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For the Middle Cedar Watershed Management Authority

North Beaver Creek HUC-12 Subwatershed Plan

March 2020

Cover Image:

Beaver Creek at Spruce Avenue near Ackley, Iowa (Photo credit: Emmons and Olivier Resources).

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1. INTRODUCTION

This plan was developed for the North Beaver Creek Subwatershed (**Figure 1**) as a component of the Middle Cedar Watershed Management Plan (MCWMP). The MCWMP was funded using federal funds from the U.S. Department of Housing and Urban Development pursuant to Title I of the Housing and Community Development Act of 1974. The Iowa Economic Development Authority (IEDA) was awarded a Community Development Block Grant National Disaster Resilience (CDBG-NDR) Federal award B-13-DS-19-0001 and awarded a portion of those funds to Benton County through grant 13-NDRI-006 to develop the MCWMP.

As a component of the overall watershed management planning process, development of this subwatershed management plan used an abbreviated stakeholder engagement process consisting of two meetings with local representatives to discuss issues facing the watershed and approaches for improvements. The subwatershed plan includes a general overview of the physical conditions of the area with references to more detailed information that can be found in the MCWMP.

The planning team, Emmons & Olivier Resources (EOR), Iowa Valley Resource Conservation and Development (IVRCD) and the Iowa Soybean Association (ISA), would like to extend a sincere thank you to the following organizations and individuals: Lawrence Green, Iowa Natural Resources and Conservation Services (NRCS) District Conservationist. Meeting attendees Jack Wittgreve, Jason Schildroth, Tyler Schildroth, Ken Fogt, Frank Wyatt, Victor Devick, Eileen Johnson, Ron Hirth, Wes Swieter, Todd Nolte, Leland Kreimeyer, Nathan Ackerman, Kenneth Ackerman, Dawson Ackerman, Jim Brandt, Michael Vassen, Markley Koop, Jeff Mohwinkle, Ralph Mohwinkle, Ken Mutschler, Leon Meyer, Ron Brandt, and Jack Beyer.

The following plan provides a snapshot of information that will assist watershed planners, resource conservationists, and organized groups in creating targeted strategies for improving this subwatershed. **Section 2** of this report describes the stakeholder engagement process used to develop this plan. **Section 3** outlines general watershed characteristics such as, demographics, geographic and political boundaries, and land use. A focus on water resources highlights any stream impairments and lakes within the watershed, with a more detailed analysis of the pollutant assessment included.

A narrative describing the issues facing the Middle Cedar Watershed (MCW) and the specific issues facing this subwatershed is provided in **Section 4** of this plan. The issues summary was developed after the series of meetings with subwatershed residents. The flood mitigation and water quality conservation practices and the recommended adoption rates needed to meet the Iowa Nutrient Reduction Strategy (INRS) targets are summarized in **Section 6**. A cost benefit analysis of the recommended conservation practice adoption rates is provided in **Section 7**. Recommendations for practices and areas within the subwatershed to prioritize implementation are also provided in **Section 6**, along with maps that can be found in **Appendix A**.

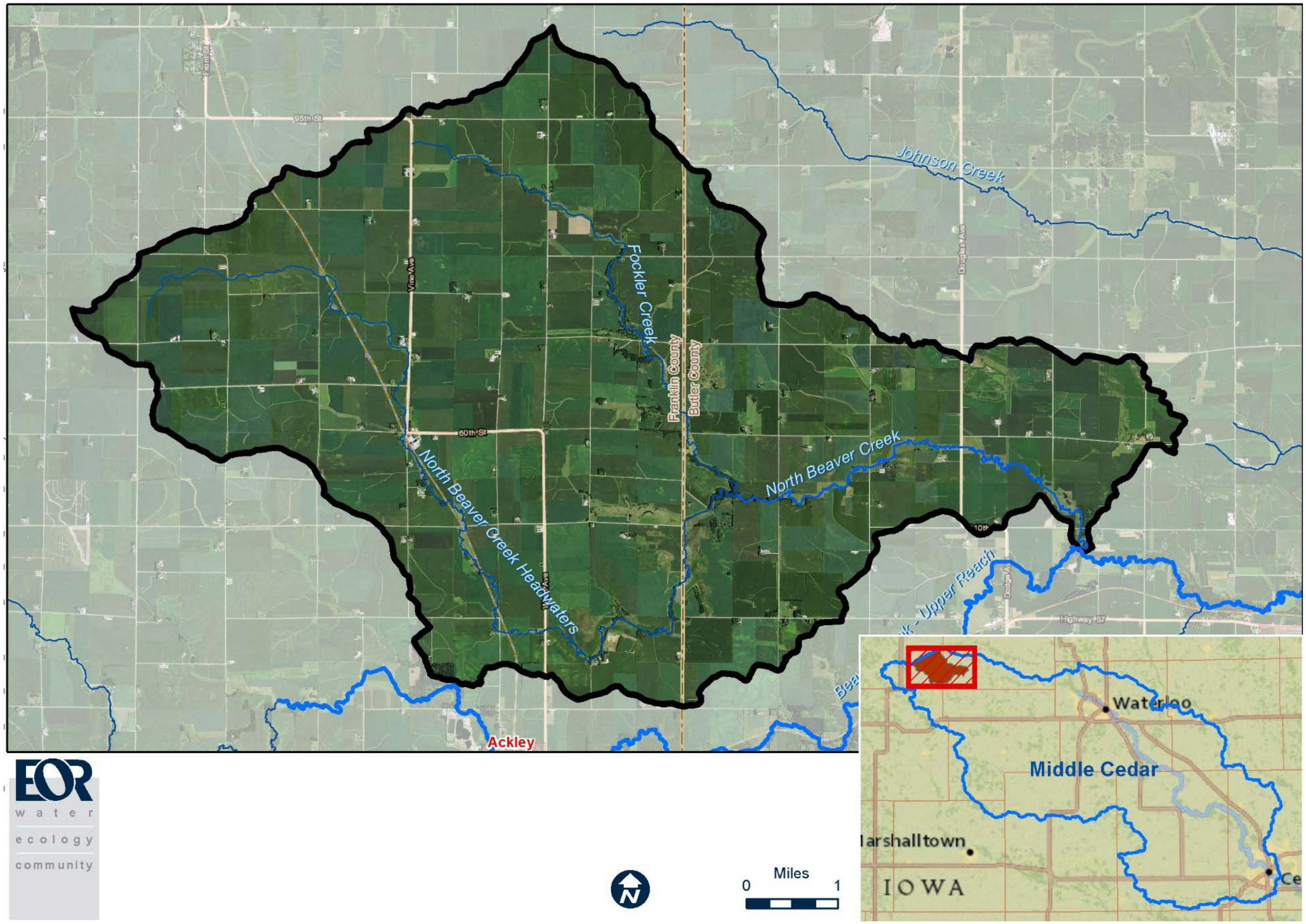

Figure 1. North Beaver Creek Subwatershed.

2. STAKEHOLDER ENGAGEMENT PROCESS

Partnering with the Iowa Soybean Association (ISA) and the Iowa Valley RC&D, the planning team hosted two separate meetings to engage local landowners and residents. Both meetings were held in the City of Ackley at the Ackley Public Library on February 23 and March 9, 2018.

The planning team executed these outreach practices to reach residents:

- A letter sent via U.S. postal mail inviting more than 174 ISA Members in the watershed to join the input sessions.
- Handouts and fliers were mailed to the City of Ackley to be posted in local gathering places, such as City Hall and the Public Library.
- Phone calls were made to all attendees of the first meeting, in order to gauge interest and attendance for the second meeting.

The initial meeting had 17 participants, including farmers, landowners, and soil and water professionals. The first portion of the meeting covered basic watershed information, such as how a watershed is delineated on the landscape and how different land uses impact water quality and soil health. In order to provide context for the series of input meetings, the planning team described the larger Middle Cedar Watershed Management Plan (MCWMP) and outlined the upcoming timeline and deliverables.

During the second portion of the meeting, the team walked participants through two ranking exercises, where attendees submitted anonymous ballot sheets to be tallied and analyzed after the meeting. The first exercise provided a list of priorities, such as the Iowa Nutrient Reduction Strategy (INRS), water quality, and flood risk, and asked attendees to rank them according to importance. During this section of the discussion, several people commented that the local creeks were small and man-made, there was a general sense of skepticism aimed at any watershed planning.

Many residents indicated that one of the main issues they experienced in the area was flooding caused by felled trees blocking the creeks, which was seen as a responsibility of the Iowa Department of Natural Resources (Iowa DNR). Additionally, residents felt that bridge crossings were undersized and caused flooding in their fields. Many felt as though the Iowa Department of Transportation was addressing bridges upstream but that the bridges that needed more help were downstream and were not getting upgraded fast enough.

The second exercise had participants rank conservation practices that would have a high adoption rate in the watershed. The planning team walked the group through each item on the list, which included practices such as, grassed waterways, saturated buffers, and nitrification inhibitors, and described the specific benefits and challenges of each practice. For instance, grassed waterways effectively reduce phosphorous runoff and provide beneficial wildlife habitat, but do not increase soil health, reduce flooding, or improve aquatic life. The group response to the list of conservation practices was fairly mixed, with several participants indicating that buffer strips might be possible, but that cost was a limiting factor for farmers to adopt additional practices.

The ISA has been conducting limited nutrient sampling in the watershed and was asked to show their results. When the group saw how high the nutrients loads were reported, the room was noticeably upset with several residents asking about the details of the time of year and frequency of the sampling process. One individual stated that a one-season snapshot of data is not enough time to show trends and if an environmental activist group saw the data it would misrepresent nutrient loads in the streams. The group expressed an interest in setting comprehensive nutrient monitoring as a high priority. The planning team agreed and further explained that in-stream nutrient monitoring required substantial financial resources.

There were additional comments from individuals that implicated wildlife for the high presence of Escherichia coli (*E. coli*) bacteria in the waterways, and one attendee noted that, “The best thing for a creek is straight. The fastest way to the Gulf, the better.” Unfortunately, there was one farmer who had a negative experience with cover crops and indicated that he would never do it again and that there was not enough technical support to make them successful. Saturated buffers were one practice that was seen as having a potential for increased adoption if funding was made available.

The second meeting invited all of the original invitees that ISA had contacted for the first meeting, and previous attendees received personal, follow-up phone calls or emails. There were eight attendees present, and the purpose of this meeting was:

1. Report and ground-truth the initial ranking results for priorities and practices.
2. Introduce modeling data to assist the group in visualizing the impacts of their prioritized practices.
3. Create achievable practice implementation goals that meet the INRS.

The planning team kicked off the meeting by going through each priority and practice and asking if the collective, individual rankings accurately reflected the general experience of the watershed. The group agreed that the results of the priorities were accurate with their experience, noting that the top three priorities are inter-related: Agricultural Sustainability/Profitability, Flood Risk, and Soil Health. It was pointed out that Soil Health impacts Flood Risk, which in turn has implications for Agricultural Sustainability/Profitability.

There was a lingering sentiment that the public needs to be taught the truth about farming practices and that long-term monitoring would provide adequate data to show that urban areas substantially contribute to the nutrient levels in the watershed. There was a noticeable decline in the number of attendees during this meeting, which may speak to the timing of the meeting or the content of the material covered. Several attendees said they wanted to show up to the meeting to make sure that decisions were not made without their input. One farmer said he did not show up to a previous Drainage District meeting and they voted to raise his dues $20,000 a year, and he wasn’t going to let that happen again. The planning team noted that the wildlife habitat and recreation priorities were ranked low, particularly recreation, and members of the group pointed out that the creeks were too small and did not have water in them year-round.

When reviewing the results of the prioritized practices, the grassed waterways, nutrient management, and terraces were the top three highest priorities selected. Attendees expressed a desire to keep the practices to familiar in-field practices, and only if there was additional funding provided to the farmer.

In order to achieve the INRS goals of a 41 percent load reduction in nitrogen and 29 percent load reduction in phosphorus to meet the overall 45 percent reduction goal, the planning team introduced the Agricultural Conservation Planning Framework (ACPF). This framework is a data-modelling tool that processes high-resolution topographic data to identify field-scale and edge-of-field practices that can be installed in the subwatershed. The ACPF helps planners and stakeholders visualize where certain practices can be strategically located to create the greatest benefit to the watershed.

One of the few practices that was seen as feasible was an increase in terrace practices in the watershed. It was noted that even though previous farmers indicated that saturated buffers would be acceptable, this group felt that the creeks have narrow channels and almost non-existent edge-of-field space for saturated buffers to be an effective solution. Overall, the opportunity to install practices hinged on cost assessments that were not available at the time.

3. WATERSHED CHARACTERIZATION

3.1. General Background

The North Beaver Creek Subwatershed spans across Franklin and Butler Counties (**Figure 1**). This watershed lies in an entirely rural area; there are no urban towns or rural villages. There is one small, unincorporated community, Faulkner, which is located along county highways C55 and S56. According to the 2010 US Census Bureau data, the subwatershed has an estimated population of 305. The population density of the subwatershed is 11 people per 1,000 acres (or 7 people/square mile). The North Beaver Creek subwatershed population represents less than 1 percent of the total population of the Middle Cedar Watershed.

The 28,028-acre area is classified as a HUC-12 Subwatershed in the United States Geological Survey hierarchical system. It is a subdivision of the Headwaters Beaver Creek HUC-10 Watershed and the Middle Cedar HUC-8 Subbasin.

3.2. Land Cover

The predominant land cover of the North Beaver Creek Subwatershed is row crop agriculture. According to the High Resolution Landcover (HRLC) of Iowa 2009 data set the subwatershed is 84 percent row crop agriculture. The HRLC data was derived from three dates of aerial imagery and elevation information derived from LiDAR (Light Detection And Ranging). The HRLC has a spatial resolution of one meter, and a class resolution of 15 classes, which were combined into the five general categories shown in Figure 2. Additional information, including a link to download the actual data, on the HRLC can be found at https://geodata.iowa.gov/dataset/high-resolution-land-cover-iowa-2009.

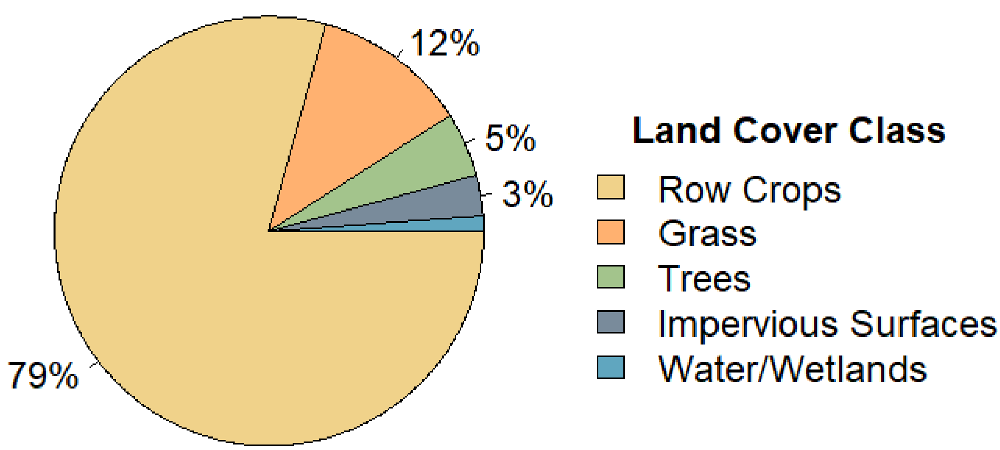

Figure 2. Land Cover of the North Beaver Creek Subwatershed.

3.3. Streams

The North Beaver Creek Subwatershed is home to the headwaters of North Beaver Creek. The subwatershed includes a drainageway sometimes referred to as Fockler Creek (see **Figure 3**).

North Beaver Creek. The creek is defined as the following segment: Mouth (S23, T90N, R18W, Butler Co.) to confluence with Fockler Cr. (S18, T90N, R18W, Butler Co.). While the waterway extends much further into the subwatershed (as shown in **Figure 3**) this is the Iowa Designated Stream Reach portion of the stream.

North Beaver Creek has a designated use classification of A1 B(WW-2). The Designated Uses are defined as follows:

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

Warm water Type 2: Class B(WW-2) - Waters in which flow or other physical characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.

3.4. Lakes

There are no lakes in the North Beaver Creek Subwatershed.

3.5. Ground Water

The North Beaver Creek subwatershed does not contain a Highly Susceptible Community Water Supply or a Priority Community Water Supply System. Refer to the Middle Cedar Watershed Management Plan (MCWMP) for information related to source water quality and groundwater sensitivity.

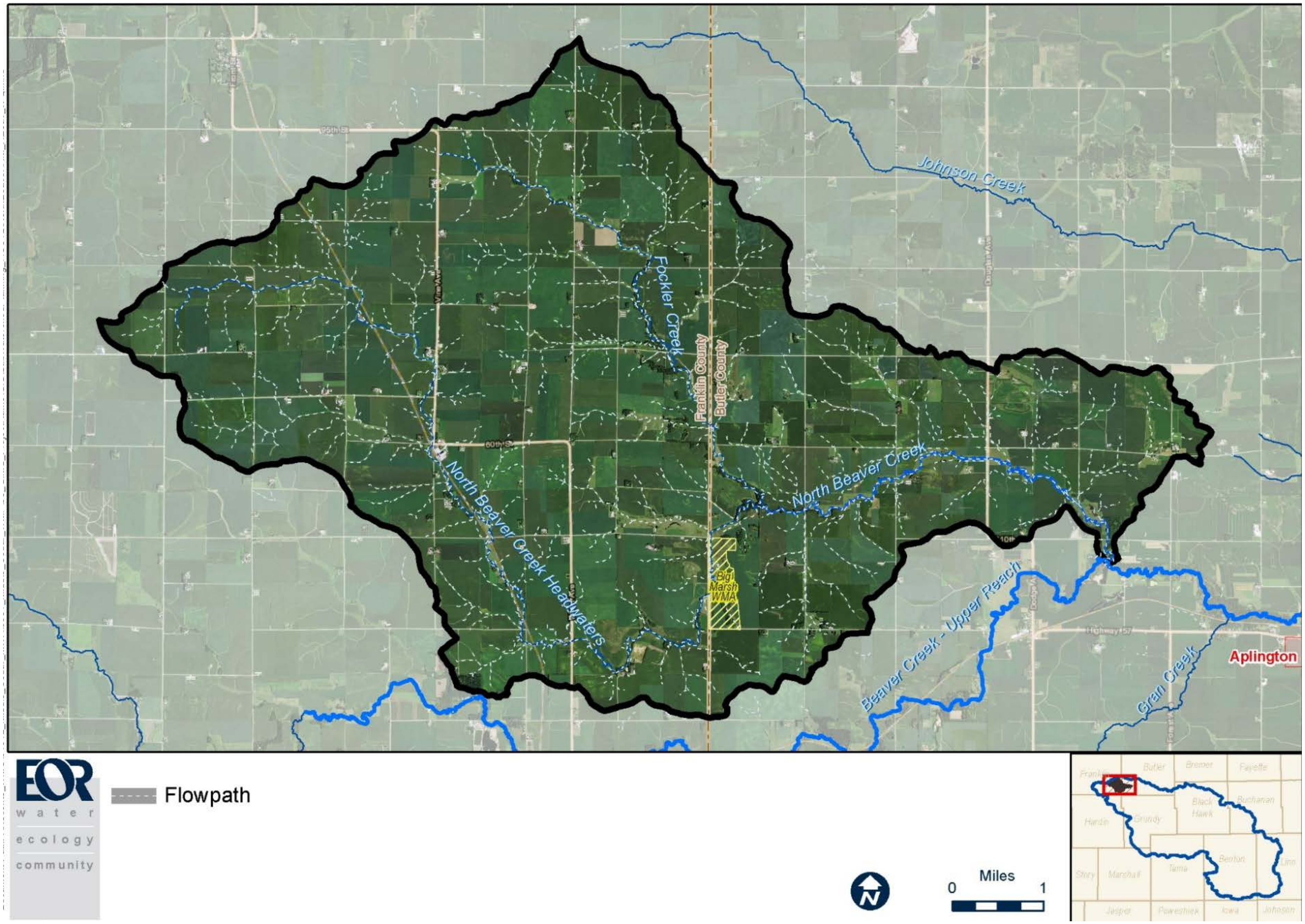

Figure 3. Water Resources of the North Beaver Creek Subwatershed.

3.6. Flooding

Flooding occurs within the subwatershed along the entire reach of North Beaver Creek and the local drainageways. No developed areas are impacted by flooding in this subwatershed but downstream communities are impacted by floods including Applington and Parkersburg. **Figure 4** shows the areas that become inundated during a 100-year flood event. This information was developed by the Iowa Flood Center (IFC). Further information and interactive tools to display flooding information can be viewed at the Iowa Flood Information System http://ifis.iowafloodcenter.org/ifis/.

The financial impact to buildings and their content as a result from the 100-year storm event within the subwatershed is estimated at $213,018 according to the Flood Risk Report for the Middle Cedar Watershed developed by the Federal Emergency Management Agency (FEMA) (2015). This loss is equivalent to roughly $700 per resident of the subwatershed. The North Beaver Creek subwatershed has the 59th highest financial losses due to the 100-year flood event of the 68 subwatersheds within the MCW. **Figure 4** shows areas within the subwatershed that have been determined to have high to very high risk for flood damages according to the FEMA study.

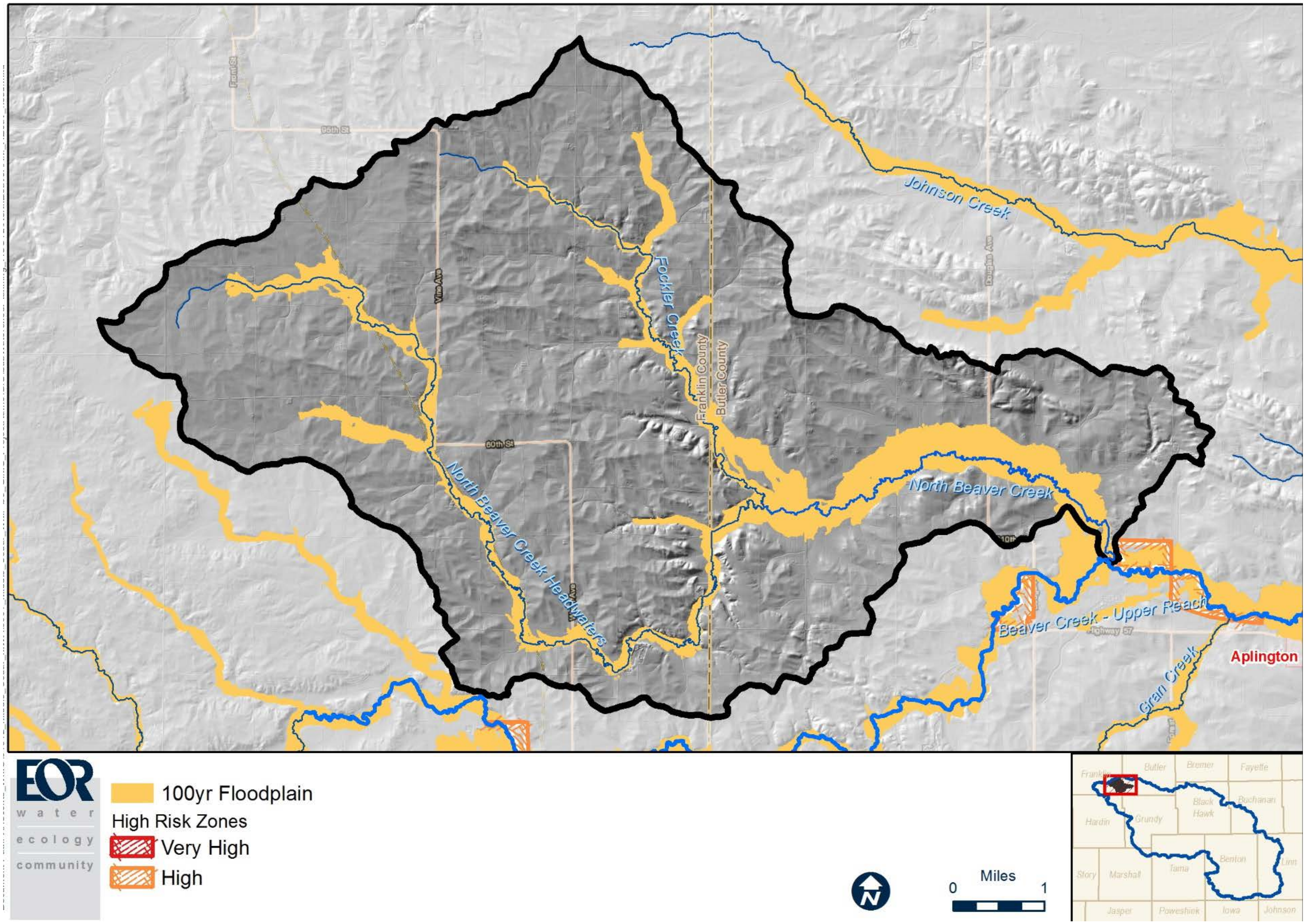

Figure 4. Flooding within the North Beaver Creek Subwatershed.

3.7. Water Quality

Nonpoint source pollutants traditionally addressed in watershed management plans include sediment, fecal bacteria, nitrogen, and phosphorus. These pollutants are derived in varying degrees from natural areas, agricultural land, urban areas, construction sites, roads, parking lots, and other areas. Other common pollutants include pesticides, salts, oil and grease, as well as a suite of pollutants that are typically referred to as contaminants of emerging concern (CECs), which include pharmaceuticals and personal care products.

In Iowa, sediment is the leading nonpoint source pollutant. Most sediment in Iowa comes from erosion on agricultural land, but high levels of sediment also come from erosion of construction sites, streambanks, and lake shorelines. Sediment can be harmful by filling in lakes and depositing on streambeds which covers fish habitat, and it reduces visibility in the water.

Disease producing (pathogenic) organisms are a prevalent nonpoint pollutant that can cause health problems for people coming into contact with contaminated waters. Testing for disease producing organisms is difficult and expensive so two closely related bacteria groups, fecal coliforms and Escherichia coli (*E. Coli*) are commonly used to indicate the presence of pathogens. For simplicity this pollutant group is then referred to as fecal bacteria. Sources of fecal bacteria to our waters are diverse and include wildlife populations, livestock, pets, and even human sewage. High levels of bacteria have been found in several segments of the Cedar River (refer to the Cedar River Watershed Bacteria TMDL discussion) including a segment downstream of the Prairie Creek confluence.

Nutrients, especially nitrogen and phosphorus, are other major nonpoint pollutants in Iowa. Nutrients are naturally occurring within our soils and plant matter, but excess nutrients can be added to our waters from fertilizers (both on agricultural land and on residential lawns, golf courses, etc.) and from organic sources such as manure and human sewage. While nitrogen and phosphorus pose similar concerns for the water resources within the watershed, there are fundamental differences that impact our ability to manage them. Nitrogen, in its various forms, is soluble in water whereas the major form of phosphorus is often attached to soil particles.

Excessive nutrients in water from either chemical fertilizer or organic matter (including manure) can cause algae blooms in lakes, sometimes making lakes smelly and boating difficult. Algal blooms can reach harmful levels when they pose significant health concerns. Harmful algal blooms are common in lakes during calm, hot summer weather. People and animals can become sick from contact with toxic blue-green algae, by swallowing or having skin contact with water or by breathing in tiny droplets of water in the air. Dogs are particularly vulnerable to toxic algae because they are more likely to wade into lakes with algal scum; several have died from blue-green algae exposure.

There is no State standard for phosphorus in Iowa. Minnesota has established standards for phosphorus in streams that are unique to nutrient regions across the State (https://www.revisor.mn.gov/rules/?id=7050.0222). The total phosphorus standard for streams in the Southern region of Minnesota is 0.15 mg/l. This number can be used as a reference point for reviewing water quality measurements in the subwatershed. Total phosphorus is made up of several forms of phosphorus; dissolved reactive phosphorus, particulate inorganic phosphorus, dissolved organic phosphorus, and particulate organic phosphorus. Not all of these forms of phosphorus are routinely measured. As shown in **Table 1**, the ISA currently monitors dissolved reactive phosphorus and dissolved organic phosphorus. A relationship can be established between this form and total phosphorus so a reference point could be developed for comparison to the Minnesota derived reference point described above.

High levels of nutrients can also cause water to be unfit for drinking. A segment of the Cedar River within Cedar Rapids has been designated by the State as a drinking water supply. The North Beaver Creek Subwatershed contributes flow to this segment of the Cedar River.

3.7.1. Subwatershed Monitoring Data

The ISA conducted snapshot monitoring during 2017 at several tributaries to the Middle Cedar River, including a site on North Beaver Creek at the outlet of this subwatershed. ISA snapshot monitoring for 2017 is shown in **Table 1**. Monitoring results in **bold** indicate elevated levels of nitrate and *E. coli*. A final report summarizing the findings of the 2018 monitoring will be completed and will be available from the City of Cedar Rapids.

Table 1. ISA Snapshot Monitoring Results, 2017.

North Beaver Creek Sampling Site	CR48	CR48
Sample Date	4/24/2017	6/5/2017
Chloride (mg/L)	17.5	17.3
Conductivity (mS/cm)	373	444
Dissolved Oxygen (mg/L)	11.6	10.2
Dissolved Reactive Phosphorus as P (mg/L)	<0.03	<0.03
E.coli (MPN/100mL)	100	**886**
Fluoride (mg/L)	<0.3	<0.3
Nitrate as N (mg/L)	**13.7**	**13.1**
Nitrite as N (mg/L)	0.43	0.39
pH	8.06	7.83
Phosphorus-O as P (mg/L)	<0.13	0.3
Sulfate (mg/L)	17.9	19.6
Temperature (Degrees C)	10.8	13.8
Total Suspended Solids (mg/L)	100	42.3
Turbidity (NTU)	29.6	16.4

3.7.2. Impaired Waters

The State of Iowa has developed State Water Quality Standards that are found in Chapter 61 of the Iowa Administrative Code (https://www.legis.iowa.gov/docs/ACO/chapter/567.61.pdf.) The water quality standards are based on the designated use of the receiving water. As water quality monitoring data is collected on streams and lakes, compliance to these standards determines whether or not given water body is meeting its designated use. In cases where the water body does not meet its designated use it is considered to be an impaired water. This process is prescribed under the Clean Water Act. The State of Iowa develops a list of impaired waters every two years that is presented to the U.S. Environmental Protection Agency (U.S. EPA). This list, referred to as the Impaired Waters

List includes information on impaired use, the source of impairment and whether or not a Total Maximum Daily Load (TMDL) study will be required.

The North Beaver Creek subwatershed contributes drainage to a segment of Beaver Creek that has been assessed by the Iowa DNR and determined to be impaired. A summary of the assessment can be found in **Table 2**. Details on the assessment and resulting impairment listings can be found at the following link https://programs.iowadnr.gov/adbnet/Segments/555.

Table 2. Beaver Creek Segment 555 Assessment Summary.

Impairment Code	5p - Impairment occurs on a waterbody with a presumptive A1 or B(WW1) use.
Cause Magnitude	Slight
Status	Continuing
Source	Unknown: Source Unknown
Source Confidence	N/A
Cycle Added	2008
Impairment Rationale	Geometric mean criterion exceeded
Data Source	Ambient monitoring: Iowa DNR-rivers

The Class A1/A3 (primary contact recreation) uses are assessed (monitored) as "partially supported" (IR 5a) due to levels of indicator bacteria that violate state water quality criteria. The Class A2 (secondary contact recreation uses) are assessed as “fully supporting” (IR 2a). The Class B(WW1) aquatic life uses are assessed (monitored) as “fully supported” (IR 2a) based on results of IOWA DNR ambient water quality monitoring, Iowa DNR/SHL biological data and Iowa DNR Fisheries data. Fish consumption uses remain "not assessed" (IR 3a) due to the lack of fish contaminant monitoring in this stream segment. The sources of data for this assessment are:

1) The results of IOWA DNR monthly ambient monitoring from January 2012 through December 2014 at the county road T75 bridge approximately 3.5 miles northwest of Cedar Falls (STORET station 10070001);
2) The results of IOWA DNR/SHL biological sampling in 2003, 2012, 2013 and 2014; and
3) 2001 IOWA DNR Fisheries sampling.

The Class A1/A3uses are assessed as "partially supported" based on results of ambient monitoring for indicator bacteria (*E. coli*). The geometric means of indicator bacteria (*E. coli*) in the 24 samples collected during the recreational seasons of 2012 through 2014 at IOWA DNR ambient station 10070001 were as follows: the 2012 geometric mean was 297 orgs/100 ml, the 2013 geometric mean was 226 orgs/100 ml, and the 2014 geometric mean was 114 orgs/100 ml. The 2012 and 2013 geometric means very slightly exceed the Class A1/A3 criterion of 126 orgs/100 ml; the 2014 geometric mean is below this criterion. 11 of the 24 samples (46 percent) exceeded the Class A1 single-sample maximum criterion of 235 orgs/100 ml. According to U.S. EPA guidelines for Section 305(b) reporting and IOWA DNR’s assessment/listing methodology, if a recreation season geometric mean exceeds the respective water quality criterion, the contact recreation uses should be assessed as “impaired” (see pgs 3-33 to 3-35 of U.S. EPA 1997b). Thus, because at least one recreation season geometric mean exceeded criteria for Class A1/A3 uses, these uses are assessed as "impaired." Similar to the previous (2010-2012) monitoring period, the results of bacteria monitoring from 2012 through 2014 at IOWA DNR ambient station 10070001 show that all recreation season geometric means meet the Class A2 geometric mean criterion of 630 orgs/100 ml, and only one of the 24 samples (4 percent) exceeds Iowa's single-sample maximum criterion. These results suggest that the Class A2 secondary contact recreation uses should be assessed as "fully supporting."

The Class B(WW1) aquatic life uses remain assessed as "fully supported" based on results of both chemical/physical and biological monitoring. Results of IOWA DNR ambient water quality monitoring station NW of Cedar Falls during the 2012-2014 assessment period showed no violations of Class B(WW) water quality criteria for dissolved oxygen, pH, ammonia-nitrogen, temperature, chloride, or sulfate in the 36 samples collected.

The assessment of the Class B(WW1) aquatic life uses as "fully supporting" remains partially based on results of biological monitoring conducted in 2003, 2012, 2013 and 2014 by IOWA DNR/SHL as part of the REMAP and large river sampling projects and on data collected in 2001 by the IOWA DNR Fisheries bureau. A series of biological metrics which reflect stream water quality and habitat integrity were calculated from the biological sampling data. The biological metrics are based on the numbers and types of benthic macroinvertebrate taxa and fish species collected in the stream sampling reach. The biological metrics were combined to make a fish community index of biotic integrity (FIBI) and a benthic macroinvertebrate index (BMIBI).

The indexes rank the biological integrity of a stream sampling reach on a rising scale from 0 (minimum) to 100 (maximum). The 2001 IOWA DNR Fisheries FIBI score was 62 (good). The 2003 FIBI score was 45 (fair) and the 2003 BMIBI score was 77 (excellent). The 2012 BMIBI score was 76 (excellent), the 2013 BMIBI score was 57 (good) and the 2014 BMIBI score was 56 (good). The aquatic life use support was assessed as fully supporting (=FS), based on a comparison of the FIBI and BMIBI scores with biological impairment criteria (BIC) established for previous Section 305(b) reports. The biological impairment criteria were determined from a statistical analysis of data collected at stream ecoregion reference sites from 1994-2008. The non-riffle FIBI BIC for this ecoregion is 44 and the artificial substrate BMIBI BIC for this ecoregion is 52. This segment passed the FIBI BIC 2/2 times in the last 14 years and passed the BMIBI BIC 4/4 times in the last 12 years.

This aquatic life assessment is now considered "monitored" based on a change in the 2010 IOWA DNR assessment methodology. IOWA DNR now requires a segment have two or more biological samples collected from the segment in multiple years over a five-year period to be considered "monitored". This segment had three BMIBI samples collected between 2012 and 2014.

Fish consumption uses remain "not assessed" due to the lack of fish contaminant monitoring in this stream reach.

3.7.3. Total Maximum Daily Load (TMDL) Studies

The North Beaver Creek Subwatershed drains to two impaired stream segments for which a TMDL study has been developed. A TMDL is a determination of the maximum load of pollutant a given water body can receive and continue to meet water quality standards for that particular pollutant. TMDL studies are conducted on water bodies where pollutant levels have been found to be in excess of water quality standards resulting in that water body failing to meet a designated use (also referred to as having an impairment). TMDL studies determine a pollutant reduction target and allocate a portion of the needed reductions to each source of pollutant. Pollutant sources are characterized as either point sources or nonpoint sources.

Point sources receive a wasteload allocation and include all sources that are subject to regulation under the National Pollutant Discharge Elimination System program, e.g. wastewater treatment facilities, stormwater discharges in Municipal Separate Storm Sewer System Communities and concentrated animal feeding operations. Nonpoint sources receive a load allocation and include all remaining sources of the pollutant as well as natural background sources.

Cedar River Watershed Bacteria TMDL

EPA Region 7 developed the *Total Maximum Daily Load Cedar River Watershed, Iowa for Indicator Bacteria, Escherichia coli (E. coli)* in 2010. The TMDL covers the entire Cedar River watershed and includes four impaired segments of the Cedar River within the MCW. Two additional reaches of the Cedar River downstream of the Middle Cedar are included in the TMDL which is relevant because the entire MCW drains to these impaired reaches and, therefore, is subject to the TMDL. The primary contact recreation (Class A1) uses for each stream reach were determined to be impaired by the bacteria indicator (*E. coli)*. Based on a review of the flow and water quality data available throughout the watershed, it was determined that bacterial concentrations were primarily a function of flow, therefor; a flow-variable daily load was selected to represent these TMDL studies. The TMDL establishes the level of bacteria reductions over a range of flows that would be needed for each reach to meet State water quality standards.

The TMDL includes an informational implementation plan. An implementation plan is not a requirement for a TMDL but Region 7 developed a model (Hydrologic Simulation Program Fortran) to test potential scenarios. The model determined that the following scenario will result in the river reaches meeting the Iowa water quality standards. This scenario assumes that all wastewater treatment facilities effluent and rivers entering Iowa will have bacteria concentrations less than or equal to the Iowa water quality standard.

1. Unpermitted feedlots will control/capture the first one-half inch of rain.
2. Cropland bacteria loading will be reduced by 40 percent through proper timing and application of animal waste.
3. Cattle in streams will be reduced by 40 percent.
4. Leaking septic systems will be eliminated.

Cedar River Nitrate TMDL

The Iowa DNR approved the *Total Maximum Daily Load For Nitrate Cedar River, Linn County, Iowa* in 2006. The TMDL was developed to address a reach of the Cedar River that had been identified as being impaired by excess nitrate. The impaired reach is defined as the Cedar River from its confluence with McCloud Run (S16, T83N, R07W) to the Cedar River confluence with Bear Creek (S21, T84N, R08W). Designated uses for the impaired segment are significant resource warm water [Class B(WW)], primary contact recreational use (Class A1) and drinking water supply (Class C). Excess nitrate loading has impaired the drinking water supply water quality criteria [567 IAC 61.3(3)] and hindered the designated use. The target of this TMDL is the drinking water nitrate concentration standard of less than 10.0 mg/L NO3-N.

The TMDL was written as a phased TMDL. Phasing TMDL studies is an iterative approach to managing water quality that becomes necessary when the origin, nature and sources of water quality impairments are not well understood. In this first phase the waterbody load capacity, existing pollutant load in excess of this capacity, and the source load allocations were estimated based on the limited information available. A monitoring plan was then developed to determine if prescribed load reductions result in attainment of water quality standards and whether or not the target values are sufficient to meet designated uses. Monitoring activities may include routine sampling and analysis, biological assessment, fisheries studies, and watershed and/or waterbody modeling. A future phase of the TMDL will consist of implementing the monitoring plan, evaluating collected data, and readjusting target values if needed.

The targeted nitrate reduction is 35 percent. This would equal a yearly reduction of 9,999 tons nitrate-N/year from the current loading of 28,561 tons of nitrate per year. The TMDL states that the majority (91 percent) of the nitrate delivered downstream in the watershed is from nonpoint sources and sets a reduction target for nonpoint sources at 37 percent. The adjusted reduction (from the overall 35 percent target) accounts for wildlife, atmospheric deposition, and point sources.

The TMDL included an implementation plan that recommended use of incentive-based, best management practices (BMPs) focused on reducing surface water nitrate concentration. These practices include fertilizer reduction, wetland construction, and Conservation Reserve Program enrollment. The implementation plan further recommended focusing more heavily on subbasins that have higher nitrate loading per unit area.

3.8. Recreational Opportunities

There are currently no formal water-based recreational uses of North Beaver Creek within the subwatershed. There are several recreation opportunities in the region, particularly on the downstream Cedar River. For more information, including maps and access points, see the Cedar Falls Tourism website at: http://www.cedarfallstourism.org/webres/File/Trails/Cedar-Valley-Paddlers-Trail-Map-Iowa-DNR.pdf.

3.9. Pollutant Source Assessment

Three separate tools have been developed for the MCW to estimate pollutant loading at the HUC-12 Subwatershed level. These tools allow for a comparison between subwatersheds and are used to prioritize subwatersheds for future implementation.

3.9.1. Soil and Water Assessment Tool (SWAT) Model

The World Wildlife Federation along with researchers at the University of Minnesota developed a SWAT model for the MCW. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. SWAT is a public domain software enabled model actively supported by the United States Department of Agriculture - Agricultural Research Service. It is a hydrology model with the following components: weather, surface runoff, return flow, percolation, evapotranspiration, transmission losses, pond and reservoir storage, crop growth and irrigation, groundwater flow, reach routing, nutrient and pesticide loading, and water transfer.

The Middle Cedar SWAT model simulates a 10-yr period from 1/1/2004 to 12/31/2013 and has a fairly course level of resolution. Limited data was available at the time of model construction for use in calibration so the most appropriate use of this model is for making comparisons between subwatersheds. The loading rates estimated by the SWAT model are appropriate for evaluating relative differences between subwatershed and not for determining absolute values. The SWAT model is well suited for rural watersheds. It does not adequately simulate hydrology or nutrient loading dynamics that occur in urban areas.

The SWAT model estimates loading rates at the subwatershed scale for total nitrogen, NO_3 from tile drainage, phosphorus and sediment with results reported in terms of average annual loads per acre.

Table 3. SWAT Model Results for the North Beaver Creek Subwatershed

Total Nitrogen		Total Phosphorus		Tile Nitrate		Sediment	
Load (lbs/ac/yr)	MC Rank (# of 68)	Load (lbs/ac/yr)	MC Rank (# of 68)	Load (lbs/ac/yr)	MC Rank (# of 68)	Load (tons/ac/yr)	MC Rank (# of 68)
49.8	1	1.3	50	43.4	1	0.7	49

3.9.2. Daily Erosion Project

The Daily Erosion Project (DEP) tool developed by the Department of Agronomy at Iowa State University that allows users to understand how fast soil is being lost off the land. The tool takes precipitation data provided by the Next Generation Weather Radar and estimates the amount of soil erosion taking place on the land based on soil type, vegetative cover and slope on a daily basis. The tool also estimates the amount of hillslope soil loss using the Water Erosion Prediction Project Model. Further documentation can be found at: https://www.dailyerosion.org/documentation.

The DEP was run for the 68 HUC-12 subwatersheds in the MCW for the 10-year period 2008-2017. The output from the DEP analysis is used to show the average annual soil detachment and hillslope soil loss in terms of tons/acre (**Table 4**). Note that this is a different measurement than the sediment loading estimate derived from the SWAT model.

Table 4. Daily Erosion Project Results for the North Beaver Creek Subwatershed.

Average Annual Soil Detachment		Average Annual Hillslope Soil Loss	
Tons/Acre	MC Rank (# of 68)	Tons/Acre	MC Rank (# of 68)
2.4	55	2.3	53

3.9.3. Bacteria Source Assessment

Humans, pets, livestock, and wildlife all contribute bacteria to the environment. These bacteria, after appearing in animal waste, are dispersed throughout the environment by an array of natural and man-made mechanisms. Bacteria fate and transport is affected by disposal and treatment mechanisms, methods of manure reuse, imperviousness of land surfaces, and natural decay and die-off due to environmental factors such as ultraviolet light exposure and detention time.

According to the Iowa DNR Animal Feeding Operations (AFO) permit database, there are an estimated 17,949 animal units within the subwatershed. This number does not include any animals that are not included on AFO permits. There are no wastewater treatment facilities in the subwatershed (see **Figure 5**).

An assessment of bacteria sources was conducted as part of the *Total Maximum Daily Load Cedar River Watershed, Iowa for Indicator Bacteria, Escherichia coli (E. Coli)* (EPA 2010). The assessment concluded that the predominant source of bacteria (85 percent) to the Cedar River from the Dam of Cedar Falls Impoundment to the Upper End of the Impoundment, segment IA 02-CED-0050_L_0 (the segment to which the North Beaver Creek subwatershed drains) was from open feedlots.

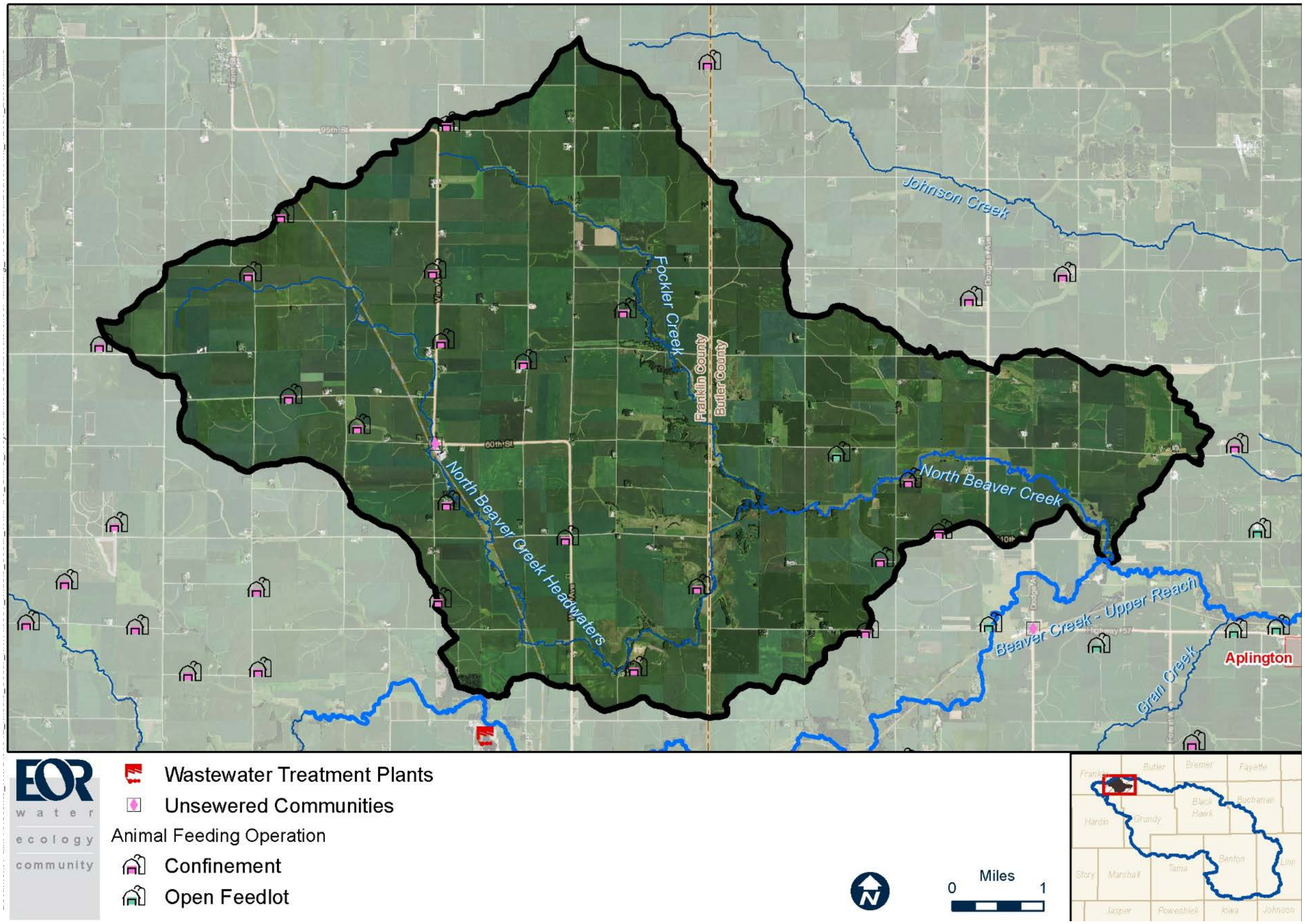

Figure 5. Wastewater Treatment Plants, Unsewered Communities and Animal Feeding Operations in the North Beaver Creek Subwatershed.

4. ISSUES

An overall analysis of the Middle Cedar Watershed shows that the watershed experiences a number of issues that have an effect on the North Beaver Creek Subwatershed.

4.1. Middle Cedar Watershed Issues

- Flooding/Water Quantity: Though the watershed experiences flooding primarily along the Cedar River, it also experiences flooding on many of the smaller tributaries. Specifically, Prairie Creek flooding impacts portions of Blairstown, Norway and Fairfax. Flood levels, rates of streamflow and flood frequency have become more severe in recent years.
- Water Quality: Water quality of the Cedar River is degraded by high levels of fecal bacteria that pose a threat to public health. The Cedar River also has elevated levels of nitrate. Refer to the watershed characterization section for further description of these water quality issues.
- Recreation: The Cedar River and many of its tributaries provide opportunities for water-based recreational activities including fishing, canoeing/kayaking, and wildlife observation. More frequent flooding and increasing pollutant loads are impacting the recreational value of these resources.
- Funding & Organization: Effective watershed management is contingent on organizational structure and internal capacity of the Middle Cedar Watershed Management Authority (MCWMA) as well as the security of adequate funding sources in the future. It has been shown repeatedly that there needs to be a long-lasting organizational structure, accountability to the public, along with a stable funding mechanism.
- Policy: While there are stormwater regulations in place for municipal separate storm sewer systems, construction activities and industrial activities, much of the land use activities in the MCW are unregulated. This creates a significant burden on those entities charged with providing financial and technical assistance to the agricultural community in order to address the quantity and quality of agricultural stormwater runoff.
- Education & Outreach: Many of the people who live, recreate or conduct business in the watershed are unfamiliar with watershed management concepts and the impact their activities have on the quality of downstream water resources.
- Evaluation & Monitoring: In order to assess performance and communicate achievements at the local, state and federal level, the MCWMA needs to establish a monitoring program. Not only should this monitoring program establish baseline conditions on resource health but it should continue to collect the information needed to establish trends and evaluate projects and programs to better inform future management decisions.
- Partnerships: Watershed Management Authorities are, by definition, partnerships between local Cities, Counties, and Soil & Water Conservation Districts. The MCWMA was formed to jointly address the challenges facing the watershed. While the MCWMA intends to assume a leadership role it does not bear the sole responsibility nor does it possess all the financial resources, regulatory authority, or knowledge needed to meet the challenge of managing the watershed.

4.2. North Beaver Creek Subwatershed Specific Issues

As noted in the Stakeholders Engagement Process, participants in both input meetings helped to identify important issues to them and their community. In particular, in both meetings, participants emphasized the importance of increased communication with the community at-large in regards to the watershed planning underway and future watershed-related projects. It is important that community members are asked for their input early on, as demonstrated with the first in-put meeting with stakeholders. Other important issues brought up and identified by participants are:

- Debris in the river channels causes jams that flood fields: Several farmers noted that felled trees were seen in the creeks and this backed up the water under bridges and diverted more flooding in their fields. The straightening of the creeks has only worsened the washing out of the creek beds and farmers felt that the state needed to be more proactive about maintaining the trees along the creeks and streams.
- Drainage Water Management: Watershed stakeholders rated drainage water management as more likely to be implemented, when compared to other watersheds. This could be an area to explore further and see what farmers would be willing to change.
- Address abandoned pastures: Several attendees pointed out that abandoned pastures were being taken over by trees and brush and this only exacerbated the amount of debris in the creeks. While this is occurring on private land, stakeholders felt that local Soil and Water Conservation District or Farm Service Agency offices could contact landowners and work with them to get the areas cleared out.

5. GOALS AND OBJECTIVES

5.1. Middle Cedar Watershed Management Plan

Goals and objectives have been established for the Middle Cedar Watershed (MCW) based on the general issues that were identified during the planning process. These goals and objectives are used to guide the implementation plan for the Middle Cedar Watershed Management Plan (MCWMP) and will be used to set the framework for the Headwaters Prairie Creek HUC-12 Subwatershed Plan.

In order to address the issues identified in the MCW, the following primary goals have been established:

Flooding/Water Quantity Goals: Reduce flood risk and damage to local communities/ neighborhoods; Reduce causes of flooding potential; Protect life and property from flood damage; Improve stormwater management at local levels; and Increase watershed awareness related to water quantity.

Water Quality Goals: All waters within the MCW meet their designated uses, promote management activities to protect high quality drinking water sources, and meet the INRS goals for nitrogen and phosphorus reduction at the HUC-8 scale.

Recreation Goals: Enhance the watershed's existing water-based recreational areas, develop new recreational opportunities on lakes and streams across the watershed, and improve the health of the watershed ecosystems.

Monitoring and Evaluation Goals: Evaluate temporal trends in water quality and quantity, determine the water quality and quantity conditions of water sources within the watershed, and evaluate the effectiveness of the Middle Cedar Watershed Management Authority (MCWMA) management efforts.

Funding and Organizational Goals: Identify and obtain funding sources that are reliable and sufficient to meet the goals identified in the watershed management plan, and effectively manage the MCWMA through implementation of the plan and appropriate governance structure.

Watershed Policy Goal: Encourage communities with regulations in place that protect water resources to improve oversight and enforcement of those regulations.

Education and Outreach Goals: Increase awareness of the watershed and its resources, inspire watershed stewardship and ownership, disseminate water-resource information and materials, ensure all stakeholders in the watershed are included in activities and programs, and identify and empower local watershed stewards to build watershed management ethic at the grassroots levels.

Partnership Goal: Work cooperatively to achieve mutual watershed management objectives.

Each of these goals has a set of specific objectives to practice in order to meet the goal. For more on the goals and objectives, please refer to the MCWMP.

5.2. North Beaver Creek Subwatershed Specific Goals

The following specific goals and objectives have been identified for the North Beaver Creek Subwatershed. These goals and objectives were developed through the following:

- Input received by local subwatershed resident in stakeholder engagement meetings.
- The goals and objectives framework established for the MCWMP.
- Goals established in approved TMDL studies.

5.2.1. Flooding/Water Quantity Goals

Flooding in the North Beaver Creek subwatershed results in significant financial losses. Over $200 thousand dollars in damage to buildings and their content results from the 100-year (1 percent annual chance) flooding event within the watershed (see section **6.5** for further information).

The goal for this subwatershed is to reduce flooding and minimize financial losses due to flooding.

The GHOST Hydrologic & Hydraulic model, developed by the Iowa Flood Center, was used to estimate the flood reduction benefits resulting from implementation of a suite of conservation practices across the watershed. This was accomplished by comparing the peak flood stage that occurred on Beaver Creek within the City of Applington during the June 24th, 2013 flooding event with the flood stages predicted by the GHOST model for various implementation scenarios.

5.2.2. Water Quality Goals

The Iowa Nutrient Reduction Strategy serves as a foundation for the water quality goals in the MCW. Specifically, the load reduction goal for nitrogen is a 41 percent reduction from non-point sources and the load reduction goal for phosphorus is a 29 percent reduction from non-point sources by the year 2035.

The Mississippi River Gulf of Mexico Watershed Nutrient Task Force developed a New Goal Framework in 2014 that established an Interim Target of a 20 percent reduction of nitrogen and phosphorus loading by 2025 is a milestone for immediate planning and implementation actions

The MCWMP established a goal of having all waters within the watershed meet their designated uses. Currently, three stream segments that receive drainage from the North Beaver Creek Subwatershed do not meet their designated uses.

Beaver Creek (Mouth (S34, T90N, R14W, Black Hawk Co.) to Confluence with South Beaver Creek in S25, T90R, R17W, Butler Co.): A TMDL has not been developed for this stream segment. No goals for bacteria reduction have been established.

Cedar River from McCloud Run to Bear Creek: This segment of the Cedar River is impaired due to levels of nitrate above the State Standard for drinking water. A TMDL was developed for this segment of the Cedar River that established a 37 percent loading reduction target for nonpoint sources of nitrate.

Cedar River from the Dam of Cedar Falls Impoundment to the Upper End of the Impoundment: This segment of the Cedar River is impaired due to elevated levels of *E. coli* bacteria. A TMDL was developed for all impaired reaches of the Cedar River in 2010. The TMDL includes an informational implementation plan. An implementation plan is not a requirement for a TMDL but EPA Region 7 developed a Hydrologic Simulation Program Fortran model to test potential scenarios. The model determined that the following scenario will result in the river segments meeting the Iowa water quality standards. This scenario assumes that all wastewater treatment plants effluent and rivers entering Iowa will have bacteria concentrations less than or equal to the Iowa water quality standard.

1. Unpermitted feedlots will control/capture the first one-half inch of rain.
2. Cropland bacteria loading will be reduced by 40 percent through proper timing and application of animal waste.
3. Cattle in streams will be reduced by 40 percent.
4. Leaking septic systems will be eliminated.

6. IMPLEMENTATION PLAN

6.1. Existing Conservation Practices

The Iowa Department of Natural Resources, Iowa Department of Agriculture and Land Stewardship, Iowa Nutrient Research Center at ISU, National Laboratory for Agriculture and the Environment and Iowa Nutrient Research and Education Council are currently developing an inventory of the conservation practices across the State. The effort is referred to as the Iowa Best Management Practice (BMP) Mapping Project. The goal of the project is to provide a complete baseline set of BMPs dating from the 2007-2010 timeframe for use in watershed modeling, historic occurrence, and future practice tracking. The BMPs mapped are: Terraces, Water and Sediment Control Basins, Grassed Waterways, Pond Dams, Contour Strip Cropping and Contour Buffer Strips. The Iowa BMP Mapping Project data can be accessed at: https://athene.gis.iastate.edu/consprac/consprac.html.

The existing conservation practices of the North Beaver Creek Subwatershed are shown in **Figure 6**. In addition to the Iowa BMP Mapping Project, conservation practice locations provided by participants in the stakeholder engagement meetings are shown.

North Beaver Creek (Photo credit: EOR).

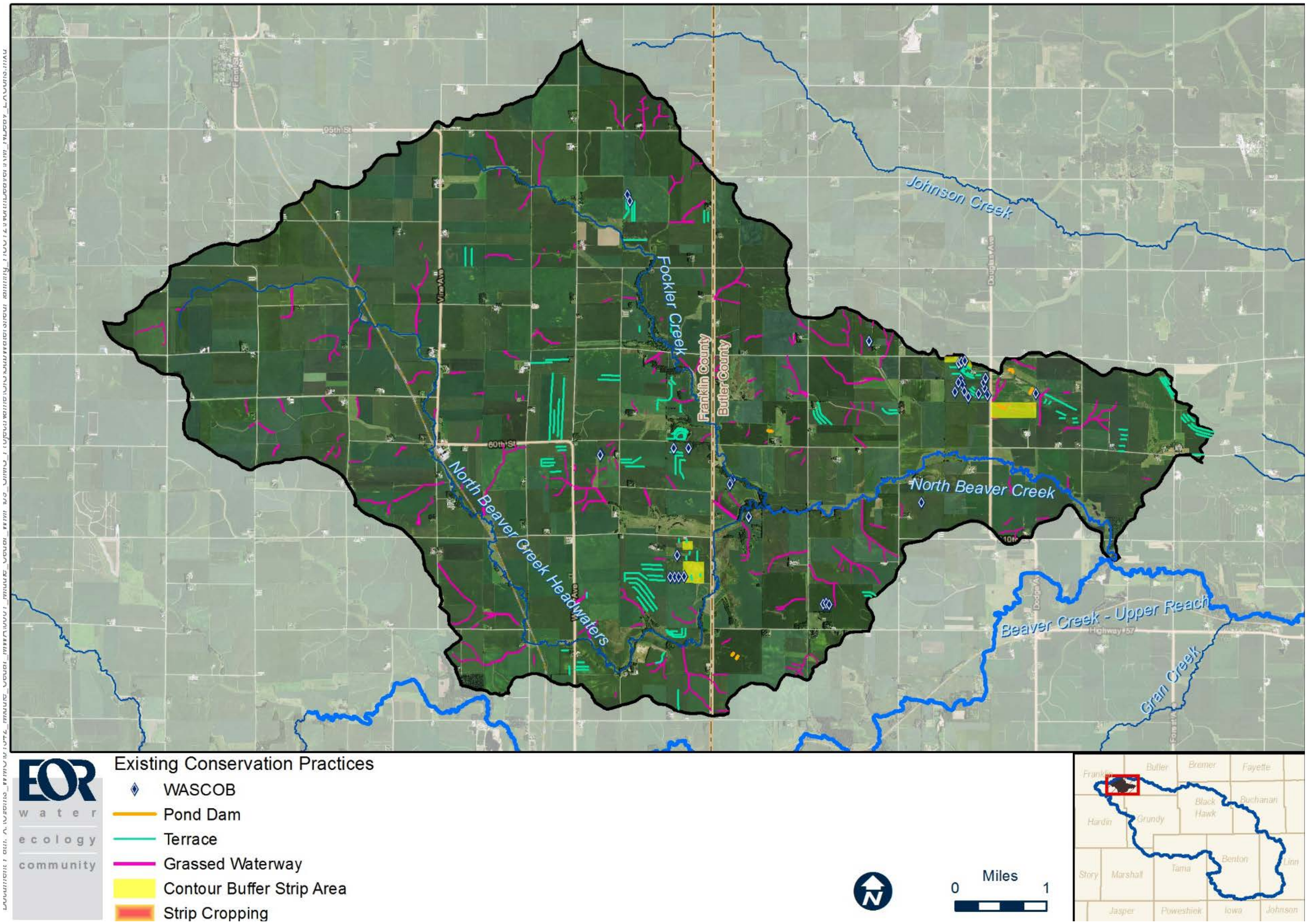

Figure 6. Existing Conservation Practices in the North Beaver Creek Subwatershed.

6.2. Potential Agricultural Conservation Practices

The ACPF Version 2.2 was run for the North Beaver Creek Subwatershed. The ACPF is a GIS-based tool developed by the Agricultural Research Service (USDA-ARS) that analyzes "soils, land use, and high-resolution topographic data to identify a broad range of opportunities to install conservation practices in fields and in watersheds." The ACPF tools identify suitable locations for terrain-dependent conservation practices:

- Grassed Waterways
- Contour Buffer Strips
- Nutrient Removal Wetlands
- Edge-of-Field Bioreactors
- WASCOB
- Drainage Water Management
- Saturated Buffers
- Riparian Buffers

Additional conservation practices that are not terrain-dependent have also been identified as potential options for reducing nutrient and sediment loading within the subwatershed. The following section (**Soil Health Practices**) describes the suite of conservation practices recommended for implementation recommended for the subwatershed organized by tier of the conservation pyramid as shown in **Figure 7**. The conservation practices sited by the ACPF analysis are shown in **Figure 8**.

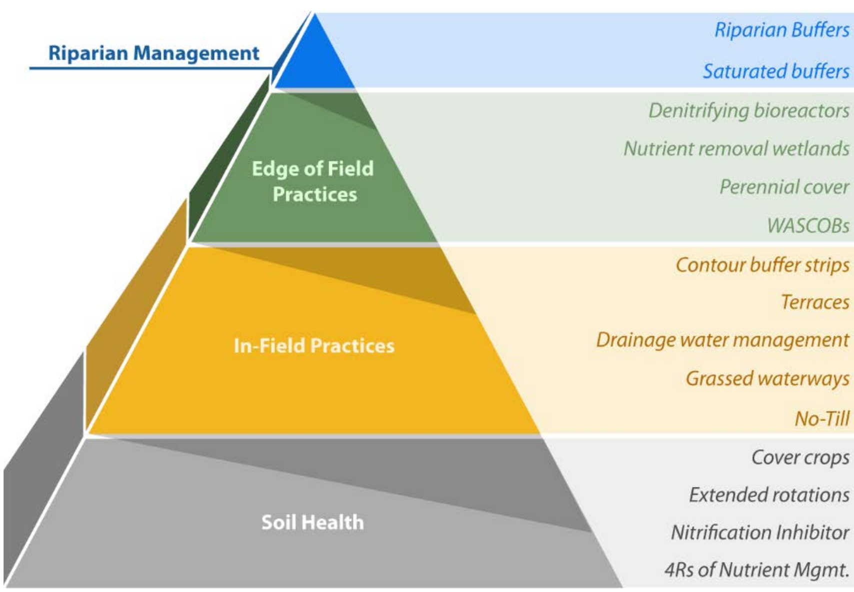

Figure 7. Conservation Pyramid (adapted from Tomer et al. 2013)

6.2.1. Soil Health Practices

Starting at the base of the conservation pyramid, the following practices reduce nutrient and sediment runoff from fields while also building soil health.

Cover Crops: Cover crops is a term to describe any crop grown primarily for the benefit of the soil rather than the crop yield. Cover crops are typically grasses or legumes (planted in the fall between harvest and planting of spring crops) but may be comprised of other green plants. Cover crops prevent erosion, improve the physical and biological properties of soil, supply nutrients, suppress weeds, improve the availability of soil water, and break pest cycles, in addition to a wide range of additional benefits. More information on cover crop use in Iowa can be found at:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_005818.pdf

Extended Crop Rotations: An extended crop rotation is a farming practice that includes a rotation of corn, soybean, and two to three years of alfalfa or legume-grass mixtures managed for hay harvest. Extended rotations reduce the application and loss of both nitrate-N and phosphorus. By growing nitrogen-fixing legumes three years in a row, very little, if any nitrogen needs to be applied in the subsequent corn year. Additional information can be found at:

https://www.cleanwateriowa.org/extended-crop-rotation/

Nitrification Inhibitors: When ammonia or ammonium nitrogen is added to the soil, it is subject to a process called nitrification. Soil bacteria converts the ammonia (NH_3) or ammonium (NH_4) to nitrate (NO_3). This conversion is strongly temperature dependent and occurs quickly under warm soil temperature conditions. Using a nitrification inhibitor with applications of ammonia or ammonium nitrogen will slow the conversion to nitrate until it can be readily used by crops. This will allow the crop to uptake more of the nitrogen at critical times in the growing season. To learn more, visit: https://www.cleanwateriowa.org/new-page-1

4Rs of Nutrient Management: The 4Rs of nutrient management refer to fertilizer application techniques focused on minimizing the risk of nutrient loss from the field. The principles of the 4R framework include:

- Right Source – Ensure a balanced supply of essential nutrients, considering both naturally available sources and the characteristics of specific products, in plant available forms.
- Right Rate – Assess and make decisions based on soil nutrient supply and plant demand.
- Right Time – Assess and make decisions based on the dynamics of crop uptake, soil supply, nutrient loss risks, and field operation logistics.
- Right Place – Address root-soil dynamics and nutrient movement, and manage spatial variability within the field to meet site-specific crop needs and limit potential losses from the field.

Recently a program called 4R Plus was developed by a coalition of organizations dedicated to conservation stewardship for Iowa's farmers. 4R Plus is a nutrient management and conservation program to make farmers aware of practices that bolster production, build soil health and improve water quality in Iowa. The program is guided by a coalition of more than twenty-five organizations, including agribusinesses, conservation organizations, commodity and trade associations, government agencies and academic institutions. To learn more, visit:

https:www.4RPlus.org/.

Soil health practices can be implemented on areas of row crop production throughout the subwatershed regardless of topographic setting.

In the North Beaver Creek Subwatershed, there are currently approximately 23,275 row crop acres. Soil health practices are already in place on many of these acres. Assumptions for existing adoption rates for soil health practices within this subwatershed are shown in **Table 5**. These assumptions are based on professional judgement, communication with local Soil & Water Conservation Districts and Natural Resources Conservation Service staff members, and input from local farmers who participated in the stakeholder engagement meetings.

Table 5. Soil Health Management Conservation Practice Existing Adoption Rate Assumptions for the North Beaver Creek Subwatershed.

Conservation Practice		Existing Adoption Rate	Existing Adoption Acres
	Cover crops	2%	466
	Extended rotations	1%	233
	Nitrogen management: nitrification inhibitor	50%	11,638
4Rs	Nitrogen management: rate control	10%	2,328
	Nitrogen management: source control	18%	4,189
	Nitrogen management: timing control	26%	6,052
	Phosphorus management: placement control	50%	11,638
	Phosphorus management: rate control	50%	11,638
	Phosphorus management: source control	18%	4,189

6.2.2. In-field Conservation Practices

The following conservation practices are categorized as in-field management practices because they are implemented directly within the actively farmed area of a field. Note that in the case of no-till, this practice can also improve soil health. These practices have benefits for both water quality improvement as well as flood mitigation, since the practices help to slow down runoff rates while also filtering out pollutants.

Contour Buffer Strips: Contour buffer strips are strips of grass, or a mixture of grasses and legumes, that run along the contour of a farmed field. Buffer strips are installed in rows down the slope of a field, alternating with wider cropped strips. Established contour buffer strips can significantly, reduce sheet and rill erosion, slow runoff, and trap sediment. Contaminants such as sediment, nutrients, and pesticides are removed from the runoff as they pass through a buffer strip. Buffer strips may also provide food and nesting cover for wildlife and pollinators. Additional information can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcseprd413956

Terraces: A terrace is an earth embankment, channel, or a combination ridge and channel constructed across the slope to intercept runoff water. This practice generally applies to cropland but may also be used on other areas where field crops are grown such as wildlife or recreation lands. Terraces serve several purposes, including reducing slope length for erosion control, intercepting and directing runoff, and preventing gully development. Additional information can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026229.pdf

Drainage Water Management: Controlled drainage describes the practice of installing water level control structures within the drain tile system. This practice reduces nitrogen loads by raising the water tables during part of the year, thereby reducing overall tile drainage volume and nitrate load. The water table is controlled through the use of gate structures that are adjusted at different times during the year. When field access is needed for planting, harvest or other operations, the gate can be opened fully to allow unrestricted drainage. When the gate is used to raise local water table levels after spring planting season, this 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. Additional information can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081603.pdf

Grassed Waterways: Grassed waterways are constructed channels, seeded with grass, that drain water from areas of concentrated flow. The vegetation slows down the water and the channel conveys the water to a stable outlet at a non-erosive velocity. Grassed waterways should be used where gully erosion is a problem. These areas are commonly located between hills and other low-lying areas on hills where water concentrates as it runs off the field (USDA-NRCS 2012). The size and shape of a grassed waterway is based on the amount of runoff that the waterway must carry, the slope, and the underlying soil type. Although a limited function, it is important to note that grassed waterways also have an ability to trap sediment entering them via field surface runoff and in this manner performs similarly to riparian buffer strips. Additional information on grassed waterways can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026051.pdf

No-till: No-till is a way of growing crops or pasture from year to year without disturbing the soil through tillage. No-till increases the amount of water that infiltrates into the soil, the soil's retention of organic matter and its cycling of nutrients. It can also reduce or eliminate soil erosion and increase the amount and variety of life in and on the soil. The most powerful benefit of no-tillage is improvement in soil biological fertility, making soils more resilient to degradation and erosion (NWRM 2015). Additional information on the use of no-till can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_015627.pdf

The current extent of in-field management practices in this subwatershed was estimated by reviewing the Iowa DNR BMP Mapping Project (see **Figure 6**), and through professional judgement as described for the soil health management practices.

Table 6. In-field Conservation Practice Existing Adoption Rate Assumptions for the North Beaver Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Contour buffer strips	0%	Comparison of ACPF output to BMP Mapping Project findings
Terraces	100%	Comparison of ACPF output to BMP Mapping Project findings
Drainage Water Management	0%	Professional Judgement
Grassed Waterways	27%	Comparison of ACPF output to BMP Mapping Project findings
No-Till	20%	Professional Judgement

6.2.3. Edge of Field Conservation Practices

The following conservation practices are categorized as edge of field practices due to their typical location just off the edge of a farm field. Note that conversion to perennial cover is included in this group. The rationale is that the converted area would no longer be an actively farmed area, it would essentially be converted to a field edge.

Denitrifying bioreactors: Denitrifying bioreactors are trenches in the ground packed with carbonaceous material, such as wood chips, which allow colonization of soil bacteria that convert nitrate in drainage water to nitrogen gas. Installed at the outlet of tile drainage systems, bioreactors are typically capable of treating 40-60 acres of farmland. These have limited benefits for flood mitigations, but they can be highly beneficial for water quality improvement. According to the INRS, bioreactors can achieve an average nitrate reduction of 43 percent for water going through the bioreactor. Additional information on denitrifying bioreactors can be found at:
https://www.nrcs.usda.gov/wps/portal/nrcs/ia/newsroom/factsheets/NRCSEPRD414822/

Nutrient Removal Wetlands: This conservation practice is a shallow depression 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. A 0.5 percent to 2 percent range in wetland pool-to-watershed ratio permits the wetlands to efficiently remove nitrogen runoff from large areas and data has shown that at times 40 percent to 90 percent of the nitrate flowing into the wetland can be removed. These wetlands and surrounding grassland buffers also provide environmental benefits beyond water quality improvement such as increases in wildlife habitat, carbon sequestration, and minor flood water retention (Crumpton et al. 2006). Additional information on nutrient removal wetlands can be found at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025770.pdf

Perennial Cover: Perennial cover refers to the practice of converting cropland to a permanent perennial vegetative cover and/or trees to accomplish any of the following: reduce soil erosion and sedimentation, improve water quality and quantity, improve infiltration, enhance wildlife habitat, improve soil quality, or manage plant pests. Additional information on the use of perennial cover for conservation can be found at:
https://store.extension.iastate.edu/product/The-Iowa-Watershed-Approach-Perennial-Cover

Water and Sediment Control Basin (WASCOB): Water and sediment control basins are small earthen ridge-and-channel or embankments built across a small watercourse or area of concentrated flow within a field. They are designed to trap agricultural runoff water, sediment and sediment-borne phosphorus as it flows down the watercourse; this keeps the watercourse from becoming a field gully and reduces the amount of runoff and sediment and phosphorus leaving the field. WASCOB's are usually created through construction of a small, grassed berm that is just long enough to bridge an area of concentrated flow. The runoff water detained in a WASCOB is released slowly, usually via infiltration or a pipe outlet and tile line. These practices also have benefits for water storage/flood risk reduction. Additional information on WASCOBs can be found at:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025622.pdf

The current extent of edge of field conservation practices in this subwatershed was estimated by reviewing the Iowa DNR BMP Mapping Project (see **Figure 6**), and through professional judgement as described for the soil health management practices.

Table 7. Edge of field Conservation Practice Existing Adoption Rate Assumptions for the North Beaver Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Denitrifying bioreactors	0%	Professional Judgement
Nutrient removal wetlands	0%	Comparison of ACPF output to BMP Mapping Project findings
Perennial cover	1%	Professional Judgement
WASCOBs	37%	Comparison of ACPF output to BMP Mapping Project findings

6.2.4. Riparian Area Management

The final tier of the conservation pyramid is management practices within the areas adjacent to existing waterways. These practices are commonly referred to as riparian area conservation practices. An evaluation of the existing riparian area throughout the subwatershed was conducted. The land cover types within 50 feet on either side of each stream (the riparian area) within the subwatershed were inventoried to determine the current condition. Areas where natural land cover types (forests, wetlands, etc.) were found within the riparian area were determined to have an existing buffer. The existing adoption rates shown in **Table 8** are the percentage of natural cover types within each type of riparian area management as sited in the ACPF tools.

Riparian Buffers: The ACPF tools identify a variety of riparian buffers types based on the primary function they serve. The riparian buffer types are as follows:

- Critical Zone- sensitive areas: identified as areas with a high level of surface runoff delivery
- Deep-rooted Vegetation – for areas with saturated soils
- Multi-species – for water uptake, nutrient and sediment trapping
- Stiff stemmed grasses – for areas with overland runoff where sediment can be trapped
- Stream stabilization – for areas where bank stability is the emphasis

Additional information on riparian buffer types can be found at:
https://www.cleanwateriowa.org/stream-buffers

Saturated Buffers: Saturated buffers are vegetated areas, typically in a riparian area along a stream or ditch where drain tile water is dispersed in a manner that maximizes its contact with the soils and vegetation of the area. Drain tile lines that typically discharge directly to the ditch or stream are intercepted and routed into a new drain tile pipe that runs parallel to the ditch or stream. This allows drain water to exfiltrate and saturate the buffer area. The contact with soil and vegetation results in denitrification. Additional information on saturated buffers can be found at:
https://www.ars.usda.gov/midwest-area/ames/nlae/news/what-are-saturated-buffers/

Table 8. Riparian Area Management Practice Existing Adoption Rate Assumptions for the North Beaver Creek Subwatershed.

Conservation Practice	Existing Adoption Rate	Adoption Rate Estimate Source
Critical zone riparian buffer	68%	Evaluation using HRLC Mapping Data and Stream Riparian Areas
Deep-rooted vegetation riparian buffer	75%	
Multi-species riparian buffer	75%	
Stiff stem grass riparian buffer	86%	
Stream stabilization riparian buffer	81%	
Saturated buffers	0%	Professional Judgement

The conservation practices described in the previous section were compiled for the North Beaver Subwatershed and processed using a custom set of scripts written in the R programming language. Essentially, these scripts aggregated the individual BMP features and created a summary for the North Beaver Creek HUC-12 containing the total potential extent for each BMP type along with the total footprint and drainage area served (see **Table 9**).

A tool was developed in Microsoft Excel that uses the BMP summaries to apply pollutant loading values to the drainage areas, along with pollutant reduction values that are unique to each BMP. The pollutant reduction estimates were derived from a combination of sources, but were primarily taken from the INRS. Existing BMP adoption rates were estimated using a combination of sources, including feedback for specific watersheds from the Grundy SWCD and the ISA, as well as using the results from the Iowa BMP Mapping Project as described in the previous section (**Edge of Field Conservation Practices**). After consideration of the existing pollutant reductions provided by BMPs currently in place, the Excel tool provides an overall estimate for the subwatershed of the expected maximum nitrogen and phosphorus reduction potential assuming a 100% implementation rate of each individual BMPs. The results of this analysis are shown in **Table 9**.

Table 9. Maximum Potential Load Reduction by BMP for the North Beaver Creek Subwatershed.

	Conservation Practice	Existing Adoption	Full Adoption	Load Reduction %	
				N	P
Soil Health Management	Cover crops	2%	100%	25.5%	23.8%
	Extended rotations	1%	100%	34.9%	0.0%
	Nitrogen management: nitrification inhibitor	50%	100%	3.8%	0.0%
	Nitrogen management: rate control	10%	100%	7.5%	0.0%
	Nitrogen management: source control	20%	100%	2.8%	0.0%
	Nitrogen management: timing control	50%	100%	3.7%	0.0%
	Phosphorus management: placement control	50%	100%	0.0%	12.6%
	Phosphorus management: rate control	50%	100%	0.0%	7.1%
	Phosphorus management: source control	50%	100%	0.0%	31.6%
In-Field Management	Contour buffer strips	0%	100%	0.0%	20.6%
	Terraces	100%	100%	0.0%	0.0%
	Drainage water management	0%	100%	3.1%	0.0%
	Grassed waterways	27%	100%	0.0%	38.7%
	No-Till	20%	100%	0.0%	60.4%
Edge-of-Field Management	Denitrifying bioreactors	0%	100%	9.9%	0.0%
	Nutrient removal wetlands	0%	100%	20.0%	0.0%
	Perennial cover	1%	100%	59.8%	28.2%
	WASCOBs	37%	100%	0.0%	1.8%
Riparian Management	Riparian buffer: Critical zone buffer	68%	100%	0.6%	0.4%
	Riparian buffer: Deep-rooted vegetation buffer	75%	100%	0.2%	0.1%
	Riparian buffer: Multi-species buffer	75%	100%	1.0%	0.7%
	Riparian buffer: Stiff stem grass buffer	86%	100%	0.0%	0.2%
	Riparian buffer: Stream stabilization buffer	81%	100%	0.0%	0.1%
	Saturated buffers	0%	100%	10.1%	0.0%

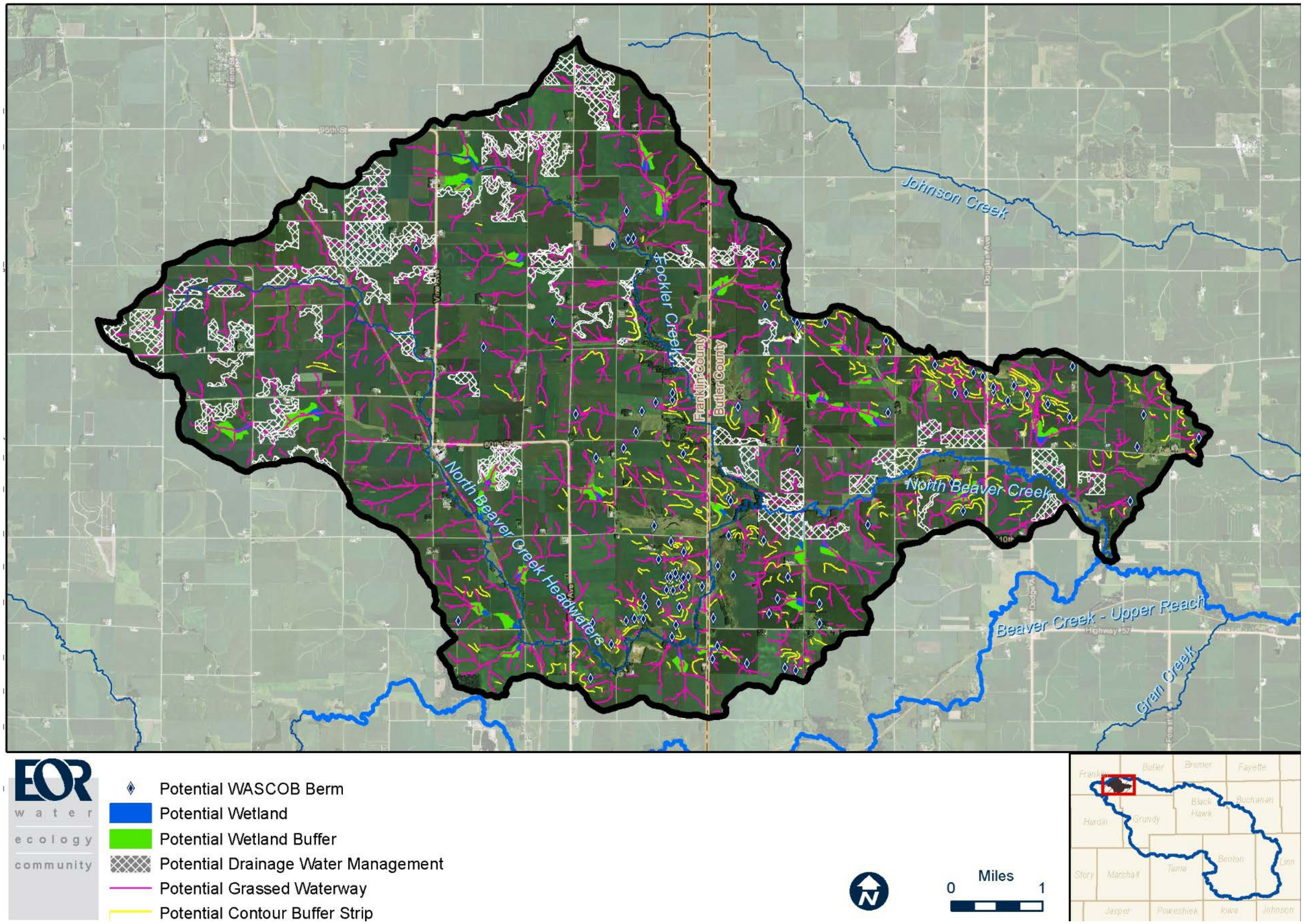

Figure 8. Potential Conservation in the North Beaver Creek Subwatershed.

6.3. Strategies to Address Bacteria Loading

Identify, map, and monitor sources: The most important step is to identify potential and known sources of bacteria. Determining the most likely sources is typically a desktop exercise using mapping to identify where bacteria could be introduced to waterbodies such as pastures/agricultural land where manure is applied, feedlots, and residential onsite wastewater treatment system near waterbodies, at dog parks and areas where wildlife congregate near waterbodies such as fields and golf courses. Mapping bacteria conveyance systems (e.g. stormwater and ditches) is also important. Mapping known and potential sources will ensure that these areas are regularly monitored and inspected. Field monitoring will also identify sources, and it should be conducted to regularly inspect known sources.

A cursory mapping of potential sources of bacteria in the subwatershed is presented in **Section 3** of this plan, but additional investigation would be beneficial in refining the bacteria source assessment and to guide future management decisions.

Federal, State, and Local Requirements: Ensuring state laws and local ordinances are up-to-date and enforced is also a cost effective and efficient way to reduce bacteria loading into waterbodies. Specifically, local ordinances that address manure management and land use regulations should be coordinated with State-level water resource regulations that protect water resources and minimize potential release of bacteria.

Outreach/Education: It is very important that residents are aware of and understand the state and local water and land use regulations, as well as steps they can take to reduce bacteria entering water resources. For example, outreach and education can ensure that landowners and residents understand the regulations governing water resources such as collection of pet waste or bans on wildlife feeding in order to comply with them. Residents should also be aware of the best management practices and opportunities available to minimize sources of bacteria on their property.

Best Management Practices that Limit Introduction of Bacteria: The most effective method to reduce loads and meet long-term water quality goals is to address the sources that directly contribute bacteria to waterbodies. Source controls are best management practices that focus on limiting the introduction of bacteria into the landscape where it could be transported to waterbodies. Source control activities that reduce bacteria releases from direct sources include excluding livestock from surface waterbodies, effective manure management, regular onsite wastewater treatment system maintenance, pet waste collection, and green infrastructure practices.

Best Management Practices that Reduce Bacteria Loading to Waters: Source control and the methods mentioned above should be the first step of reducing bacterial loading as these methods are the most cost efficient and effective. Source control, however, is not always feasible and there are a number of BMPs that can reduce bacteria-laden runoff to waterbodies. Based on available data, some conventional stormwater BMPs reduce bacterial loads to receiving waters by (a) treating stormwater and removing bacteria from discharged water, or (b) reducing total water discharge along with the associated bacterial load. In some cases, multiple BMPs, including pre-treatment, may be necessary to achieve significant reductions in bacteria concentrations. Additionally, many BMPs are designed to reduce the loading of several pollutants at the same time.

Prior to evaluating BMP performance or selecting BMP strategies to target bacteria, it is important to understand basic fate and transport mechanisms as well as treatment processes anticipated to be effective for removing or inactivating bacteria. Inactivating bacteria refers to a natural process in which bacteria die-off or fail to reproduce due to existing environmental factors such as pH. Bacteria can thus be controlled without being removed. However, bacteria population can also increase without further bacteria loading if environmental conditions are conducive to population growth within the conveyance or receiving waters.

Properly designed BMPs that reduce the total volume of agricultural or urban runoff (e.g., infiltration BMPs) to receiving waters can effectively reduce the bacteria load by an amount equivalent to that contained in the reduced volume. They may also reduce the frequency of bacterial discharges to receiving waters if volume reductions are sufficient to retain runoff from most events.

BMPs that filter and/or reduce the rate or frequency of runoff (e.g., filtration or other BMPs that do not reduce volumes but do provide treatment) may reduce bacteria concentrations in this runoff and thereby reduce loading to receiving waters. Filtration and similar BMPs should, however, be carefully planned and investigated before implementation as they are sometimes ineffective and may even result in increased bacteria concentrations in discharges.

Overall, data on BMP effectiveness is limited and, with the exception of properly designed infiltration BMPs, broadly applicable conclusions cannot be drawn. Additional studies are needed for all BMP types to increase the confidence of performance estimates with regard to bacteria.

The strategies described above provide a general outline and description for the first steps of reducing bacterial loads through source controls. However, there are inherent differences in how to reduce bacteria loadings from urban as opposed to rural subwatersheds. The MCWMP provides more detailed explanations of source controls and BMPs that are applicable more specifically to urban and rural areas. The measures and BMPs described in the MCWMP are not the only available methods for reducing bacteria, but are the actions most recommended and applicable to the Middle Cedar Watershed (MCW) and the North Beaver Creek Subwatershed.

6.4. Recommended Conservation Practice Adoption Rates

A specific scenario for conservation practice implementation/adoption rates was developed for each of the 68 subwatersheds of the MCW. The objective for the scenario was to meet the nutrient reduction targets established in the INRS for non-point sources of 41 percent reduction in nitrogen and 29 percent reduction for phosphorus for each subwatershed. The specific conservation scenario developed for the North Beaver Creek Subwatershed is shown in **Table 10**. The table indicates the recommended adoption rate of each practice with the corresponding acreage or quantity, and the percentage of the subwatershed treated by that practice. The table also includes the estimated subwatershed nutrient load reduction provided as a result of the recommended adoption rate of each specific practice. The conservation practice scenario was developed through an iterative process using a cost-benefit analysis that is described in the MCWMP. Over 60 percent of the nitrogen removal and over 80 percent of the phosphorus removal in this subwatershed is achieved through the use of soil health practices. The recommended conservation practice scenario results in an estimated total reduction of over 574,000 pounds per year of nitrogen and over 10,000 pounds per year of phosphorus.

Table 10. Recommended Adoption Rates for Conservation Practices in the North Beaver Creek Subwatershed.

Conservation Practice	Existing Adoption	Target Adoption Rate	Target Adoption Quantity		Load Reduction (lbs/year) N	Load Reduction (lbs/year) P
Cover crops	2%	72%	16,128	acres	248,993	6,008
Extended rotations	1%	2%	230	acres	4,819	0
Nitrogen management: nitrification inhibitor	50%	75%	5,760	acres	25,817	0
Nitrogen management: rate control	10%	50%	9,216	acres	45,897	0
Nitrogen management: source control	18%	36%	4,147	acres	8,262	0
Nitrogen management: timing control	26%	51%	5,875	acres	17,556	0
Phosphorus management: placement control	50%	59%	2,074	acres	0	799
Phosphorus management: rate control	50%	60%	2,304	acres	0	503
Phosphorus management: source control	18%	36%	4,147	acres	0	2,450
Contour buffer strips	0%	1%	1	miles	0	73
Terraces	100%	100%	-	miles	0	0
Drainage water management	0%	50%	34	fields	21,106	0
Grassed waterways	27%	27%	0	miles	0	4
No-Till	20%	25%	1,152	acres	0	1,332
Denitrifying bioreactors	0%	25%	31	reactors	33,833	0
Nutrient removal wetlands	0%	40%	14	wetlands	109,362	0
Perennial cover	1%	2%	235	acres	8,430	103
WASCOBs	37%	38%	1	basins	0	8
Riparian buffer: Critical zone buffer	68%	100%	0.40	miles	8,219	135
Riparian buffer: Deep-rooted vegetation buffer	75%	100%	5.93	miles	2,195	36
Riparian buffer: Multi-species buffer	75%	100%	2.46	miles	14,302	235
Riparian buffer: Stiff stem grass buffer	86%	87%	0.03	miles	0	3
Riparian buffer: Stream stabilization buffer	81%	82%	0.1	miles	0	1
Saturated buffers	0%	50%	11.9	miles	70,288	0

6.5. Flood Benefits

To demonstrate the flood damage reduction benefits achieved through implementing the recommended suite of conservation practices throughout the MCW, a series of flood damage reduction reporting locations were established. The objective in developing this network of locations was to decentralize the evaluation. The traditional approach for demonstrating flood damage reduction benefits is to look at the downstream-most area within the watershed or at a few key locations in the watershed that experience the largest impacts due to flooding. The approach developed for the MCWMP is to look at several locations throughout the watershed including upper portions of headwaters subwatersheds as well as main-stem Cedar River sites.

The flood damage reduction reporting location for the North Beaver Creek Subwatershed is located at the Beaver Creek crossing at Hickory Avenue north of the City of Aplington.

Selection of the flood damage reduction reporting locations was based on the following:

- Areas within the watershed identified as having high or very high flood risk according to the Risk MAP for the MCW (FEMA 2015) and were associated with easily recognizable locations (cities, road intersection).
- Stream segments that were explicitly included in the GHOST Hydrologic and Hydraulic Model (IIHR 2018) and where both stream flow data and stage/elevation data were available.
- Sites on tributaries near the Cedar River were located far enough upstream to avoid the impact of Cedar River flooding on the flow and/or stage of the given tributary.

The flood damage reduction benefits associated with BMP implementation were estimated using results from modeling that was performed as part of the IFC / IIHR's MCW Hydrologic Assessment. As a continuous simulation was used for these model runs – in part because design storm simulations lose their meaningfulness at such a large scale – for each location a specific simulated flood event was chosen for analysis. The events were chosen to be as close to the 10-year recurrence interval (return period) as possible for several reasons: first, the most significant flood events (e.g. floods with magnitudes equal to or above the 100-year recurrence interval) may not be significantly impacted by the types of controls that the proposed BMPs provide; second, minor flood events (e.g. floods with magnitudes equal to or below the 5-year recurrence interval) are perhaps not significant enough in terms of damages to be meaningful for reporting risks and/or benefits. Conversely, the ~10-year recurrence interval flood is both large enough to have significant flood damages and small enough to show significant flood damage reductions resulting from BMP implementation, and as such provides a convenient metric that will be meaningful to stakeholders.

The flood event used for the North Beaver Creek Subwatershed was June 8, 2008.

By implementing the recommended conservation practices, the flood benefits that would have been achieved during this particular flood event is $12,100 in reduced losses and a 0.2-foot flood stage reduction. Therefore, it is inferred that this reduction in losses would be achieved if an event similar to this one were to happen in the future, assuming all recommended conservation practices were implemented. Maintaining the assumption of full implementation, it is also estimated that the subwatershed would see annual reduced flood losses of $4,100 if annual flood events conform to predicted patterns.

6.6. Prioritized Implementation

The prioritization of conservation practice implementation within the subwatershed is determined using two primary criteria: 1) the existing threat of land topography on water quality, and 2) the value of the land's resource production capacity. The first criteria guides practice implementation toward areas that will produce the most benefit to the overall subwatershed, while the second criteria guides it toward areas that will minimize financial barriers to implementation.

For the first criterion, runoff risk was applied to the landscape to expose regions with the greatest need for practice implementation. Runoff risk is a function of the proximity to a stream and the steepness of a slope. The proximity to a stream establishes the potential conveyance of sediment into the water – ultimately leading to increased pollution. A higher runoff risk indicates a higher priority for implementation. The runoff risk for this subwatershed is shown below in **Figure 9**.

For the second criterion, the Corn Suitability Rating 2 Index (CSR2) tool was used. This is a rating applied to different soils based on row-crop productivity. This information indicates the value certain land has to a farmer's productivity. The values are ranked from high to low based on their relation to other land within the subwatershed. A lower CSR2 indicates a higher priority for implementation. The CSR2 for this subwatershed is shown below in **Figure 10**.

Corn stover bales, Grundy Center, Iowa (Photo credit:EOR).

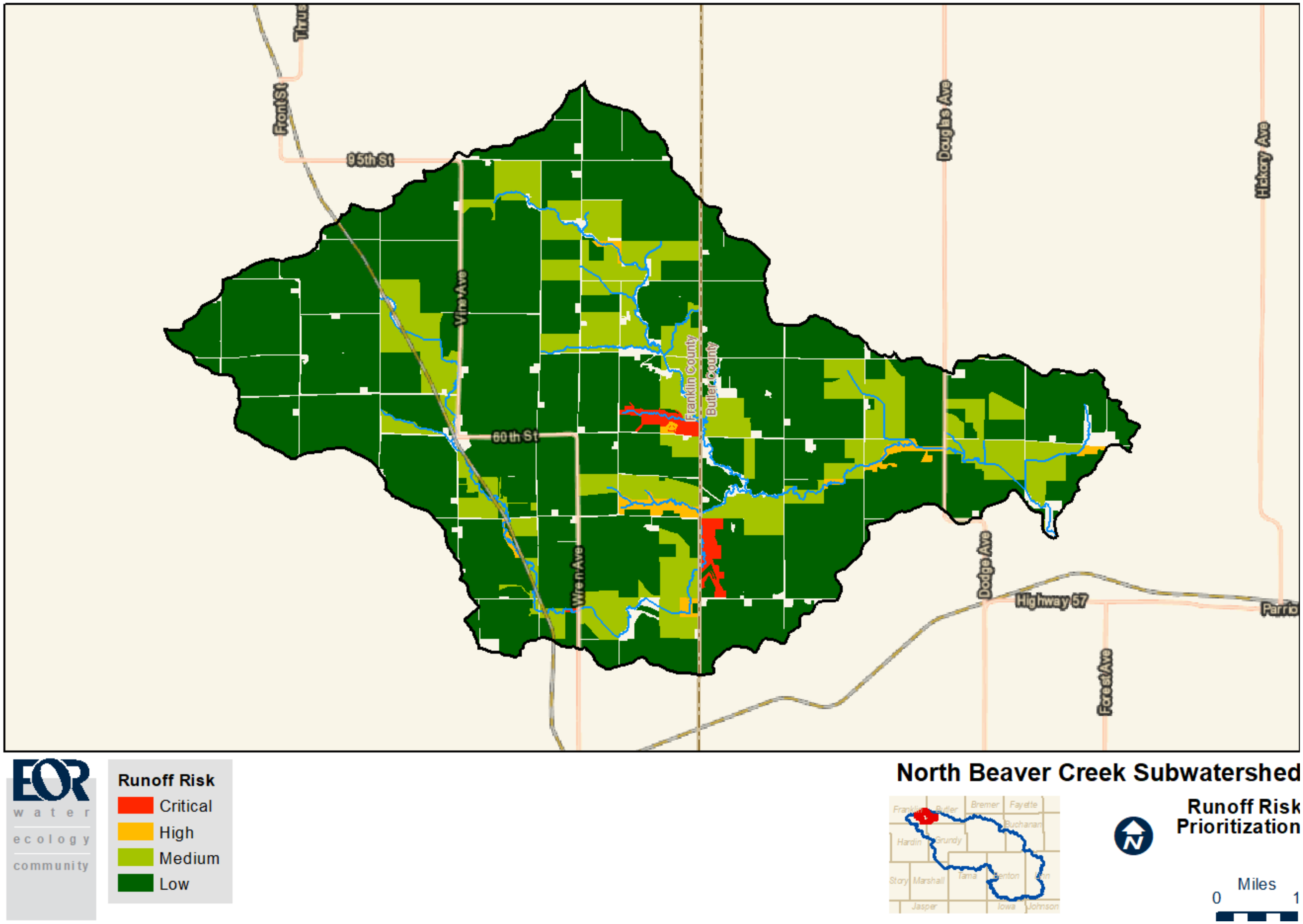

Figure 9: Runoff Risk for the North Beaver Creek Subwatershed.

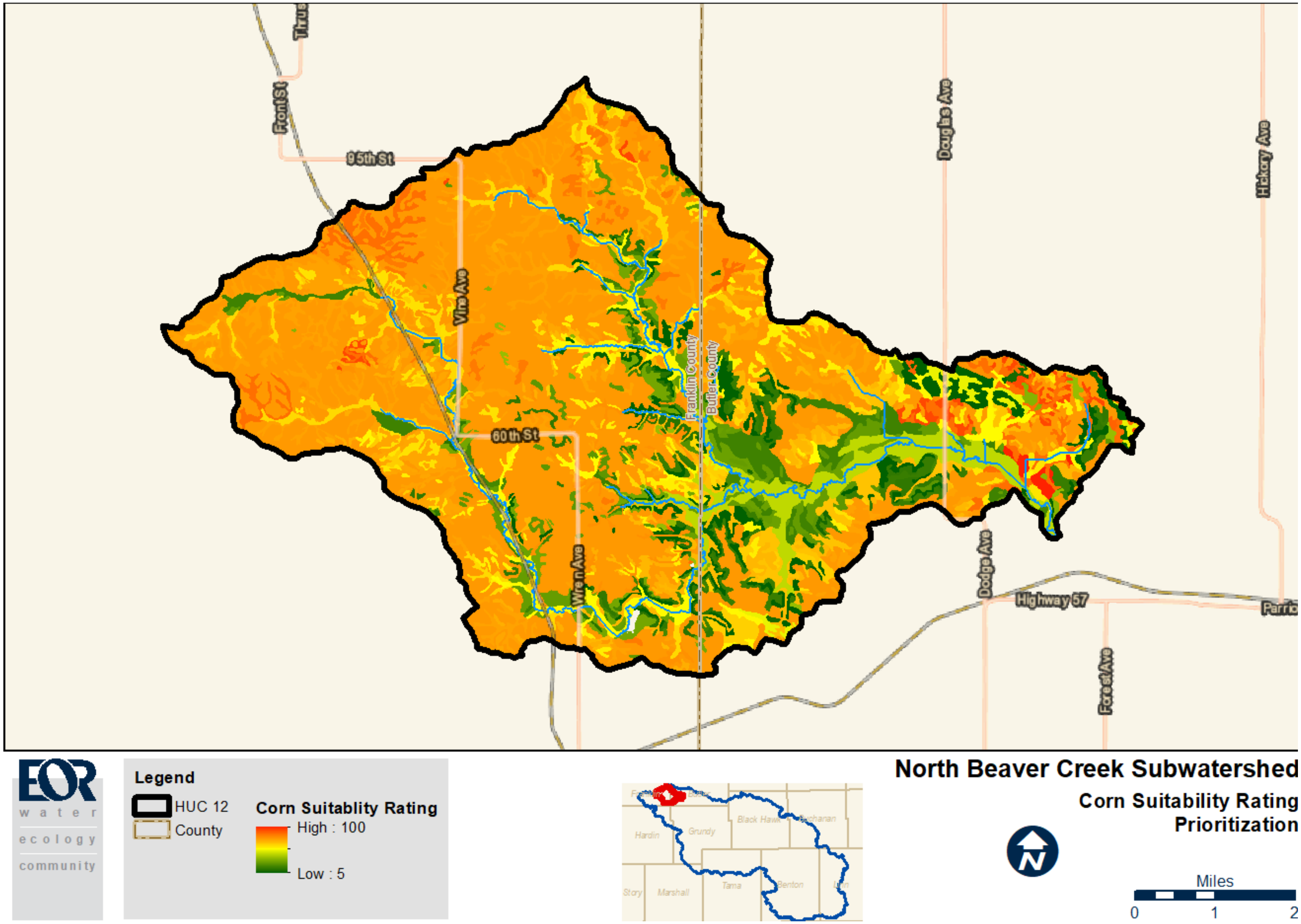

Figure 10: Corn Suitability Rating 2 for the North Beaver Creek Subwatershed.

Four maps are provided as a guide for implementation within the North Beaver Creek Subwatershed. Each map contains information for the prioritization of different conservation practices. These maps are located in Appendix A. The implementation process for this subwatershed should utilize these maps and tables as a guide for conservation practice prioritization.

Map #1 includes practices with a specified location, but no rank. These include drainage water management practices (in-field), denitrifying bioreactors (edge of field), and saturated buffers (riparian area management). These practices do not have a specific criteria that would provide a helpful guide for implementation. However, the CSR2 map may serve as a first step for assessing implementation potential of the practices. The locations suitable for implementing each of these practices, as determined by the ACPF analysis are shown in this map.

Map #2 includes practices with a specified location that have been ranked individually using different parameters. These practices include grassed waterways (in-field), nutrient removal wetlands (edge of field), and riparian buffers (riparian area management).

- Grassed waterways are beneficial in locations where gullies are most likely to form in streams. Moore's Stream Power Index (SPI) is applied to these practices to determine ideal locations for implementation. The SPI determines which locations for these practices have the highest stream power, therefore determining areas where gullies are more likely to form. Therefore, the grassed waterways in locations with the highest relative SPI were ranked in highest priority. All grass waterways shown in red should be prioritized for implementation.
- Riparian buffers are ranked based on the relative runoff risk associated with the area draining to each practice. Riparian buffers located in areas of relatively high runoff risk should be prioritized over those in areas with a smaller runoff risk.

The nutrient removal wetlands are ranked based on the CSR2 because of the large cost and amount of land associated with wetlands. These wetlands are labeled based on CSR2 mean, starting with the lowest CSR2 mean at #1. The ranked wetlands are listed in **Table 11**.

Map #3 includes practices ranked based on the relative slope steepness within the subwatershed. These include contour buffer strips (in-field) and terraces (in-field). Their implementation is prioritized based on slope steepness rather than runoff risk because such practices are found all across the landscape and not just adjacent to streams. Both contour buffer strips and terraces reduce sheet and rill erosion, which is why they are most valuable on steeper slopes. Therefore, these practices should be prioritized in locations where slopes are steepest in relation to the subwatershed's landscape.

Map #4 prioritizes practices based on runoff risk. These practices include all the soil health practices (cover crops, extended rotations, nitrogen management, and phosphorus management), no-till (in-field), perennial cover (edge of field), and WASCOBs (edge of field). All of these practices are recommended across the watershed and are very valuable in reducing the pollutant loads in runoff. Therefore, land with a relatively higher runoff risk should be prioritized for these practices.

Table 11. Nutrient Removal Wetland Rankings for the North Beaver Creek Subwatershed.

Rank	Mean CSR2	Basin Size (HA)	Drainage Area (HA)	Rank	Mean CSR2	Basin Size (HA)	Drainage Area (HA)
1	39.40	4.08	66.90	18	74.96	7.26	139.00
2	48.39	2.18	62.20	19	74.97	1.92	73.68
3	49.20	3.95	66.58	20	76.37	3.58	106.15
4	50.43	1.99	108.52	21	76.57	5.48	84.73
5	54.10	7.09	176.32	22	76.89	3.62	92.80
6	58.54	4.39	123.19	23	77.61	4.44	98.68
7	62.46	1.28	66.30	24	77.85	1.44	92.70
8	63.08	5.59	181.34	25	78.86	9.58	436.63
9	63.16	6.41	127.97	26	79.45	13.69	348.50
10	63.25	2.03	73.79	27	80.52	8.13	93.26
11	64.67	2.63	63.53	28	80.78	7.39	308.33
12	65.97	3.53	161.04	29	81.76	8.66	118.86
13	68.24	3.02	112.62	30	82.09	7.31	185.39
14	70.10	4.24	102.74	31	82.39	8.21	87.50
15	71.96	5.67	133.93	32	82.68	2.18	62.03
16	73.05	3.71	90.98	33	84.34	6.93	103.85
17	73.70	3.56	142.60	34	84.53	3.53	65.25

Only one wetland per wetland train should be implemented in the initial process. Use Table 12 to determine which wetlands to implement first. In addition, the area of each wetland and drainage area can be used a secondary measure for prioritization.

Table 12: Prioritization of wetlands based on groupings.

Grouping	Implement first
1, 14, 4, 5	1
2, 10	2
3, 8	3
6, 16	6
11, 19	11
18, 12	12
15, 17	15
23, 24	23
25, 28	25
26, 29	26
27, 31	27
32, 34	32

7. FUNDING NEEDS

Table 13 shows the total implementation costs over a 20-year period for meeting the Iowa Nutrient Reduction Strategy (INRS) targets for nitrogen and phosphorus for the North Beaver Creek Subwatershed, listed by conservation practice. The annualized total cost for meeting INRS targets within the North Beaver Creek Subwatershed is $528,000. This total annual cost includes conservation practice expenditures of $1,373,000 per year and conservation practices that result in a savings of $845,000 per year. Note that the cost provided are for conservation practices only. Cost associated with additional implementation activities to meet the goals of the North Beaver Creek Subwatershed can be found in the MCWMP.

Table 13. 20 Year Total Implementation Costs by Conservation Practices.

	Target Adoption			
BMP Name	(%)	Quantity		Total Cost
Cover crops	72%	16,128	acres	$10,700,000
Extended rotations	2%	230	acres	$93,900
Nitrogen management: nitrification inhibitor	75%	5,760	acres	-$235,000
Nitrogen management: rate control	50%	9,216	acres	-$10,800,000
Nitrogen management: source control	36%	4,147	acres	
Nitrogen management: timing control	51%	5,875	acres	
Phosphorus management: placement control	59%	2,074	acres	
Phosphorus management: rate control	60%	2,304	acres	
Phosphorus management: source control	36%	4,147	acres	
Contour buffer strips	1%	1	miles	$7,390
Terraces	100%	-	miles	$0
Drainage water management	50%	34	fields	$182,000
Grassed waterways	27%	0	miles	$4,950
No-Till	25%	4,608	acres	$188,000
Denitrifying bioreactors	25%	31	reactors	$209,000
Nutrient removal wetlands	40%	14	wetlands	$1,250,000
Perennial cover	2%	235	acres	$1,250,000
WASCOBs	38%	1	basins	$43,500
Riparian buffer: Critical zone buffer	100%	0.40	miles	$363,000
Riparian buffer: Deep-rooted vegetation buffer	100%	5.93	miles	
Riparian buffer: Multi-species buffer	100%	2.46	miles	
Riparian buffer: Stiff stem grass buffer	87%	0.03	miles	
Riparian buffer: Stream stabilization buffer	82%	0.1	miles	
Saturated buffers	50%	11.9	miles	$3,910,000

8. EVALUATION AND MONITORING

Refer to the Middle Cedar Watershed Management Plan (MCWMP) for detailed recommendations for monitoring in the watershed. The Iowa Soybean Association (ISA), in cooperation with the City of Cedar Rapids, currently conducts snapshot water quality monitoring on North Beaver Creek near the outlet of the subwatershed. This monitoring provides vital information that can be used to detect trends in water quality and help prioritize conservation effort. The ISA monitoring should be continued into the future as a minimum level of water quality monitoring.

Potential expansion of water quality monitoring in the Headwaters Prairie Creek Subwatershed could include the following:

- Increase the number of samples that are taken throughout the year, targeting a wide range of flow conditions.
- Measure stream flow using either a continuous flow logger or develop a rating curve to be used with stream stage measurements.
- Conduct *E. coli* / bacteria monitoring per Iowa water quality assessment guidelines.
- Add total phosphorus to the monitored parameters or develop a relationship between dissolved reactive phosphorus and total phosphorus to be used as a reference point.

Refer to the MCWMP for further details on recommended methodologies for evaluating progress being made in achieving the goals developed in this HUC-12 Subwatershed Plan.

9. EDUCATION AND OUTREACH

Iowa State University Extension and Outreach developed a detailed education and outreach plan that is located in the appendices section of the Middle Cedar Watershed Management Plan. This plan is a useful tool that outlines ways to perform targeted outreach to producers and landowners that engages them in the planning and implementation process.

The Iowa Department of Natural Resources and the Environmental Protection Agency also have some general guidelines for public outreach that can be helpful:

- Involving stakeholders builds trust and support for the process and outcome.
- Successful watershed groups actively recruit members from diverse backgrounds and perspectives to take advantage of their unique skills and ideas.
- Forming a technical advisory team is helpful to provide further watershed-related data and analysis. They are usually comprised of subject matter experts, such as fisheries biologists, regional watershed Basin Coordinators, and Natural Resources Conservation Service staff.
- Coming together and assessing the watershed as a community provides the most current knowledge of water quality problems, generates an understanding how resources are valued, and garners support for the project.
- Pose simple questions to begin: Where are we now and where do we want to go? How do we get there? How will we know that we've arrived?

There are many additional educational resources available from other states and agencies that can be found online, including:

- Iowa Stormwater Education Partnership
- "Welcome to your Watershed" Poster and Game (Maryland Department of Agriculture)
- Growing the Next Generation of Watershed Stewards (Missouri Watershed Education Network)
- "A Watershed Moment: The Delaware River Watershed" (short film)

10. REFERENCES

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APPENDIX A. CONSERVATION PRACTICE PRIORITIZATION MAPS

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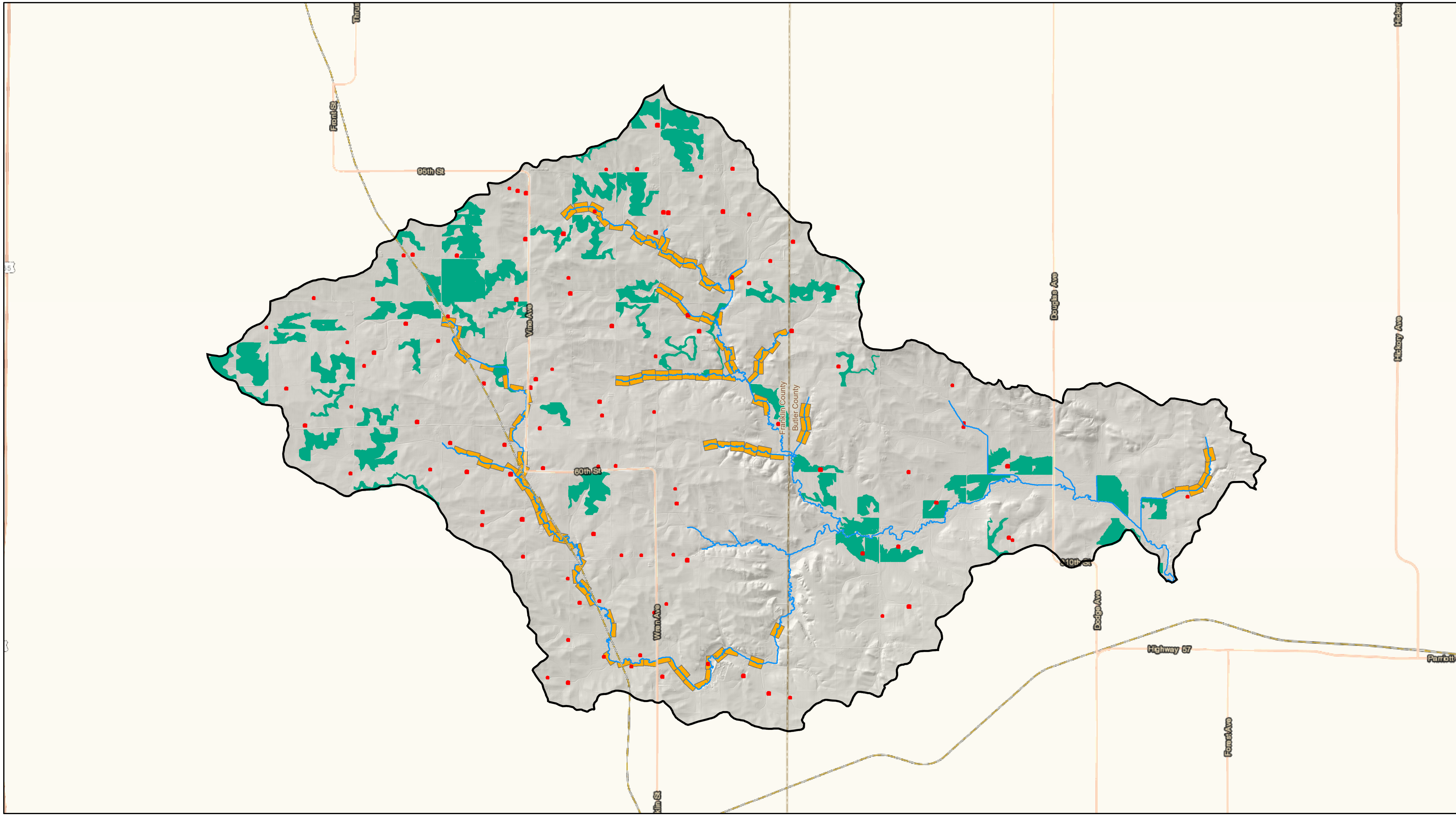

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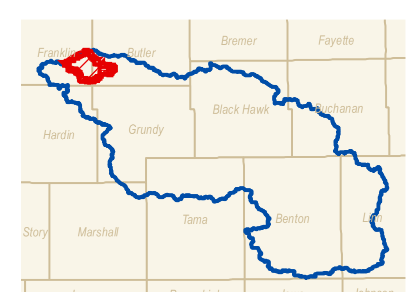
Non-prioritized Conservation Practice Locations

- Denitrification Bioreactor
- Saturated Buffer
- Drainage Water Management



North Beaver Creek Subwatershed

Conservation Practice Prioritization
Map #1

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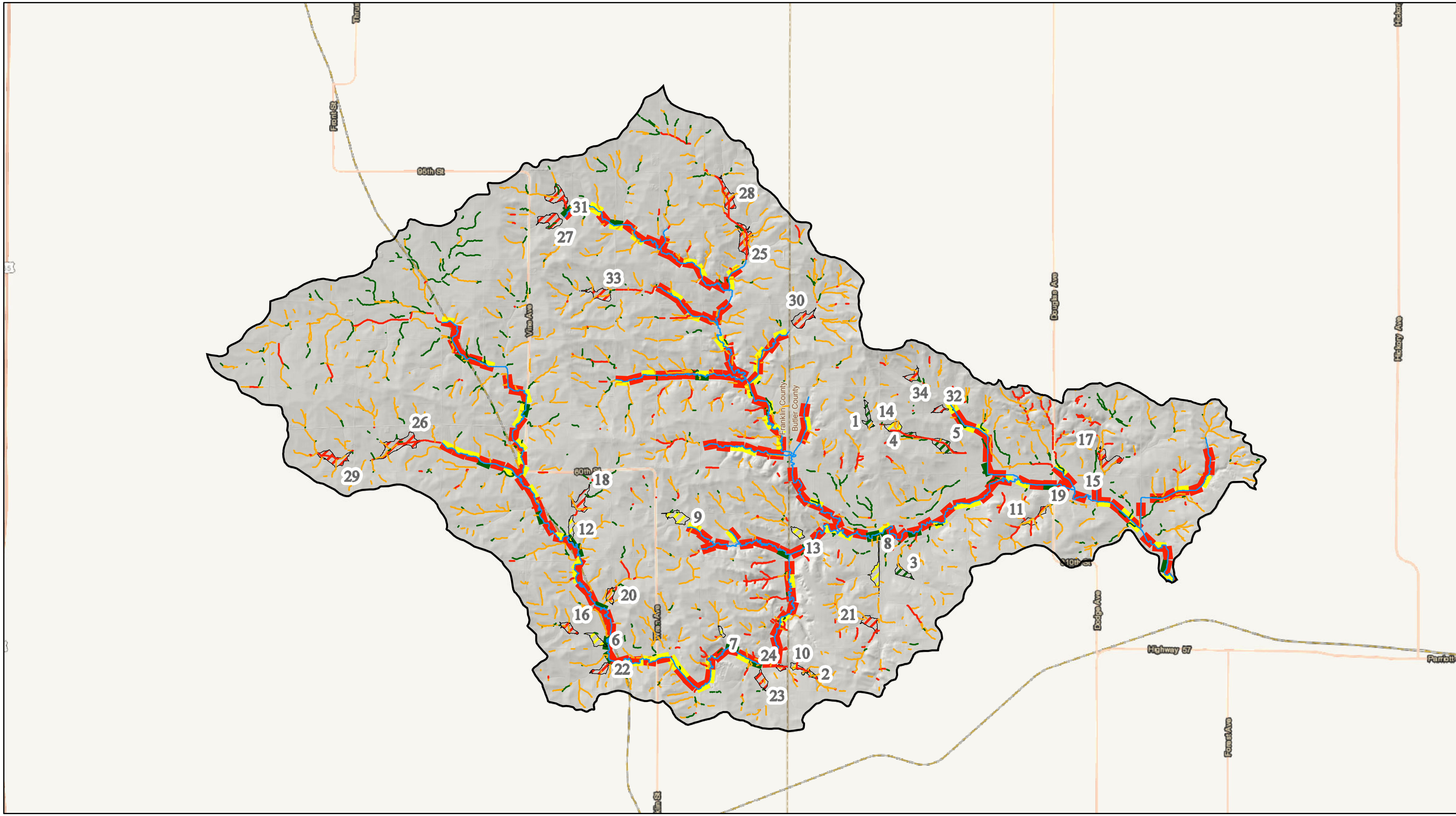

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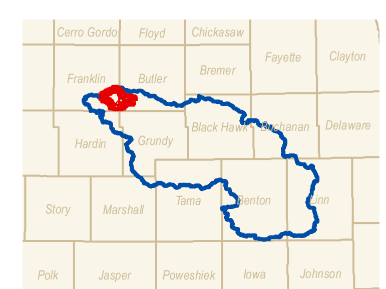
Prioritization of Conservation Practices

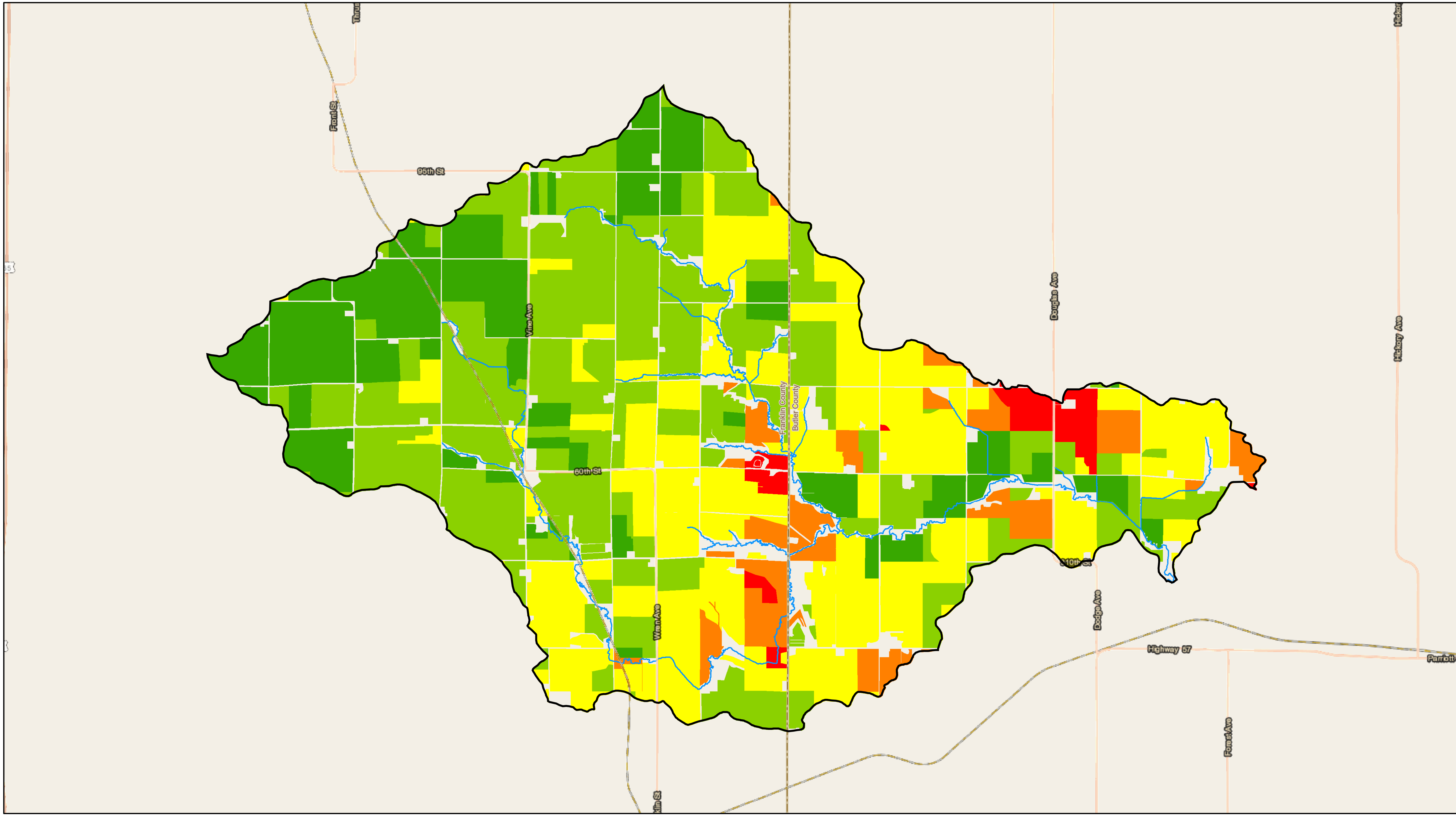
Saturated Buffer	Grass Waterway	Nutrient Treatment Wetland
High runoff risk	Low	Low CSR
Med runoff risk	Medium	Medium CSR
Low runoff risk	High	High CSR



North Beaver Creek Subwatershed

Conservation Practice Prioritization
Map #2

Miles
0 1 2 3



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EOR
water
ecology
community

Prioritization of Conservation Practices: Contour Buffer Strips and Terraces

Slope Steepness

- Low
-
- Medium
-
- High

North Beaver Creek Subwatershed

Conservation Practice Prioritization

Map #3

Miles

0 1 2 3

Date: 2/6/2019 Time: 5:26:05 PM Author: russell
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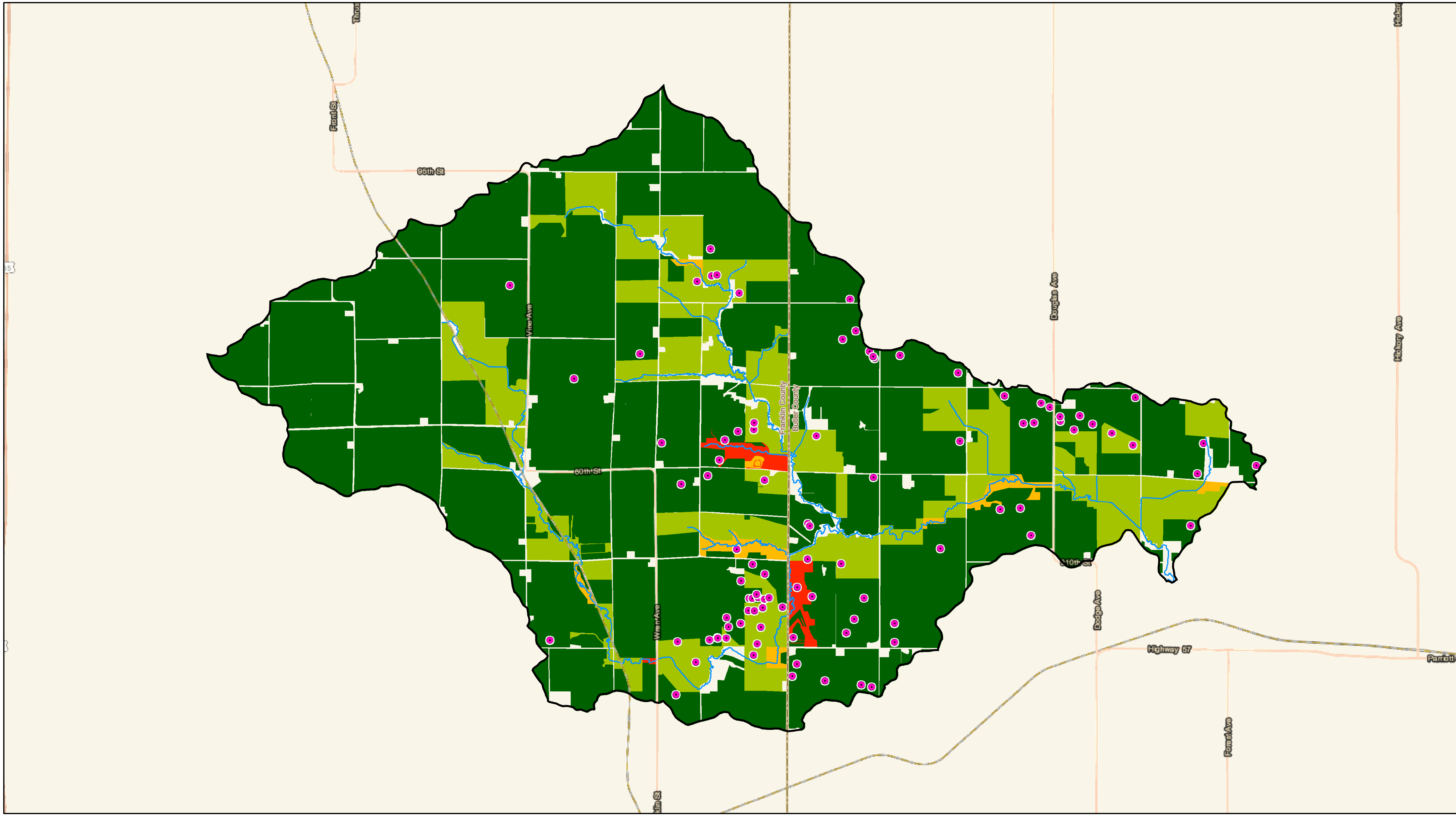

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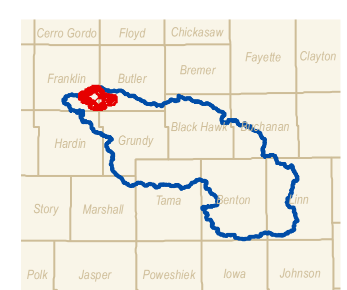
ecology
community

Prioritization of Conservation Practices:
Soil Health practices, no-till, perennial cover & WASCOBs

WASCOB

Run off Risk

- Low
- Medium
- High
- Critical



North Beaver Creek Subwatershed

Conservation Practice Prioritization
Map #4

Miles
0 1 2 3