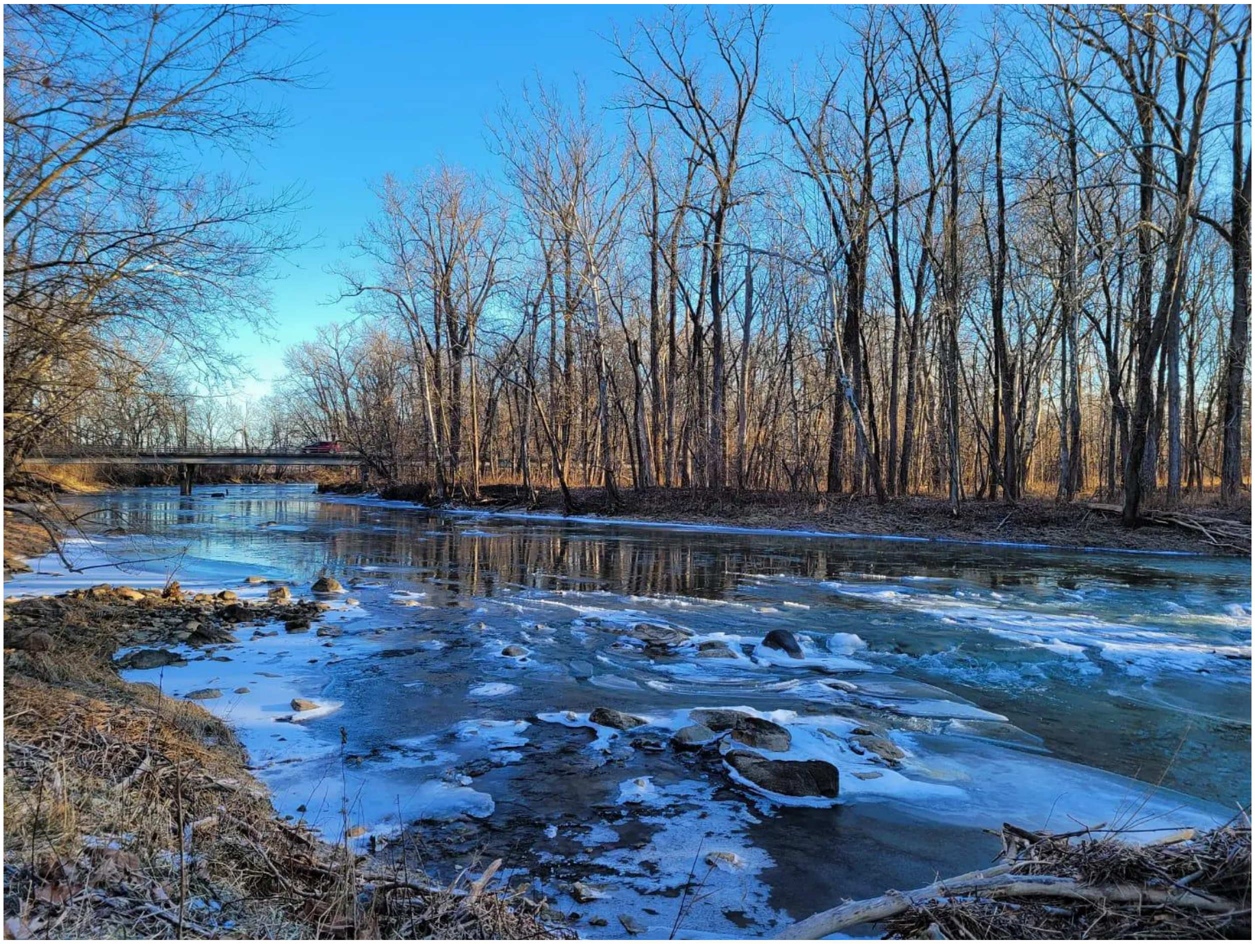
UPPER SUGAR CREEK WATERSHED MANAGEMENT PLAN
SECTION 319 FINAL REPORT



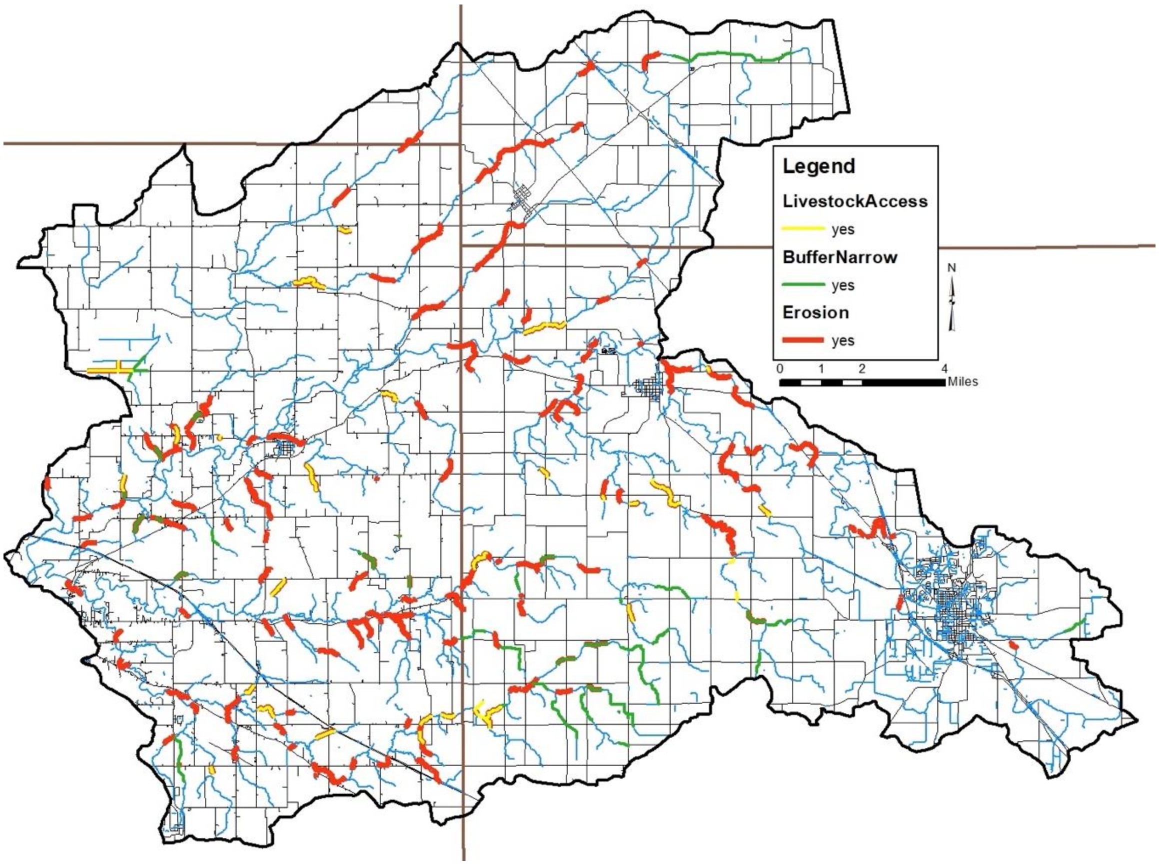
Executive Summary

Montgomery County Soil and Water Conservation District
18 November 2021 – 17 November 2023
Sara Peel, Upper Sugar Creek Project Coordinator

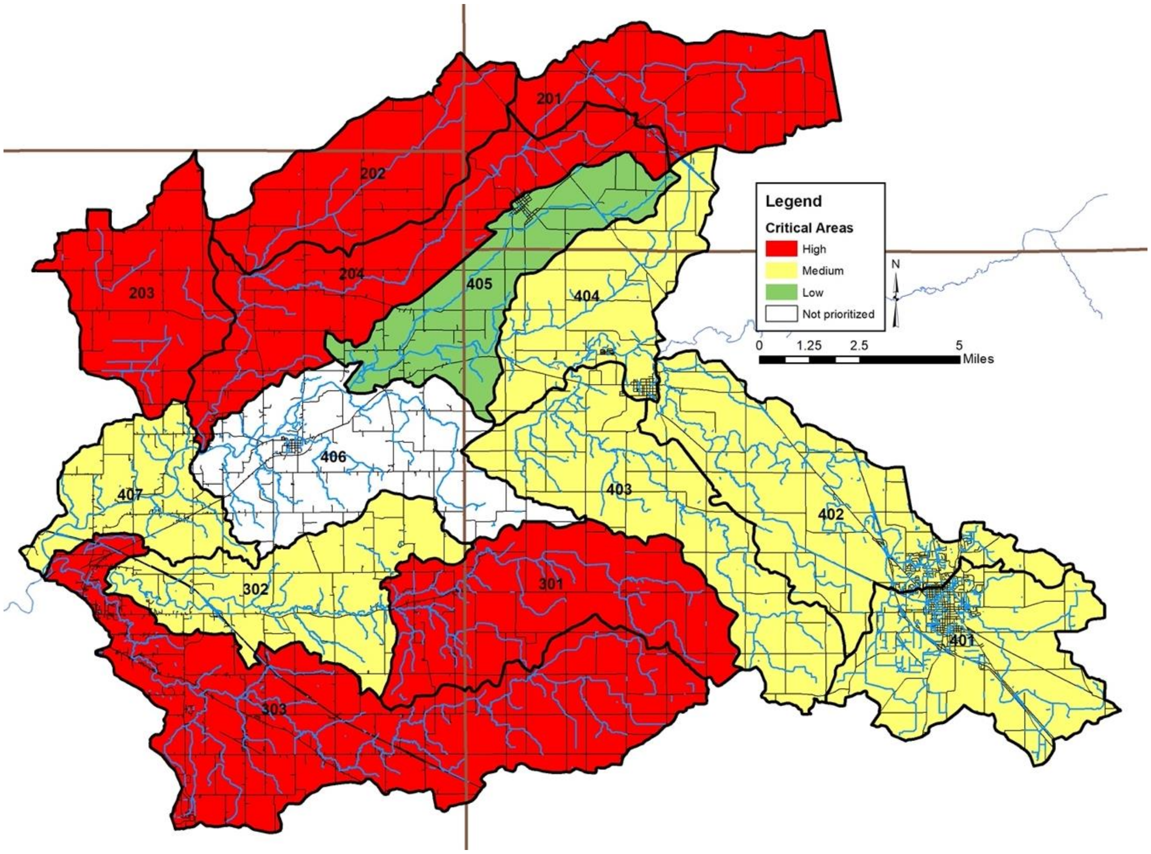
Project Overview: This project lays the foundation for watershed planning and water quality improvement in the Upper Sugar Creek Watershed. The main goals were to: 1) complete a watershed management plan; 2) develop and implement an education and outreach program; and 3) develop and implement a water quality monitoring program aimed at showing change in water quality following implementation.

Watershed Management Plan: The Montgomery County SWCD hired a watershed project coordinator who led development of a watershed management plan for the Upper Sugar Creek Watershed. This plan was guided by nearly three dozen steering committee members representing governmental agencies, local non-for profits, educational entities, community groups, and producers.

Watershed stakeholders identified hundreds of miles of problems within the Upper Sugar Creek Watershed. They plan to implement water quality improvement projects in the following critical areas. By working in these areas, stakeholders hope to improve water quality within the Upper Sugar Creek Watershed.



Stream-related watershed concerns identified during Upper Sugar Creek Watershed inventory efforts.



Upper Sugar Creek Watershed critical areas.

<u>Project Goals</u>:

- Reduce nitrate-nitrogen loading from 3,314,191 lb/year to 514,580 lb/year (84%) by 2053 and reduce total phosphorus loading from 1,214,352 lb/year to 41,166 lb/ year (97%) by 2053.
- Reduce total suspended solids loading from 160,733,493 lb/year to 7,718,695 lb/year (95%) by 2053.
- Reduce E. coli loading from 5.79E+15 to 5.49E+14 (90%) by 2053.
- Reduce flooding impacts by increasing storage and infiltration across the watershed by 2053.
- Natural habitat (grasslands, forest, wetlands) will increase by a total of 5% with a focus on improving habitat connectivity across the Upper Sugar Creek watershed by 2053.
- By 2053, 50% of property owners and producers will be informed about practices that can be implemented to positively impact Upper Sugar Creek and no less than 30% of individuals living and farming in the watershed will be engaged in the project within 30 years. These efforts will be guided by a well-funded, robust, cohesive watershed group.

Education and Outreach: The Upper Sugar Creek Watershed steering committee provided numerous opportunities for watershed stakeholders to learn about the Upper Sugar Creek Watershed; facilitated education-based events; and coordinated programs to recognize the opportunities and commitments made by businesses and individuals throughout the watershed. Public meetings, listening sessions, float trips, clean ups, workshops, and field days are just some of the activities used to educate our stakeholders.

Water Quality Monitoring: Collecting water quality data allowed the Upper Sugar Creek Watershed steering committee to learn more about our watershed, prioritize water quality problem areas, and provide volunteers with monitoring opportunities while laying a foundation by which changes in water quality can be observed following implementation of best management practices.

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1. INTRODUCTION

The Upper Sugar Creek Project launched in late 2021 as a result of a Section 319 grant awarded to develop the Upper Sugar Creek Watershed Management Plan. The Upper Sugar Creek Watershed includes all of the City of Lebanon and Towns of Colfax, Thorntown and Darlington. The watershed includes a variety of land uses including agricultural, forest and natural areas, including nature preserves, as well as urban and urbanizing land uses. Much of the watershed is dominated by agricultural land use with intact forested riparian areas especially adjacent to the mainstem of Sugar Creek. One exception is the predominantly urban and urbanizing drainages in the Prairie Creek headwaters (Sanitary Ditch-Prairie Creek and Deer Creek-Prairie Creek). The mix of land uses generate nutrient, sediment and pathogen runoff concerns. Stakeholders also identified the need to maintain high-quality habitat and aesthetic conditions that leads Sugar Creek to be a recreation destination.

Based on these concerns, the Montgomery County SWCD approached community groups and individuals throughout the watershed that might be interested in working with them to assess and improve water quality within Upper Sugar Creek and its tributaries. Identified potential stakeholders include: Boone, Clinton and Tippecanoe County SWCD and NRCS staff; City of Lebanon MS4; Indiana DNR; Indiana State Department of Agriculture; Boone, Clinton, Montgomery and Tippecanoe County surveyors, parks departments, health departments and Purdue Extension; The Nature Conservancy; Wabash College faculty, students and staff; Friends of Sugar Creek, NICHES Land Trust; local landowners, educators and more. This group formed a steering committee, conducted windshield surveys of the watershed and held several meetings open to the public in order to generate input in the development of a watershed management plan for the Upper Sugar Creek Watershed.

The Upper Sugar Creek Watershed starts downstream of the Browns Wonder-Sugar Creek Watershed receiving water from Prairie Creek, Walnut Fork-Sugar Creek and Lye Creek in addition to drainage from the Browns Wonder-Sugar Creek Watershed (Figure 1). In total, the Upper Sugar Creek Watershed drains 508 square miles of which 319 square miles are addressed in this watershed management plan. The watershed includes drainage from the cities and towns of Lebanon, Darlington, Colfax and Thorntown. The watershed includes three 10-digit hydrologic unit codes (HUCs): 0512011002 (Lye Creek), 0512011003 (Walnut Fork-Sugar Creek) and 0512011004 (Prairie Creek-Sugar Creek). The Upper Sugar Creek Watershed is comprised of three major basins: Prairie Creek draining north and west from the City of Lebanon, Walnut Fork-Sugar Creek draining west along the southern portion of the watershed and Lye Creek draining the north and eastern portion of the watershed. Lye Creek, Prairie Creek and Walnut Fork-Sugar Creek and other tributaries join Sugar Creek upstream of Crawfordsville. Sugar Creek continues south and west through Montgomery, Fountain and Parke Counties where it meets the Wabash River north of Montezuma. The Wabash River flows south to join with the Ohio River.

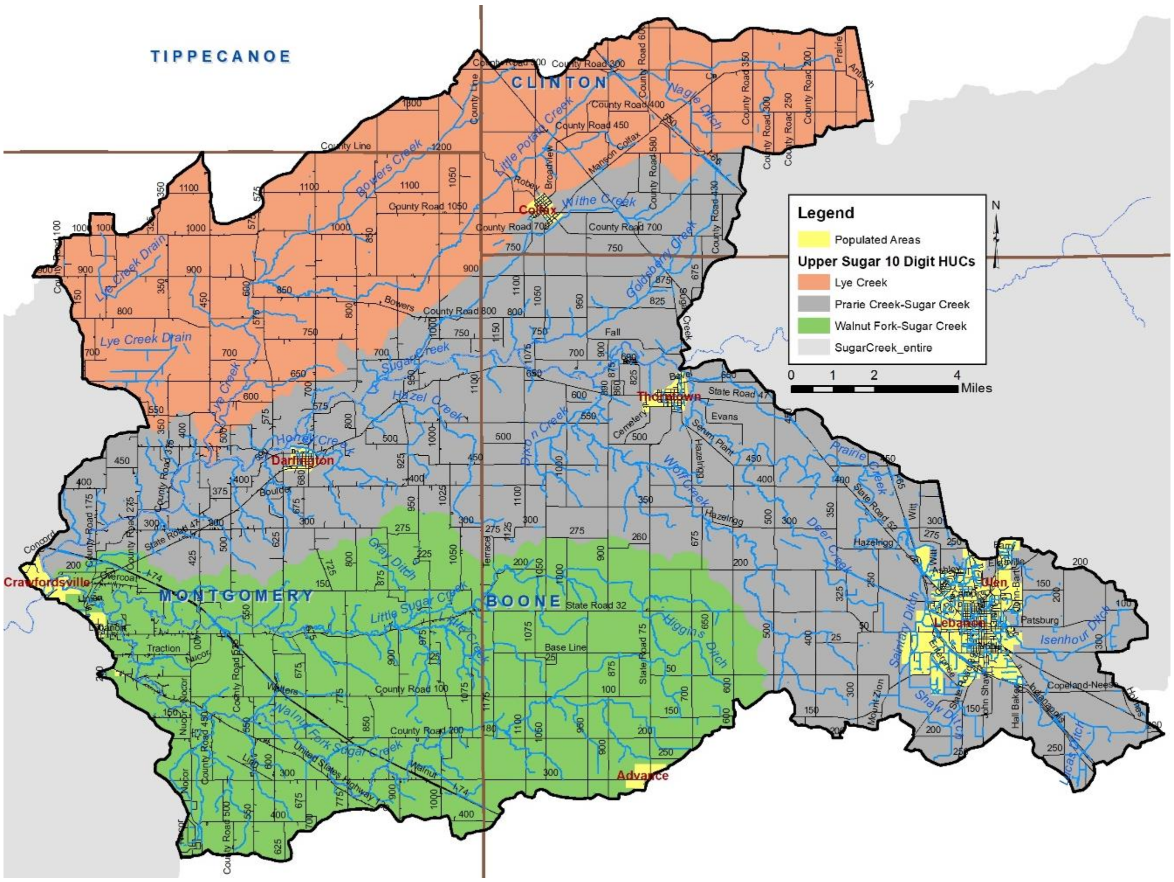

Figure 1. Upper Sugar Creek Watershed.

2. DOCUMENTATION OF COMPLETED TASKS

Task A: Produce a watershed management plan for the Upper Sugar Creek Watershed that includes all elements listed in the State's *Watershed Management Plan Checklist* (updated 2009).

The Montgomery County SWCD developed a watershed management plan in accordance with IDEM's *Watershed Management Plan Checklist Instructions, June 2009*. To begin this effort, the SWCD identified all potential partners and approached each entity about providing a representative to serve on the project's steering committee. Individuals representing the cities, towns, and counties within the watershed; environmental groups; natural resource and engineering professionals; and industrial and educational entities comprised the steering committee. In total, 17 individuals attended steering committee meetings. Meetings occurred January 19, 2022; April 26, 2022; July 12, 2022; October 25, 2022; January 24, 2023; March 21, 2023; May 23, 2023 and August 15, 2023. These individuals guided the planning effort; refined and grouped stakeholder concerns; identified draft goals; developed subcommittees to flesh out objectives and strategies for each goal; and reviewed all water quality data, loading calculations, and drafts of the watershed management plan. These individuals also served as a conduit of information about the planning effort and its future goals.

Stakeholder Concerns

Throughout the planning process, project stakeholders, the steering committee, and the general public detailed concerns for Sugar Creek, its tributaries, and the Upper Sugar Creek Watershed. Public and committee meetings formed the primary mechanism for individual concerns to be recorded; however, concerns were also gathered at other education events. The committee and public's concerns voiced throughout the process are listed in Table 1. The order of concern listing does not reflect any prioritization by watershed stakeholders.

Table 1. Stakeholder concerns identified during public input sessions and grouped for use during the planning process.

Stakeholder Concerns
Additional water inputs are changing Sugar Creek – getting straighter
Beaver impacts
Bridges are not replaced in Lye Creek Basin due to high flow – options to study flow through these systems
Change is hard – fear reduced yields
Climate change
Concerns about how this information will be used
Confined feeding operations, manure volume
County roads –build right up to them
Cover crop information is lacking
Cover crop profitability must be emphasized/detailed for farmer adoption
Cover crops - climate barrier
Dam removal at Crawfordsville opens the Upper Sugar Creek to recreation
Deer death in small streams/deer over population
Drinking water protection (Indiana American Water)/source water
E. coli levels are elevated
Economic development – Lebanon (water pollution, water usage, trash)
Education for controlled drainage – drainage water management and others that target water quantity are needed
Elevated sediment and nutrient levels
Encourage landowners to practice stewardship at their residence
Encourage local farmers to practice a good land ethic
Engaging/leveraging resources for industrial developers
Erosion – farmers are farming into ditches
Farmers are blamed even if it isn't their fault
Farmers are resistant to change
Farmland conservation and preservation needed
Fertilizer use optimization (4Rs)
Fish community is declining
Fish seining and netting
Flooding: too much water entering stream too quickly
Funding constraints
Industrial and residential development along I65/within city of Lebanon
Invasive species threats to biodiversity of both flora and fauna with an untold economic cost to forestry and tourism
Is new development in Boone County following requirements or best practices?
Issues with cover crop planting, harvest, timing

Keeping the creek healthy/ maintain quality fish community
Lack of awareness
Lebanon is growing, lack of land for agriculture, increased traffic, no room for ag equipment on roads
Livestock access
Logjams
Maintenance of regulated drains needed
Municipal sludge is applied to farm ground
Need to build a sense of community between agriculture and recreation
Need to engage agricultural landowners
On farm issue: time and interest in cover crops, but time constraint for fall harvest
Ponding sometimes occurs when farmers farm into (road) ditches
Protect and improve (terrestrial) habitat
Provide opportunities to access Sugar Creek
Recreational vehicles must be excluded from streams
River otter population impacting fish communities in farm ponds and Sugar Creek
Runoff from pesticides and soil
Septic soil limitations, straight pipes, lack of maintenance
Soil erosion and nutrient loss
Some farmers don't want to be told what they can/cannot do
Spray, drift, and volatilization issues/concerns – herbicides, others
Stream flow issues
Stream widening through erosion – shallow water
Streambank erosion
Sugar Creek provides good habitat and aesthetics – it should be protected
Threats from industry, residential development
Towns are an issue but don't get blamed
Traditional farming and traditional tillage leads to silt runoff, wind erosion, soil loss
Trash accumulation
Tree line removal impacts
Urban areas and their water quality impacts – City of Lebanon
Washouts in large rain events
Water quality is poor
Wetland loss/wetland restoration in marginal land targeting Lye/Potatoe Creek areas
What is the source of E. coli (human, animal, etc)
Wildlife corridors should connect watershed headwaters

Geographic information system (GIS) data, watershed inventories, and historic and current water quality data were used to determine the severity and validity of stakeholder concerns. Mapping efforts are detailed in the watershed management plan and are not repeated in full detail herein. It should be noted that land use within the Upper Sugar Creek Watershed is 86% row crop agriculture or pasture with nearly 5% in forested land use. Urban land uses, including urban open space and low, medium, and high intensity developed areas, account for 8% of the watershed land use. Grassland, open water, and wetlands cover the remaining 1% of the watershed. Highly erodible soils cover 52% of the watershed or 6,329 acres. Highly erodible soils are found throughout the watershed with no discernable pattern of location. All other soils are not rated as highly erodible or potentially highly erodible. Nearly 11,915 acres or 99.9% of the watershed is covered by soils that are considered very limited for use in septic tank absorption fields. Approximately 425 (0.2%) acres are somewhat limited meaning that these soils are generally suitable for septic systems. The remaining 1,623 acres (0.7%) not rated for septic usage as it is not generally industry standard to install a septic system in these geographic locations. Tile drained soils are those soils located on cultivated cropland and classified as somewhat poorly, poorly, and very poorly drained. Using GIS data for calculations, tile drained soils cover approximately 76% of the watershed.

The Upper Sugar Creek Watershed was inventoried by watershed inventory volunteers and staff in the spring of 2022. Figure 2 details locations throughout the Upper Sugar Creek Watershed where problems were identified. Much of the watershed is not visible from the road and additional assessments will be on-going; therefore, those identified in Figure 2 should not be considered exhaustive Nearly 22.3 miles of streams possessed limited buffers, nearly 84.8 miles of streambank were eroded, and livestock had access to nearly 15.8 miles of streams.

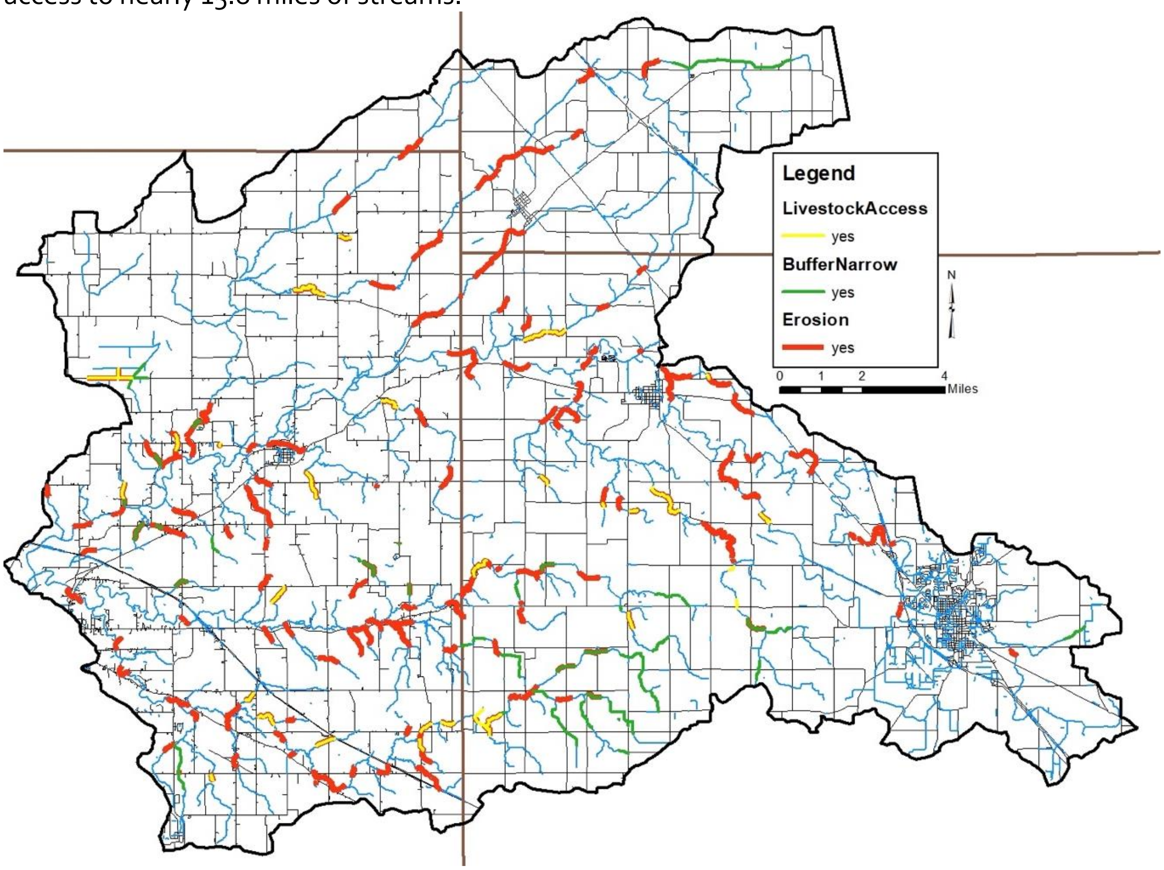

Figure 2. Stream-related watershed concerns identified during watershed inventory efforts.

Several water quality impairments were identified during the watershed inventory process, based on historic data collected from a variety of sources when these data are compared to water quality benchmarks (Table 2). The Indiana Department of Environmental Management (IDEM), Indiana Department of Natural Resources (IDNR), U.S. Geological Survey (USGS), James Gammon of DePauw University, Hoosier Riverwatch, and Arion Consultants have all completed assessments within the watershed.

Table 2. Water quality benchmarks used to assess water quality from historic and current water quality assessments.

Parameter	Water Quality Benchmark	Source
Dissolved oxygen	>4 mg/L	Indiana Administrative Code
pH	>6 or <9	Indiana Administrative Code
Temperature	Monthly standard	Indiana Administrative Code
Conductivity	<1050 mmhos/cm	Indiana Administrative Code
E. coli	<235 colonies/100 mL	Indiana Administrative Code
Nitrate-nitrogen	<1.5 mg/L	Dodds et al. (1998)
Ammonia-nitrogen	0.0 – 0.21 mg/L	Indiana Administrative Code
Total phosphorus	<0.08 mg/L	Dodds et al. (1998)
Orthophosphorus	<0.05 mg/L	Dunne and Leopold (1978)
Total suspended solids	<15 mg/L	Waters (1995)
Turbidity	<5.7 NTU	USEPA (2001)
Qualitative Habitat Evaluation Index	>51 points	IDEM (2008)
Index of Biotic Integrity	>36 points	IDEM (2008)
Macroinvertebrate Index of Biotic Integrity	>2.2 points (old) >36 points (new)	IDEM (2008)

Table 3 summarizes current samples which measured outside the target values during the current assessment. Figure 3 provides a map of current sampling sites that exceed target values. Elevated nitrate-nitrogen concentrations were observed at all sample sites with Lye Creek Drain, Little Sugar Creek, Sanitary Ditch-Prairie Creek and Deer Creek-Prairie Creek samples exceeding nitrate-nitrogen target concentrations during all sampling events. In total, 69% of collected samples throughout the watershed exceeded nitrate-nitrogen target concentrations Elevated total phosphorus concentrations were observed at all sample sites with concentrations exceeding total phosphorus targets in 70% of collected samples. Bowers Creek, Lye Creek Drain and Little Creek-Little Sugar Creek samples exceeded target total phosphorus concentrations in 80% or more of collected samples. Elevated total suspended solids concentrations were observed at all sites with 20% of all samples exceeding targets. However, no site exceeded target TSS concentrations in more than half of collected samples. Rather, TSS concentrations generally measured low then increased to concentrations higher than targets during storm flow events. *E. coli* concentrations that exceeded the state grab sample standard were measured at all sites. Exceedances were most common at Lye Creek Drain, Little Creek-Little Sugar Creek, Sanitary Ditch-Prairie Creek and Deer Creek-Prairie Creek sites. In total, 36% of samples exceeded state standards.

Table 3. Percent of samples collected in the Upper Sugar Creek Subwatershed during the 2022 sample collection which measured outside target values.

Subwatershed	DO	pH	Turb	Cond	TP	Nitrate	TSS	Ecoli
Headwaters Little Potatoe	0%	0%	42%	0%	67%	50%	25%	42%
Bowers Creek	0%	8%	33%	0%	83%	58%	17%	25%
Lye Creek Drain	0%	0%	29%	0%	86%	100%	29%	86%
Little Potatoe Creek-Lye Creek	0%	0%	33%	0%	67%	67%	17%	17%
Little Creek-Little Sugar Creek	0%	0%	50%	0%	80%	80%	20%	60%
Little Sugar Creek	0%	0%	25%	0%	67%	100%	25%	25%
Town of Linnsburg-Walnut Fork Sugar Creek	8%	0%	33%	8%	67%	83%	17%	33%
Sanitary Ditch-Prairie Creek	0%	0%	33%	50%	75%	100%	8%	58%
Deer Creek-Prairie Creek	0%	0%	25%	25%	67%	100%	25%	58%
Wolf Creek	0%	0%	17%	0%	75%	92%	17%	33%
Goldsberry Creek-Sugar Creek	0%	0%	31%	4%	78%	96%	26%	48%
Withe Creek-Sugar Creek	0%	0%	17%	0%	58%	83%	17%	25%
Hazel Creek-Sugar Creek	0%	0%	25%	0%	58%	75%	17%	25%
Town of Garfield-Sugar Creek	0%	0%	33%	0%	50%	83%	17%	42%

Only two samples exceeded dissolved oxygen state standards – both were measured in the Town of Linnsburg-Walnut Fork Sugar Creek subwatershed and measured above the high state standard. Specific conductivity exceeded targets at four sites – Town of Linnsburg-Walnut Fork Sugar Creek, Deer Creek-Prairie Creek, Goldsberry Creek-Sugar Creek and Sanitary Ditch-Prairie Creek, the latter of which exceeded conductivity targets in 50% of collected samples. pH concentrations exceeded targets at a single site (Bowers Creek) during one sampling event.

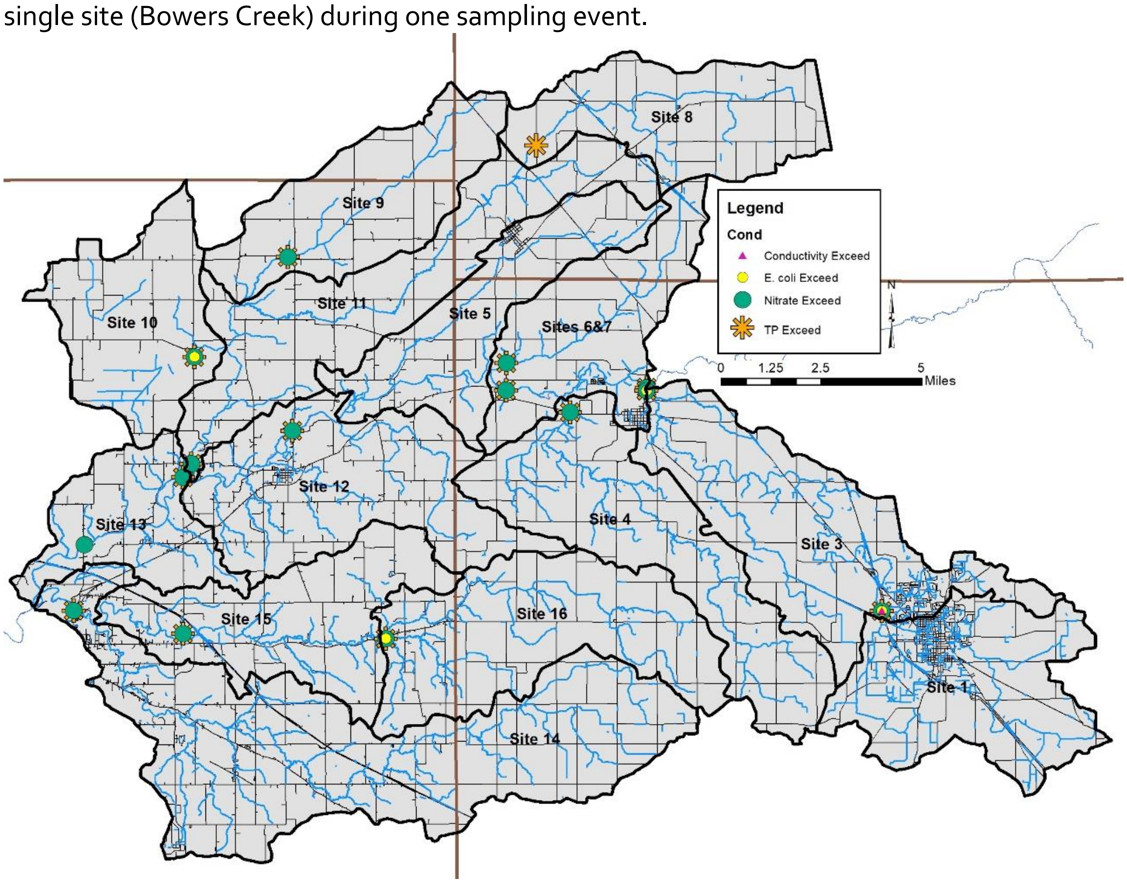

Figure 3. Upper Sugar Creek Watershed sampling sites that exceed target values during the current sampling period.

Using data collected through the watershed inventory, stakeholder concerns detailed in Table 4 were evaluated to determine their validity and consequences to the Upper Sugar Creek watershed. All of the identified concerns generated both from stakeholder input and through water quality and watershed inventory efforts are detailed in Table 4. The steering committee rated each concern as to whether it is supported by watershed-based data, what evidence does or does not support the concerns, whether the concern is quantifiable, whether it is in the scope of the watershed management plan, and if it is something on which the committee wants to focus. Nearly all concerns were quantifiable, and many were rated as being within the scope and items on which the committee wants to focus.

Table 4. Analysis of stakeholder concerns.

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Streambank erosion	Yes	86.1 miles of streambank were identified as eroding during the windshield survey. 85% of the watershed is covered by row crop or pastureland. Between 58 and 61% of corn and 50 and 63% of soybean fields use conservation tillage per the tillage transect. 58% of the watershed is covered by highly erodible lands. 30% of turbidity and 20% of TSS samples exceed targets.	Yes	No	Yes
Soil erosion and nutrient loss					
Elevated sediment and nutrient levels	Yes	20% of TSS samples, 70% of TP samples, 69% of nitrate samples, 36% of E. coli samples collected during current monitoring exceed water quality targets. 11% of E. coli samples, 71% of turbidity samples, 25% of TP samples, 76% of nitrate samples collected historically exceed water quality targets. 10.6 miles of streams are listed as impaired for nutrients and 115.2 miles of streams are listed as impaired for E. coli.	Yes	No	Yes
Water quality is poor					
Septic soil limitations, straight pipes, lack of maintenance	No data available	99% of the watershed is covered by soils which rate as very limited for septic use. Anecdotal information suggests that straight pipes and facility maintenance is an issue in the watershed.	Not really	Yes – education	Yes - education

<table>
<tr><th>Concern</th><th>Supported by our data?</th><th>Evidence</th><th>Able to Quantify?</th><th>Outside Scope?</th><th>Group wants to focus on?</th></tr>
<tr><td>E. coli levels are elevated</td><td>Yes</td><td>36% of E. coli samples collected during current monitoring exceed water quality targets.

11% of E. coli samples collected historically exceed water quality targets.

115.2 miles of stream area listed as impaired for E. coli</td><td>Yes</td><td>No</td><td>Yes</td></tr>
<tr><td>What is the source of E. coli (human, animal, etc)</td><td>No</td><td>Source water assessment has not been completed for Upper Sugar Creek.</td><td>Consider source typing once full data set is collected</td><td>Possibly</td><td>No</td></tr>
<tr><td>Stream widening through erosion – shallow water</td><td>No</td><td>86.1 miles of streambank were identified as eroding during the windshield survey.

Data on stream widening or shallowness created by widening has not been collected.</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Fertilizer use optimization (4Rs)</td><td>yes</td><td rowspan="3">NASS estimates (2005) indicates that approximately 265 tons of atrazine and 281 tons of glyphosate are applied to cropland in the Upper Sugar Creek Watershed counties annually.

IN State Chemist data indicates 148,810 tons of fertilizer were applied in 2015 (most recent data).</td><td>yes</td><td>No</td><td>Yes</td></tr>
<tr><td>Runoff from pesticides and soil</td><td>No</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>Spray, drift, and volatilization issues/concerns – herbicides, others</td><td>No</td><td>No</td><td>Yes</td><td>No</td></tr>
</table>

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<tr><td>Flooding: too much water entering stream too quickly</td><td rowspan="9">Yes</td><td rowspan="9">Floodplain covers 9,992 acres of the watershed (5%).

Tile drainage occurs on an estimated 76% of the watershed.

93% of historic wetlands in Upper Sugar Creek have been modified or lost.

25.4 miles or narrow buffer were observed during the windshield survey.

CBBEL estimated a peak 100 year discharge for Lye Creek Drain of 1790 to 13600 cfs, 0.4 increase in flood elevation, 6% increase in flooded acres (CBBEL, 2017).

There is anecdotal evidence of historic flooding in the Lye Creek, Potatoe Creek basins

No data have been collected with regards to ponding of watershed streams.

Anecdotal evidence based on communication with stakeholders.
.
The watershed approximately 200 miles of tile drains, underground pipes and artificial channels.

Maintenance data have not been collected by the group. Surveyors have data and are constantly completing maintenance.</td><td rowspan="9">Yes</td><td rowspan="9">No</td><td rowspan="9">Yes

Consult with surveyors office to coordinate maintenance and associated projects

Also, consider climate change impacts in long term impacts</td></tr>
<tr><td>Ponding sometimes occurs when farmers farm into (road) ditches</td></tr>
<tr><td>Washouts in large rain events</td></tr>
<tr><td>Erosion – farmers are farming into ditches</td></tr>
<tr><td>Climate change impacts</td></tr>
<tr><td>Additional water inputs are changing Sugar Creek – getting straighter</td></tr>
<tr><td>County roads –build right up to them</td></tr>
<tr><td>Stream flow issues</td></tr>
<tr><td>Maintenance of regulated drains needed</td></tr>
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Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Bridges are not replaced in Lye Creek Basin due to high flow – options to study flow through these systems	N/A	Anecdotal evidence based on communication with stakeholders.	Yes	Yes	No
Protect and improve (terrestrial) habitat	Yes	Central Till Plain Flatwoods, Wet-mesic Floodplain forest, mesic prairie and Circumneutral Seep rate as high-quality natural communities. Cool Creek PF 3000 acres of habitat restoration.	Yes	No	Yes
Sugar Creek provides good habitat and aesthetics – it should be protected	Yes	Stream health assessments (QHEI) occurred 37 times historically. 86% of assessments indicate stream reaches meet their aquatic life use designation. Fish communities assessed at all but one site during the current project meet their aquatic life use designation. QHEI assessments should be used to assess individual sites and rate potential for improving instream habitat.	Yes	No	Yes
Keeping the creek healthy/ maintain quality fish community	Yes	The fish community was assessed by IDEM, DNR 15 times historically. 93% of assessments indicate that the fish community meets their aquatic life use designation. 38% of sites assessed do not meet state habitat quality targets. Fish communities assessed at all but one site during the current project meet their aquatic life use designation.	Yes	No	Yes
Fish community is declining	No	Historic and current Sugar Creek fish community assessments do not document a decline in fish community quality.	Not at this time	yes	No

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Drinking water protection (Indiana American Water)/source water	Yes	10 wellhead protection areas are present in the watershed, protecting drinking water for 35,770 people.	Yes	No	Yes
Recreational vehicles must be excluded from streams	No	While the impacts of recreational vehicles is well documented, areas of access and watershed impacts from rec vehicles has not been documented.	No	Yes	No
Provide opportunities to access Sugar Creek	Yes	The DNR & Darlington Parks (public), Sugar Creek campground (CR 175, private) provide access.	Yes	No	No – access is adequate; Yes- education
Urban areas and their water quality impacts – City of Lebanon Towns are an issue but don't get blamed Economic development – Lebanon (water pollution, water usage, trash) Lebanon is growing, lack of land for agriculture, increased traffic, no room for ag equipment on roads Threats from industry, residential development Engaging/leveraging resources for industrial developers Industrial and residential development along I65/within city of Lebanon Is new development in Boone County following requirements or best practices?	Yes	Urban land uses cover approximately 14,188.7 acres or nearly 8% of the watershed. A majority of the urban land is located in the City of Lebanon. Lebanon adopted a comprehensive plan and addended it to include a thoroughfare plan in 2017. These plans guide development along the interstate. Stormwater impacts in Lebanon are governed by the Lebanon MS4 which requires documented stormwater improvements for development impacts. Developments are required to follow the Lebanon stormwater technical standards.	Yes	No	Yes
Need to engage agricultural landowners	Yes	85% of the watershed is covered by row crop or pastureland. To positively impact the watershed, agricultural producer and landowner engagement is necessary.	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Some farmers don't want to be told what they can/cannot do	Yes	Anecdotal evidence based on communication with stakeholders.	Yes	No	Yes
Farmers are resistant to change	Yes		Yes	No	Yes
Change is hard – fear reduced yields	Not at this time	Anecdotal evidence based on communication with stakeholders.	No, survey may provide data	No	Yes
Traditional farming and traditional tillage leads to silt runoff, wind erosion, soil loss	Yes	85% of the watershed is covered by row crop or pastureland. Tillage transect data indicates 58-63% of corn and 50-61% of soybean fields utilize conservation tillage in Upper Sugar Creek counties. Traditional farming tends to leach the land of its nutrition over time resulting in soil that is undernourished and eroded.	Yes	No	Yes
Farmers are blamed even if it isn't their fault	No	Anecdotal evidence based on communication with stakeholders.	No	Yes	No
Farmland conservation and preservation needed	Yes	The most recently available NASS data (2017) notes a 2% loss of land in farms in Montgomery County, a 4%, 1% and 11% increase in Boone, Tippecanoe and Clinton Counties respectively from 2012 to 2017.	Yes	Yes	No
On farm issue: time and interest in cover crops, but time constraint for fall harvest	Yes	Research documents the top barriers to cover crop use: establishment; time and labor required to manage cover crops and seeding the right species for my operation. Farmers' motivations to plant cover crops are directly related to their perceived benefits of increased soil health, increased organic matter and reduced soil erosion	Yes	No	Yes
Cover crop profitability must be emphasized/detailed for farmer adoption					
Cover crops - climate barrier					
Cover crop information is lacking					
Issues with cover crop planting, harvest, timing					

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Need to build a sense of community between agriculture and recreation Encourage farmer to practice stewardship	No	The committee deemed this a magical unicorn – the ultimate goal for which everyone should be working.	No	No	Yes
Wetland loss/wetland restoration in marginal land targeting Lye/Potatoe Creek areas	Yes	Wetlands cover 5,613 acres (8%) of the watershed. It is estimated that 93% of wetlands have been modified or lost over time.	Yes	No	Yes
Trash accumulation	No	Individual observations during the watershed inventory indicate trash accumulation is a problem.	No	No	Yes – education
Logjams	Yes	Logjams were identified during the windshield inventory. Anecdotal information documents the presence of logjams.	No	No	Yes
Beaver impacts	No	Anecdotal information documents the impacts of beavers in the watershed. No data have been collected on their impacts.	No	No	No
Encourage local residents to have a good land ethic	No	Anecdotal evidence based on communication with stakeholders.	No	No	Yes - education
Tree line removal impacts Wildlife corridors should connect watershed headwaters	No	6% of the watershed is forested. Historically 42% of the watershed was mapped in forest land.	No	No	Yes
Lack of awareness	Yes	Anecdotal evidence based on communication with stakeholders.	No	No	Yes
Education for controlled drainage/drainage water management that target water quantity are needed	Yes		No	No	Yes
Dam removal at Crawfordsville opens the Upper Sugar Creek to recreation	Yes	Dam removal occurred downstream of the Upper Sugar Creek Watershed. It's removal is likely to impact recreation on Sugar Creek but it is likely too soon to know what those impacts will be.	Yes	Yes	No
Funding constraints	Yes	Anecdotal evidence based on communication with stakeholders.	Yes	No	Yes

Concern	Supported by our data?	Evidence	Able to Quantify?	Outside Scope?	Group wants to focus on?
Concerns about how this information will be used	Yes	Anecdotal evidence based on communication with stakeholders.	Not really	No	Yes - education
Livestock access	Yes	Livestock have access to approximately 16 miles of watershed streams. Additional access is likely present but was not observed during the windshield survey.	Yes	No	Yes
Confined feeding operations, manure volume	Yes	119,000 animals are permitted on CFOs in the watershed producing more than 45,200 tons of manure annually.	Yes	No	Yes
Municipal sludge is applied to farm ground	Yes	Municipal sludge is applied to 5325 acres of row crop agriculture in the watershed.	Yes	No	Yes
Invasive species threats to biodiversity of both flora and fauna with an untold economic cost to forestry and tourism	Yes	Several invasive species were observed in riparian areas during the windshield survey; however, specific species list and presence/absence surveys have not been complete.	Yes	No	Yes-education
River otter populations negatively impact farm pond and Sugar Creek fish populations	Yes, anecdotal	River otter reintroduction occurred 1995-1999 and otters were removed from the state endangered species list in 2005. DNR notes that damage to farm ponds is common and suggestions using a licensed trapper to relocate nuisance otters.	Not really	Yes	No

Figure 4 details the critical areas prioritized by the Upper Sugar Creek steering committee To identify the highest priority subwatersheds, the steering committee decided to divide them into three tiers (high, medium and low priority), based on the number of parameters that were determined to be critical. The highest priority subwatersheds are those that were determined to be critical for three or more parameters of the four potential parameters (nutrients, sediment, *E. coli*, flooding). The medium priority subwatersheds are those that were determined to be critical for two of four potential parameters. The lowest priority subwatersheds were critical for one of four potential parameters.

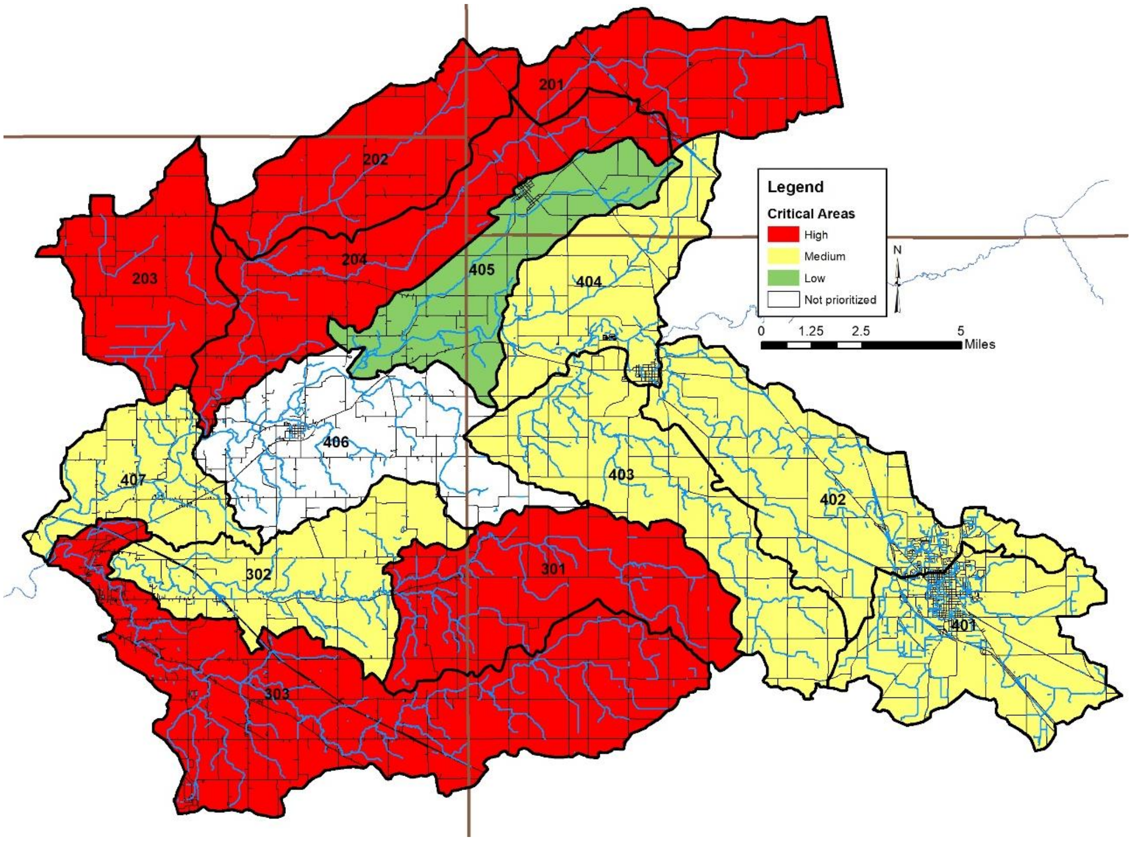

Figure 4. Critical areas in the Upper Sugar Creek Watershed.

One subwatershed, Hazel Creek-Sugar Creek was not prioritized as critical meaning it was not identified as an area of highest concern for any of the four parameters (nutrients, sediment, pathogen, flooding). Implementation efforts will target high priority critical areas first, followed by medium priority then low priority areas. It is anticipated that implementation efforts will be targeted in medium and low priority subwatersheds as part of EPA-funded implementation efforts only after implementation efforts are exhausted in higher priority areas. Implementation via other funding sources, via landowner interest in NRCS-based federal funding programs will occur as landowners are interested. The Upper Sugar Creek stakeholder group will continue volunteer monitoring efforts to continue to assess the quality of these subwatersheds and identify any changes in water quality as they occur.

Reduce Nutrient Loading

Based on collected water quality data for the Upper Sugar Creek Watershed, the committee set the following long-term goals: Reduce nitrate-nitrogen loading from 3,314,191 lb/year to 514,580 lb/year (84%) by 2053 and reduce total phosphorus loading from 1,214,352 lb/year to 41,166 lb/ year (97%) by 2053 (Table 5 and Table 6).

High priority goal: Reduce total phosphorus inputs from 1,214,352 pounds per year to 823,291 pounds per year (32% reduction) and nitrate-nitrogen from 3,314,191 pounds per year to 2,380,988 pounds per year (28% reduction) in Upper Sugar Creek in 10 years (2033).

Medium priority goal: Reduce total phosphorus inputs from 823,291 pounds per year to 432,228 pounds per year (47% reduction) and nitrate-nitrogen from 2,380,988pounds per year to 1,447,783 pounds per year (39% reduction) in Upper Sugar Creek in 10 years (2043).

Low priority goal: Reduce total phosphorus inputs from 432,228 pounds per year to 41,166 pounds per year (90% reduction) and nitrate-nitrogen from 1,447,783 pounds per year to 514,580 pounds per year (64% reduction) in Upper Sugar Creek in 10 years (2053).

Table 5. Nitrate-nitrogen short, medium, and long-term goal calculations for prioritized critical areas in Upper Sugar Creek.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
High Priority (10 years)	3,314,190.9	933,203.8	2,380,987.2	28%
Medium Priority (20 years)	2,380,987.2	933,203.8	1,447,783.4	39%
Low Priority (30 years)	1,447,783.4	933,203.8	514,579.6	64%

Table 6. Total phosphorus short, medium, and long-term goal calculations for prioritized critical areas in Upper Sugar Creek.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
High Priority (10 years)	1,214,352.5	391,062.0	823,290.5	32%
Medium Priority (20 years)	823,290.5	391,062.0	432,228.4	47%
Low Priority (30 years)	432,228.4	391,062.0	41,166.4	90%

Reduce Sediment Loading

Based on collected water quality data for the Upper Sugar Creek Watershed, the committee set the following long-term goal: reduce total suspended solids loading from 160,733,493 lb/year to 7,718,695 lb/year (95%) by 2053 (Table 7).

High priority goal: Reduce total suspended solids inputs from 160,733,493 pounds per year to 109,728,561 pounds per year (32% reduction) in Upper Sugar Creek in 10 years (2033).

Medium priority goal: Reduce total suspended solids inputs from 109,728,561 pounds per year to 58,723,628 pounds per year (46% reduction) in Upper Sugar Creek in 10 years (2043).

Low priority goal: Reduce total suspended solids inputs from 58,723,628 pounds per year to 7,718,695 pounds per year (87% reduction) in Upper Sugar Creek in 10 years (2053).

Table 7. Total suspended solids short, medium, and long-term goal calculations for prioritized critical areas in Upper Sugar Creek.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
High Priority (10 years)	160,733,493.5	51,004,932.9	109,728,560.6	32%
Medium Priority (20 years)	109,728,560.6	51,004,932.9	58,723,627.6	46%
Low Priority (30 years)	58,723,627.6	51,004,932.9	7,718,694.7	87%

Reduce *E. coli* Loading

Based on collected water quality data for the Upper Sugar Creek Watershed, the committee set the following long-term goal: reduce E. coli loading from 5.79E+15 to 5.49E+14 (90%) by 2053 (Table 8).

High priority goal: Reduce total suspended solids inputs from 5.79E+15 colonies per year to 4.04E+15 colonies per year (30% reduction) in Upper Sugar Creek in 10 years (2033).

Medium priority goal: Reduce total suspended solids inputs from 4.04E+15 colonies per year to 2.30+15 colonies per year (43% reduction) in Upper Sugar Creek in 10 years (2043).

Low priority goal: Reduce total suspended solids inputs from 2.30+15 colonies per year to 5.49+14 colonies per year (76% reduction) in Upper Sugar Creek in 10 years (2053).

Table 8. E. coli short, medium, and long-term goal calculations for prioritized critical areas in Upper Sugar Creek.

Goal Timeframe	Current Load (lb/yr)	Load Reduction (lb/yr)	Target Load (lb/yr)	Percent Reduction
High Priority (10 years)	5.79E+15	1.75E+15	4.04E+15	30%
Medium Priority (20 years)	4.04E+15	1.75E+15	2.30E+15	43%
Low Priority (30 years)	2.30E+15	1.75E+15	5.49E+14	76%

Reduce Flooding Impacts

Long term: Reduce flooding impacts by increasing storage and infiltration across the watershed by 2053. Baseline in 2023 - Wetland acreage (NWI): 5,612 acres; floodplain land cover acreage: 9,992.5 acres; and coverage of poorly drained and very poorly drained soils: 74,609 acres.

Habitat Impacts

Long term: Natural habitat (grasslands, forest, wetlands) will increase by a total of 5% with a focus on improving habitat connectivity across the Upper Sugar Creek watershed by 2053.

Increase Public Awareness, Education and Funding

Long term: By 2053, 50% of property owners and producers will be informed about practices that can be implemented to positively impact Upper Sugar Creek and no less than 30% of individuals living and farming in the watershed will be engaged in the project within 30 years. These efforts will be guided by a well-funded, robust, cohesive watershed group.

Task B: Conduct a monitoring program to assist in the development of the Upper Sugar Creek Watershed Management Plan.

The Upper Sugar Creek Watershed Project implemented a one-year water quality monitoring program. The program included monthly water chemistry sample collection and one fish community, macroinvertebrate community and habitat assessment. The program is detailed below and in the Quality Assurance Project Plan for the Upper Sugar Creek Watershed Management Plan approved on January 7, 2022. Sites sampled through this program are displayed in Figure 5. Sample sites were selected based on watershed drainage and correspond with sites sampled by IDEM in the past. The monthly sampling regimen was enacted to create a baseline of water quality data.

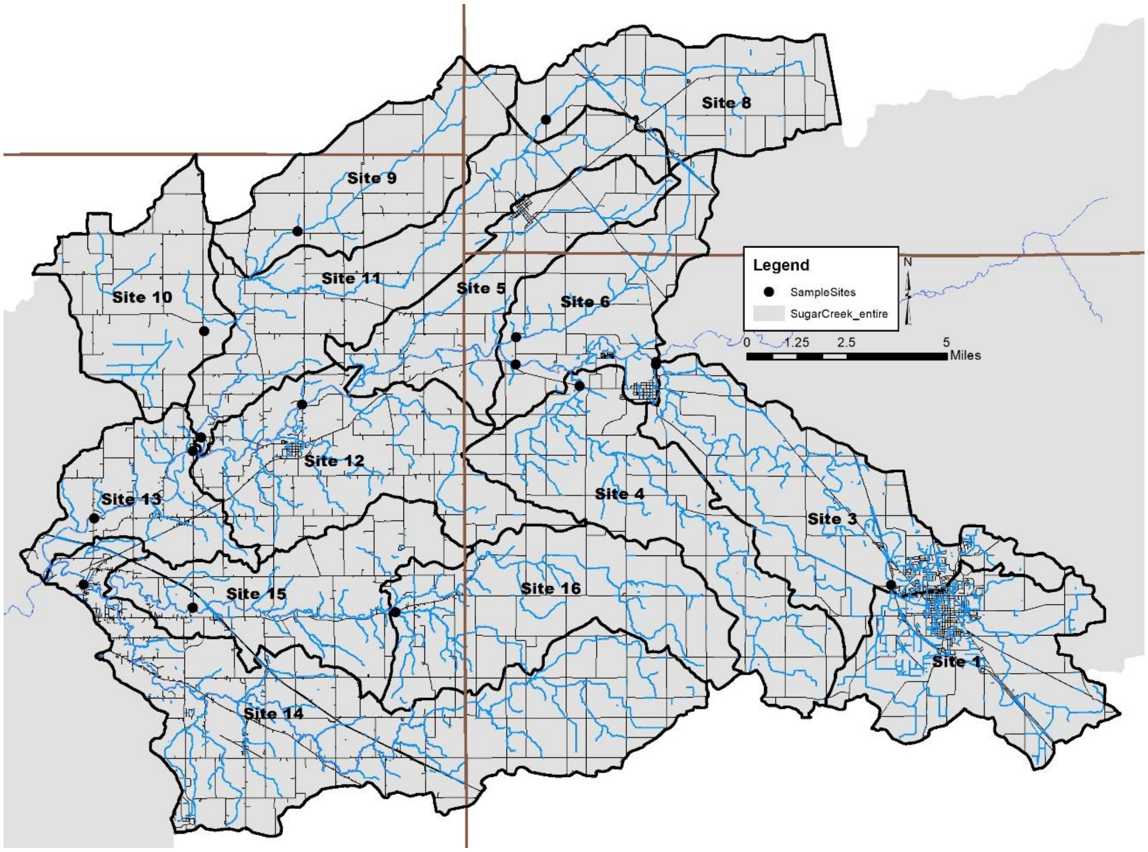

Figure 5. Sites sampled as part of the Upper Sugar Creek Watershed Management Plan. The gray area displays the Sugar Creek drainage upstream and downstream of the current planning area.

Stream Flow

Stream flow was calculated by scaling stream flow measured at the U.S. Geological Survey (USGS) stream gages to subwatershed drainage area during high flow events. The Sugar Creek USGS gage at Crawfordsville (USGS 03339500) was used to scale flow for the outlet of Sugar Creek, while the Prairie Creek at Lebanon (USGS 03339280) was used for tributary stream sites.

Field and Laboratory Chemistry Parameters

The Upper Sugar Creek Watershed Project established sixteen chemistry monitoring stations as part of the monitoring program. Dissolved oxygen, temperature, pH, turbidity, conductivity, nitrate-nitrogen, total phosphorus, E. coli and total suspended solids were measured monthly at the sampling stations. Sampling occurred from January 2022 through December 2022. Appendix 1 details the parameters measured. Site 10 was either dry or frozen from August to December 2022.

Biological Community and Habitat

The physical habitat at each of the 16 sample sites was evaluated using the Qualitative Habitat Evaluation Index (QHEI). The Ohio EPA developed the QHEI for streams and rivers in Ohio (Rankin, 1989, 1995) and the IDEM adapted the QHEI for use in Indiana. Macroinvertebrate and fish communities were assessed using the Index of Biotic Integrity (IBI) with all 16 sites assessed from July to August 2022.

Field Chemistry Results

Temperatures measure approximately the same at each of the stream sites with seasonal changes in temperature creating major differences in temperature throughout the sampling period. Temperatures measured between -2.7 to 26.4 °C in all streams. The highest temperatures occurred during the June, July, and August assessments depending on riparian cover and stream depth present at each location. Dissolved oxygen concentrations also display seasonal changes like those observed for temperature. All streams display variation in dissolved oxygen concentration due to individual conditions present within each system. The lowest dissolved oxygen concentrations occurred at Site 14 during July 2022. . In total, 1.1% of samples (2 of 184 samples) measured above or below the lower and higher dissolved oxygen state standard (4 m/g/L and 12 m/g/L). Throughout the sampling period, pH generally remained in an acceptable range in all watershed streams. No discernible pattern can be found in pH levels in any of the monitored streams and all samples measured with state standards. Conductivity measurements varied greatly over the sampling period. Conductivity exceeded state standard (1050 mg/L) during several sampling events. In total, 11 out 184 samples (6%) exceeded the conductivity target. Exceedances occurred at Site 1 (six events), Site 3 (three events), Site 7 (one event) and Site 14 (one event) Conductivity did not exceed state standards at any other sites. Sites that exceed state standards peak between fall and early winter.

Nutrient concentrations were elevated in collected samples with 70% of total phosphorus and 68% of nitrate-nitrogen samples exceeding target concentrations. The highest average concentrations occurred at Sites 1, 3, 6 and 15. Concentrations measured throughout the watershed measured in excess of the level at which total phosphorus concentrations impair biological communities (0.08 mg/L) with exceedances under all flow conditions. All sites possess average total phosphorus concentrations in excess of the level at which biological impairments occur (0.08 mg/L). Nitrate-nitrogen concentrations measured the highest during the spring, falling throughout the summer and increasing again in the fall. Sites 1, 3, 6, 10 and 15 nitrate-nitrogen loading rates measured above target levels around 90% of the time. This suggests that a steady stream of nitrate-nitrogen is available within these subwatersheds.

Total phosphorus concentrations exceed target concentrations in 70% of samples. Site 7 had the highest total phosphorus average (0.90 mg/L) while Site 16 had the lowest with an average of 0.23 mg/L. Concentrations measured throughout the watershed measured in excess of the level at which total phosphorus concentrations impair biological communities (0.08 mg/L) with exceedances under all flow conditions. In total, 13 out of 16 sites peaked in the month of March with the remaining sites peaking in a summer month.

Total suspended solids (TSS) levels measured above target levels (15 mg/L) during high flow events with 20% of samples exceeding target concentrations (36 of 184 samples). Most sites (15 of 16 sites) possessed the highest TSS concentrations in February or March. Site 8's highest TSS measurement occurred in August. Site 13 contained the highest average concentrations measuring 30.0 mg/L.

E. coli concentrations observed at Upper Sugar Creek Watershed sites are shown in **Error! Reference source not found.**. *E. coli* concentrations exceed state standards in 36% of collected samples (66 of 184 samples). All sites except Site 9 and Site 11 possessed average *E. coli* concentrations in excess of state standards (235 col/100 mL). *E. coli* exceedances at several sites appear to coincide with both high and low flow conditions. Site 1, Site 3 and Site 16 exceeded state standards almost half (43%) of the time samples were collected. Most exceedances occurred between late spring and fall.

Biological Community Results
Overall, macroinvertebrate community quality was good in the Upper Sugar Creek Watershed with 13 of 16 sites rating as not impaired. Sanitary Ditch-Prairie Creek (Site 1) and Browns Wonder-Sugar Creek (Site 2) supported the most diverse community with 28 and 32 taxa observed, respectively. Browns Wonder-Sugar Creek (Site 2) possessed the greatest mIBI score (44), while Sanitary Ditch-Prairie Creek (Site 1) and Little Sugar Creek (Site 15) possessed the second highest scores (42). It is important to note, however, that Sites 1 and 2 contained more tolerant species than intolerant species. Sanitary Ditch-Prairie Creek (Site 1) had only 2% of taxa identified as intolerant species, while 22% were tolerant species. Similarly, Browns Wonder-Sugar Creek (Site 2) had 6% of taxa identifies as intolerant species with 40% identified as tolerant species. Site 5 (Withe Creek-Sugar Creek) contained the highest percentage of intolerant species (14%) with only 1% of tolerant species observed. However, Site 5 had the second lowest mIBI rating with a score of 34 suggesting it is an impaired stream. Site 9 (Bowers Creek) had the worst mIBI score of the sixteen sites sampled, with a score of 28. Bowers Creek supported the least diverse communities with 14 taxa observed. Further, Bowers Creek had the highest percent tolerant species (87%) present and the lowest percent of observed intolerant species (0%). It also had one of the lowest numbers of the sensitive EPT taxa observed with only two individuals collected. Site 10 (Lye Creek Drain) also only had two individuals of the EPT taxa collected.

Habitat Assessment: Stream water quality and available habitat influence the quality of a biological community in a stream, and it is necessary to assess both factors when reviewing biological data. Site 5 (Withe Creek-Sugar Creek), Site 7 (Goldsberry Creek-Sugar Creek) and Site 14 (Town of Linnsburg-Walnut Fork Sugar Creek) rated as excellent, while Site 11 (Little Potatoe Creek-Lye Creek), Site 12 (Hazel Creek-Sugar Creek) and Site 15 (Little Sugar Creek) rated as good. For these sites, pool/riffle development scores, stream substrate, instream cover, and gradient were relatively good for Indiana streams contributing to overall high quality QHEI scores. Site 2 (Browns Wonder), Site 3 (Deer Creek-Prairie Creek), Site 4 (Wolf Creek), Site 6 (Goldsberry Creek-Sugar Creek), Site 13 (Town of Garfield-Sugar Creek) and Site 16 (Little Creek-Little Sugar Creek) rated as fair. Site 1 (Sanitary Ditch-Prairie Creek), Site 8 (Headwaters Little Potatoe) and Site 10 (Lye Creek Drain) rated poor while Site 9 (Bowers Creek) rated very poor. The lowest scores occurred at sites which possessed poor substrate, poor instream cover, limited riparian quality and lacked pool/riffle complexes.

Task C: Conduct an education and outreach program designed to bring about behavioral changes that will lead to reduced nonpoint source pollution in the watershed.
The Montgomery County SWCD developed an education program based on a combination of required grant-based elements and the needs and wants of community partners. Public participation is necessary for the long-term success of any watershed planning and subsequent implementation effort. Several events occurred throughout the watershed with the goal of engaging the public and obtaining their opinion on the Upper Sugar Creek Watershed. These included two public meetings to launch and close the project as well as farmer and recreation focused listening sessions. In addition to public meetings, educational outreach, workshops, field days, and educational events, a social indicator survey was conducted and mailed to 472 agricultural producers. With this in mind, the Montgomery County SWCD mixed hands-on, field activities with static, traditional information sources to provide a balanced education and outreach program to watershed stakeholders and conducted a social indicator survey to measure the progress of previous education and outreach efforts to urban and agricultural residents.

Educational Materials: Education and outreach materials were developed throughout the planning process. Newsletters, press releases, partner emails and social media occurred quarterly throughout much of the project. These include monthly newsletter articles and press releases which the Montgomery

SWCD published in their newsletters and an educational brochure highlighting that project that was also produced in February of 2022. The Montgomery County SWCD Facebook page and website were used to post meeting information, educational materials and updated with details about the watershed management planning process. In total, more than 122 social media posts targeted Upper Sugar Creek Watershed project information and events, promoted best management practices and informed about on-going events. The website was updated more than 35 times during the project. The project steering committee met a total of eight times: January 19, 2022; April 26, 2022; July 12, 2022; October 25, 2022; January 24, 2023; March 21, 2023; May 23, 2023 and August 15, 2023. Representative highlights of educational materials are included in Appendix 2.

Public Meetings and Listening Sessions: Public participation is necessary for the long-term success of any watershed planning and subsequent implementation effort. One component of public participation for this project was public meetings and listening sessions. The public meetings occurred in March 16, 2022, and July 31, 2023. They were used to introduce the project, develop a concerns list and allow individuals to provide their thoughts on potential projects that will be targeted in future implementation efforts. The public meetings were advertised through press releases distributed to local newspapers in the watershed and via postcards and emails sent to local landowners and conservation partners. The meetings were also advertised through word of mouth as staff from the Soil and Water Conservation District put together mailings that advertised the events and distributed information via their website and social media pages as well as through their email distribution list.

The first public meeting occurred on March 16, 2022 and was hosted in part by the Wabash College Democracy and Public Discourse. The farmer listening session occurred on August 15, 2022 and the recreation listening session occurred on January 24, 2023. Concerns and other input gathered as part of the three events are included in the subsequent sections.

The second public meeting occurred July 31, 2023 and was hosted in part by the Friends of Sugar Creek. The meeting included an overview of the project and included an update on the status of the project and focused on gathering feedback on critical areas, practices selected for implementation and the likelihood of meeting project goals gathered.

Two listening sessions occurred targeting producers across the watershed (August 15, 2022) and recreational users (January 24, 2023) of Sugar Creek. Both events targeted information gathering for strengths, weaknesses, opportunities and threats related to each target audience.

Social Indicator Survey

Social indicator surveys provide one way to analyze these attitudes, awareness, behavior, and constraint measures. The data obtained provide a snapshot of a given time, helping to direct outreach efforts, and allowing for measurement of temporal change observed during future assessments. The Upper Sugar Creek project tailored an existing survey system that was originally developed for use in nonpoint source pollution projects by a regional team of researchers.

A standardized delivery and collection method was used. In February 2023, a five-wave mail survey was utilized to collect the data (Dillman, 2000). An advance notice letter was sent to potential respondents to inform them of the survey's purpose and to notify them that they would be receiving a paper survey in the next week. This letter also included instructions on how to complete the survey online. The paper survey was sent the following week and included verbiage similar to the original advance letter, instructions for completing the survey online, and a summary of the survey's purpose. A postcard reminder was sent two weeks later, followed by a replacement survey two weeks following the postcard. After two more weeks, a final letter was sent to all non-respondents with instructions on how to complete the survey online.

The survey covered the social indicators developed for use in 319-funded watershed projects. The indicators are grouped into four categories: awareness, attitudes, constraints, and behaviors. Socio-demographic information was also collected. Appendix 3 includes the social indicator survey and survey final report.

Survey Summary
Most Upper Sugar Creek Watershed survey respondents, primarily agricultural landowners and producers, believe that good water quality is important for the communities that they live in for both economic and quality-of-life reasons. Most individuals feel a degree of personal responsibility for the actions they take that affect local water resources, though they may be unwilling to pay for improvements. It is clear that Upper Sugar Creek Watershed producers frequently feel that they must compromise between desired environmental outcomes and their financial concerns.

In general, survey respondents readily identified visible water quality concerns such as littering and turbidity. Other problems, especially those related to nutrient loading and aquatic habitat alteration, garnered less awareness amongst respondents. Education and outreach efforts are needed across the board in order to effectively change management behaviors. Particularly successful campaigns may target those who have never heard of or are only slightly familiar with a given best management practice. Respondents frequently identified financial factors as the primary constraint to adopting conservation practices.

Hands-on Educational Activities:
Press releases promoting local events, soil health and tillage workshops farmer float trips, public meetings and more occurred throughout the project. A series of field days, workshops and events occurred as follows:

- February 19, 2022: Boone SWCD annual meeting
- February 23, 2022: Tippecanoe SWCD annual meeting
- March 1, 2022: Clinton SWCD annual meeting
- March 8, 2022: Montgomery SWCD annual meeting
- April 30, 2022: River clean up
- June 21, 2022: Hoosier Riverwatch training
- July 23, 2022: Farmer float trip
- September 17, 2022: Street clean up
- October 19, 2022: Women for the Land
- June 4, 2022: Farm tour
- October 5, 2022: Forestry field day
- July 25, 2023: Farmer float trip
- July 29, 2023: Garden walk

3. EVALUATION OF SUCCESS IN MEETING PROJECT GOALS

Project Outcome I: Develop the Upper Sugar Creek Watershed Management Plan meeting IDEM's watershed management plan checklist. The Upper Sugar Creek Watershed Project met the administrative, environmental and social outcomes as follows:

- The Upper Sugar Creek Watershed Management Plan was developed through the support of a 36-member steering committee.
- The committee represents a variety of watershed stakeholders whose participation was key in the plan's development and integral in its implementation.
- IDEM and EPA approved the Upper Sugar Creek Watershed Management Plan in October 2023.

Project Outcome II: Complete baseline water quality monitoring. The Upper Sugar Creek Watershed Project met the administrative, environmental and social outcomes as follows:

- Dissolved oxygen, temperature, pH, turbidity, conductivity, nitrate-nitrogen, total phosphorus, E. coli and total suspended solids were measured monthly at the sampling stations. Sampling occurred from January 2022 through December 2022.
- Macroinvertebrate and fish communities were assessed at all 16 sample sites from July to August 2022.
- All data collection occurred as detailed in the approved QAPP and all data met required QA/QC protocols.
- A watershed inventory was completed in the spring of 2022.

Project Outcome III: Increase engagement with the Upper Sugar Creek, its water quality and how individual actions impact water quality. The Upper Sugar Creek Watershed Project met the administrative, environmental and social outcomes as follows:

- A targeted education program was implemented from 2022 through 2023 including workshops, field days, local meetings, farmer float trips, hosting public meetings and more.
- The Upper Sugar Creek Watershed Program released press releases and newsletters throughout the project.
- More than 300 individuals engaged with the project throughout 2022 and 2023 with more than 150 individuals attending public meetings or listening sessions.

4. PARTNERSHIPS

The Montgomery County SWCD maintained several partnerships as part of the planning and implementation process. Relationships with Pheasants Forever, the county Health Department, The Nature Conservancy, Wabash College, each of the counties' Purdue Extension office, Surveyors, SWCD and NRCS staff, and local farmers were also cultivated. These relationships will continue to serve us well in the future. Many of these entities served on our steering or technical committees and provided volunteers for key activities occurring as part of our effort. Their volunteers, time, and commitment to improving the Upper Sugar Creek Watershed is invaluable. These relationships will be key in future activities occurring during cost-share program development and implementation. We anticipate using each of the partners described above to successfully implement our cost-share and education programs in the future.

5. LESSONS LEARNED: SUCCESSES AND FAILURES

Lesson 1: Watershed management is all about the people! Their interest is fickle – meaning you can catch it with one activity or event but may not hold it for long. Using that interest to its fullest ability is necessary to successfully engage individuals long-term. Thankfully, many of our partnerships enabled us to capitalize on relationships already in place throughout the watershed and build on these during the implementation phase.

Lesson 2: Partnerships are required for long-term success and development of these partnerships takes time. Each partner has something they can offer to the planning and education process and finding that niche is important for both short and long-term successes in managing water quality in the Upper Sugar Creek. Likewise, we have something that we can offer each partner – finding that connection is a necessary part of each partnership.

Lesson 3: Volunteers make or break a project. Our successes during this project really hinge on volunteer input of both knowledge and time. Without their efforts, our plan would be just that – ours. Through their participation, volunteers gained interest in the Upper Sugar Creek, its tributaries, and its watershed, pride in their accomplishments, and a sense of ownership of the plan, event, booth space, or water quality samples. Their awe and excitement will drive the success of this project into the future.

FUTURE ACTIVITIES

The next steps for the project include starting implementation of the Upper Sugar Creek Watershed Management Plan. The Montgomery County SWCD in partnership with the project steering committee and other regional partners will consider options for submitting implementation-focused grant applications for IDEM Section 319 funds, Mississippi River Basin Initiative Funds, DNR LARE, Clean Water Indiana and other funds. If funded, these grants would provide funds for a cost-share program to install BMPs, promotion of the cost-share program, and an education and outreach program. If the grant is awarded, the steering committee will develop a cost-share program that will include steps to meeting the goals and management strategies of this plan. The anticipated cost-share program will use a ranking system to fund applications that will have the most impact in improving water quality. Factors such as location within watershed (priority areas), distance from streams, number of resource concerns addressed, and number of practices planned will be considered as part of the ranking process to further prioritize BMPs. It is anticipated that implementation efforts will target high priority critical areas and focus on the implementation of short-term goals.