Twin Cedars Watershed Plan

A roadmap to sustain and improve agricultural productivity, Water quality, habitat, and soil health in the Twin Cedars Watershed

Prepared by:

IOWA SOYBEAN Association

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Twin Cedars Watershed Plan

A guide for water quality, soil health & reduced flooding in the Twin Cedars-Cedar Creek Watershed

Developed by

Funded by

Planning partners

Watershed farmers, landowners and residents
South Central Iowa Cedar Creek Watershed Management Authority
Marion and Monroe County Soil and Water Conservation Districts
Iowa Department of Agriculture and Land Stewardship
USDA-Natural Resources Conservation Service
Iowa Soybean Association

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Contents

1. Summary

The Twin Cedars Watershed encompasses 32,701 acres in south central Iowa (Figure 1.1). The watershed is a sub-watershed of the Cedar Creek Watershed and includes the area of land that drains to and through Cedar Creek into the Des Moines River. The Cedar Creek Watershed is supported by the South Central Iowa Cedar Creek Watershed Management Authority.

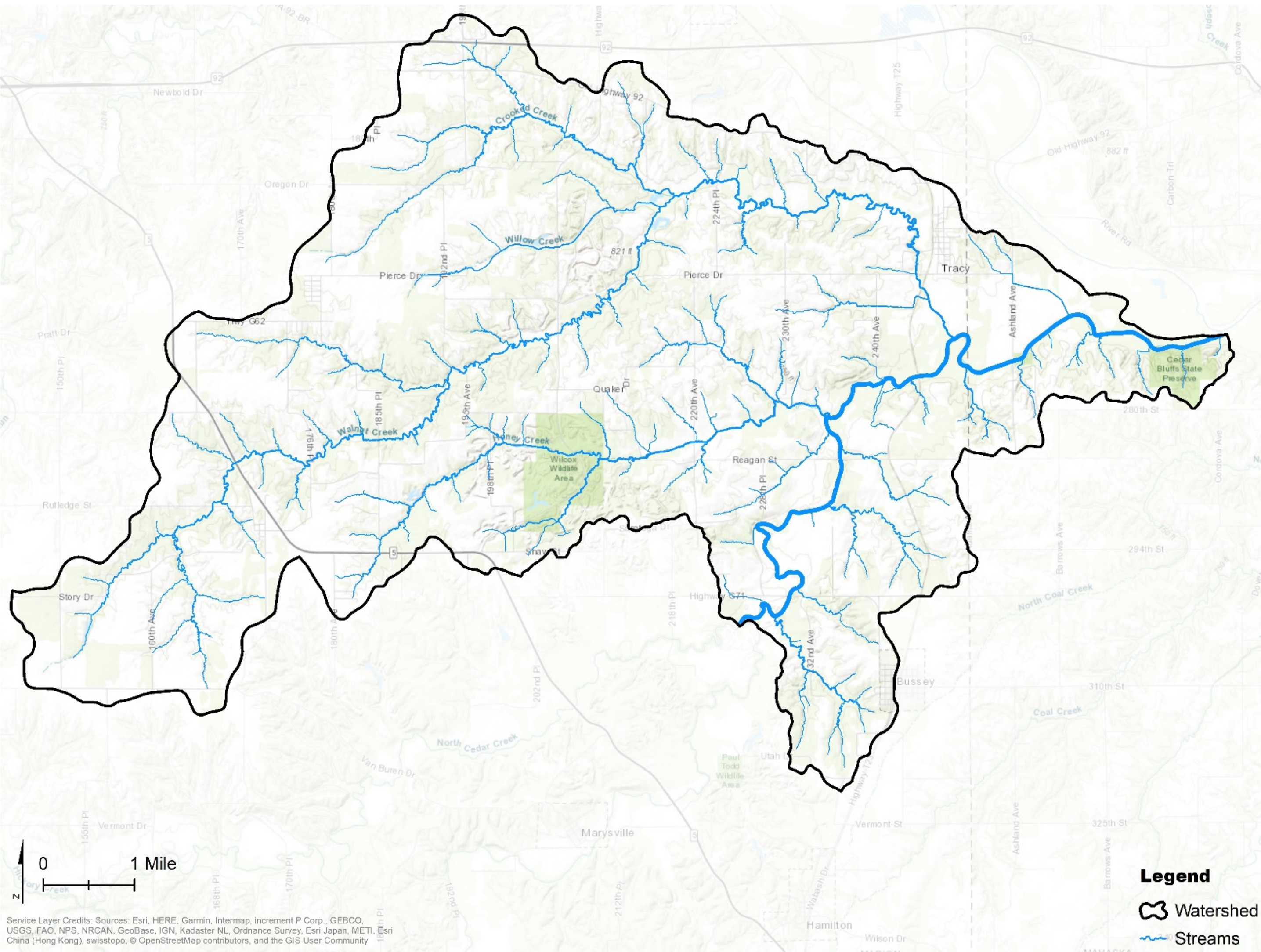

Figure 1.1. The Twin Cedars Watershed is a sub-watershed of the Cedar Creek Watershed in south central Iowa.

The Twin Cedars Watershed Plan was developed to support local stakeholders to establish goals, develop partnerships, and identify an action plan. The watershed plan is intended to provide guidance for land and water improvements while simultaneously enhancing agricultural sustainability and vitality. This document integrates existing datasets, assessment and mapping, and stakeholder input. The plan is designed to incorporate and address input from the watershed community. The community-based planning process integrated with data analysis and research synthesis was used to develop goals, objectives, and action steps for stakeholders and partners in the Twin Cedars Watershed. The goals established by watershed stakeholders are to:

1. Improve water quality.
2. Build soil health.
3. Pursue and secure conservation funding.
4. Reduce flooding.
5. Provide education and information on available practices, resources, and assistance.

The primary natural resource concerns in the Twin Cedars Watershed are water quality and soil health, which include loss of nutrients and sediment to and through Cedar Creek and its tributary streams. Priority conservation practices identified by stakeholders include nutrient management, no-till, cover crops, extended rotations, wetlands and farm ponds, saturated buffers and bioreactors, basins, terraces, and stream buffers. A combination of these conservation actions will be needed to fully meet local and statewide water quality goals.

The total investment needed to attain necessary levels of conservation adoption is estimated to be $4,275,000 for practice construction plus up to $343,000 per year. If fully implemented, it is anticipated that farmers and landowners would not only locally attain Iowa Nutrient Reduction Strategy goals but also would further reduce soil erosion, build soil health, and reduce flooding.

2. Watershed Characteristics

2.1. General Information

The Twin Cedars Watershed is a 32,701-acre (51-square mile) area of land located in Marion and Mahaska counties. Bussey is the only incorporated city in the watershed, but there also are unincorporated communities including Pershing, Attica, and Tracy. The population as of the 2010 census is estimated to be 1,252. General watershed information is listed in Table 2.1.1.

Table 2.1.1. General information about the Twin Cedars Watershed.

Location	Marion and Mahaska counties, Iowa
Incorporated Communities	Bussey
Unincorporated Communities	Pershing, Attica, Tracy
Population (2010)	1,252
Watershed Area	32,701 acres
Major Land Uses	Row crop agriculture, pasture/grass, forest
HUC-12 Watersheds	Walnut Creek, Cedar Creek
HUC-12 IDs	071000090309, 071000090310
HUC-10 Watershed	Cedar Creek
HUC-10 ID	0710000903
HUC-8 Watershed	Lower Des Moines
HUC-8 ID	07100009

The Twin Cedars Watershed is comprised of two 12-digit hydrologic unit code (HUC-12) watersheds within the larger Cedar Creek Watershed. Cedar Creek flows into the lower Des Moines River, so each of these watersheds are part of the Des Moines River basin, which stretches from southwest Minnesota to southeast Iowa (Figure 2.1.1).

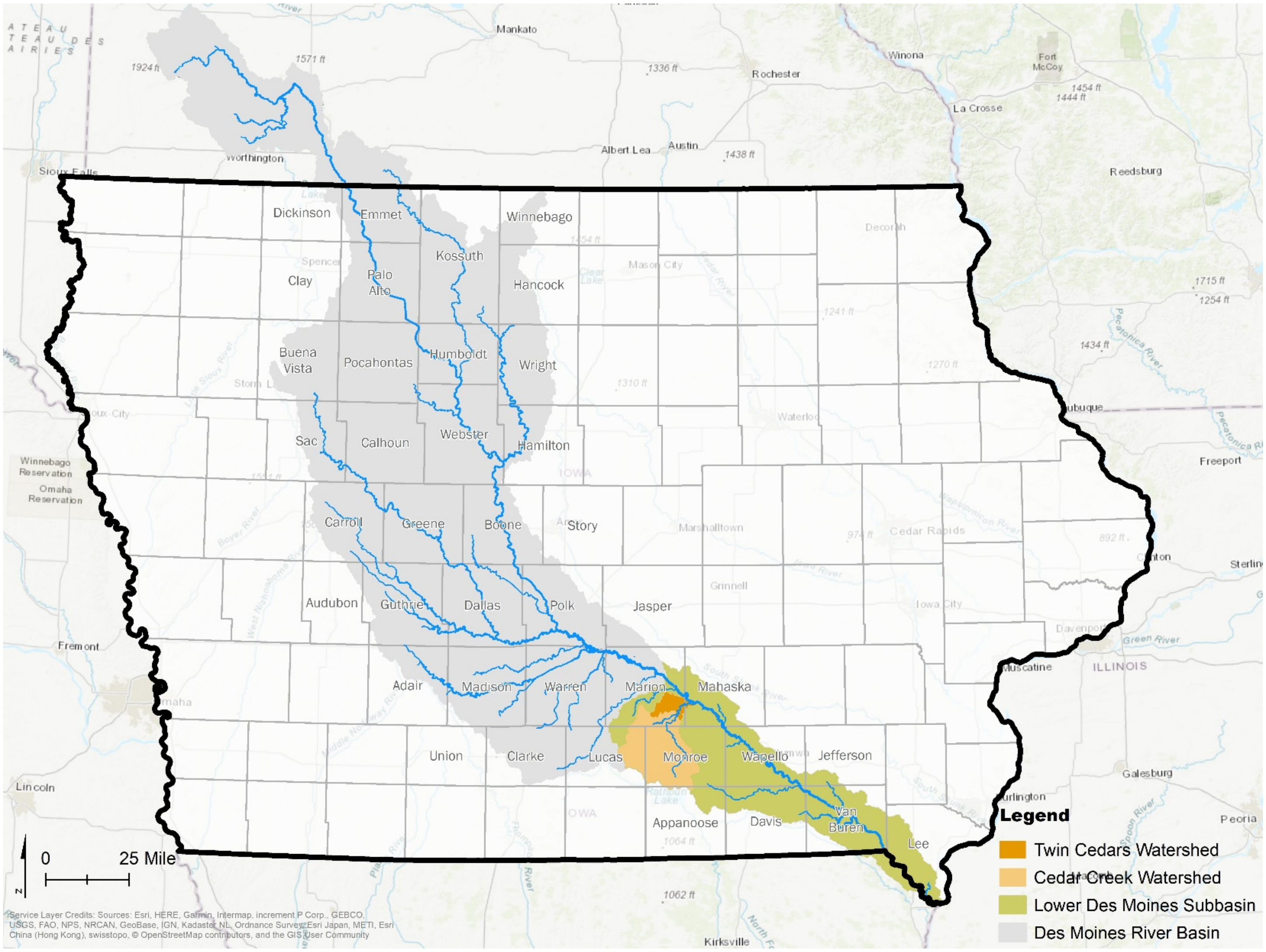

Figure 2.1.1. The Twin Cedars Watershed is nested within the Cedar Creek and Des Moines River watersheds.

Agriculture is the primary land use. According to public records, there are 270 landowners of agricultural land in the watershed. Of that agricultural land, 88 percent is owned by landowners living in or near the watershed, 10 percent is owned by other Iowa residents, and less than 2 percent is owned by out-of-state landowners.

2.2. Water Resources

Surface water in the watershed includes Cedar Creek, Honey Creek, Walnut Creek, Crooked Creek, and Willow Creek, along with additional unnamed tributary streams (Table 2.2.1). Cedar Creek has presumptive use designations including primary contact recreation, aquatic life, and fish consumption. Cedar Creek has a documented bacteria impairment. The tributary streams do not have designated uses, and therefore do not have completed assessments.

Table 2.2.1. Streams and assessment information for the Twin Cedars Watershed (source: Iowa Department of Natural Resources).

Waterbody	Cedar Creek
ADB Code	IA 04-LDM-1053
Legacy Code	IA 04-LDM-0160_0
Segment Length	9.7 miles
Use Designations	A1 (recreation), B(WW-1) (warm water aquatic life), HH (human health/fish consumption)
Impairments	Bacteria (Class A1 use partially supported)
Tributaries	Crooked Creek, Willow Creek, Walnut Creek, Honey Creek
Total Streams Length	145 miles

According to the National Wetlands inventory, there are 982 acres of wetlands in the watershed. This includes 890 acres that are flooded or exposed intermittently, temporarily or seasonally.

2.3. Climate and Hydrology

Precipitation and hydrologic data show that for the most recent 30 years of record, total precipitation at Knoxville, Iowa, averaged 39.4 inches per year for water years 1990 through 2019, with a range of 21.9 to 60.0 inches per year (Figure 2.3.1). Area-normalized discharge (water yield) for the same period averaged 11.1 inches per year. On average over 30 years, 26 percent of precipitation ultimately left the landscape through streamflow, including 6.6 inches per year of surface runoff and 4.5 inches per year of baseflow (Figure 2.3.2.). Monthly precipitation in the watershed tends to peak during the months of April through August, with each of these months averaging at least 4 inches of precipitation from 1990 through 2019 (Figure 2.3.3).

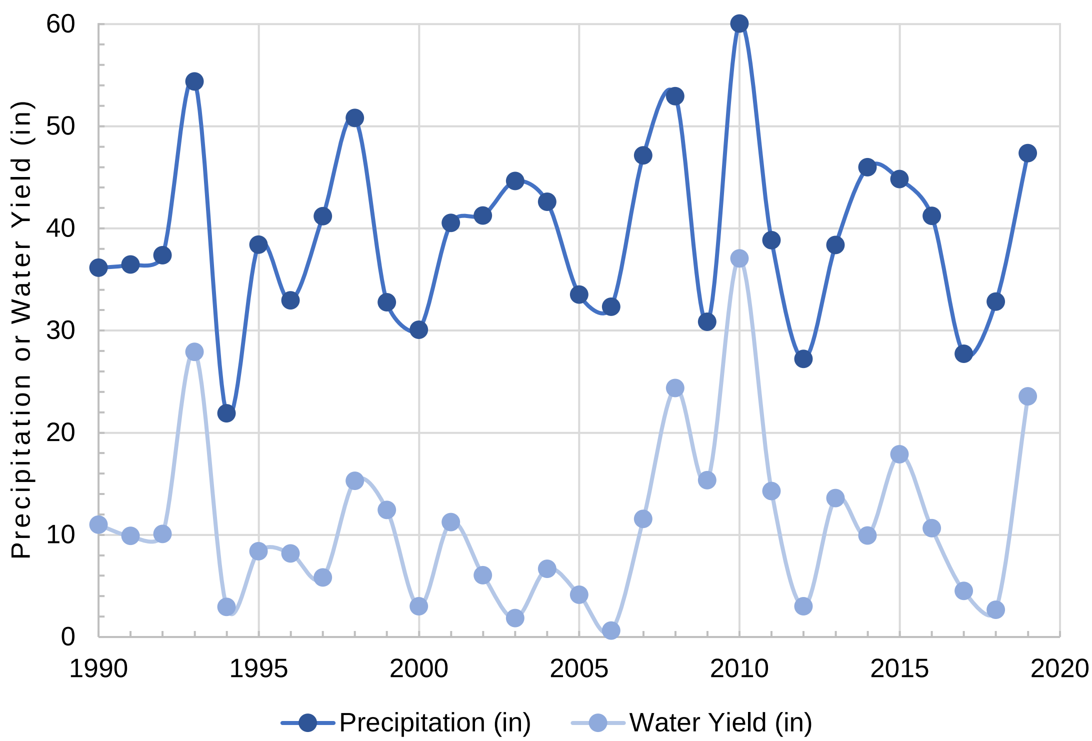

Figure 2.3.1. Precipitation at Knoxville, Iowa, averaged 39.4 inches per year for water years 1990 through 2019 (source: Iowa Environmental Mesonet). Water yield of Cedar Creek near Bussey, Iowa, averaged 11.1 inches per year for the same period (source: U.S. Geological Survey). A water year extends from October 1 of the previous calendar year through September 30.

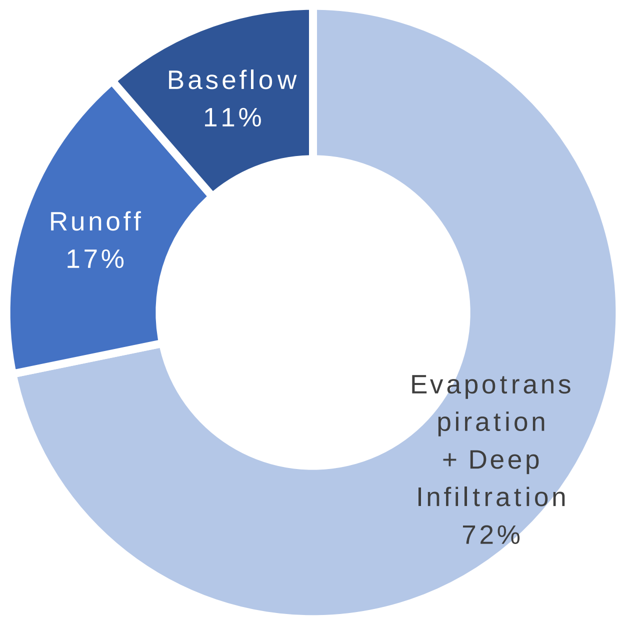

Figure 2.3.2. Thirty-year average water balance components for the Twin Cedars Watershed include 11.1 inches per year of discharge (comprised of 6.6 inches per year of runoff and 4.5 inches per year of baseflow) and 28.3 inches per year of evapotranspiration plus deep infiltration, for a total average precipitation of 39.4 inches per year. This partitioning is similar to an Iowa Flood Center 2018 study of the Cedar Creek Watershed (75 percent evaporation, 15 percent surface flow, and 10 percent baseflow) (sources: Iowa Environmental Mesonet, U.S. Geological Survey, Iowa Daily Erosion Project, Iowa Flood Center).

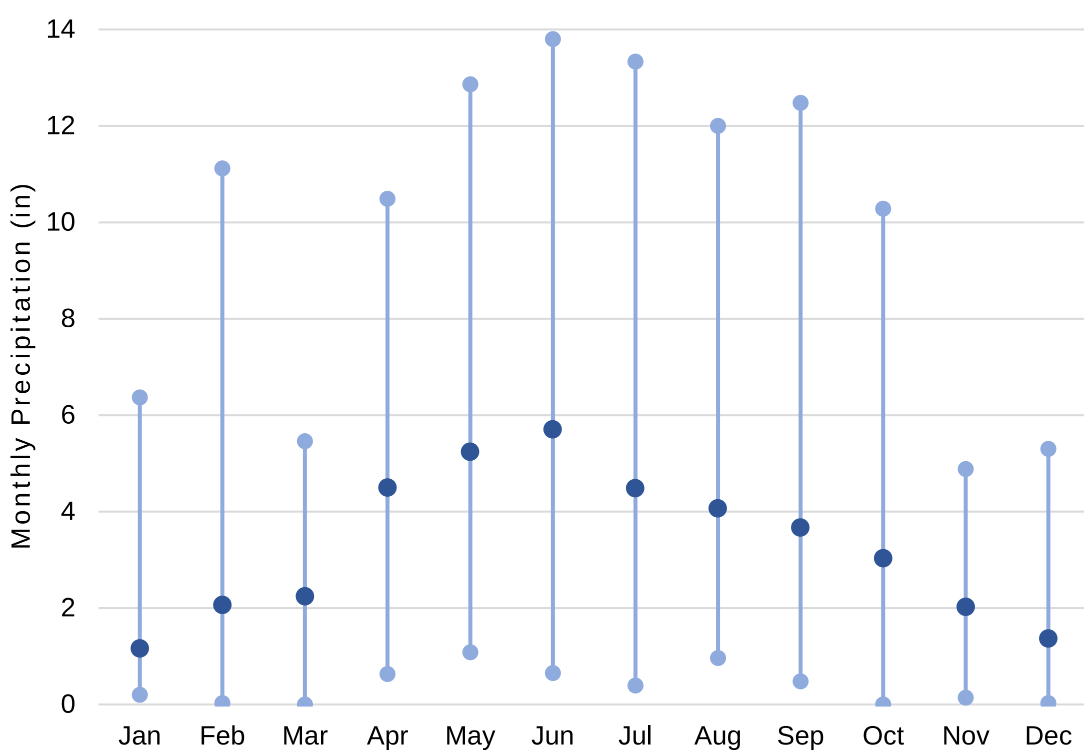

Figure 2.3.3. Monthly average precipitation at Knoxville, Iowa, from 1990 through 2019. Bold circles indicate mean, and lower and upper bounds denote 30-year minimum and maximum, respectively (source: Iowa Environmental Mesonet).

2.4. Landscape

The Twin Cedars Watershed is located in two Major Land Resource Areas (MLRA): 108C Illinois and Iowa Deep Loess and Drift, West-Central Part; and 109 Iowa and Missouri Heavy Till Plain. Similarly, the watershed also is located along the transition between two ecoregions: 47f Southern Iowa Rolling Loess Prairies, and 40 Central Irregular Plains. The watershed lies completely within the Southern Iowa Drift Plain landform region.

The watershed is dissected by a mature and connected surface drainage network. The landscape is characterized by relatively small hilltop ridges, moderate to steep hillslopes, and flat alluvial valleys. Geologic parent material includes moderately fine pre-Illinoian glacial drift mantled by moderately think blankets of loess. Approximately 17 percent of the watershed contains alluvial deposits. Floodplains are narrow along tributary streams and broad along Cedar Creek (Figure 2.4.1).

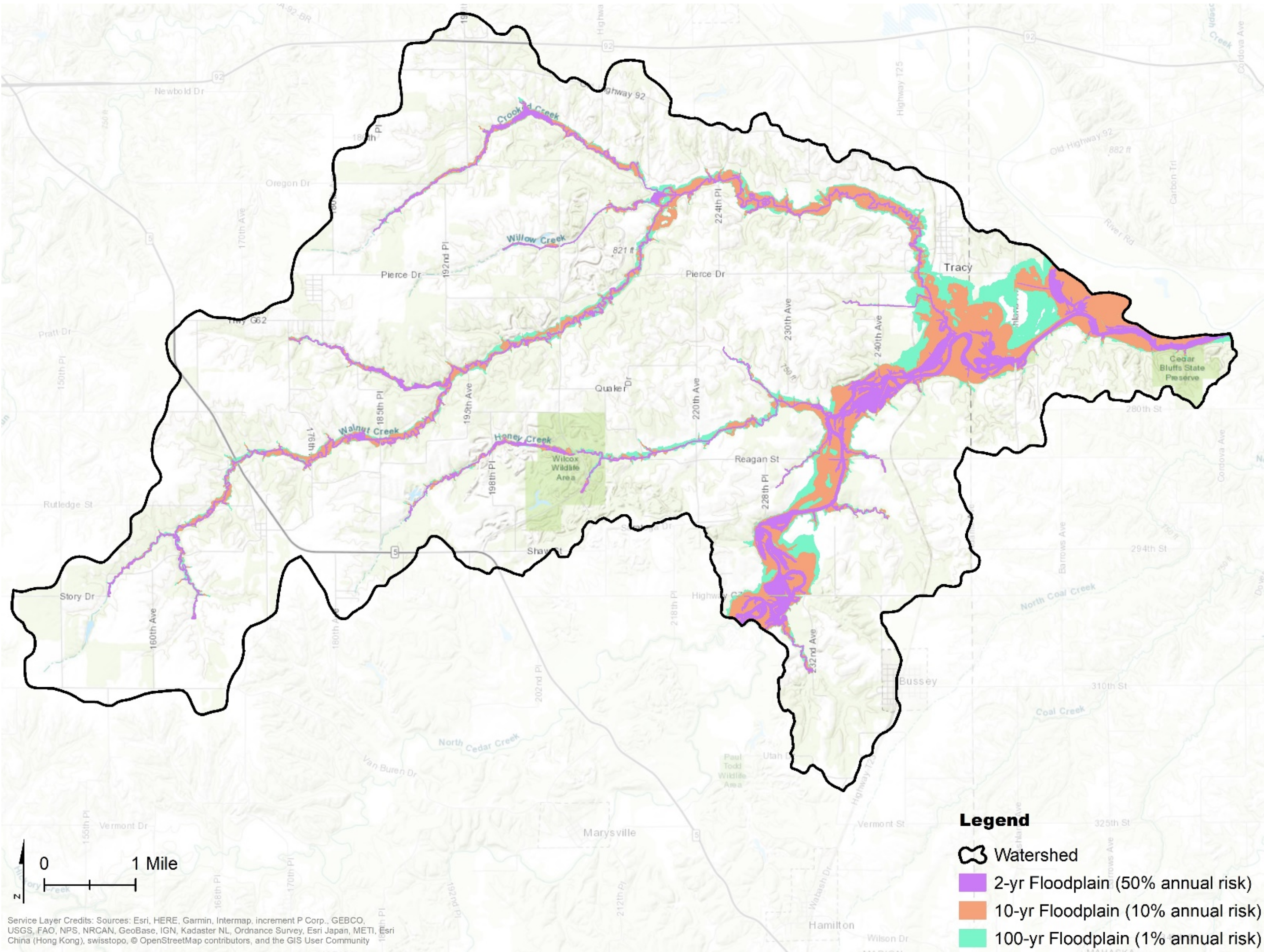

Figure 2.4.1. Floodplains at the 2-year, 10-year, and 100-year event levels are most expansive adjacent to Cedar Creek.

Land surface elevation in the Twin Cedars Watershed ranges from 671 to 946 feet above sea level (Figure 2.4.2). Slopes vary significantly throughout the watershed, with more than 60 percent of the watershed having a local slope of 5 percent or greater (Table 2.4.1 and Figure 2.4.3).

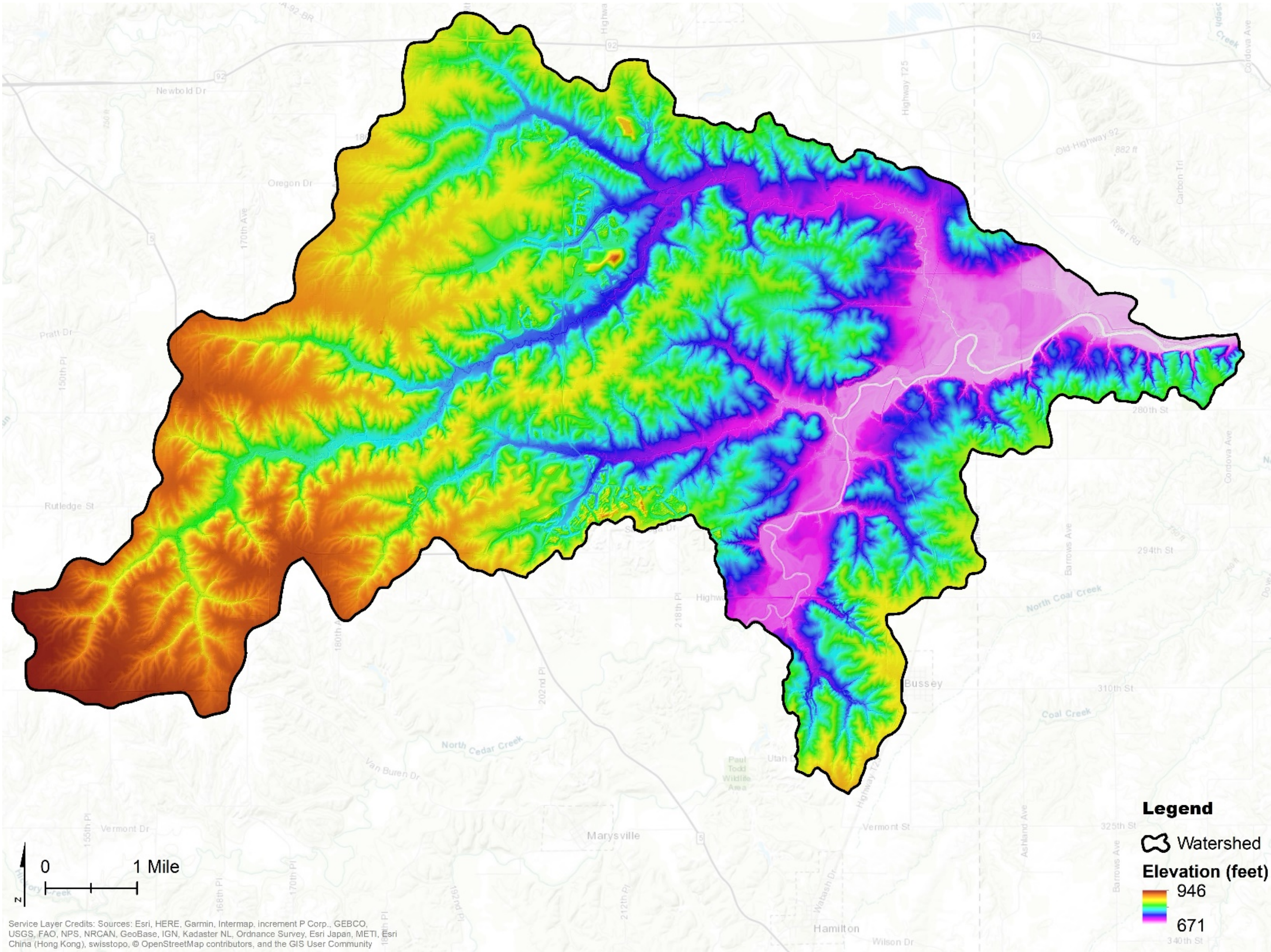

Figure 2.4.2. Elevation in the Twin Cedars Watershed derived from a high-resolution digital elevation model.

Table 2.4.1. Extent of each slope class within the Twin Cedars Watershed.

Slope Class	Range	Acres	Percent
A	0-2%	11,109	18%
B	2-5%	12,524	20%
C	5-9%	15,089	25%
D	9-14%	11,467	19%
E	14-18%	3,886	6%
F	18-25%	3,097	5%
G	> 25%	4,138	7%

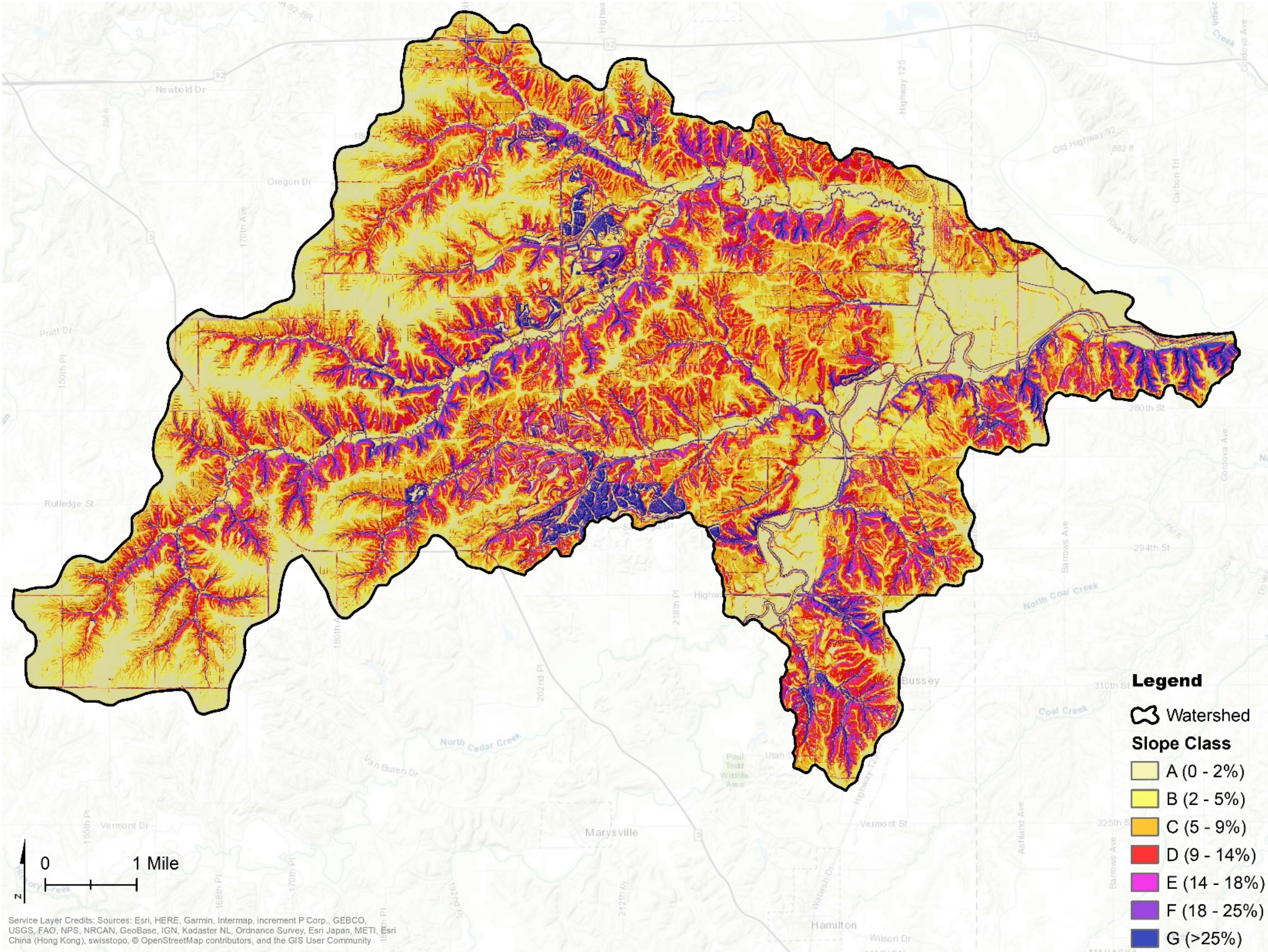

Figure 2.4.3. Slope classifications in the Twin Cedars Watershed derived from elevation data.

2.5. Soils

Soil associations in the watershed include Pershing-Gosport-Gara, Otley-Ladoga, and Grundy-Haig-Arispe-Gara. These soils formed in loess or glacial till. Native vegetation was prairie grass and deciduous forest. Soils in the watershed are predominantly well drained. Common soils in the Twin Cedars Watershed are show in Figure 2.5.1. The most abundant soil series mapped in the watershed include Ladoga, Sharpsburg, and Gosport, which together comprise 42 percent of the watershed (Table 2.5.1).

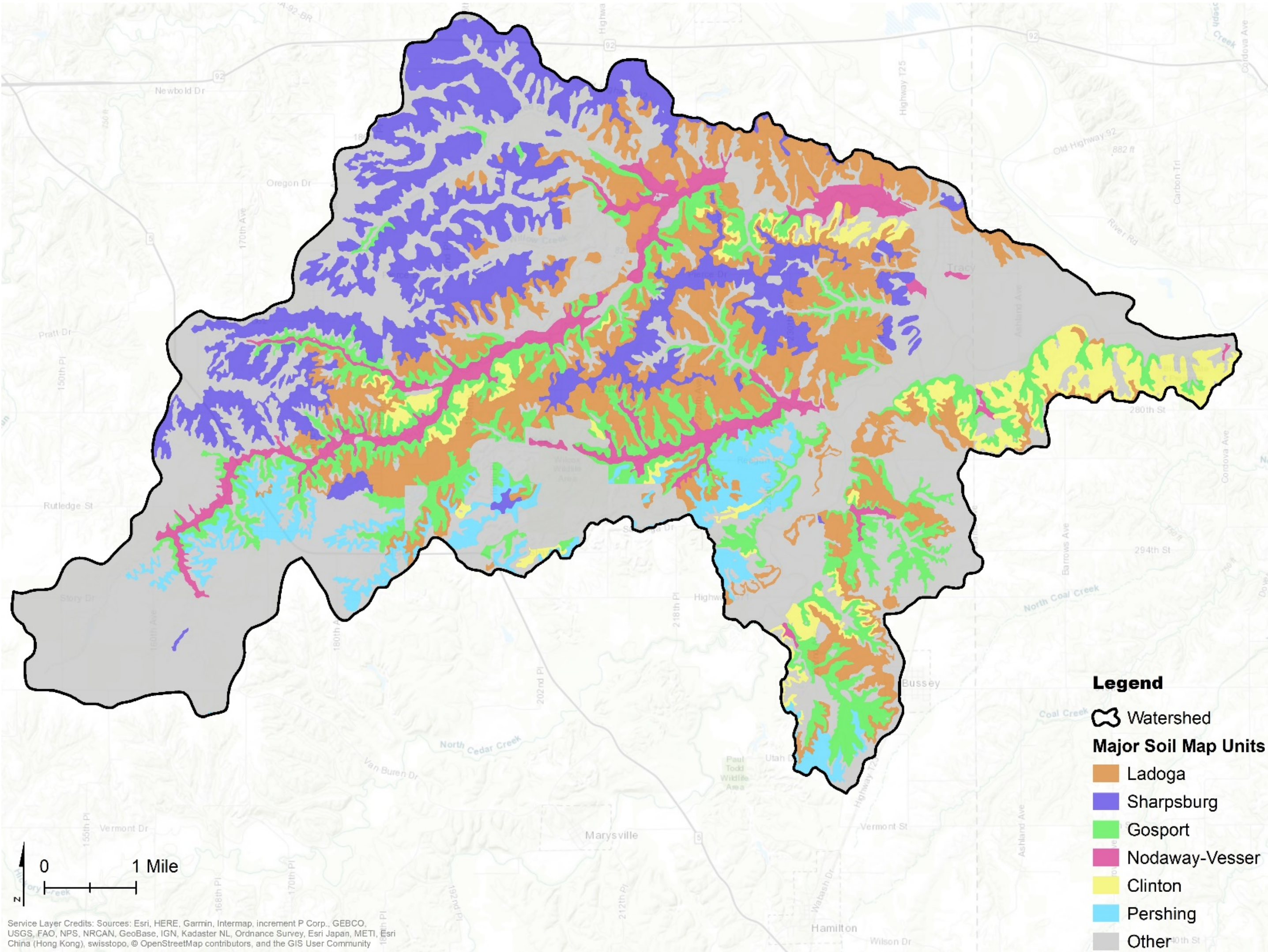

Figure 2.5.1. Twin Cedars Watershed soil map (source: Soil Survey Geographic Database).

Table 2.5.1. Descriptions of common soils in the Twin Cedars Watershed (source: quoted directly from USDA-NRCS Official Soil Series Descriptions).

Series	Description
Ladoga	Very deep, moderately well drained soils formed in loess. These soils are on convex summits of interfluves, side slopes, and nose slopes on dissected till plains and treads and risers on stream terraces. Slope ranges from 0 to 30 percent.
Sharpsburg	Very deep, moderately well drained soils formed in loess. These soils are on interfluves and hill slopes on uplands and on treads and risers on stream terraces in river valleys. Slope ranges from 0 to 18 percent.
Gosport	Moderately deep, moderately well drained soils formed in silty or loamy materials and in the underlying residuum from clayey shale. These soils are on convex side slopes and escarpment-like areas that parallel major streams. Slope ranges from 5 to 50 percent.

Soil drainage properties affect surface and subsurface water movement in the watershed. Approximately 27 percent of the soils in the watershed are classified as hydric (Figure 2.5.2). While public records of subsurface tile drainage are sparse, it is likely that tile drainage in the watershed is limited to poorly drained or hydric soils (Figure 2.5.3). Regardless of drainage status, many soil types in the watershed are generally productive, although there is high variability throughout the watershed (Figure 2.5.4).

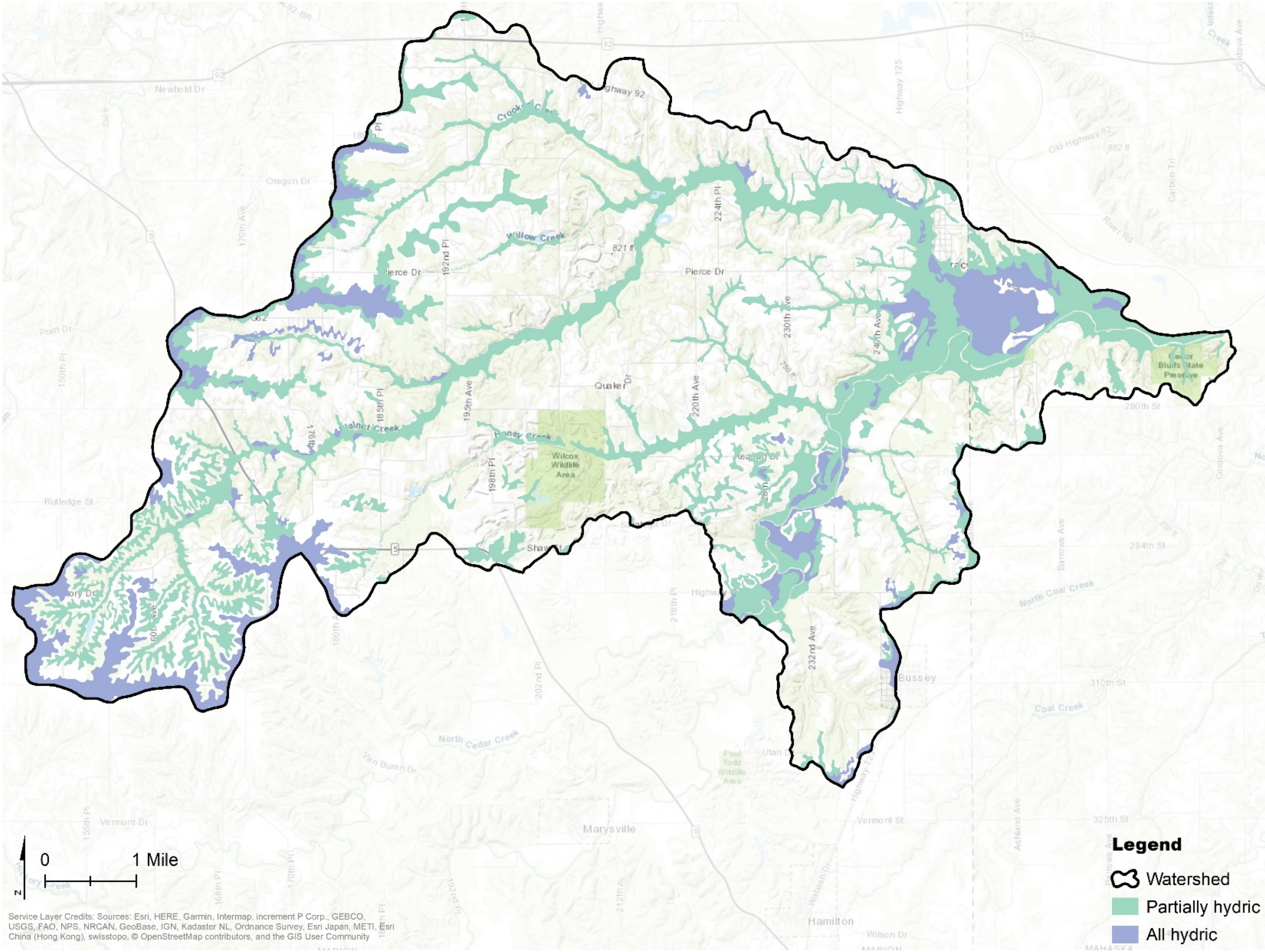

Figure 2.5.2. Hydric soils of the Twin Cedars Watershed.

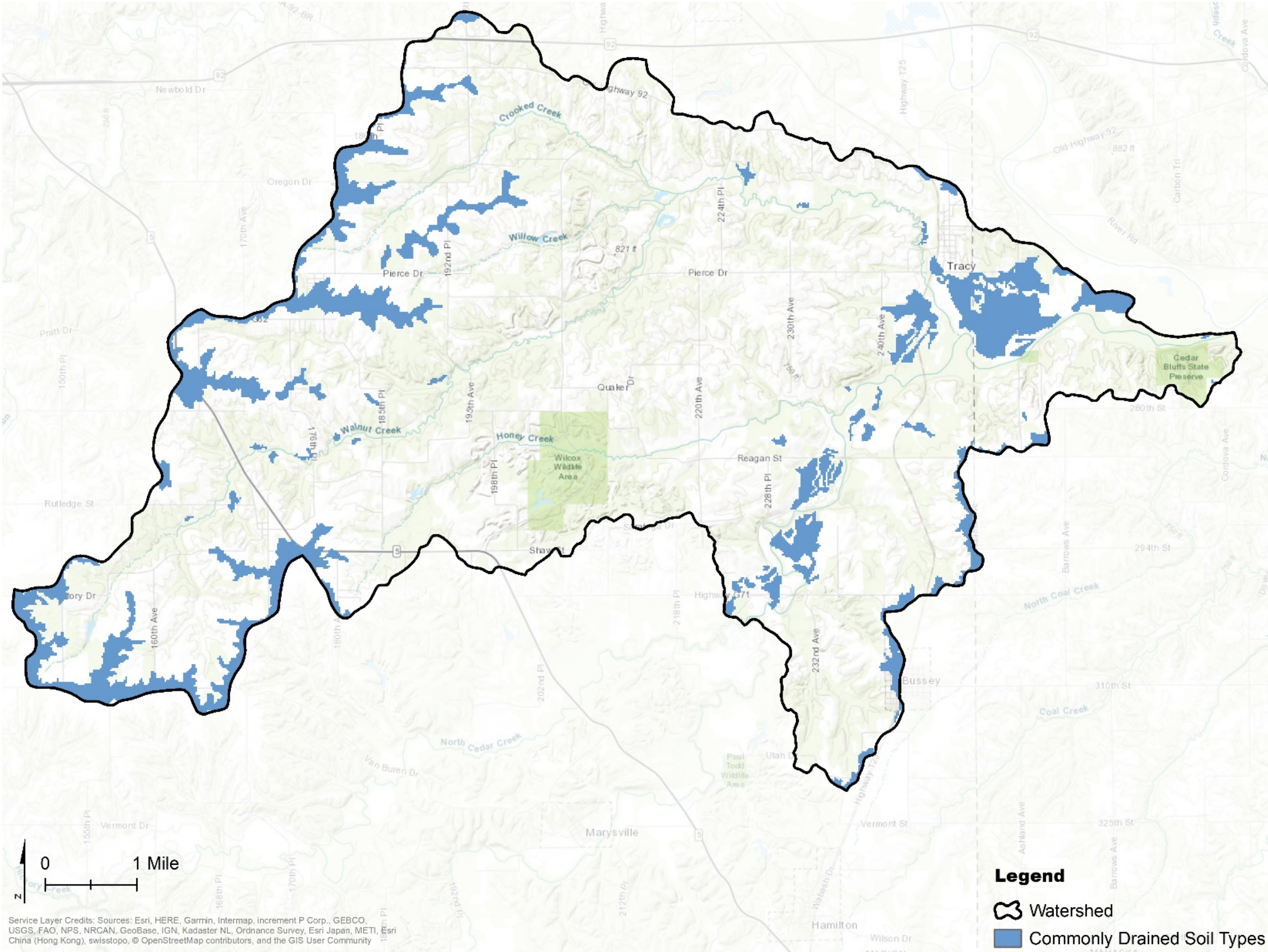

Figure 2.5.3. Soil types in the Twin Cedars Watershed that typically are artificially drained.

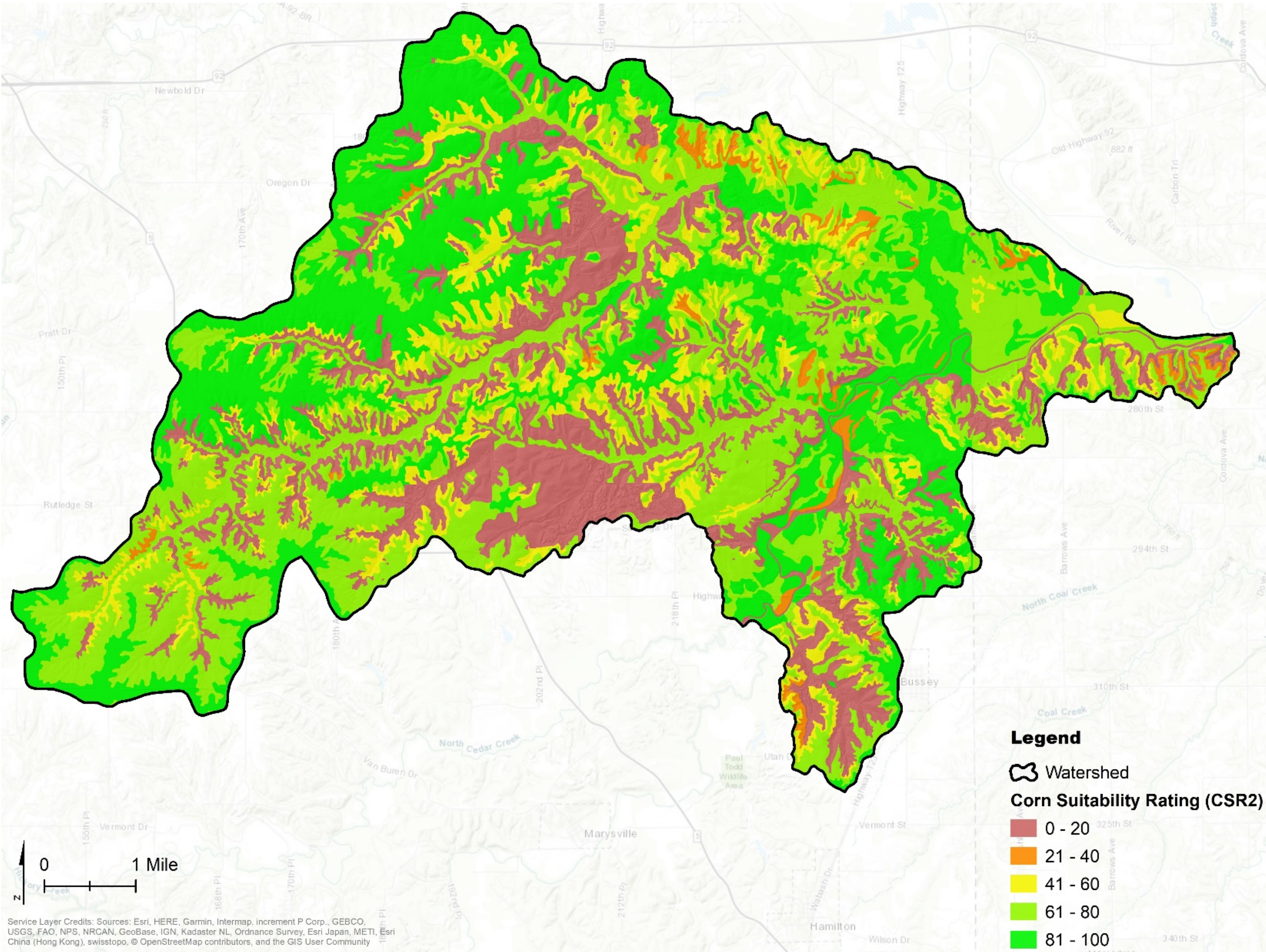

Figure 2.5.4. Corn suitability ratings (CSR2) values vary significantly for land in the Twin Cedars Watershed (source: Iowa Soil Properties and Interpretations Database).

Many soil map units in the watershed are designated as highly erodible land (Figure 2.5.5). According to Daily Erosion Project data, hillslope soil loss as a result of sheet and rill erosion averaged 3.91 tons per acre per year from 2009 through 2018. Soil erodibility factors and digital elevation model-derived topographic factors for the Revised Universal Soil Loss Equation were used to map locations of relative soil erosion risk (Figure 2.5.6). The sediment delivery ratio for the Twin Cedars Watershed is 22 percent, which represents the fraction of eroded upland sediment delivered to the watershed outlet.

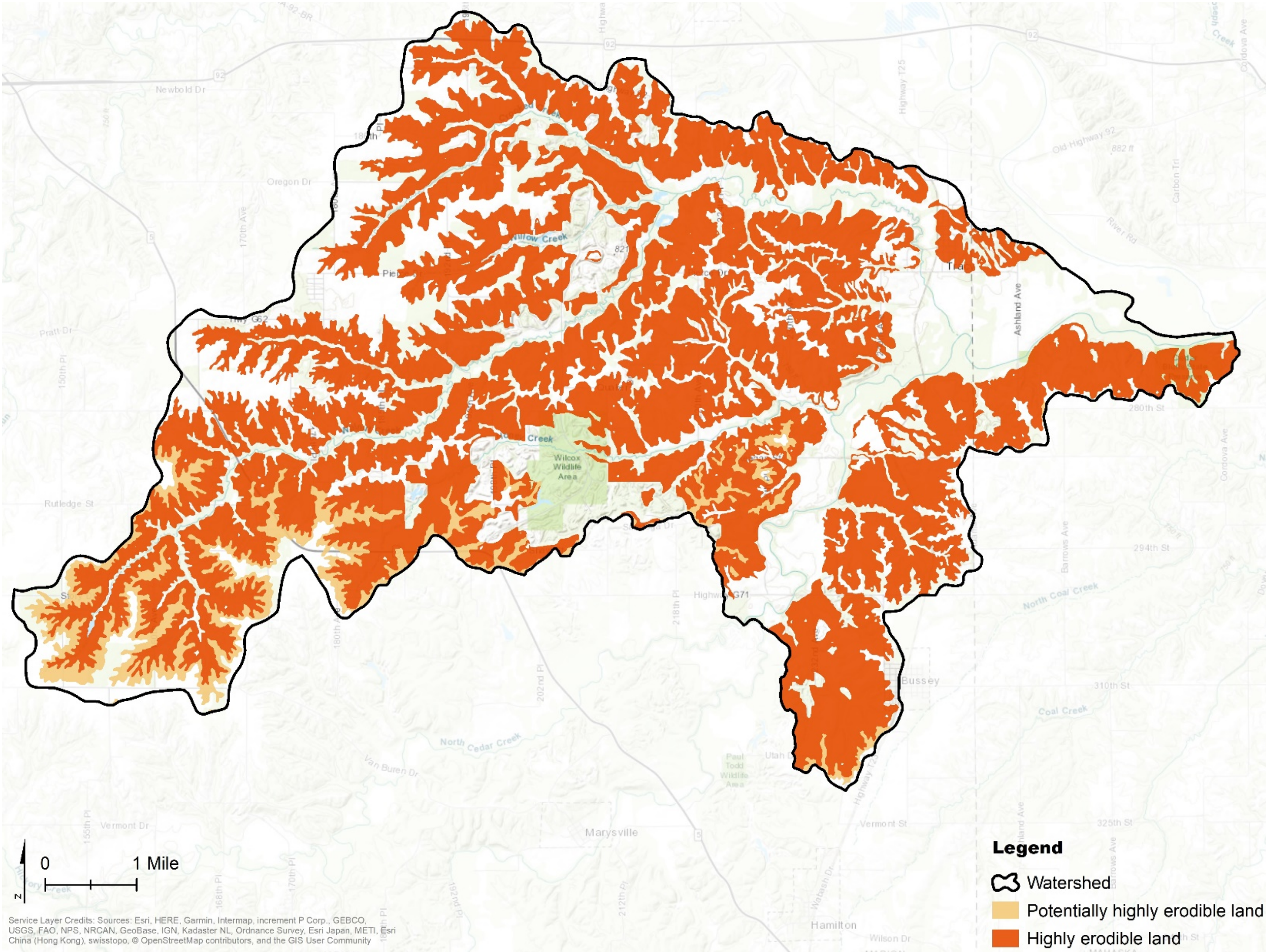

Figure 2.5.5. Highly erodible land in the Twin Cedars Watershed.

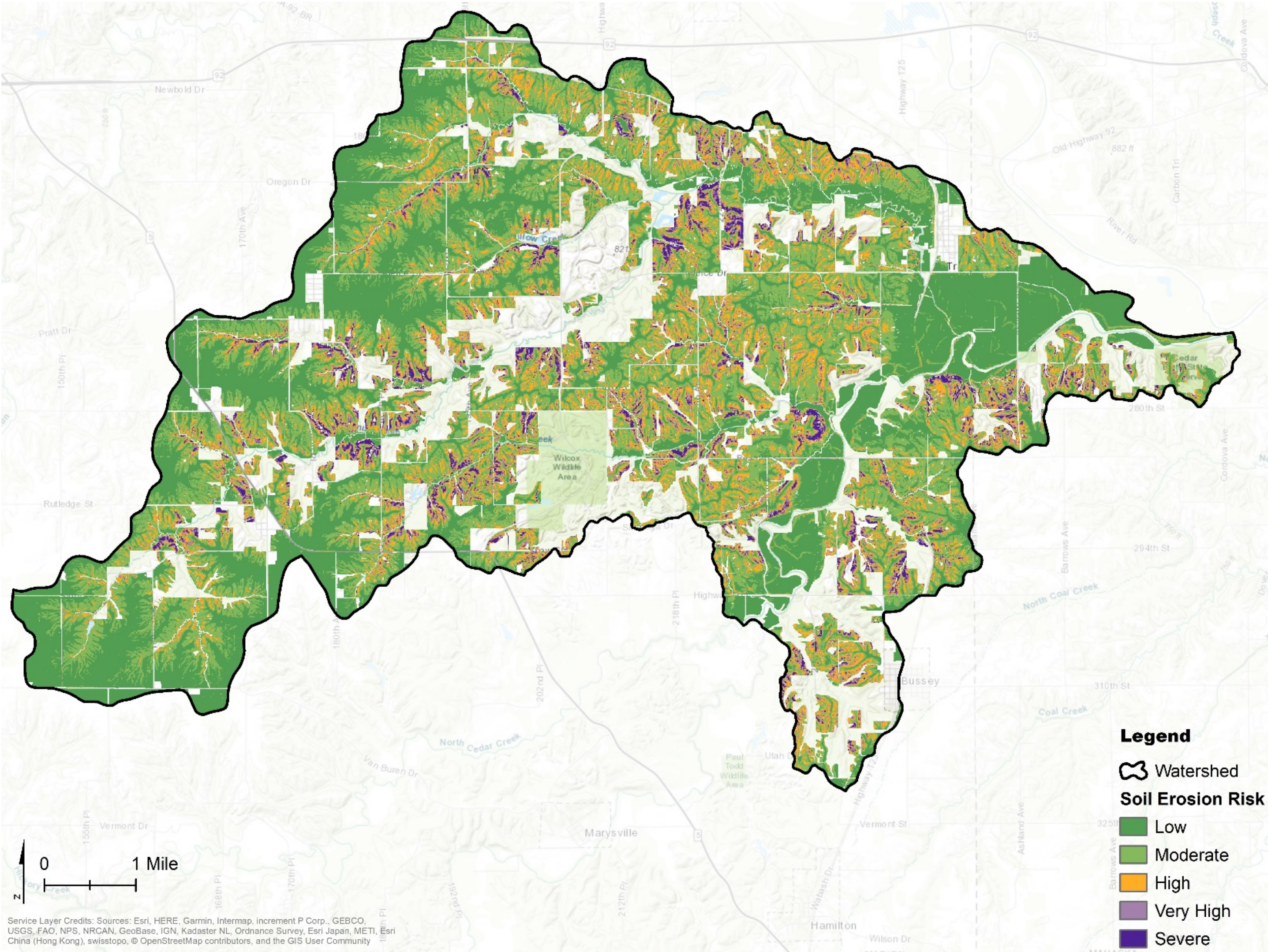

Figure 2.5.6. Soil erosion risk naturally varies throughout the watershed based on topography and soil properties.

2.6. Land Use

Native vegetation the Twin Cedars Watershed included a mix of prairie (69 percent), forest (30 percent), and savanna and fields (approximately 1 percent) (Figure 2.6.1). Presently, land in the watershed is used primarily for agriculture. According to the USDA-National Agricultural Statistics Service, on average 50 percent of land in the watershed was used for corn and soybean production from 2009 through 2018 (Table 2.6.1). High-resolution land use for the Twin Cedars watershed is shown in Figure 2.6.2.

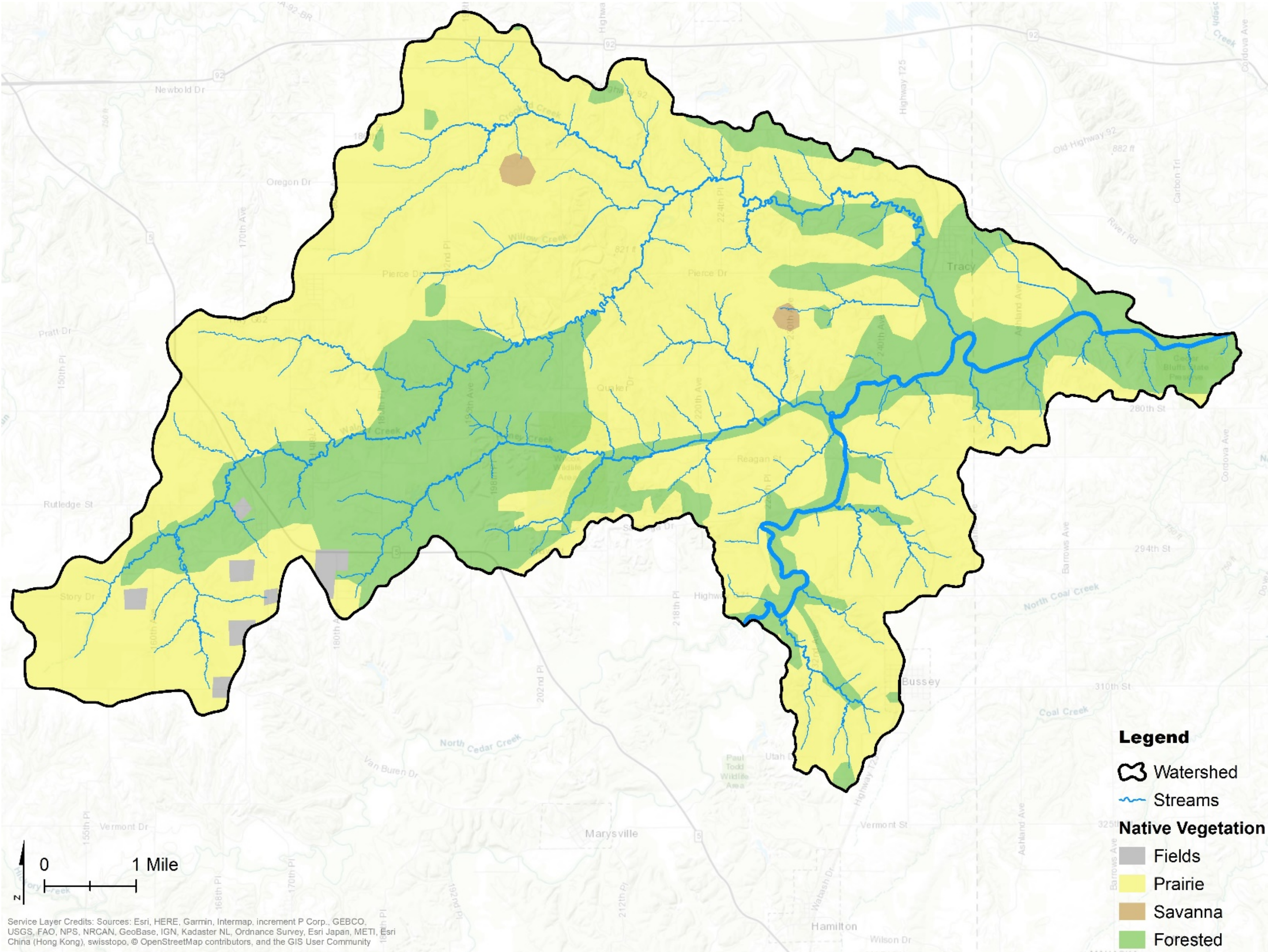

Figure 2.6.1. Native vegetation in the Twin Cedars Watershed was primarily prairie along with timber and savanna.

Table 2.6.1. Typical land use in the Twin Cedars Watershed based on 2009 through 2018 averages (source: Cropland Data Layer).

Land use	Acres	Percent
Corn and soybeans	16,372	50%
Grass and pasture	8,478	26%
Forest and trees	5,300	16%
Water and wetlands	695	2%
Developed	1,758	5%
Other	98	0.3%
Total	32,701	100%

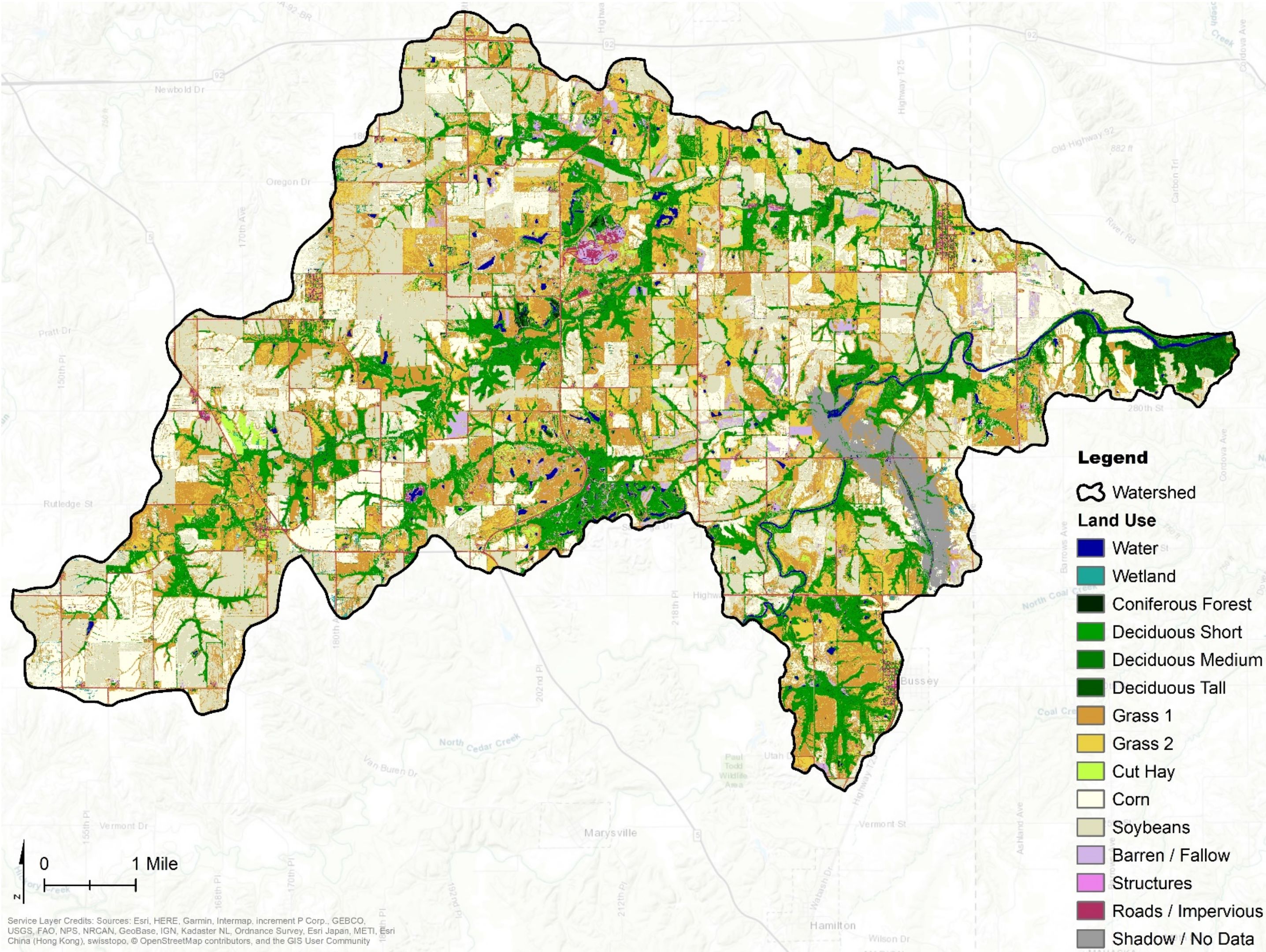

Figure 2.6.2. High-resolution land use in the Twin Cedars Watershed. The interpretation year is 2009, as land use classes were mapped based on multi-year aerial imagery and high-resolution digital elevation models (source: Iowa Department of Natural Resources).

2.7. Conservation

Substantial conservation infrastructure already is in place in the Twin Cedars Watershed (Figure 2.7.1). An inventory of conservation practices was completed by integrating a 2019 field assessment of in-field practices with locations of constructed practices identified through the Iowa Best Management Practices Mapping Project (Table 2.7.1). While it is difficult to capture agronomic conservation practices, watershed residents and stakeholders confirmed that these estimates adoption levels are appropriate.

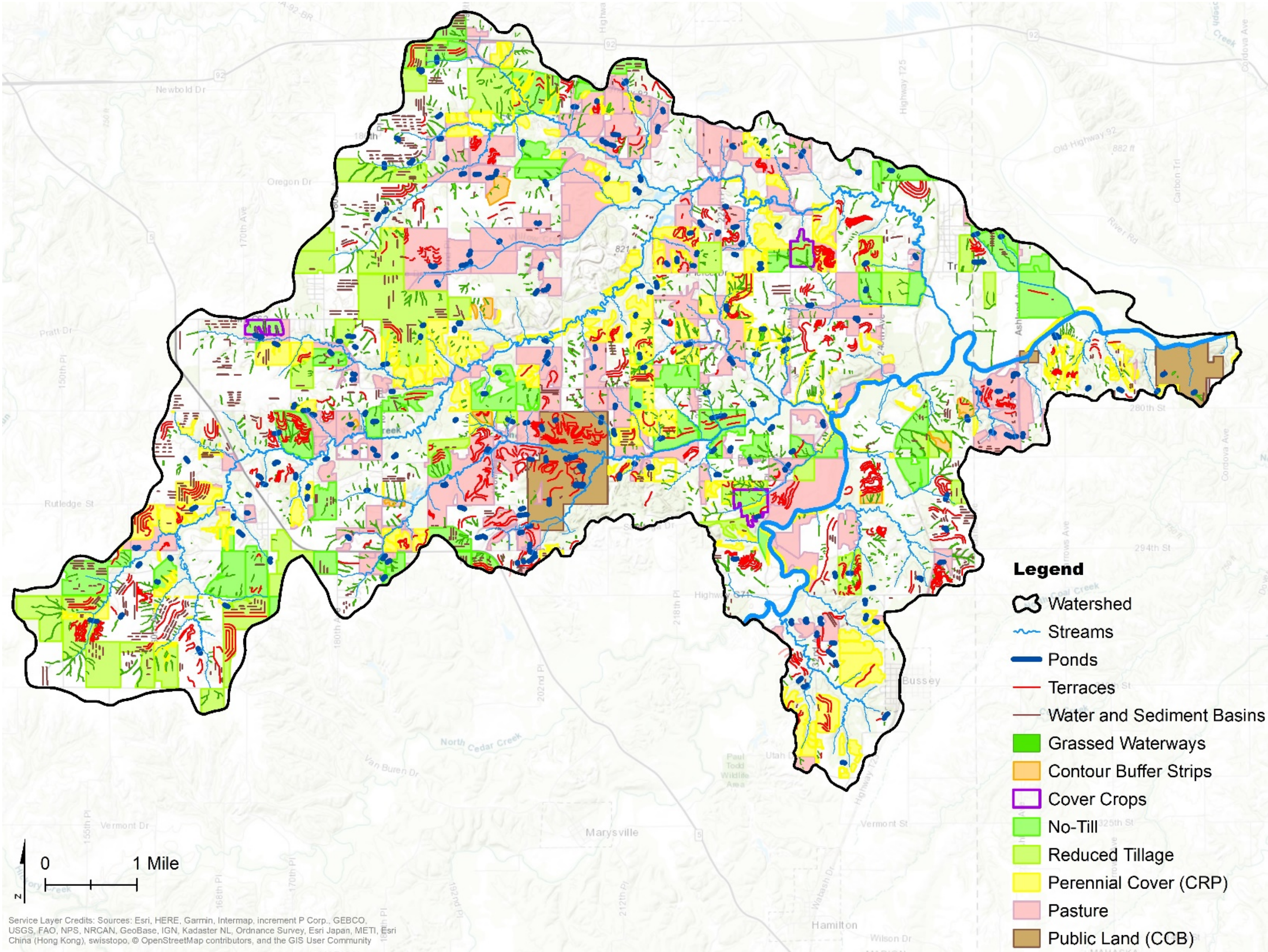

Figure 2.7.1. Conservation practices with known locations in the Twin Cedars Watershed (source: Iowa Best Management Practices Mapping Project).

Table 2.7.1. Inventory of agronomic and constructed conservation practices in the Twin Cedars Watershed (source: Iowa Best Management Practices Mapping Project).

Practice	Quantity	Units
No-till	2,740	acres
Cover crops	150	acres
Ponds	235	sites
Terraces	520,600	feet
Sediment basins	185,100	feet
Grassed waterways	598,300	feet
CRP	2,370	acres
County conservation	840	acres

3. Water Quality Conditions

3.1. Resource Concerns

The water quality constituents of interest in the Twin Cedars Watershed include sediment, phosphorus, and nitrogen (Table 3.1.1). In addition to soil conservation to enhance agricultural productivity and local surface water quality, nitrogen and phosphorus transport is a high priority due to the Iowa Nutrient Reduction Strategy (INRS). The INRS provides a scientific and technological framework for agriculture, industries, and communities in Iowa to reduce nitrogen and phosphorus loss to Iowa and downstream waters.

Table 3.1.1. Water quality constituents of concern in the Twin Cedars Watershed include nitrogen, phosphorus, and sediment. There also is a bacteria water quality impairment documented for Cedar Creek.

Constituent	Context
Nitrogen	Local stakeholder goal and Iowa Nutrient Reduction Strategy
Phosphorus	Local stakeholder goal and Iowa Nutrient Reduction Strategy
Sediment	Local stakeholder goals to address water, soil, and flooding resource concerns
Bacteria	Secondary concern due to impairment of presumed recreational use

The Iowa Department of Natural Resources has identified a bacteria water quality impairment for the segment of Cedar Creek within the Twin Cedars Watershed, and farther downstream the Des Moines River also is impaired by bacteria. A total maximum daily load (TMDL) has not been developed for either bacteria impairment.

Local flooding also was identified by watershed stakeholders as a priority resource concern. Flood impacts are most evident along Cedar Creek between the communities of Bussey and Tracy (Figure 2.4.1). According to a 2018 study by the Iowa Flood Center, flood events have occurred in the Cedar Creek Watershed approximately 30 percent of years during the period of record, typically between May and August.

3.2. Water Quality

Water quality monitoring data for the Twin Cedars Watershed is limited. The Iowa Department of Natural Resources measures water quality of Cedar Creek near Bussey through its ambient stream water monitoring program. However, the water quality information from that location is indicative of the portion of the Cedar Creek Watershed upstream of the Twin Cedars sub-watershed. Assessment information from the ADBNet, BioNet, and AQuIA databases for Cedar Creek, along with estimated nutrient loss and erosion rates, are provided in Table 3.2.1.

Table 3.2.1. Use designations, assessment details, biological and chemical water quality, and watershed-scale nutrient and sediment yields and loads for Cedar Creek and the Twin Cedars Watershed (sources: Iowa Department of Natural Resources, University of Iowa-IIHR, Daily Erosion Project).

Parameter	Value	Interpretation and Details
Class A1	-	Partially supporting (Primary contact recreation)
Class B(WW-1)	-	Fully supporting (Warm water aquatic life)
Class HH	-	Not assessed (Fish consumption/human health)
FIBI	48	Fair (FIBI, Fish Index of Biotic Integrity)
BMIBI	42	Fair (Benthic macroinvertebrate index of biotic integrity)
RHA Composite Score	109	Sub-Optimal (Rapid habitat assessment: riffle/run)
NOx-N (mg/L)	0.18	Nitrate (NO3) + nitrite (NO2) as nitrogen (N)
PO4-P (mg/L)	0.51	Phosphate (PO4) as phosphorus (P)
NO3-N yield (lb/ac/yr)	13.1	Nitrate (NO3) as N
Phosphorus yield (lb/ac/yr)	0.86	Integrates erosion rate, sediment delivery ratio, and P enrichment ratio
Soil loss (t/ac/yr)	3.91	Sheet and rill erosion transported from hillslopes
Nitrate-N load (lb/yr)	214,840	Baseline nitrogen loss
P load (lb/yr)	14,018	Baseline phosphorus loss
Soil erosion (t/yr)	64,124	Baseline sheet and rill erosion

As the majority land use in the watershed, agriculture is the primary source of nitrogen, phosphorus, and sediment loss from uplands in the watershed. Critical source areas have been identified for these priority water resource constituents (Figure 3.2.1). These areas were prioritized through an analysis of soil, topographic, and hydrologic factors.

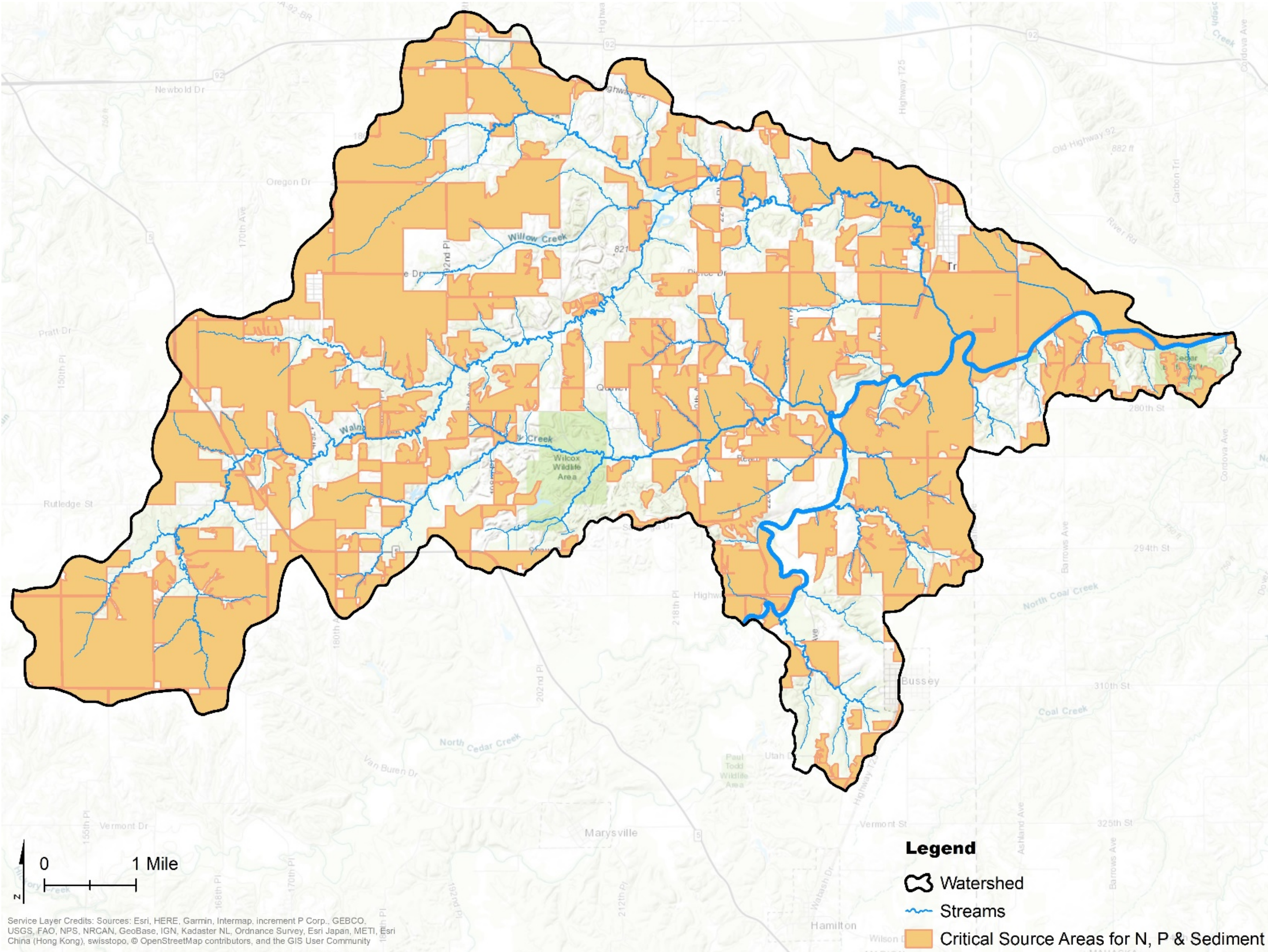

Figure 3.2.1. Critical source areas for nitrogen, phosphorus and sediment loss in the Twin Cedars Watershed.

Continued and increased water quality monitoring will be important to evaluate trends and outcomes of the watershed project over time. Stakeholders in the Twin Cedars Watershed identified water quality improvement as a top priority.

4. Goals and Objectives

4.1. Goals

Watershed goals were established through a community-based, participatory planning process. Local farmers, landowners, technical experts, and watershed partners engaged in facilitated discussions to identify local conditions, challenges, and opportunities. From these conversations a set of goal statements was developed to serve as guides for watershed improvement. The goals for the Twin Cedars Watershed are to:

1. Improve water quality.
2. Build soil health.
3. Pursue and secure conservation funding.
4. Reduce flooding.
5. Provide education and information on available practices, resources, and assistance.

4.2. Objectives

Specific objectives have been established for each goal to facilitate implementation and evaluation as watershed improvement actions occur.

Goal 1. Improve water quality.

Objective 1.1. Achieve Iowa Nutrient Reduction Strategy goals of 41 percent nitrogen and 29 percent phosphorus loss reductions relative to baseline conditions.

Objective 1.2. Monitor water quality to assesses trends. Nitrogen, phosphorus, sediment, and bacteria levels each should be quantified regularly.

Goal 2. Build soil health.

Objective 2.1. Minimize soil erosion by meeting or exceeding USDA-Natural Resources Conservation Service soil erosion conservation planning criteria.

Objective 2.2. Increase soil organic matter as indicated by positive trends in the Soil Conditioning Index.

Goal 3. Pursue and secure conservation funding.

Objective 3.1. Identify relevant and timely public, private, and innovative sources of funding to provide and increase technical and financial assistance in the watershed.

Objective 3.2. Track investment in the watershed, quantify benefits provided, and report outcomes to funding partners and stakeholders.

Goal 4. Reduce flooding.

Objective 4.1. Increase water storage across the watershed by improving soil infiltration and constructing practices to permanently and temporarily hold water.

Objective 4.2. Manage flood-prone areas to maximize natural and economic resilience.

Objective 4.3. Monitor meteorological and hydrological conditions and provide timely updates to emergency managers.

Goal 5. Provide education and information on available practices, resources, and assistance.

Objective 5.1. Develop and distribute outreach materials regularly to watershed residents, farmers, landowners, and partners.

Objective 5.2. Partner with individuals and organizations that can implement and support conservation in the watershed.

4.3. Timeline

Watershed stakeholders established 2035 as the target date to achieve full-scale implementation of the watershed plan. A 15-year planning horizon balances the needs for immediate adoption with long-term transitions in conservation cropping systems. Additionally, 2035 aligns with the goal of the Mississippi River/Gulf of Mexico Hypoxia Task Force. To facilitate adaptive management and evaluation of interim milestones, three 5-year phases for project implementation are recommended: 2021 through 2025, 2026 through 2030, and 2031 through 2035. A detailed implementation schedule for each phase is provided in Section 5.3.

4.4. Outcomes

Fully implemented, the conservation practices in this watershed plan are anticipated to contribute to significant environmental outcomes. Annually, these outcomes would include 88,202 pounds of nitrogen loss reduction, 12,191 pounds of phosphorus loss reduction, 43,740 tons of soil conserved from erosion, and net greenhouse gas reductions equivalent to 12,591 tons of carbon dioxide.

5. Implementation Plan

5.1. Priority Conservation Practices

Priority conservation practices were identified through stakeholder input and applied analysis. To determine a set of high priority practices, watershed farmers and technical experts weighed the relative impact and adoption likeliness of many conservation practices. These two characteristics were compared (Figure 5.1.1).

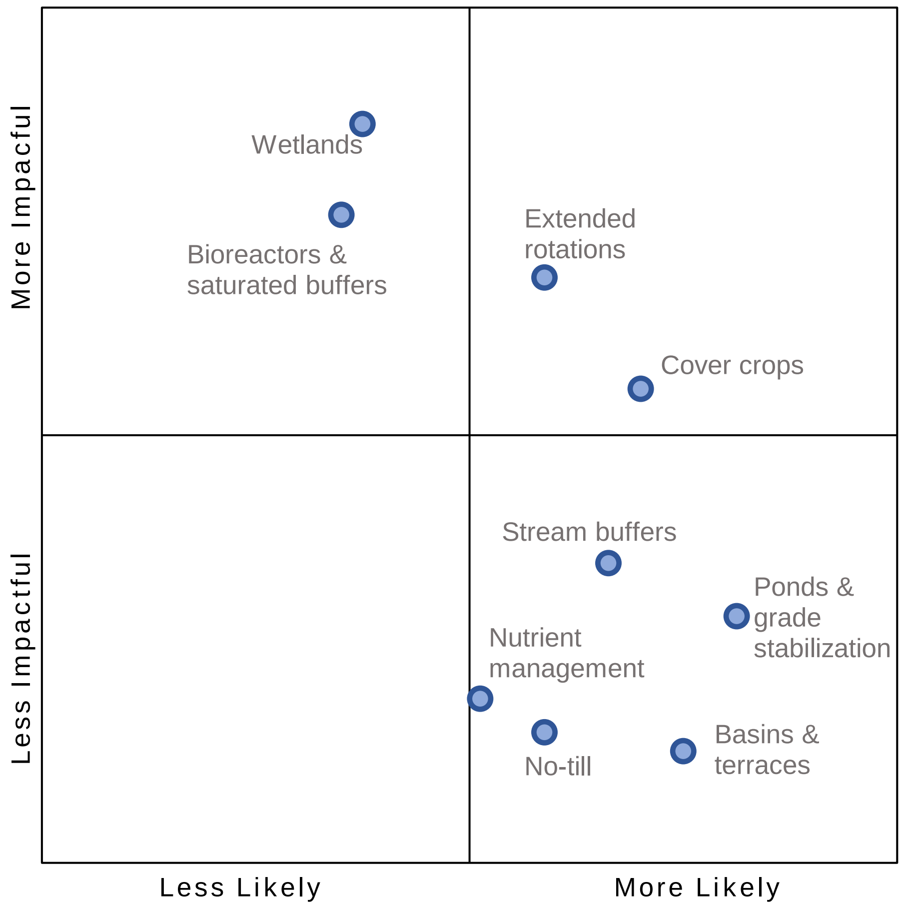

Figure 5.1.1. Relative impact and adoption likeliness for conservation practices according to watershed stakeholders. In general, higher priority practices are those that have greater potential to impact watershed goals and that are more likely to be broadly adopted.

The needed levels of each of these priority conservation practices were determined using simple water quality models based on the Iowa Nutrient Reduction Strategy. Potential locations for conservation practices throughout the watershed were identified with the Agricultural Conservation Planning Framework (ACPF) mapping software. The ACPF tools provided insights into landscape capacity for various types of practices. These locations are mapped in an atlas included as an appendix to this plan.

5.2. Conceptual Plan

Priority conservation practices along with their needed quantities are listed in Table 5.2.1, and potential locations for adoption are shown in Figure 5.2.1. While conceptual, this combination of practices and geographic distribution illustrates the level of effort that will be needed to meet watershed goals.

Table 5.2.1. Priority conservation practices and adoption level goals.

Practice	Units	Goal	Note
N management	ac/yr	6,400	75% of corn
No-till	ac/yr	12,100	Soybeans + 50% of corn
Cover crops	ac/yr	9,900	Soybeans + 25% of corn
Extended rotation	ac/yr	As needed	for farm profitability and soil health
Wetlands	sites	5	Larger impoundments for flood control
Farm ponds	sites	40	Water retention for small catchments
Saturated buffers & bioreactors	sites	50	Targeted to fields with drainage tile
Basins & terraces	feet	As needed	for erosion control
Stream buffers	acres	As needed	for stream protection

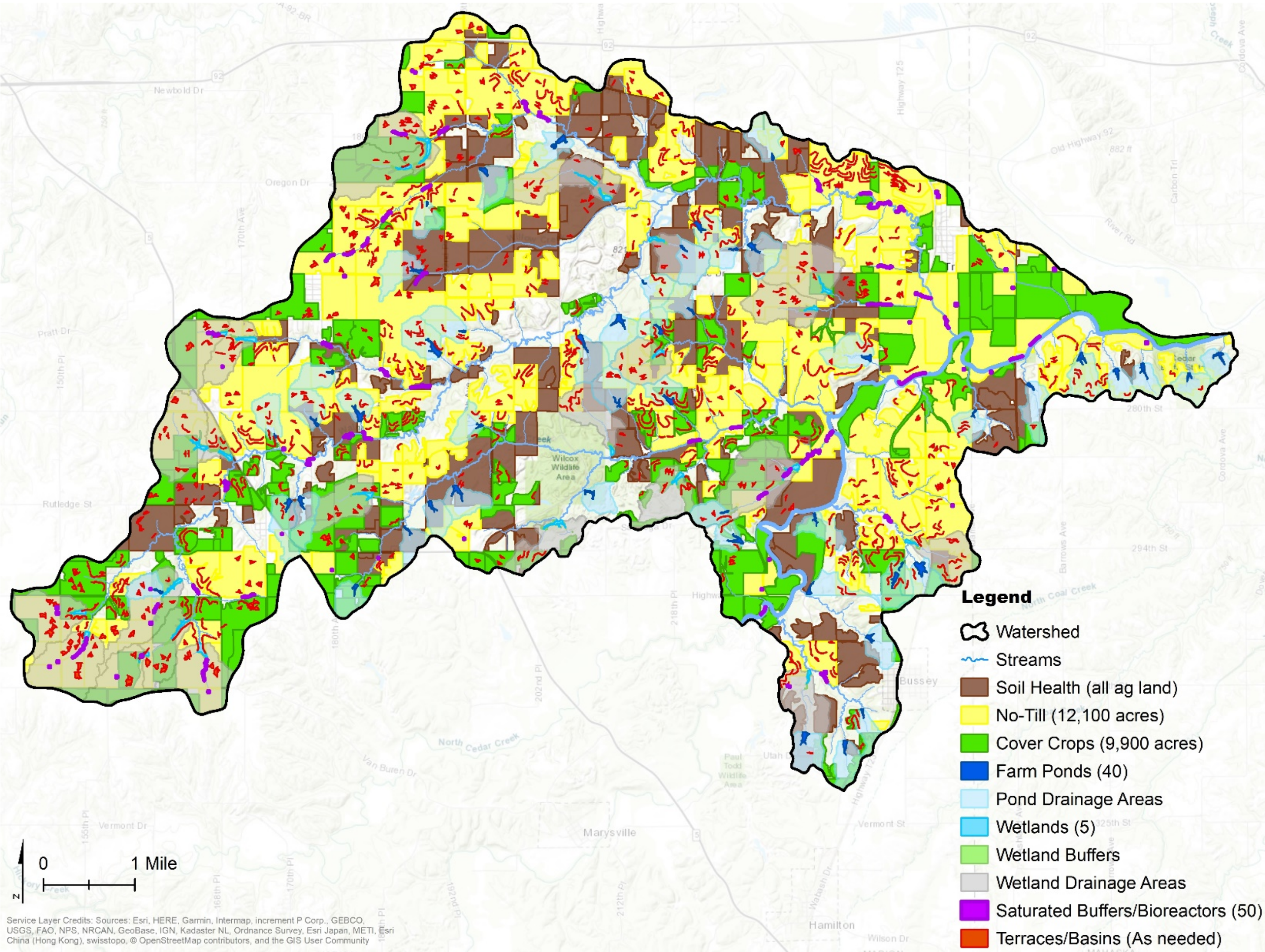

Figure 5.2.1. Conceptual plan for conservation practice implementation.

5.3. Implementation Schedule

An implementation schedule was developed to facilitate evaluation of interim project milestones before the 2035 target date for full plan implementation. The three project phases are recommended: 2021 through 2025, 2026 through 2030, and 2031 through 2035. Existing, phased, and cumulative implementation goals are laid out in Table 5.3.1.

Table 5.3.1. Implementation schedule for the Twin Cedars Watershed.

Priority Conservation Practice	Units	Current Level	Phase 1: 2021-2025	Phase 2: 2026-2030	Phase 3: 2031-2035	Cumulative Goal
N management	acres/year	-	1,400	3,000	2,000	6,400
No-till	acres/year	2,740	3,360	4,000	2,000	9,360
Cover crops	acres/year	150	2,250	3,000	4,500	9,750
Extended rotation	acres/year	-	*As needed for farm profitability and soil health*			
Wetlands	sites	-	1	1	3	5
Farm ponds	sites	235	10	20	10	40
Saturated buffers & bioreactors	sites	-	5	15	30	50
Basins & terraces	feet	705,700	*As needed for erosion control*			
Stream buffers	acres	-	*As needed for stream protection*			

6. Roles and Responsibilities

Watershed management requires commitment, collaboration, and coordination among multiple entities. Much of the responsibility for implementing the watershed plan ultimately will be assumed by farmers and landowners, so it is critical to continue to involve them in leadership roles. The following list identifies current and potential project partners along with their key functions.

Stakeholder Group	Roles
Farmers and landowners	Implement conservation practices, evaluate on-farm performance, share knowledge and experience with others, and partner with relevant operator or owner on conservation practice adoption.
South Central Iowa Cedar Creek Watershed Management Authority	Coordinate watershed activities with other watershed management authority member entities across the broader Cedar Creek Watershed.
Marion and Mahaska Soil and Water Conservation Districts	Hire watershed project staff, pursue and obtain grants and other funding, evaluate implementation progress, and develop partnerships.
USDA-Natural Resources Conservation Service	Provide technical and financial assistance, provide conservation practice design and engineering, house project staff as needed, and provide associated office space, computer, phone, and vehicle as available. In addition to assistance provided through the local USDA service center, the NRCS is well positioned to support watershed goals by providing access to federal funding programs for working lands conservation.
Iowa Department of Agriculture and Land Stewardship	Provide technical support for the watershed project and provide opportunities for state funding for soil and water conservation practices.
Iowa Department of Natural Resources	Conduct water quality monitoring and water resources assessments.
Marion and Mahaska Counties	Coordinate with county emergency managers as needed, maintain county conservation board properties and provide public educational opportunities, and coordinate on infrastructure projects with an emphasis on natural resource resilience.
Conservation and farm organizations	Engage members, provide environmental and/or agronomic services as appropriate, and support mutual goals.
Educational institutions	Local schools can provide educational programming. Universities such as Iowa State University and the University of Iowa can provide opportunities for research, extension, and flood-focused programs.

7. Funding Needs and Opportunities

7.1. Resource Needs

Watershed management requires substantial investment in technical assistance (human resources) and financial assistance (funding to support practice adoption or construction). Table 7.1.1. provides estimated implementation costs by conservation practice.

Table 7.1.1. Estimated annual or initial costs of priority conservation practices.

Practice	Units	Goal	Unit Cost	Total Cost
N management	ac/yr	6,400	-$5	-$32,000
No-till	ac/yr	12,100	-$10	-$121,000
Cover crops	ac/yr	9,900	$40	$396,000
Wetlands	sites	5	$65,000	$325,000
Farm ponds	sites	40	$85,000	$3,400,000
Saturated buffers & bioreactors	sites	50	$11,000	$550,000

The total cost to fully implement the Twin Cedars Watershed Plan is estimated to be $4,275,000 in up-front capital plus an additional $343,000 per year in annual operating expenses. This annual operating budget includes $243,000 per year in conservation financial assistance plus approximately $100,000 per year to fund watershed management and technical assistance, which includes salary and benefits for a watershed coordinator, supplies for outreach materials and events, water monitoring, and overhead costs such as office space, computer, phone, and vehicle.

Short- and long-term cost savings to farmers and landowners are anticipated from adoption of no-till and optimized nutrient management. These financial gains could offset near-term adoption costs associated with other practices such as cover crops. Investment in soil and water conservation should be balanced between one-time, up-front construction and annual, in-field practices to efficiently achieve watershed goals. The costs and benefits (both economic and environmental) should be aligned with needs and goals of individual farmers and landowners that will implement each conservation practice.

For context, these implementation costs were compared to annual revenue and asset value of cropland in the watershed. Based on 10-year averages of corn and soybean acreages, yields, and prices, the gross annual revenue from corn and soybean production in the watershed is $10,503,385, or $640 per acre. The annual plan implementation cost of $343,000 per year represents 3.3 percent of annual gross revenue. Based on 2019 data, agricultural land in Marion County, Iowa averaged $6,770 per acre, for a total asset value of $111,028,000. The initial capital investment cost of $4,275,000 represents 3.9 percent of the total value of watershed cropland.

7.2. Funding Sources

Funding opportunities include state and federal grants and cost-share, which typically are obtained and administered by a soil and water conservation district. State programs include the Iowa Water Quality Initiative and the Iowa Financial Incentive Program. Federal programs include Environmental Quality Incentives Program, Conservation Stewardship, Conservation Reserve Program, and Regional Conservation Partnership Program.

Nontraditional, innovative approaches will be necessary to secure long-term sustainable funding for watershed improvement. To supplement cost-share from state and federal sources, watershed stakeholders could pursue finance-based funding models that provide payments for environmental outcomes generated by conservation practices. Opportunities to measure, research, manage, and optimize farm enterprise-scale profitability also could be pursued to ensure that farmers maintain and build their financial strength over time in addition to their natural resource capital.

8. Outreach and Engagement Plan

Outreach and education will be needed on an ongoing basis to provide information to watershed stakeholders. Outreach initiatives and materials should be designed to accomplish specific goals. Messaging and formats should be tailored to specific audiences. Local and regional media should be engaged as appropriate to build awareness and understanding of the watershed project.

Communications and coordination should be conducted by a watershed leadership team. The South Central Iowa Cedar Creek Watershed Management Authority board of directors may be an appropriate group for this role. Ideally, the Twin Cedars Watershed group also should include farmers and landowners, USDA-Natural Resources Conservation Service, soil and water conservation district commissioners and staff, Iowa Department of Agriculture and Land Stewardship, and other local partner organizations.

In addition to sharing information, outreach should drive engagement and participation. Public events such as field days and meetings are important venues to share information, yet these events present important opportunities to foster community ties within and around the watershed. Watershed improvement is highly collaborative, so such community bonds and cooperation will be essential for sustained, long-term success. For example, cooperative learning opportunities that facilitate farmer-to-farmer knowledge sharing will allow more producers to adopt best practices and adaptive management as they refine their operations with new or additional conservation practices.

9. Monitoring and Evaluation Plan

9.1. Monitoring

Multiple indicators should be monitored to track progress and measure success. Water quality monitoring will be a key indicator of overall conditions within the watershed. Stakeholders should continue to work with the Iowa Department of Natural Resources to monitor stream water quality and assess trends. At a minimum, water quality parameters to measure include inorganic nitrogen, dissolved phosphorus, turbidity or total suspended solids, and bacteria. In addition to monitoring Cedar Creek, tributary streams also could be monitored to evaluate water quality at a finer scale (Figure 9.1.1).

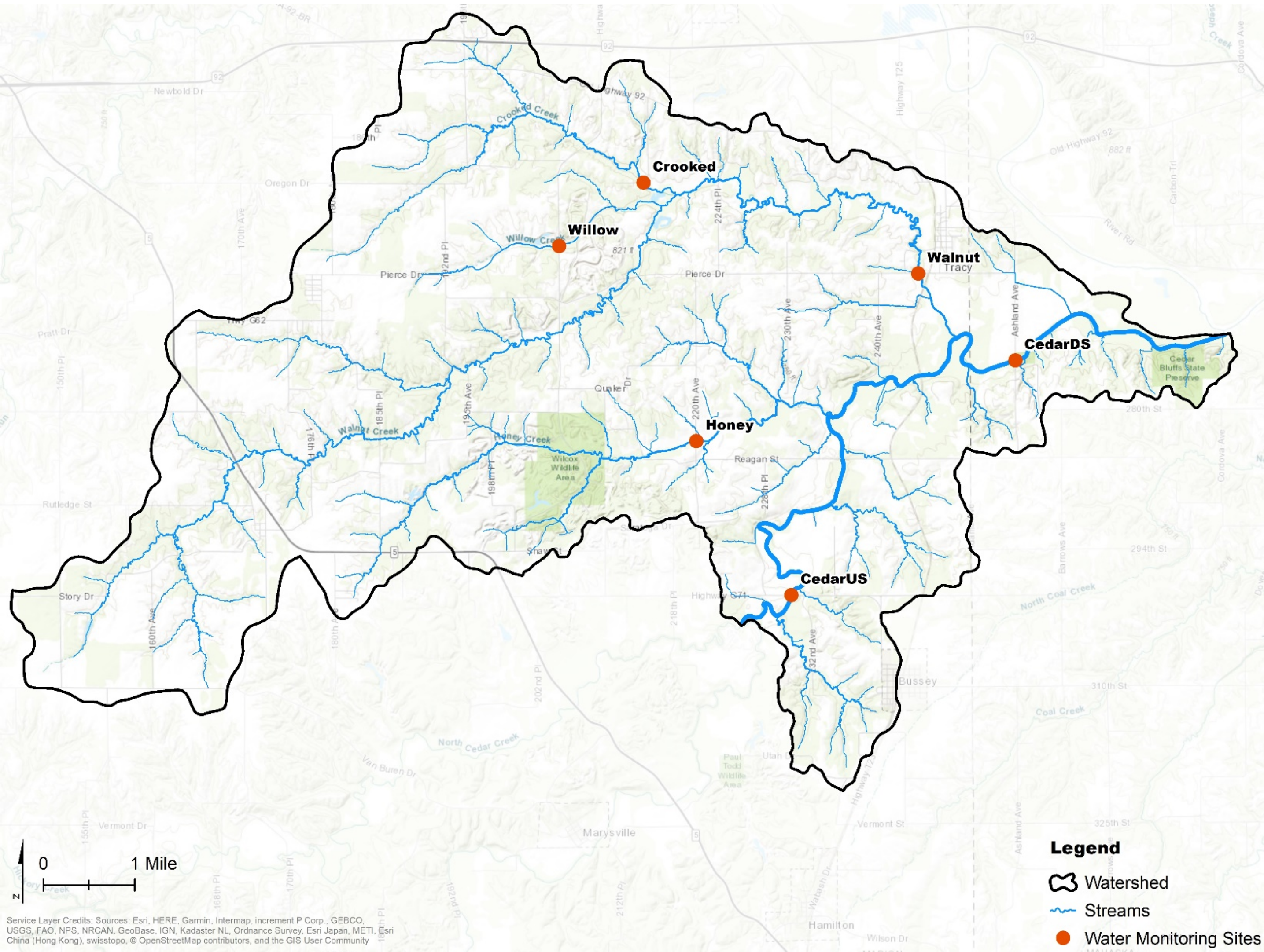

Figure 9.1.1. Locations to monitor surface water quality of Cedar Creek and its tributaries in the Twin Cedars Watershed, including Crooked Creek, Willow Creek, Walnut Creek, and Honey Creek.

Field-scale water monitoring also can be used to evaluate the effectiveness of individual conservation practices. Additional field-scale monitoring could include soil health testing, nutrient management trials, or crop tissue sampling. Such agronomic studies can be important sources of data to inform decision making by individual farmers and landowners. Environmental outcomes of conservation practice implementation can be measured using Natural Resource Conservation Service conservation planning tools and criteria (e.g., Revised Universal Soil Loss Equation 2, Soil Conditioning Index), other public agroecosystem models (e.g., Nutrient Tracking Tool, COMET-Farm), or private sustainability and stewardship technology platforms.

Watershed project evaluation also should include tracking of social indicators such as surveys of attitudes and awareness, event attendance, and media reach. Additional success indicators such as practice adoption and retention, new project participants, and new project partners should be documented and reported.

9.2. Evaluation

Watershed project actions and progress should be tracked in four categories: administration, engagement, implementation, and outcomes. The following chart provides details on what, when, and how to measure within each of these categories.

Metric	Frequency	Details
Administration		
Formal project review	Annually	An annual project review meeting should be conducted with project partners, funding entities, and supporting agencies. The review should capture the following metrics and provide a platform both to celebrate accomplishments from the past year and to plan for the next year.
Project advisory meetings	Quarterly	Project leaders—including farmers—should meet regularly, ideally quarterly, depending on timing of agriculture field work. These gatherings should be used to ensure project goals and objectives are being accomplished. Upcoming outreach, events, and monitoring activities also should be coordinated.
Engagement		
Awareness and attitudes	Periodically	Awareness of the project and watershed goals should be assessed. This qualitative data will provide a measure of trends in stakeholder knowledge, opinions, and actions.
Event engagement	Event-based	Evaluations can be tied to specific events in order to provide direct feedback to increase participation and learning outcomes from future events.
Project participation	Annually	The number of watershed farmers and landowners that implement and maintain conservation practices should be tracked annually. Other types of participation such as leadership and event attendance also could be tracked.
Implementation		
Practice adoption	Annually	Locations of newly implemented conservation practices should be tracked throughout the project, and total adoption levels and acres treated should be reported annually.
Practice retention	Annually	In addition to constructed practices that will function over multiple years, retention of in-field management practices should be emphasized. Locations of these conservation practices can be identified through field assessments, and will become increasingly easy to track with remote sensing technology.
Outcomes		
Water quality monitoring	Monthly	Surface water quality parameters should be measured monthly or semi-monthly during the growing season. Stream water monitoring data will be essential to determine if long-term water quality improvements are attained.
Agronomic testing	Seasonally	Agronomic and profitability outcomes should be evaluated to determine and understand the impacts and benefits of individual or integrated conservation practices. Research results can be aggregated and shared with all farmers across the watershed to support learning, practice adoption, adaptive management, and continuous improvement.
Outcomes modeling	Annually	Conservation outcomes should be quantified, especially nutrient loss reduction, soil conservation, and greenhouse gas reductions. While it likely will not be feasible to perform field measurements for all implemented conservation practices, agroecosystem models, tools, and technologies should be used to estimate the environmental benefits of all conservation practices adopted across the watershed.