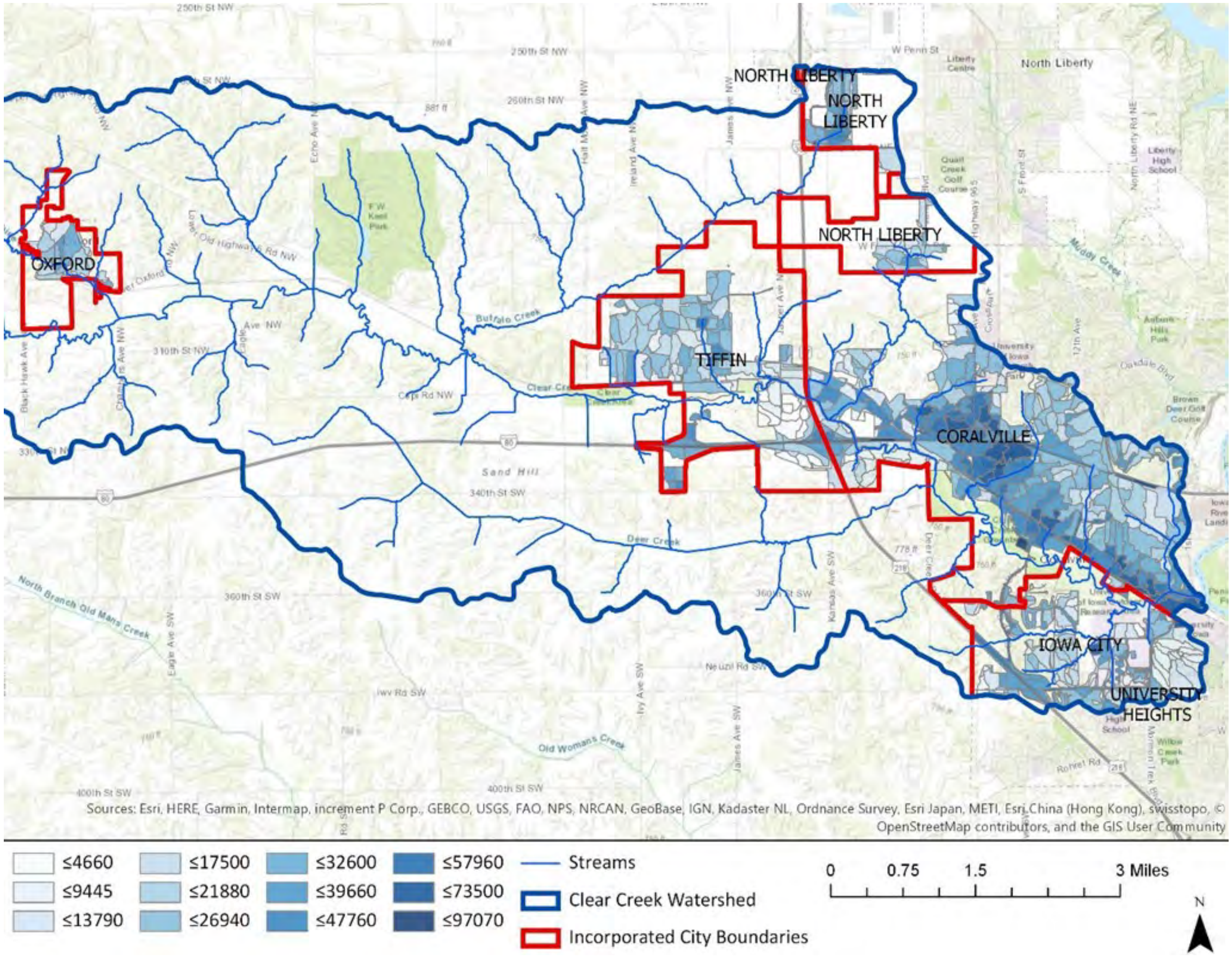
- Avoid placing new benches too low. Observe local depositional features within the reach and adjust design accordingly.
- Include riparian vegetation improvement where possible. The roots of native vegetation will stabilize sandy banks better than non-native species or tree roots alone.
- Oxbows and wetlands are positive features, but design must be carefully considered. Potential locations represented in Figure 6-6.
    - These features need to be very large to have significant effects this low in the watershed, and therefore may be better suited to placement higher in the Clear Creek watershed.
    - These features also rely on careful design of the inlet and outlet, including proper elevation and vegetated banks. Too low of an entrance will allow too much deposition of sediment, and the feature will fill rapidly. Too high of an entrance, and the feature will be disconnected. Vegetation of the entrance is also important to stabilize the elevation and help prevent sediment fouling.
    - Approximate elevations and geometries should be based on the existing oxbow recently surveyed in Section 5 (seen in Figure 6-5). This oxbow should be monitored over time to develop sustainable oxbow design parameters.

6.1.3 Low Impact Development (LID)/Green Infrastructure (GI)

Urbanization has added vast amounts of impervious surface to the watershed and is dramatically altering the hydrology of the Clear Creek watershed. Low Impact Development or Green Infrastructure promotes infiltration-based practices that can help to mitigate the effect of impervious surface. Prioritizing locations for green infrastructure is important for plan implementation, however, it will depend upon the individual homeowners, business owners, and a community's willingness to make it a reality.

Some assist in that effort, the modeling analysis performed by the GeoTREE Center at the University of Northern Iowa using ArcSLAMM/ WinSLAMM identifies potential areas to target LID and GI as shown in Figure 6-7. The darker blue indicates where more runoff has been modeled indicating areas to focus urban practices. More details about the GeoTREE modeling can be found in Section 3.8 and Appendix E.

Figure 6-7. WinSLAMM Modeled Runoff Volume (cubic feet/acre/year)



Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

Infiltration Practices: The GeoTREE modeling identified 1,922 acres of impervious surface in the watershed where infiltration practices that mitigate flood risk by storing water in urban and residential areas could be implemented. Examples of practices include:

Rain Garden

Source: Iowa Stormwater Education Partnership

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 can be an alternative to storm sewers or aid and protect existing storm sewers. They absorb runoff from a light rain and intercept the first flush of runoff from heavy rains to reduce the amount headed to storm sewer inlets and surface waters.

Rain Gardens are depression 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 impervious surfaces by 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.

Permeable Pavement 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 flowing into storm sewers and streams is reduced. This helps maintain more stable base flows to streams, reduces flood peaks, and reduces stream bank erosion.

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 detains runoff from each rain event and has a permanent pool of water. 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 extended detention of stormwater runoff.

Permeable Pavement

Source: Iowa Stormwater Education Partnership

Local Priorities

CCWC members have identified a large upstream detention basin concept west of Half Moon Road NW on the west side of Tiffin as a priority project costing an estimated $2 million. Other priorities identified by CCWC members include working towards green infrastructure retrofits on all commercial buildings and incorporating green infrastructure into all future road improvement projects.

6.2 Water Quality Improvements

6.2.1 Agricultural Best Management Practices

Agricultural conservation encompasses a broad array of strategies and identification of potential practices and viable locations to implement them is an important component of the Clear Creek Watershed Management Plan. This section describes some targeted practice locations identified through the watershed assessments completed for the watershed planning process. However, due to the geographic scope of the Clear Creek HUC-10 watershed, this plan does not aim to provide specific field-scale recommendations for all agricultural Best Management Practices (BMPs). This section also includes a description of the suite of practices that could be implemented in the areas used for row-crop production identified in the land use assessment more broadly.

As plan implementation rolls out, specific agricultural conservation strategies will be developed by working one-on-one with farm owners or operators to identify the practices that meet their agronomic and conservation goals. The CCWC and the Clear Creek Watershed Coordinator will work with partners such as the local SWCDs, NRCS, ISU Extension, and crop consultants / advisors to promote a balanced strategy of managing natural resources while maintaining agricultural productivity.

Sediment Control

The watershed assessment identified areas in the watershed with greater than 1 ton per acre per year sediment delivered to Clear Creek and its tributaries. These areas seen in Figure 8-8 are high priority locations for sediment-trapping practices, on farmed ground as well as other areas in the watershed. The practices include:

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%.

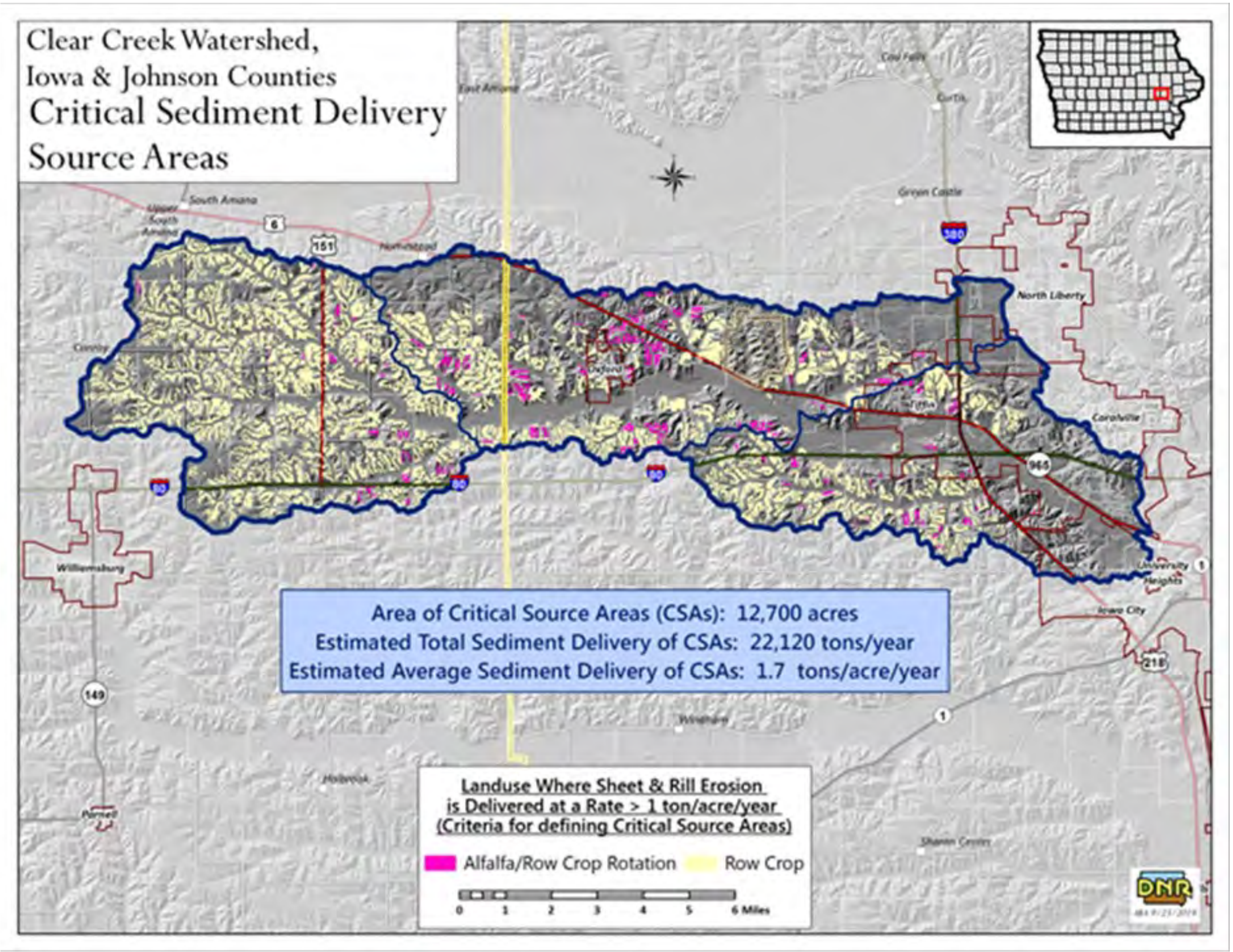
Grade Stabilization Structure is a dam, embankment or other structure built across a grassed waterway or existing gully control to reduce water flow. The structure drops water from one stabilized grade to another and prevents over-fall gullies from advancing up a slope.

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.

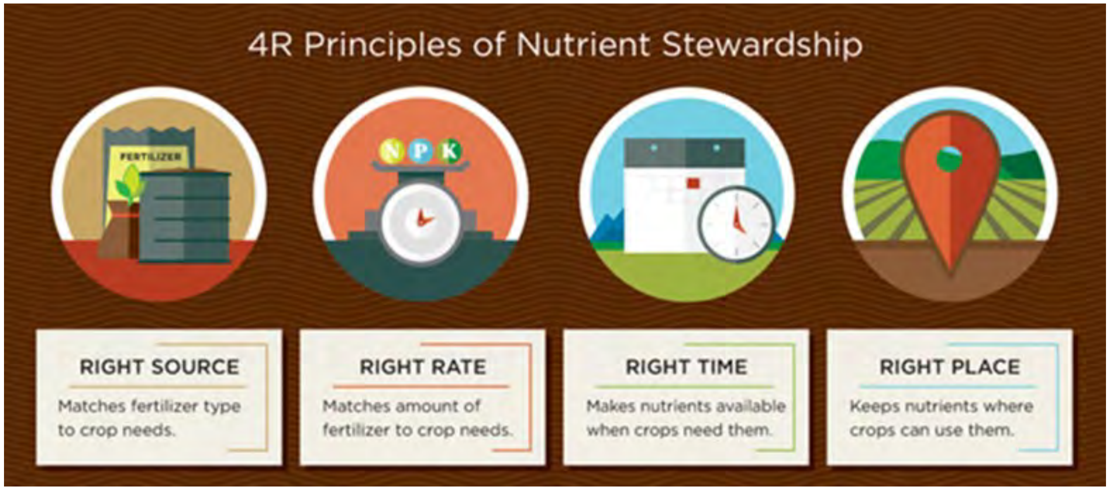
Figure 6-8. Priority Areas for Erosion Control Practices



Source: Iowa Department of Natural Resources

6.2.2 In-field Agricultural Management Strategies

In-field practices 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: Right Time, Right Place, Right Amount, Right Source.



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

Nutrient Management Practices

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

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, fuel prices can drive 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 crops 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 to perennial vegetation to limit soil erosion. This is a long-term Conservation Reserve Program (CRP) of 10-15 years. 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 of the land. As water makes its way down a hill, terraces serve as small dams to intercept water and guide it to an outlet.

6.2.3 Edge of field Agricultural Management Strategies

Edge-of-field 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 using 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.

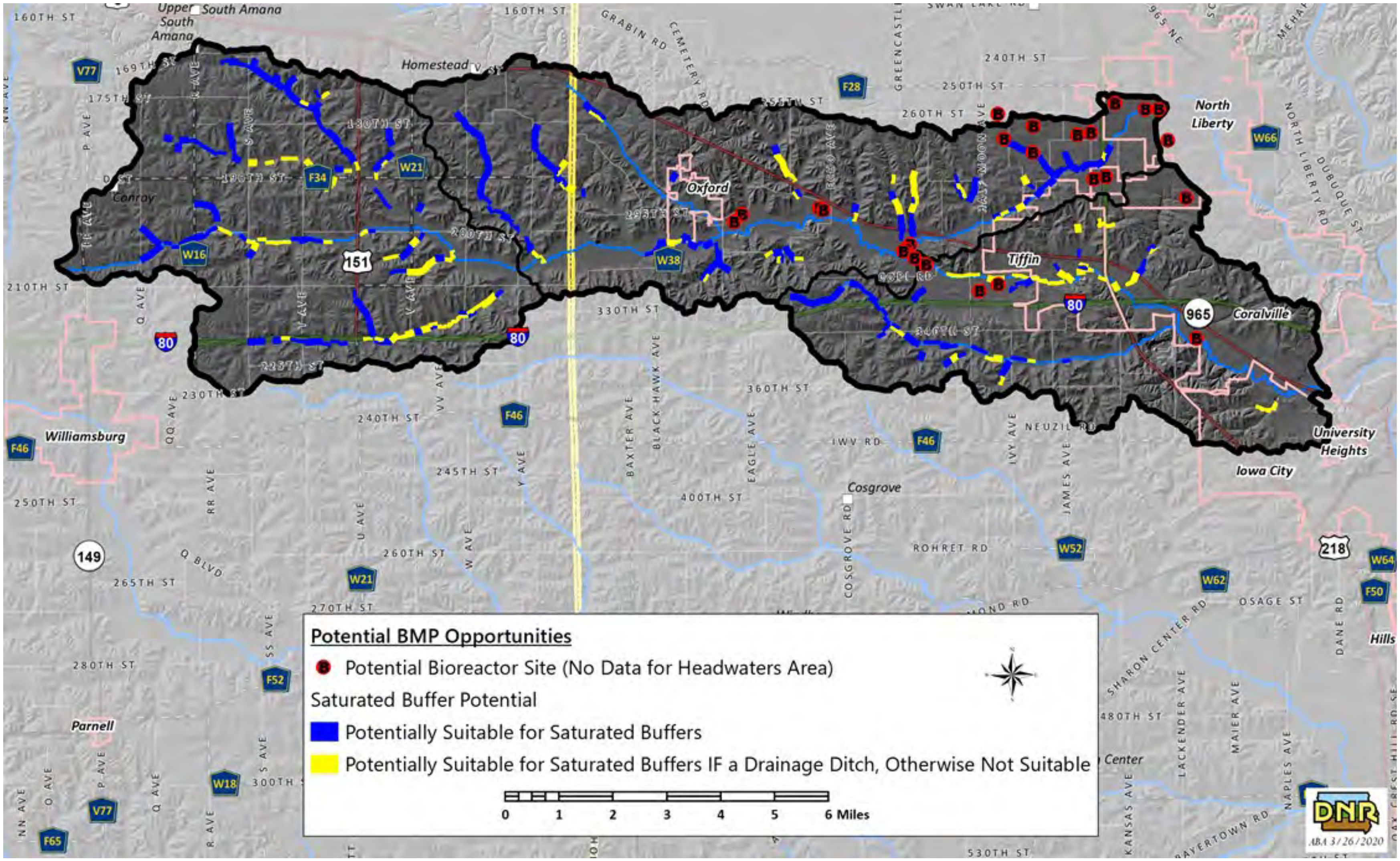
Denitrification bioreactors are trenches in the ground packed with carbonaceous material, such as wood chips, that allow colonization of soil bacteria that convert nitrate in drainage water to nitrogen gas. Installed at the outlet of tile drainage systems, bioreactors usually treat 40-60 acres of farmland.

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 facilitating contact with soil and vegetation resulting in significant denitrification.

6.2.4 Agricultural Conservation Planning Framework (ACPF)

Agricultural Conservation Planning Framework (ACPF) is a watershed planning toolbox developed by Mark Tomer and his research team at the USDA-Agricultural Research Service in Ames, Iowa (Tomer et al., 2013). The ACPF is a watershed approach to conservation planning facilitated with ArcGIS software. The ACPF can be used for terrain analyses to determine which fields are most prone to runoff. Figure 6-9 shows the ACPF results using watershed assessment data to identify locations where edge-of-field bioreactors and saturated buffers could be installed based on general design criteria.

Figure 6-9. Potential Locations for Bioreactors & Saturated Buffers



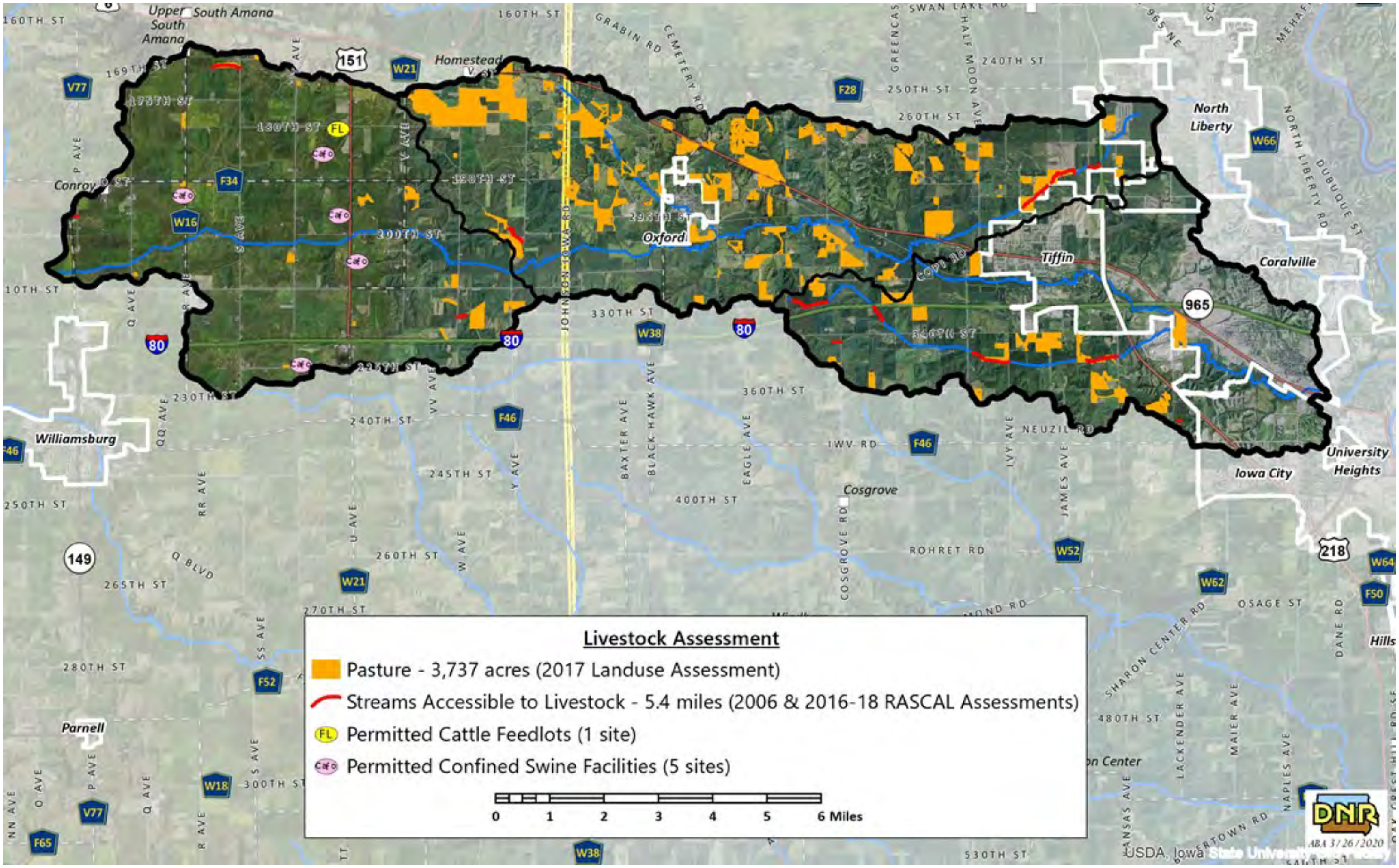
Source: Iowa Department of Natural Resources

6.2.5 Livestock Management

The RASCAL and land use assessments identified areas in the watershed where livestock management practices could be implemented (Figure 6-10). 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.

Figure 6-10. Priority Areas for Livestock Management Practices



Source: Iowa Department of Natural Resources

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.

6.3 Urban Practices

Urbanization has added vast amounts of impervious surface to the watershed and is dramatically altering the hydrology of the Clear 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 the 1,922 acres of impervious surface in the watershed. The modeling analysis performed by the GeoTREE Center at the UNI using ArcSLAMM/WinSLAMM provides a mechanism for quantifying urban runoff and pollutant loads to gain a better understanding of urban area contributions and prioritize drainage areas for best management practices (BMPs). The implementation of BMPs will depend upon the individual homeowners, business owners, and community's willingness to implement green infrastructure strategies instead of traditional stormwater conveyance systems. Figures 6-11, 6-12 and 6-13 show the ArcSLAMM/WinSLAMM results identifying locations where urban BMPs could be installed. The full report in Appendix E includes maps of each urban area for more detail. Example BMPs 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 the 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%.

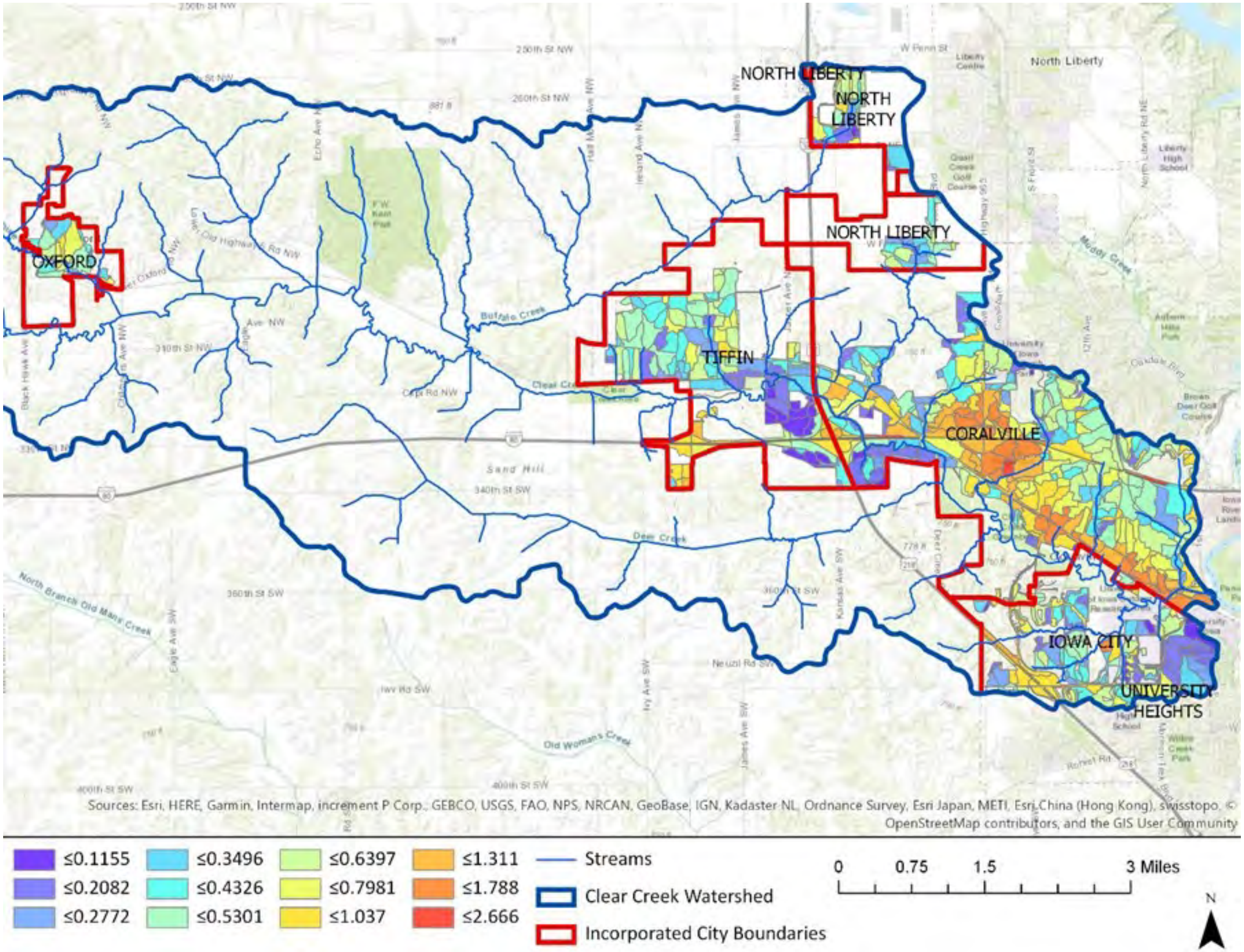
Rain Gardens are depressional areas landscaped with perennial flowers and native vegetation that soak up rainwater. They are strategically located to capture runoff from impervious surfaces, such as roofs and streets.

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.

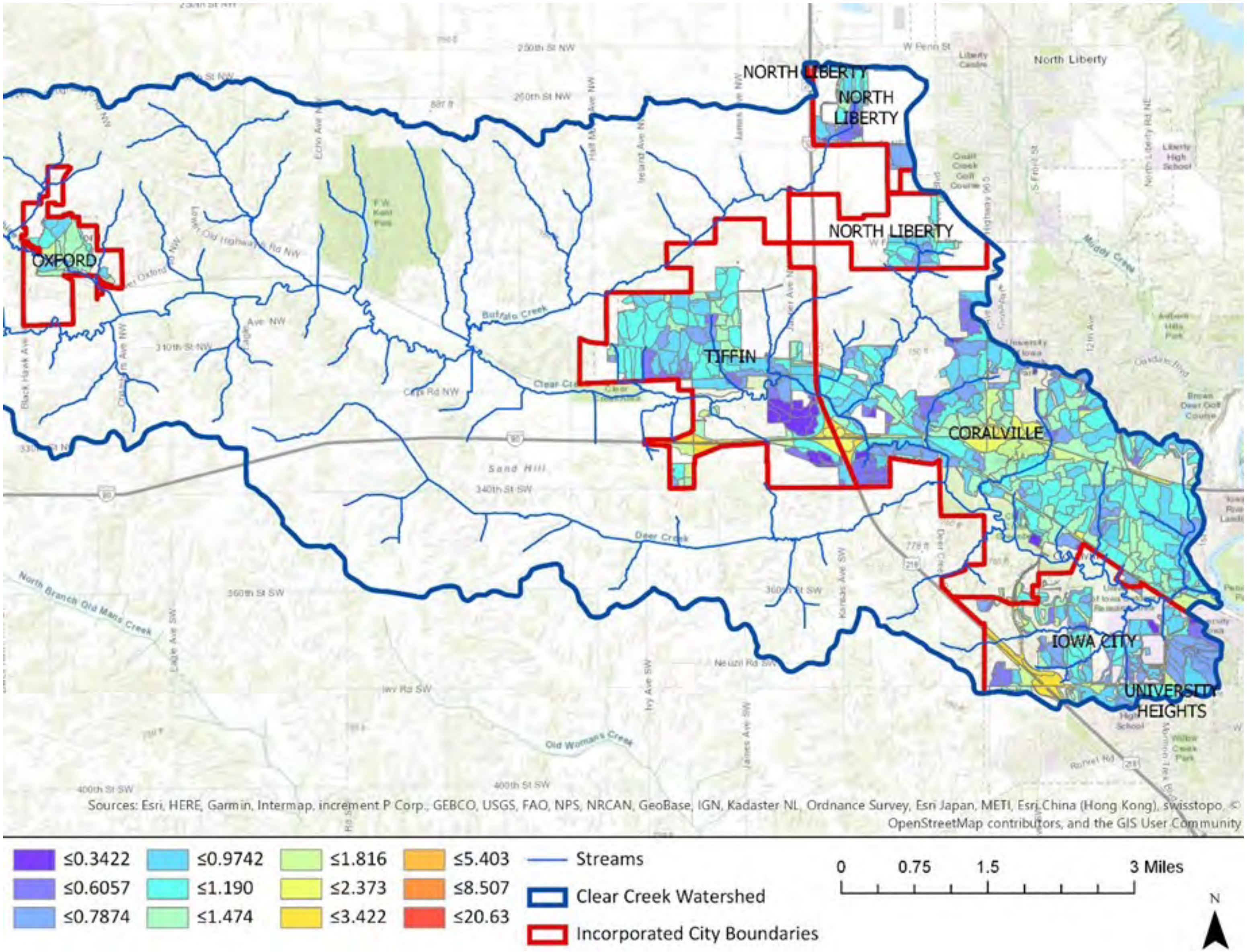
Detention Basins can be either wet or dry detention basins used to reduce peak discharge and detain runoff for a specified short period of time. A wet detention basin is a constructed stormwater detention basin that has a permanent pool of water. Runoff from each rain event is detained and treated in 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.

Figure 6-11. Total Nitrate Load (lb/acres/year) Normalized by Area



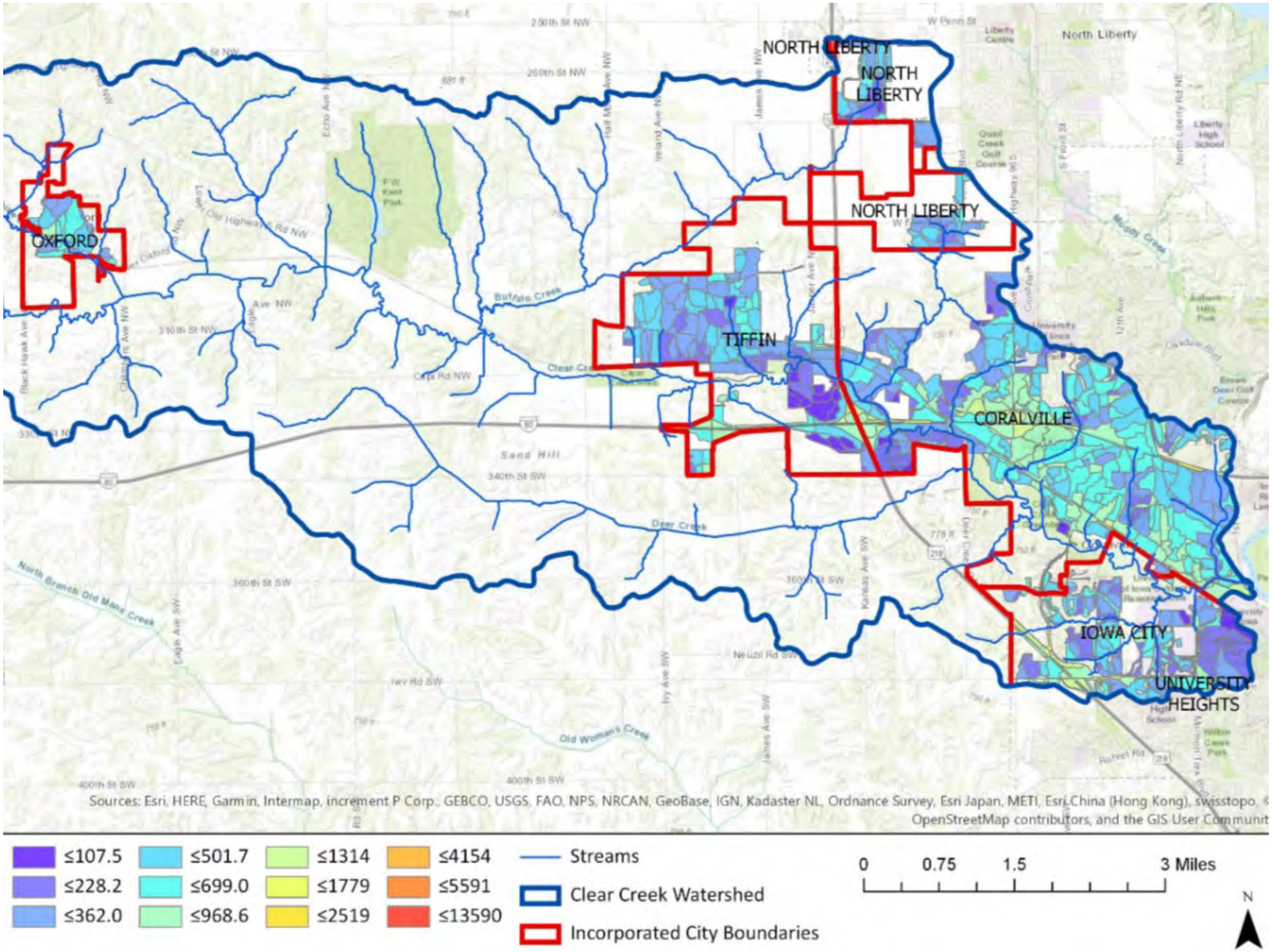
Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

Figure 6-12. Total Phosphorus Load (lb/acres/year) Normalized by Area



Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

Figure 6-13. Total Solids Load (lb/acres/year) Normalized by Area



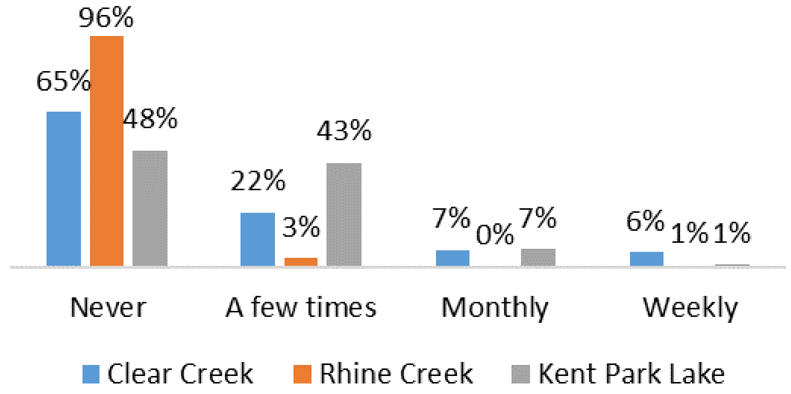
Source: GeoTREE Center, "Using ArcSLAMM/WinSLAMM System to Develop Database Source Areas for Clear Creek Watershed Urban Areas"

Chapter 7

SOCIAL ASSESSMENT

Completing a social assessment of the Clear Creek watershed inhabitants was one of the priorities for the planning process. The goal of the Clear Creek Watershed Community Social Assessment was to understand general attitudes about and awareness of water quality in the Clear Creek watershed (Iowa & Johnson counties). The CCWC partnered with UNI Center for Social and Behavioral Research to complete a social assessment of the 292,109 residents in the watershed. Separate surveys were used to examine people´s views, knowledge, and attitudes regarding water quality and their attitudes towards water protection practices of rural landowners/farmers and urban/suburban residents.

Figure 7-1. Annual Visitation to Local Waterbodies



Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

7.1 Urban Resident Survey

The Clear Creek Watershed Social Assessment: Urban Survey represents one aspect of the two-part Clear Creek Watershed Social Assessment and complement the information gathered in the survey of agricultural landowners and operators in Johnson and Iowa Counties. This summary provides the key findings from a survey of urban residents of the watershed focused on perceptions of and attitudes toward water quality in the Clear Creek watershed. All the survey findings can be found in the Clear Creek Watershed Social Assessment: Urban Survey report from UNI Center for Social and Behavioral Research in Appendix F. The report is also available on the Clear Creek Watershed Coalition website. www.clearcreekwatershedcoalition.org

7.1.1 Urban Resident Survey Methods

A random sample of 1,500 addresses were selected and adult residents (18 years of age or older) who reside in towns within the Clear Creek watershed boundaries (all in Johnson County) were invited to participate in the study. A self-administered mail-back survey design was used to collect information from the sample. There were 399 usable questionnaires for an overall adjusted response rate of 27%.

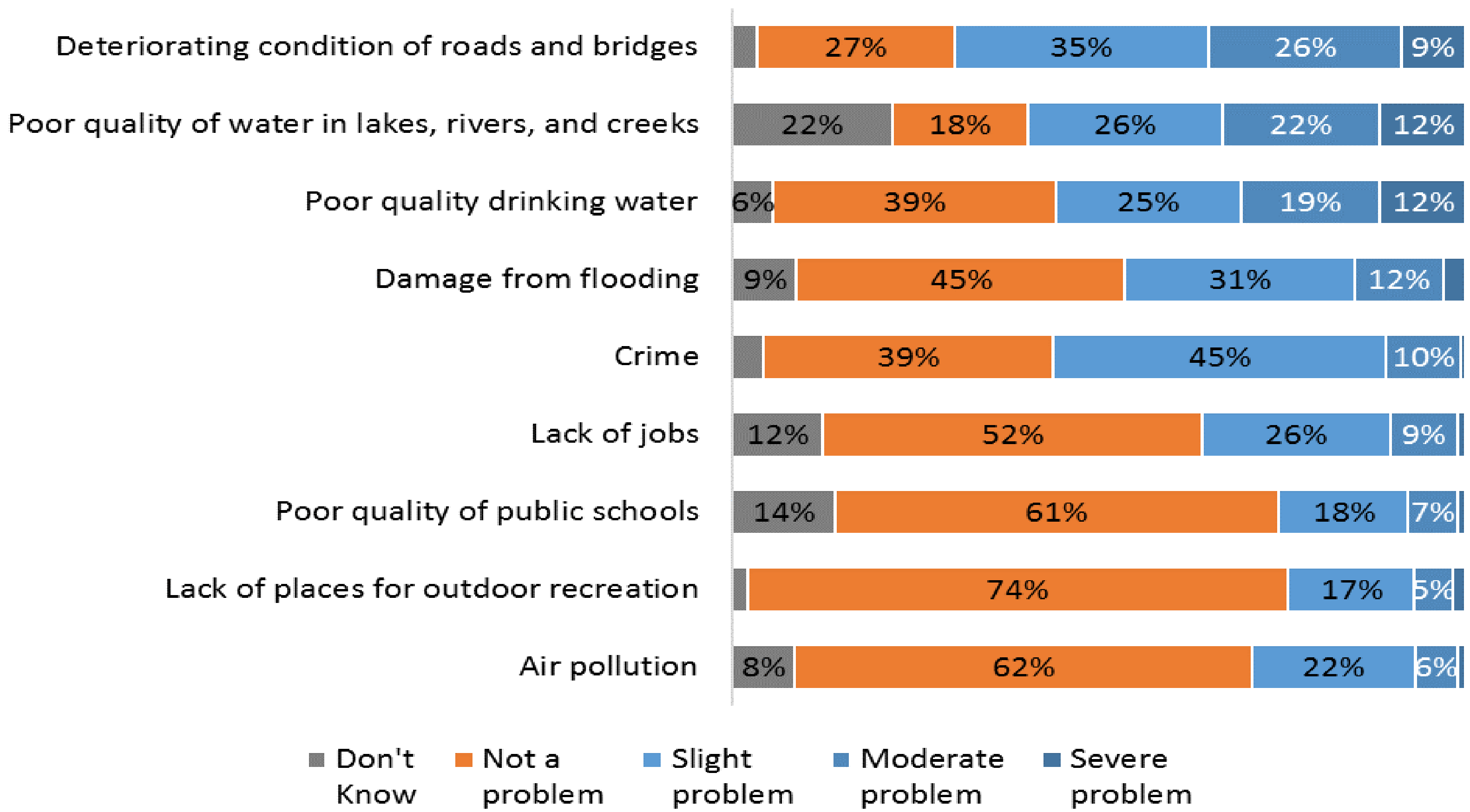
7.1.2 Urban Resident Survey Findings

Knowledge of water quality issues: Approximately one-third of respondents (34%) indicated that they were not at all knowledgeable about water quality, half reported that they were slightly knowledgeable, 15% said that they were moderately knowledgeable, and only 2% identified themselves as being very knowledgeable. Although half of the respondents indicated that they could not define a watershed very well or at all, when presented with four possible definitions, seven out of ten (71%) chose the correct answer (that a watershed refers to an area of land that drains to a common body of water).

Waterbody quality: Respondents were asked about the quality of water in nearby waterways and about the frequency with which they visited lakes, rivers, and creeks in their area. As indicated in Figure 7-1, respondents reported visiting local waterways with different frequencies. The waterway reportedly visited most within the last 12 months was Kent Park Lake, with 52% of respondents reporting having visited the lake a few times or more. In contrast, Rhine Creek was the waterway visited the least, with only 4% of respondents having visited the creek within the last 12 months. Clear Creek was in between, with 35% of respondents indicating that they had visited the creek a few times or more in the previous year.

Views on water quality. Urban residents were asked to report their level of concern about a variety of issues facing their community. Topics ranged from jobs to crime with three specific environmental issues related to water quality and air pollution on the list. As can be seen in Figure 7-2, the poor quality of drinking water was one of the top three problems identified by respondents, with approximately one-third (31%) indicating that this was a moderate or a severe problem. The other two issues identified as most problematic were the poor quality of water in lakes, rivers, and creeks and the deteriorating condition of roads and bridges. In both cases, approximately one-third of respondents reported that these were moderate or severe problems in their area (34% and 35%, respectively). Six-in-ten respondents (60%) rated their home drinking water as fair or poor, 35% rated it as good, and 5% rated it as excellent. Regarding waterway quality, lakes were viewed as the bodies of water with the highest quality water while rivers were viewed as the waterways with the lowest water quality.

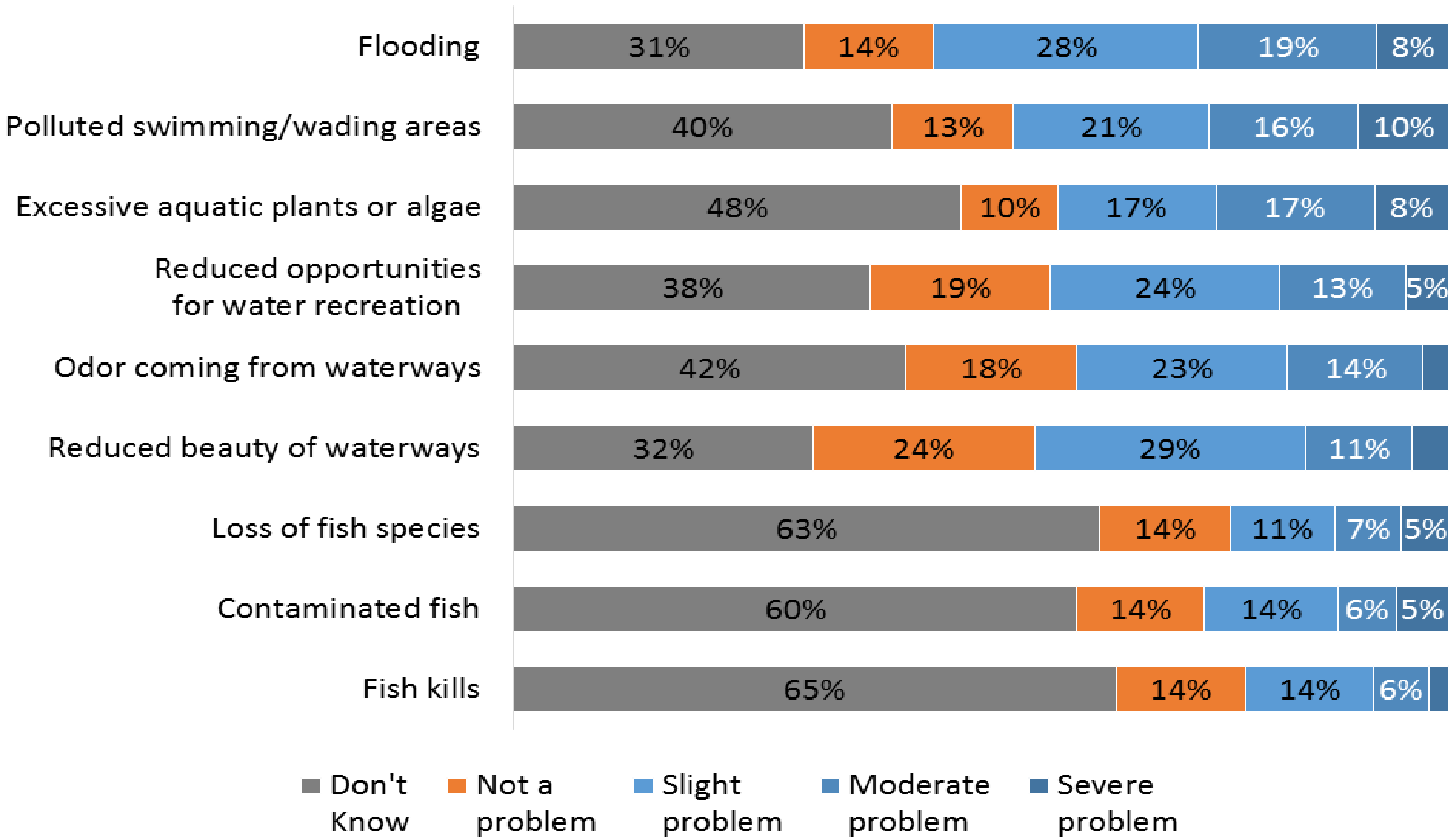
Figure 7-2. Severity of issues facing urban areas of Clear Creek Watershed



Source: Clear Creek Watershed Community Social Assessment, UNI Center for Social and Behavioral Research

Perceived water quality problems: When asked about specific problems for their local lakes, rivers, and creeks, respondents identified flooding, polluted swimming/wading areas, and excessive aquatic plants or algae as the main problems with approximately one-quarter of respondents classifying them as moderate or severe problems in their area (Figure 7-3). Other issues considered problematic (severe or moderate problem) by more than 15% of respondents included reduced opportunities for water recreation (18%), odor coming from waterways (17%), and reduced beauty of waterways (15%).

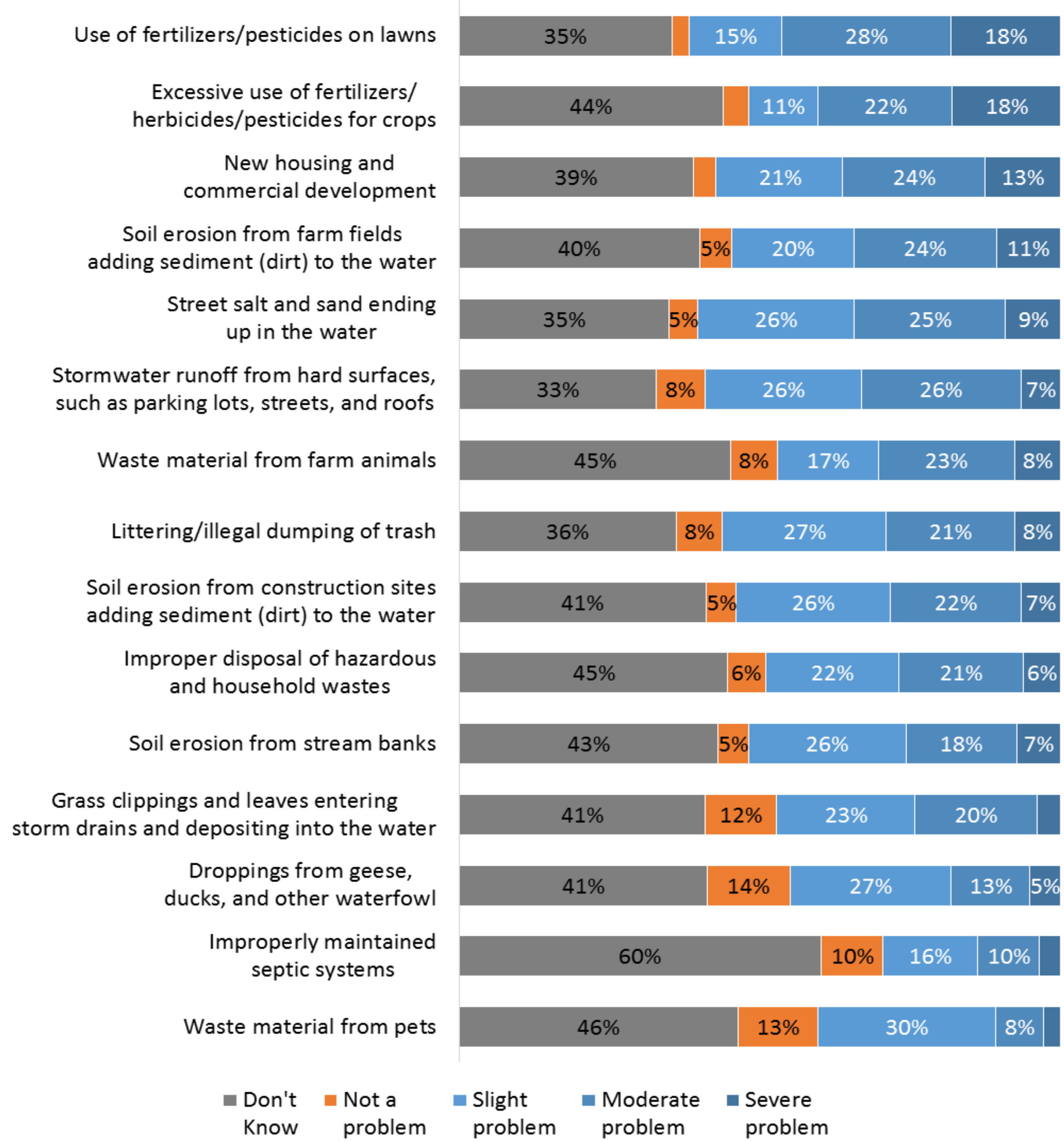
Figure 7-3. Perceived problems with local waterways



Source: Clear Creek Watershed Community Social Assessment, *Perceived contributions to problems for local waterways*: Respondents were presented with several activities and situations and asked to rate the extent to which they have been problematic for their local waterways (Figure 6-4). For each item, a plurality of respondents indicated that they did not know whether the activities and situations have been a problem, with percentages ranging from 33% to 60%, depending on the specific items. The situations identified as moderate or severe problems by the greatest number of respondents included the use of fertilizers/pesticides on lawns (46%), the excessive use of fertilizers/ herbicides/pesticides for crops (40%), and the new housing and commercial development (37%).

Information: Regarding water quality messages, approximately half of the respondents (49%) indicated that they would be moderately or very interested in learning more about local water quality issues. Most respondents preferred to receive information through the mail (57%), the internet (42%), or newspapers (39%) and only 6% of all respondents said that they preferred not to receive information on this topic.

Figure 7-4. Contributions to problems for local waterways

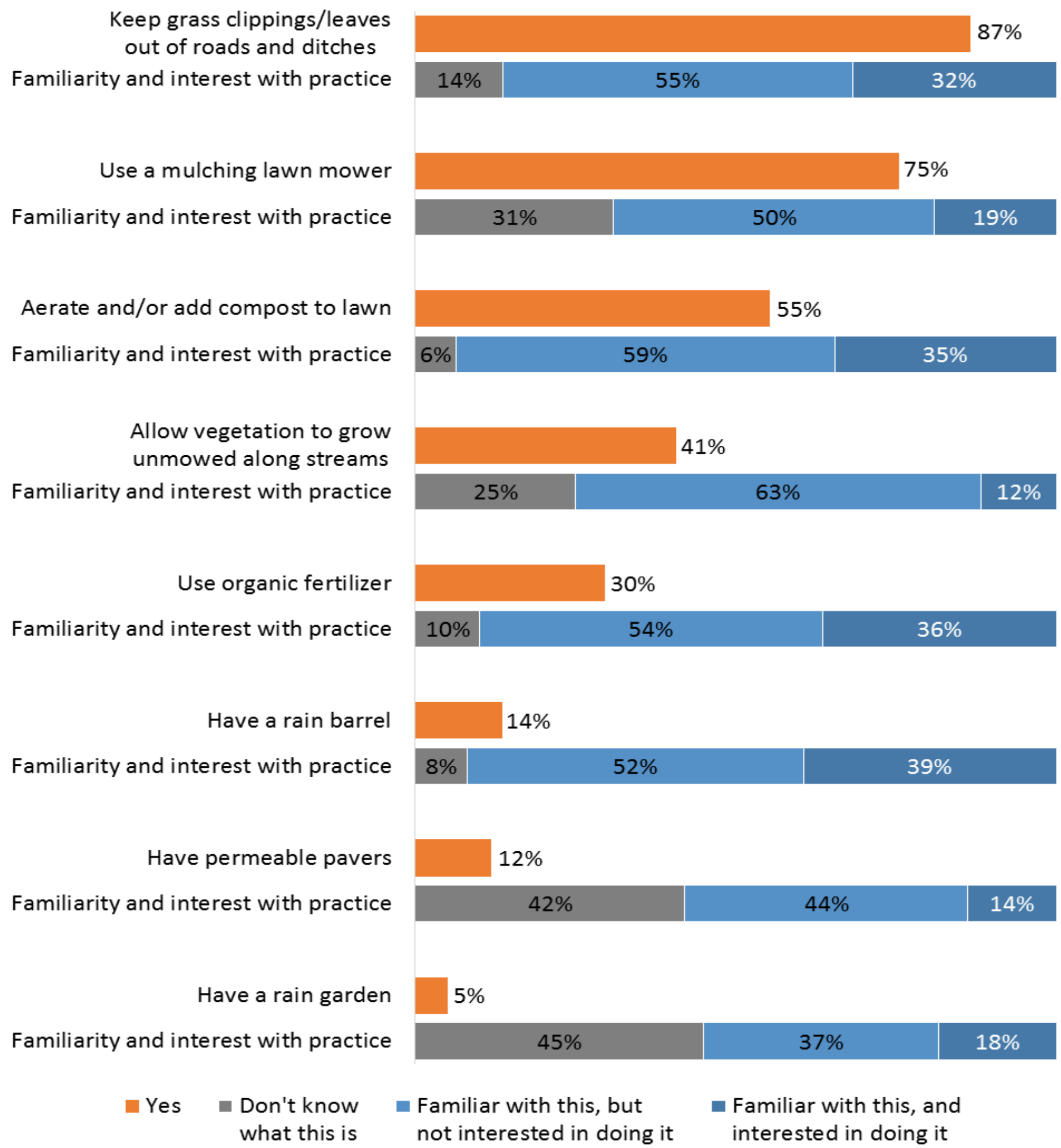


Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Water quality and lawn care practices: In terms of individual and community efforts made to preserve or improve water quality in the past three years, the action reported by the greatest number of individuals was to reduce their use of water for yard care (43%). Other efforts reported were to reduce their use of pesticides, fertilizers, or other chemicals (33%), and change the way their yard is landscaped (17%).

Lawn care practices: Approximately two-thirds of respondents (66%) indicated that they or another member of their household are responsible for making decisions about lawn care on the property where they live. Those who responded affirmatively were asked about their lawn care activities (Figure 6-5). Practices used by the majority of the respondents included keeping grass clippings out of roads and ditches (87%), using mulching lawn mowers (75%), and aerating/adding compost to their lawn (55%). Practices adopted by more than one-quarter of the respondents also included allowing vegetation to grow unmowed along streams (41%) and using organic fertilizers (30%). The most infrequent practices were having a rain garden (5%) and having permeable pavers (12%). These two practices were not only the most infrequent but also the least well known by non-users, with over four out of ten respondents indicating that they did know what rain gardens and permeable pavers were (45% and 42%, respectively). In contrast, the practices with which non-users were more familiar and interested in trying included having a rain barrel (39%), using organic fertilizers (36%), and aerating/adding compost to their lawn (35%).

Figure 7-5. Awareness levels and participation in lawn care practices

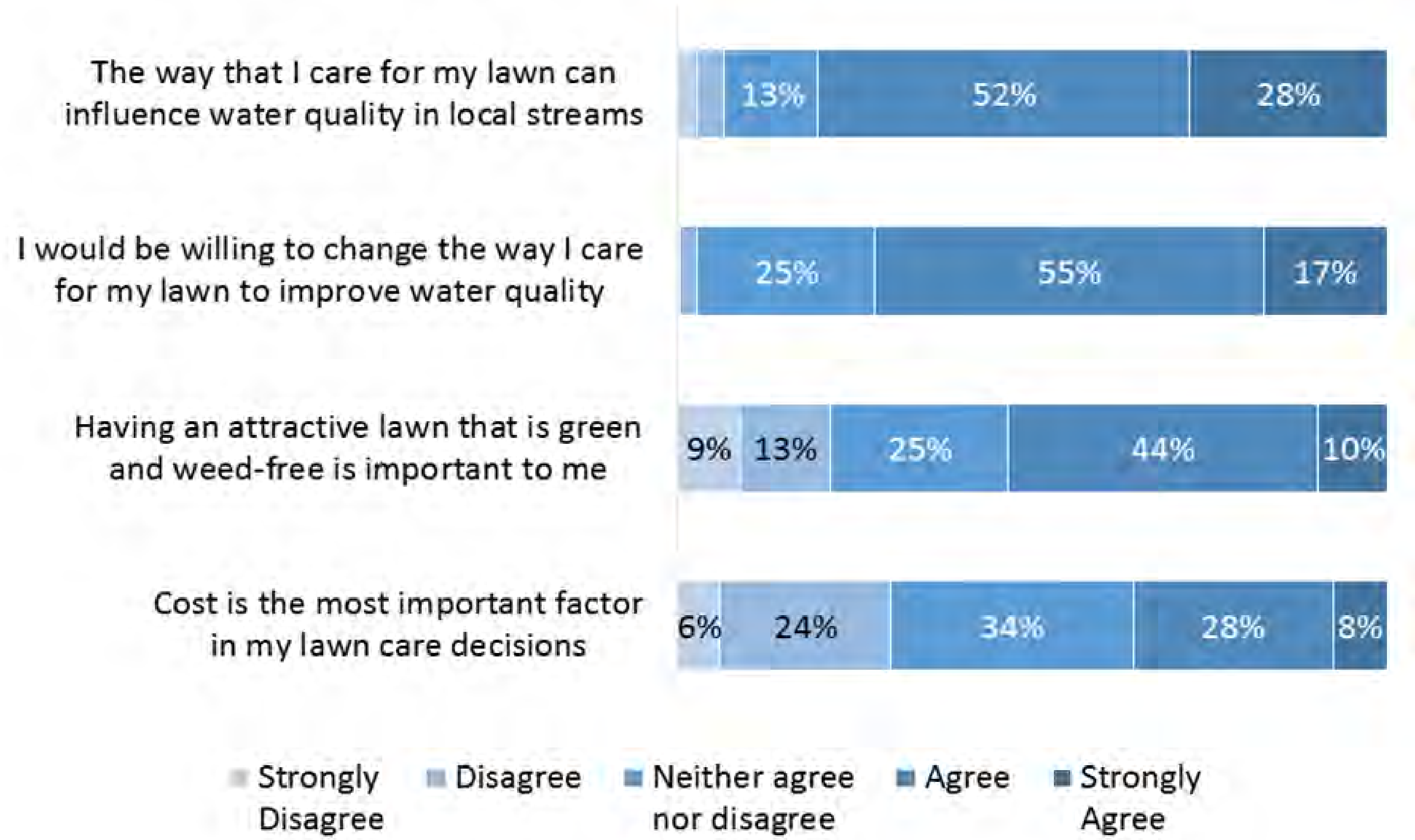


Source: Clear Creek Watershed Community Social Assessment, UNI Center for Social & Behavioral Research

Lawn care opinions: Respondents were asked the degree to which they disagreed or agreed with a list of issues related to water quality and lawn care. A vast majority of respondents (80%) agreed or strongly agreed that the way their lawn is cared for can influence water quality in local streams. Most respondents said that they would be willing to change their lawn care practices to improve water quality (72% agreed or strongly agreed).

Respondents were divided in terms of the importance of cost in their own decision-making. Slightly over one-third (36%) agreed that cost is the most important factor in their lawn care decisions, while 30% disagreed (i.e., disagreed or strongly disagreed) with this statement (Figure 7-6). A majority of respondents (54%) agreed that having an attractive lawn that is green and weed-free is important to them, while 22% disagreed that an attractive lawn was important and another quarter (25%) neither agreed nor disagreed with this statement.

Figure 7-6. Lawn care opinions by residents

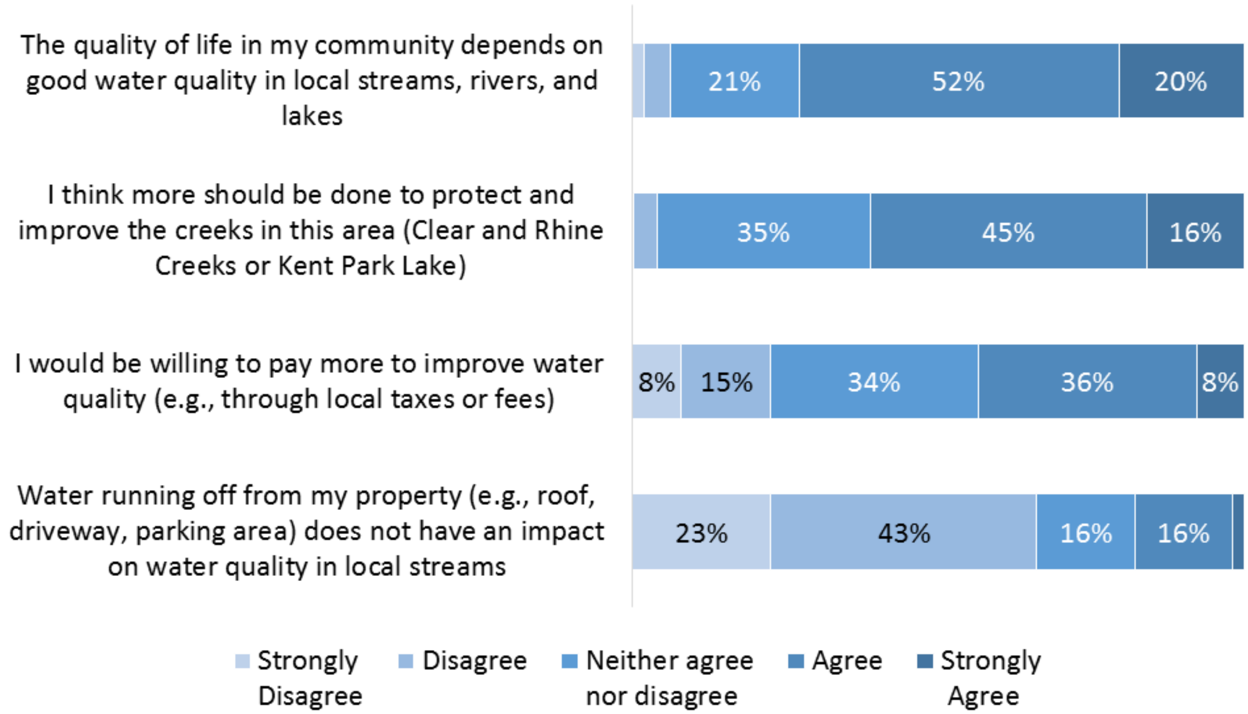


Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Attitudes toward water quality improvements

Regarding water quality attitudes, six in ten respondents (61%) indicated that more should be done to protect and improve the creeks in their area. Approximately two-thirds of respondents (66%) disagreed or strongly disagreed with the statement “water running off from my property (e.g., roof, driveway, parking area) does not have an impact on water quality in local streams” (Figure 7-7). Nearly three-quarters (72%) agreed that the quality of life in their community depends on good water quality in local streams, rivers, and lakes. Over 40% of respondents (44%) said that they agreed or strongly agreed that they would be willing to pay more to improve water quality. However, almost one-quarter of respondents (23%) opposed paying more for water quality improvement.

Figure 7-7. Opinions about water quality



Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

7.1.3 Urban Results Summary

The urban survey was designed to analyze perceptions and attitudes toward water quality in the Clear Creek watershed providing baseline data on attitudes about the watershed, sources of information, knowledge levels and willingness to engage in watershed improvements. When asked general views about problems facing the area, poor quality of drinking water and poor quality of water in lakes, rivers and creeks were two of the top three problems identified by respondents. In terms of understanding water quality, most respondents (84%) indicated that they were not at all or only slightly knowledgeable about water quality issues. An overwhelming majority of respondents (80%) agreed or strongly agreed that the way their lawn is cared for can influence water quality in local creeks. Moreover, most respondents (72%) said they would be willing to change their lawn care practices to improve water quality. Regarding water quality attitudes, six in ten respondents (61%) indicated that more should be done to protect and improve the creeks in the area. A plurality of respondents (44%) agreed or strongly agreed that they would be willing to pay more to improve water quality, while nearly one-quarter disagreed with this initiative.

7.2 Landowner / Farmer Survey

The Clear Creek Watershed Social Assessment: Landowner Survey represents one aspect of the two-part Clear Creek Watershed Social Assessment and complements the information gathered in the survey of urban Johnson County residents. This summary provides the key findings from the survey of landowners and farmers in the watershed on topics related to decision-making, management and conservation practices, conservation and land stewardship attitudes, trust in the sources of conservation information, livestock ownership and manure application practices, and views on water quality and experiences with flooding. All the survey findings can be found in the Clear Creek Watershed Social Assessment: Landowner Survey report from UNI Center for Social and Behavioral Research in Appendix F. The report is also available on the Clear Creek Watershed Coalition website. www.clearcreekwatershedcoalition.org

7.2.1 Landowner / Farmer Survey Methods

A self-administered mail-back survey design was used to gather information from landowners in Iowa (sample n = 508) and Johnson counties (sample n = 524). We received 272 completed questionnaires from eligible individuals who own agricultural land and/or farm in Iowa County (n = 118), Johnson County (n = 141), or both counties (n = 13), resulting in an overall adjusted response rate of 39%. Slightly over one-half of respondents (52%) farmed or owned land in Johnson County, 43% of respondents indicated they farmed or owned land in Iowa County, and a small portion of respondents (5%) indicated owning or farming land in both counties.

7.2.2 Landowner / Farmer Survey Methods

Land ownership: Just under half of the respondents reported that they owned land but did not farm (46%). The most common situations for those who farmed were farming a combination of land they owned and land that is rented (21%) and farming their own land (19%). Only a small percentage indicated that they rented all of the land that they farmed (8%). When they retire from farming, landowners and farmers reported that they would most likely sell the land to a family member to farm (24%), have the land custom farmed (17%), or pass it on to a family member through a trust or inheritance (11%).

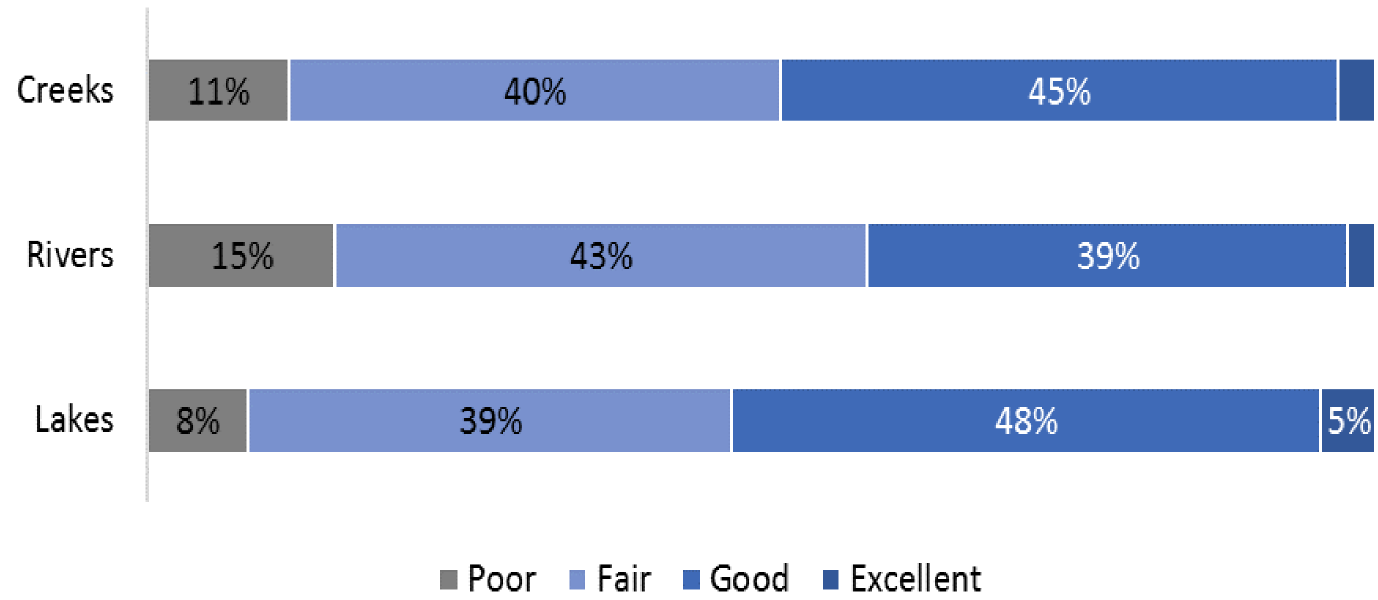
Farming Practices: Landowners most frequently reported that an all no-till corn/bean rotation (37%) was used on the acres they rent to farmers, followed by a corn/corn/bean rotation that uses minimum tillage for the corn and no-till for the beans (24%) and hay (17%). Similar proportions of owner-operators reported using a no-till corn/bean rotation (36%) and corn/corn/bean (minimum-till corn, no-till beans; 25%), but a greater proportion used their acres for hay (34%). Tenant farmers were the most likely group to have used a no-till method with corn and beans, with over half (51%) reportedly having used this type of crop rotation.

Decision-making: Approximately six out of 10 respondents (61%) identified themselves as the primary decision-makers of a farming operation, with half of those having been the primary decision-makers for 25 years or more. Across all farming situations, whether the acres were rented or owned, the operators of the land, not the owners, were identified most often as making decisions about all aspects of the land, from crop rotation to soil and water conservation practices.

Views on water quality: Regarding water quality, lakes were seen as having the best quality when compared to creeks and rivers, with 53% of respondents indicating that the quality of the water in their lakes was good or excellent. In contrast, rivers were considered the body of water with the worst water quality. Overall, only 41% of respondents rated their quality of water in rivers as good or excellent and 15% stated that it was poor. When asked how they would prefer to get information about local efforts to improve water quality, most respondents preferred to be contacted through the mail (74%). The next preferred mediums for receiving information were newspaper (28%), email (24%), Internet (21%), and radio broadcasts (21%).

Trust in the sources of conservation information: The public and governmental groups with the most reported trust from respondents about conservation issues included Iowa State University Extension and the Iowa or Johnson County Soil and Water Conservation District, which were trusted moderately or a great deal by more than two-thirds of respondents (75% and 70%, respectively). By contrast, the public or government entities with the least trust from respondents as conservation information sources were city or county government staff and their county's public health office (38% and 27%, respectively). Regarding non-governmental sources of conservation information, farmers and landowners in the Clear Creek Watershed were most trusting of their family members and neighbors or friends who farm (74% and 69%, respectively). In contrast, 39% of respondents indicated that they did not trust local media (e.g., newspaper, television, radio) at all as a source of conservation information.

Figure 7-8. Rating water quality



Source: CCWC Social Assessment, UNI Center for Social & Behavioral Research

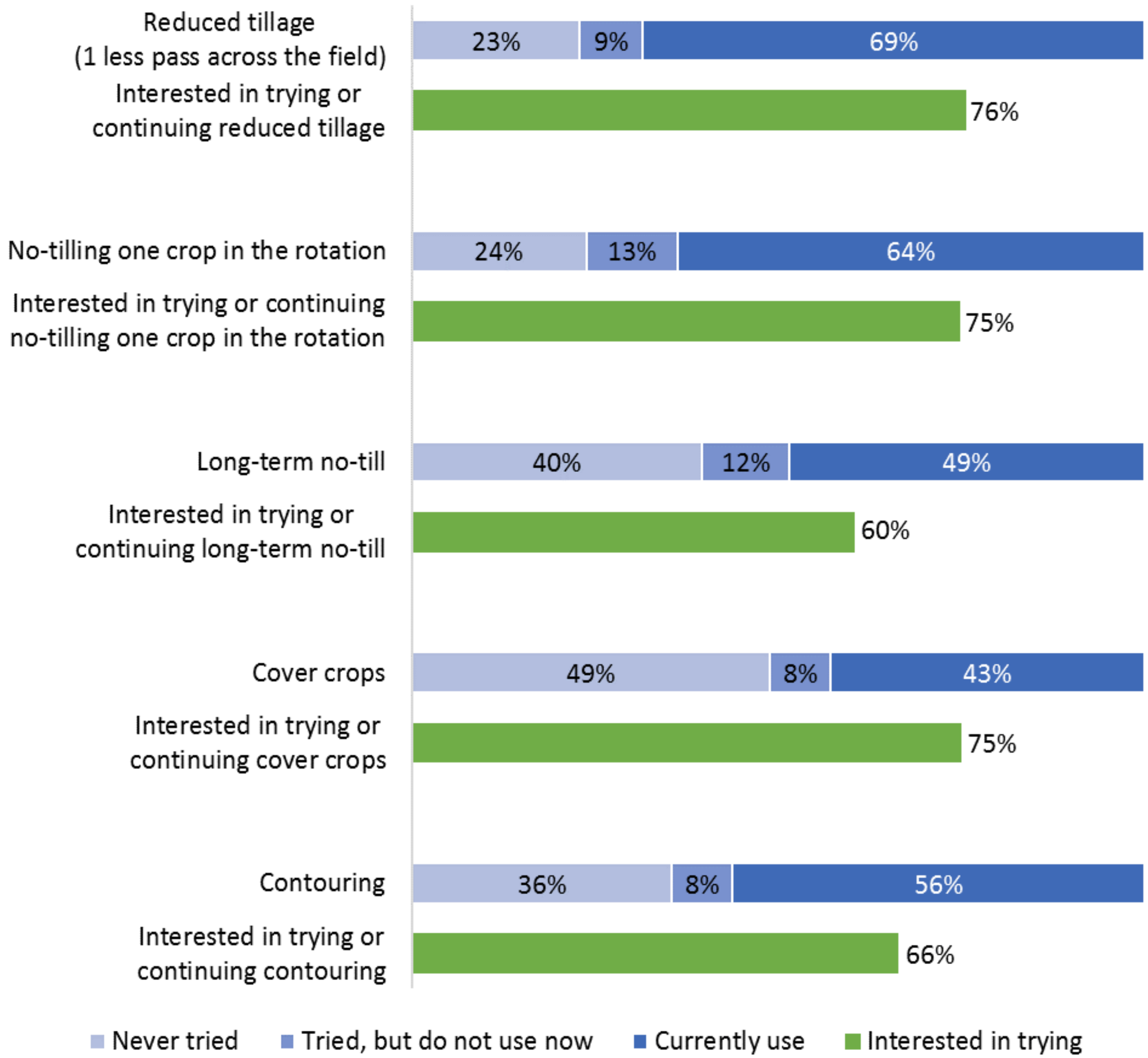
Flooding experiences: When asked about their experiences with flooding in the past, one out of five (20%) farmers reported that the ground they farm was prone to flooding. Fourteen percent of respondents indicated the property they own or farm has been affected by flooding from Clear, Buffalo, Deer, or Rhine Creeks. Although most of the respondents indicated that their crops did not suffer from high or standing water in the past 10 years (77%), slightly less than one-quarter (23%) reported having had those experiences.

Land use management practices:

The most common land use management practices that landowners and farmers used were reduced tillage (69%), no-tilling one crop in the rotation (64%), and contouring (56%). In contrast, cover crops and long-term no-till were the practices used least. Although cover crops were one of the least used management practices, a majority of respondents (75%) showed interest in continuing or trying it in the future.

Cover crops and contouring were perceived by the most individuals as having limitations to their adoption and expansion. Only 25% of respondents reported no limiting factors for cover crops and 41% indicated the same for contouring. For these two practices, time was considered a main obstacle along with expenses and lack of information and training. Although cover crops and long-term no-till were the land use management practices used least, they were seen as the most effective in improving water quality (61% and 57%, respectively).

Figure 7-9. Experience with using land use management practices

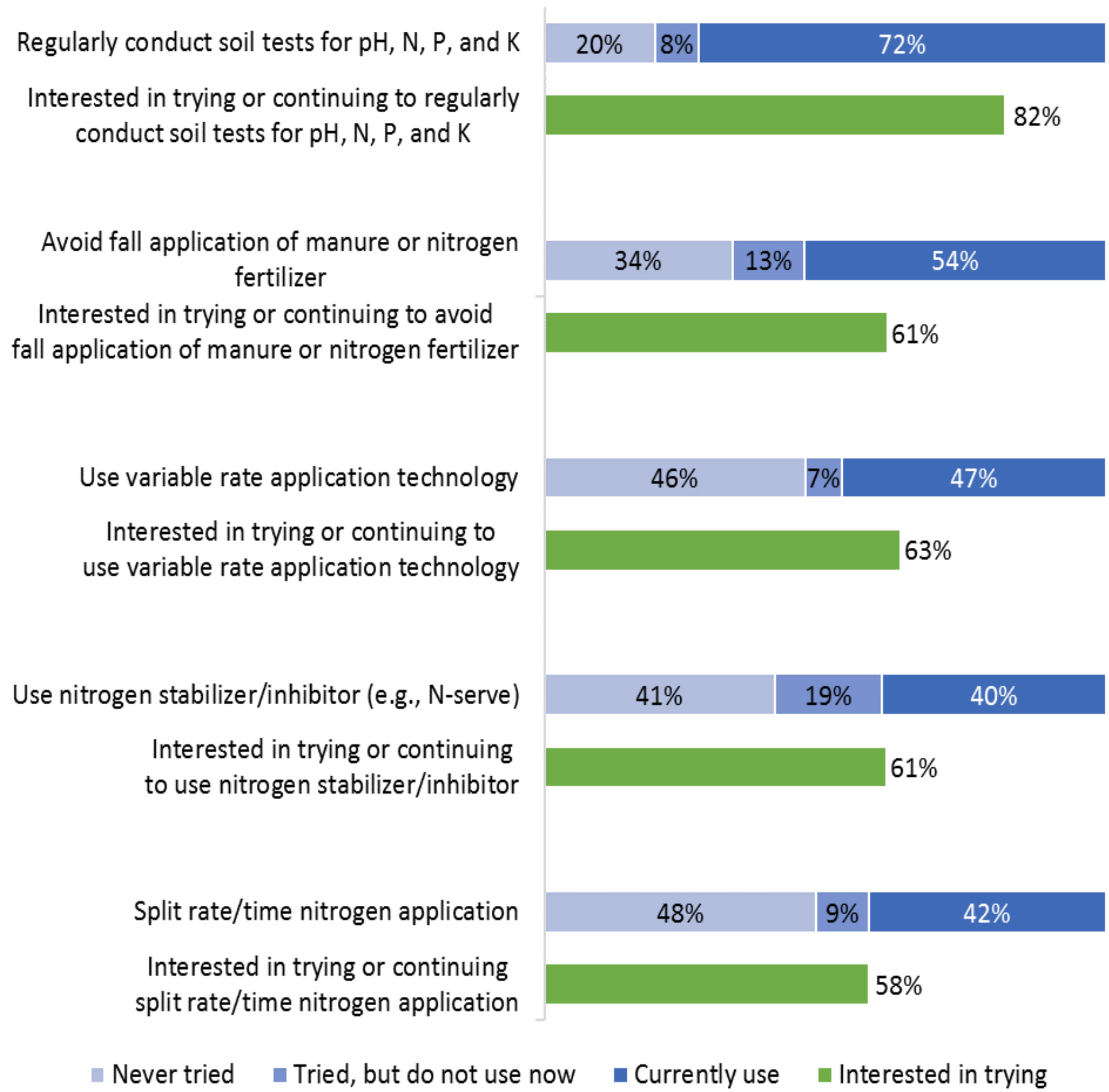


Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Nitrogen and phosphorous management practices: The nitrogen and phosphorus management practices used most often by farmers and landowners were soil tests (72%) and avoiding fall application of manure or nitrogen fertilizer (54%). In contrast, nitrogen stabilizers or inhibitors, variable rate application technology, and split rate/time nitrogen application were the practices used less frequently by farmers and landowners (41%, 46%, and 48%, respectively).

Interest in continuing or trying nitrogen and phosphorous practices was high, ranging from 58% for split rate/time nitrogen application to 82% for conducting soil tests on a regular basis. However, expense of implementation was noted as a limiting factor by over one-quarter of respondents for most of the nitrogen and phosphorous management practices. Time was the primary limiting factor reported for farmers changing nutrient application practices such as avoiding fall manure or nitrogen fertilizer application (21%) and using split rate/time nitrogen application (27%). Regularly conducting soil tests for pH, phosphorous, nitrogen, and potassium was seen as the most effective practice for improving water quality while avoiding application of manure or nitrogen fertilizer in the fall was viewed as the least effective.

Figure 7-10. Experience with nitrogen and phosphorous management practices

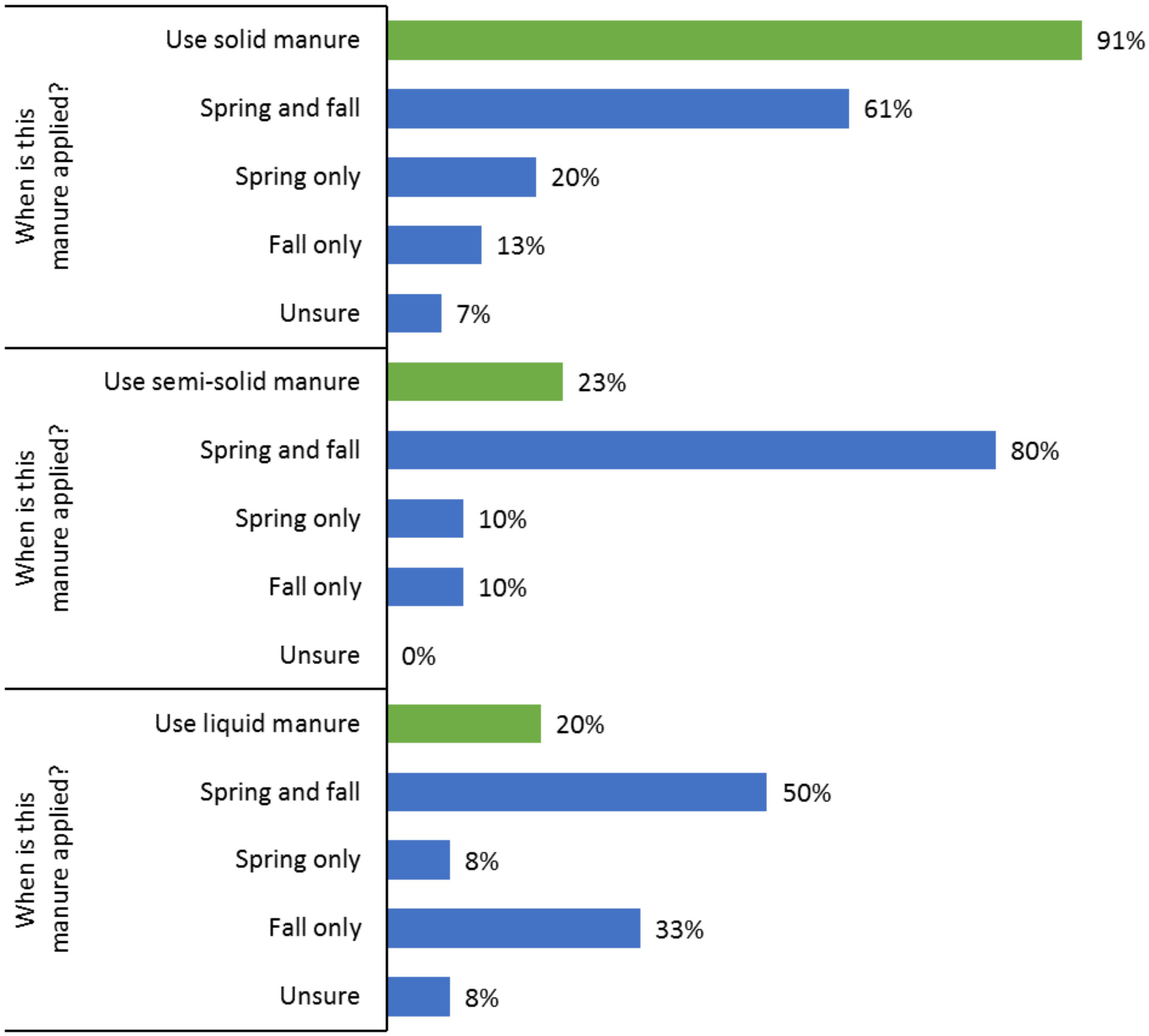


Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Livestock and manure application: About 31% of respondents owned livestock at the time of the survey. The most common type of livestock owned was cattle, with two-thirds of livestock owners (66%) reportedly having them. A plurality of respondents indicated a 50% cost-share program would be a reasonable financial incentive for improving pasture management with practices such as rotational grazing or improving watering systems.

Three of 10 farmers and landowners indicated manure was applied to the fields they farm or own. The most common form of manure applied to fields was solid manure (91%), followed by semi-solid and liquid manure (23% and 20%, respectively). Across all types of manure used, the majority of farmers applied manure in both the spring and fall. The most important factors for determining where to spread manure were crop nutrient needs (91%), soil test results (85%), own judgement based on experience (81%), and proximity to the manure source (76%). Conversely, the least important factors selected by respondents were recommendations from a variety of groups including the Natural Resources Conservation Service, family who farm, consultants, neighbors who farm, and equipment manufacturers, with pluralities of respondents indicating that these sources were not at all important.

Figure 7-11. Type of manure used and time of application

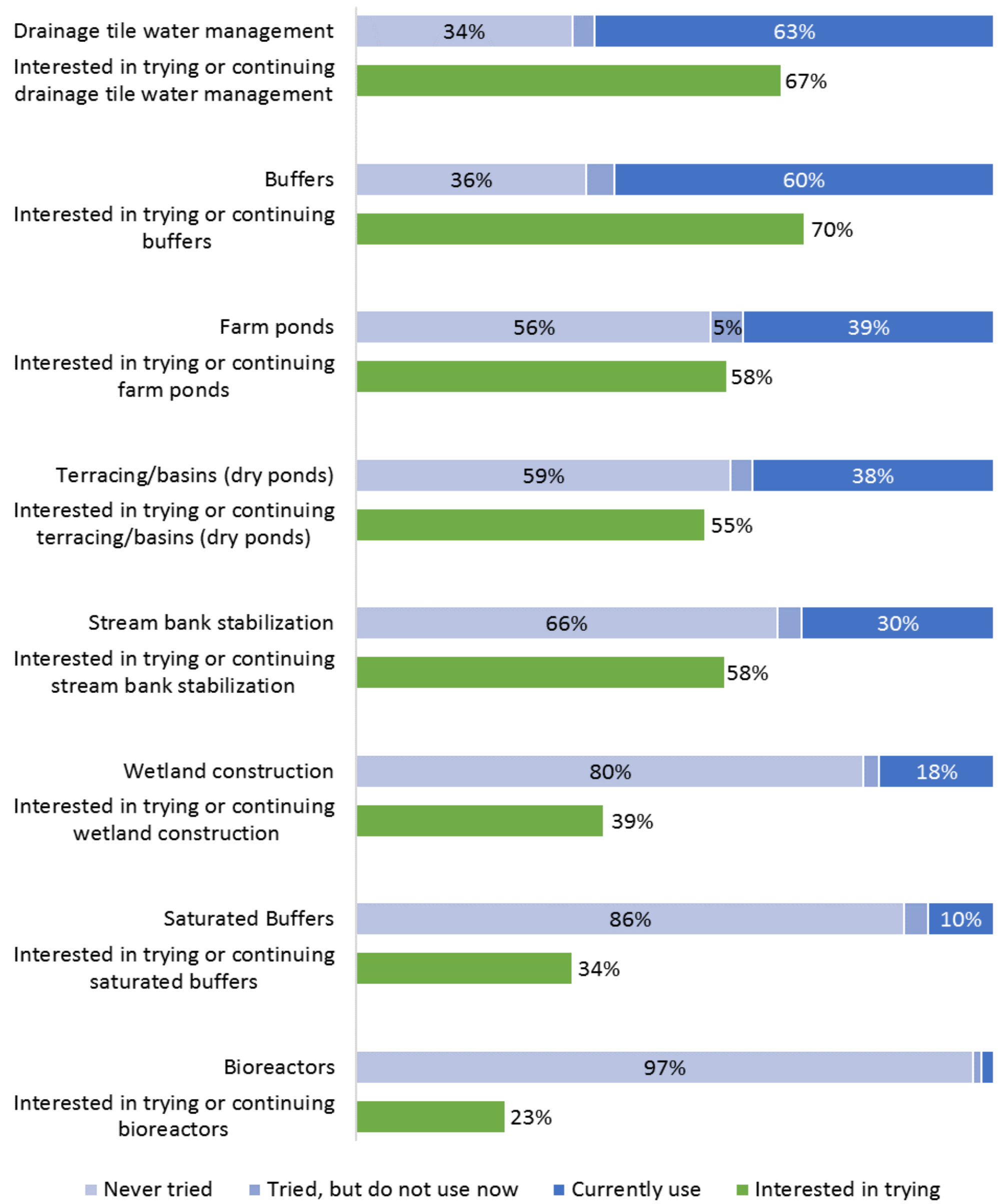


Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Soil and water conservation practices: The soil and water conservation practice with which farmers had the most personal experience was buffers (60%). This practice also had the highest reported interest from farmers and landowners regarding continuation or adoption (70%). Wetland construction, saturated buffers, and bioreactors were reportedly used by the fewest number of farmers and landowners (18%, 10%, and 2%, respectively), and had the lowest percentages of respondents indicating interest in adopting or continuing to use (39%, 34%, and 23%, respectively). However, this may indicate untapped opportunities for implementation of these practices given that levels of interest are higher than reported use.

Expense was seen as the most limiting factor for all soil and water conservation practices, with over one-half of respondents noting expense as a factor for all but two practices. For those two practices, buffers (43%) and saturated buffers (47%), the majority of landowners did not view expense as a limiting factor. A lack of training was also seen as a limiting factor by one-quarter of respondents for implementing saturated buffers (26%) and by about one-third of respondents for installing bioreactors (34%). A majority of farmers and landowners believed all the soil and water conservation management practices to be moderately or very effective at improving water quality in their area. However, saturated buffers, wetland construction, and bioreactors were viewed as less effective than were the other practices.

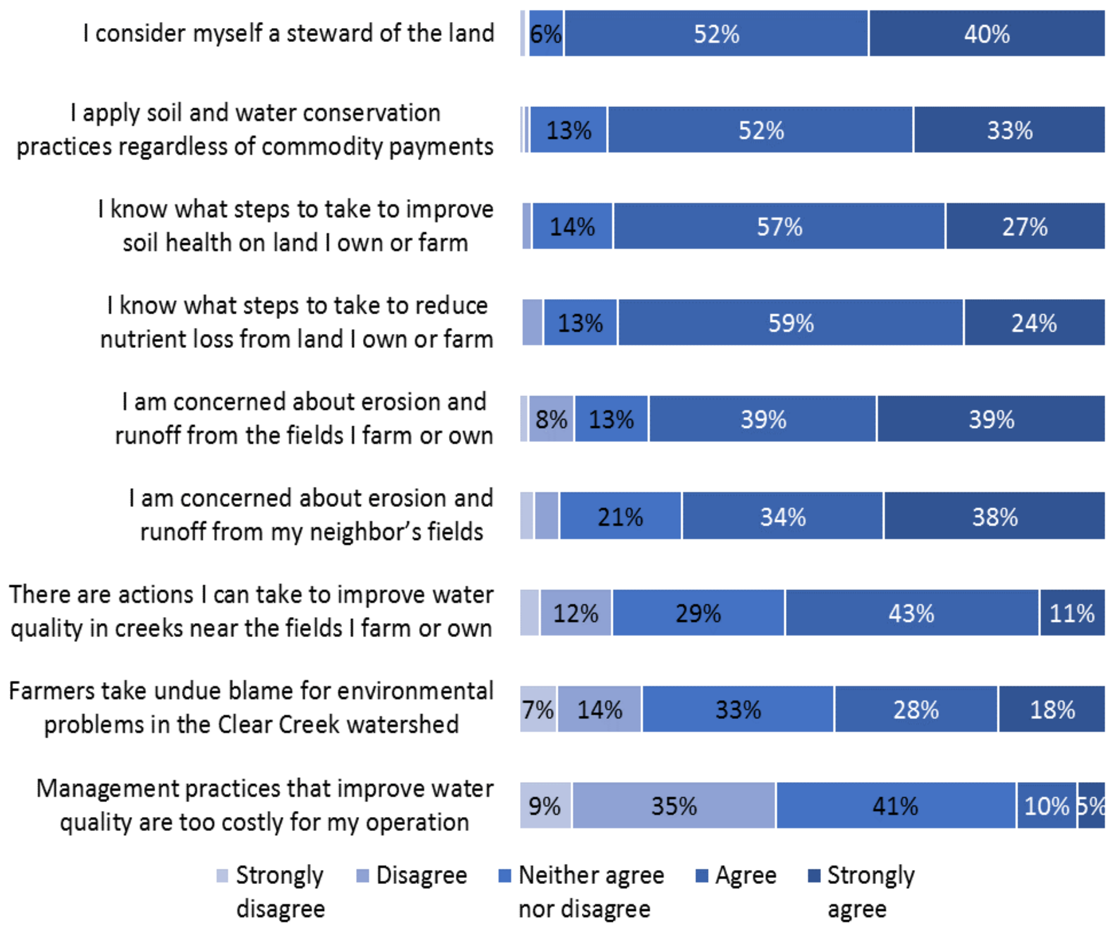
Figure 7-12. Experience with soil & water conservation practices



Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

Conservation and land stewardship attitudes: When asked about soil health and water quality, a vast majority of respondents agreed or strongly agreed that they apply soil and water conservation practices regardless of commodity payments (85%), they know what steps to take to improve soil health on (83%) and reduce nutrient loss (83%) from the land they own or farm. Seven in 10 respondents agreed or strongly agreed that they are concerned about the erosion from the fields they own or farm (78%) or the fields owned or farmed by their neighbors (72%). This concern did not necessarily translate to perceived ability to make change, as only 54% of respondents agreed or strongly agreed that there are actions they can take to improve the water quality in the creeks near where they farm.

Figure 7-13. Agreement or Disagreement with land stewardship statements



Source: Clear Creek Watershed Community Social Assessment, University of Northern Iowa Center for Social and Behavioral Research

7.2.3 Farm Results Summary

The this survey, nearly one-half of respondents owned land, but did not farm and most farmers rented at least some of the acres they farmed. Across all farming situations, the operators of the land, not the owners, were most often making decisions about crop rotation and soil and water conservation practices. One out of five (20%) farmers reported that the ground they farmed was prone to flooding. Although cover crops and long-term no-till were the land use management practices least used, they were viewed as the most effective in improving water quality. Three of four respondents showed interest in continuing or trying cover crops in the future. Expense was viewed as the most limiting factor for all soil and water conservation practices. Seven in 10 respondents agreed or strongly agreed that they are concerned about erosion from the fields they own or farm (78%) or the fields owned or farmed by their neighbors (72%). However, this concern did not necessarily translate to perceived ability to make change, as only 54% of respondents agreed or strongly agreed that there are actions they can take to improve the water quality in the creeks near where they farm. Just over half of respondents indicated that the quality of the water in their lakes was good or excellent. In contrast, rivers were considered the body of water with the worst water quality.

Chapter 8

WATERSHED ACTION PLAN

8.1 Process to Develop Goals & Objectives

Goals and objectives for the Clear Creek Watershed Management Plan were developed through an iterative process involving watershed stakeholders, the CCWC Board, and the Tech Team. The first step was a series of Planning Sessions that served two purposes. Stakeholders learned about research conducted and technical aspects of the watershed and participated in developing goals with locally driven objectives and implementation ideas. Three Planning Sessions were held, each with a specific watershed topic as summarized below.

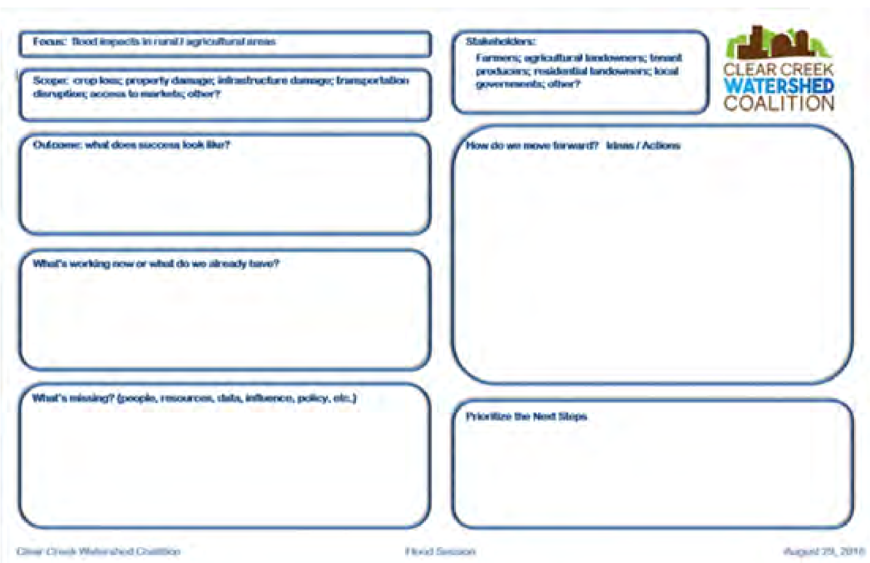
Flooding & Resiliency Planning Session

Photo Credit: Kate Giannini, Iowa Flood Center

8.1.1 Watershed Flooding & Resiliency Planning Session

On August 29, 2018, watershed stakeholders were invited to an information and goal setting event focused on Clear Creek's hydrology and factors that influence flooding and its impacts. The Clear Creek hydrology modeling results were presented by Antonio Arenas Amado, Assistant Research Engineer, with IIHR-Hydroscience & Engineering at the University of Iowa. James Martin, Regional Basin Coordinator with the Iowa Department of Agriculture and Land Stewardship, discussed how agriculture influences flooding and the impacts of on crops. A discussion on flood resiliency was led by Craig Just, Associate Professor in Civil & Environmental Engineering and Ashlee Johannes, IIHR-Hydroscience & Engineering Outreach & Engagement Coordinator, highlighting the disproportionate impact flooding has on socially vulnerable populations in the watershed.

Figure 8-1. Placement for Flood Mitigation Goal Setting



Source: East Central Iowa Council of Governments

The event concluded with an exercise to gather input about flood mitigation strategies where participants were provided placemats (example in Figure 8-1) with prompts to guide small group discussions about what successful flood mitigation would look like and how to get there. Feedback was requested on what is working, what is needed and suggested action steps. The written responses from each participant were recorded into one document included in Appendix B. A total of 37 stakeholders attended representing city & county staff; state agency staff; property owners; local college students; conservation interests; residents and elected officials.

8.1.2 Water Quality & Public Perception Planning Session

On September 19, 2018, watershed stakeholders were invited to an information and goal setting event focused on Clear Creek's water quality research and the local perceptions of water quality. Mary Beth Stevenson, IDNR Watershed Projects Manager, described the water quality monitoring, results and trends in the Clear Creek watershed. Chris Jones, University of Iowa IIHR Research Engineer, presented water quality research and provided a statewide perspective. Finally, Andrew Stephenson, Project Coordinator, and Mary Losch, Director of the Center for Social & Behavioral Research at the University of Northern Iowa, described the results of two surveys to measure awareness of and attitudes about water quality in the watershed.

The event concluded with an exercise to gather input about strategies to improve water quality in the watershed. Participants used color dot stickers to rank practices on posters (example in Figure 8-2) in terms of importance for improving water quality and their level of interest in the practice. The results were discussed as a larger group and consensus formed around the strategies and ideas presented in the summary document included in Appendix B.

A total of 27 stakeholders attended representing city & county public official and staff; state agency staff; agriculture interests; property owners; conservation interests; and business interests.

Water Quality Planning Session

Photo Credit: Kate Giannini, Iowa Flood Center

Water Quality Planning Session

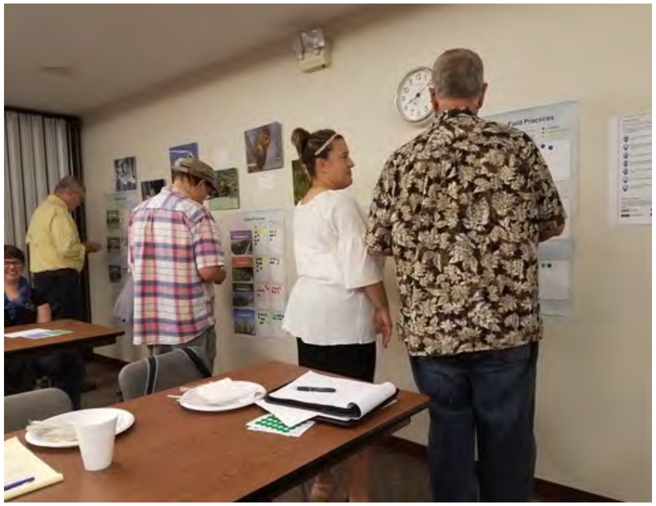
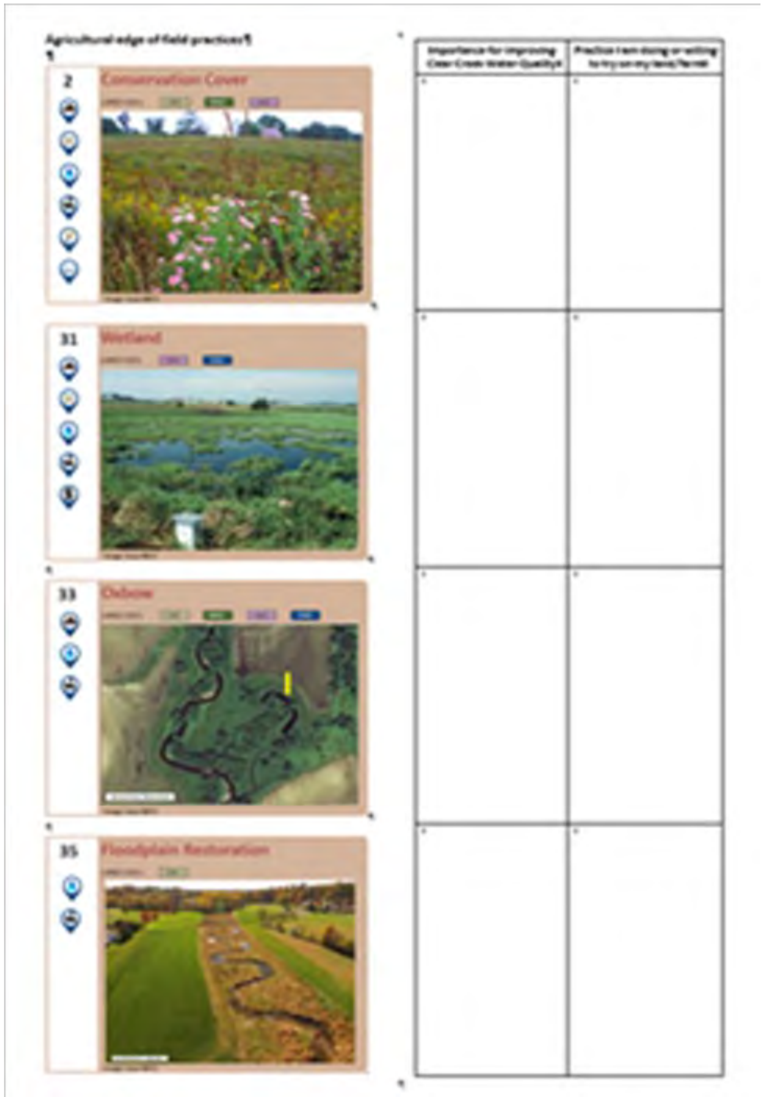


Photo Credit: Kate Giannini, Iowa Flood Center

Figure 8-2. Water Quality Practice Poster

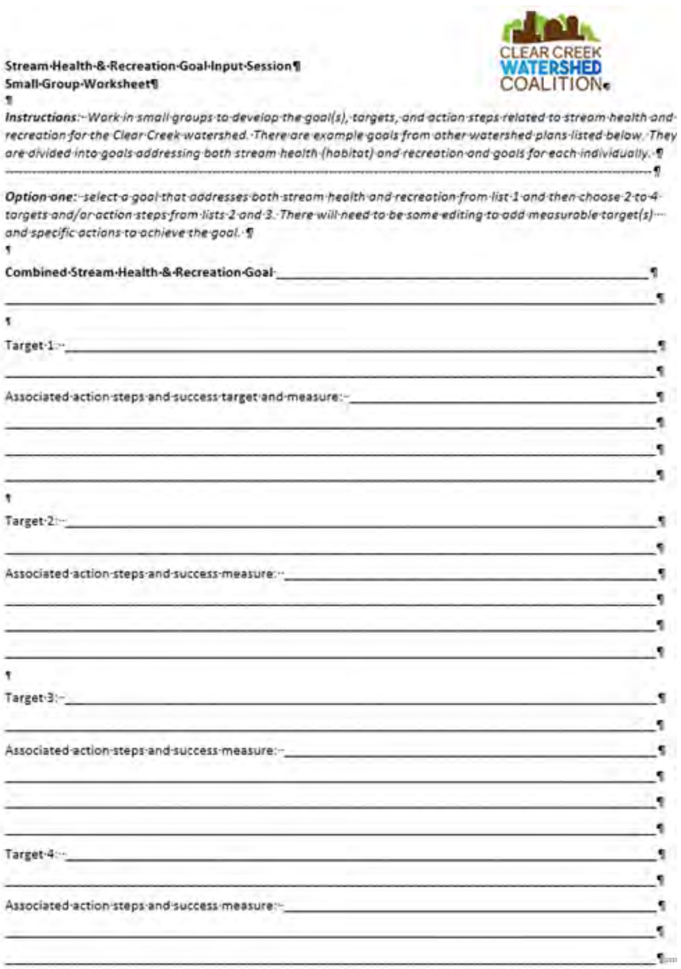


Source: ECICOG & Natural Resource Conservation Service

8.1.3 Stream Health and Recreation Planning Setting Session

On January 16, 2019, watershed stakeholders were invited to an information and goal setting event focused on Clear Creek's stream health and recreation opportunities. The event began with a presentation about what a healthy creek should look like and how it should function by Aaron Gwinnup, Project Manager with HR Green. Aaron also summarized potential improvements to address conditions in lower Clear Creek, which was part of an assessment HR Green did for the watershed plan and can be found in Appendix G. Brad Freidhof, Conservation Program Manager with Johnson County Conservation (pictured in Figure 8-3), described the restoration projects at Kent Park Lake and what lessons can benefit the larger watershed. To finish, Sherri Proud, Parks Director for the City of Coralville, presented information about the existing parks and trails in the watershed and the potential for an expansion of recreation opportunities.

Figure 8-4. Stream Health Goal Worksheet



CLEAR CREEK WATERSHED COALITION

Stream Health & Recreation Goal Input Session
Small Group Worksheet

Instructions: *Work in small groups to develop the goal(s), targets, and action steps related to stream health and recreation for the Clear Creek watershed. There are example goals from other watershed plans listed below. They are divided into goals addressing both stream health (habitat) and recreation and goals for each individually.*

Option one: *select a goal that addresses both stream health and recreation from list 1 and then choose 2 to 4 targets and/or action steps from lists 2 and 3. There will need to be some editing to add measurable target(s) and specific actions to achieve the goal.*

Combined Stream Health & Recreation Goal ______

Target 1: ______

Associated action steps and success target and measure: ______

Target 2: ______

Associated action steps and success measure: ______

Target 3: ______

Associated action steps and success measure: ______

Target 4: ______

Associated action steps and success measure: ______

Source: ECICOG

Participants were asked to form small groups and complete goal setting worksheets (example in Figure 8-4) to identify their preferred goal and actions to achieve the goal. The small groups reported their responses to the whole group, who provided reactions and suggestions for the goals and action steps presented. These responses were used to form the habitat and recreation strategies in the Implementation Section. A summary of the responses is included in Appendix B.

A total of 49 stakeholders attended representing city & county public officials and staff; state agency staff; local health department staff; agriculture interests; property owners; local college students; and conservation interests.

Figure 8-3 Steam Health & Recreation Planning Session

Photo Credit: Kate Giannini, Iowa Flood Center

8.2 Goals & Objectives

The input from the Goal Setting Sessions was reviewed and discussed by both the CCWC Board and the Tech Team over the course of several meetings and work sessions. The CCWC 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 took a close look at the watershed assessment data and further refined the goals, objectives and implementation strategies based on the assessment and the resource concerns identified at the start of the planning process.

Organizational Goal is to establish the Clear Creek Watershed Coalition as a leader and advocate for local solutions to water quality and flooding concerns. This will be accomplished through working cooperatively with stakeholders to establish partnerships and shared resources to implement the Clear Creek Watershed Management Plan.

Flood Risk Management Goal is to protect the floodplain and reduce the peak flow observed at the Clear Creek USGS gage (Camp Cardinal Road) in April 2013 by 25%. The April 2013 flood event recorded a peak flow of 6,480 cubic feet per second, which is the highest flow event in the last 15 years. It was selected as a more recent event that falls between the 4% (25-year) and 2% (50-year) flood occurrence probabilities. The target reduction is 1,620 cubic feet per second through the following objectives:

1. Communities reduce stormwater from impervious areas and protect local floodplains by encouraging infiltration practices, undertaking flood mitigation projects to protect critical infrastructure and participate in the National Flood Insurance Program (NFIP) and its Community Rating System (CRS).
2. Recommend policy changes to protect open space and the floodplain for people and wildlife by educating policy makers about flood impacts of various land uses and encouraging the development and adoption of a future development ordinance to limit development in the floodplain.
3. Improve community resilience by connecting people and building watershed empathy by removing or protecting structures that suffer repetitive loss from flooding and encourage policies to construct quality housing outside flood prone areas accessible to socially vulnerable populations.
4. Engage with rural communities to mitigate flood impacts by implementing the Flood Risk Reduction Conservation Scenario. The Flood Risk Reduction Conservation Scenario (FRRC) was developed by IIHR using the GHOST model as the combination of practices that would reduce peak flow by 1,620 cubic feet per second. The Flood Risk Reduction Conservation Scenario assumes that all row crop acres in the watershed have adopted the STRIPS Project recommendation of 10% native vegetation and calculates the level of cover crops and distributed storage implementation that is needed to reduce the peak flow. Using the 2017 land use figures from Table 2-4, the total number of row crop acres is 40,088 meaning that the Flood Risk Reduction Conservation Scenario would require 4,000 acres be converted to native vegetation per the STRIPS Project, 14,382 acres would utilize cover crops and 2,858 acre-feet of storage added through structural practices.

Water Quality Goal is to protect and improve surface and ground water in the Clear Creek Watershed through the following objectives:

1. Follow Iowa's Nutrient Reduction Strategy guidance to implement conservation practices that reduce N and P load at Camp Cardinal Road monitoring site using 2017 sampling as the baseline as follows:

   Reduce in-stream nitrogen levels by 41% (4,961 pounds/day) to be in line with Iowa Nutrient Reduction Strategy statewide goals. The Clear Creek Technical Team recommends adopting the Iowa Nutrient Reduction Strategy goal of reducing nitrogen levels by 41% (4,961 lbs / day) in Clear Creek.

   Reduce in-stream phosphorus levels by 86% (1,065 pounds/day) in average flow conditions to meet benchmark indicators for aquatic life. The Clear Creek Technical Team recommends using the Trophic State Index as a benchmark to establish a goal of reducing phosphorus levels by 86% in average flow conditions. There is more detail on setting the water quality goals in Section 3.8.

2. Encourage & implement practices that reduce in-stream E. coli levels by 94% in average flow conditions in order to protect human health. The water quality goal for Clear Creek to meet state standards is a reduction of 94% (2.26E+12 colony forming unit (cfu) / day) in average flow conditions. There is more detail on setting the water quality goals in Section 3.8.

3. Encourage & implement practices that treat the number of acres delivering above 1 ton per year of sediment by 50%

4. Encourage & implement Stormwater management practices that will infiltrate runoff up to a 2.5-inch rain event (the channel protection volume) as recommended in the Iowa Stormwater Management Manual

Habitat & Recreation Goal is to create healthy watershed function that enhances recreation and public health through improved water quality, habitat restoration and improved connectivity to parks, trails and streams in the Clear Creek watershed through the following objectives:

1. Increase the quantity and quality of habitat to support an abundance of terrestrial, aquatic and avian wildlife in the watershed
2. Recommend Implementation of restoration recommendations from the *Lower Clear Creek Stream Assessment Within Coralville* by HR Green 2019
3. Promote and improve existing recreational resources such as park amenities, trails and stream access points

8.3 Implementation Strategies

The goal objectives are organized in this section into a detailed action plan with implementation strategies that can be used by CCWC member governments, watershed stakeholders, and other partners to make progress towards, and measure, watershed management goals. The action plans are organized by the Plan goals and add a target outcome by the end of the 20-year plan horizon with 7-year milestone action steps. The action plans also recommend a group to take the lead on each implementation strategy, estimates the cost in 2020 dollars and lists possible technical resources / funding options. Each goal objective has associated Information & Education Components to assist with the completion of the implementation strategies.

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

- Agriculture Related Advisory Group – will include representatives from local farmers, local chapters of the Farm Bureau and commodity groups, IDALS, NRCS and certified crop advisors to advise on project development and education strategies.
- Policy & Ordinance Review Subcommittee – will include elected and staff representatives from the cities and counties.
- Infrastructure Subcommittee – will include representatives from city stormwater and public works staff and county road department staff.
- Education & Outreach Subcommittee – will include representatives from city stormwater staff, schools, CCWC Member communications staff and Soil & Water Conservation District to develop and implement education strategies.
- Monitoring & Analysis Subcommittee – will include representatives from the University of Iowa, DNR, Iowa Flood Center, and the Soybean Association to develop and implement a long-term monitoring and data collection plan.

Table 8.1 Clear Creek Watershed Action Plan for the Clear Creek Watershed Coalition as an Organization

Organizational Goal: CCWC established as a leader and advocate for local solutions to water quality and flooding concerns							
Objective 1: Work cooperatively with stakeholders to establish partnerships and shared resources to implement the Watershed Management Plan							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
1a)	Establish a planning framework for tracking Clear Creek Watershed Management Plan implementation and progress	Plan adopted and tracking process established; year 2, 4 & 6 progress reports completed and presented to the CCWC Board	Ten year Plan update completed; year 8, 12 & 14 progress reports completed and presented to the CCWC Board	20 year plan adopted with bi-annual progress reports tracking BMPs, flood impact costs and water quality results	CCWC Board; CCWC Coordinator	Included in Coordinator support	CCWC Board & Member Entities
1b)	Develop a water quality monitoring plan for Clear Creek and its tributaries	Request that Clear Creek be added to the Iowa DNR's Ambient Stream Testing program; collect samples to establish baselines for N, P and sediment	Carry out the monitoring plan and continue collecting water samples	Water quality baselines and regular sampling established to measure progess in reducing N, P, bacteria and sediment as called for in the Plan	CCWC Coordinator	Included in Coordinator support	CCWC Board; Iowa DNR
1c)	Establish funding mechanisms to continue the CCWC as an organization and to implement the Plan	Develop & recommend a CCWC Member contribution formula; pursue at least two grant opportunities for project(s) in the Plan	Pursue at least two grant opportunities for projects identified in the Plan	Stable funding for the CCWC as an organization and to fund Plan implementation	CCWC Board; CCWC Coordinator	Included in Coordinator support	CCWC Board & Member Entities
1d)	Establish a full time Watershed Coordinator position to provide organizational management for the CCWC and to implement the Plan	Funding secured to employ a coordinator beyond the end of the IWA project ending in December 2021	Coordinator continues Plan implementation and reports on progress bi-annually	Full time Watershed Coordinator in place working with the CCWC to implement the Plan	CCWC Board; CCWC Coordinator	$128,960 annually ($2,579,200 total)	CCWC Board; NRCS IPC grant
Information & Education Component: Create education programs that inspires environmental stewardship and generates involvement in local watershed solutions							
I/E Task 1.1	Develop an education & outreach plan to build watershed awareness and assist in implementing the Plan	Program options: Create & install signs highlighting stream features, function and how to improve Clear Creek; Create program to recognize and share BMPs on the CCWC Facebook page and other social media	Program options: Partner with Take a Kid Outdoors program on events; Create program encouraging people to send pictures of plants & animals they see in the Clear Creek Greenbelt to CCWC Facebook page	Create and implement watershed awareness & education programs to generate involvement in watershed solutions to build support for Plan implementation	CCWC Coordinator; CCWC Members; Local CCBs	Included in Coordinator support	CCWC Board; local CCBs; ISU Extension

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.2 Clear Creek Watershed Action Plan for Flood Risk Management

Flood Risk Management Goal: Protect the floodplain & reduce peak flow observed at Clear Creek USGS gage (Camp Cardinal Road) in April 2013 by 25							
Objective 1: Communities reduce stormwater from impervious areas and protect local floodplains							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
1a)	Recommend policies to increase the use of infiltration practices by 75% in all new development and all capital improvements in existing communites	Communities determine their infiltration practice implementation baseline in 2019 and complete 25% more projects over baseline	Communities complete 50% more stormwater infiltration practices over 2019 baseline	Each community increase stormwater infiltration practice implementation by 75% using 2019 as a baseline	CCWC Members; Developers	Included in Coordinator support	IDALS - Urban Practices grant program & local funds
1b)	Encourage participation in the National Flood Insurance Program (NFIP) and its Community Rating System (CRS) by CCWC Members	Promote the NFIP and CRS to CCWC Members and assist in joining the NFIP and/or improving their CRS rank	Promote the CRS to CCWC Members and assist in improving their rank	All CCWC Members participating in NFIP and achieve a CRS Classification rank of 2 points better than their 2019 rank or better	CCWC Coordinator; CCWC Members	Included in Coordinator support	CCWC Board & Member Entities
1c)	Encourage communities to protect critical facilities & infrastructure; complete flood mitigation projects identified in local Hazard Mitigation Plans; and construct Half Moon Road regional detention basin	Use watershed assessment and local Hazard Mitigation Plans to identify locations at risk and map. Prioritize projects and begin seeking funding.	Complete projects as funding becomes available	Critical infrastructure protection and other flood mitigation projects indentified, prioritized and completed by 2040	CCWC Members	$3 million	FEMA - HMGP
Information & Education Component: Educate the community about flood risks and how they can be part of the solution							
I/E Task 1.1	Organize opportunities to take urban residents to rural areas and rural residents to urban areas to observe issues caused by flooding and the solutions implemented to date	Organize at least two urban / rural tour	Organize at least two urban / rural tour	More informed watershed residents who advocate for urban and rural projects to address flooding through hosting a total of 6 workshop/tours with an average of 20 participants	CCWC Coordinator	Included in Coordinator support	CCWC Members; local sponsors - co-ops / ag groups / banks
I/E Task 1.2	Build awareness of flood risk and intensifying rain events due to climate change and promote ways residents can reduce stormwater run-off	Annual "flood awareness" event at CCWC meeting inviting Iowa Flood Center to present recent trends; increase $$ spent on local BMP cost share programs by 15% over 2019	Annual "flood awareness" event at CCWC meeting inviting Iowa Flood Center to present recent trends; increase dollars spent on local BMP cost share program by 30% over 2019	Clear Creek watershed community have access to annual flood awareness information and uses local BMP cost share programs 40% more than in 2019	CCWC Coordinator; CCWC Members	$60,000 annually for municipal cost-share	Municipal / County cost-share program

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.2 continued

Flood Risk Management Goal: Protect the floodplain & reduce peak flow observed at Clear Creek USGS gage (Camp Cardinal Rd) in April 2013 by 25%							
Objective 2: Recommend policy changes to protect open space and the floodplain for people and wildlife							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
2a)	Educate CCWC Member policy makers about the flood impacts of various land uses	Contract with IIHR to run more future development scenarios using the GHOST model to show the impact on peak flows	Use the future development scenarios to educate policy makers	CCWC Member policy makers informed about the flood impacts of land use decisions using future development scenarios from the IIHR GHOST model	CCWC Coordinator; Watershed Partners	$20,000 for model run	CCWC Board & Member Entities
2b)	Encourage policy language for future development that decreases stormwater impacts and adapts to climate change predictions of more intense rainfall events	Educate CCWC Members about policies to protect floodplains and be resilient to flooding. Create future development ordinance language to limit development in the floodplain.	Promote the adoption of future development ordinance language to limit development in the floodplain	future development policy aligned with the Clear Creek Watershed Management Plan enacted in all CCWC Member entities	CCWC Members; CCWC Coordinator	Included in Coordinator support	CCWC Board & Member Entities
Information & Education Component: Educate CCWC Member policy makers and staff about ways to minimize flood impacts							
I/E Task 2.1	Educate CCWC Member policy makers about the flood impacts of various land uses	Host at least one "Land Use Flood Impacts" workshop for CCWC Member policy makers	Host at least one "Land Use Flood Impacts" workshop for CCWC Member policy makers	CCWC Member policy makers informed about the flood impacts of land use decisions through at least 3 workshops with an average of 10 participants	CCWC Coordinator; Watershed Partners	Included in Coordinator support	CCWC Board & Member Entities

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.2 continued

Flood Risk Management Goal: Protect the floodplain & reduce peak flow observed at Clear Creek USGS gage (Camp Cardinal Rd) in April 2013 by 25%							
Objective 3: Improve community resilience by connecting people and building watershed empathy							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
3a)	Encourage buyouts of the 40 structures defined as Repetitive Loss structures (Table 2-7) and any other flood prone structures	Identify and prioritize buyout and relocation / demolition projects in the 100-year and 500-year floodplain	Complete projects as funding becomes available	The 40 Repetitive Loss structures cleared or protected by flood mitigation projects by 2040	CCWC Members	$6 million	FEMA - HMGP
3b)	Encourage policies to construct quality housing accessible to socially vulnerable populations not in flood prone areas	Increase awareness of flood impacts to vulnerable populations and availability of housing outside the floodplain	Promote the adoption of the Flood Resilience for All policy to prioritize housing outside flood prone areas	Flood Resilience for All policy aligned with the Clear Creek Watershed Management Plan enacted in all CCWC Member entities	CCWC Members	Included in Coordinator support	CCWC Board & Member Entities
Information & Education Component: Educate socially vulnerable populations about flood risk and ways to protect themselves							
I/E Task 3.1	Develop awareness campaigns for renters and other socially vulnerable populations connecting them to resources for flood awareness and recovery	Awareness campaign developed and delivered about flood risks and resources available to avoid flood impacts and/or recover from flooding	Continue awareness campaign and expand ways to inform the public about flood risk and the resources available to them	Reduce risk to vulnerable populations in flood events through awareness campaign that increases requests for assistance by 10%	Local Emergency Management; CCWC Coordinator	Included in Coordinator support	CCWC Board & Member Entities

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.2 continued

Flood Risk Management Goal: Protect the floodplain & reduce peak flow observed at Clear Creek USGS gage (Camp Cardinal Rd) in April 2013 by 25%							
Objective 4: Engage with rural communities to mitigate flood impacts by implementing the Flood Risk Reduction Conservation Scenario (FRRCS)							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
4a)	Implement Flood Risk Reduction Conservation Scenario = 10% native vegetation (Prairie STRIPS Project) & 37% cover crops on row crop acres and add 2,858 acre-feet of storage with structural practices	One-third to the target = 1,333 acres converted to native vegetation (STRIPS); 4,944 acres planted to cover crops annually; 953 acre-feet of storage added by structural practices	Two-thirds to the target = 2,667 acres converted to native vegetation (STRIPS); 9,888 acres planted to cover crops; 1,906 acre-feet of storage added by structural practices	4,000 row crop acres converted to native vegetation (STRIPS); 14,832 acres of cover crops planted annually; 2,858 acre-feet of storage added by structural practices	CCWC Coordinator	STRIPS - $1.6M; Cover crops - $741,600 in year 20; Structural - $64.3M	NRCS; IDALS; FEMA; Landowners
4b)	Complete the Iowa Watershed Approach projects	Project complete in 2021	Seek funding for projects identified through the IWA but not funded	Complete the 50 practices that made it through Iowa Watershed Approach	CCWC Coordinator	$4 million IWA grant funded	Iowa Watershed Approach - HUD
4c)	Partner with county road departments to identify flood impacted areas and implement projects to mitigate impact / reduce reoccurring damage costs	Identify priority locations for flood mitigation projects such as on-road structures; complete projects as funding becomes available	Complete projects as funding becomes available	Reduce flood impacts to County roads; contribute to the FRRCS target to add 2,858 acre-feet of storage; quantify flood impacts of completed projects	CCWC Coordinator; CCWC Members	$2 million	County Road Department; FEMA - HMGP; IDALS
Information & Education Component: Educate the agricultural community about flood risks and how they can be part of the solution							
I/E Task 4.1	Engage the agricultural community through small events with ag groups and youth groups such as FFA and 4-H clubs	Organize at least two outreach event with neighbors and/or farm related groups	Organize at least two more outreach event with neighbors and/or farm related groups	Reach a diverse set of rural audiences to increase flood mitigation projects and activities through at least 6 events with an average of 10 participants	CCWC Coordinator; local school districts	Included in Coordinator support	CCWC Board & Member Entities

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

The Flood Risk Reduction Conservation Scenario is a combination of native vegetation, cover crops and structural practices like ponds or terraces to reduce the peak flow observed at the Clear Creek USGS gage (Camp Cardinal Road) in April 2013 by 25%. The 2013 flood event recorded a peak flow of 6,480 cubic feet per second at the Camp Cardinal Road USGS gage. The Flood Risk Reduction Conservation Scenario assumes that all row crop acres in the watershed have adopted the Prairie STRIPS Project recommendation of 10% native vegetation and calculates the level of cover crops/no-till and distributed storage implementation that is needed to reduce the April 2013 peak flow by 1,620 cubic feet per second.

Table 8.3 Clear Creek Watershed Action Plan for Water Quality Improvement

Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
Water Quality Goal: Protect and improve surface and ground water resources in the Clear Creek Watershed							
Objective 1: Follow Iowa's Nutrient Reduction Strategy guidance to implement practices that reduce N load by 41% and P load by 86% at Camp Cardinal Road monitoring site using 2017 sampling as the baseline							
1a)	Encourage management practices such as no-till / strip-till, cover crops, contour farming, conservation cover and nutrient management	Implement up to 1,872 new acres of cover crop annually over the Flood Risk Reduction Conservation Scenario totals to reduce N 41% and P 86%	Implement up to 3,745 new acres of cover crop annually over the Flood Risk Reduction Conservation Scenario totals to reduce N 41% and P 86%	In conjunction with full implementation of the Flood Risk Reduction Conservation Scenario, implement an additional 5,618 acres of cover crop (total of 5,618 acres treated in 1a and 1c)	CCWC Coordinator; Local SWCD	$280,900 in year 20 or $50 per acre	NRCS; IDALS
1b)	Encourage edge of field practices such as wetlands, bioreactors and saturated buffers	Implement a combination of bioreactors and saturated buffers that will treat a total of 566 acres to reduce N 41% and P 86%	Implement a combination of bioreactors and saturated buffers that will treat a total of 1,133 acres to reduce N 41% and P 86%	Implement a combination of bioreactors and saturated buffers that will treat a total of 1,700 acres to reduce N 41% and P 86%	CCWC Coordinator; Local SWCD	$200,600	NRCS; IDALS
1c)	Encourage structural practices such as ponds, terraces and grade stabilization structures	Implement a combination of ponds, terraces and grade stabilization structures that will treat up to 1,872 acres to reduce N 41% and P 86%	Implement a combination of ponds, terraces and grade stabilization structures that will treat up to 3,745 acres to reduce N 41% and P 86%	In conjunction with 1a, implement a combination of ponds, terraces and grade stabilization structures to reach a total of 5,618 acres treated to reduce N 41% and P 86%	CCWC Coordinator; Local SWCD	$19,663,000 in year 20 or $3,500 per acre treated	NRCS; IDALS
Information & Education Component: Educate the agricultural community about the Nutrient Reduction Strategy							
I/E Task 1.1	Promote the Nutrient Reduction Strategy and its recommended practices	Organize at least one workshop, tour, field day or other peer to peer event for farmers and other stakeholders	Organize at least one workshop, tour, field day or other peer to peer event for farmers and other stakeholders	More informed farmers interested in practices by hosting a total of three workshops/tours with an average of 20 participants	CCWC Coordinator; Local SWCD	Included in Coordinator support	NRCS; IDALS; local banks / co-ops / ag groups
I/E Task 1.2	Partner with local FFA teachers to incorporate watershed & water quality issues into their classes	Identify FFA teachers in the watershed and establish a recurring presentation schedule to FFA chapters	Give reocurring presentations to FFA chapters	Clear Creek water quality informaton utilized by local FFA groups through a presentation program reaching future farmers	CCWC Coordinator; Local SWCD	Included in Coordinator support	NRCS; IDALS

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.3 continued

Water Quality Goal: Protect and improve surface and ground water resources in the Clear Creek Watershed							
Objective 2: Encourage & implement practices to reduce in-stream *E. coli* levels by 94% in average flow conditions to protect human health							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
2a)	Request bacteria monitoring on Clear Creek and its tributaries to meet designated use standards	Secure funding to support bacteria monitoring and develop a monitoring plan	Complete monitoring plan	Implement strategies to meet designated use according to the monitoring plan	CCWC Coordinator; Local SWCD	Included in Coordinator support	NRCS; IDALS
2b)	Promote development of Manure Nutrient Management Plans by landowners with pastured cattle in the watershed	One-third to the target = Complete Manure Nutrient Management Plans for 785 animal units (cows)	Two-thirds to the target = Complete Manure Nutrient Management Plans for 1,570 animal units (cows)	Complete Manure Nutrient Management Plans for 2,356 animal units (cows)	CCWC Coordinator; Local SWCD	$3,000 per plan; $150,000 total	NRCS; IDALS
2c)	Focus on improving septic systems in the watershed through promotion of State Revolving Fund programs	Establish a 2022 baseline of the use of State Revolving Fund programs to repair failing septic systems	25% increase in the use State Revolving Fund programs to repair failing septic systems	50% increase in the use of State Revolving Fund programs over 2022 baseline to repair failing septic systems	Local Health Dept.; CCWC Coordinator	Included in Coordinator support	State Revolving Fund
Information & Education Component: Educate various audiences about the importance of reducing bacteria levels in surface water							
I/E Task 2.1	Communicate with residents about the relationship between stream health and human health	Host at least one community engagement events about water quality (outdoor classrooms, watershed tours, paddling outings, creek clean-ups)	Host at least one community engagement events about water quality (outdoor classrooms, watershed tours, paddling outings, creek clean-ups)	Increase awareness through a total of 3 community engagement events, with an average of 15 participants, about the impact people, pets and wildlife have on stream health	CCWC Coordinator & Members; SWCDs; CCBs; Health Depts	Included in Coordinator support	CCWC Members
I/E Task 2.2	Communicate with households utilizing septic systems about impacts of human waste management on stream health	Organize at least one workshop for septic system upgrades	Organize at least one workshop for septic system upgrades	Increase awareness through a total of 3 workshops with an average of 10 participants, about the impact of failing septic systems and the resources to upgrade those systems	Local Health Dept.; CCWC Coordinator	Included in Coordinator support	State Revolving Fund

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.3 continued

Water Quality Goal: Protect and improve surface and ground water resources in the Clear Creek Watershed							
Objective 3: Encourage & implement practices that treat agricultural acres delivering above 1 ton per year of sediment by 50%							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
3a)	Promote structural practices (terraces & sediment basins) on all crop acres identified as a Critical Sediment Delivery Source Areas displayed in Figure 6-8	Sediment reducing practices implemented to treat up to 2,116 acres in the Critical Sediment Delivery Source Areas	Sediment reducing practices implemented to treat up to 4,233 acres in the Critical Sediment Delivery Source Areas	Sediment reducing practices implemented to treat up to 6,350 acres in the Critical Sediment Delivery Source Areas	CCWC Coordinator; Local SWCD	$22,225,000 in year 20 or $3,500 per acre treated	NRCS; IDALS
3b)	Promote management practices such as cover crops, no-till and strip-till on all crop acres identified as a Critical Sediment Delivery Source Areas displayed in Figure 6-8	Locate up to 2,116 acres of the total recommended annual cover crop / no-till target outlined in Table 9-1 in Critical Sediment Delivery Source Areas	Locate up to 4,233 acres of the total recommended annual cover crop / no-till target outlined in Table 9-1 in Critical Sediment Delivery Source Areas	Locate up to 6,350 acres of the total recommended annual cover crop / no-till target outlined in Table 9-1 in Critical Sediment Delivery Source Areas	CCWC Coordinator; Local SWCD	$317,500 in year 20 or $50 per acre	NRCS; IDALS
Information & Education Component: Educate agricultural community about practices to reduce sediment through erosion							
I/E Task 3.1	Promote structural and management practices that reduce sediment through erosion	Organize at least one workshop, tour, field day and other peer to peer event for farmers and other stakeholders	Organize at least one workshop, tour, field day and other peer to peer event for farmers and other stakeholders	More informed farmers interested in erosion practices through hosting 3 workshop/tours with an average of 20 participants	CCWC Coordinator; Local SWCD	Included in Coordinator support	NRCS; IDALS; local sponsors

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.3 continued

Water Quality Goal: Protect and improve surface and ground water resources in the Clear Creek Watershed							
Objective 4: Encourage & implement stormwater management practices that will infiltrate runoff up to a 2.6 inch rain event (the channel protection volume) as recommended in the Iowa Stormwater Management Manual							
Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
4a)	Encourage stormwater infiltration practices on 1,922 acres of impervious surface in urban subwatersheds identified in the GeoTREE report	Target 640 acres of impervious surface to be addressed with infiltration practices	Target 1,280 acres of impervious surface to be addressed with infiltration practices	Complete infiltration practices on all 1,922 acres of impervious surface in urban subwatersheds identified in GeoTREE report	CCWC Members	$192.2 million	IDALS; IDNR; SRF; REAP programs
4b)	Encourage road salt storage and use improvements to decrease chloride loading	Organize training that offers continuing education credits (CEUs) about road salt best practices; track projects implemented	Organize training that offers continuing education credits (CEUs) about road salt best practices; track projects implemented	Training for public works staff about reducing chloride loading and track improvement projects that result	CCWC Members	Included in Coordinator support	CCWC Members
4c)	Encourage implementation of green infrastructure practices as part of the capital improvements planned in the watershed over the next 20 years	Provide upcoming project reports at each CCWC meeting to encourage a green infrastructure component in 33% of capital improvement projects	Provide upcoming project reports at each CCWC meeting to encourage a green infrastructure component in 66% of capital improvement projects	Provide upcoming project reports at each CCWC meeting to encourage a green infrastructure component in 100% of capital improvement projects	CCWC Members	Included in Coordinator support	IDALS; CCWC Members
Information & Education Component: Educate various audiences about infiltration practices to improve water quality							
I/E Task 4.1	Hold workshops (with CEUs) for developers, builders, engineers, and inspectors about infiltration practices and green infrastructure	Organize at least one workshop that offers continuing education credits (CEUs); track projects resulting from workshop	Organize at least one workshop that offers continuing education credits (CEUs); track projects resulting from workshop	Increased awareness in the development community about the benefits of green infrastructure by organizing a total of 3 workshops with an average 10 participants	CCWC Coordinator; CCWC Members	Included in Coordinator support	CCWC Members; local sponsors - co-ops / ag groups / banks
I/E Task 4.2	Organize green infrastructure workshops and urban BMP tours for homeowners, policy makers, or other interested stakeholders	Organize at least one workshop or tour; track projects resulting from workshop	Organize at least one workshop or tour; track projects resulting from workshop	Increased homeowner and policy maker awareness about the benefits of stormwater BMPs by organizing a total of 3 workshops with an average 10 participants	CCWC Coordinator; CCWC Members	Included in Coordinator support	CCWC Members; local sponsors - co-ops / ag groups / banks

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Table 8.4 Clear Creek Watershed Action Plan for Habitat & Recreation Improvement

Task	Implementation Strategies	7-year Milestone (2027)	14-year Milestone (2034)	Target by 2040	Responsible Entity(s)	Cost Estimate *{$ in 2020}*	Resources
Habitat & Recreation Goal: Create healthy watershed function that enhances recreation and public health through improved water quality, habitat restoration and improved connectivity to parks, trails and streams in the Clear Creek watershed							
Objective 1: Increase the quantity and quality of habitat to support an abundance of terrestrial, aquatic and avian wildlife in the watershed							
1a)	Improve habitat in the Clear Creek corridor by restoring oxbows, adding riparian buffers and maintaining naturally occuring woody debris	Complete a biologic assessment on Clear Creek and its primary tributaries to establish a baseline and prioritize habitat improvements	Assessment completed and habitat improvement projects identified; Complete at least half of the projects	Complete all projects in priority areas as outlined in a biologic assessment	CCWC Members; Local CCBs	Assessment = $150,000; Projects = $2.5M	CCWC Members; Local CCBs
1b)	Incorporate or improve native habitat on the 23 public lands identified in Figure 2-18	8 of 23 public lands include some native habitat	15 of 23 public lands include some native habitat	All 23 public lands identified in Figure 2-18 include native habitat	Local CCBs; CCWC Members	$1.61 million	CCWC Members; Trees Forever
Objective 2: Recommend Implementation of restoration recommendations from the *Lower Clear Creek Stream Assessment Within Coralville* by HR Green 2019							
2a)	Implement 8 streambank stabilization & restoration projects at high-risk locations identified in the stream restoration assessment and 4 restoration projects identified by local leaders	Identify resources for the recommended projects; complete at least three projects	Complete at least 8 projects	Complete the 8 streambank stabilization & restoration projects as outlined in Table 8.2 and 4 projects identified by local leaders in Section 6.1.2 (page 130)	CCWC Coordinator; Local SWCD	$12.95 million	NRCS; IDALS; IDOT
Objective 3: Promote and improve existing recreational resources such as park amenities, trails and stream access points							
3a)	Increase and protect stream access points for water related recreation	Identify the needs of each access point in terms of potential for improvement	Install signs that indicate distance to other access points and improve parking at existing sites	Improved network of stream access points with better information about the amenities and ADA accessibility	CCWC Members	$50,000	CCWC Members; REAP grant

Note: All cost estimates are in 2020 dollars and represent the total cost over the 20-year plan unless otherwise stated

Chapter 9

FUNDING ESTIMATES & OPPORTUNITIES

9.1 Funding Estimates

Watershed improvement requires substantial investment in technical assistance (human resources) and financial assistance (funding to support practice adoption or construction). Table 9-1 provides estimated implementation costs for recommended practices identified in the Implementation Strategies in Tables 8-1 to 8-4. Cost estimates are in 2020 dollars and expressed as a total cost over the 20-year plan unless noted otherwise.

Table 9-1. Estimated Annual or Initial Costs of Implementing the Plan

Practice / Project / Tour / Workshop	Units	Goal	Unit Cost	Total Cost
Ag Practices				
Prairie STRIPS (10% native vegetation)	acres	4,000	$400	$1,600,000
Cover crops with conservation no-till	acres/year	20,450	$50	$1,022,500
Structural practices (ponds, terraces, wetlands, etc.)	acre-feet of storage	2,858	$22,500	$64,305,000
Saturated buffers & bioreactors	acres treated	1,700	$118	$200,600
Structural practices (ponds, terraces, grade stabilization)	acres treated	11,968	$3,500	$41,888,000
Manure Nutrient Management Plans	plans	50	$3,000	$150,000
Ag Subtotal				**$109,166,100**
Urban Practices & Modeling				
Flood mitigation projects & detention basin at Half Moon Road				$3,000,000
Local cost share for urban practices	$/year	20	$60,000	$1,200,000
Modelling for flood impacts of land use	model	1	$20,000	$20,000
Buyouts in 100-year floodplain	structures	40	avg $150,000	$6,000,000
On-Road Structures / County road projects	project	11	avg $182	$2,000,000
Infiltration practices in urban areas	acres	1,922	avg $100,000	$192,200,000
Biologic assessment & habitat improvement projects	assessment + projects			$2,650,000
Native vegetation on public lands	project	23	avg $70,000	$1,610,000
Streambank stabilization & restoration projects	project	12		$12,950,000
Stream access improvements	project			$50,000
Urban Subtotal				**$221,680,000**
Administrative & Monitoring				
Supplies for education and training	$/year	20	$990	$19,800
Education & outreach events	event/tour/workshop	33	$2,970	$59,400
Watershed Coordinator	$/year	20	$120,000	$2,400,000
Monitoring for water quality	$/year	20	$5,000	$100,000
Admin & Monitoring Subtotal	**$/year**		**$128,960**	**$2,579,200**
Total				**$333,425,300**

Source: East Central Iowa Council of Governments

The total cost to fully implement the Clear Creek Watershed Management Plan is estimated to be $330.8 million in capital costs and practice cost share plus a total of $2.6 million in administrative and monitoring expenses. The annual operating budget is $128,960 per year to fund watershed management and technical assistance, which includes salary and benefits for a watershed coordinator, supplies for outreach materials and events, water monitoring expenses, and overhead costs. A proposed work plan for the Watershed Coordinator is presented in Table 9-2 as a road map for the work identified in the Clear Creek Watershed Coalition Plan (CCWC Plan) implementation strategies.

Table 9-2. Proposed Watershed Coordinator Work Plan

	Tasks & Associated Actions	Milestones / Progress	Estimated Hours/Cost
a.	ICWMA Board of Directors		Subtotal = $15,000 (12%)
	Quarterly Board meeting	Meeting third Wednesday in July, Oct, Jan, and April	80 hrs. = $4,615
	Complete grant applications as opportunities arise	Complete at least one grant application on behalf of the CCWC and CCWC Members	120 hrs. = $6,925
	Represent the CCWC among the public, partners and the watershed community around the State	Give informational presentations as requested and/or continue communication with other WMAs in Iowa	60 hrs. = $3,460
b.	Education & Outreach		Subtotal = $16,650 (13%)
	Organize meetings, workshops and awareness campaign identified in the CCWC Plan & aligned with the Education & Outreach Sub-Committee work plan	Host annual Flood Awareness presentation at CCWC Board meeting Host at least one workshop identified in the CCWC Plan. Develop and deliver Flood Risk Awareness campaign	80 hrs. = $4,615 $2,970 for event / tour / outreach expenses
	Connect with High School FFA groups and other youth groups involved in agriculture and/or conservation	Give at least one presentation about agricultural conservation practices and other watershed issues	60 hrs. = $3,460
	Organize events and outreach programs that connect people to the creeks such as clean-ups, outdoor classrooms or recognition programs as identified in the CCWC Plan	Organize at least one event identified in the CCWC Plan.	80 hrs. = $4,615 $990 for supplies & education expenses

Source: East Central Iowa Council of Governments

Table 9-2 continued. Proposed Watershed Coordinator Work Plan

Tasks & Associated Actions		Milestones / Progress	Estimated Hours/Cost
c.	Plan Implementation		Subtotal = $78,465 (61%)
	Establish Sub-Committees Education & Outreach Agriculture Related Monitoring & Analysis Policy & Ordinance Review Infrastructure	Recruit participants and organize initial meeting for at least 2 sub- committees to develop their individual work plans	80 hrs. = $4,615
	Outreach to ag producers and landowners to promote the conservation practices identified in the CCWC Plan	Initiate communications to implement conservation practices and complete Manure Nutrient Management Plans as identified in the CCWC Plan	640 hrs. = $36,925
	Outreach to communities to pursue the flood mitigation and water quality strategies identified in the CCWC Plan	Initiate communications needed to promote infiltration practices and flood mitigation projects as identified in the CCWC Plan	640 hrs. = $36,925
d.	Monitoring CCWC Plan Progress		Subtotal = $18,845 (15%)
	Coordinate with Monitoring & Analysis Sub-Committee and CCWC Members to collect and compile watershed assessment data for the bi-annual State of Clear Creek Watershed report	Monitoring plan established and data collected for the report	160 hrs. = $9,230 $5,000 for sampling costs
	Establish a process to track BMPs and create a summary map for the bi-annual State of Clear Creek Watershed report	BMP tracking method developed, and summary map completed	80 hrs. = $4,615
		Estimated Staffing Total =	$120,000
		Total =	$128,960

Source: East Central Iowa Council of Governments

9.2 Funding Opportunities

9.2.1 Local Funding

Table 9-3. Possible Contribution Formula Supporting the CCWC

Entity	% Population	50% Population Calculation	% Area	50% Area Calculation	FY22 Total
Coralville	56.70%	$ 36,563	8.01%	$ 5,166	**$ 41,729**
Iowa City	17.20%	$ 11,088	2.63%	$ 1,696	**$ 12,784**
North Liberty	5.97%	$ 3,852	2.02%	$ 1,299	**$ 5,151**
Tiffin	6.78%	$ 4,370	4.01%	$ 2,584	**$ 6,954**
Oxford	2.98%	$ 1,924	0.88%	$ 567	**$ 2,491**
Iowa County	4.87%	$ 3,142	42.34%	$ 27,298	**$ 30,439**
Johnson County	5.49%	$ 3,541	40.12%	$ 25,870	**$ 29,411**
Totals	**100.00%**	**$ 64,480**	**100.00%**	**$ 64,480**	**$ 128,960**

Source: East Central Iowa Council of Governments

The Clear Creek Watershed Coalition (CCWC) is considering several options for funding watershed improvements. Determining a funding contribution formula based on the area, population and/or value of parcels in the watershed by jurisdiction is one option. The CCWC Board of Directors devoted time at two meetings to discuss the final budget for the organization and what variables a contribution formula would use. There is some interest in this approach and the CCWC Board will continue to consider local funding at some level. Some of the benefits would be a stable funding stream for local staff and potential matching funds for future grant opportunities. The challenges include uncertain budgets for many during the COVID-19 outbreak and conveying the longer-term outcomes to justify the investment. Table 9-3 is one possible contribution formula that is calibrated to the implementation strategies and proposed watershed coordinator work plan presented in the Clear Creek Watershed Management Plan.

9.2.2 Grants, Cost Share Programs, Easement Programs & Loans

This section provides a description of available funding sources and assistance programs for watershed management efforts. There is a website link for each program to access additional information about eligibility and application details. Other groups with funding or assistance programs to benefit watershed improvements include Trees Forever, National Association of Conservation Districts and a variety of foundations. There may be other funding sources not captured here, so the reader is encouraged to check with watershed resource personnel at the Iowa Department of Natural Resources or Iowa Department of Agriculture and Land Stewardship for more up to date opportunities.

Iowa Department of Agriculture and Land Stewardship (IDALS)

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 regarding 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 IDNR.

Natural Resources Conservation Service (NRCS)

Iowa Partners for Conservation funding is intended to leverage NRCS and partner resources to build soil health on cropland; improve environmental and economic performance of grasslands, woodlands and wildlife areas; support the Iowa Nutrient Reduction Strategy; and build capacity to better manage and maintain watershed infrastructure.

National Association of Conservation Districts partners with NRCS to offer Technical Assistance Grants to help conservation districts build capacity and enhance their ability to provide conservation planning and technical assistance to customers.

Conservation Innovation Grants (CIG) is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production.

Environmental Quality Incentive Program (EQIP) 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 for participants installing or implementing structural and management practices on eligible agricultural land.

Regional Conservation Partnership Program (RCPP) promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS aids producers through partnership agreements and through program contracts or easement agreements.

Conservation Reserve Program (CRP) 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) is a voluntary program offering farmers the opportunity to protect, restore, and enhance wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum 10-year duration. As a requirement of the program, landowners voluntarily limit future use of the land, yet retain private ownership.

Grassland Reserve Program (GRP) 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. A grazing management plan is required for participants.

Agricultural Conservation Easement Program (ACEP) 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. Land eligible for agricultural easements includes cropland, rangeland, grassland, pastureland, and nonindustrial private forest land. 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) is a voluntary program for landowners who want to develop and improve wildlife habitat 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. NRCS and the participant enter into a cost-share agreement for wildlife habitat development that lasts from 5 to 10 years.

Iowa Department of Natural Resources (IDNR)

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 IDNR 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 of 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 and 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.

State Revolving Fund

Clean Water State Revolving Fund is jointly administered by the Iowa Finance Authority (IFA) and DNR Clean Water Program and 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 quarterly basis, which determines the eligibility of a project's application.

Livestock Water Quality Program offers low-interest loans through participating lenders to Iowa livestock producers for projects to prevent, minimize or eliminate non-point source pollution of Iowa's rivers and streams from animal feeding operations.

On-site Wastewater Assistance Program (OSWAP) offers low-interest loans through participating lenders to rural homeowners for the replacement of inadequate or failing septic systems. According to Iowa law, all septic systems, regardless of when they were installed, must have a secondary wastewater treatment system following the septic tank.

Local Water Protection Program (LWPP) offers low-interest loans through participating lenders to Iowa landowners for projects to control the runoff of sediment, nutrients, pesticides or other nonpoint source pollutants from entering Iowa waters.

Storm Water Loan Program provides low-cost loans for projects to address stormwater quality. Funds are 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.

U.S. Fish & Wildlife Service

Visit the U.S Fish & Wildlife website for a listing of the different grant programs funded through the Cooperative Endangered Species Conservation Fund, with the funding levels for this fiscal year. Eligibility criteria and the application process for each grant program is different.

The North American Wetlands Conservation Act (NAWCA) grant programs fund projects in the United States, Canada and Mexico that involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats.

The Urban Conservation Treaty for Migratory Birds (Urban Bird Treaty) is a program working with cities and partners to conserve migratory birds through education, hazard reductions, citizen science, conservation actions, and conservation and habitat improvement strategies in urban/suburban areas. Urban areas can become effective sanctuaries for birds by restoring and conserving greenspace.

Iowa Economic Development Authority (IEDA)

Enhance Iowa - Improving Community Vitality Through Recreational Attractions provides grant funds to assist projects that provide recreational, cultural, entertainment and educational attractions, as well as sports tourism. The funds help communities create transformational projects that enhance the vitality of a region and the state overall.

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.

Federal Emergency Management Agency (FEMA)

FEMA administers three programs that provide funding for eligible mitigation planning and projects that reduces disaster losses and protect life and property from future disaster damages.

- Hazard Mitigation Grant Program (HMGP) assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration
- Pre-Disaster Mitigation (PDM) provides funds for hazard mitigation planning and projects on an annual basis
- Flood Mitigation Assistance (FMA) provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis

FEMA requires state, territorial, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance.

Chapter 10

EDUCATION & OUTREACH PLAN

Education and public awareness are 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; and
- Coordinate with other public as well as private entities to maximize the visibility of the Clear Creek Watershed Coalition and its messages.

This section outlines how the education and public awareness program could be organized as both a watershed-wide program managed by the CCWC and education activities undertaken by member governments or other partners. Another resource available to the CCWC and its members is the Clear Creek Watershed Education and Outreach Action Plan prepared by Iowa State University Extension (Appendix I). The Extension plan includes action steps and contacts for agricultural stakeholders and partners.

An Education & Outreach Subcommittee of the CCWC will be established to coordinate the education messages, materials and methods used among CCWC Members. A variety of resource partners including State agencies and the County Conservation Boards 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.

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

10.1 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 10-1. 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

10.2 Education & Outreach Workplan

The activities presented in Table 10-2 align with the Information and Education Components of the Implementation Strategies in Tables 8-1 to 8-4 and is meant to highlight the number of activities completed in each 7-year phase of Plan implementation. In general, there will be two events, tours, presentations or workshops to organize each year along with outreach to urban residents and rural landowners.

Table 10-2. Clear Creek Watershed Education and Outreach Workplan

	7-Year Milestone (2027)	14-Year Milestone (2034)	20-Year Milestone (2040)	2040 Targets
	Activities in First 7 Years	Activities in Second 7 Years	Activities in Last 6 Years	Outcomes by 2040
Activities	Annual Flood Awareness Presentation at CCWC Board of Directors meeting	Annual Flood Awareness Presentation at CCWC Board of Directors meeting	Annual Flood Awareness Presentation at CCWC Board of Directors meeting	20 flood data presentations; 40% increased use of BMP cost share programs
	Flood Risk Awareness Campaign	Flood Risk Awareness Campaign	Flood Risk Awareness Campaign	Reduce risk to vulnerable populations & increase assistance requests by 10%
	Education & Outreach Activites	Education & Outreach Activites	Education & Outreach Activites	Deliver watershed education & outreach programs to build support for the Plan
	Presentations to FFA groups	Presentations to FFA groups	Presentations to FFA groups	Reach FFA groups in the watershed to raise awareness of watershed issues
	(2) Urban/Rural Flood Awareness Tours	(2) Urban/Rural Flood Awareness Tours	(2) Urban/Rural Flood Awareness Tours	Reach 120 residents through six Urban/Rural Flood Tours
	(2) Ag Neighbor / Youth Outreach Event	(2) Ag Neighbor / Youth Outreach Event	(2) Ag Neighbor / Youth Outreach Event	Reach 60 farmers/youth through six small events to increase flood mitigation projects
	(1) Landuse Flood Impact workshop	(1) Landuse Flood Impact workshop	(1) Landuse Flood Impact workshop	Reach 30 Policy Makers through three Land Use Flood Impacts workshops
	(1) Nutrient Reduction Strategy Event	(1) Nutrient Reduction Strategy Event	(1) Nutrient Reduction Strategy Event	Reach 60 farmers through three events to increase NRS practice implementation
	(1) Water Quality Community Event	(1) Water Quality Community Event	(1) Water Quality Community Event	Reach 45 residents through three events to raise awareness of our impact on stream health
	(1) Septic System Upgrade Event	(1) Septic System Upgrade Event	(1) Septic System Upgrade Event	Reach 30 residents through three workshops to increase improvements to failing septic systems
	(1) Erosion Control Ag Peer-to-Peer Event	(1) Erosion Control Ag Peer-to-Peer Event	(1) Erosion Control Ag Peer-to-Peer Event	Reach 60 farmers through three events to increase erosion control practice implementation
	(1) Stormwater for Builder/Developer Workshop	(1) Stormwater for Builder/Developer Workshop	(1) Stormwater for Builder/Developer Workshop	Reach 30 developers/builders through three workshops to increase green infrastructure
	(1) Stormwater for Residents Workshop	(1) Stormwater for Residents Workshop	(1) Stormwater for Residents Workshop	Reach 30 residents/policy makers through three workshops to increase infiltration practices

Source: Implementation Strategies Tables 8-1 to 8-4

10.2.1 Stakeholder Input on Education Strategies

The following education strategies were identified as priorities in the Goal Setting Sessions for the Plan and will guide the efforts of the Education & Outreach Subcommittee in the near term.

- Develop an education & outreach plan to build watershed awareness and assist in implementing the Plan
  - ◊ Create & install signs highlighting stream features, function and how to improve Clear Creek
  - ◊ Create program to recognize and share BMPs on the CCWC Facebook page and other social media
  - ◊ Partner with Take a Kid Outdoors program on events
  - ◊ Create program encouraging people to send pictures of plants & animals they see in the Clear Creek Greenbelt to CCWC Facebook page
- Organize opportunities to take urban residents to rural areas and rural residents to urban areas to observe issues caused by flooding and the solutions implemented to date
- Build awareness of flood risk and intensifying rain events due to climate change by hosting an annual “flood awareness” meeting and promote ways residents can reduce stormwater run-off
- Educate CCWC Member policy makers about the flood impacts of various land uses by hosting “Land Use Flood Impacts” workshops
- Develop awareness campaigns for renters and other socially vulnerable populations connecting them to resources for flood awareness and recovery
- Educate the agricultural community about flood risks and how they can be part of the solution by engaging the agricultural community through small events with ag groups and youth groups such as FFA and 4-H clubs
- Promote the Nutrient Reduction Strategy and its recommended practices through workshops field days or other peer to peer event for farmers & stakeholders
- Recognize farmers who implement BMPs by creating a "Friend of Clear Creek" awards program
- Partner with local FFA teachers to incorporate watershed & water quality issues into their classes each year
- Communicate with residents about the relationship between stream health and human health through community engagement events about water quality (outdoor classrooms, watershed tours, paddling outings, creek clean-ups)
- Communicate with households utilizing septic systems about impacts of human waste management on stream health through workshops
- Educate agricultural community about practices to reduce sediment through erosion through workshops and other events for farmers & stakeholders
- Educate various audiences about infiltration practices to improve water quality through:
  - ◊ Workshops (with CEUs) for developers, builders, engineers, and inspectors about infiltration practices and green infrastructure
  - ◊ Green infrastructure workshops and urban BMP tours for homeowners, policy makers, or other interested stakeholders

10.3 Watershed Public Education Messages

The CCWC Education & Outreach Subcommittee will consider incorporating these messages for the watershed level education and public awareness program.

- Everything we do, where we work, live or play can impact our water resources
- Now is the time to do something about flooding! Don't get flood amnesia
- We are all part of the solution to stormwater pollution / We all live downstream
- 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
- Being a steward of your land includes the water

10.4 Education Focus for Target Audiences

The CCWC Education & Outreach Subcommittee will tailor the messages for the target audiences identified in the Goal Setting Sessions as follows.

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

Students / Schools: Partner with Iowa Learning Farms 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.

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.

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.

10.5 Education Program Delivery Techniques

There are several 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.

10.5.1 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.

10.5.2 Printed Materials

- Brochures & Fact Sheets – Brochures, fact sheets and other literature can be for general information or provide messages and tips specific to a 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.
- 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.

10.5.3 Mass Media

- Press Relations – Both local communities and the CCWC 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.

10.5.4 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 11

WATER MONITORING PLAN

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 Clear 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 Clear Creek watershed, several groups are conducting water monitoring summarized in Table 11-1.

- U of I Students & Watershed Coordinator: seasonal monthly monitoring for dissolved oxygen, pH, temperature, and turbidity at 11 sites
- U of I IIHR: Continuous monitoring for dissolved oxygen, Nitrate+Nitrite, pH, conductance, temperature, Chlorophyll a and b at 3 sites
- USGS: Discharge, gage height, precipitation on Clear Creek at Oxford and at Camp Cardinal Road, Coralville
- Iowa Flood Center: Bridge water stage sensors at 10 locations throughout the watershed

Table 11-1. Monitoring Sites in the Clear Creek Watershed

Sampling Site	Monthly Monitoring	Continuous Monitoring	USGS Gage	Watershed Placement	Site Description
Site ID# 948078	X	X		Upper Clear Creek	190th & U Ave
Site ID# 948046	X			Upper Clear Creek	Clear Creek @ 200th
Site ID# 948028	X			Upper Clear Creek	Clear Creek @ W Ave
Site ID# 948057	X			Upper Clear Creek	210th Bridge between W Ave & Y Ave
Site ID# 948030	X			Middle Clear Creek	Clear Creek @ Johnson & Iowa Roads
Site ID# 952063	X			Middle Clear Creek	Rhine Creek @ 295th St
Site ID# 952065	X	X	X	Middle Clear Creek	Clear Creek @ Eagle Ave
Site ID# 952074	X			Middle Clear Creek	Buffalo Creek @ NW Half Moon
Site ID# 952068	X			Lower Clear Creek	Clear Creek @ Jasper Ave
Site ID# 952073	X			Lower Clear Creek	Deer Creek @ Kansas
Site ID# 952070	X	X	X	Lower Clear Creek	Clear Creek @ Camp Cardinal

Source: Iowa Department of Natural Resources

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

11.1 Flows

Monitoring flows in Clear 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 Clear Creek watershed to the Iowa 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. 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 sites at Oxford (Station # 05454220) and Camp Cardinal Road, Coralville (Station #05454300).

11.2 Pollutant Concentrations

CCWC benefits from the partnership with the University of Iowa 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 Clear 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 if individual data collection points are not listed.

- Storm Event Sampling is useful for characterizing the 'first flush' of contaminants reaching Clear 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.

11.3 Bacteria (E.coli) Monitoring

Bacteria monitoring should also be continued in the Clear 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.

11.4 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 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 IDNR stream bio-assessment program has offered to provide technical advice on developing habitat and biological sampling design.

11.5 Compiling the Data and Calculating Loads

The 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 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 IDNR or IDALS Basin Coordinators can assist with setting up an account for the Clear 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 CCWC 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 12

PLAN EVALUATION

There will need to be evaluation of the progress towards implementation of the specific actions identified in the Clear Creek Watershed Management Plan and towards meeting the long-term goal of a healthy watershed. It is recommended that evaluation be completed through bi-annual plan reviews and plan updates that occur every seven 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 action steps that happen in the first 7 years are reasonably firm, whereas those beyond 14 years are expected to be refined several times before they are implemented.

12.1 Implementation

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

- Agriculture Related Advisory Group to advise project development and education strategies.
- Infrastructure Subcommittee to incorporate low impact development and best management practices into capital improvement projects.
- Monitoring & Analysis Subcommittee to develop and implement a long-term monitoring and data collection plan.

12.2 Bi-annual Reviews

The purpose of the bi-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 an element of the Clear Creek Watershed Management Plan.

The bi-annual reviews are a reminder that the Plan is adaptable, dynamic and flexible. Information that will be collected as part of the bi-annual survey and evaluation of progress will include:

- **Education Activities** – Reporting of education and outreach efforts
- **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 CCWC they will be included in the bi-annual survey and progress report.

12.3 Plan Updates

Plan updates occur every 7 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;
- Tracking of BMPs; and
- 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 CCWC members and stakeholders.

12.4 Conclusions

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

- 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; and
- Progress on improving surface water quality and reducing the risk of flood impacts.

CLEAR CREEK WATERSHED COALITION

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EAST CENTRAL IOWA COUNCIL OF GOVERNMENTS
YOUR REGIONAL PLANNING AGENCY

IOWA WATERSHED APPROACH

DNR