VFC Index - Watershed (Plan)

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Document Date: 9/18/2009

Security Group: Public

Project Name: Sugar Creek Watershed Management Plan

Plan Type: Watershed Management Plan

HUC Code: 05120204 Driftwood

Sponsor: Hancock County SWCD

Contract #: 7-81

County: Hancock

Cross Reference ID: 15782523

Comments: Henry, Madison, Shelby

Additional WMP Information

Checklist: 2003 Checklist

Grant type: 319

Fiscal Year: 2006

IDEM Approval Date: 9/18/2009

EPA Approval Date:

Project Manager: Leanne Whitesell

Sugar Creek Watershed Management Plan

6/30/09

Hancock, Henry, Madison, and Shelby Counties, Indiana

PREPARED BY:
V3 COMPANIES

PREPARED FOR:
HANCOCK COUNTY
SOIL AND WATER CONSERVATION DISTRICT

TABLE OF CONTENTS

Sugar Creek Watershed Plan

EXECUTIVE SUMMARY

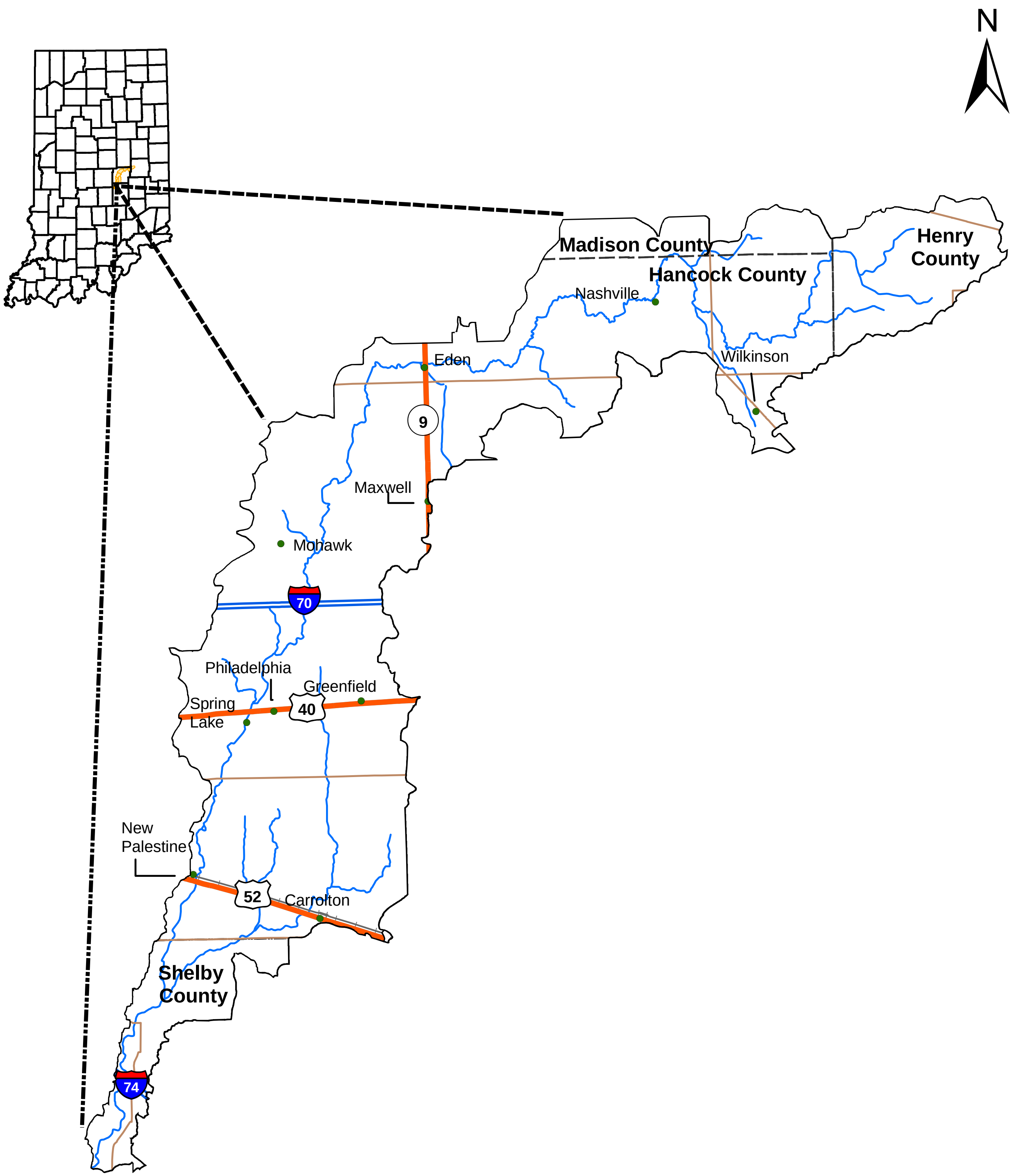
The Sugar Creek Watershed occupies portions of Hancock, Henry, Madison and Shelby Counties. Sugar Creek has its origins in west central Henry County and flows west into Madison and Hancock Counties. Sugar Creek then turns south and flows through Hancock County into Shelby County where it is joined by Buck Creek. Some of the cities and towns located in the Sugar Creek Watershed include: Greenfield, New Palestine, Eden, Philadelphia, Spring Lake, Carrolton, Wilkinson, Mohawk, Maxwell and Nashville. The general location map is shown on Exhibit 1.

The Watershed encompasses approximately 84,750 acres of mixed land use consisting mainly of row crop agriculture and pasture. Approximately 92 linear miles of cumulative waterways are contained in the Sugar Creek Watershed. The majority of the Watershed (79%) is located within Hancock County, which is the third fastest growing county in the State.

The Hancock County Soil and Water Conservation District (SWCD) is responsible for the conservation and development of soil, water and related natural resources throughout Hancock County. To help accomplish this goal, the SWCD applied for and received an Environmental Protection Agency (EPA) Section 319 watershed planning grant through the Indiana Department of Environmental Management (IDEM) to study the Sugar Creek Watershed and develop a management plan that would evaluate the present state of the resource, and provide guidance on how to improve and protect this fundamental aspect of their community. A Steering Committee of stakeholders within the watershed was organized to work with the Hancock County SWCD to develop and implement the Watershed Management Plan.

The Sugar Creek Watershed Management Plan is intended as a guide for the protection and enhancement of the environment and quality of the Sugar Creek Watershed while balancing the different uses and demands of the community on this natural resource. These goals address items such as:

- education and outreach
- increasing preservation, restoration and protection of this vital system
- increasing cooperation, coordination and collaboration among all stakeholders in the Watershed
- building and maintaining a solid organization to look to the welfare of this important natural resource



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **Sugar Creek Watershed Location Map**	PROJECT: **Sugar Creek Watershed Project**
	BASE LAYER: N/A	PROJECT NO. 07065 / EXHIBIT: 1 / SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A / DATE: 4/9/08 / SCALE: NTS

PROBLEMS AND CAUSES IDENTIFIED IN THE WATERSHED

On December 12, 2007 and January 10, 2008, the Sugar Creek Watershed's Steering Committee discussed the water quality parameters of concern, and the general locations that the contributions from these pollutants were most prominent. The Steering Committee studied the original stakeholder concern list, the windshield survey data, historical data, and V3 field data to identify areas of concern within the Watershed. The Steering Committee identified pathogens (*E. coli*), sediment, nutrients and flooding as the most significant pollutant and condition in the Sugar Creek Watershed. The Steering Committee developed the following list of problems and causes identified in the Watershed:

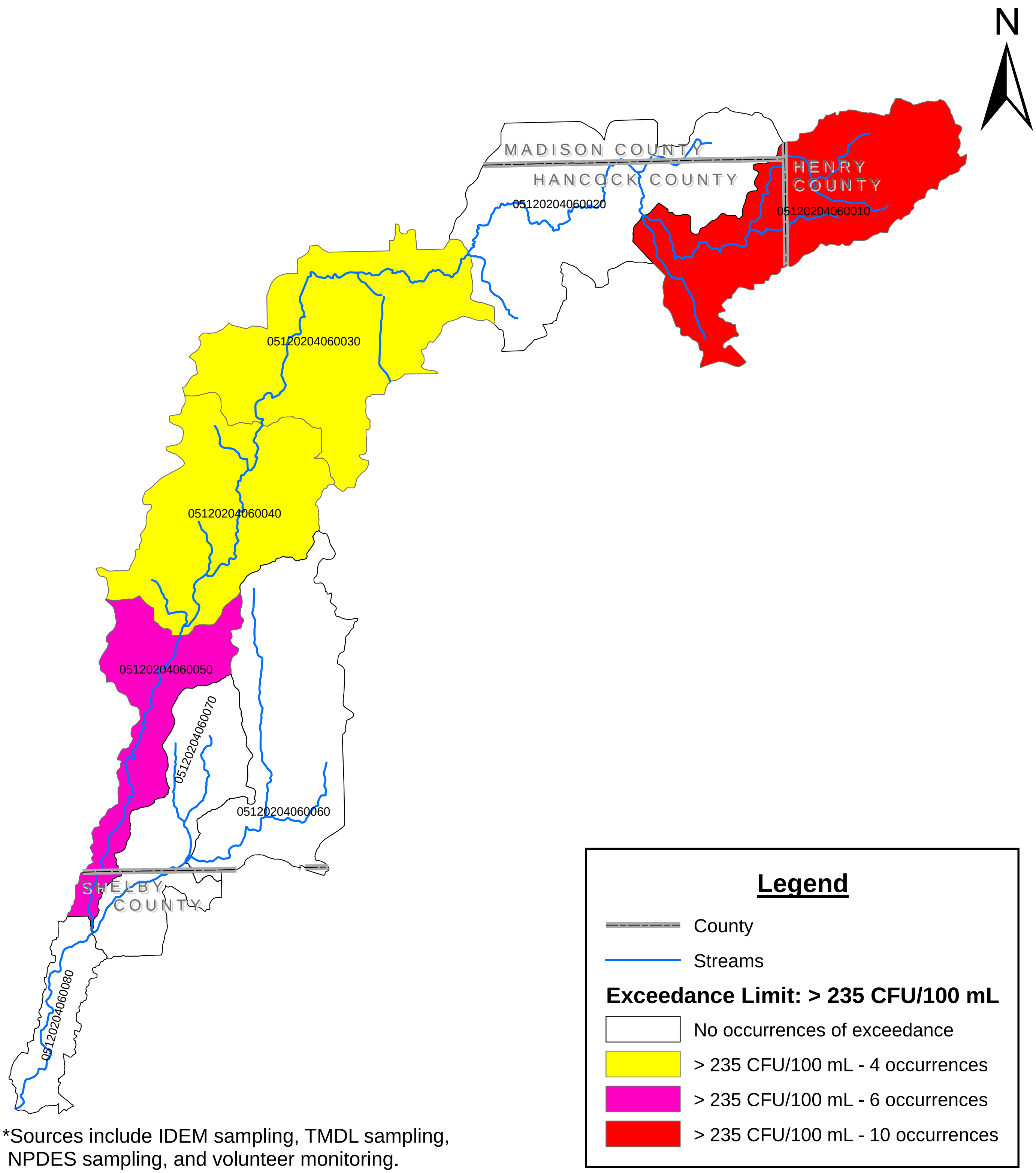
Problem Statement 1

E. coli/pathogen levels in the Sugar Creek Watershed regularly exceed the state standard of 235 CFU/100ml, based on current and historical water quality data results, and often exceed safety standards for allowing Sugar Creek to be fishable and swimmable. The data collected for this WMP supports this conclusion are shown in Exhibit 30 and Exhibit 35.

<u>Stressor:</u> *E. coli* bacteria

<u>Source:</u> animal waste, human waste, failing septic systems, point sources, package plants, maintaining proper drainage from farmlands, flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to Sugar Creek and its tributaries, land use changes, stormwater management, lack of proper wildlife management

<u>*Areas Where Sources Have Been Observed:*</u> Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, Heartland Resort, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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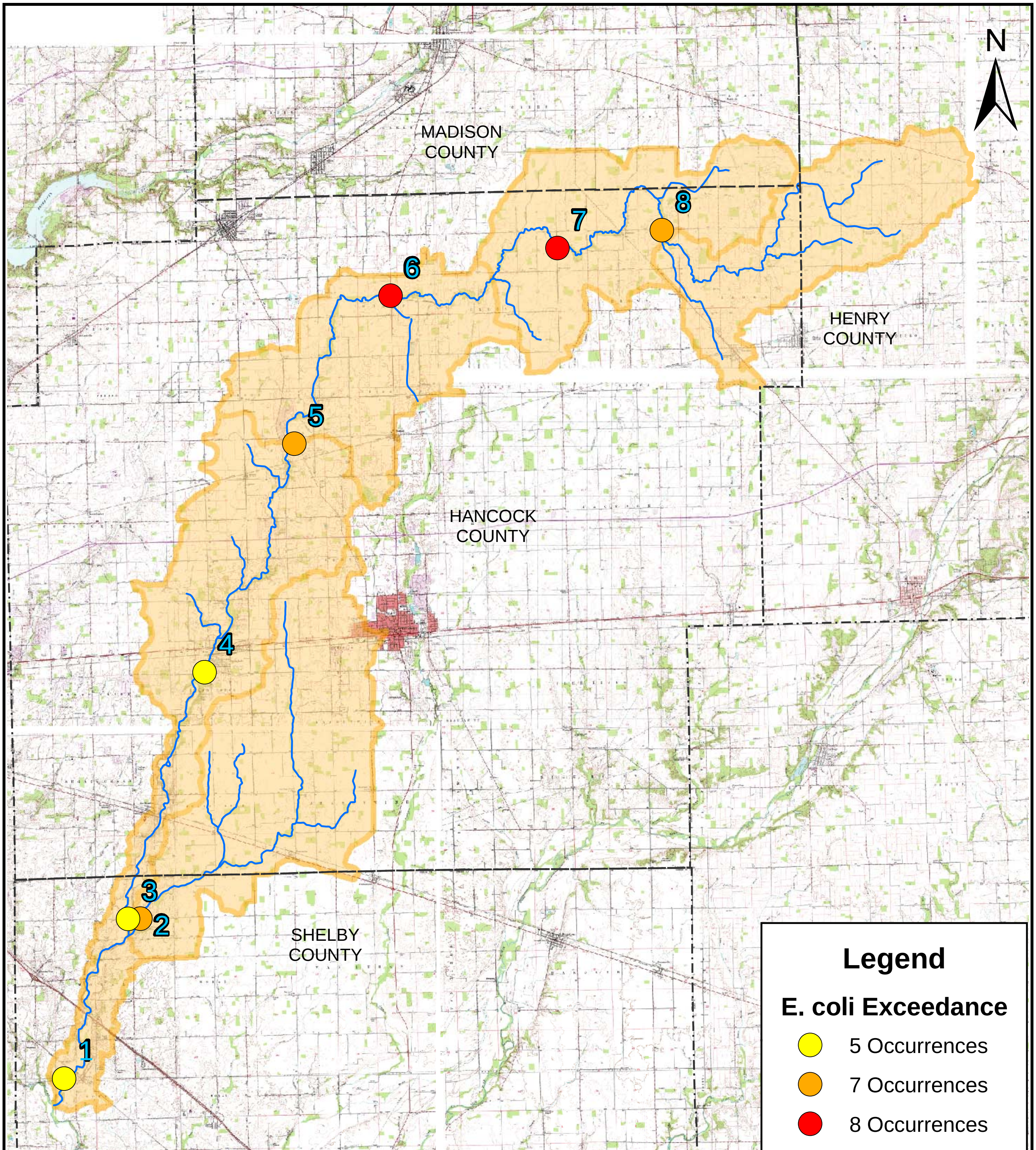
TITLE: **E. coli Exceedance**		PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A		PROJECT NO. 07065	EXHIBIT: 30	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140		QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



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TITLE:	E.coli Exceedances at V3 Sampling Stations
PROJECT:	Sugar Creek Watershed Project
BASE LAYER:	USGS Topographic Map
CLIENT:	Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140
PROJECT NO.	07065
EXHIBIT:	35
SHEET:	1
OF:	1
QUADRANGLE:	N/A
DATE:	4/29/08
SCALE:	NTS

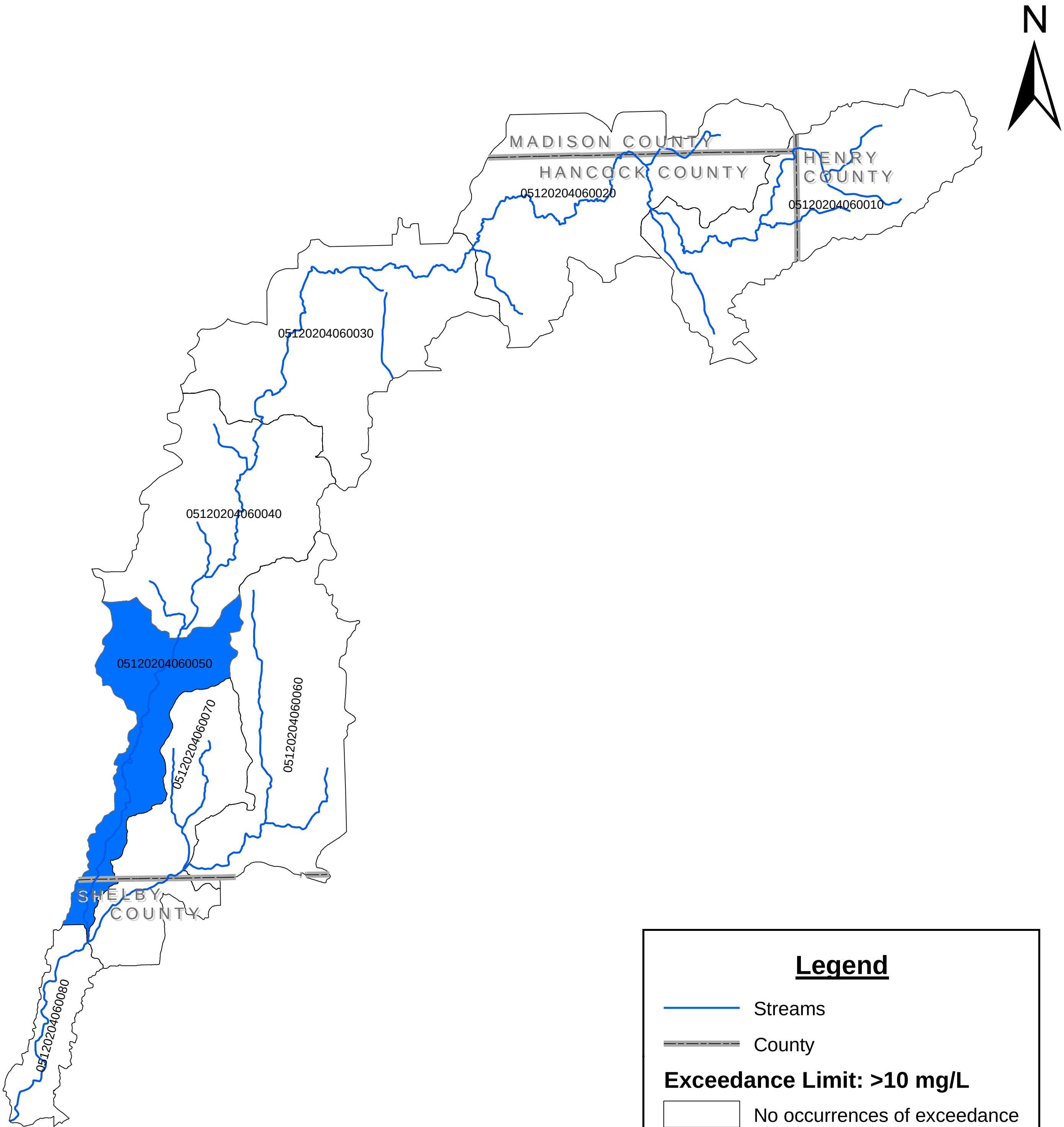
Problem Statement 2

Excessive nutrient levels, documented in historic and recent water quality sampling, are negatively affecting the Sugar Creek Watershed. Nutrients that are stressors for the Sugar Creek watershed include Nitrate (NO_3), Nitrite (NO_2) and Phosphorus. The data collected for this WMP identifying Nitrate and Nitrite as a stressor are shown in Exhibit 28, Exhibit 33, and Exhibit 39. The data collected identifying Phosphorus as a stressor are shown in Exhibit 27, Exhibit 32, and Exhibit 40.

Stressor: Nutrients, including Nitrate (NO_3), Nitrite (NO_2) and Phosphorus.

Source: Flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to the stream, failing septic systems, land use changes, stormwater management

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, and Heartland Resort



Legend

- Streams
- County

Exceedance Limit: >10 mg/L

- No occurrences of exceedance
- >10 mg/L - 1 occurrence

*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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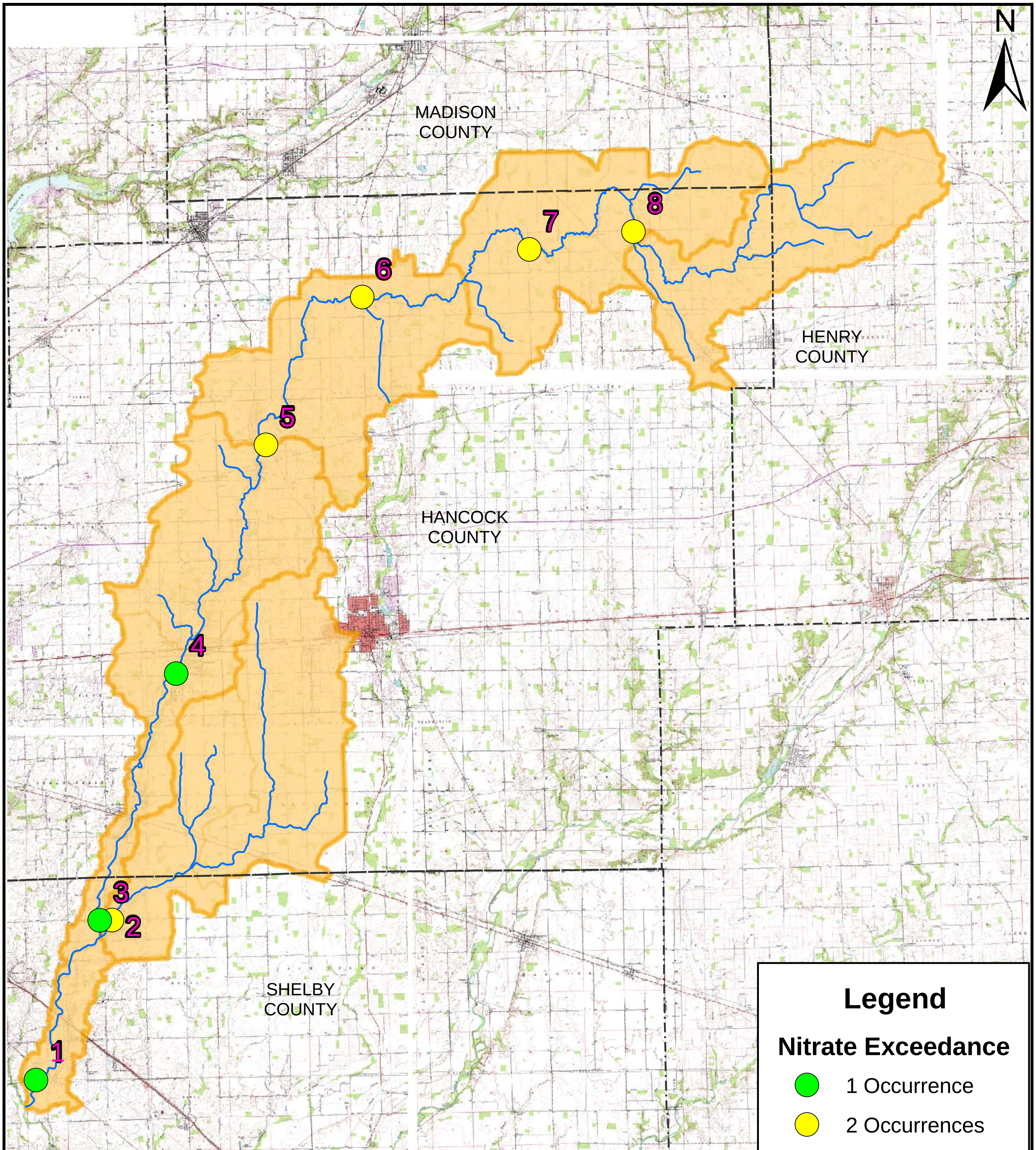
	BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 28	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



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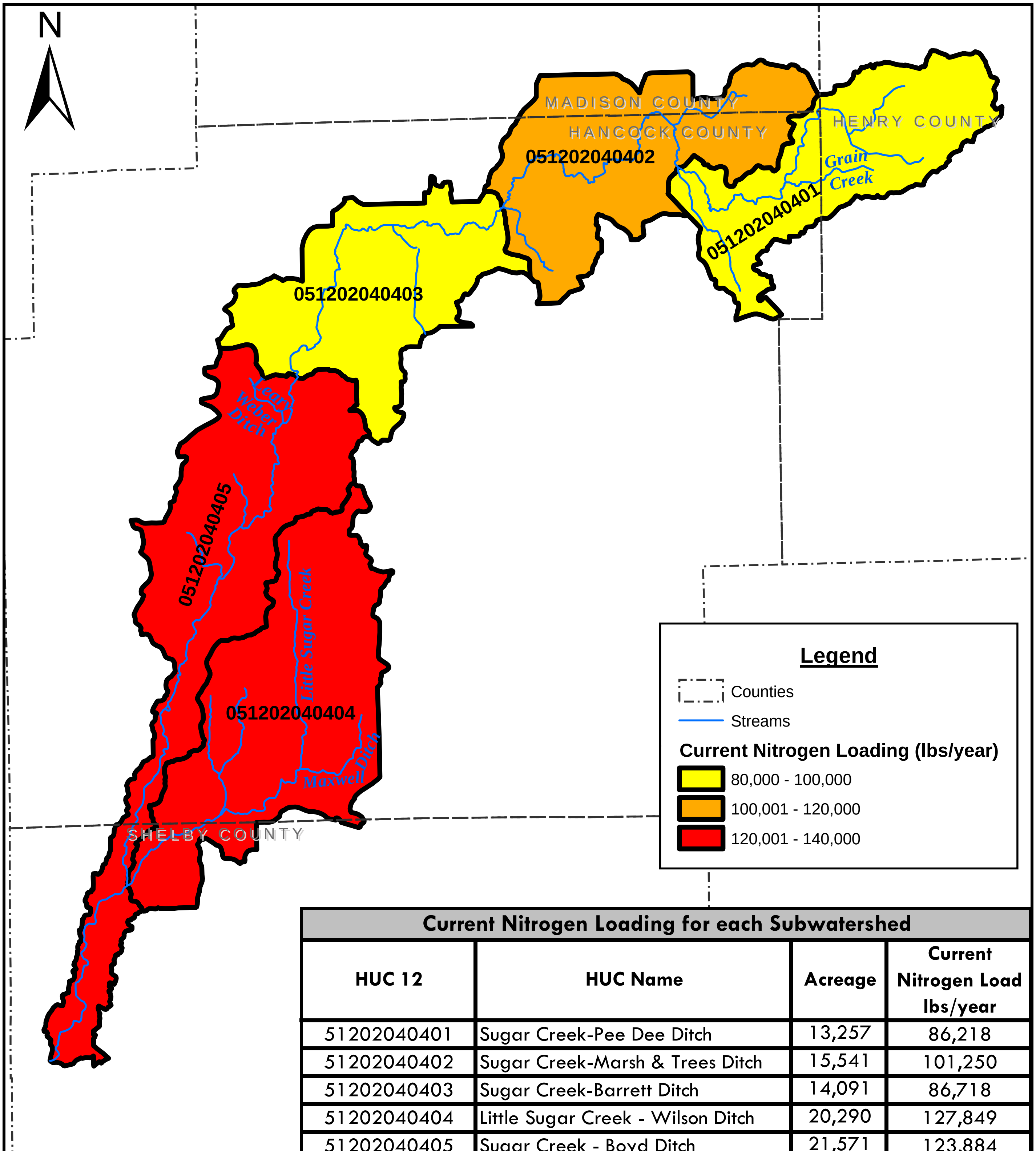
TITLE: **Nitrate Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**			
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 33	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS	



Current Nitrogen Loading for each Subwatershed			
HUC 12	**HUC Name**	**Acreage**	**Current Nitrogen Load lbs/year**
51202040401	Sugar Creek-Pee Dee Ditch	13,257	86,218
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	101,250
51202040403	Sugar Creek-Barrett Ditch	14,091	86,718
51202040404	Little Sugar Creek - Wilson Ditch	20,290	127,849
51202040405	Sugar Creek - Boyd Ditch	21,571	123,884

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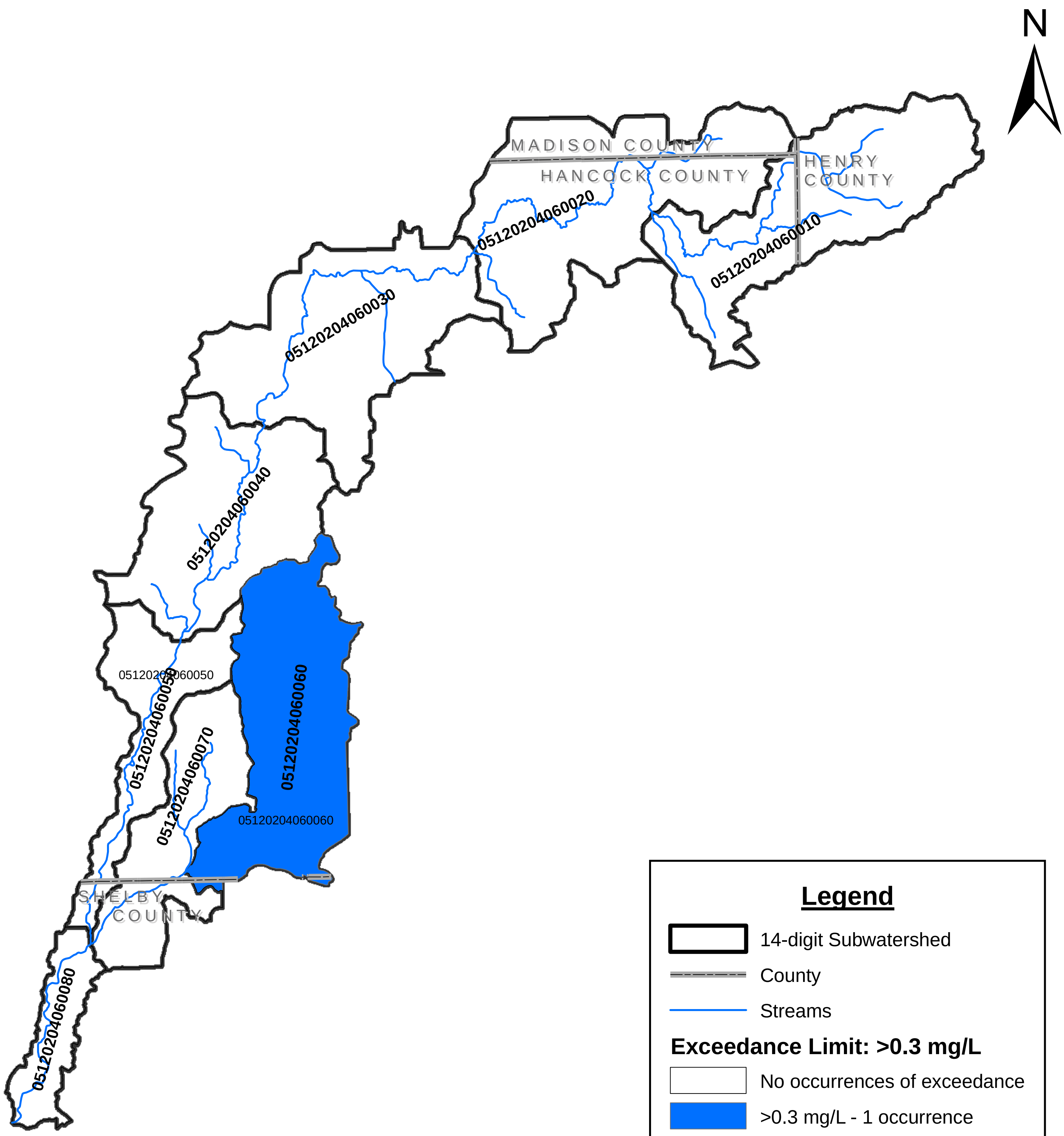
TITLE: **Estimated Nitrogen Loading**	PROJECT: **Sugar Creek Watershed Project**	
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 39	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 3/1/09	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

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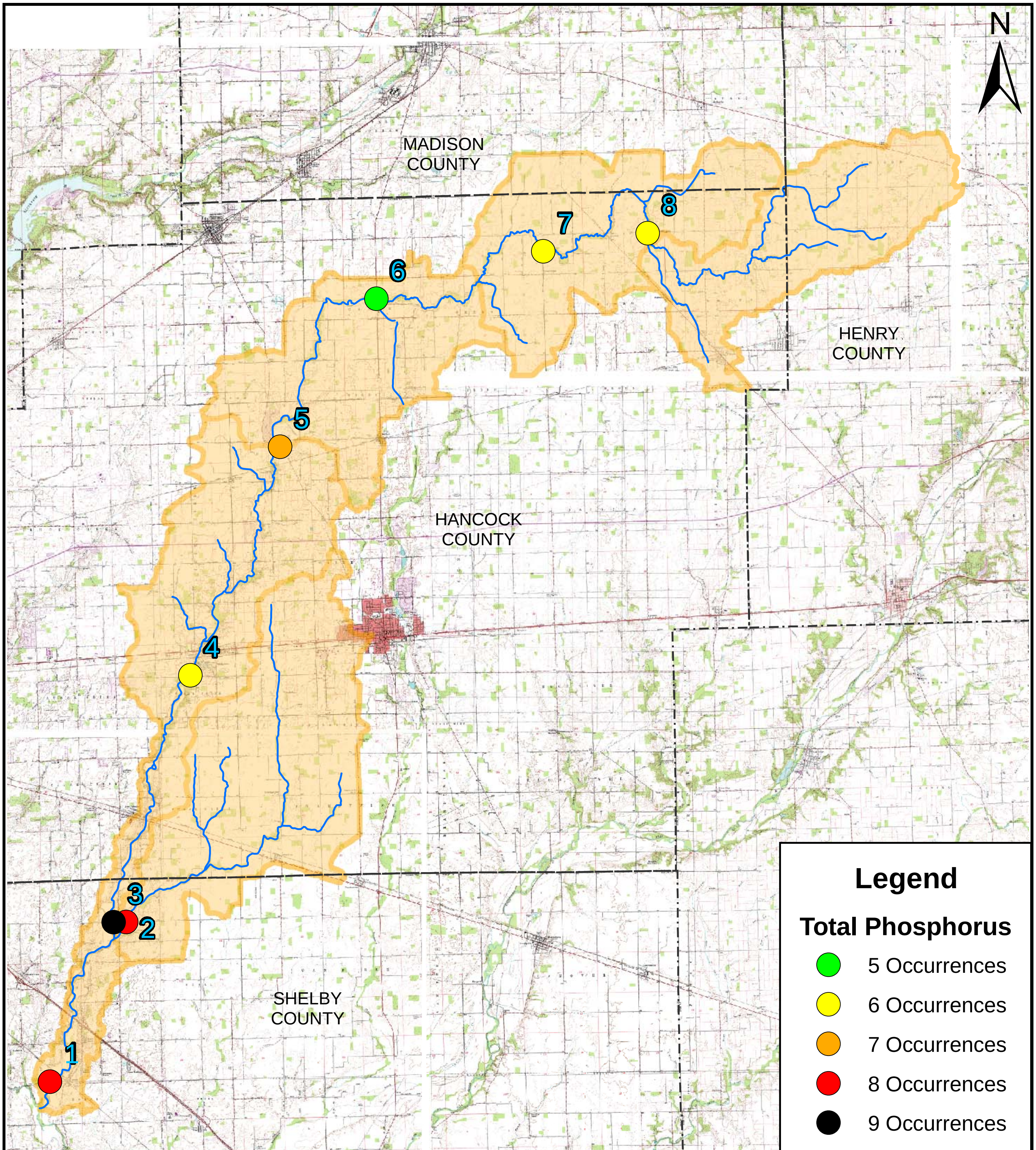
TITLE: **Phosphorus Exceedance**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 27	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



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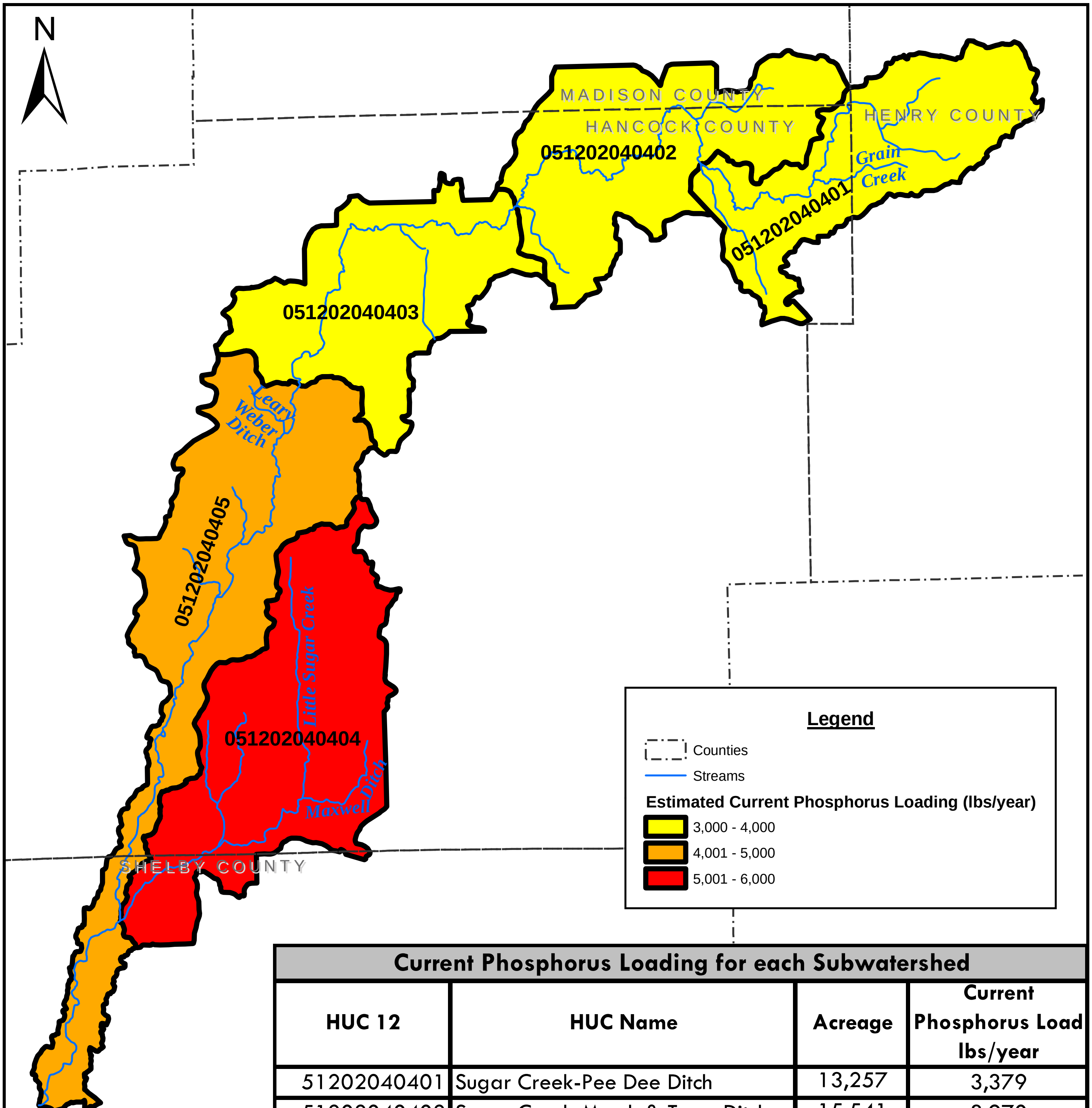
TITLE: **Total Phosphorus Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 32	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/29/08	SCALE: NTS



Current Phosphorus Loading for each Subwatershed

HUC 12	HUC Name	Acreage	Current Phosphorus Load lbs/year
51202040401	Sugar Creek-Pee Dee Ditch	13,257	3,379
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	3,970
51202040403	Sugar Creek-Barrett Ditch	14,091	3,391
51202040404	Little Sugar Creek - Wilson Ditch	20,290	5,005
51202040405	Sugar Creek - Boyd Ditch	21,571	4,827

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TITLE: Estimated Phosphorus Loading	PROJECT: Sugar Creek Watershed Project
BASE LAYER: N/A	PROJECT NO. 07065
EXHIBIT: 40	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A
DATE: 3/1/09	SCALE: NTS

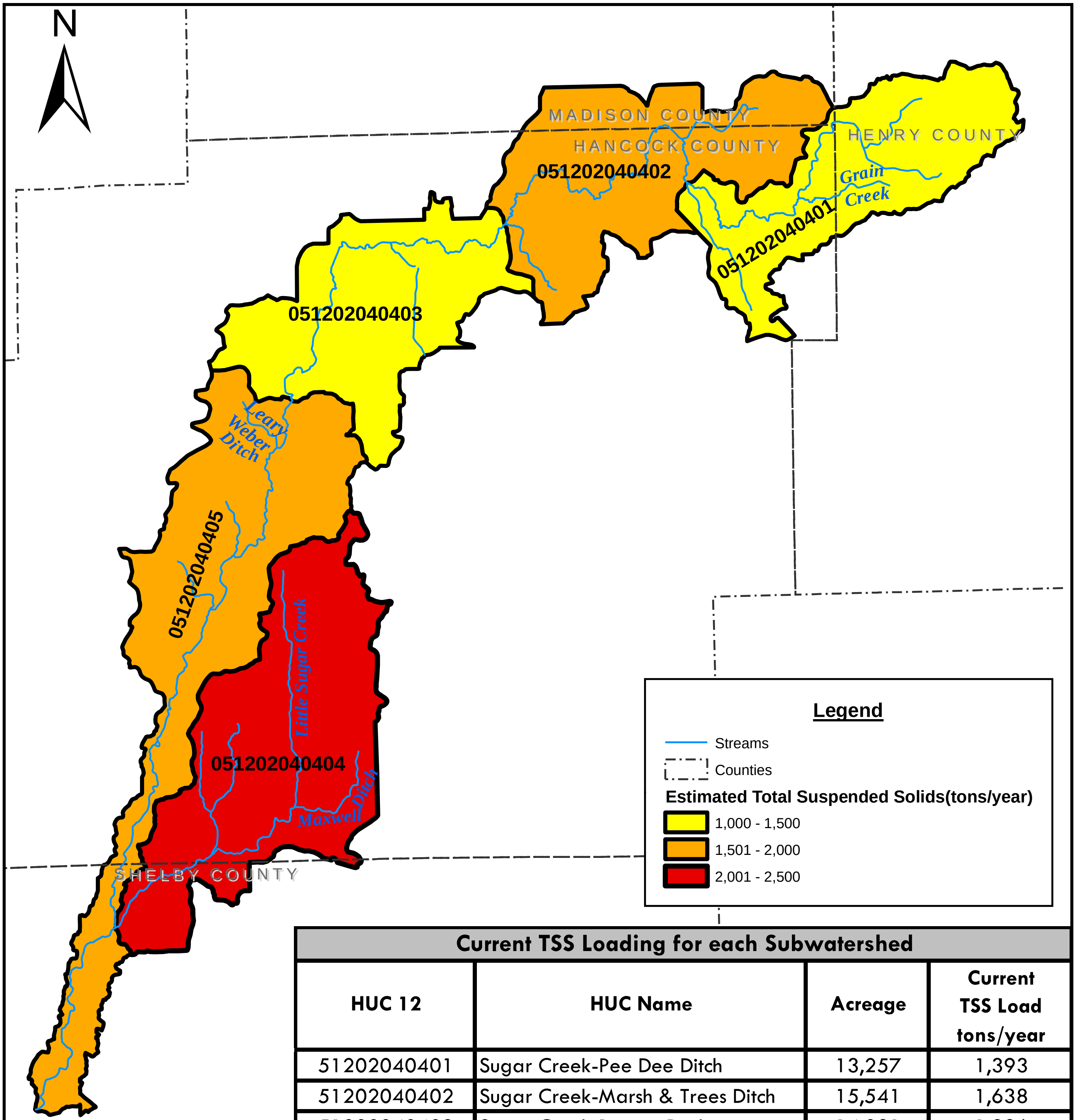
Problem Statement 3

Excessive soil erosion and sedimentation associated with agricultural lands, urban lands, and development sites is degrading the Sugar Creek Watershed and limiting the aesthetics, recreational access, wildlife habitat, and drainage of Sugar Creek. For the purpose of this WMP sediment will be discussed in terms of total suspended solids (TSS). The data identifying sedimentation as a stressor is shown in Exhibit 41.

Stressor: Silt and sediment, nutrients that bind to sediment, pathogens that bind to sediment

Source: Flooding impacts, proper drainage from agricultural lands, streambank erosion, cattle access to the stream, land use changes, stormwater management, log jams, beaver, wildlife effects on water quality by contributing to nutrients through their waste, lack of proper wildlife management, presence of existing sandbars

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision



Current TSS Loading for each Subwatershed

HUC 12	HUC Name	Acreage	Current TSS Load tons/year
51202040401	Sugar Creek-Pee Dee Ditch	13,257	1,393
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	1,638
51202040403	Sugar Creek-Barrett Ditch	14,091	1,396
51202040404	Little Sugar Creek - Wilson Ditch	20,290	2,073
51202040405	Sugar Creek - Boyd Ditch	21,571	1,987

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TITLE: Estimated Total Suspended Solids	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 41	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 7/8/08	SCALE: NTS

Problem Statement 4

Excessive flow rates and volumes of water during large precipitation events are causing crop damage and loss within the Sugar Creek Watershed.

Stressor: damaging flood levels

Source: Lack of proper drainage in the Watershed, log jams, beaver creating log jams, flooding impacts, streambank erosion, cattle access to the stream, land use changes, stormwater management, presence of existing sandbars

Areas Where Sources Have Been Observed: Urban areas surrounding Eden, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, Arrowhead Mobile Park, and the Sugar Creek Watershed along Sugar Creek between 200 S to 600 S

Problem Statement 5

There is a lack of open space/greenways along Sugar Creek and its tributaries. Pollutants are allowed to enter Sugar Creek and its tributaries without any filtration process.

Stressor: unfiltered stormwater run-off

Source: lack of filter strips and Best Management Practices, lack of native vegetation, lack of greenway corridor along Sugar Creek, Preservation areas that are not maintained

Areas Where Sources Have Been Observed: Areas void of open space and greenway along the Sugar Creek corridor

Problem Statement 6

Stakeholders in the Sugar Creek Watershed are not knowledgeable about their daily impact on the Sugar Creek Watershed and its water quality.

Stressor: Lack of education and outreach with regard to the Watershed health and condition

Source: Lack of sponsored workshops within the Watershed, lack of interest from the Stakeholders, lack of media coverage about the detrimental effects of humans and their daily activities on the Watershed

Target Audience: Stakeholders, local groups

Problem Statement 7

Stakeholders in the Sugar Creek Watershed are not aware of the watershed planning process or the existence of the watershed group.

Stressor: Lack of education and interest with regard to the Watershed health and condition

Source: Lack of time and commitment

Target Audience: Neighborhood groups, stakeholders, schools, local newspapers, local radio, local television

SUGAR CREEK WATERSHED CRITICAL AREAS

On May 13, 2008, the Sugar Creek Watershed's Steering Committee identified 9 critical areas. The Critical Area discussion continued to mature as the sources of the problems in the watershed were tied to specific critical locations. Subsequent discussions between V3, Hancock County SWCD, IDEM and the Steering Committee attempted to correlate BMP implementation project placement to solving the problems and causes of pollutant loading sources. The Steering Committee finalized five critical areas as significant areas for pathogens (*E. coli*), sediment, nutrients and flooding. The five critical areas are listed in Table 31 and depicted in Exhibit 43. The critical areas are represented by HUC-12 subwatersheds and account for approximately 64,460 total acres (livestock stream access did not contribute acreages), which is approximately 76% of the Watershed by area.

Table 31. Finalized Critical Area Locations within the Sugar Creek Watershed

Critical Area #	Name	County(s)	*E. coli*	Sediment	Nutrients	Flooding	Critical Area Acreage
1	Pee Dee Ditch –Sugar Creek	Hancock and Henry Counties	X	X	X	X	13,257
2	Marsh and Trees Ditch – Sugar Creek	Hancock and Madison Counties	X	X	X	X	15,541
3	Barrett Ditch – Sugar Creek	Hancock County	X	X	X	X	14,091
4	Boyd and Leary Weber Ditch - Little Sugar Creek	Hancock and Shelby Counties	X	X	X	X	21,571
5	Livestock Stream Access	Hancock, Henry, Madison and Shelby Counties	X	X	X	X	-
		Total:	5	5	5	5	64,460

Critical Area #1, HUC-12 number 051202040401, includes Pee Dee Ditch, Grain Ditch and urban areas surrounding Warrington. This critical area is 13,257 acres and is located in both Hancock and Henry Counties. Pee Dee Ditch, Grain Ditch, and four other tributaries to Sugar Creek, along with Sugar Creek itself combine for a total of 18 miles of stream reach. This area has been identified as being a critical area because it is a significant contributor of nutrient loading (both nitrogen and phosphorus) within the watershed. Critical Area #1 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where field drain tiles discharge into Sugar Creek or its tributaries

Critical Area #2, HUC-12 number 051202040402, includes the urban area associated with Nashville and the problematic floodplain area between Nashville and Eden. The critical area is 15,541 acres and is located in both Hancock and Madison Counties. Marsh & Trees Ditch combine with all the other surface water drainageways for a total of 13 miles. This area has been identified as being a critical area because it similarly is a significant contributor of both nitrogen and phosphorus. Critical Area #2 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where field drain tiles discharge into Sugar Creek or its tributaries

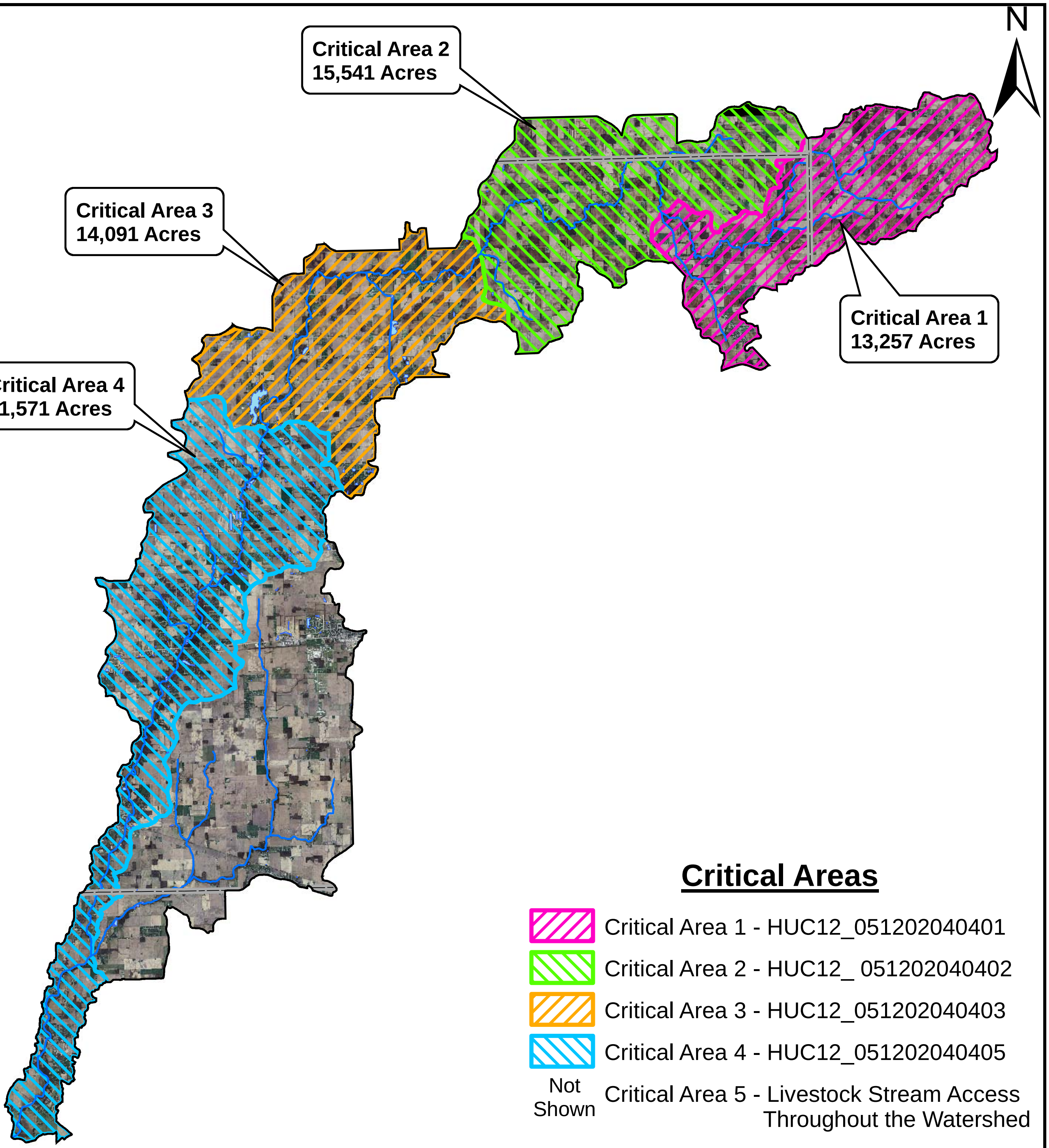
Critical Area #3, HUC-12 number 051202040403, includes the urban area associated with Eden and the problematic floodplain area between Nashville and Eden. The critical area is 14,091 acres and is located in Hancock County. Barrett Ditch and three other tributaries, along with Sugar Creek combine for a total of 16 miles of stream reach. This area has been identified as being a critical area because implementing BMPs to control the source of sediment loads and nutrient loads will reduce the amount of TSS, nutrients and phosphorus in the streams. Critical Area #3 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries

Critical Area #4, HUC-12 number 051202040405, includes: the urban area associated with Mohawk and Mohawk Campground, Conservation Club; the Leary Weber Ditch; the Heartland Resort; the S&H Campground; urban areas surrounding Philadelphia; the Wildwood Subdivision; urban areas surrounding Spring Lake; the Arrowhead Mobile Park; the Overlook Subdivision; and the problematic floodplain corridor along Sugar Creek between 200 S and 600 S. The critical area is 21,571 acres which includes 38 miles of waterway and is located in Hancock and Shelby Counties. Both the town of Mohawk and the Mohawk Campground have been identified as contributors to the problem of nutrients, *E. coli*, and sediment. The Heartland Resort, located immediately south of the town of Mohawk, is identified as a contributor to the problem of nutrients and *E. coli*. The steering committee noted this subwatershed as the most significant contributor of *E. coli*. through failing septic systems. Critical Area #4 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where vegetated buffer is lacking along a waterway within the Watershed

Critical Area #5, not shown on an exhibit, is the livestock stream access critical area. Areas in the watershed where livestock have direct access to the stream are identified as being critical as they contribute to the problems of *E. coli* and sediment. Addressing these concerns will also impact concerns regarding streambank degradation. The implementation of BMPs such as exclusion fencing and alternative water supply would improve the condition of the Watershed.



Critical Areas

- Critical Area 1 - HUC12_051202040401
- Critical Area 2 - HUC12_ 051202040402
- Critical Area 3 - HUC12_051202040403
- Critical Area 4 - HUC12_051202040405
- Not Shown — Critical Area 5 - Livestock Stream Access Throughout the Watershed

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TITLE: **Final Nutrient, E. Coli, Sediment, and Flooding Critical Areas**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: 43	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/8/08	SCALE: NTS

SET GOALS AND OBJECTIVES

The Steering Committee evaluated the priority resource concerns that were gathered from stakeholders throughout the Sugar Creek Watershed, evaluated the problem statements, and examined the mission statement of the Sugar Creek WMP. With this information in mind, seven goals were developed, which the committee hopes to achieve through the implementation of the Sugar Creek WMP. The complete listing of the Sugar Creek WMP's goals is as follows:

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

Objectives:

- Meet as a Committee on a quarterly basis,
- Increase involvement and participation with the planning process from Stakeholders within the Watershed,
- Pursue and implement watershed improvement projects,
- Sustaining active subcommittees.

Goal #2: Reduce *E. coli* concentrations to meet state standard of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices,
- Reduce the amount of *E. coli* runoff from urban lands,
- Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants, and
- Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders.

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

Objectives:

- Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology,
- Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers,
- Increase the riparian buffer zone using filter strips and grassed waterways,
- Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology,
- Discourage the Fall and Winter application of fertilizer,

- Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.),
- Encourage lower application rates of fertilizers within the watershed through education workshops and field days.

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Objectives:

- Reduce soil erosion and sedimentation from agricultural lands,
- Reduce soil erosion and sedimentation from urban lands, and
- Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed,
- Protect and restore floodplain functions,
- Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding,
- Create and restore wetland areas to increase storage within the Watershed.

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Objectives:

- Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members,
- Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors,
- Promote sustainable drainage practices,
- Educate homeowners in urban communities about the use of fertilizers,
- Educate stakeholders using septic systems about the importance of septic system maintenance,
- Establish a legislative liaison,
- Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed,
- Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed,
- Educate homeowners within the Watershed about the Storm Drain Marking Program.

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

Objectives:

- Increase acquisition of land to be dedicated to open space and greenways,
- Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed,
- Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed,
- Encourage farmland preservation within the Watershed.

SELECTED BEST MANAGEMENT PRACTICES

Based on what is practical for this Watershed and what Best Management Practices (BMPs) will provide the most cost effective pollutant reduction, the Steering Committee has chosen twelve agricultural BMPs and eight urban BMPs. The BMPs chosen will help achieve the Watershed goals and objectives by decreasing the concentrations of pathogens (*E. coli*), sediment, and nutrients, as well as decrease the impacts of flooding.

Agricultural Best Management Practices:

1. Exclusion Fencing
2. Rotational Grazing
3. Nutrient Management Plan
4. Manure Management Plan
5. Alternative Watering System
6. No-till/Reduced Till (Conservation Tillage)
7. Grassed Waterways
8. Buffers/Filter Strips
9. Grade-Stabilization Structures
10. Cover Crop
11. Wetland Restoration
12. Soil Infiltration Trench

Urban Best Management Practices:

1. Rain Barrel/Rain Garden
2. Naturalized Wet-bottom Detention Basin
3. Filtration Basin
4. Pervious Paving
5. Soil Infiltration Trench
6. Sand Filter
7. Bioretention Practices
8. Natural Stream Buffer

MONITORING EFFECTIVENESS

The Steering Committee established both a programmatic action plan and measurable milestones for the goals of the WMP. The programmatic action plan assigns goal as a short-term or long-term measurable milestone, identifies the objectives and action items, identifies the responsible party or parties involved with the implementation of the actions, and outlines both the technical and financial assistance needs for each action item (see Section 5 of this report). Tables 32a-32g lists the measurable milestones for each of the seven goals identified by the Steering Committee. These milestones have been suggested in order to help track the process of implementing action items within the Sugar Creek Watershed.

Table 32a Priority Ranking of Objectives:
Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group. All action items are short-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Meet as a Committee on a quarterly basis	Retain active committee participants and acquire new committee members.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
Increase involvement and participation with the planning process from Stakeholders within the Watershed	Expand responsibilities and stewardship of active committee participants and stakeholders with the planning process.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
	Research local stakeholder groups with similar missions or interest within the Watershed.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
	Network with related stakeholder groups and use public forums as recruiting opportunities	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Pursue and implement watershed improvement projects	Promote urban BMPs by pursuing funding, implementing urban BMP demonstration projects and providing field day tours of implementation sites.	**Research/Grant Writing; Media/Marketing/Website; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote rural BMPs by pursuing funding, implementing rural BMP demonstration projects and providing field day tours of implementation sites.	**Research/Grant Writing; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Sustaining active subcommittees	Retain active subcommittee participants and acquire new subcommittees and subcommittee members.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations

Table 32b Priority Ranking of Objectives:
Goal #2: Reduce *E. coli* concentrations to meet state standards of 235 CFU/100 ml in the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices	Promote and provide technical assistance to implement exclusionary fencing installation which would prevent livestock from having access to the stream.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to implement alternative water supplies for livestock in order to replace direct access to the stream.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to educate and implement manure management practices.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Reduce the amount of *E. coli* runoff from urban lands	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants	Educate stakeholders about the detrimental impacts to water quality from point sources, failed septic systems and package plants.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
	Encourage regular maintenance and repair of failing septic systems.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding

Table 32c Priority Ranking of Objectives:
Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology	Educate farmers, home owners, landscaping companies, stakeholders about the proper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Utilize and promote the Farm Bill Program.	**Steering Committee**	SWCDs, NRCS	Grant Funding
Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers	Educate farmers, home owners, landscaping companies, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of excessive fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Increase the riparian buffer zone using filter strips and grassed waterways	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Promote filter strips and grassed waterways as BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Promote BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Discourage the Fall and Winter application of fertilizer	Educate farmers, home owners, landscaping companies, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.)	Promote and provide technical assistance to encourage more soil testing to optimize nitrogen application.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Encourage lower application rates of fertilizers within the Watershed through education workshops and field days	Educate farmers, home owners, landscaping companies, stakeholders through workshops and field days about the impacts to water quality (both groundwater and surface water) from the improper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding

Table 32d Priority Ranking of Objectives:
Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Reduce soil erosion and sedimentation from agricultural lands	Promote and provide technical assistance to implement appropriate agricultural land BMPs.	**Education; Media/ Marketing/ Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote agricultural land BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Education; Research/ Grant Writing; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Utilize and promote the Farm Bill Program.	**Steering Committee**	SWCDs, NRCS	Grant Funding
	Designate a volunteer for specific areas throughout the Watershed as the main contact for reporting violations.	**Steering Committee**	Volunteers, Steering Committee	Volunteers
Reduce soil erosion and sedimentation from urban lands	Promote and provide technical assistance to implement appropriate urban land BMPs.	**Education; Media/ Marketing/ Website; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote urban land BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Education; Research/ Grant Writing; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Designate a volunteer for specific areas throughout the Watershed as the main contact for reporting violations.	**Steering Committee**	Volunteers, Steering Committee	Volunteers
Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed	Work with permitting entities to adopt building permit ordinances with more conservative erosion control practices.	**Legislative/ Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Work with permitting entities to adopt more stringent enforcement of erosion control practices.	**Legislative/ Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Establish a volunteer group that will monitor construction sites for violations.	**Monitoring; Legislative/ Local Advocacy Sub-Committees**	Volunteers, Steering Committee	Volunteers

Table 32e Priority Ranking of Objectives:
Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed	Work with permitting entities to adopt stormwater permit ordinances with more conservative stormwater runoff rate and volume limits.	**Legislative/Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to implement appropriate BMPs within developed areas to reduce stormwater runoff flow rates and volumes.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote BMPs within developed areas to reduce stormwater runoff flow rates and volumes by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Protect and restore floodplain functions	Promote and provide technical assistance to protect and restore floodplain functions within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote the protection and restoration of floodplain functions by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding	Promote and provide technical assistance for maintenance and management practices which will result in reducing flood damage within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Create and restore wetland areas to increase storage within the Watershed	Promote and provide technical assistance to implement wetland creation and restoration projects to increase storage.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote wetland creation and restoration projects by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding

Table 32f Priority Ranking of Objectives: **Goal #6:** Develop and implement watershed education and outreach programs in the Sugar Creek Watershed. All action items are short-term measureable milestone priorities.				
Objective	**Action Item**	**Responsible Party**	**Technical Assistance**	**Financial Assistance**
Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members	Promote the effective use of media (TV, newspaper, newsletters and radio) to share and communicate watershed improvement activities.	**Media/Marketing/Website Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors	Promote activities to recruit and train volunteers for monitoring watershed conditions including biological, physical and chemical parameters.	**Education; Monitoring Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Provide training and educational opportunities for volunteer monitors.	**Education; Monitoring Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Promote sustainable drainage practices	Encourage implementation of sustainable drainage practices throughout the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate homeowners in urban communities about the use of fertilizers	Educate home owners, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of excessive fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate stakeholders using septic systems about the importance of septic system maintenance	Encourage regular maintenance and repair of failing septic systems.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Establish a legislative liaison	Promote the establishment of a legislative liaison with a prime directive of improving the water quality of the Sugar Creek Watershed.	**Legislative/Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed	Promote awareness of detrimental effects on the health of the Watershed from ATV use in and along Sugar Creek.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed	Encourage stakeholder awareness with respect to studies conducted within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate homeowners within the Watershed about the Storm Drain Marking Program	Promote implementing a Storm Drain Marking Program throughout the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding

Table 32g Priority Ranking of Objectives:
Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Increase acquisition of land to be dedicated to open space and greenways	Promote greenway corridors	**Steering Committee**	Parks Departments, Volunteers	Volunteer/Donations/ and Grants
	Promote park expansion and use of public land	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Connect open spaces with conservation corridors.	**Steering Committee**	Volunteers, Consultants	Volunteers/ Donations/ and Grants
	Identify current and future recreational needs and match with appropriate open space within the Watershed.	**Steering Committee**	Volunteers	Volunteers/ Donations
Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed	Identify natural resources, ecological areas, and unique habitats to be preserved and protected.	**Steering Committee**	IDEM, DNR, Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Promote awareness of invasive species and their impact on native ecosystems.	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Promote awareness of threatened and endangered species throughout the Watershed. Encourage and educate the public on ways they can protect these species.	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Manage current open spaces for invasive species.	**Steering Committee**	Parks Departments, DNR, Volunteers	Volunteers/ Donations/ and Grants
	Support wetland, prairie and woodland restoration.	**Steering Committee**	IDEM, DNR, Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed	Educate stakeholders on management practices which simulate natural processes such as burning or thinning.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants
	Use native vegetation extensively in BMPs to enhance wildlife habitat.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants
Encourage farmland preservation within the Watershed	Promote the preservation of farmland within the Watershed.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants

A monitoring plan is needed to track the indicators and evaluate the effectiveness of the implementation efforts over time. Indicators of success are listed for each of the seven goals.

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

Indicators of Success:

- Having quarterly Steering Committee Meetings,
- Completing grant applications and receiving funding,
- Implementing watershed improvement projects,
- Having active subcommittees.

Goal #2: Reduce *E. coli* concentrations to meet state standard of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

Indicators of Success:

- Number of Agricultural BMPs installed, e.g. exclusionary fencing, alternative water supplies, implementation of manure management practices,
- Number of Urban BMPs installed, e.g. increasing infiltration and decreasing stormwater runoff washing pet waste into surface water bodies,

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

Indicators of Success:

- Number of Agricultural BMPs installed, participation in CRP, both programs include filter strips and grassed waterways,
- Number of independent participants using cover crops, grid mapping, variable rate technology, soil testing, and low application rates of fertilizers,
- Number of Urban BMPs installed,
- Number of independent participants using rain gardens, rain barrels, no phosphorus fertilizer,
- Nitrogen model demonstrating Load Reduction,
- Phosphorus model demonstrating Load Reduction

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Indicator of Success:

- Number of Agricultural BMPs installed, participation in CRP, both programs include filter strips, grassed waterways and field borders,
- Number of independent participants using cover crops and grid mapping,
- Number of Urban BMPs installed,
- Number of construction sites using proper erosion control procedures,
- Total Suspended Solids model demonstrating Load Reduction.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Indicator of Success:

- Number of new development sites which have incorporated appropriate volume of stormwater retention and/or detention,
- Increase acreage of new floodplain storage and develop new wetland areas,
- Prevent further development within the floodplain,

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Indicator of Success:

- Number of events including: workshops, field days, educational display booth events, river clean-up days,
- Number of people involved categories includes: steering committee member participation, general public attendance, number of volunteers at clean up events, number of river watch participants in the watershed,

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

Indicator of Success:

- Number of acres dedicated to open space and greenways,
- Number of acres for the preservation of wildlife habitat and protected areas, within the Sugar Creek Watershed,

This Management Plan is meant to be a flexible tool to achieve water quality improvements within the Sugar Creek Watershed. The WMP will be evaluated by assessing the progress made on each of the seven goals. The evaluation and adaptation of the plan will be the responsibility of the Steering Committee.

The plan should be evaluated every five years to assess the progress made as well as to revise the plan, if appropriate, based on the progress achieved. The plan will also have a comprehensive review every 15 years. Amendments and changes may be made more frequently as laws change or new information becomes available that will assist in providing a better outlook for the Sugar Creek Watershed. As goals are accomplished and additional information is gathered, efforts may need to be shifted to watershed issues of higher priority.

INFORMATION AND OBJECTIVES

The Sugar Creek Watershed Planning Process is being sponsored by the Hancock County Soil and Water Conservation District. As mentioned previously, it came out of the desire of Hancock County SWCD to continue to fulfill their mission. The Mission Statement of the Hancock County SWCD is:

> The Hancock County Soil and Water Conservation District (SWCD) is a local unit of state government responsible for the conservation and development of our soil, water, and related natural resources through education, public information, leadership, technical assistance, and development of innovative programs.

The mission statement of the Sugar Creek Watershed Management Plan project is:

> The Sugar Creek Watershed Project is focused on improving water quality by raising public awareness, and conserving and enhancing natural resources with community involvement in the watershed management program.

Intentions of the Watershed Management Plan

The Sugar Creek WMP is intended as a guide for the protection and enhancement of the environment and quality of the Sugar Creek Watershed while balancing the different uses and demands of the community on this natural resource. These goals address items such as:

- education and outreach
- increasing preservation, restoration and protection of this vital system
- increasing cooperation, coordination and collaboration among all stakeholders in the Watershed
- building and maintaining a solid organization to look to the welfare of this important natural resource

The WMP follows IDEM requirements for watershed management plans, including sections on: Watershed Description, Problem Cause and Stressor Identification, Stressor Source Identification, Critical Watershed Areas, Setting Goals and Indicator Selection for Performance Assessment, Selecting Measures for Improvement, Calculating Load Reductions, Implementation of Planned Measures, Monitoring Indicators, and Plan Evaluation and Adaptation.

Public input is essential for the sustainability and success of the Watershed improvement effort. Stakeholder input was sought and included during all aspects of the planning process. This local input was essential for developing a plan that would have broad appeal throughout the watershed and continued support. A steering committee and several sub-committees were developed to address the diverse needs in the watershed.

As mentioned previously, the Sugar Creek WMP is intended to be comprehensive, identifying problem areas and suggesting improvement measures for both water quality and quantity concerns. The Sugar Creek Watershed is large and diverse, and thus has a variety of issues and concerns that need to be addressed. To address some of these issues, the Sugar Creek Steering Committee will work with local stakeholder groups to pursue Best Management Practices (BMPs) that will result in the improvement of water quality in the Sugar Creek Watershed. Because of the size of the task at hand, this plan will also be used as a platform on which to pursue additional grants and other funding for implementation of the many different improvement measures recommended in the plan.

INFORMATION AND OBJECTIVES

History of the Sugar Creek Watershed Planning Process

The Hancock County Soil and Water Conservation District (SWCD), organized on May 24, 1954, is responsible for the conservation and development of soil, water and related natural resources throughout Hancock County. A large portion of the Sugar Creek Watershed is located in Hancock County. To help accomplish this goal, the SWCD applied for and received an Environmental Protection Agency (EPA) Section 319 watershed planning grant through the Indiana Department of Environmental Management (IDEM) to study the Sugar Creek Watershed and develop a management plan that would evaluate the present state of the resource, and provide guidance on how to improve and protect this fundamental aspect of their community.

The SWCD is governed by a Board of Supervisors consisting of Hancock County stakeholders. Three are elected by landowners in the county and two are appointed by the State Soil Conservation Board, upon recommendation of the local SWCD. Hancock County also has five volunteer Associate Supervisors who complete the Board of the SWCD.

Hancock County, which is mostly agricultural, is seeing drastic changes in land use. An increase in population throughout the area has led to an increase in urban development. Between 2000 and 2004, the population of Hancock County increased 9.53% and between 2000 and 2006 increased 17.40%. It is the third fastest growing county in the State. With changes occurring rapidly throughout the Watershed, the implementation of the Sugar Creek Watershed Management Plan (WMP) will help assist in the use, and protection of this vital resource. In addition, benefits achieved through the use and implementation of this WMP will hopefully assist other portions of the county.

The stakeholders of the Sugar Creek Watershed have many important partners in conservation including:

Hancock County Soil and Water Conservation District (SWCD)
Indiana State Department of Agriculture (ISDA) Division of Soil and Water Conservation
United States Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS)
Indiana Department of Natural Resources (IDNR)
Farm Service Agency (FSA)
Purdue Cooperative Extension Service
Indiana Department of Environmental Management (IDEM).

It is hoped that through this process the list of stakeholder groups will continue to grow for the betterment of the Sugar Creek Watershed. A complete list of stakeholder groups and related organizations is available in Appendix A of this document.

Mission Statement, Hancock County Soil and Water Conservation District

The Sugar Creek Watershed Planning Process is being sponsored by the Hancock County Soil and Water Conservation District. As mentioned previously, it came out of the desire of Hancock County SWCD to continue to fulfill their mission. The Mission Statement of the Hancock County SWCD is:

> The Hancock County Soil and Water Conservation District (SWCD) is a local unit of state government responsible for the conservation and development of our soil, water, and related natural resources through education, public information, leadership, technical assistance, and development of innovative programs.

The mission statement of the Sugar Creek Watershed Management Plan project is:

> The Sugar Creek Watershed Project is focused on improving water quality by raising public awareness, and conserving and enhancing natural resources with community involvement in the watershed management program.

Intentions of the Watershed Management Plan (WMP)

The Sugar Creek WMP is intended as a guide for the protection and enhancement of the environment and quality of the Sugar Creek Watershed while balancing the different uses and demands of the community on this natural resource. These goals address items such as:

- education and outreach
- increasing preservation, restoration and protection of this vital system
- increasing cooperation, coordination and collaboration among all stakeholders in the Watershed
- building and maintaining a solid organization to look to the welfare of this important natural resource

The WMP follows IDEM requirements for watershed management plans, including sections on: Watershed Description, Problem Cause and Stressor Identification, Stressor Source Identification, Critical Watershed Areas, Setting Goals and Indicator Selection for Performance Assessment, Selecting Measures for Improvement, Calculating Load Reductions, Implementation of Planned Measures, Monitoring Indicators, and Plan Evaluation and Adaptation.

Public input is essential for the sustainability and success of the Watershed improvement effort. Stakeholder input was sought and included during all aspects of the planning process. This local input was essential for developing a plan that would have broad appeal throughout the watershed and continued support. A steering committee and several sub-committees were developed to address the diverse needs in the watershed.

As mentioned previously, the Sugar Creek WMP is intended to be comprehensive, identifying problem areas and suggesting improvement measures for both water quality and quantity concerns. The Sugar Creek Watershed is large and diverse, and thus has a variety of issues and concerns that need to be addressed. To address some of these issues, the Sugar Creek Steering Committee will work with local stakeholder groups to pursue Best Management Practices (BMPs) that will result in the improvement of water quality in the Sugar Creek Watershed. Because of the size of the task at hand, this plan will also be used as a platform on which to pursue additional grants and other funding for implementation of the many different improvement measures recommended in the plan.

SECTION 1: INTRODUCE WATERSHED

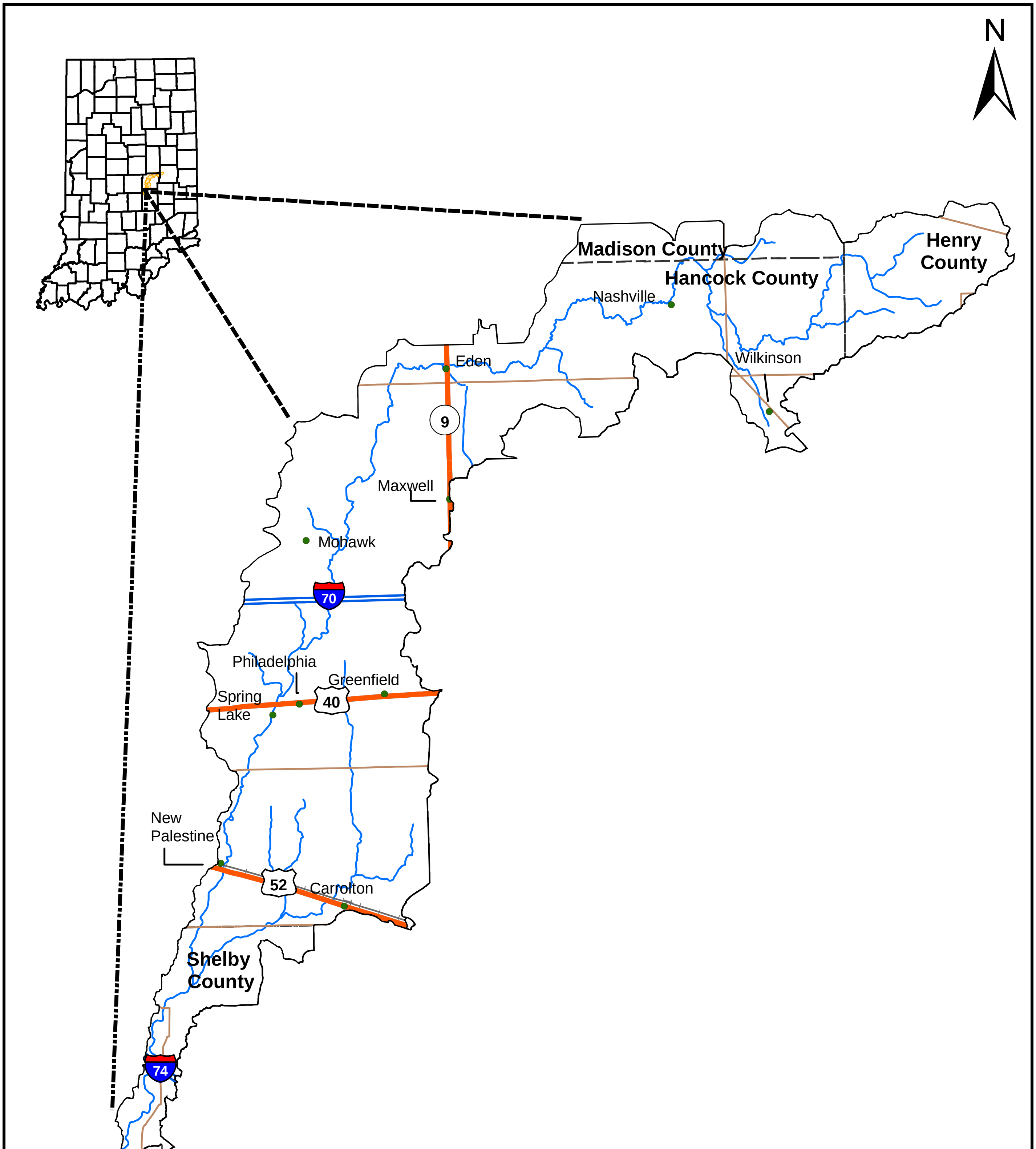
Location, Characteristics and Size of the Sugar Creek Watershed

Watershed and Watershed Health

A watershed is an area of land from which water drains to a single point in a natural basin and contributes flow (i.e., water) to a place or point on a body of water. Watershed health references the overall rating of a watershed based on the presence, condition, and numbers of different biological indicators. Some of these biological indicators include the different types of fish, insects, algae, plants and other aquatic life that are present or not present within the body or bodies of water within the watershed. These biological factors can provide accurate information about the health of a specific waterbody such as a river, stream, lake, or wetland. Water quality parameters also indicate the watershed health based on the quality of water entering and exiting the watershed. Some of these water quality parameters include temperature, pH, dissolved oxygen (DO), nitrates, nitrites, salinity, and total phosphate.

Location

Sugar Creek has its origins in west central Henry County and flows west into Madison and Hancock Counties (Exhibit 1). Sugar Creek then turns south and flows through Hancock County into Shelby County where it is joined by Buck Creek. The watershed encompasses approximately 84,750 acres of mixed land use consisting mainly of row crop agriculture and pasture. Approximately 92 linear miles of cumulative waterways are contained in the Sugar Creek Watershed. Some of the cities and towns located in the Sugar Creek Watershed include: Greenfield, New Palestine, Eden, Philadelphia, Spring Lake, Carrolton, Wilkinson, Mohawk, Maxwell and Nashville (Exhibit 1).



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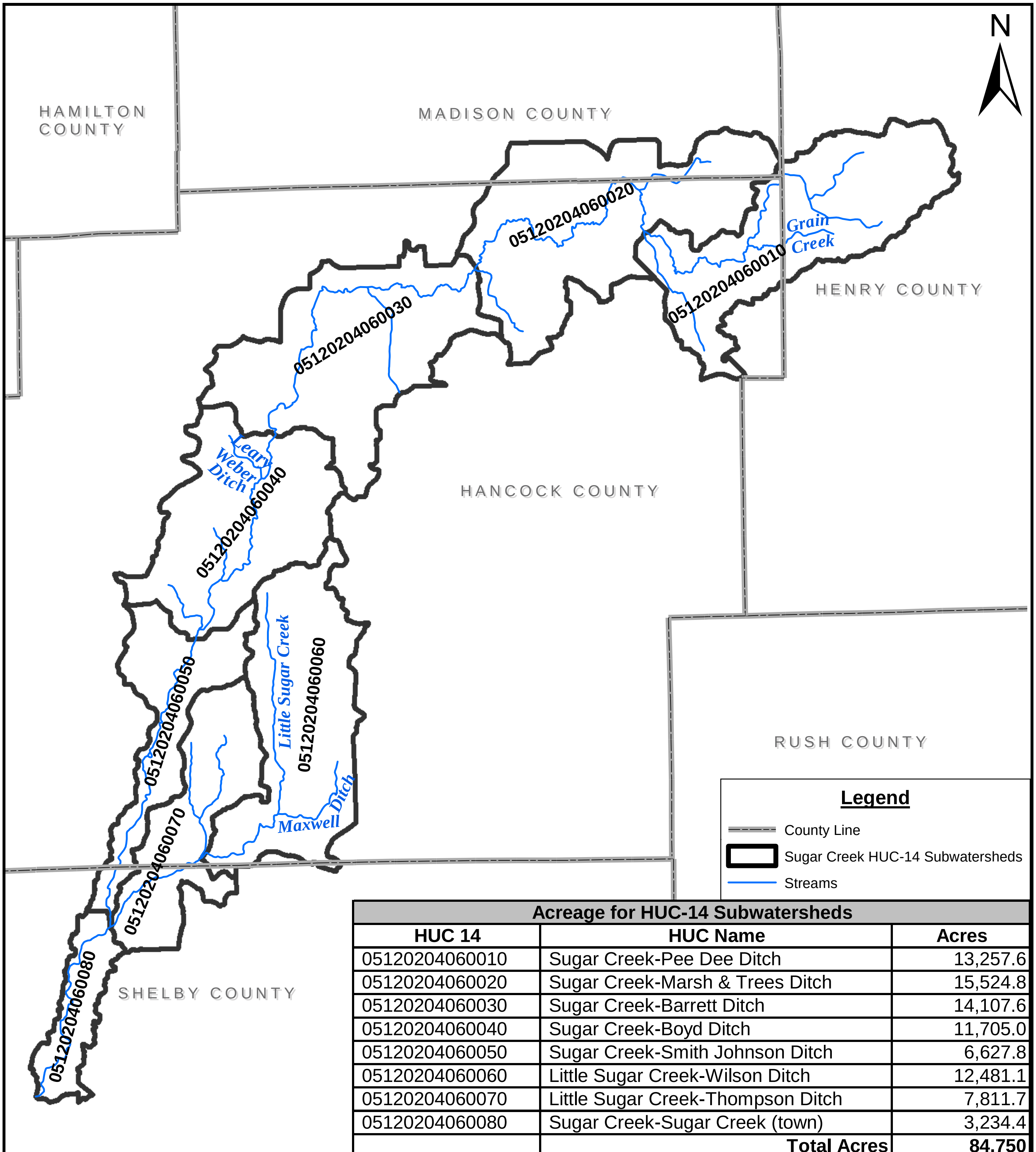
TITLE: **Sugar Creek Watershed Location Map**	PROJECT: **Sugar Creek Watershed Project**			
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 1	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/9/08	SCALE: NTS	

The US Geological Survey (USGS) created the Hydrologic Unit Code (HUC) system to classify the nation's watersheds and sub-watersheds. At the time the Sugar Creek Watershed Management Plan was awarded and contracted, 14-digit HUCs were being used. All of the mapping analysis through August 2008 was based on 14-digit HUCs (Exhibit 2a). In an effort to position the Sugar Creek Watershed for additional funding, much of the watershed management plan has been converted into 12-digit HUCs so that the presentation and report could more easily apply for and receive funding while abiding by the 12-digit HUC requirements. The study area acreage remained 84,750 and the boundaries of the Sugar Creek Watershed did not change during the transition from 14-digit HUCs to 12-digit HUCs (Exhibit 2a and 2b, Table 1). The subwatershed boundaries within the Sugar Creek Watershed changed with the HUC code transition. The 14-digit subwatersheds with the code of 05120204060060 and 05120204060070 combined to form the 12-digit subwatershed with the code of 051202040404. The 14-digit subwatersheds with the code of 05120204060040, 05120204060050, and 05120204060080 combined to form the 12-digit subwatershed with the code of 051202040405.

The Sugar Creek Watershed consists of five (5) 12-digit Hydrologic Unit Codes or HUCs (Exhibit 2b). Some of the major tributaries include Little Sugar Creek, Maxwell Ditch, Grain Creek, and Leary Weber Ditch (Exhibit 2b). Hydrologic unit codes were developed by the USGS in cooperation with the US Water Resource Council and the USDA Natural Resources Conservation Service (NRCS). Most federal and state agencies use this coding system. HUCs are a way of cataloguing portions of the landscape according to their drainage. Landscape units are nested within each other and described as successively smaller units. The hydrologic code attached to a specific watershed is unique, enabling different agencies to have common terms of reference and agree on the boundaries of the watershed. These commonly understood boundaries foster understanding of how landscapes function, where water quality problems should be addressed, and who needs to be involved in the planning process.

Table 1. Sugar Creek Subwatershed Comparative Acreages of HUC 12 and HUC 14

HUC 12	HUC 14	HUC Name	HUC 12 Acres	HUC 14 Acres
051202040401	05120204060010	Sugar Creek - Pee Dee Ditch	13,257	13,257.6
051202040402	05120204060020	Sugar Creek - Marsh and Trees Ditch	15,541	15,524
051202040403	05120204060030	Sugar Creek - Barrett Ditch	14,091	14,107.6
051202040404	05120204060060	Little Sugar Creek - Wilson Ditch	20,290	12,481.1
-	05120204060070	Little Sugar Creek – Thompson Ditch	-	7,811.7
051202040405	05120204060040	Sugar Creek - Boyd Ditch	21,571	11,705
-	05120204060050	Sugar Creek – Smith Johnson Ditch	-	6,627.8
-	05120204060080	Sugar Creek – Sugar Creek (town)	-	3,234.4
		Total Acres	**84,750**	**84,750**



Acreage for HUC-14 Subwatersheds		
HUC 14	**HUC Name**	**Acres**
05120204060010	Sugar Creek-Pee Dee Ditch	13,257.6
05120204060020	Sugar Creek-Marsh & Trees Ditch	15,524.8
05120204060030	Sugar Creek-Barrett Ditch	14,107.6
05120204060040	Sugar Creek-Boyd Ditch	11,705.0
05120204060050	Sugar Creek-Smith Johnson Ditch	6,627.8
05120204060060	Little Sugar Creek-Wilson Ditch	12,481.1
05120204060070	Little Sugar Creek-Thompson Ditch	7,811.7
05120204060080	Sugar Creek-Sugar Creek (town)	3,234.4
	Total Acres	**84,750**

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TITLE: **HUC- 14 Watershed Map**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

PROJECT NO. 07065

EXHIBIT: 2a

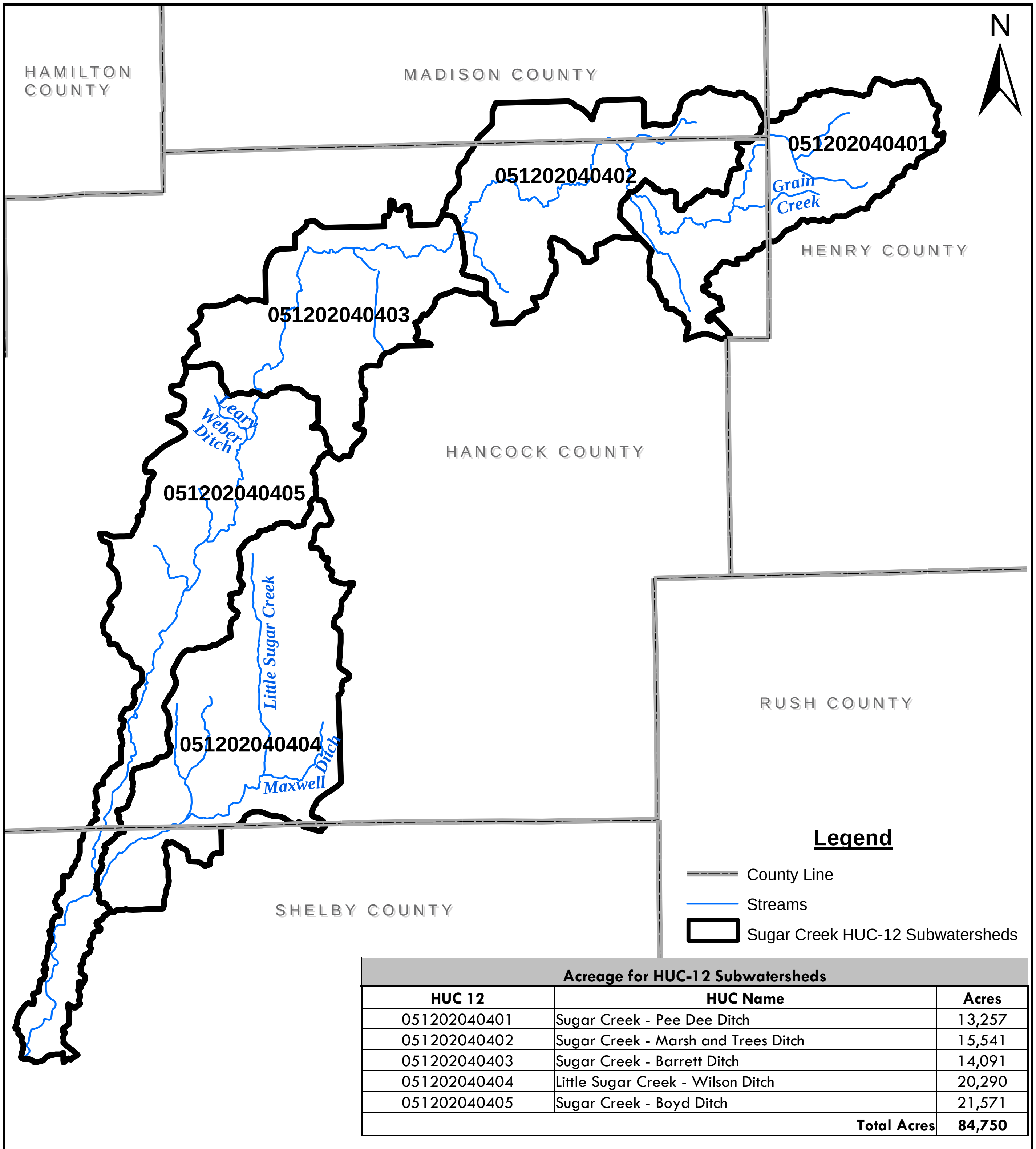
SHEET: 1 OF: 1

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

QUADRANGLE: N/A

DATE: 10/29/08

SCALE: NTS



Acreage for HUC-12 Subwatersheds		
HUC 12	**HUC Name**	**Acres**
051202040401	Sugar Creek - Pee Dee Ditch	13,257
051202040402	Sugar Creek - Marsh and Trees Ditch	15,541
051202040403	Sugar Creek - Barrett Ditch	14,091
051202040404	Little Sugar Creek - Wilson Ditch	20,290
051202040405	Sugar Creek - Boyd Ditch	21,571
	Total Acres	**84,750**

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TITLE: **HUC- 12 Watershed Map**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

PROJECT NO. 07065

EXHIBIT: 2b

SHEET: 1 OF: 1

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
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QUADRANGLE: N/A

DATE: 10/29/08

SCALE: NTS

Climate

The surface water and groundwater resources in the Sugar Creek Watershed provide critical support for both human and natural systems. Surface water from Sugar Creek, its tributaries, and local diversion and irrigation canals, is the primary source of water for human needs in the Watershed; including water for irrigation, livestock watering, industry and commerce, recreation, and waste assimilation. Rural domestic water users rely on both surface water and groundwater to supply their needs. Human demands for water must be balanced with the water requirements of terrestrial and aquatic ecosystems. Balancing these demands involves recognition of a myriad of values, both human and ecological, and presents significant challenges, particularly when considered in the context of climatic variability and change. Changes in air temperature, precipitation, and the frequency and severity of drought events related to climate change could adversely affect agriculture and other sectors in the Sugar Creek Watershed.

The average daily maximum temperature in July is 85.4°F, and the average daily minimum in January is 16.8°F. Using climate data from Greenfield, Indiana from 1971 – 2000, the lowest temperature on record occurred on January 1, 1985 and was -24°F. The highest temperature on record occurred on July 11, 1936 and was 109 °F. Typical relative humidity is about 58% - 68% in the mid-afternoon. Humidity is higher in the evening and averages around 90% at dawn. On average, 25 inches of moisture a year move into the atmosphere due to evapotranspiration (Lathrop, 2006). Winds are most often from the southwest, although in winter the dominant direction is from the northwest. Average velocities range from 7 miles per hour (mph) in September to 11mph in March and April.

Precipitation and temperature data can be found in Table 2 (as follows). Rainfall is moderately heavy and averages around 43.43 inches annually. Rainfall is generally well distributed throughout the year, but is slightly lower in mid to late winter. The record rainfall based on data from 1903 – 2000 occurred on August 10, 1968 and totaled 5.2 inches. The heaviest snowfall occurred on December 20, 1973 and totaled 10.8 inches. Average annual snowfall is 13.6 inches.

Table 2 Historical Climate Data, 1971- 2000

Month	Maximum Temperature (°F)	Minimum Temperature (°F)	Mean Temperature (°F)	Mean Precipitation (in.)	Mean Snowfall (in.)
January	33.6	16.8	25.2	2.47	5.6
February	38.8	20.2	29.5	2.37	2.2
March	49.9	29.9	39.9	3.33	1.5
April	61.8	40.4	51.1	4.07	0.2
May	72.9	51.4	62.2	4.69	0.0
June	81.8	60.5	71.2	4.48	0.0
July	85.4	64.4	74.9	4.85	0.0
August	83.6	62.2	72.9	4.01	0.0
September	77.5	54.6	66.1	3.16	0.0
October	65.4	42.5	54.0	3.05	0.1
November	51.1	32.9	42.0	3.88	0.7
December	38.6	22.6	30.6	3.07	3.3
Monthly Mean	61.7	41.5	51.6	na	na
Annual Total	na	na	na	43.43	13.6
Source: NCDS Normals, Station 123527, Greenfield, Indiana, Midwest Regional Climate Center, 2007					

Indiana has a varying climate with strongly marked seasons. The transition from cold to hot weather can produce an active spring with thunderstorms and tornadoes. Oppressive humidity and high temperatures arrive in summer. Autumn is favored with lower humidity than the other seasons, and mostly sunny skies. Indiana's location within the continent highly determines its climate. The Gulf of Mexico is a major player in Indiana's climate. Southerly winds from the Gulf of Mexico region readily transport warm, moisture-laden air into the State. The warm, moist air collides with continental polar air brought southward by the jet stream from central and western Canada.

Local climate variations within the State of Indiana are caused by differences of latitude, terrain, soil type and lakes. The State's record maximum temperature of 116 degrees Fahrenheit (° F) was set at Collegeville on July 14, 1936. The record minimum temperature is -36° F observed on January 19, 1994 at New Whiteland.

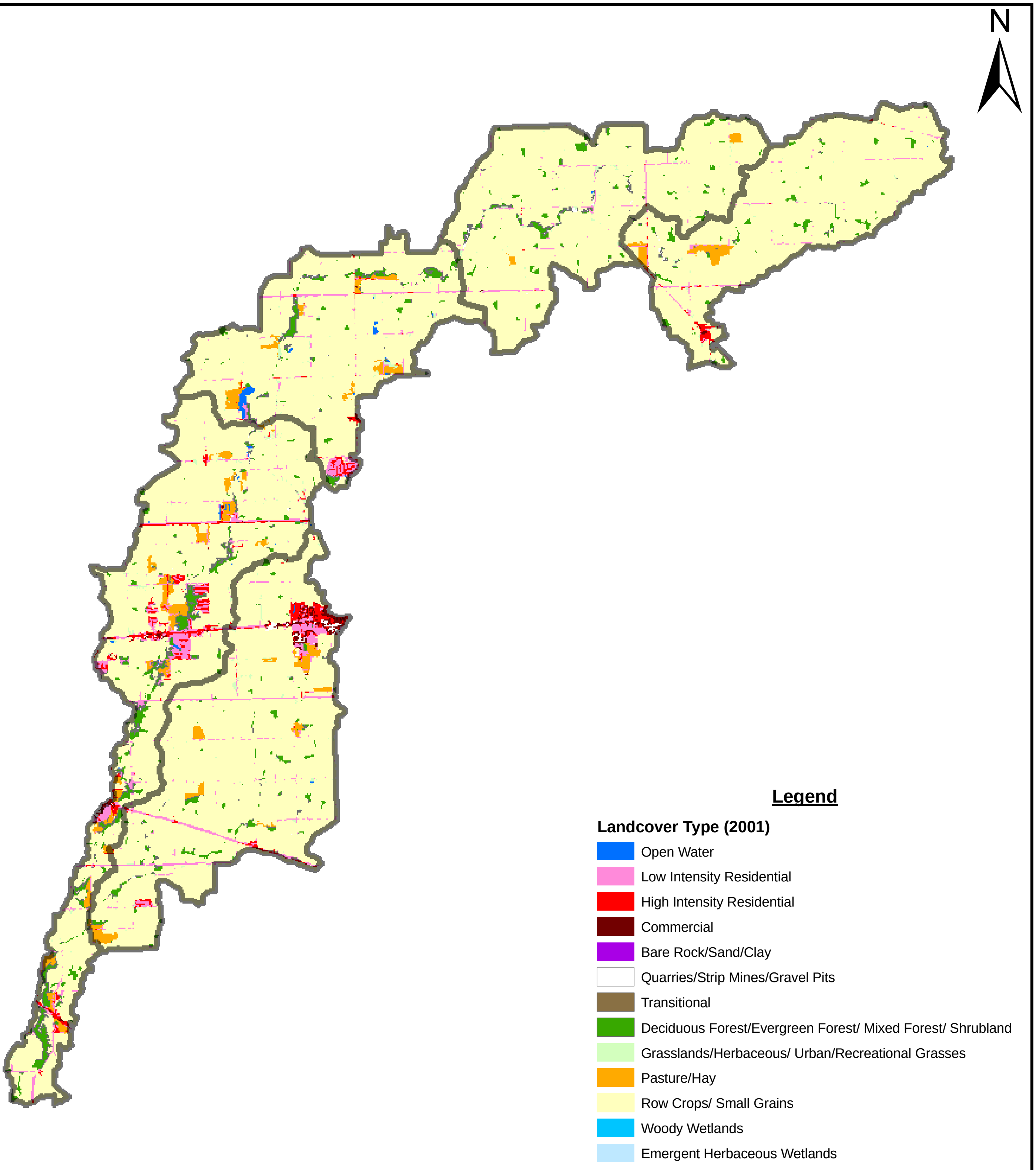
Trends in Land Development

Land Use and Population

The Sugar Creek Watershed consists of approximately 84,750 acres of mixed land use, according to the 2001 National Land Cover Data (NLCD) published by the USGS (Exhibit 3; Table 3). This watershed has historically been dominated by agricultural land and currently comprises 83.9% of its area. Additionally, forests and wetlands comprise 5.8%, and urban and residential lands comprise 8.6% of the Watershed. As urban development increases within the watershed, it should be considered when evaluating and protecting the natural resources within the basin.

Table 3 Land use in the Sugar Creek Watershed

GRIDCODE	Land Cover Type	Acres
11	Open Water	204
21	Low Intensity Residential	5,373
22	High Intensity Residential	1,451
23	Commercial/Industrial/Transportation	330
24	Developed High Intensity	115
41	Deciduous Forest	4,513
42	Evergreen Forest	8
52	Shrub/Scrub	89
71	Grassland/Herbaceous	1,215
81	Pasture/Hay	2,292
82	Row Crops	68,789
90	Woody Wetlands	298
95	Emergent Herbaceous Wetlands	72
	Other	1
	Grand Total Land Use	**Approx. 84,750**



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TITLE: **Land Use NLCD (2001)**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

PROJECT NO. 07065

EXHIBIT: 3

SHEET: 1 OF: 1

CLIENT: Hancock County SWCD
1101 West Main St., Ste. N
Greenfield, IN 46140

QUADRANGLE: N/A

DATE: 10/29/08

SCALE: NTS

Agricultural Land Use

Agricultural production is a large component of the counties within the Watershed. A summary showing the 2006 – 2007 agricultural statistics for Hancock, Henry, Madison, and Shelby counties is presented in Table 4 (published by the USDA). A ranking is given to each county based on the amount of crop harvested or livestock produced and is used as a comparison to all of the 92 counties of Indiana. Over the years a switch between conventional farming to no-till conservation practices has been made. Conventional farming practices typicaly involve regular tilling that agitates the soil in various ways, usually with tractor-drawn implements. Tilling is used to remove weeds, to mix in soil amendments such as fertilizers, to shape the soil into rows for crop plants and furrows for irrigation, and to prepare the surface for seeding. This can lead to unfavorable effects which include soil compaction; loss of organic matter; degradation of soil aggregates; disruption of soil microbes, arthropods, and earthworms; and soil erosion. No-till farming avoids these unfavorable effects by reducing or excluding the use of conventional tillage. No-till farming practices provides additional benefit through the presence of plant stems and residual plant materials left on the soils surface, known as residue. The amount or percent of soil covered by residue is variable based on field topography, precipitation events causing runoff to move residue off the fields towards surface water drainage features and by wind intensities. Benefits associated with the use of no-till practices include the reduction of soil loss by up to 90% in comparison to conventional tillage (USEPA 2002). This reduction of erosion benefits Sugar Creek Watershed as it protects the streambeds from sedimentation and improves water quality through reducing the particulates suspended in the water column.

Based on the 2007 Indiana Cropland Tillage Transect Survey, no-till corn increased from 19% (2004) to 27% (2007) and soybeans went from 61% (2004) to 69% (2007). In Hancock County, no-till corn practices increased from 2% (2004) to 38% (2007), while no-till soybean practices increased from 47% (2004) to 95% (2007), based on percentage. In 2007, the state of Indiana ordered counties within Indiana by agricultural best management practices categories, Hancock County was ranked first of all Indiana counties in the use of no-till for soybean crop production. Best management practices are actions that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources to water bodies. Non-point source pollution consists of pollutants that cannot be measured from a single source. Non point source pollutants are moved over land through runoff.

Table 4 Agricultural Statistics of Counties within the Watershed				
Hancock County				
2006 Crops	**Planted (acres)**	**Yield per acre**	**Produced**	**Rank**
Corn	67,900	155 Bu	10,505,000 Bu	36
Soybeans	82,500	50 Bu	4,088,600 Bu	32
Wheat	4,500	65 Bu	293,700 Bu	31
Hay	---	4.14 Ton	14,900 Ton	60
Livestock	**Number Head**	**Rank**		
All Cattle (2007)	3,300	79		
All Hogs (2002)	37,082	29		
All Sheep (2002)	1,941	6		
Chickens (2002)	1,141	18		
Henry County				
2006 Crops	**Planted (acres)**	**Yield per acre**	**Produced**	**Rank**
Corn	71,400	157 Bu	11,080,600 Bu	31
Soybeans	87,100	53 Bu	4,565,400 Bu	22
Wheat	4,200	66 Bu	277,000 Bu	35
Hay	---	4.38 Ton	25,400 Ton	33
Livestock	**Number Head**	**Rank**		
All Cattle (2007)	12,700	22		
All Hogs (2002)	11,457	56		
All Sheep (2002)	935	25		
Chickens (2002)	395	44		
Madison County				
2006 Crops	**Planted (acres)**	**Yield per acre**	**Produced**	**Rank**
Corn	80,500	163 Bu	12,945,100 Bu	23
Soybeans	98,600	54 Bu	5,300,100 Bu	11
Wheat	2,900	72 Bu	207,500 Bu	48
Hay	---	3.40 Ton	16,300 Ton	56
Livestock	**Number Head**	**Rank**		
All Cattle (2007)	6,400	57		
All Hogs (2002)	26,875	42		
All Sheep (2002)	655	39		
Chickens (2002)	348	48		
Shelby County				
2006 Crops	**Planted (acres)**	**Yield per acre**	**Produced**	**Rank**
Corn	97,000	150 Bu	14,482,400 Bu	19
Soybeans	96,400	52 Bu	5,028,600 Bu	15
Wheat	4,300	65 Bu	278,900 Bu	34
Hay	---	3.47 Ton	11,100 Ton	71
Livestock	**Number Head**	**Rank**		
All Cattle (2007)	4,500	68		
All Hogs (2002)	25,471	44		
All Sheep (2002)	685	38		
Chickens (2002)	216	57		
**Note: Bu= Bushel*				

Population Changes within the Watershed

A sub-category related to trends in land development includes population estimates of the Watershed. The majority of the Watershed (79%) is located within Hancock County. Between 2000 and 2006, the population in Hancock County increased 17.40% (Table 5). It is the third fastest growing county in the State. The increase in population growth of Hancock County is attributed to the development of business and infrastructure as well as its proximity to the Indianapolis metropolitan area which is desirable to commuters. This exponential growth rate is having an impact on the Sugar Creek Watershed, which has traditionally been almost exclusively an agricultural watershed. Henry, Madison, and Shelby counties have experienced either slow growth or negative growth between 2000 and 2006. Henry County's population decreased by 3.22% and Madison County's by 2.09% during this time frame. Shelby County experienced slow growth during this period increasing by only 1.54%; well below the state average of 3.8%.

As the Watershed changes from a largely rural setting to one that is increasingly more urban and residential, water quality and other natural resources in the basin have become an issue of concern. Sugar Creek Watershed is also experiencing changes from larger farms to smaller hobby farms. All of these land use changes have the potential to negatively impact the Watershed if they are not addressed in appropriate ways. Exhibit 4 demonstrates the population in the Sugar Creek Watershed in 2000. US Census populated areas were included to demonstrate major population centers. Change in population density trends from 1970 to 2000 are demonstrated in Exhibit 5. Most of the growth is occurring in the central portions of the Watershed in Hancock County. Areas in the northern portions of the basin in Hancock and Henry County seem to be growing at a slower rate with even some losses between 1980 and 1990. The highest population concentrations in 2000 within the Sugar Creek Watershed were in Hancock County east of New Palestine.

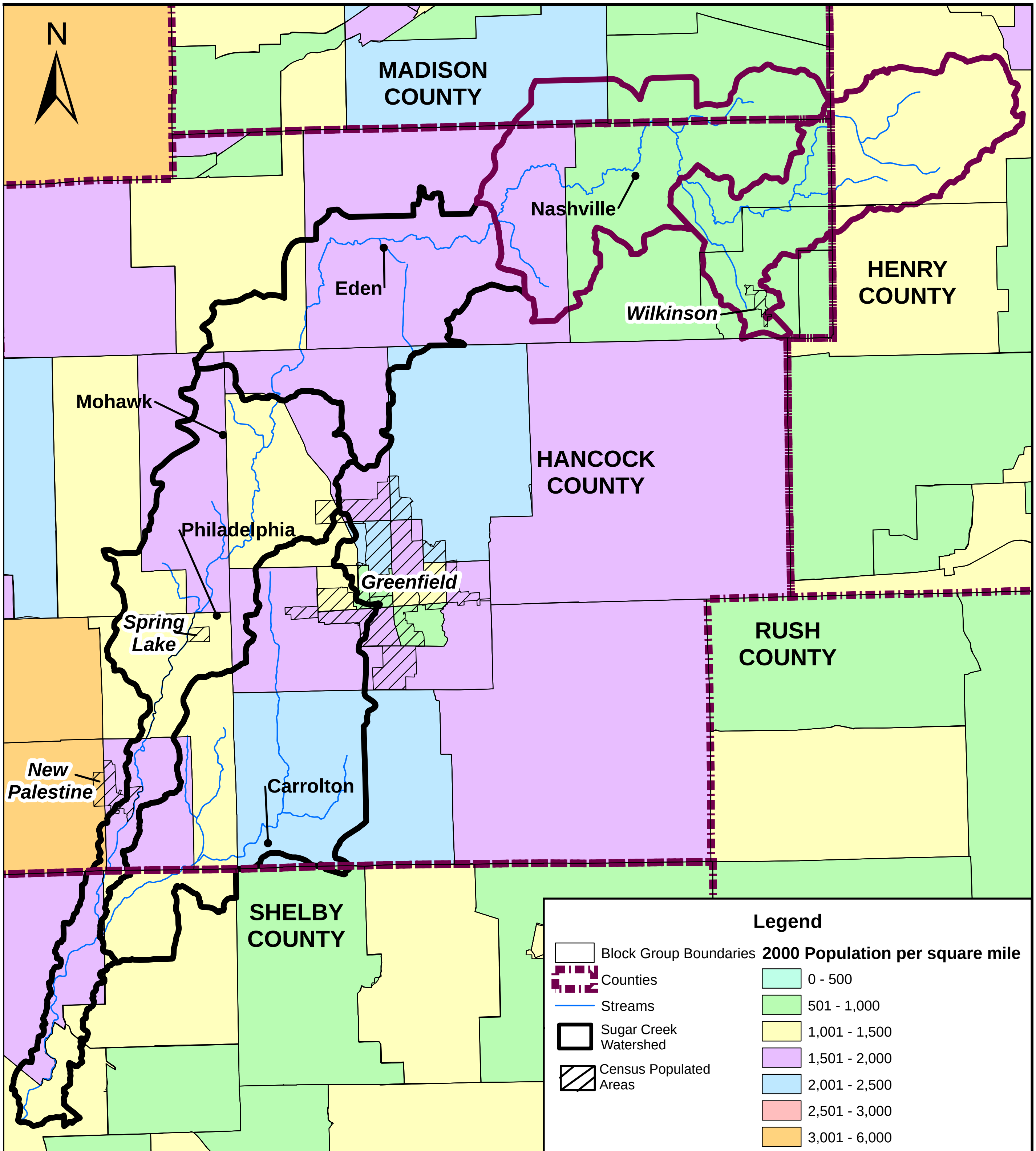
Growth in the basin must be sustainable for the protection and improvement of rivers and streams water quality as well as the protection of high-quality farmland and other valuable natural resources. Therefore, the implementation of this plan will have a focus both on the urban and rural areas of the Watershed.

Table 5 Trends in Land Development: 2006 Population Estimates for Sugar Creek Watershed Counties

	Population Estimates and Counts							Change July 1, 2000 to July 1, 2006	
	July 1, 2000	July 1, 2001	July 1, 2002	July 1, 2003	July 1, 2004	July 1, 2005	June 1, 2006	Number	Percent
Indiana	**6,091,955**	**6,125,677**	**6,154,739**	**6,196,269**	**6,226,537**	**6,271,973**	**6,324,990**	**233,035**	**3.80%**
Hancock	55,660	56,699	58,249	59,644	60,965	63,138	65,050	9,659	17.40%
Henry	48,469	48,353	48,056	47,770	47,662	47,244	46,947	-1,561	-3.20%
Madison	133,299	132,404	131,922	130,982	130,482	130,412	130,575	-2,783	-2.10%
Shelby	43,610	43,910	43,770	43,599	43,711	43,766	44,114	669	1.50%

Population Size Rank

	July 1, 2000	July 1, 2001	July 1, 2002	July 1, 2003	July 1, 2004	July 1, 2005	July 1, 2006
Hancock	25	25	25	25	25	25	25
Henry	27	27	28	29	29	30	31
Madison	10	10	10	10	10	10	12
Shelby	33	33	33	33	33	33	33



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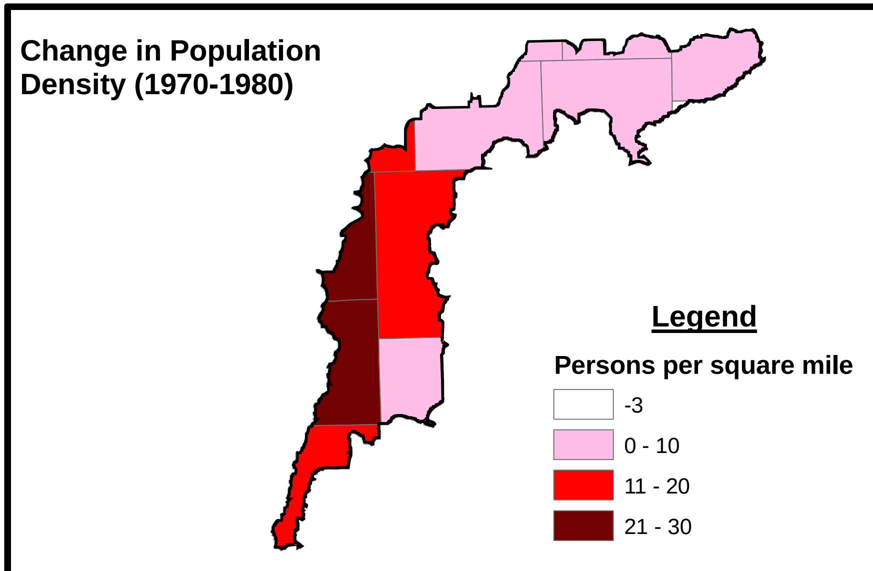
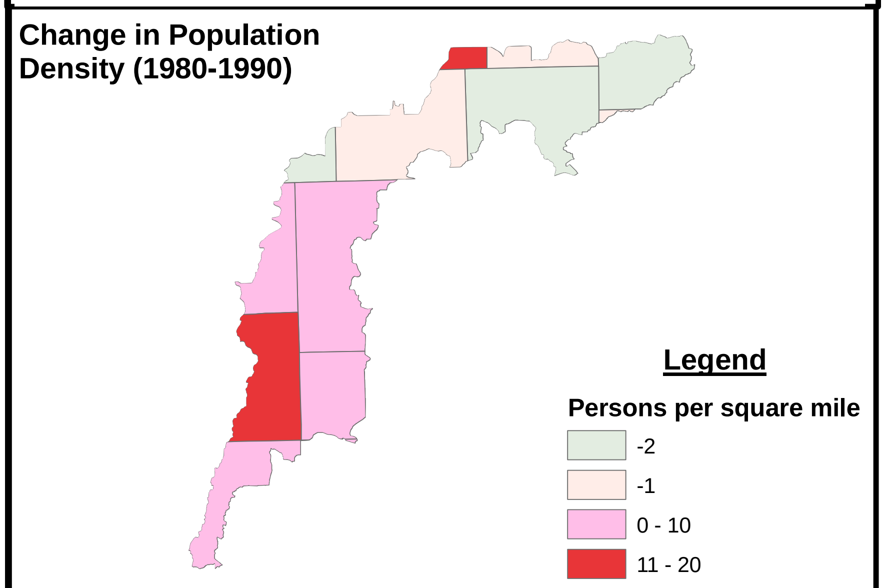
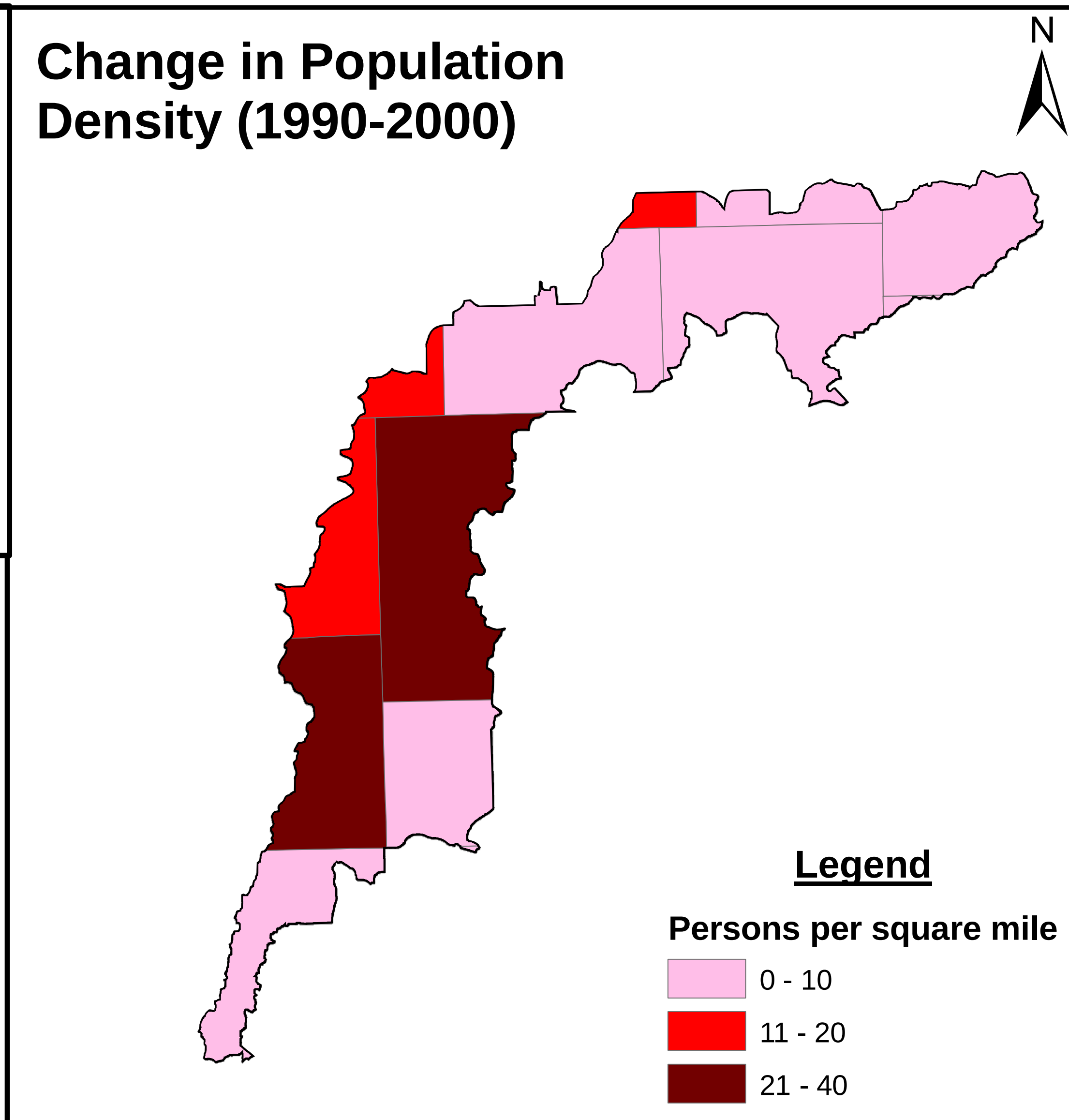
TITLE: 2000 Population Estimate	PROJECT: Sugar Creek Watershed Project			
BASE LAYER: United States Census Bureau	PROJECT NO. 07065	EXHIBIT: 4	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS	







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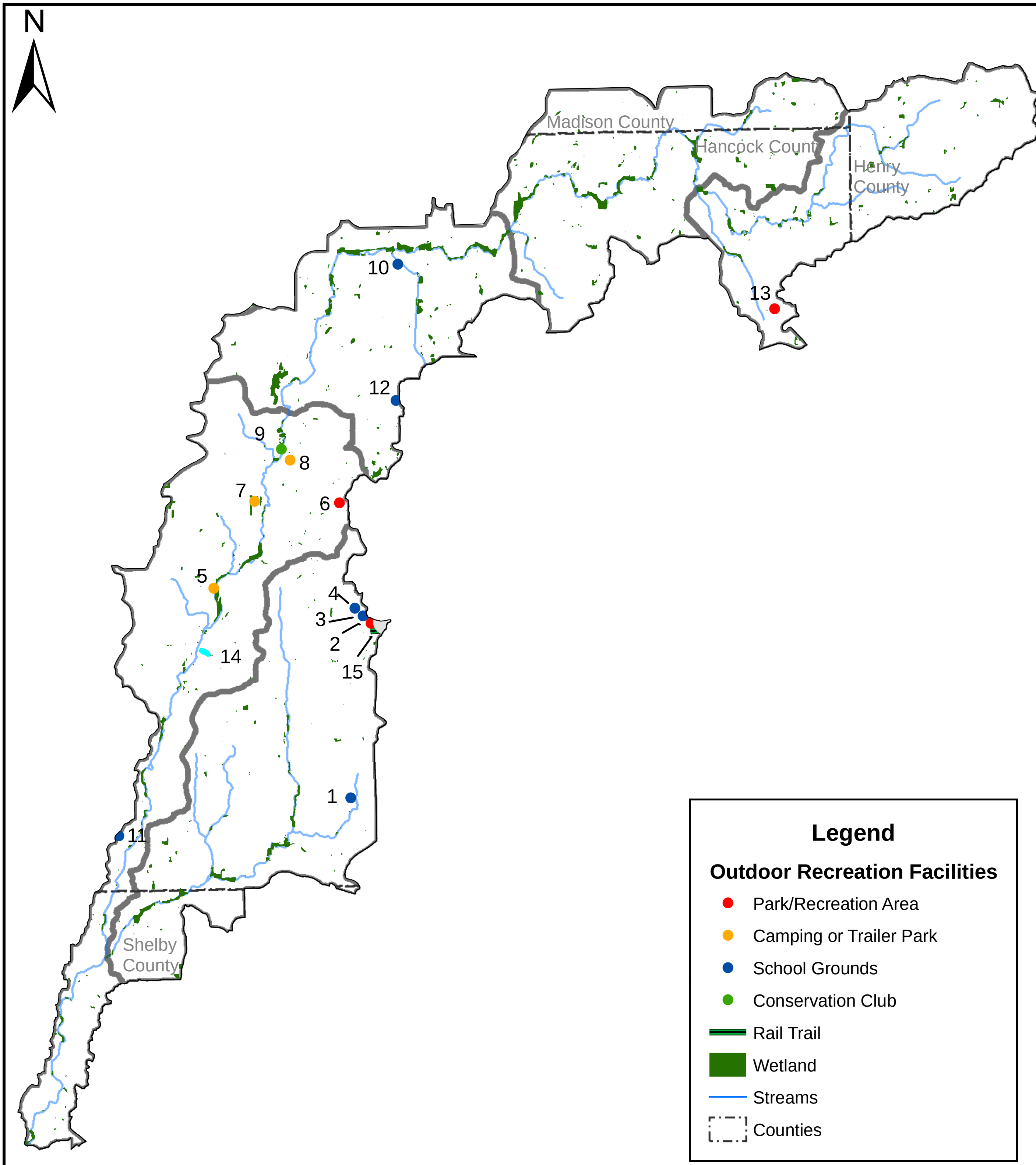
TITLE:	**Change in Population Density**
BASE LAYER:	United States Census Bureau
CLIENT:	Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140
PROJECT:	**Sugar Creek Watershed Project**
PROJECT NO.:	07065
EXHIBIT:	5
SHEET:	1
OF:	1
QUADRANGLE:	N/A
DATE:	10/29/08
SCALE:	NTS

Recreational Resources and Significant Natural Areas

A number of recreational opportunities are scattered throughout the Sugar Creek Watershed. The recreational facilities, parks, and trails within the Sugar Creek Watershed serve as an opportunity for the public to enjoy the natural landscape within their community as well as learn about valuable natural resources within the Sugar Creek Watershed. Activities such as walking, canoeing and driving the Watershed create educational outreach opportunities to teach stakeholders and children of all ages about the dynamic aquatic system within their community. They range from parks and conservation clubs to camping and activities on school grounds (Exhibit 6, and Table 6). Wetlands within the Sugar Creek Watershed provide important filtration functions as well as serve as a productive habitat for many species. Sugar Creek is a unique surface-water resource that is home to several endangered species and species of special concern (see section entitled Threatened and Endangered Species on page 41 of this plan). Many portions of Sugar Creek still have natural riparian zones adjacent to the river which provide habitat for a variety of wildlife and offer opportunities for wildlife viewing and enjoyment.

Table 6 Unique Recreational Resources: Outdoor Recreational Facilities and Trails

Site	City	Type of Facility	Number in Exhibit 6
Brandywine Elementary School	Greenfield	School Grounds	1
Commons Park	Greenfield	Park/Recreation Area	2
Weston Elementary School	Greenfield	School Grounds	3
St Michael's School	Greenfield	School Grounds	4
S & H Campground	Greenfield	Camping or Trailer Park	5
Beckenholdt Park	Greenfield	Park/Recreation Area	6
Heartland Resort (Sugar Creek Resort Club)	Greenfield	Camping or Trailer Park	7
Mohawk Campground	Greenfield	Camping or Trailer Park	8
Greenfield Conservation Club	Greenfield	Conservation Club	9
Eden Elementary School	Greenfield	School Grounds	10
New Palestine Elementary School	New Palestine	School Grounds	11
Maxwell Middle School	Maxwell	School Grounds	12
Wilkinson City Park (War Memorial)	Wilkinson	Park/Recreation Area	13
Spring Lake	Spring Lake	Park/Recreation Area	14
Trails	**County**	**Type of Trail**	
Pennsy Trail	Hancock	Hiking/biking	15



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TITLE:	**Unique Recreational Resources**
PROJECT:	**Sugar Creek Watershed Project**
BASE LAYER:	Indiana Geological Survey
PROJECT NO.	07065
EXHIBIT:	6
SHEET:	1 OF: 1
CLIENT:	Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140
QUADRANGLE:	N/A
DATE:	10/29/08
SCALE:	NTS

Current Watershed Description

Watershed Boundaries

The watershed consists of approximately 84,750 acres. It extends from the west-central portion of Henry County into southeast Madison and northeast Hancock counties. It then extends through the east central portion of Hancock County into northwest Shelby County. The majority of the basin (79%) is located within Hancock County (Exhibit 6).

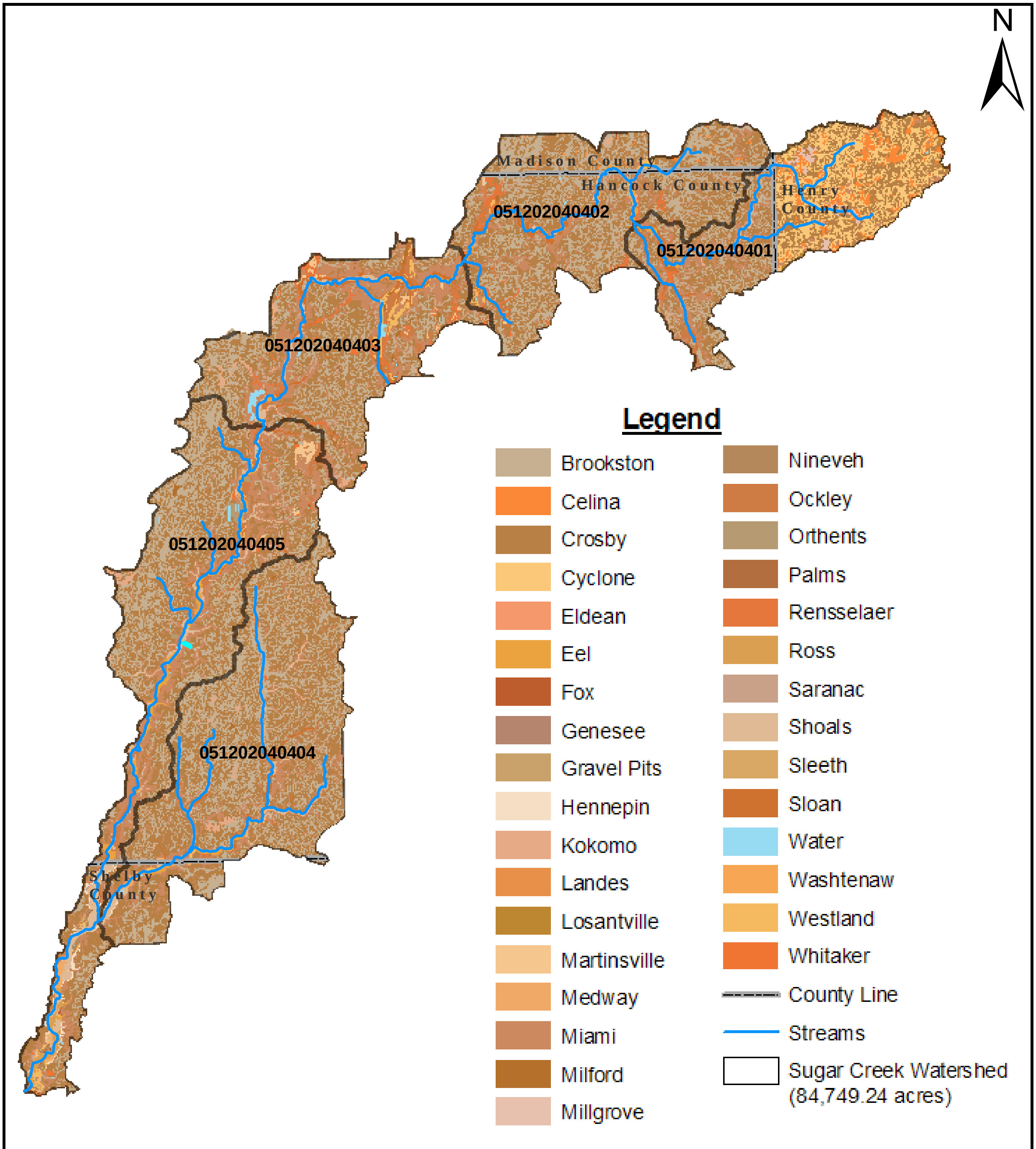
Geology and Soils

The bedrock geology of Indiana bedrock formed during the Paleozoic Era. The principal bedrock formations in the Sugar Creek Watershed are associated mainly with rocks of Silurian and Devonian age, and consist mainly of limestone and dolomites with some shale or argillaceous zones, whereas the Silurian material consists of limestone, dolomite, and much more argillaceous material than in the Devonian age rock (Uhl, 1975).

The topography of Sugar Creek, which lies in the Tipton Till Plain physiographic unit, consists of a flat to slightly rolling plain. Streams tend to have very low gradients, and lie only a few feet below the general land surface. Extensive alteration of the drainage system has occurred via ditching and the installation of drainage tiles. This has resulted in excellent land for agricultural production. Some rolling and hummocky areas may be present and would be related to glacial activity. Gradient throughout the Watershed ranges from 1,110 elevation to 750 elevation, or a change of 360 feet.

Parent materials are the unconsolidated mass in which a soil forms. Sugar Creek lies in a portion of Indiana that has had extensive glacial activity with multiple advances and retreats of the ice sheets during the Pleistocene Epoch. The materials laid down by glaciers in the Sugar Creek Watershed are mostly of local origin, but some materials might have originated as far away as Canada. This deposited material of gravel, sand, silt, and clay was then reworked as the glaciers melted resulting in the aquifer systems being used today. Sand and gravel deposits in the Sugar Creek valleys are extensive and have been excavated for use as construction materials.

There are many different soil types throughout Indiana based on their unique characteristics (Exhibit 7; Table 7). Many counties arrange these soil types by like characteristics into groups, or major soil associations. A soil association is a geographic area consisting of landscapes on which soils are formed. Soil associations are groups of soil types that generally share one or more common characteristics; such as parent material or drainage capability. These soil associations provide general characteristics for the specific soil association, but should not be used at the decision making level. The major soil associations in the Sugar Creek Watershed are listed in Table 8 along with their general characteristics, the percent of the county where they are found, and their use.



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TITLE: **Soil Survey of Hancock, Henry, Madison, and Shelby Counties, Indiana**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 7	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS

Table 7 Soil Survey Legends

MU Symbol	Map Unit Name	Acres
	HANCOCK COUNTY	
Br	Brookston silty clay loam	20,058.66
CrA	Crosby silt loam, 0-3% slopes	27,845.23
Ee	Eel silt loam	1,263.78
Ge	Genesee silt loam	225.64
Gp	Pits, gravel	64.93
Ko	Kokomo silty clay loam	465.89
MaA	Martinsville loam, 0-2% slopes	178.25
MaB2	Martinsville loam, 2-6% slopes	107.06
MmA	Miami silt loam, 0-2% slopes	1,563.86
MmB2	Miami silt loam, 2-6% slopes	7,139.67
MmC2	Miami silt loam, 6-12% slopes	577.79
MmD2	Miami silt loam, 12-18% slopes	337.79
MpC3	Miami complex, 6-12% slopes, severely eroded	908.83
MpD3	Miami complex, 12-18% slopes, severely eroded	103.10
Mr	Milford silty clay loam	304.97
OcA	Ockley silt loam, 0-2% slopes	381.67
OcB2	Ockley silt loam, 2-6% slopes, eroded	442.77
OkC2	Ockley complex, 6-12% slopes, eroded	228.29
Or	Orthents	115.10
Ps	Palms muck	59.42
Re	Rensselaer silty clay loam	897.44
Sh	Shoals silt loam	1,412.79
So	Sloan silty clay loam	1,228.07
We	Westland clay loam	367.28
Wh	Whitaker loam	176.11
	Hancock County Total:	**66,454.38**

MU Symbol	Map Unit Name	Acres
	HENRY COUNTY	
CeB2	Celina silt loam, 1-6% slopes, eroded	913.23
CrA	Crosby silt loam, 0-3%slopes	2,726.94
Cy	Cyclone silty clay loam	3,153.74
EdA	Eldean silt loam, 0-2% slopes	4.34
EdB2	Eldean silt loam, 2-6% slopes, eroded	5.63
Ge	Genesee loam, occasionally flooded	6.73
La	Landes loam, rarely flooded	20.02
LeB2	Losantville silt loam, 2-6% slopes, eroded	20.96
LeC2	Losantville silt loam, 6-12% slopes, eroded	11.12
LhC3	Losantville clay loam, 6-12%, severely eroded	55.25
MlA	Miami silt loam, gravelly substratum, 0-2% slopes	13.12
MlB2	Miami silt loam, gravelly substratum, 2-6% slopes, eroded	12.33
MmB2	Miamian silt loam, 2-6% slopes, eroded	247.28
Mx	Millgrove loam	211.72
Wb	Washtenaw silt loam	17.55
	Henry County Total:	**7,419.95**

	MADISON COUNTY	
Bs	Brookston silty clay loam	1,831.04
CnA	Celina silt loam, 0-2% slopes	8.69
CnB2	Celina silt loam, 2-6% slopes, moderately eroded	100.60
CrA	Crosby silt loam, 0-2% slopes	1,727.01
CrB2	Crosby silt loam, 2-6% slopes, moderately eroded	162.56
Es	Eel silt loam	28.95
FoB2	Fox silt loam, 2-6% slopes, moderately eroded	5.71
FoC2	Fox silt loam, 6-12% slopes, moderately eroded	2.02
Kc	Kokomo silty clay loam	18.27
MnA	Miami silt loam, 0-2% slopes	11.09
MnB2	Miami silt loam, 2-6% slopes, moderately eroded	160.91
MnC2	Miami silt loam, 6-12% slopes, moderately eroded	5.24
MpB3	Miami soils, 2-6% slopes, severely eroded	4.23
MpC3	Miami soils, 6-12% soils, severely eroded	10.52
Sl	Sleeth silt loam	4.57
Wd	Westland silty clay loam	69.06
	Madison County Total:	**4,150.46**

	SHELBY COUNTY	
Br	Brookston silty clay loam	1,029.54
CrA	Crosby silt loam, 0-2% slopes	2,203.64
CrB	Crosby silt loam, 2-4% slopes	351.63
CsB	Crosby-Miami silt loam, 0-6% slopes	171.30
Ee	Eel silt loam	65.43
FoA	Fox loam, 0-2% slopes	21.14
FoB2	Fox loam, 2-6% slopes, eroded	3.32
FxB3	Fox clay loam, 2-6% slopes, severely eroded	20.96
FxC3	Fox clay loam, 6-12% slopes, severely eroded	10.14
Ge	Genesee loam	29.71
Gp	Gravel pits	3.84
HeE	Hennepin loam, 18-25% slopes	82.21
HeF	Hennepin loam, 25-50% slopes	100.35
MaA	Martinsville loam, 0-2% slopes	2.67
Me	Medway silt loam	173.31
MlB2	Miami silt loam, 2-6% slopes eroded	618.04
MlC2	Miami silt loam, 6-12% slopes, eroded	47.53
MlD2	Miami silt loam, 12-18% slopes	50.89
MmB3	Miami clay loam, 2-6% slopes, severely eroded	36.81
MmC3	Miami clay loam, 6-12% slopes, severely eroded	173.11
MmD3	Miami clay loam, 12-18% slopes, severely eroded	94.95
NnA	Nineveh loam, 0-2% slopes	102.00
NnB	Nineveh loam, 2-6% slopes	4.06
OcA	Ockley loam, 0-2% slopes	30.96
Re	Rensselaer clay loam	11.10
Rt	Ross silt loam	208.51
Sa	Saranac silty clay loam	12.50
Sh	Shoals silt loam	627.83
Sm	Sleeth loam	24.50
Wc	Westland clay loam	134.72
We	Westland and Brookston loams, overwash	6.49
Wh	Whitaker loam	16.40
	Shelby County Total:	**6,469.58**
	Grand Total:	**84,494.37**

Table 8 Major Soil Associations for Counties with Land in the Sugar Creek Watershed*			
Hancock County			
Soil Association	**Characteristics**	**County Coverage**	**Use**
Crosby-Brookston	Deep Somewhat poorly drained and very poorly drained nearly level silt loams and silty clay loams that formed in glacial till or in loamy sediment and underlying glacial till; on uplands	73%	When adequately drained, the soils are well suited to intensive row cropping, although wetness is a main limitation. Crops grown include corn, soybeans and small grains. Severe limitations for septic systems.
Miami-Crosby	Deep, well drained and somewhat poorly drained, nearly level to strongly sloping silt loams and clay loams that formed in glacial till; on uplands	17%	Suitable for crop production if managed properly. Crops include corn, soybeans, small grain, and grasses and legumes for forage. Well suited for livestock farming. Moderate to severe limitations for septic systems.
Ockley-Sloan-Shoals	Deep, well drained, somewhat poorly drained and very poorly drained, nearly level to moderately sloping silt loams and silty clay loams that formed in glacial outwash and alluvium; on terraces, outwash plains and bottom lands	10%	Well suited to intensive cropping. Erosion is a limitation on slopes, and wetness is also a limitation. Commonly used for corn, soybeans and small grain. Slight limitations for residential development. Limited areas have severe limitations for this purpose due to flooding and high water tables.
Henry County			
Crosby-Cyclone-Miamian	Deep, nearly level and gently sloping, somewhat poorly drained, poorly drained and well drained, medium textured and moderately fine textured soils formed in loess or silty material and in the underlying loamy glacial till; on till plains and moraines	46%	Used mainly for cultivated crops including corn, soybeans and small grain. Some pasture, but overgrazing is a concern. Wetness limits uses. Poorly suited for septic systems.
Miamian-Losantville	Deep, gently sloping to steep, well drained, medium textured and moderately fine textured soils formed in glacial till or in a thin mantle of loess and the underlying loamy glacial till; on till plains and moraines	29%	Fairly well suited to cultivated crops. Cleared hilly areas are suited to clay. Overgrazing is a concern in areas. Large portions of this association are wooded and include species such as walnut, white ash, sugar maple and black cherry. Fairly to well suited for sanitary systems.
Madison County			
Brookston-Crosby	Nearly level and gently sloping soils formed in medium-textured till on uplands	61%	Suitable for all crops commonly grown in the county. Artificial drainage is needed and a good program for fertilization.
Miami-Celina	Gently sloping to steep soils formed in medium-textured glacial drift on uplands	8%	Susceptible to erosion if cultivated. Soils are acidic and often require the addition of lime. Proper fertilization is recommended.
Fox-Eel	Nearly level to strongly sloping soils on terraces and flood plains	14%	Level areas are suitable for crops. Sloping soils must be well managed for crop production. Periodic additions of lime and fertilizer may be needed for acceptable yields.
Shelby County			
Crosby-Brookstan	Deep, somewhat poorly drained and very poorly drained, nearly level and gently sloping, medium-textured and moderately fine textured soils; on uplands	61%	Soils can be intensively cropped if properly drained and managed. Corn and soybeans are the main crop, with some small grain and meadow. This association has severe limitations for urban development or for septic systems.
Genesee-Ross-Shoals	Deep, well-drained and somewhat poorly drained, nearly level, medium-textured soils; on flood plains	8%	Used mainly for crops (corn and soybeans). Some areas are in trees and grasses. Severe limitations for urban development and septic systems.

*Information taken from the Soil Conservation Service Soil Surveys for each county.

Septic Tank Suitability

In rural areas, households often depend on septic tank absorption fields. These waste treatment systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high water tables, shallow compact till and coarse soils present limitations for septic systems. While system design can often overcome these limitations (i.e. perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system.

Heavy clay soils require larger (and therefore more expensive) absorption fields; while sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems.

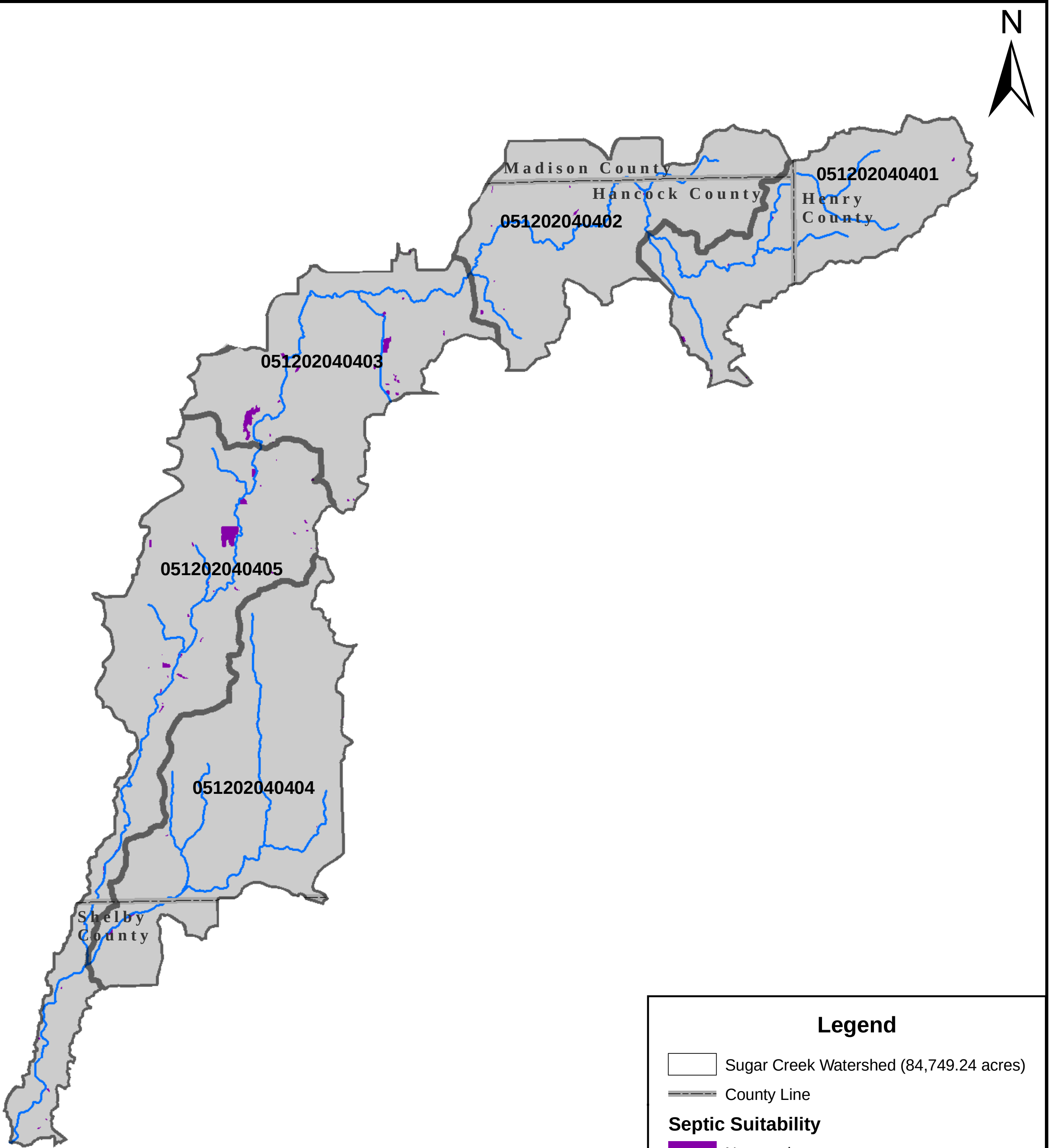
The septic disposal system is considered failing when the system exhibits one or more of the following:
1. The system refuses to accept sewage at the rate of design application thereby interfering with the normal use of plumbing fixtures
2. Effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters
3. Effluent is discharged from the system causing contamination of a potable water supply, ground water, or surface water.

Prior to 1990, residential homes on 10 acres or more of land -- and at least 1,000 feet from a neighboring residence -- did not have to comply with any septic system regulations. A new septic code in 1990 fixed this loophole but many of these homes still don't have functioning septic systems. The septic effluent from many of these older homes discharges into field tiles and eventually flows to open ditches. Unfortunately, the high cost of septic repair (typically from $4,000 to $15,000) has been an impediment to modernization.

Individual septic sites must be evaluated on a case-by-case basis to determine septic system suitability. Systems for new construction cannot be placed in the 100-year flood plain and systems for existing homes must be above the 100-year flood elevation.

Exhibit 8 is a map of soil classes related to septic suitability within the Watershed. Soils labeled "very limited" indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 95% of the Sugar Creek Watershed is mapped as "very limited" with regards to soils being suitable for septic systems.

Approximately 5% of the soils within the Watershed are "not rated." These soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. Soils designated "not limited" were not found in the Sugar Creek Watershed.



Legend

Sugar Creek Watershed (84,749.24 acres)

County Line

Septic Suitability

Not rated

Very limited

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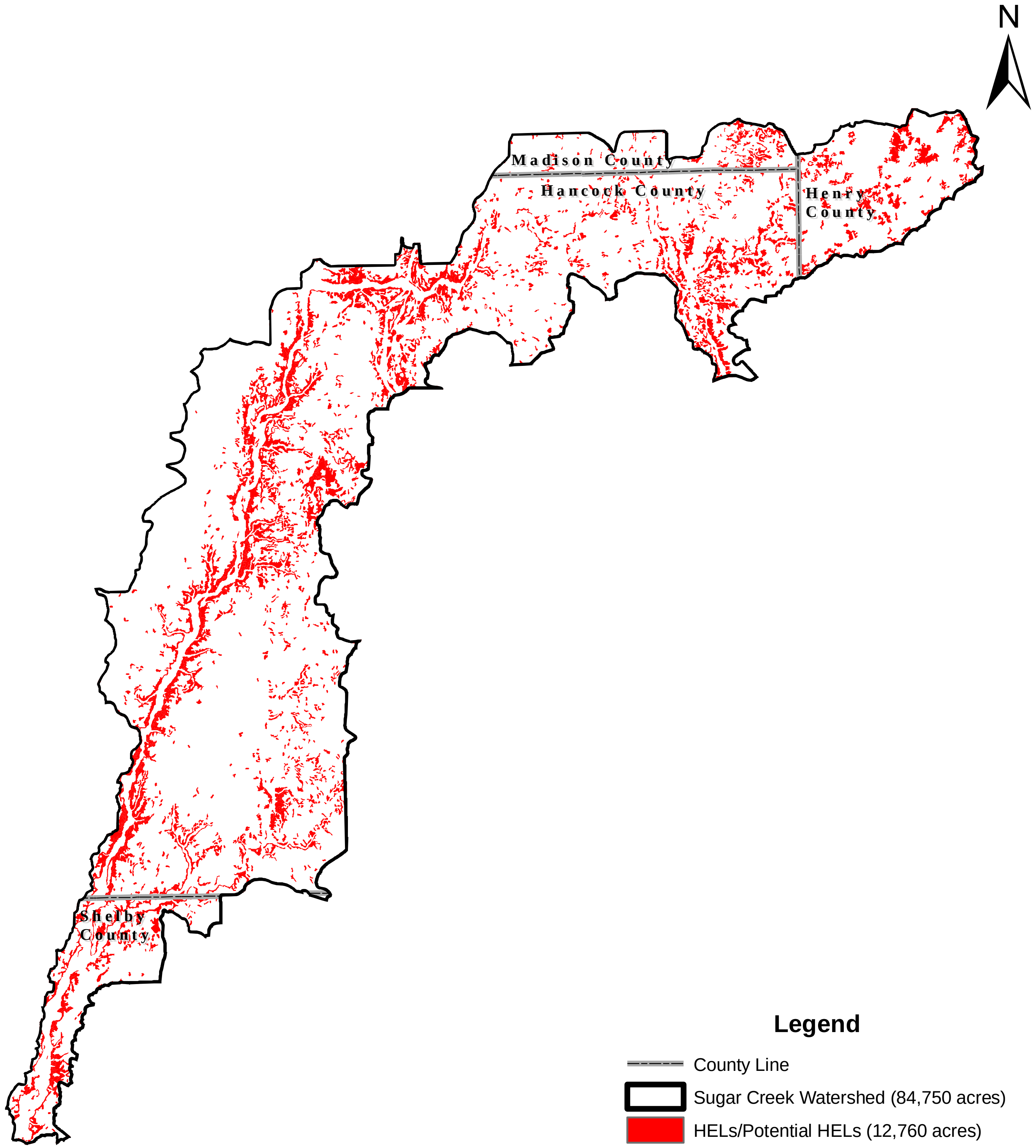
	BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 8	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 5/11/07	SCALE: NTS

Highly Erodible Soils

Erosion is a natural process within stream ecosystems; however excessive erosion negatively impacts the health of the Watershed. Erosion throughout the Watershed increases sedimentation of the streambeds which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. As water flows over land and enters the stream as runoff it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms. Highly erodible soils and potentially highly erodible soils in the Sugar Creek Watershed are mapped in Exhibit 9. The data used to create Exhibit 9 was collected from the NRCS offices of Hancock, Henry, Madison, and Shelby counties. A total of approximately 12,760 acres or 15% of the Watershed is considered highly erodible or potentially highly erodible.

Highly erodible soils are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. Rainfall within the Sugar Creek Watershed is moderately heavy with an annual average of 43.43 inches. Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

In areas with highly erodible soils special care must be taken to insure that land use practices do not result in severe wind or water erosion. The soil types and acreages of highly erodible lands (HEL) in the Sugar Creek Watershed are listed by county in Table 9. Although natural erosion cannot be prevented, the effects of runoff can be moderated so that it does not diminish the health of the Watershed. The windshield survey identified eroded stream banks and sedimentation of streambeds as problems within the Sugar Creek Watershed. Many Best Management Practices or BMPs have been designed for both urban and rural landscapes to address this problem.



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TITLE: HELs/Potential HELs Map	PROJECT: **Sugar Creek Watershed Project**			
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 9	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS	

Table 9 HEL and Potential HEL Soils Within Sugar Creek Watershed		
Soil Code	**Map Unit Name**	**Acres**
	HANCOCK COUNTY	
HELs/Potential HELs		
Gp	Pits, gravel	64.93
MmB2	Miami silt loam, 2-6% slopes	7,139.67
MmC2	Miami silt loam, 6-12% slopes	577.79
MmD2	Miami silt loam, 12-18% slopes	337.79
MpC3	Miami complex, 6-12% slopes, severely eroded	908.83
MpD3	Miami complex, 12-18% slopes, severely eroded	103.10
OcB2	Ockley silt loam, 0-2% slopes	442.77
OkC2	Ockley complex, 6-12% slopes, eroded	228.29
	Total HELs/Potential HELs:	**9,803.16**
	HENRY COUNTY	
HELs/Potential HELs*		
CeB2	Celina silt loam, 1-6% slopes, eroded	913.23
EdB2	Eldean silt loam, 2-6% slopes, eroded	5.63
LeB2	Losantville silt loam, 2-6% slopes, eroded	20.96
LeC2	Losantville silt loam, 6-12% slopes, eroded	11.12
LhC3	Losantville clay loam, 6-12% slopes, severely eroded	55.25
MlB2	Miami silt loam, gravelly substratum, 2-6% slopes, eroded	12.33
MmB2	Miamian silt loam, 2-6% slopes, eroded	247.28
	Total HELs/Potential HELs:	**1,265.79**
	MADISON COUNTY	
HELs/Potential HELs*		
CnB2	Celina silt loam, 2-6% slopes, moderately eroded	100.60
CrB2	Crosby silt loam, 2-6% sloes, moderately eroded	162.56
FoB2	Fox silt loam, 2-6%, moderately eroded	5.71
FoC2	Fox silt loam, 6-12% slopes, moderately eroded	2.02
MnB2	Miami silt loam, 2-6% slopes, moderately eroded	160.91
MnC2	Miami silt loam, 6-12% slopes, moderately eroded	5.24
MpB3	Miami soils, 2-6% slopes, severely eroded	4.23
MpC3	Miami soils, 6-12% slopes, severely eroded	10.52
	Total HELs/Potential HELs:	**451.78**
	SHELBY COUNTY	
HELs/Potential HELs*		
FoB2	Fox loam, 2-6% slopes, eroded	3.32
FxB3	Fox clay loam, 2-6% slopes, severely eroded	20.96
FxC3	Fox clay loam, 6-12% slopes, severely eroded	10.14
HeE	Hennepin loam, 18-25% slopes	82.21
HeF	Hennepin loam, 25-50% slopes	100.35
MlB2	Miami silt loam, 2-6% slopes	618.04
MlC2	Miami silt loam, 6-12% slopes	47.53
MlD2	Miami silt loam, 12-18% slopes	50.89
MmB3	Miami clay loam, 2-6% slopes, severely eroded	36.81
MmC3	Miami clay loam, 6-12% slopes, severely eroded	173.11
MmD3	Miami clay loam, 12-18% slopes, severely eroded	94.95
	Total HELs/Potential HELs:	**1,238.31**
	Grand Total HELs/Potential HELs:	**12,759.04**

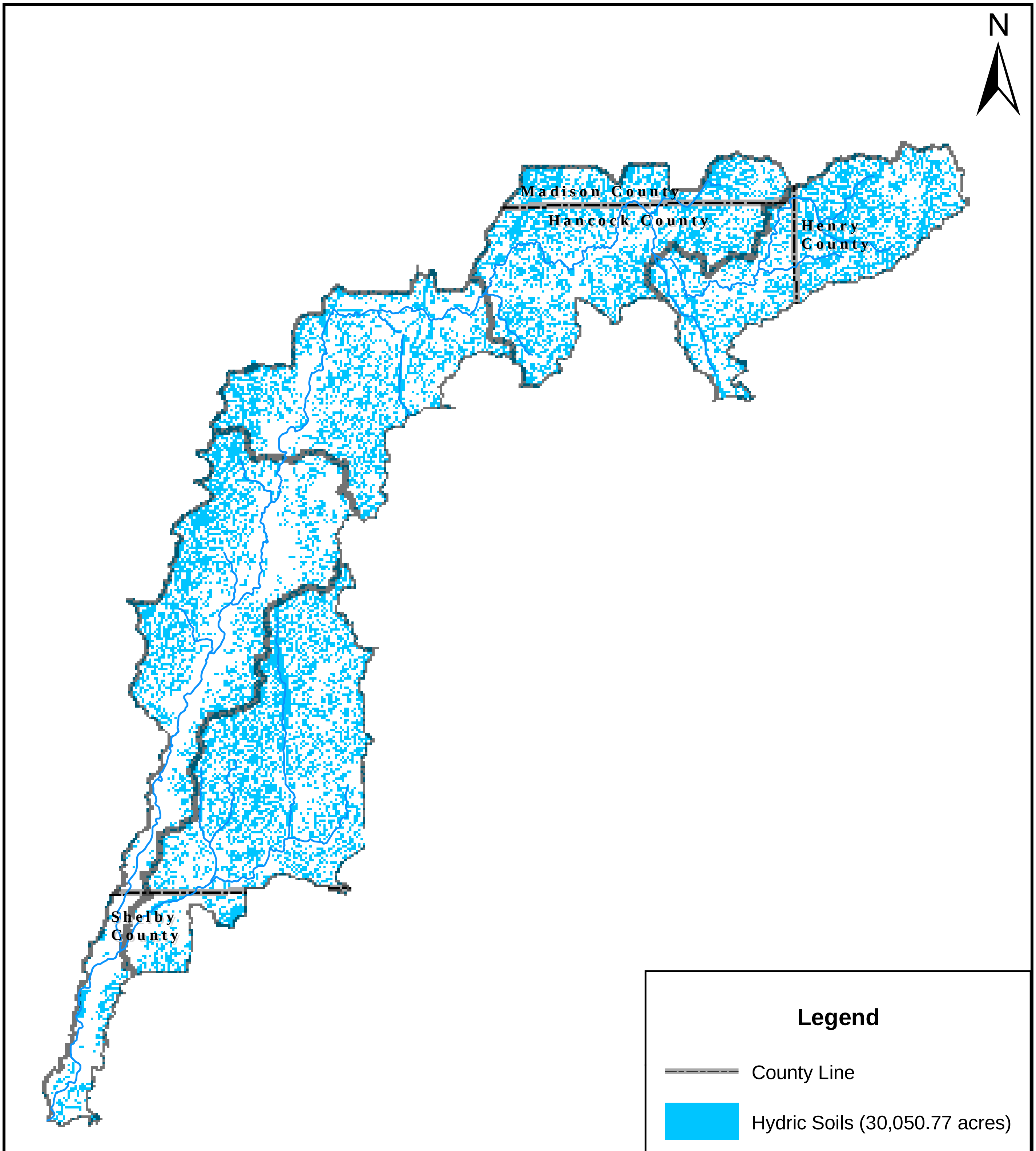
* - HELs/Potential HELs were assumed based on USDA NRCS Map Unit Legend Soil Reports 12/1/06

Hydric Soils

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Approximately 30,300 acres or 36% of the soils in the Sugar Creek Watershed are considered hydric (Exhibit 10; Table 10). However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils can be used to consider possible locations of wetland creation or enhancement. Wetland creation involves many components in addition to soil type that must be considered before moving forward with wetland design and creation.

Table 10 Hydric Soils Within Sugar Creek Watershed

MU SYM	Map Unit Name	Acres
	HANCOCK COUNTY	
Br	Brookston silty clay loam	20,058.66
Ko	Kokomo silty clay loam	465.89
Mr	Milford silty clay loam	304.97
Ps	Palms muck	59.42
Re	Rensselaer silty clay loam	897.44
So	Sloan silty clay loam	1,228.07
We	Westland clay loam	367.28
	Hancock County Total:	**23,381.74**
	HENRY COUNTY	
Cy	Cyclone silty clay loam	3,153.74
Mx	Millgrove loam	211.72
Wb	Washtenaw silt loam	17.55
	Henry County Total:	**3,383.02**
	MADISON COUNTY	
Bs	Brookston silty clay loam	1,831.04
Kc	Kokomo silty clay loam	18.27
Wd	Westland silty clay loam	69.06
	Madison County Total:	**1,918.37**
	SHELBY COUNTY	
Br	Brookston silty clay loam	1,029.54
Me	Medway silt loam	173.31
Re	Rensselaer clay loam	11.10
Sa	Saranac silty clay loam	12.50
Wc	Westland clay loam	134.72
We	Westland and Brookston loams, overwash	6.49
	Shelby County Total:	**1,367.65**
	Grand Total:	**30,050.78**



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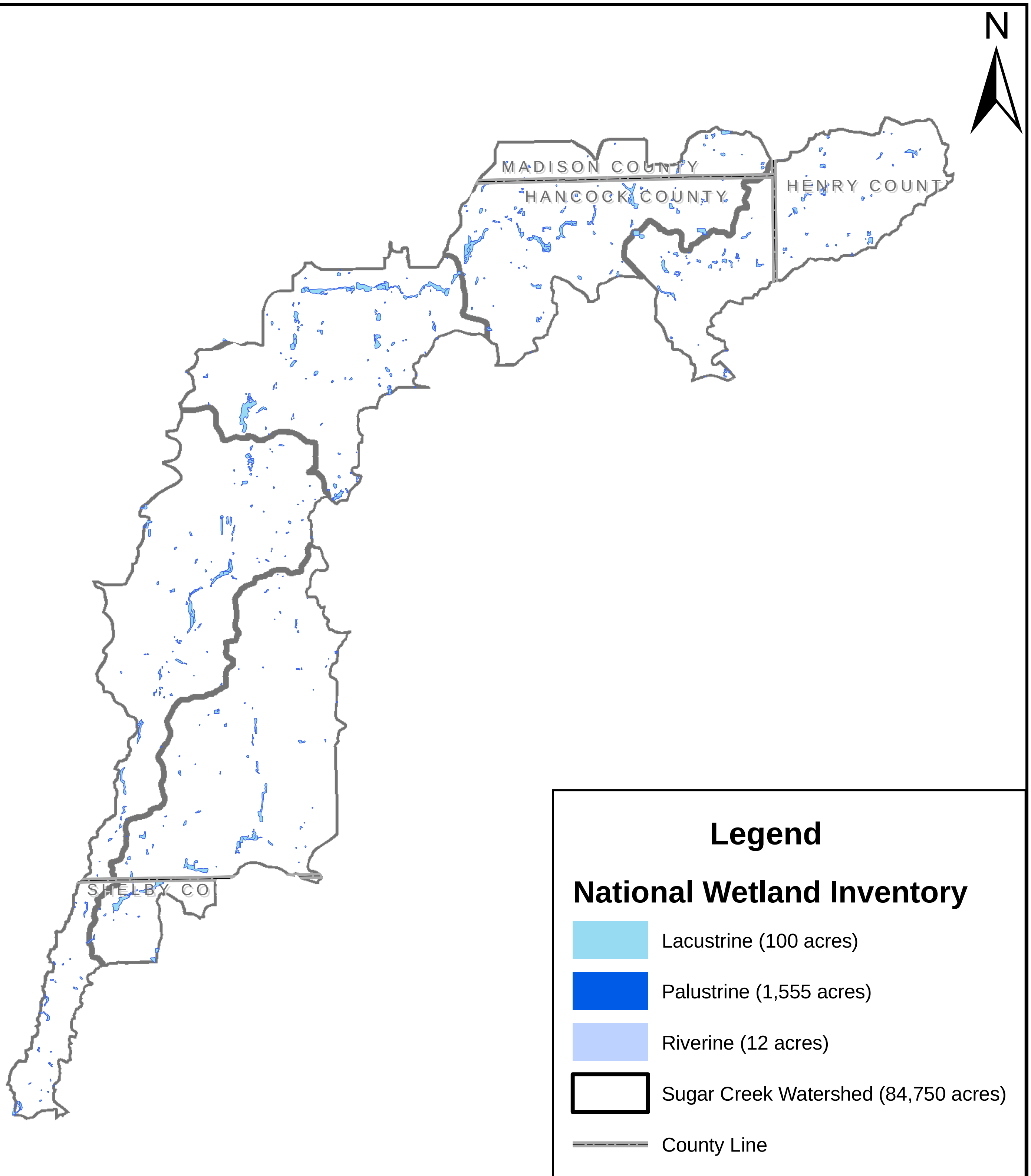
	BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 10	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS

Wetlands

Wetlands are a valuable resource not only for the habitat they create but for the water filtration they provide within a watershed. Wetland classifications are based on attributes which can be measured and when combined, help to define the nature of a specific wetland and distinguish it from others. The three wetland classifications within the Sugar Creek Watershed include lacustrine, palustrine, and riverine. There are 1,667 acres (2%) of wetlands scattered throughout the Sugar Creek Watershed. Among the three wetland classification 100 acres are considered lacustrine, 1,555 acres are palustrine, and 12 acres are riverine (Exhibit 11, Table 11).

Lacustrine wetlands are associated with lakes and are characterized by a lack of trees and a dominance of emergent and submersed aquatic vegetation. Lacustrine wetlands typically extend from the shoreline to depths of 6.5 feet or until emergent vegetation no longer persists. Lacustrine wetlands are important in removing sediment and nutrients as well as providing habitat for fish and macroinvertebrates which are a vital food source within a lake ecosystem. Palustrine wetlands are related to marshes, swamps and bogs. Palustrine habitats are wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. Palustrine habitats have structural features that provide feeding, breeding, nesting, over wintering and migration habitat for wildlife in addition to their natural filtration properties. Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Riverine wetlands are directly affected by streamflow including overbank and backwater conditions. Riverine wetlands are very important in sediment retention as well as pollutant removal.

Table 11 National Wetland Inventory: Wetlands Within Sugar Creek Watershed		
Attribute	**Wetland Habitat Classification**	**Acres**
	LACUSTRINE	
L1UBHH	Limnetic, unconsolidated bottom, permanently flooded, diked/impounded	74.05
L1UBHX	Limnetic, unconsolidated bottom, permanently flooded, excavated	25.72
	Lacustrine Total	**99.77**
	PALUSTRINE	
PEM/FO1F	Emergent/Forested, broad leaved deciduous, seasonally flooded/saturated	9.08
PEM/SS1C	Emergent/Scrub-shrub, broad leaved deciduous, seasonally flooded	10.57
PEMA	Emergent, irregularly exposed, temporarily flooded	43.92
PEMAD	Emergent, temporarily flooded, partially drained/ditched	4.58
PEMC	Emergent, seasonally flooded	36.21
PEMCH	Emergent, seasonally flooded, diked/impounded	0.71
PEMCX	Emergent, seasonally flooded excavated	0.40
PEMF	Emergent, semipermanently flooded	9.21
PFO1/EMA	Forested, broad-leaved deciduous/Emergent, temporarily flooded	6.82
PFO1/EMC	Forested, broad-leaved deciduous/Emergent, seasonally flooded	1.63
PFO1A	Forested, broad-leaved deciduous, temporarily flooded	1,241.43
PFO1C	Forested, broad-leaved deciduous, seasonally flooded	33.56
PSS1/EMA	Scrub-shrub, broad-leaved deciduous/Emergent, temporarily flooded	0.25
PSS1/EMF	Scrub-shrub, broad-leaved deciduous/Emergent, semipermanently flooded	0.42
PSS1A	Scrub-shrub, broad-leaved deciduous, temporarily flooded	3.27
PSS1C	Scrub-shrub, broad-leaved deciduous, seasonally flooded	2.78
PSS1F	Scrub-shrub, broad-leaved deciduous, semipermanently flooded	4.43
PUB/ABG	Unconsolidated bottom/Aquatic bed, intermittently exposed	1.96
PUB/SS1F	Unconsolidated bottom/Scrub-shrub, broad-leaved deciduous, semipermanently flooded	0.26
PUBF	Unconsolidated bottom, semipermanently flooded	2.58
PUBFX	Unconsolidated bottom, semipermanently flooded, excavated	1.51
PUBG	Unconsolidated bottom, intermittently exposed	6.10
PUBGH	Unconsolidated bottom, intermittently exposed, diked/impounded	28.14
PUBGX	Unconsolidated bottom, intermittently exposed, excavated	105.32
PUBH	Unconsolidated bottom, permanently flooded	0.27
	Palustrine Total	**1,555.41**
	RIVERINE	
R2UBH	Lower perennial, unconsolidated bottom, permanently flooded	7.34
R2USC	Lower perennial, unconsolidated shore, seasonally flooded	4.65
	Riverine Total	**11.99**
	Grand Total	**1,667.17**



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TITLE: **National Wetland Inventory Map**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

PROJECT NO.	EXHIBIT:	SHEET:
07065	11	1 OF: 1
QUADRANGLE:	**DATE:**	**SCALE:**
N/A	10/29/08	NTS

Wetlands provide numerous valuable functions that are necessary for the health of a watershed. They play a critical role in protecting and moderating water quality. Water quality is improved through a combination of filtering and stabilizing processes. Wetland vegetation adjacent to waterways help to stabilize slopes and prevent mass wasting, thus reducing the sediment load within the river system. An unprotected streambank can easily erode, which results in an increase of sediment and nutrients entering the water. Additionally, wetland vegetation removes pollutants through the natural filtration that occurs, or by absorption and assimilation. This effective treatment of nutrients and physical stabilization leads to an increase in overall water quality to downstream reaches.

In addition, wetlands have the ability to increase storm water detention capacity, increase storm water attenuation, and moderate low flows. These benefits help to reduce flooding and reduce erosion. Wetlands also facilitate groundwater recharge by allowing water to seep slowly into the ground, thus replenishing underlying aquifers. This groundwater recharge is also valuable to wildlife during the summer months when precipitation is low and the base flow of the river draws on the surrounding groundwater table.

Although wetlands occupy a small percentage of the surrounding landscape, these areas typically contain large percentages of wildlife and produce more flora and fauna per acre than any other ecosystem. As a result of this high diversity, wetlands provide many recreational opportunities, such as fishing, hunting, boating, hiking and bird watching. Many of these recreational activities are available in the wetland areas within the Sugar Creek Watershed. However, wetlands within this watershed have experienced degradation as a result of urbanization and development. Development projects that have wetlands present or adjacent to the property are applying for and receiving Section 404 of the Clean Water Act permits to fill and develop wetlands. This practice reduces the amount of wetland acreage in the Watershed. The U.S. Army Corps of Engineers (ACOE), Louisville District, was contacted to coordinate an approximate acreage of wetland impact within the Sugar Creek Watershed within the last ten years. The ACOE stated that in order to generate this number all approved permit applications in the last ten years would need to be reviewed for the Watershed. The ACOE indicated that they do not have the time to calculate this acreage number.

Isolated and adjacent wetlands are regulated through IDEM and ACOE, respectively. Although wetlands are typically avoided during the development phase of properties, permits have been given to fill wetlands that cannot be avoided. Some isolated wetlands are being converted to detention/retention basins in new residential developments. Other types of mitigation occur within the Sugar Creek Watershed. Some development and agency permits require on-site mitigation, which includes the creation of wetlands and natural areas on the same piece of land where wetland impacts occur. Some development projects that impact wetlands are allowed to mitigate for wetland impacts at an approved off-site wetland mitigation bank facility. In this case, the wetland impacts are offset through the purchase of wetland mitigation credits at an approved wetland mitigation bank. The Indiana Department of Transportation (INDOT) requires impacts to wetlands associated with roadway improvements to be mitigated for in the same watershed. Stream enhancement and stream mitigation are some of the options that INDOT offers to offset wetland/stream impacts.

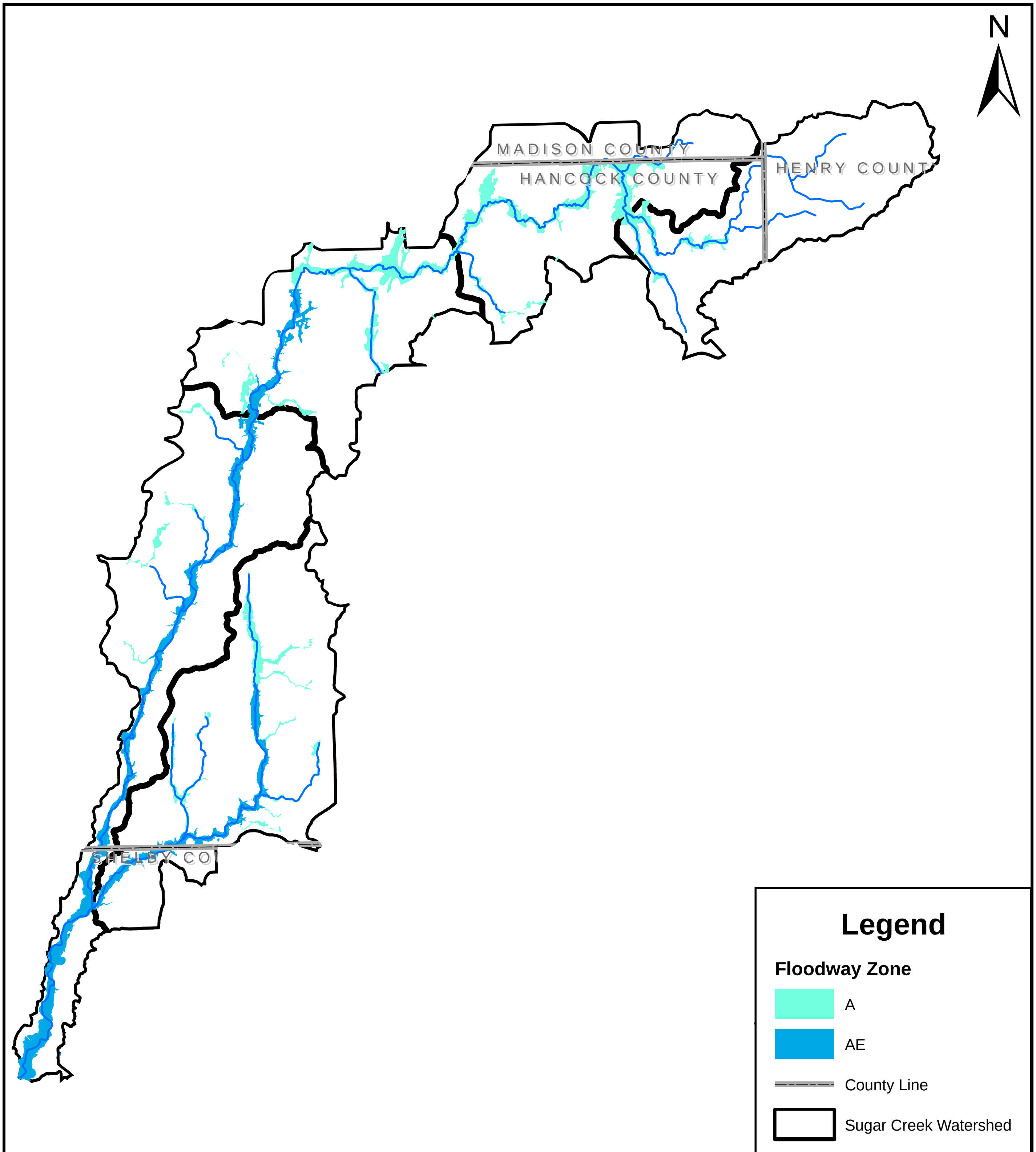
Regulatory Floodplain

Flooding is one of the most common hazards in the United States. Floods can occur on a local level, or can affect entire river basins. The Federal Emergency Management Agency (FEMA) has developed Flood Insurance Rate Maps (FIRMs) for many parts of the country in order for individuals and governments to assess the risk of flooding in specific areas. These maps also indicate what insurance rates property owners may need to pay to develop property in these areas. The current FIRM panels for the Sugar Creek Watershed are shown on Exhibit 12.

There are three flood hazard areas identified within the Watershed. Zone A, which is defined as an area inundated by 100-year flooding for which no base flood elevations (BFEs) have been established, comprises 3,961 acres (4.67% of the Watershed). In this zone there is a 1% chance of annual flooding, and a 26% chance that the area will be inundated at sometime during the life of a 30-year mortgage. Zone AE, which is defined as an area inundated by 100-year flooding for which BFEs have been determined, comprises 4,301 acres (5.01% of the Watershed). Chance of flooding in Zone AE is the same as in Zone A. However, Zone A floodplain boundaries are based off of approximate methods, and Zone AE floodplain boundaries are based off of detailed hydrologic and hydraulic analyses, establishing BFEs and making the delineation more accurate. Zone X, which is defined as an area that is either determined to be outside the 100-year floodplain but within the 500-year floodplain (0.2% chance of annual flooding) or have a 1% chance of sheet flow flooding where the average depths are less then 1 foot, comprises only 722 acres (0.85% of the Watershed). These areas are considered to have a moderate or minimal risk of flooding, and the purchase of flood insurance is available but not required.

Identifying the location of floodplain areas within the Sugar Creek Watershed allows for targeted areas for floodplain management. Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms and generally include requirements for zoning, and special-purpose floodplain ordinances. In addition to stormwater runoff, flooding can negatively affect water quality as large volumes of water transport contaminants into water bodies and also overload storm and wastewater systems. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground and ultimately increases during periods of flooding. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, and streams. These pollutants include:

- Nutrients from the application of excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Toxic chemicals such as oil and grease from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks;
- *E.coli* from livestock access to waterways, runoff of pet wastes, and faulty septic systems.



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TITLE: **Floodplain Map**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

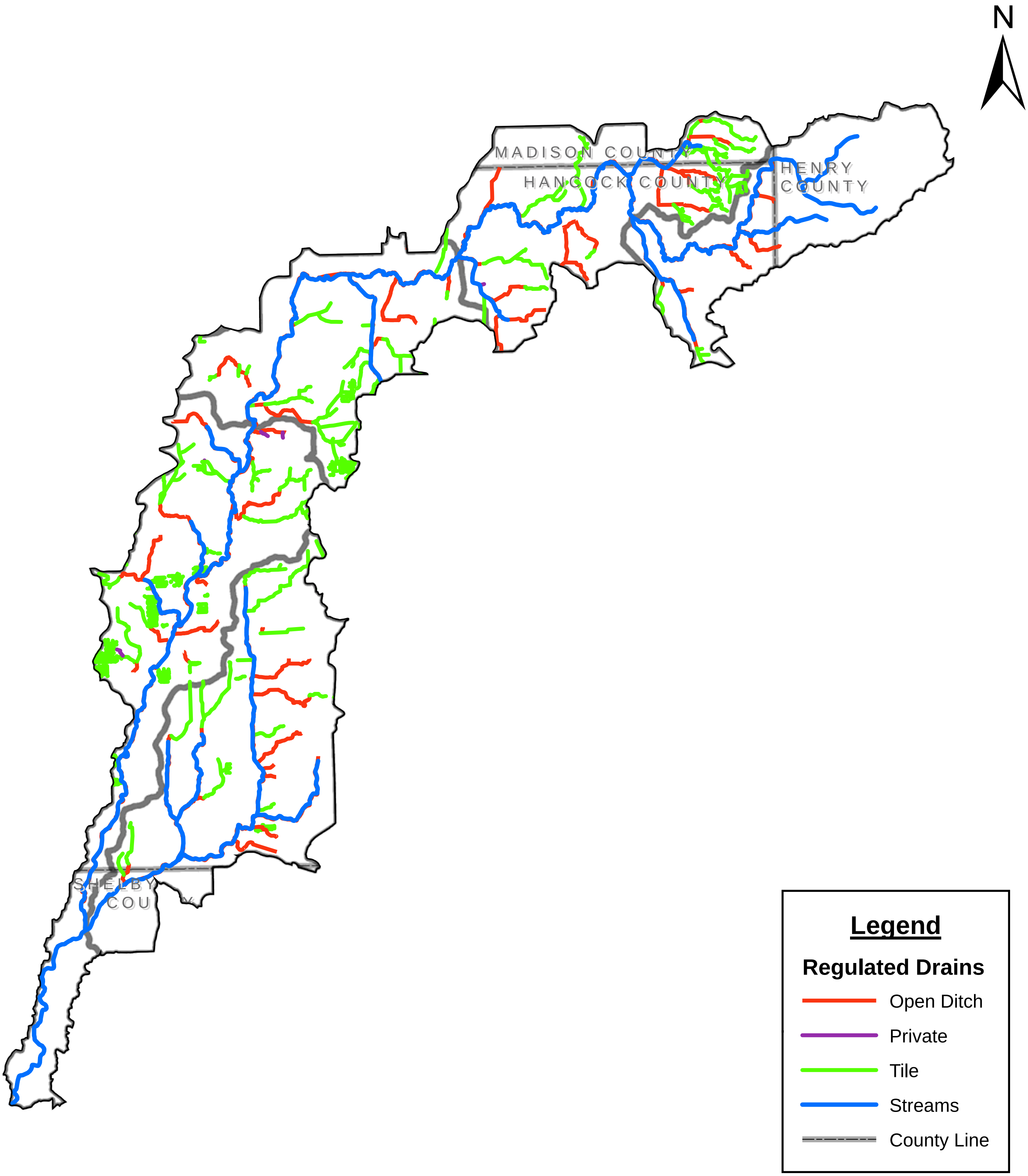
PROJECT NO.	EXHIBIT:	SHEET:
07065	12	1 OF: 1
QUADRANGLE:	DATE:	SCALE:
N/A	10/24/08	NTS

Location of Regulated Drains within the Sugar Creek Watershed

Regulated drains consist of creeks, ditches, tiles (underground pipe systems), and other structures intended to move run-off water. Regulated drains are under the jurisdiction of the local county drainage board or the County Surveyor's office. Regulated drains are common throughout Hancock County and are mainly tiles and open ditches (Exhibit 13).

Regulated drains are typically maintained by the County Surveyors office. This maintenance includes dredging with large construction equipment, removal of debris, and management of vegetation both within the regulated drains and within the riparian zone associated with the drains. Based on the unpredictable maintenance schedule of regulated drains within the Watershed, it is difficult to assign a priority rating to these areas for potential improvement of wildlife habitat, water quality improvement measures, and erosion control measures within the Sugar Creek Watershed.

Future potential BMPs within regulated drains in the Sugar Creek Watershed should be evaluated prior to implementation. If regulated drains are considered for BMP measures, the steering committee should contact the local County Surveyors offices of Hancock, Henry, Madison, and Shelby counties because the mapped locations of regulated drains change frequently.

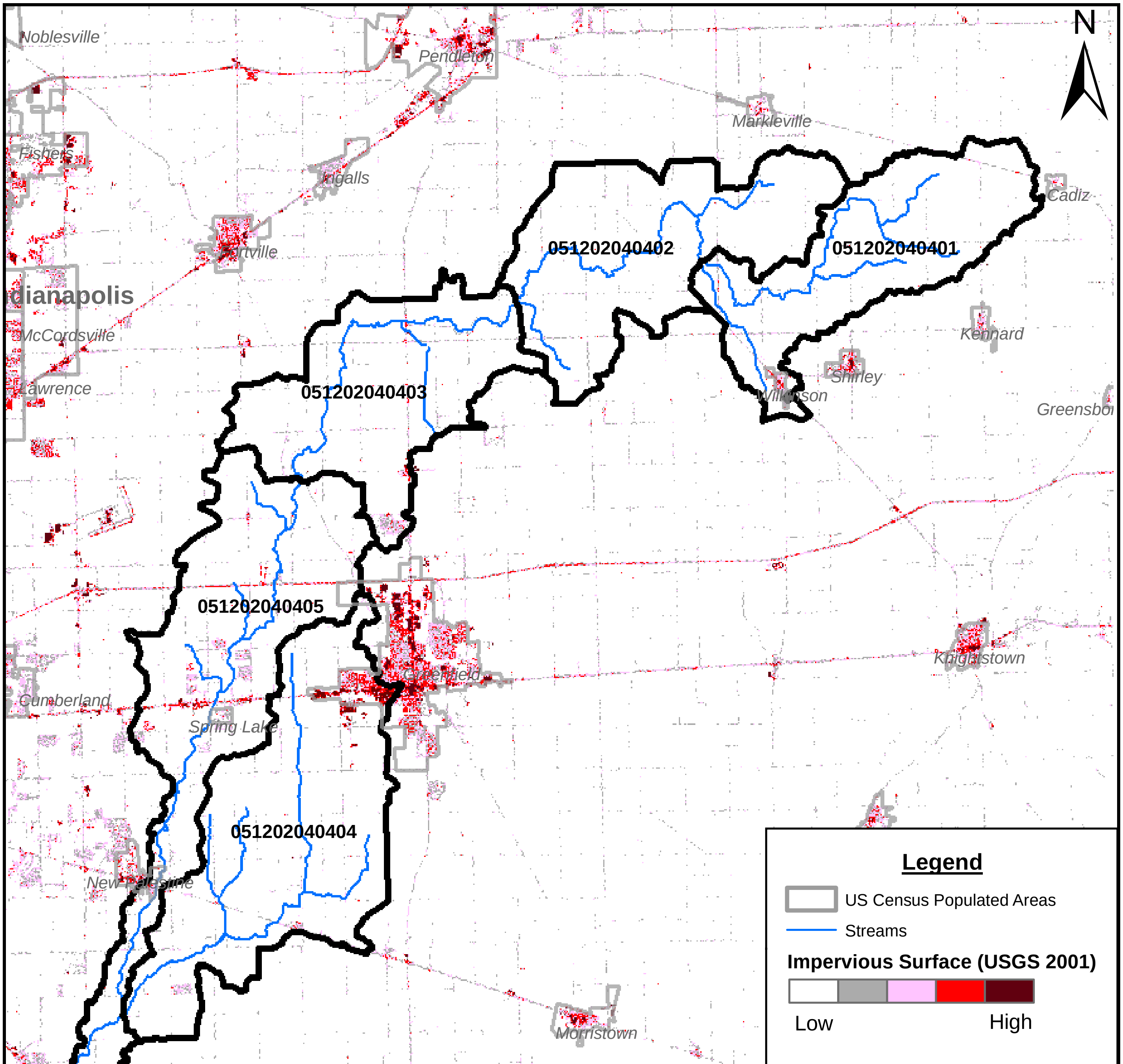


V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **Regulated Drains**	PROJECT: **Sugar Creek Watershed Project**		
	BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 13	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS

Impervious Surfaces within the Sugar Creek Watershed

Impervious surfaces are mainly constructed surfaces such as rooftops, sidewalks, roads, and parking lots that are covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent water from infiltrating soils. Soils compacted by urban development are also highly impervious. Impervious surfaces increase as land use changes within the Watershed to more urban development. Most of the impervious surfaces within the Sugar Creek Watershed are the result of urbanization (Exhibit 14). Greenfield, Spring Lake and New Palestine had the most impervious surface within the Watershed. Land development is related to impervious surfaces as native vegetation is replaced by impervious surfaces. Vegetation reduces the amount of surface runoff by intercepting rainfall and through evapotranspiration processes. Construction efforts can also lead to impervious surfaces as soil becomes compacted by heavy equipment and grading efforts. When soil is compacted it destroys the soil structure by decreasing the large pore space that is used to hold water. Undeveloped open land is able to infiltrate rainfall into the ground, and ponded runoff is stored in numerous natural depressions in the landscape.

Many types of pollutants accumulate over impervious urban surfaces. These pollutants are subsequently washed into water bodies during, and immediately following, storm events, severely degrading water quality and harming aquatic life. The temperatures of stormwater runoff during summer months can be dramatically increased via heat conduction from impervious surfaces. These forms of water pollution, which arise over broad land areas, are known as nonpoint source pollution, with pollutants being conveyed to water bodies through overland flow rather than by pipes, ditches, or conduits issuing from factories or sewage treatment plants. This type of pollution is linked to land-use activities, and its severity is a function of land-use type and intensity, including the amounts of impervious surface and the frequency and magnitude of storm events.



HUC 12	HUC Name	HUC Acreage	Impervious Surface Acreage
051202040401	Sugar Creek - Pee Dee Ditch	13,257	356
051202040402	Sugar Creek - Marsh and Trees Ditch	15,541	255
051202040403	Sugar Creek - Barrett Ditch	14,091	760
051202040404	Little Sugar Creek - Wilson Ditch	20,290	1,199
051202040405	Sugar Creek - Boyd Ditch	21,571	1,545

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TITLE: **Sugar Creek Watershed Impervious Surface Area**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS 2001	PROJECT NO. 07065	EXHIBIT: 14	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/1/08	SCALE: NTS

Threatened and Endangered Species

The Indiana Department of Natural Resources Division of Nature Preserves was contacted to provide any Indiana Natural Heritage Data or related records for all listed threatened, endangered or rare species, high quality natural communities or natural areas documented within the Sugar Creek Watershed. Their response indicated that the Sugar Creek Watershed is home to seven Species of Special Concern to Indiana, five State Endangered Species, and one Federally Endangered Species (Table 12). These listed species are mostly centered on the unique surface water resource that is Sugar Creek.

Six of the seven Species of Special Concern are Mollusks which live in Sugar Creek and its tributaries. They include the Slippershell Mussel, Kidneyshell, Purple Lilliput, Lilliput, Little Spectaclecase and the Wavyrayed Lampmussel. Two of the five State Endangered Species are Mollusks as well and include the Snuffbox and Clubshell. The Clubshell is also listed as Federally Endangered. The final Species of Special Concern, although not a mussel, may still commonly be found in areas along the stream is the Least Weasel. This species is considered the smallest living mammalian carnivore and often frequents marshy areas, although it is at home in grassy and brushy fields as well. The State Endangered Black-crowned Night-heron has also been known to feed along Sugar Creek and its tributaries. Two other State Endangered Species in the Watershed are not reliant on the river, but utilize other habitats available in the Sugar Creek Watershed. The Upland Sandpiper is a "shore bird" of grasslands and prairie, and the Loggerhead Shrike prefers short grasses interspersed with spiny shrubs and trees.

Table 12 Threatened and Endangered Animal Species

Type	Common Name	State Status	Federal Status
Mussel	Slippershell mussel	Special Concern	
Mussel	Kidneyshell	Special Concern	
Mussel	Purple lilliput	Special Concern	
Mussel	Lilliput	Special Concern	
Mussel	Little spectaclecase	Special Concern	
Mussel	Wavyrayed lampmussel	Special Concern	
Mammal	Least weasel	Special Concern	
Mammal	North American river otter	Special Concern	
Mussel	Snuffbox	Endangered	
Mussel	Clubshell	Endangered	Endangered
Bird	Black-crowned night heron	Endangered	
Bird	Upland sandpiper	Endangered	
Bird	Loggerhead shrike	Endangered	

SECTION 2: IDENTIFY PROBLEMS AND CAUSES OF POLLUTION

Stakeholder Concerns from Initial Public Meeting

To address the concerns of stakeholders in the Sugar Creek Watershed, the Steering Committee began by identifying the major stakeholder groups within the Watershed; individuals who best represented those stakeholder groups; and identified a current Steering Committee member that would be responsible for presenting individuals a personal invitation to attend a meeting on the Sugar Creek Watershed. A list of identified stakeholder groups is included in Appendix A. A representative from each of the stakeholder groups was invited to a meeting on May 14, 2007 to discuss the watershed planning process, to begin gathering information on concerns people had related to Sugar Creek and its watershed, and to solicit volunteers to help with different aspects of the planning and implementation process.

Following the success of this initial meeting, an open public meeting was held on October 11, 2007 to convey this information to all interested stakeholders in the watershed. At this meeting, stakeholders were informed of the watershed planning process, updated on where the Steering Committee was in the process, and given the opportunity to provide suggestions of priority resource concerns in the watershed. Over 40 people attended this meeting. Overall the meeting was successful and individuals volunteered for various portions of the planning and implementation process. Specific concerns were taken verbatim from the stakeholders and later listed in categories by Steering Committee members to aid in understanding the issues. The priority resource concerns that were identified at the public meeting are listed as follows.

Agricultural Issues:

- Drainage – need to maintain proper drainage for farming
- Log Jams – issues related to proper drainage
- Beaver – damming up drainage ways
- Flooding Impacts

Pollution Issues:

- Wildlife Effects on Water Quality
- Streambank Erosion – sediment and associated nutrients
- Trash/Illegal dumping
- Water Clarity
- Health Issues with bacteria – is it safe to swim and fish in Sugar Creek?
- Fish Consumption Advisories
- Cattle in the stream –health issues (*E. coli* etc.)

Development/Urban Issues:

- Land Use Changes – increased urbanization
- Stormwater Management
- Flooding Impacts

Recreational Issues:

- Log Jams – issues related to canoeing
- Beaver – desired for wildlife viewing
- Canoeing and fishing, swimming (is it safe- bacterial problems)
- Identify hunter-friendly farms

Wildlife/Habitat Issues:

- Proper Wildlife Management – balance of diversity
- Sandbars (erosion and hydrologic modification)
- Habitat and Wildlife preservation, conservation
- Cattle in the stream – destruction of habitat

Other Issues and Concerns:

- Streams are more wide and shallow – what is the cause?
- Changes in weather patterns – effect on watershed
- Land Use Changes – Large Farms converted to Mini Farms
- Greenways along the river – desire to create parks and work through private property issues
- Finances – how do we pay for the changes that need to be made?
- Preservation – acquire land along streams from willing sellers

As part of the Sugar Creek Watershed management planning process, the concerns listed above from the public meeting held on October 11, 2007 will be evaluated as more information and data are gathered. The collection and analysis of the information/data will validate or invalidate some of the concerns as well as identify some of the listed concerns as not capable of being addressed under the proposed scope of this watershed management plan.

Windshield Survey Review

A windshield survey is a type of watershed assessment conducted via a motorized vehicle at stream crossings and accessible locations where real time data was collected. During Fall 2007 and Spring 2008, the Steering Committee volunteers, and employees of the Hancock County Soil and Water Conservation District conducted a windshield survey at 33 site locations within the Sugar Creek Watershed (Exhibit 15).

Evidence of problems identified in the Sugar Creek Watershed as a result of the windshield survey data include, but are not limited to:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where field drain tiles discharge into Sugar Creek or its tributaries
- Areas where vegetated buffer is lacking along a waterway within the Watershed

The windshield survey data results (Appendix B) provided concrete evidence that many of the Stakeholders concerns, expressed at the initial public meeting and beyond, exist within the Sugar Creek Watershed and need to be addressed in this watershed management plan. Table 13a demonstrates the number of windshield survey stations observed to have the previously listed problems from both the fall 2007 and spring 2008 surveys.

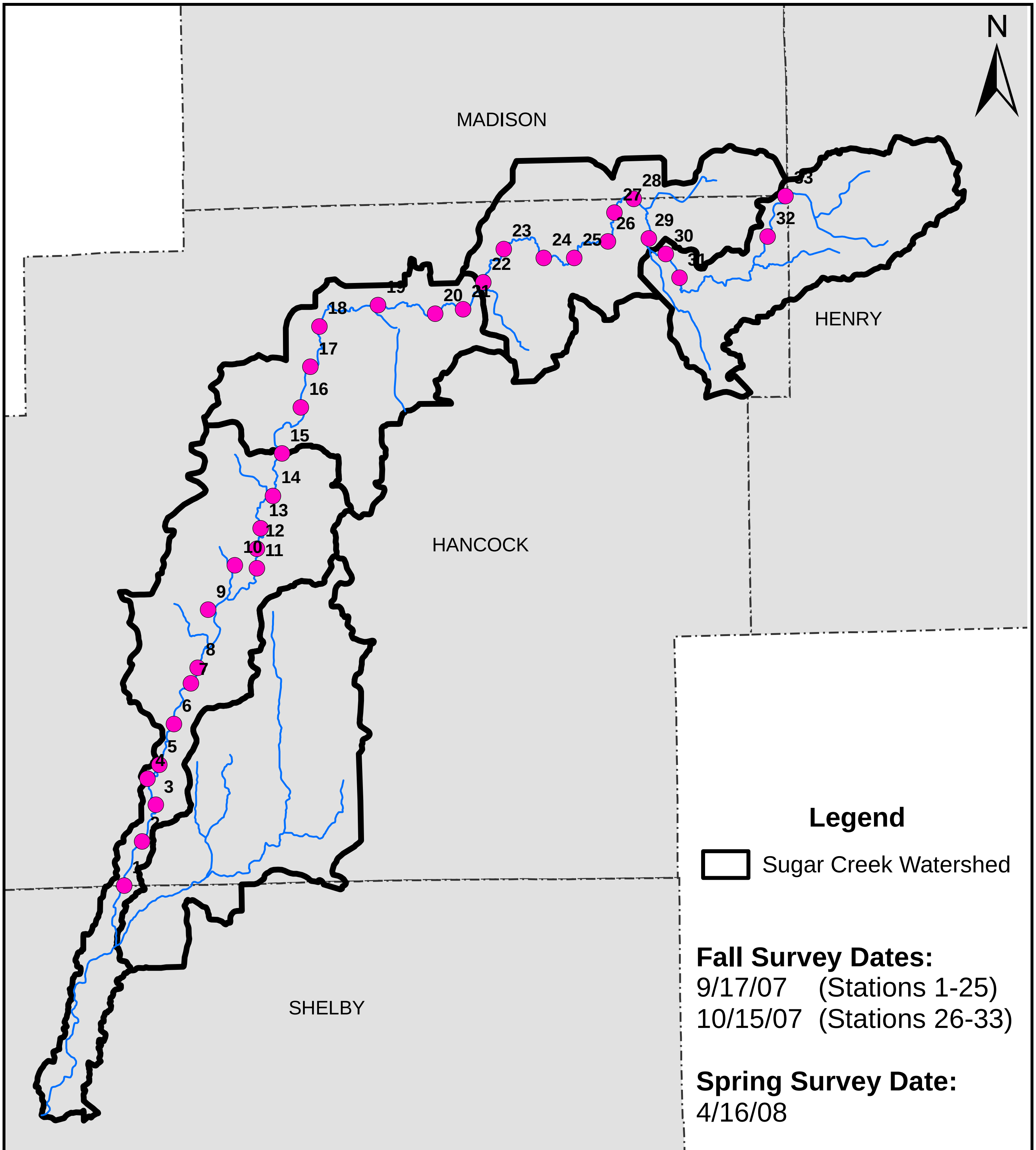
Table 13a. Windshield Survey Summary by Problem for 2007 and 2008

Observed Watershed Problem	Fall 2007 Survey Results		Spring 2008 Survey Results	
	Total Number	Percent	Total Number	Percent
Areas of sedimentation	8	24%	12	36%
Log jams	7	21%	9	27%
Bank protection and stabilization needed	9	27%	11	33%
Excessive streambank erosion	9	27%	11	33%
Flooding	2	6%	6	18%
Livestock have direct stream access	10	30%	17	52%
Stagnant water	4	12%	4	12%
Excessive trash and debris	9	27%	11	33%
Septic system pipes	1	3%	5	15%
Field drain tile discharge	0	0	5	15%
Needs vegetated buffer along stream	0	0	1	3%

Relating subwatersheds to problems and causes from the windshield survey data results, *E. coli* demonstrates the most significant problem within the Pee Dee Ditch subwatershed with up to 75% of the 2007 and 100% of the 2008 stations observing livestock having direct access to the stream. Sedimentation and erosion problems are most significant within the Pee Dee Ditch subwatershed as well, as up to 50% of the stations observed areas of sedimentation, log jams, need for bank protection/stabilization, and excessive streambank erosion. Nutrient problems are linked to animal excrement and the attachment of phosphorus and nitrogen to fine particles within sediment, therefore, the Pee Dee Ditch subwatershed also contributes to the most significant nutrient problem within the Sugar Creek Watershed. The windshield survey summary data listed by problems and the percent of subwatershed observation stations is shown in Table 13b.

Table 13b. Windshield Survey Problems by Subwatershed for 2007 and 2008

Observed Watershed Problem	Percent contributions of stations in 2007 & 2008, respectively			
	Pee Dee Ditch	Marsh/Tree Ditch	Barrett Ditch	Boyd Ditch
Areas of sedimentation	25% / 50%	11% / 22%	33% / 33%	28% / 43%
Log jams	25% / 50%	33% / 33%	0 / 0	21% / 28%
Bank protection and stabilization needed	25% / 50%	33% / 33%	17% / 17%	28% / 36%
Excessive streambank erosion	25% / 50%	33% / 33%	17% / 17%	28% / 36%
Flooding	0 / 0	11% / 33%	0 / 17%	7% / 14%
Livestock have direct stream access	75% / 100%	44% / 56%	33% / 50%	7% / 36%
Stagnant water	25% / 25%	33% / 33%	0 / 0	0 / 0
Excessive trash and debris	25% / 0	33% / 44%	17% / 17%	28% / 43%
Septic system pipes	0 / 0	0 / 11%	0 / 17%	7% / 21%
Field drain tile discharge	0 / 75%	0 / 22%	0 / 0	0 / 0
Needs vegetated buffer along stream	0 / 0	0 / 0	0 / 0	0 / 7%



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TITLE: Windshield Survey Locations	PROJECT: Sugar Creek Watershed Project			
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 15	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS	

Summary of Information and Data (Establish Baseline)

On December 12, 2007 and January 10, 2008, the Sugar Creek Watershed's Steering Committee discussed the water quality parameters of concern, and the general locations that the contributions from these pollutants were most prominent. Eight members of the steering committee, one representative of IDEM and two representatives of V3 evaluated the historic Total Maximum Daily Load (TMDL) water quality data sets collected by IDEM within the Sugar Creek Watershed. The exceedances of *E. coli* from the IDEM TMDL studies of 2002 and 2007 were presented. V3 used eight sampling stations to sample water quality, habitat, and macroinvertebrates in 2007 and 2008 (Table 14). All of the data, both historic and current, was depicted on a large Sugar Creek Watershed map for use by the steering committee.

In addition to the data presented by V3 to the steering committee on December 12, 2007 and January 10, 2008, the windshield survey results were also presented by the Hancock County SWCD and analyzed by the group. The windshield survey data was collected by members of the Steering committee and representatives of the Hancock County SWCD.

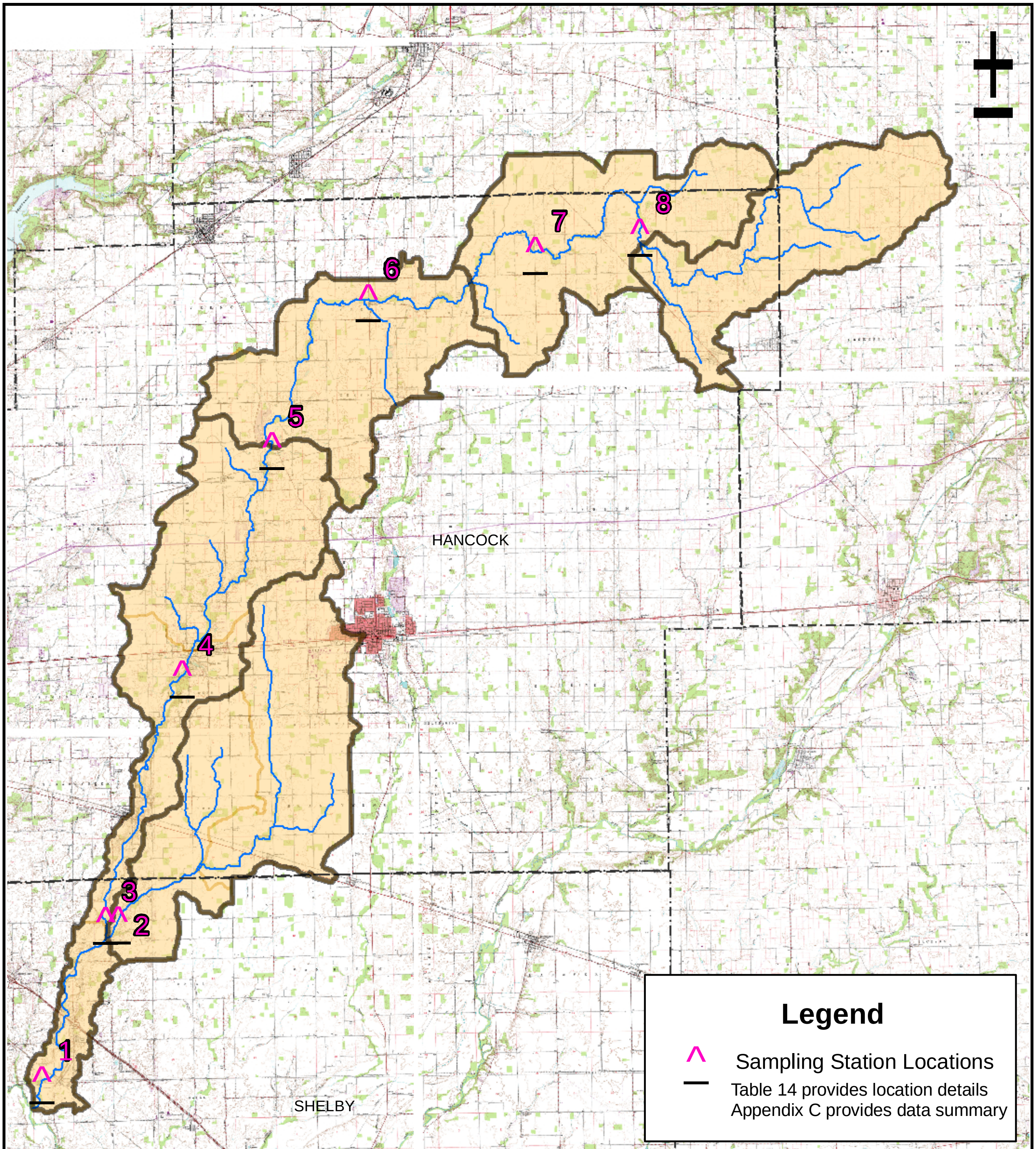
Collection and Analysis of Biological, Habitat, and Water-quality Information

Evaluation Methods

As part of the Sugar Creek WMP process, eight stations in the Sugar Creek Watershed were evaluated for macroinvertebrate communities, habitat, and water chemistry. Water chemistry parameter summary tables are included in Appendix C. These eight sampling locations were chosen for sampling in 2007 and 2008 based on access locations from bridge crossings and spatial locations throughout the watershed that would provide information for the entire Sugar Creek Watershed (Exhibit 16, Table 14). Station photographs are located in Appendix D. Macroinvertebrates were sampled on June 4 and 5, 2007, October 15 and 16, 2007, July 21 and 22, 2008, and October 6, 2008. The habitat evaluation was conducted in June and October 2007, and July and October, 2008. Water Chemistry was sampled for a period of one year which occurred on a monthly basis. Monthly water quality sampling started in June, 2007 and ended in May, 2008.

Table 14. V3 Water Chemistry, Habitat, and Macroinvertebrate Sampling Station Locations for 2007 and 2008

Station #	ID Number	Stream Name	Latitude	Longitude	Location	County
1	SC01	Sugar Creek	39.624967	-85.92965	East of Woodnotes and CR 700 N	Shelby
2	SC02	Little Sugar Creek	39.682733	-85.892867	East of 600 W and CR 1100 N	Shelby
3	SC03	Sugar Creek	39.682717	-85.898717	West of 600 W and CR 1100 N	Shelby
4	SC04	Sugar Creek	39.772133	-85.861117	East of 400 W and 200 S	Hancock
5	SC05	Sugar Creek	39.855000	-85.187000	West of N Fortville Pike and CR 500 N	Hancock
6	SC06	Sugar Creek	39.908083	-85.770883	North of SR 234 and Highway 9	Hancock
7	SC07	Sugar Creek	39.92455	-85.691550	South of CR 1000 N and CR 600 E	Hancock
8	SC08	Sugar Creek	39.930533	-85.642100	West of SR 109 and CR 1000 N	Hancock



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TITLE: **V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**			
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 16	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 10/29/08	SCALE: NTS	

Biological Evaluation Explanation

The IBI, or Index of Biotic Integrity, is composed of 12 different metrics that are used to evaluate the quality of the fish community. The IBI takes into consideration species, trophic composition (feeding and reproductive guilds), and the overall health of the fish community. The total IBI score and associated integrity class help compare the quality of one site to another, and provide a way to categorize the quality of a particular section of the river or stream. Table 15 shows the IBI scores developed by Karr et al. (1986). Although this evaluation indicates the overall health of the aquatic system, it does not specify the cause or causes of the impairment.

Table 15 IBI Scores Developed for Indiana

Total IBI Score	Integrity Class	Attributes
57-60	Excellent	Comparable to "least impacted" conditions, exceptional assemblage of species.
48-52	Good	Decreased species richness (intolerant species in particular), sensitive species present.
40-44	Fair	Intolerant and sensitive species absent, skewed trophic structure.
28-34	Poor	Top carnivores and many expected species absent or rare, omnivores and tolerant species dominant.
22-12	Very Poor	Few species and individuals present, tolerant species dominant, diseased fish frequent.
<12	No Fish	No fish captured during sampling.

Source: Karr et al. (1986)

Macroinvertebrate monitoring followed IDEM's macroinvertebrate Index of Biotic Integrity (mIBI) for the single habitat approach (personal communication from Steve Newhouse of IDEM on 11/20/2007). The single habitat approach involves sampling riffle/run areas within the sampling reach. A composite sample should be made from two kick samples (2 m^2). The sample is collected by using a one meter wide kick net with 500 μ opening mesh. A kick net is comprised of hemmed sides for poles and a reinforced bottom seam for anchoring while sampling. One person stands downstream holding the kick net in front of them, while another person disturbs a 1 m^2 area upstream of the net by using the heel or toe of the their boot to dislodge the material in the streambed. Larger substrate should be picked up and rubbed by hand to dislodge the organisms that are attached to the rocks. A one-hundred individual sub-sample should be used in order to analyze the data. The collected organisms are sorted at V3 and identified to the family level using appropriate field guides. In addition, macroinvertebrate vouchers are sent to Purdue University to verify that all taxon identifications are correct. Vouchered specimens and correspondence with Purdue is included in Appendix E. The collection procedure provides representative macroinvertebrate fauna from riffle/run substrate in the sampling reach.

The mIBI uses ten metrics which evaluate a macroinvertebrate community's species richness, evenness, composition, and density within the stream. These metrics include the family-level HBI (Hilsenhoff Biotic Index), number of taxa, number of individuals, Percent Dominant Taxa, EPT index, EPT count, EPT count to total number of individuals, EPT count to Chironomid count, Chironomid count, and number of individuals per number of squares sorted. (EPT stands for the *Ephemeropteran*, *Plecopteran*, and *Trichopteran* orders). These metrics are shown in Table 16. Each metric is scored from 0 – 8 where 8 is the highest quality. All metrics are added together and averaged to get a station score. A final score of 0 – 2 is a severely impaired stream, 2 – 4 is moderately impaired, 4 – 6 is slightly impaired and 6 – 8 is not impaired for biological quality.

Table 16 Scoring Criteria for mIBI

	Scoring				
	0	**2**	**4**	**6**	**8**
	Severely Impaired	**Moderately Impaired**	**Slightly Impaired**	**Not Impaired**	
HBI	≥ 5.63	5.06 - 5.62	4.55 - 5.05	4.09 - 4.54	≤ 4.08
Number of Taxa	≤ 7	8 -10	11 – 14	15 - 17	≥ 18
Number of Individuals	≤ 79	80 - 129	130 – 212	213 - 349	≥ 350
Percent Dominant Taxa	≥ 61.6	43.9 - 61.5	31.2 - 43.8	22.2 - 31.1	≤ 22.1
EPT Index	≤ 2	3	4 – 5	6 - 7	≥ 8
EPT Count	≤ 19	20 - 42	43 – 91	92 - 194	≥ 195
EPT To Total Number	≤ 0.13	0.14 - 0.29	0.30 - 0.46	0.47 - 0.68	≥ 0.69
EPT to Chironomid	≤ 0.88	0.89 - 2.55	2.56 - 5.70	5.71 - 11.65	≥ 11.66
Chironomid Count	≥ 147	55 - 146	20 – 54	7 - 19	≤ 6
Total Number To Number of Squares Sorted	≤ 29	30 - 71	72 – 171	172 - 409	≥ 410

Biological Evaluation Methodologies

An explanation of key benthic macroinvertebrate evaluations is summarized as follows:

Richness Measures
Total number of distinct taxa is a measure of the diversity within the sample. This value generally increases with increasing water quality, habitat diversity, and habitat suitability.

Total number of EPT taxa summarizes the richness of the benthic macroinvertebrate community within the taxa groups that are generally considered pollution sensitive and will generally increase with increasing water quality. This metric is the total number of distinct taxa within the groups Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly).

Composition Measures
Percent Contribution of Dominant Taxa uses the abundance of the numerically dominant taxa relative to the total number of organisms as an indication of community balance. This value will decrease as water quality, habitat diversity and habitat suitability improve.

The ratio of EPT (mayflies, stoneflies and caddisflies) and Chironomidae (midges) reflects good biotic condition if the sensitive groups (EPT's) demonstrate a substantial representation. If the Chironomidae have a disproportionately large number of individuals in comparison to the sensitive groups then this situation is indicative of environmental stress.

Tolerance/Intolerance Measures
Tolerance/intolerance measures are intended to be representative of relative sensitivity to perturbation. Tolerance is generally non-specific to the type of stressor. However, metrics such as the Hilsenhoff Biotic Index are oriented toward the detection of organic pollution.

The Hilsenhoff Biotic Index (HBI) was developed to detect organic pollution and is based on the family level index developed by William Hilsenhoff in 1988. Pollution tolerance values range from 0 to 10 and increase as water quality decreases. The lower the HBI, the greater the number of pollution intolerant species. A population of benthic macroinvertebrates that poses a lower HBI value is indicative of higher water quality.

V3 Biological Evaluation 2007 Results

V3 identified all macroinvertebrate specimens to family level after collecting all the field data. Appendix E includes a table that shows how many of each family were found at each station. V3 sent 49 voucher specimens of macroinvertebrates to Purdue University, Department of Entomology to be verified by Arwin Provonsha. Representative photographs of the macroinvertebrates arranged by vial and a copy of the letter sent to Purdue are located in Appendix E. V3 used the mIBI to analyze macroinvertebrates. Table 16 shows the ten metrics and scoring ranges for each. Macroinvertebrate data was taken at all stations in spring and fall of 2007. The raw macroinvertebrate data and the mIBI scoring for stations in both sampling events in 2007 are located in Exhibit 17 and Tables 17a - d respectively.

Table 17a Results From Spring Macroinvertebrate Sampling June 4 and 5, 2007

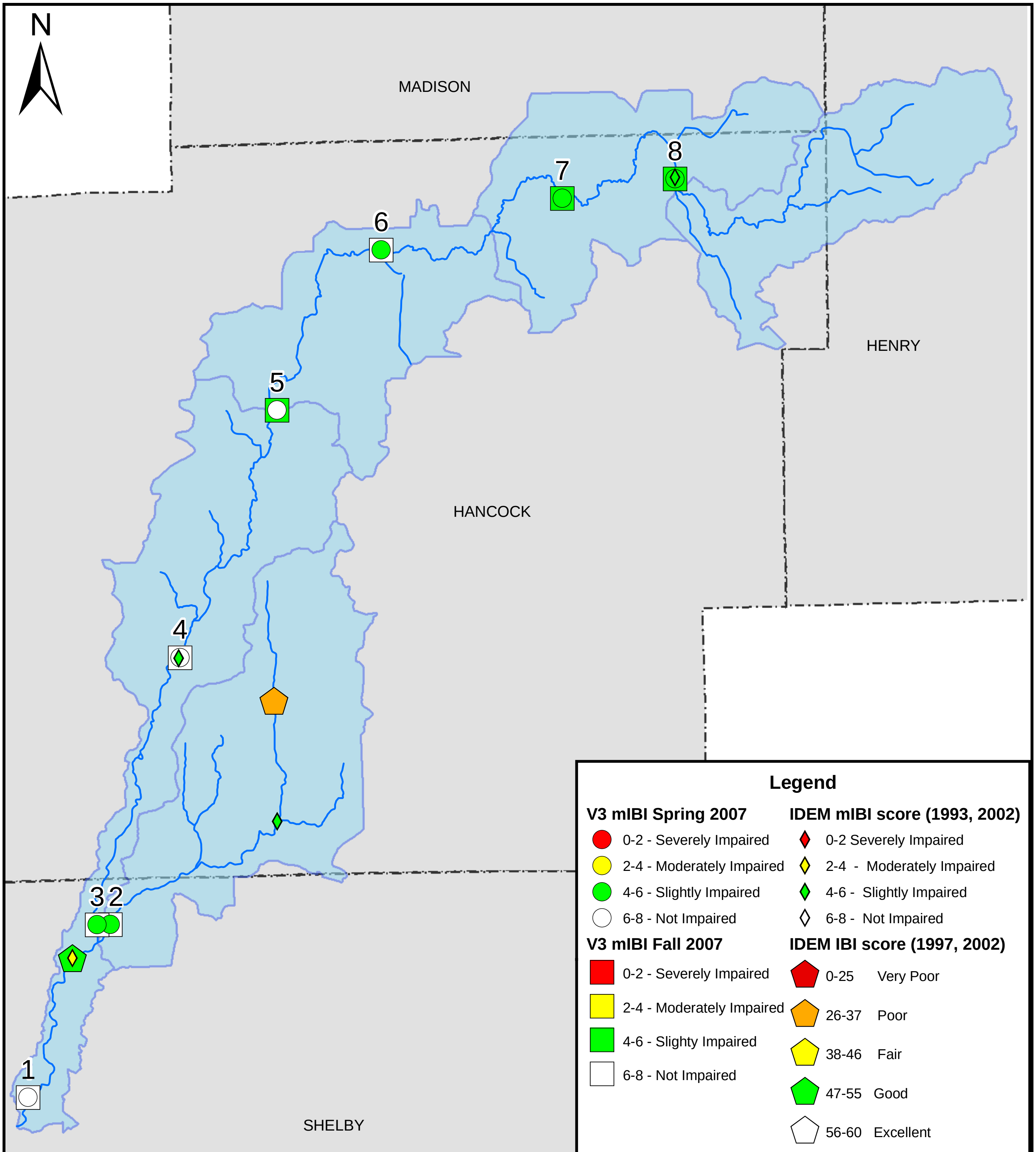
	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	3.85	5.299	4.611	3.888	4.163	5.154	4.522	4.95
Number of Taxa	21	19	18	25	26	24	25	15
Number of Individuals	142	134	137	156	158	139	182	148
Percent Dominant Taxa	27.5	19.4	20.4	19.9	17.1	18.7	13.2	23.6
EPT Index	8	6	7	10	10	6	8	4
EPT Count	100	59	74	82	90	43	71	69
EPT to Total Number	0.704	0.44	0.54	0.526	0.57	0.309	0.39	0.466
EPT to Chironomid	7.692	1.513	3.7	9.111	5.294	1.132	1.69	2.091
Chironomid Count	13	39	20	9	17	38	42	33
Total Number of Individuals/Number of Squares Sorted	72.5	134	34.25	78	79	69.5	60.67	49.33

Table 17b mIBI Scoring for Spring Macroinvertebrate Sampling June 4 and 5, 2007

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	8	2	4	8	6	2	6	4
Number of Taxa	8	8	8	8	8	8	8	6
Number of Individuals	4	4	4	4	4	4	4	4
Percent Dominant Taxa	6	8	8	8	8	8	8	6
EPT Index	8	6	6	8	8	6	8	4
EPT Count	6	4	4	4	4	4	4	4
EPT to Total Number	8	4	6	6	6	4	4	4
EPT to Chironomid	6	2	4	6	6	2	2	2
Chironomid Count	6	4	4	6	6	4	4	4
Total Number of Individuals/Number of Squares Sorted	4	4	2	4	4	2	2	2
Station mIBI Score	6.40	4.60	5.00	6.20	6.00	4.40	5.00	4.00

Table 17c Results From Fall Macroinvertebrate Sampling October 15, 16 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	4.058	4.361	4.012	3.908	4.148	4.044	4.494	5.866
Number of Taxa	17	19	19	23	19	24	17	19
Number of Individuals	169	184	201	160	191	192	174	155
Percent Dominant Taxa	36.1	55.4	34.3	22.5	25.7	33.9	29.9	45.2
EPT Index	7	7	8	7	7	7	7	7
EPT Count	128	139	145	108	134	136	113	100
EPT to Total Number	0.757	0.755	0.721	0.675	0.702	0.708	0.649	0.645
EPT to Chironomid	128/0	27.8	24.167	54	10.308	45.333	4.52	100/0
Chironomid Count	0	5	6	2	13	3	25	0
Total Number of Individuals/Number of Squares Sorted	84.5	92	100.5	80	63.67	86	87	51.67

Table 17d mIBI Scoring for Fall Macroinvertebrate Sampling October 15, 16 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	8	6	8	8	6	8	6	0
Number of Taxa	6	8	8	8	8	8	6	8
Number of Individuals	4	4	4	4	4	4	4	4
Percent Dominant Taxa	4	2	4	6	6	4	6	2
EPT Index	6	6	8	6	6	6	6	6
EPT Count	6	6	6	6	6	6	6	6
EPT to Total Number	8	8	8	6	8	8	6	6
EPT to Chironomid	8	8	8	8	6	8	4	8
Chironomid Count	8	8	8	8	6	8	4	8
Total Number of Individuals/Number of Squares Sorted	4	4	4	4	2	4	4	2
Station mIBI Score	6.20	6.00	6.60	6.40	5.80	6.40	5.20	5.00



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TITLE: **IBI and mIBI Scores (V3 2007 Data and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 17	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS

V3 Biological Evaluation 2007 Results Discussion

Station 1 had a slightly higher spring score (6.4) than fall (6.2). Station 1 was not impaired for either sampling. The Number of Individuals and Total Number of Individuals to Number of Squares Sorted metrics were slightly impaired for both samplings. Percent Dominant Taxa was also slightly impaired during the fall sampling. 36 percent of the fall sampling consisted of web spinning caddisflies, which are desirable to have in the stream.

Station 2 had a higher fall score (6.0) than spring (4.6). The spring sampling was slightly impaired, while the fall sampling was not impaired. The main reason for this is that during the spring sampling 39 chironomids were found compared to 5 in the fall. This reduced the scores of Chironomid Count, EPT to Chironomid, and the HBI metrics. The other factor was that 59 EPTs were found in the spring and 139 were found in the fall. This caused the HBI, EPT Count, EPT to Total Number, and EPT to Chironomid ratio to have lower scores.

Station 3 was slightly impaired in the spring (5.0) and not impaired in the fall (6.6). Station 3 follows the trend of having impairments due to increased chironomids and decreased EPTs during the spring. All stations followed this trend. In some stations (Station 2 for instance) the difference was dramatic from spring to fall while others (Station 4) did not have metric stores influenced much by the difference.

Along with Station 1, Station 4 had the highest average score. Station 4 was not impaired for the spring (6.2) or the fall sampling (6.4). The only metrics that were slightly impaired were Number of Individuals, Total Number of Individuals to Number of Squares Sorted, and EPT Count (spring only).

Station 5 was not impaired during the spring (6.0) and slightly impaired during the fall (5.8). The main difference was that several of the metrics were lower in the fall including Percent Dominant Taxa, EPT Index, EPT to Total Number, and Total Number of Individuals to Number of Squares Sorted. The Dominant Taxa was the web spinning caddisfly. Overall, the differences from spring to fall at station 5 were very small.

Station 6 was slightly impaired during the spring (4.4) and not impaired during the fall (6.4). There were several metrics that decreased significantly from spring to fall. HBI and EPT to Chironomid Count were both moderately impaired in the spring (2.0) and not impaired in the fall (8). A large portion of this is caused by 38 chironomids collected in the spring and 3 in the fall. Also, 43 EPTs were collected in the spring and 136 EPTs were collected in the fall.

Station 7 was slightly impaired for both samplings, but increased slightly from spring (5.0) to fall (5.2). This station was moderately impaired during the spring for EPT to Chironomid and Total Number of Individuals to Number of Squares Sorted.

Station 8 had the lowest mIBI score for both samplings. Both sampling events were slightly impaired with the spring (4.0) being lower than fall (5.0). The HBI (5.87) scored a 0 during the fall and was severely impaired. During the fall the dominant taxa was a type of mayfly in the family Caenidae. They made up 45 percent of the sample and have a HBI rating of 7. This is one of the main reasons for the low fall score. In the spring sampling, there were 33 chironomids found and 69 EPTs found. This caused many of the metrics to have a low score. Overall, the habitat at this station was more silty and conducive to macroinvertebrates with high tolerance values.

V3 Biological Evaluation 2008 Results

V3 sampled macroinvertebrates in the spring and fall of 2008 which concluded Sugar Creek's biological evaluation. V3 used the mIBI to analyze macroinvertebrates (Table 16). Macroinvertebrate data was taken at all stations in spring of 2008. Macroinvertebrate data was taken at stations 1 through 7 in the fall of 2008. Sampling station 8 could not be sampled in the fall of 2008 as water was not flowing. The raw macroinvertebrate data and the mIBI scoring for stations in both sampling events of 2008 are located in Exhibit 18 and Tables 18a - d respectively.

Table 18a Results From Spring Macroinvertebrate Sampling July 21 and August 5, 2008

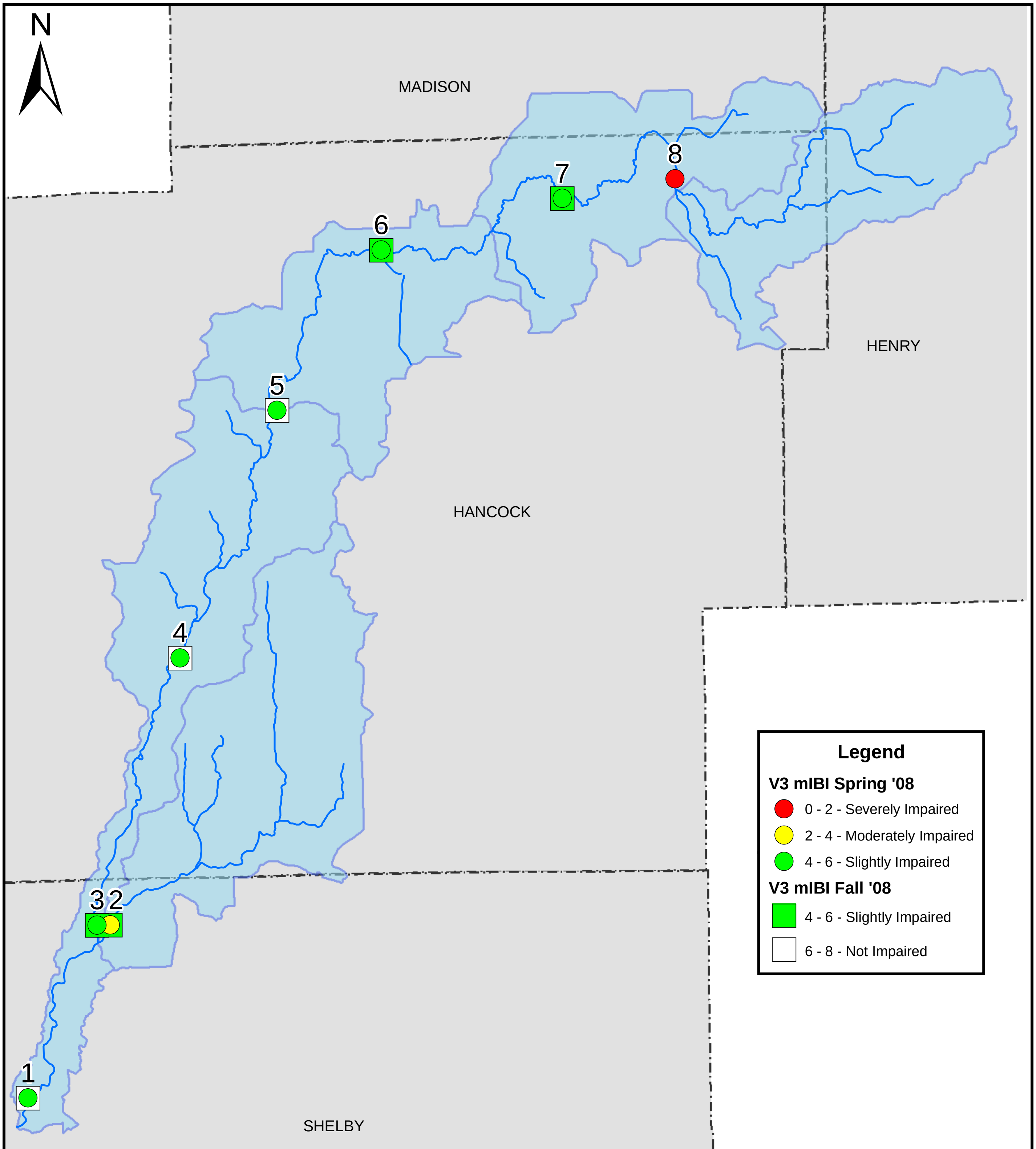
	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	4.224	5.047	4.536	4.326	3.675	4.56	4.394	5.667
Number of Taxa	13	13	12	19	18	15	17	9
Number of Individuals	114	246	197	235	209	187	213	136
Percent Dominant Taxa	60.5	45.5	25.9	32.3	27.8	41.7	18.8	58.8
EPT Index	5	4	5	7	8	6	6	3
EPT Count	88	103	106	128	122	100	125	24
EPT to Total Number	0.772	0.419	0.538	0.545	0.584	0.535	0.587	0.176
EPT to Chironomid	8.8	0.912	2.078	11.636	4.519	4.762	5.952	0.3
Chironomid Count	10	113	51	11	27	21	21	80
Total Number of Individuals/Number of Squares Sorted	16.28	49.2	65.67	117.5	69.67	46.75	71	27.2

Table 18b mIBI Scoring for Spring Macroinvertebrate Sampling July 21 and August 5, 2008

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8
HBI	6	2	6	6	8	4	6	0
Number of Taxa	4	4	4	8	8	6	6	2
Number of Individuals	2	4	4	6	4	4	6	4
Percent Dominant Taxa	2	6	6	4	6	4	8	2
EPT Index	4	4	4	6	8	6	6	2
EPT Count	4	6	6	6	6	6	6	2
EPT to Total Number	8	6	6	6	6	6	6	2
EPT to Chironomid	6	2	2	6	4	4	6	0
Chironomid Count	6	2	4	6	4	4	4	2
Total Number of Individuals/Number of Squares Sorted	0	2	2	4	2	2	2	0
Station mIBI Score	4.20	3.80	4.40	5.80	5.60	4.60	5.60	1.60

Table 18c Results From Fall Macroinvertebrate Sampling October 6, 7 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	4.236	4.134	4.158	4.135	4.256	4.247	4.378	-
Number of Taxa	19	17	15	17	17	20	18	-
Number of Individuals	205	215	209	258	245	199	260	-
Percent Dominant Taxa	21.5	54.4	23.0	32.6	51.4	25.6	37.3	-
EPT Index	7	5	6	7	8	7	6	-
EPT Count	154	177	131	189	182	102	143	-
EPT to Total Number	0.751	0.823	0.627	0.732	0.743	0.512	0.55	-
EPT to Chironomid	8.105	59	3.97	47.25	14	7.846	3.763	-
Chironomid Count	19	3	33	4	13	13	38	-
Total Number of Individuals/Number of Squares Sorted	51.5	107.5	104.5	129	122.5	49.75	260	-

Table 18d mIBI Scoring for Fall Macroinvertebrate Sampling October 6, 7 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
HBI	6	6	6	6	6	6	6	-
Number of Taxa	8	6	6	6	6	8	8	-
Number of Individuals	4	6	4	6	6	4	6	-
Percent Dominant Taxa	8	2	6	4	2	6	4	-
EPT Index	6	4	6	6	8	6	6	-
EPT Count	6	6	6	6	6	6	6	-
EPT to Total Number	8	8	6	8	8	6	6	-
EPT to Chironomid	6	8	4	8	8	6	4	-
Chironomid Count	6	8	4	8	6	6	4	-
Total Number of Individuals/Number of Squares Sorted	2	4	4	4	4	2	6	-
Station mIBI Score	6.00	5.80	5.20	6.20	6.00	5.60	5.60	-



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TITLE: V3 mIBI Scores 2008	PROJECT: Sugar Creek Watershed Project			
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 18	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 1/22/09	SCALE: NTS	

V3 Biological Evaluation 2008 Results Discussion

Station 1 had a lower spring score (4.2) than fall (6.0). Station 1 was slightly impaired in the spring in the spring sampling and not impaired in the fall sampling. The Number of Taxa, EPT Index and EPT Count were slightly impaired for the spring sampling. The Number of Individuals was the only metric that was slightly impaired for the fall sampling. Total Number of Individuals to Number of Squares Sorted was severely impaired during the spring sampling and moderately impaired during the fall sampling. 60 percent of the spring sampling consisted of web spinning caddisflies, which are desirable to have in the stream.

Station 2 had a higher fall score (5.8) than spring (3.8). The spring sampling was moderately impaired, while the fall sampling was slightly impaired. The main reason for this is that during the spring sampling 113 chironomids were found compared to 3 in the fall. This reduced the scores of Chironomid Count, EPT to Chironomid, and the HBI metrics.

Station 3 was slightly impaired in the spring (4.4) and the fall (5.2). Along with Station 2, Station 3 had the lowest average score of all stations (4.8). The dominant taxa at Station 3 in the fall were web spinning caddisflies, flat-head mayflies, and chironomids. These dominant species represent filters, scrapers and gatherers which are all important functional feeding groups in a stream system.

Station 4 had the highest average score (6.0). Station 4 was slightly impaired for the spring (5.8) and not impaired for the fall sampling (6.2). Percent Dominant Taxa was the only metric slightly impaired in both sampling efforts. Chironomids accounted for 25 percent of the spring sampling. Web spinning caddisflies and flat-head mayflies were the most frequently occurring species in the fall sampling (33% and 21% respectively).

Station 5 was slightly impaired during the spring (5.6) and not impaired during the fall (6.0). Station 5 had the second highest average score (5.8). The main difference between spring and fall sampling was several of the metrics were slightly lower in the spring including Percent Dominant Taxa, EPT to Chironomid, and Total Number of Chironomids. Individuals to Number of Squares Sorted was moderately impaired in spring and slightly impaired in the fall. The Dominant Taxa was the web spinning caddisfly in both the spring and the fall. Overall, the differences from spring to fall at this station were very small.

Station 6 was slightly impaired in the spring (4.6) and fall (5.6). Total Number of Individuals to Number of Squares Sorted was moderately impaired during the spring and fall sampling (2). Station 6 had a greater Number of Taxa in the fall and a lower Chironomid Count than the spring. EPT count was 100 in the spring and 102 in the fall. EPT to Chironomid was slightly impaired in the spring and not impaired in the fall because of the decrease in chironomid count.

Station 7 was slightly impaired for both samplings. This station was slightly impaired for Chironomid Count during the spring and fall. EPT Count increased from 125 in the spring to 143 in the fall. Percent Dominant Taxa metric was not impaired in the spring and slightly impaired in the fall. Web spinning caddisflies were the most frequently occurring species in both the fall and spring sampling.

Station 8 had the lowest mIBI score of all sampling stations (1.6). Sampling station 8 was not be sampled in the fall as water was not flowing. Station 8 was severely impaired for the spring sampling effort. The HBI (5.67) scored a 0 during the spring and was severely impaired. Chironomids were the dominant taxa and made up 59 percent of the sample. Chironomids have a HBI rating of 4.103. This is the main reasons for the low spring score. Station 8 is siltier and has significant runoff from adjacent fields which results in undesirable habitat for macroinvertebrates with lower tolerance values.

IDEM Biological Evaluation Results

Several previous macroinvertebrate studies have been conducted within the Sugar Creek Watershed. IDEM sampled macroinvertebrates (Exhibit 17; Table 19) in 1993 and in 2002. All three stations sampled in 1993 were slightly impaired and the only station sampled in 2002 was moderately impaired. All stations are considered fully supporting, as the mIBI score is greater than or equal to 2.2 (IDEM 2006). The station at CR 675 W in Shelby County sampled in 2002 scored had the lowest score at 3. Most of the lowest metric scores were a result of about 53 percent (88/164 individuals) of the sample being Chironomids, which affects many of the metric including HBI, Chironomid count, dominant taxa, and EPT to Chironomid ratio.

Table 19 IDEM Field Data (IDEM 1993, 1997, 2002)

Sample Date	Location	Stream Name	County	mIBI	IBI	QHEI	Water Temp (°C)	D.O. (mg/L)	pH	Sp. Cond. (mhos)	Turbidity (NTU)
8/14/2002	CR 675W	Sugar Creek	Shelby	3	54	78	22.11	6.91	8.15	681	16
7/14/1997	CR 200S	Little Sugar Creek	Hancock	-	34	47	23.42	11.35	8.3	1129	15
7/15/1993	CR 100W	Little Sugar Creek	Hancock	4.4	-	64	21.01	6.6	7.23	491	-
7/20/1993	CR1000N	Sugar Creek	Hancock	4.4	-	67	22.78	6.19	7.71	639	-
7/20/1993	CR 100S	Sugar Creek	Hancock	5.6	-	75	23.35	6.34	7.73	639	-

Sugar Creek Watershed fisheries data was pulled to determine species within the Watershed and changes in species composition and quantity over time. The USGS has been sampling for fish presence since 1993 within the months of July, August and September. IDEM has conducted two fish studies within the Sugar Creek Watershed (1997, 2002). Sampling locations are shown in Exhibit 17 and described in Table 19. A species presence list is located in Table 20 which includes the results of sampling efforts of USGS and IDEM.

The USGS fisheries surveys were conducted on Sugar Creek at CR 400S in New Palestine. Fisheries surveys were not conducted by USGS from 1999 to 2001. The total number of species collected at each USGS survey ranged from 27 species in 1993 to 50 species in 2002. The average number of species collected from all USGS surveys was 35 species. Species collected at all of the USGS surveys include: black redhorse, blacknose darter, bluntnose minnow, central stoneroller, creek chub, golden redhorse, greenside darter, logperch, longear sunfish, mottled sculpin, northern hog sucker, rainbow darter, rock bass, sand shiner, smallmouth bass, striped shiner, and white sucker.

During the 1997 survey, IDEM sampled one station. This was Wilson Ditch and CR 200S in Hancock County. The IBI score for this survey was a 34, with that resulting in a poor rating. Ten species were collected during the 1997 IDEM survey which was the lowest species count of all the years surveys were conducted. Wilson Ditch also had a Qualitative Habitat Evaluation Index (QHEI) score of 47 which indicates poor habitat for fish which is likely related to the low IBI score at this station. In 2002, IDEM sampled Sugar Creek at CR 675 W in Shelby County. Their result on this survey was an IBI score of 54 which is in the “good” category.

Table 20: USGS Data of Fish Presence in the Sugar Creek Watershed (IDEM Data 1997, 2002*)												
Species	**1993**	**1994**	**1995**	**1997**	**Wilson Ditch (Hancock County) 1997***	**1998**	**2002**	**Sugar Creek (Shelby County) 2002***	**2003**	**2004**	**2005**	**2007**
Bigeye Chub		X	X				X	X	X	X	X	X
Bigeye Shiner				X			X					
Black Redhorse	X	X	X	X		X	X	X	X	X	X	X
Blacknose Dace					X							
Blackside Darter	X	X	X	X		X	X		X	X	X	X
Blackside Topminnow							X					
Bluegill		X	X	X		X	X	X	X	X	X	X
Bluntnose Minnow	X	X	X	X	X	X	X	X	X	X	X	X
Brindled Madtom		X		X			X		X	X	X	
Central Stoneroller	X	X	X	X	X	X	X	X	X	X	X	X
Channel Catfish		X					X					
Chestnut Lamprey								X				
Common Carp		X	X			X		X		X		
Common Sunfish		X										
Creek Chub	X	X	X	X	X	X	X	X	X	X	X	X
Creek Chubster										X		
Dusky Darter	X	X		X			X	X				X
Eastern Shiner						X						
Emerald Shiner			X			X			X		X	X
Fantail Darter						X						
Flathead Catfish		X						X				
Gilt Darter												X
Golden Redhorse	X	X	X	X		X	X	X	X	X	X	X
Grass Pickerel										X		
Green Sunfish		X	X	X	X	X	X	X	X	X	X	X
Greenside Darter	X	X	X	X		X	X	X	X	X	X	X
Hornyhead chub										X		
Johnny Darter		X	X	X	X	X	X	X	X	X	X	
Largemouth Bass						X	X				X	X
Logperch	X	X	X	X		X	X	X	X	X	X	X
Longear Sunfish	X	X	X	X		X	X	X	X	X	X	X
Longnose Gar							X	X				
Mimic Shiner		X					X					
Mottled Sculpin	X	X	X	X	X	X	X	X	X	X	X	X
Northern Hog Sucker	X	X	X	X		X	X	X	X	X	X	X
Northern Starhead Topminnow										X		
Northern Studfish							X	X		X	X	X
Orangespotted Sunfish							X					
Orangethroat Darter		X	X		X		X	X	X	X	X	
Pumpkinseed							X					
Quillback		X										X
Rainbow Darter	X	X	X	X		X	X	X	X	X	X	X
Redear Sunfish							X					X

Table 20 Continued: USGS Data of Fish Presence in the Sugar Creek Watershed (IDEM Data 1997, 2002*)												
Species	**1993**	**1994**	**1995**	**1997**	**Wilson Ditch (Hancock County) 1997***	**1998**	**2002**	**Sugar Creek (Shelby County) 2002***	**2003**	**2004**	**2005**	**2007**
Redfin Shiner	X	X		X		X	X	X	X	X		
River Carpsucker											X	
River Chub	X	X	X	X			X			X	X	X
River Redhorse		X										
River Shiner							X					
Rock Bass	X	X	X	X		X	X	X	X	X	X	X
Rosyface Shiner	X	X	X				X				X	X
Sand Shiner	X	X	X	X		X	X	X	X	X	X	X
Shorthead Redhorse		X		X			X	X	X	X		
Silver Redhorse	X	X	X	X		X	X	X	X	X		X
Silver Shiner	X	X	X	X		X	X	X		X	X	X
Silverjaw Minnow		X	X	X	X		X	X	X	X	X	X
Slenderhead Darter						X						
Smallmouth Bass	X	X	X	X		X	X		X	X	X	X
Smallmouth Buffalo												X
Spotfin Shiner	X	X		X		X	X	X	X	X	X	X
Spotted Bass	X	X	X	X			X	X	X	X	X	
Spotted Gar							X					
Spotted Sucker	X	X	X			X	X		X			X
Steelcolor Shiner		X	X									
Striped Shiner								X				
Stonecat		X					X		X	X		
Striped Shiner	X	X	X	X		X	X		X	X	X	X
Warmouth							X					
White Crappie	X						X					
White Sucker	X	X	X	X	X	X	X	X	X	X	X	X
Yellow Bullhead		X					X	X		X		
Total Number of Species:	**27**	**44**	**32**	**31**	**10**	**31**	**50**	**34**	**32**	**39**	**33**	**35**

Habitat Evaluation Explanation

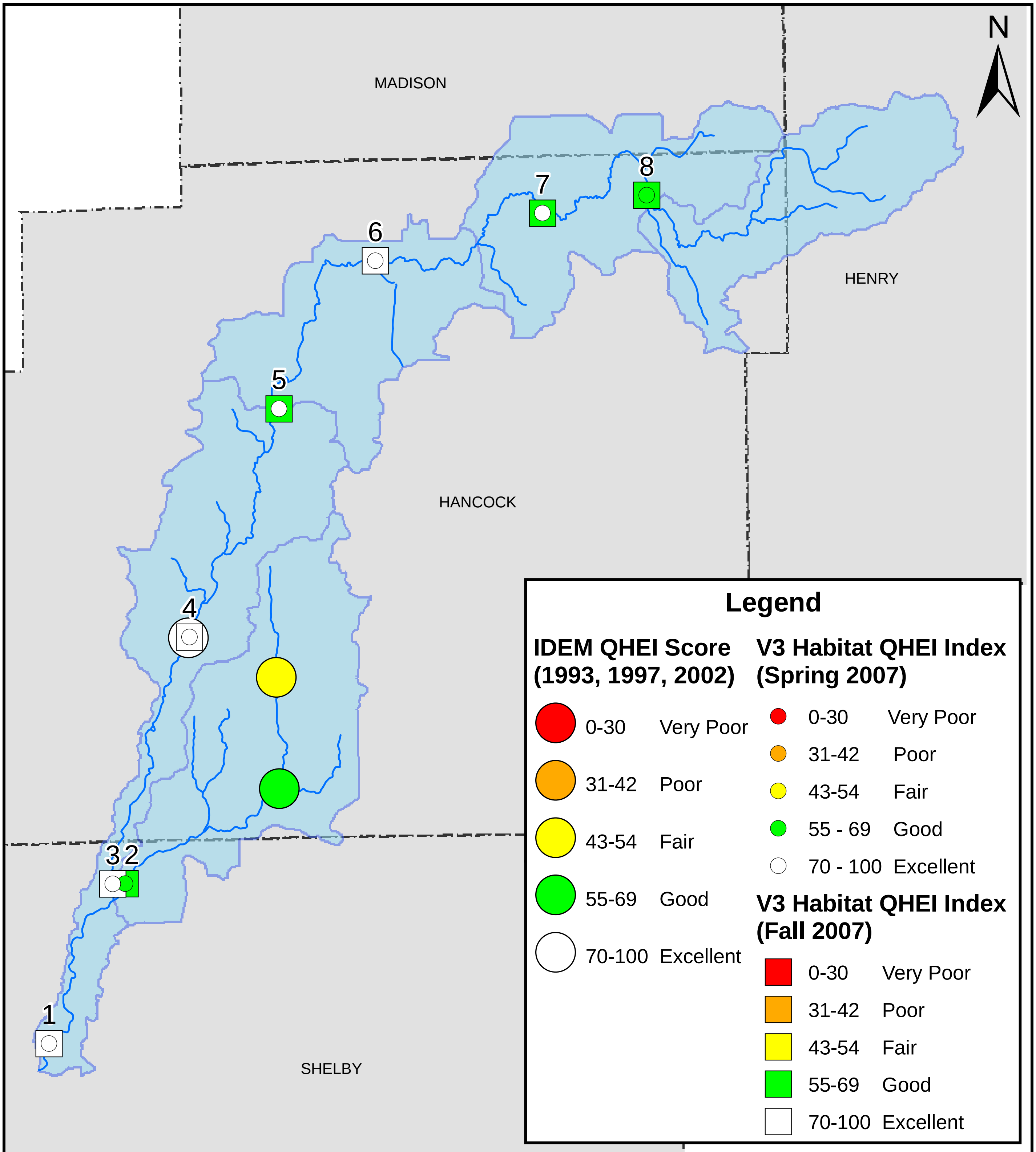
Habitat evaluation followed the IDEM QHEI habitat assessment approach which evaluates physical characteristics of a stream. Habitat incorporates all aspects of physical and chemical constituents along with the biotic interactions. Habitat includes all of the in-stream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The purpose for evaluating the physical habitat features of the selected locations within the Sugar Creek Watershed is to quantify the condition and quality of the in-stream and riparian habitat. The QHEI habitat assessment approach was developed to describe the overall quality of the physical habitat.

The maximum score that can be obtained using the IDEM QHEI is a value of 100. QHEI scores below 51 indicate that the stream is non supporting for aquatic communities (IDEM, 2006). QHEI scores form 51 to 64 are partially supporting to aquatic communities and scores above 64 are fully supporting. QHEI can also be broken down in several different categories that range from Excellent (70-100), Good (55-69), Fair (43-54), Poor (31-42), to Very Poor (<30). The maximum points possible for each of the habitat parameters are as follows: Substrate = 20, In-stream Cover = 20, Channel Morphology = 20, Riparian Zone and Bank Erosion = 10, Pool/Glide Quality = 12, Riffle/Run Quality = 8 and Gradient = 10.

Habitat Evaluation Results

Habitat was surveyed previously by IDEM (Table 19) in 1993, 1997, and 2002. Only Wilson Ditch in 1997 was considered to be non supporting habitat for aquatic life. All other stations had scores greater than 51, indicating sustainable habitat.

The V3 field collected data for habitat during spring 2007 (Exhibit 19; Table 21a) indicated that all stations were fully supportive for aquatic life. During the fall 2007 (Exhibit 19; Table 21b) showed that Stations 2 and 8 were partially supporting and all other stations were fully supporting. Habitat data was taken in July, 2008 and October, 2008 and is located in Exhibit 20; and Tables 22a and 22b. Stations 2, 7, and 8 had QHEI ratings in the good category and all other stations have a QHEI in the Excellent category. Overall, Station 8 had the lowest observed QHEI scores, which also corresponds with the lowest mIBI scores. Combined, Station 6 had the highest QHEI of all of V3's stations.



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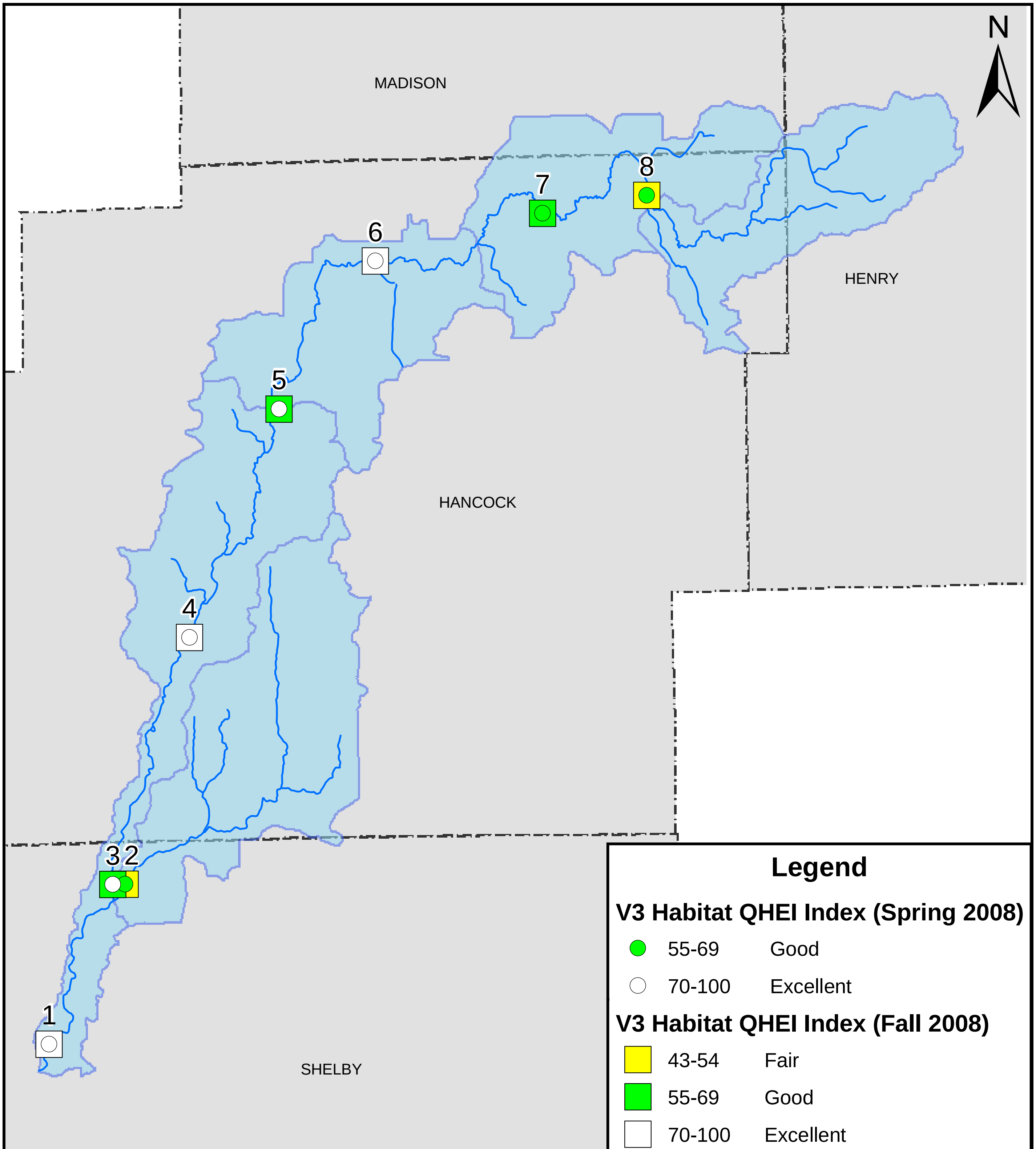
TITLE: **Habitat QHEI Index Map (V3 and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**
BASE LAYER: N/A	PROJECT NO.: 07065
	EXHIBIT: 19
	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A
	DATE: 9/5/07
	SCALE: NTS

Table 21a V3 Habitat Results for Sugar Creek in May, 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	16	18	18	18	16	18	18	15
Instream Cover	15	13	17	20	20	20	18	16
Channel Morphology	16	13	13	16	16	16	12	10.5
Riparian Zone and Bank Erosion	6	2.5	4.5	4	6.5	8	1.5	6.5
Pool/Glide Quality	12	11	10	12	10	12	12	11
Riffle/Run Quality	4	4	5	6	5	7	6.5	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**79**	**65.5**	**73.5**	**84**	**79.5**	**85**	**72**	**66**

Table 21b V3 Habitat Results for Sugar Creek in October, 2007								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	17	15	15	17	15	18	16	9
Instream Cover	18	15	17	17	15	20	15	15
Channel Morphology	16	12	12	15	16	15	12	10.5
Riparian Zone and Bank Erosion	6	2.5	4.5	4	6.5	8	1.5	5.5
Pool/Glide Quality	12	11	12	12	7	11	11	11
Riffle/Run Quality	4	2	3	3	3	6	4.5	2
Gradient	10	4	6	8	6	4	4	4
Total Score	**83**	**61.5**	**69.5**	**76**	**68.5**	**82**	**64**	**57**
Year Avg. Score	81	63.5	71.5	80	74	83.5	68	61.5



Legend

V3 Habitat QHEI Index (Spring 2008)

●	55-69	Good
○	70-100	Excellent

V3 Habitat QHEI Index (Fall 2008)

■	43-54	Fair
■	55-69	Good
□	70-100	Excellent

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TITLE: **Habitat QHEI Index Map (V3 and IDEM Data)**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 20	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS

Table 22a Habitat Results for Sugar Creek in July, 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	11	14	15	18	16	13	15	10
Instream Cover	16	12	15	20	16	19	15	15
Channel Morphology	16	12	12	16	14	16	10	10
Riparian Zone and Bank Erosion	6	2.5	4.5	6.5	6	8	3	6.5
Pool/Glide Quality	12	12	12	12	9	12	11	11
Riffle/Run Quality	5	4	5	6	5	6	6	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**76**	**60.5**	**69.5**	**86.5**	**72**	**78**	**64**	**59.5**

Table 22b Habitat Results for Sugar Creek in October, 2008								
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Substrate	15	9	16	18	10	17	14	9
Instream Cover	15	14	12	19	15	15	13	10
Channel Morphology	16	12	12	16	14	16	11	10
Riparian Zone and Bank Erosion	6	2.5	4.5	6	6.5	8	3.5	5.5
Pool/Glide Quality	10	8	8	10	9	9	7	10
Riffle/Run Quality	4	4	5	4	4	6	2	3
Gradient	10	4	6	8	6	4	4	4
Total Score	**76**	**53.5**	**63.5**	**81**	**64.5**	**75**	**54.5**	**51.5**
Year Avg. Score	76	57	66.5	83.75	68.25	76.5	59.25	55.5

Analysis of Studies Related to the Sugar Creek Watershed

The IDEM Assessment Branch evaluates all the data they collect to develop the 305(b) report, and the 303(d) list. The 305(b) report is a document that summarizes the quality of surface waters throughout Indiana. Evaluations are based on different stream segments or lakes, and are discussed in the context of watersheds. To complete the evaluation, IDEM considers not only the data they collect, but data collected by other entities as long as that data meets the rigorous quality controls that IDEM uses in the collection and analysis of their own data. Other data that doesn't meet these standards may be used informally to validate data that does meet the quality controls.

Analysis of Information Related to the IDEM 303(d) List

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's water quality standards for designated uses. These streams are to be listed on the State's 303(d) list of impaired waters. For such waters, the State is required to establish total maximum daily loads (TMDLs) to meet the state water quality standards. To determine if a waterbody should be listed on Indiana's 303(d) list, the IDEM Assessment Branch has developed a surface water quality monitoring strategy to assess the quality of Indiana's ambient waters. The goals of this monitoring strategy are as follows (IDEM 303(d) listing methodology):

1. Measure the physical, chemical, bacteriological and biological quality of the aquatic environment in all river basins and identify factors responsible for impairment.
2. Assess the impact of human and other activities on the surface water resource.
3. Identify trends through the analysis of environmental data, and
4. Provide environmental quality assessment to support water quality management programs.

Once data is collected, waterbodies are evaluated by a team of water-quality professionals within IDEM to determine if the waterbodies meet the water-quality standards set by the State, and that all designated uses are met. If a stream fails to meet these requirements, as outlined in the 303(d) listing methodology, the waterbody is considered impaired and must be listed on the 303(d) list, and a TMDL developed to address the problem.

Approximately 85% of Sugar Creek proper is listed on the 303 (d) list. The impairments include *E. coli* contamination and Fish Consumption Advisories for both PCB's and Mercury.

The specific methodologies for these listings are identified in IDEM 303(d) listing methodology and are shown in Table 23. These data are for *E. coli* impairments (Human Health Recreation Use Support [Swimmable]) and Fish Consumption Advisories (Human Health Use Support [Fishable]).

Table 23: IDEM 303(d) Listing Methodology Human Health Recreational Use Support (Swimmable)		
IDEM has two different criteria for recreational use assessments depending on the type of data set being used in making the assessment. For data sets consisting of five equally spaced samples over a 30-day period, we apply two tests, both of which are based on U.S. EPA's *Ambient Water Quality Criteria for Bacteria - 1986* (EPA440/5-84-002), which provides the foundation for Indiana's water quality standards for recreational use. For data sets consisting of ten (10) or more grab samples where no five (5) of which are equally spaced over a 30-day period, the 10% rule is applied. Specific criteria are as follows.		
	Fully Supporting	**Not Supporting**
Bacteria (*E. coli*): at least five (5) equally spaced samples over thirty (30) days. (CFU = colony forming units)	Geometric mean ≤125 CFU/100ml and no more than one sample >576 CFU/100ml.	Geometric mean exceeds 125 CFU/100mL.
Bacteria (*E. coli*): grab samples (CFU = colony forming units)	No more than 10% of measurements >576 CFU/100ml and no more than one (1) sample >2400 CFU/100ml.	More than 10% of samples >576 CFU/100ml or more than one (1) sample >2,400 CFU/100ml.
Human Health Use Support – Fish Consumption (Fishable)		
The Indiana Fish Consumption Advisory (FCA) provides site-specific advice as well as general advice for any waterbody not specifically addressed in the FCA. FCAs are presented as advisory groups based safe eating guidelines for the amount and type of fish caught. Site-specific advisories are based on site-specific fish tissue data and indicate the advisory group associated with a given species within a given size range and identify the contaminant of concern (PCBs and/or mercury) for each. The general advice provided in the FCA states that all waters for which no site-specific advisory is provided should be assumed to be a Group 2 advisory. In addition, the Indiana FCA includes a statewide advisory for carp consumption for rivers and streams. Neither the general advice nor the statewide advisory for Carp is used to make fish consumption assessments. Only site-specific fish consumption advisories were considered in determining use support status.		
	Fully Supporting	**Not Supporting**
Fish tissue (PCBs and mercury)	Waterbody has only a Group 1 "Unlimited Consumption" advisory.	Waterbody has one or more Groups 2, 3, or 4 "Limited Consumption" or Group 5 "Do Not Eat" advisories for any species.
Aquatic Life Use Support – Lakes and Reservoirs		
Indiana Department of Natural Resources surveys of the status of sport fish communities in lakes and information on trout stocking.	**Fully Supporting**	**Not Supporting**
	Supports cold water fishery, including native cisco and stocked trout, or both.	Native cisco population is gone or lake unable to support stocked trout and lake attributes, or both, appear to contribute to warm water fishery condition.

Summary of the 2008 Published IDEM TMDL for Escherichia coli (E. coli)

Section 303(d) of the Federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards. A TMDL provides a basis for determining the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of their water resources.

This TMDL applies to the 69.5 miles of the Sugar Creek Watershed where recreational uses are impaired by elevated levels of *E. coli* during the recreational season (April 1 to October 31). The target level for *E. coli* during the recreational season is 125 colony forming units (CFU) per one hundred milliliters as a geometric mean based on no less than five samples equally spaced over a thirty day period. Failing septic tanks and wildlife are known sources of *E. coli* impairments in waterbodies. Deer, geese, ducks, raccoons, and other animals all create potential sources of *E. coli* through contaminated runoff from animal habitats. IDEM conducted an intensive study of the five NPDES Permitted Discharge sites within the Sugar Creek Watershed (Exhibit 21). None of the facilities have past or open enforcement cases for violations and therefore these facilities are not considered to be major sources of *E. coli* to Sugar Creek. The linkage between the *E. coli* concentrations in the Sugar Creek Watershed and the potential sources provides the basis for the development of the TMDL. Land use within the Sugar Creek Watershed is predominately agricultural and requires drain tiles due to soil type. Field tiles are not sources of *E. coli* but they can carry *E. coli* from land applied manure and runoff from the fields and pastures. IDEM's 2002 study consisted of 15 sampling sites. IDEM's 2007 study consisted of 59 sampling sites, of which 39 were within the Sugar Creek Watershed (Exhibit 22). *E.coli* exceedance results from water quality testing from 2002 and 2007 are found in Table 24. Site Numbers that are in a corresponding row indicate sites that were used in both the 2002 and 2007 TMDL studies. The locations of sites remained the same within the watershed but were renumbered to accommodate the increase in sampling sites that occurred in 2007.

Table 24 TMDL *E.coli* Exceedance Results

2002 Site Number	2002 Geometric Mean (MPN/100mL)	2007 Site Number	2007 Geometric Mean (MPN/100mL)
		6	235.03
		9	892.81
4	n/a (30.88)	13	358.89
		17	399.53
		19	280.65
		22	276.81
		23	504.37
7	448.55	24	262.56
		25	562.67
8	263.66	28	252.41
9	309.27	32	n/a (151.07)
		43*	301.54
		47*	677.10
11	3846.25	48*	n/a (dry)
		49*	338.92
12	443.24	56*	n/a (40.8)
13	347.95	57*	n/a (dry)

*Included in 2007 TMDL study but extends outside this study's watershed boundary.

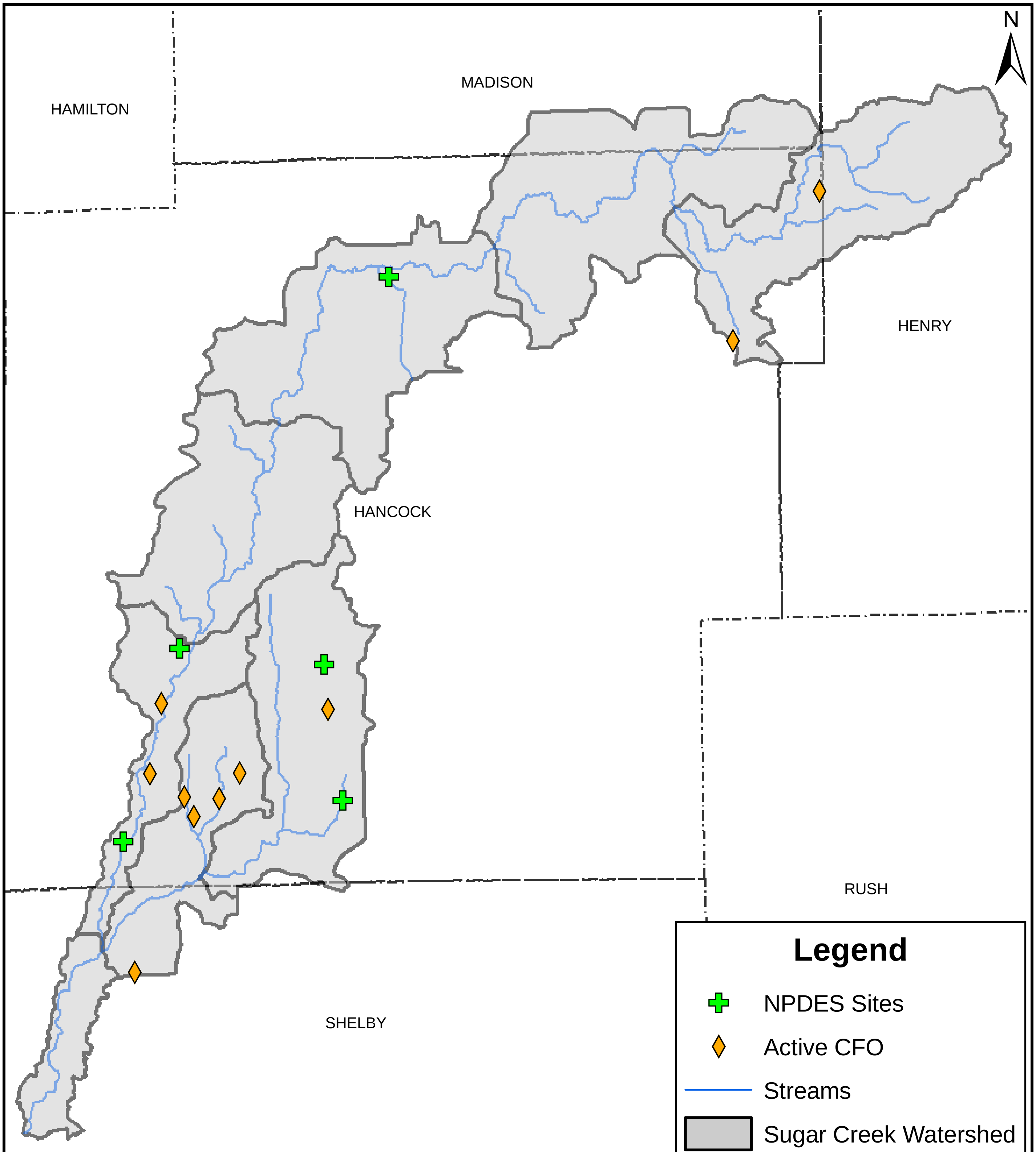
The *E. coli* exceedance results for both 2002 and 2007 IDEM TMDL studies demonstrate that the Boyd Ditch subwatershed possessed the most exceedances with 39% of the samples (9 of 23) being higher than the state standard. The second most exceedances of the state standard was the Marsh & Trees Ditch subwatershed with 33% of the samples (3 of 9) being higher than the state *E. coli* standard. The remaining two Sugar Creek subwatersheds had a 20% (2 of 10) sampling station exceedance in the Barrett Ditch subwatershed, and a 12% (1 of 8) sampling station exceedance in the Pee Dee Ditch subwatershed for *E. coli* levels.

In order for the Sugar Creek Watershed to achieve water quality standards the wasteload and load allocations for the Sugar Creek Watershed have been set to the *E. coli* water quality standard of 125 CFU per 100 mL as a geometric mean. Achieving the wasteload and load allocations for the Sugar Creek Watershed depends on:

1.) *E. coli* limits being added to dischargers who monitor for total residual chlorine.
2.) Confined feeding operations are not violating their permits.
3.) Non-point sources of *E. coli* being controlled by implementing best management practices in the Watershed.
4.) The issuance of the MS4 permits for Hancock, Johnson and Madison Counties as well as New Palestine and Edinburgh.
5.) Education and outreach for septic system care.

Analysis of Information Related to the 2007 IDEM TMDL Study

An *E. coli* TMDL has been developed by IDEM and is available for review at www.in.gov/idem/4685.htm. Sites were evaluated along Sugar Creek for *E. coli*, 10 of which are located within the Sugar Creek Sampling Area (Exhibit 22). Load duration curves were developed for four of these sites to help determine possible sources of the contamination. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources based on the time of the sampling events (TMDL for E. coli for Sugar Creek Watershed, 2007). Potential sources outlined by IDEM include: 1) Wildlife, such as deer, geese, ducks, raccoons, turkeys, and other animals, 2) Failing septic systems, 3) National Pollutant Discharge Eliminations System (NPDES) permitted dischargers including, Act III Estates, Arrowhead Mobile Home Park, Eden Elementary School, Creekside Mobile Home Park, New Palestine Municipal STP, Sugar Creek Utility Company, Franklin Plant IAWC, Shelby Petroleum, Inc., and Sonoco Flexible Packaging, and 4) Confined Feeding Operations (CFOs).



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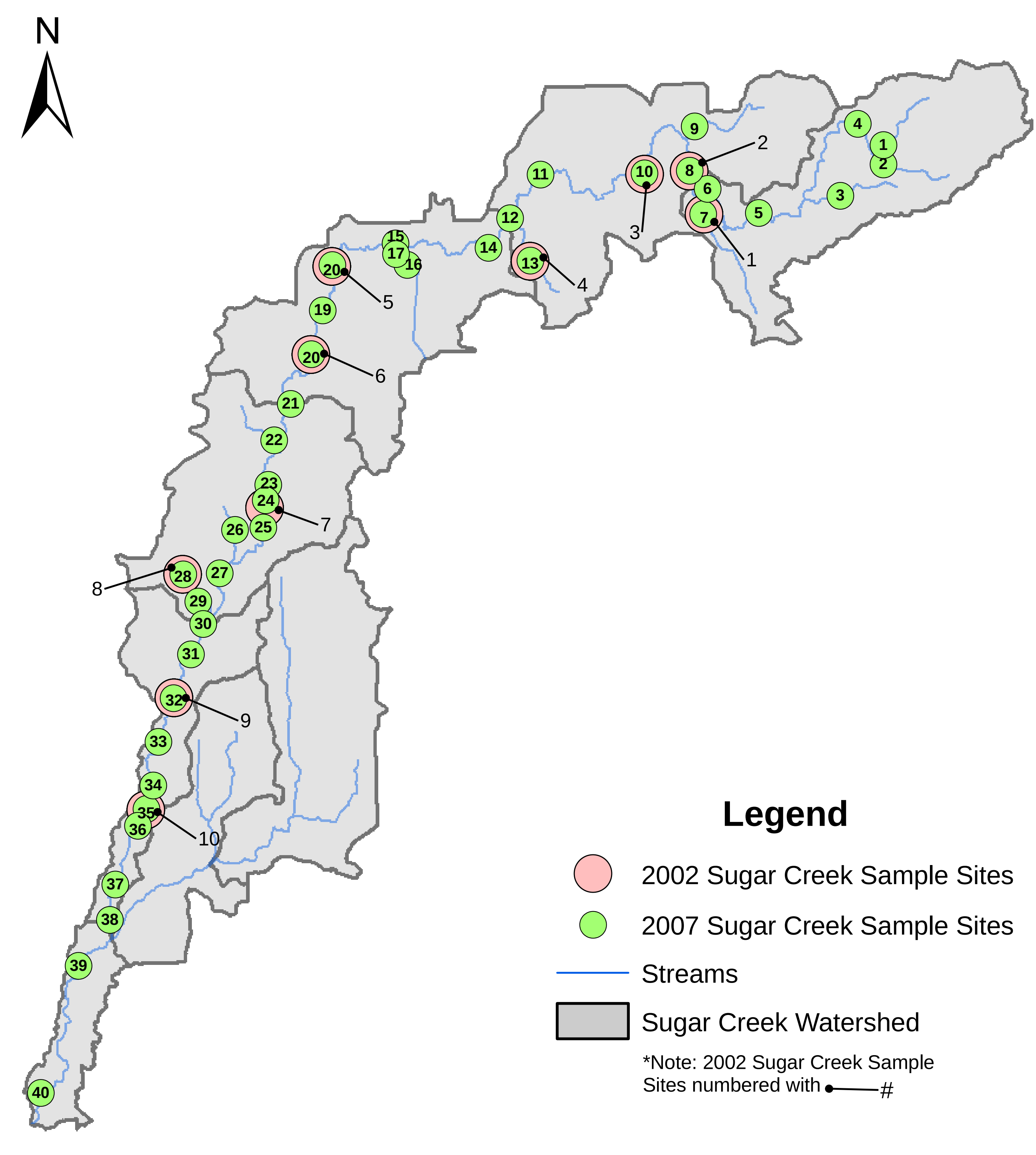
TITLE: **Active CFO and NPDES Sites**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 21	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 09/05/07	SCALE: NTS



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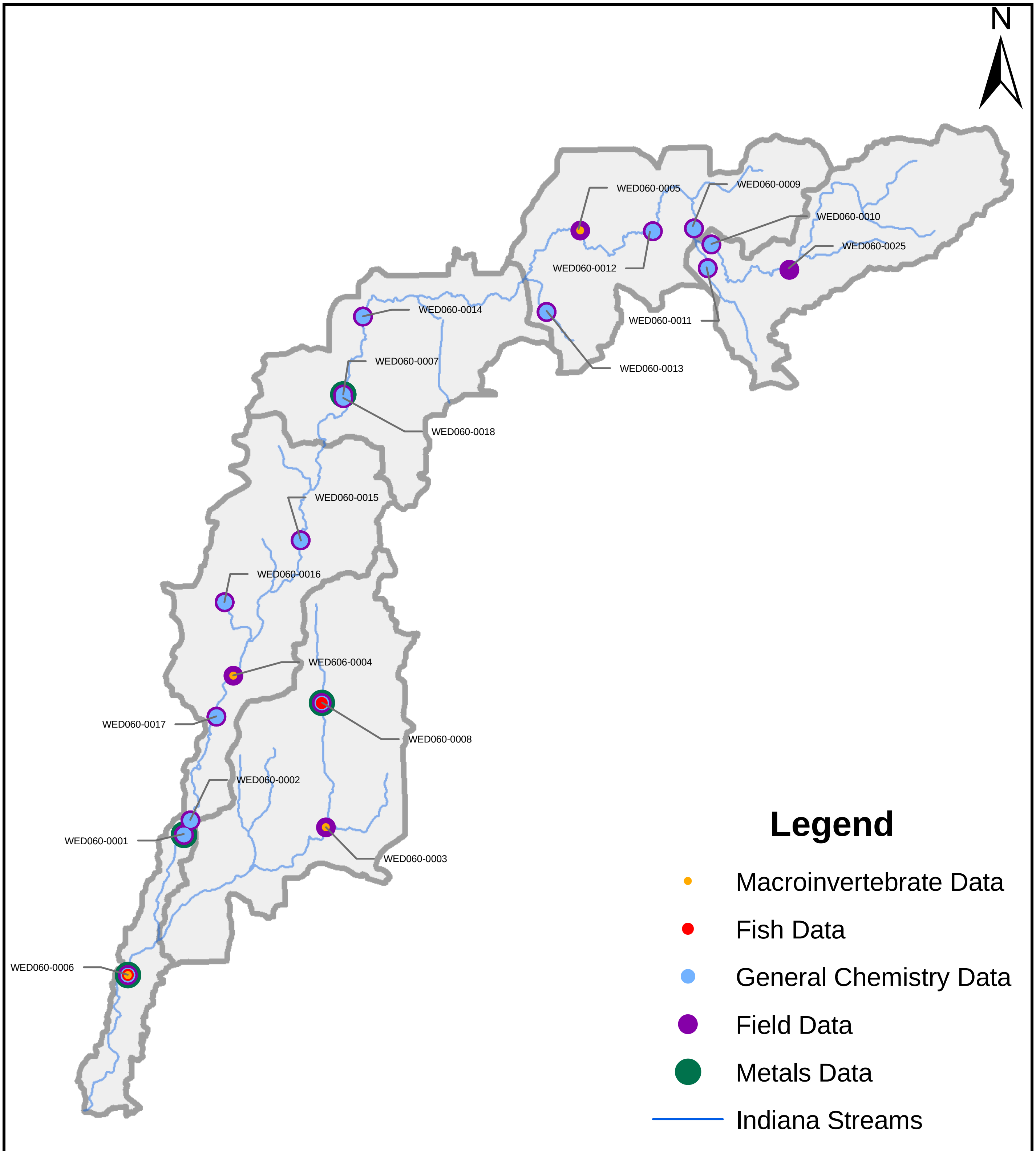
TITLE: **2002 & 2007 TMDL Sampling Location Map**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 22	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 09/05/07	SCALE: NTS

Summary of 1993 to 2007 IDEM Data

Available data from the Indiana Department of Environmental Management for the Sugar Creek Watershed between 1993 and 2007 was obtained and evaluated to determine where water-quality problems were noted in the Watershed. Data included field data, general chemistry data, metals data, macroinvertebrate data, fish community data and habitat quality data. IDEM identified each site location by assigning a code which included WED followed by a numeric sequence. Site locations were spread throughout the Watershed and are shown in Exhibit 23. Sugar Creek Watershed stream impairments are shown in Exhibit 24-26. Exhibits 24-26 are presented in the 14-digit HUC subwatershed boundary because that was the boundary used when the study was conducted.



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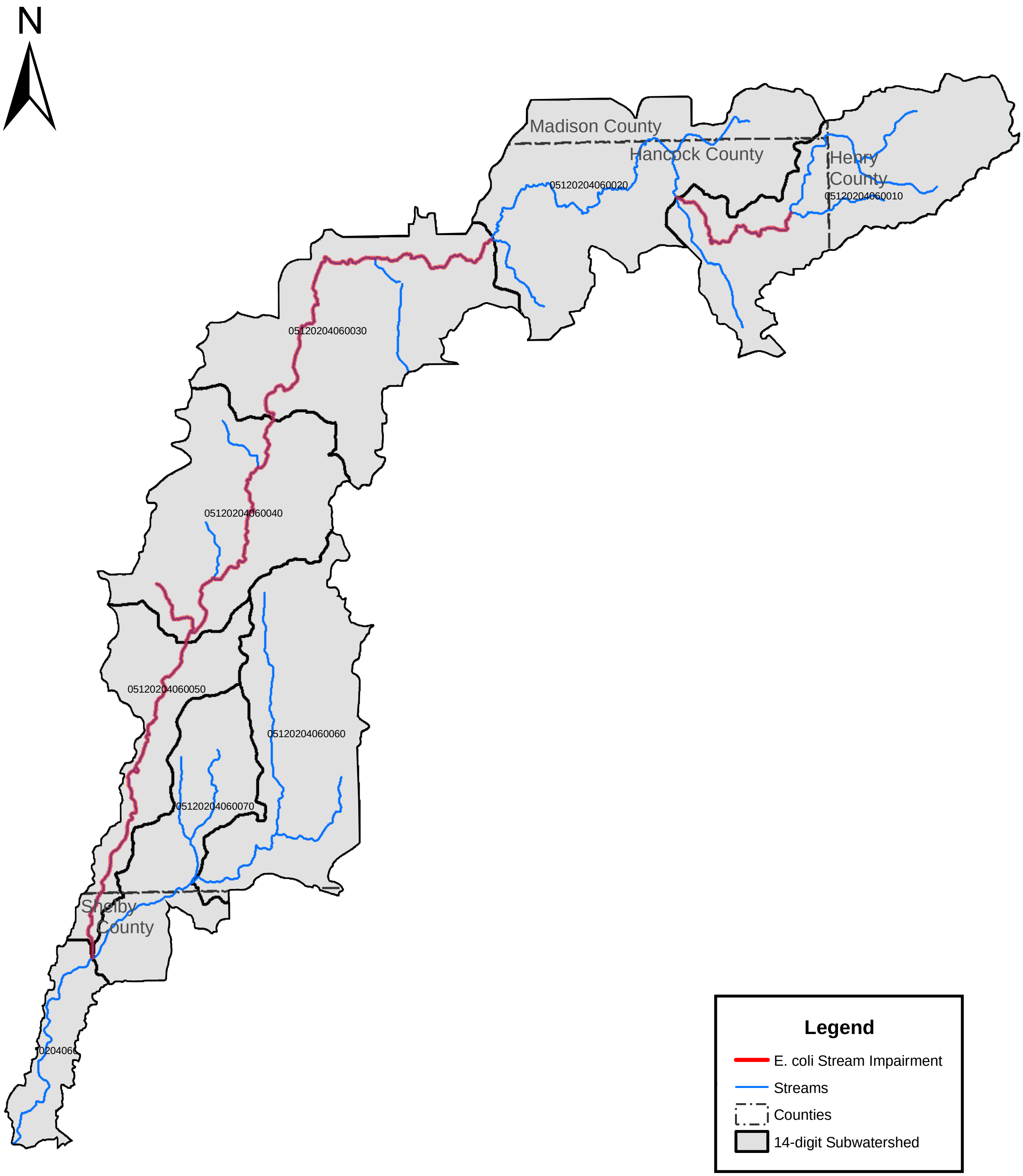
TITLE: **IDEM Data**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: IDEM	PROJECT NO. 07065	EXHIBIT: 23	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS



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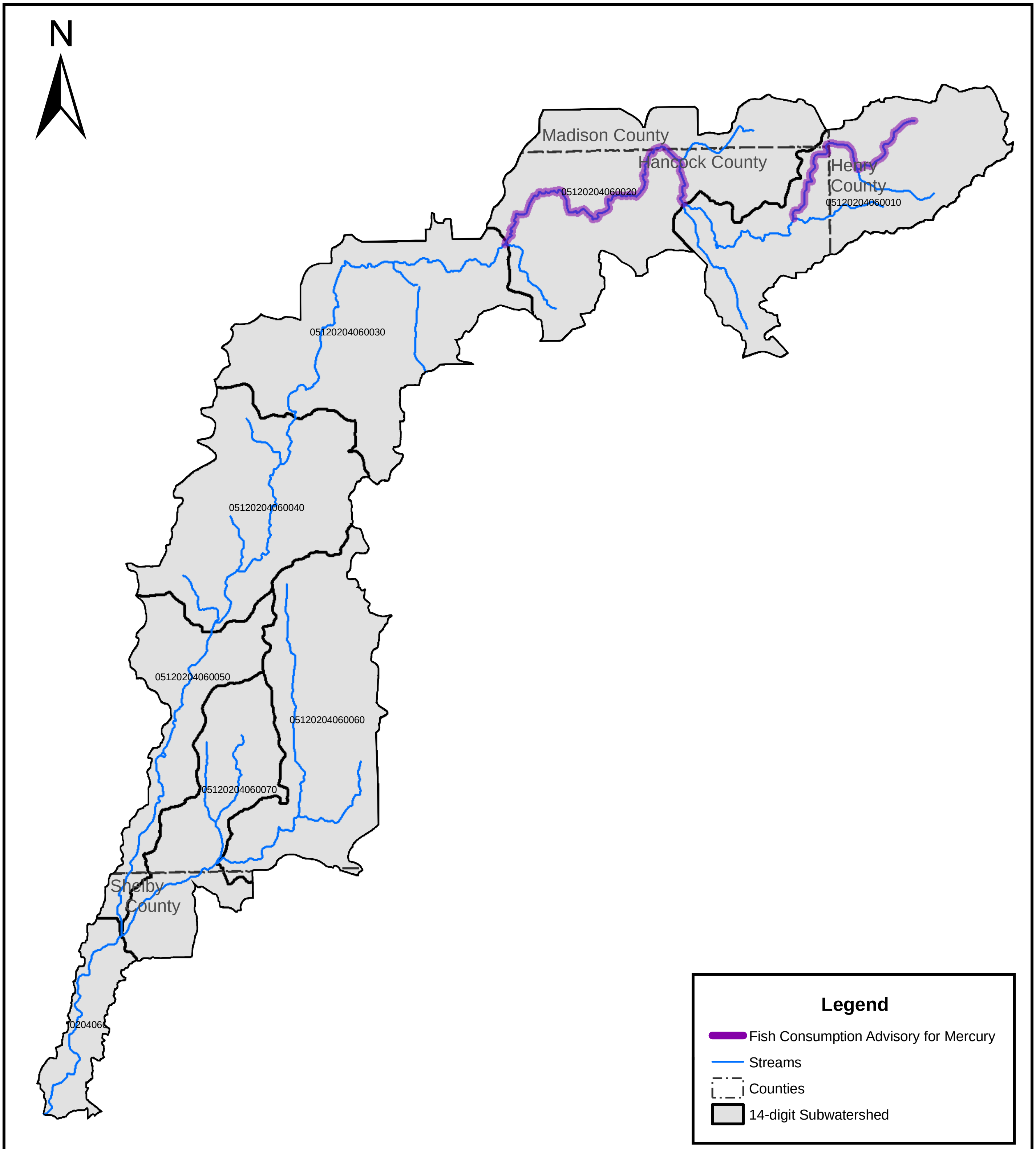
TITLE: **2006 303(d) E. coli Stream Impairments**	PROJECT: **Sugar Creek Watershed Project**
BASE LAYER: Indiana Department of Environmental Management	PROJECT NO. 07065 / EXHIBIT: 24 / SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A / DATE: 5/1/08 / SCALE: NTS



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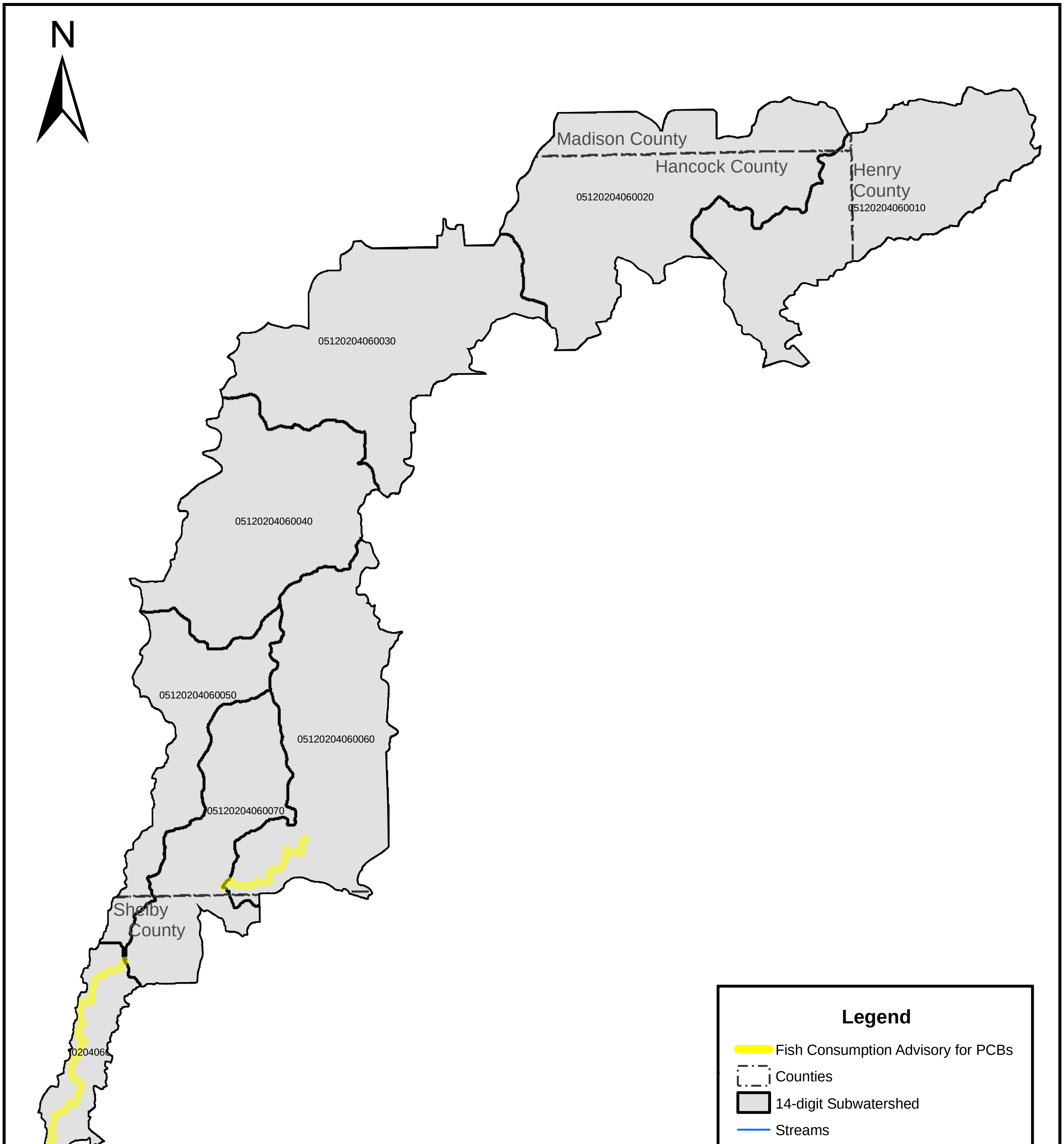
TITLE: **Fish Consumption Advisory for Mercury 2006 303(d) Stream Impairments**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: Indiana Department of Environmental Management	PROJECT NO. 07065	EXHIBIT: 25	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/5/07	SCALE: NTS



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TITLE:	**Fish Consumption Advisory for PCBs 2006 303(d) Stream Impairments**
PROJECT:	**Sugar Creek Watershed Project**
BASE LAYER:	Indiana Department of Environmental Management
CLIENT:	Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140
PROJECT NO.:	07065
EXHIBIT:	26
SHEET:	1 OF: 1
QUADRANGLE:	N/A
DATE:	5/1/08
SCALE:	NTS

Nutrients of concern within the Sugar Creek Watershed include both nitrogen and phosphorus, although phosphorus is the limiting nutrient in most of Indiana's aquatic systems, and is therefore the nutrient of most concern. Only one station had phosphorus levels exceeding 0.3 mg/L. This occurred at station WED060-0008 on Wilson Ditch with a value of 1.4 mg/L (Exhibit 23). It is interesting to note that this site also had a poor fish community, and the QHEI also indicated that the habitat was poor and unable to support a healthy aquatic community. Further analysis would need to be completed to evaluate whether habitat or pollution was causing this impairment of the fish community. Presently, no streams within the Sugar Creek Watershed are listed as impaired for nutrients. However the lack of impairment may be attributed to the lack of a numeric standard for nutrient exceedances. At this time, Indiana addresses nutrient exceedances based on more general narrative criteria that is dependant on the basis of best professional judgment. This makes the determination of impairment more difficult as there is a need for continuity between assessments. In addition, the impact of nutrients on water bodies and aquatic life has not been fully evaluated in Indiana. To address nutrient exceedances within Indiana IDEM is presently working on this issue, and hopes to have developed specific nutrient criteria for waterbodies in Indiana in the near future.

One way to indirectly assess the impact of nutrients is to look at dissolved oxygen levels in the stream. As algae and plants photosynthesize, they produce oxygen. If excessive plant and algal growth is present due to high inputs of nutrients, photosynthesis will increase causing high dissolved oxygen levels. High levels of dissolved oxygen are generally not a problem, but as night falls and plants and algae cease photosynthesis, their respiration results in a net loss of oxygen to the system. This can cause significant drops in DO levels that are harmful to many aquatic species. Sustained values below 5 mg/L and any drop in oxygen below 4 mg/L can be lethal to many aquatic organisms. Evaluation of data throughout the years has indicated that streams where DO levels above 12 mg/L most likely suffer from these large swings in DO levels.

Although no sites were found with DO levels below 4 mg/L, three sites did have values below 5 mg/L. These include WED060-0013, WED060-0014 and WED060-0015. One of these sites, WED060-0013 is on a smaller tributary stream. Small tributaries are often more susceptible to fluctuations in DO values due to lack of flow through the system, however, the other two sites are on Sugar Creek itself and may indicate a more basin-wide problem. In addition, two stations were found to have DO levels above 12 mg/L indicating a possible night-time drop in DO values. These included WED060-0011 on Pee Dee Ditch and WED060-0001 on Sugar Creek near New Palestine. IDEM data indicated problems at both WED060-0002 and WED060-0001. These sites are relatively near each other and between them had DO values over 12 mg/L, high turbidity values, and high specific conductance values ranging from 1,399 – 2,316. This can often be a sign of untreated or poorly treated wastewater.

Water Quality Evaluation Explanation

Water quality analysis was measured in the field using an YSI Model 63 Handheld pH, Conductivity, Salinity and Temperature System, YSI Model 55 Dissolved Oxygen Meter, LaMotte 2020 Turbidimeter, and MARSH-McBIRNEY FLO-MATE Model 2000 Portable Flowmeter. V3 performed the water quality measurements for the following parameters: temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow, and turbidity. V3 also collected water samples for water chemistry analysis at ESG Laboratories in Indianapolis, Indiana, for the following parameters: Biochemical Oxygen Demand (BOD), Total Phosphorus, and *Escherichia coli (E. coli)*.

An explanation of key water quality parameters is summarized as follows:

Turbidity. The water's transparency can be affected by two primary factors: algae and suspended particulate matter. An increase in the density of the phytoplankton or suspended particles signifies an increase in the water's turbidity.

Bacteria, Fecal Coliform and E coli. *Escherichia coli*, known as *E. coli*, is a member of the fecal coliform group of bacteria. When this organism is detected within water samples, it is an indication of fecal contamination. *E. coli* is an indigenous fecal flora of warm-blooded animals. Contributions of detectable *E. coli* colonies may appear within water samples due to the input from human or animal waste. Common sources of animal waste are agricultural feedlots (pigs, cattle, etc.), pet waste, or bird waste (such as Canada geese or seagulls). Rain storm events or snow melts frequently wash waste and the associated *E. coli* into surface water systems. The single sample state standard in Indiana for *E. coli* is 235 CFU/100 mL. The measure of CFU per 100 mL means the count of colony forming units (CFU) that exist in 100 milliliters of water.

Phosphorus. Phosphorus is a major cellular component of organisms. Phosphorus can be found in dissolved and sediment-bound forms. However, phosphorus is often locked up in living biota, primarily algae. In the Watershed, phosphorus is found in fertilizers and in human and animal wastes. The availability of phosphorus determines the growth and production of algae and makes it the limiting nutrient in the system. In this study, water samples were analyzed for dissolved and total phosphorus. Dissolved phosphorus is important because it is readily usable by algae. Total phosphorus values are important because concentrations greater than 0.03 mg/L (30ug/L) can cause algal blooms. The suggested exceedance level for Total Phosphorus within the Watershed is 0.3 mg/L. Those levels of Total Phosphorus greater than 0.3 mg/L exceed the suggested water quality target limit for Total Phosphorus in the state of Indiana.

Nitrogen. Nitrogen is another major cellular component of organisms. Nitrogen can enter water bodies from the air and as inorganic nitrogen and ammonia for use by bacteria, algae and larger plants. The four common forms of nitrogen are:

- Nitrite (NO_2^- or simply NO_2) – is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate. Nitrite is a negative charged ionized form of nitrogen (anion).
- Nitrate (NO_3^- or simply NO_3) – Nitrate generally occurs in trace quantities in surface water but may attain high levels in some groundwater. In excessive amounts, it contributes to the illness known as methemoglobinemia in infants. The current EPA standard of 10 parts per million (ppm) for drinking water is specifically designated to protect infants from this disorder. Nitrate is a negative charged ionized form of nitrogen (anion).

- Ammonia (NH_3) and Ammonium (NH_4^+ or simply NH_4) – Ammonia has a polar charge and can be toxic to fish, Ammonium is a positive charged ionized form (cation) and is considered nontoxic. Ammonia is present naturally in surface waters. Bacteria produce ammonia as they decompose dead plant and animal matter. The concentration of ammonia is generally low in groundwater because it adheres to soil particles and clays and does not leach readily from soils.
- Organic nitrogen (TKN) – is defined functionally as organically bound nitrogen in the trinegative oxidation state. Organic nitrogen includes nitrogen found in plants and animal materials, which includes such natural materials as proteins and peptides, nucleic acids and urea. In the analytical procedures, Total Kjeldahl Nitrogen (*TKN*) determines both organic nitrogen and ammonia. Raw sewage will typically contain more than 20 mg/L.

The suggested exceedance level for Total Nitrate and Nitrite within the Watershed is 10 mg/L. Those levels of Total Nitrate and Nitrite greater than 10 mg/L exceed the suggested water quality target limit for Total Nitrate and Nitrite in the state of Indiana.

Dissolved Oxygen. Dissolved oxygen is the gaseous form of oxygen and is essential for respiration of aquatic organisms (i.e. fish and plants). Dissolved oxygen enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Oxygen saturation in water would equal 100% if equilibrium were reached. Values greater than 100% saturation indicate photosynthetic activity within the water. Large amounts of dissolved oxygen in the water indicate excessive algae growth. Dissolved oxygen is consumed by respiration of aquatic organisms and during bacterial decomposition of plant and animal matter. The suggested exceedance levels for Dissolved Oxygen within the Watershed are values less than 5 mg/L and levels greater than 12 mg/L. Those levels of Dissolved Oxygen less than 5 mg/L and greater than 12 mg/L exceed the suggested water quality target limit for Dissolved Oxygen in the state of Indiana.

Biochemical Oxygen Demand (BOD). BOD provides a means of determining the relative oxygen requirements of wastewaters, effluents and polluted waters. The test measures the molecular oxygen utilization during a five day incubation test period for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron.

Temperature. The ecological effects of light and temperature on the photosynthesis and growth of algae are inseparable because of the interrelationships in metabolism and light saturation. One commonly observed change in the rate of respiration of planktonic algae is an increase of the rate with increasing temperature. Additionally, the ability of water to hold oxygen decreases as temperatures increase. When water is oxygen saturated, warmer water has the ability to possess lower amounts of oxygen when compared to colder water that is likewise oxygen saturated.

Conductivity. The conductance of water is the reciprocal of its resistance to electrical flow. The resistance of a water solution to electrical current or electron flow is reduced with increasing content of ionized salt. Distilled water has a conductivity of zero. The purer the water is, the lower its conductivity.

Specific Conductance. Specific Conductance is the conductance at 25°C. This reading is important because conductivity readings are directly linked to temperature and can change up to 3% for a change of one degree Celsius.

Arsenic. Arsenic enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices. Arsenic has been classified by the EPA as a human carcinogen (cancer causing agent). Long term exposure to arsenic has been linked to cancer, cardiovascular disease, immunological disorders, diabetes and other medical issues. Arsenic in water has no smell, taste or coloration even at high concentrations therefore water quality testing is required to determine its presence. The suggested exceedance level for Arsenic within the Watershed is 0.5 ug/L. Those levels of Arsenic greater than 0.5 ug/L exceed the suggested water quality target limit for Arsenic in the state of Indiana.

pH (Acidic and Alkaline). The pH of a water body reflects the hydrogen ion activity in the water body. pH is defined as the –log [H^+]. A low pH signifies an acidic medium (lethal effects of most acids begin to appear at pH = 4.5) while a high pH signifies an alkaline medium (lethal effects of most alkalis begin to appear at pH = 9.5). Neutral pH is 7. The actual pH of a water sample indicates the buffering capacity of that water body.

Salinity. Salinity is a measure of the total salts that are dissolved in water, in parts per thousand (ppt). Salinity will be variable from location and time of year. Plants are adversely affected by high salinity, which can cause stunted growth, leaf burn and defoliation. The ocean's salinity is approximately 35 ppt. The following list denotes various concentration levels of salinity in natural environments, however, urban influences of salt distribution during wintertime provides a non-natural situation:

- Fresh water, 0 ppt, no tidal influence
- Tidal Fresh, 0 – 1 ppt, tidal influence
- Oligohaline, 2 – 5 ppt, slightly brackish
- Mesohaline, 8 – 15 ppt, brackish
- Polyhaline, >18 ppt, salt water

The most commonly used road salt is sodium chloride (NaCl). NaCl dissociates in aquatic systems into chloride ions (Cl-) and sodium cations (Na+). This also results in a higher conductivity reading. Elevated sodium and chloride levels create osmotic imbalances in plants, which inhibit water absorption and reduce root growth. Various species of fish, amphibians and aquatic macroinvertebrates are adversely impacted by increased levels of sodium and chloride.

Water Quality Evaluation Methodologies

Water quality data was collected in the field using a Conductivity/Salinity/Temperature Meter, YSI 63 pH, YSI Model 55 Dissolved Oxygen Meter, and LaMotte 2020 Turbidimeter. V3 performed water quality measurements for the following parameters: temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow and turbidity. V3 utilized ESG laboratories to analyze total phosphorus, *E. coli* concentrations, and biological oxygen demand (BOD). Phosphate and Nitrate concentrations were measured using the HACH field instruments.

Water Quality Evaluation Results

Historical and current water quality data collected from within the Watershed has been reviewed from various sources which include IDEM sampling, TMDL sampling, National Pollutant Discharge Eliminations System (NPDES) sampling, and volunteer monitoring. In an effort to summarize the problems within the Watershed and evaluate their results, water quality standards were used as benchmarks. If water quality results were either below lower limit thresholds or results were greater than higher limit thresholds, an increment of exceedance was tallied. Condensing the water quality results was the method in which the eight 14-digit HUC subwatersheds were compared and prioritized.

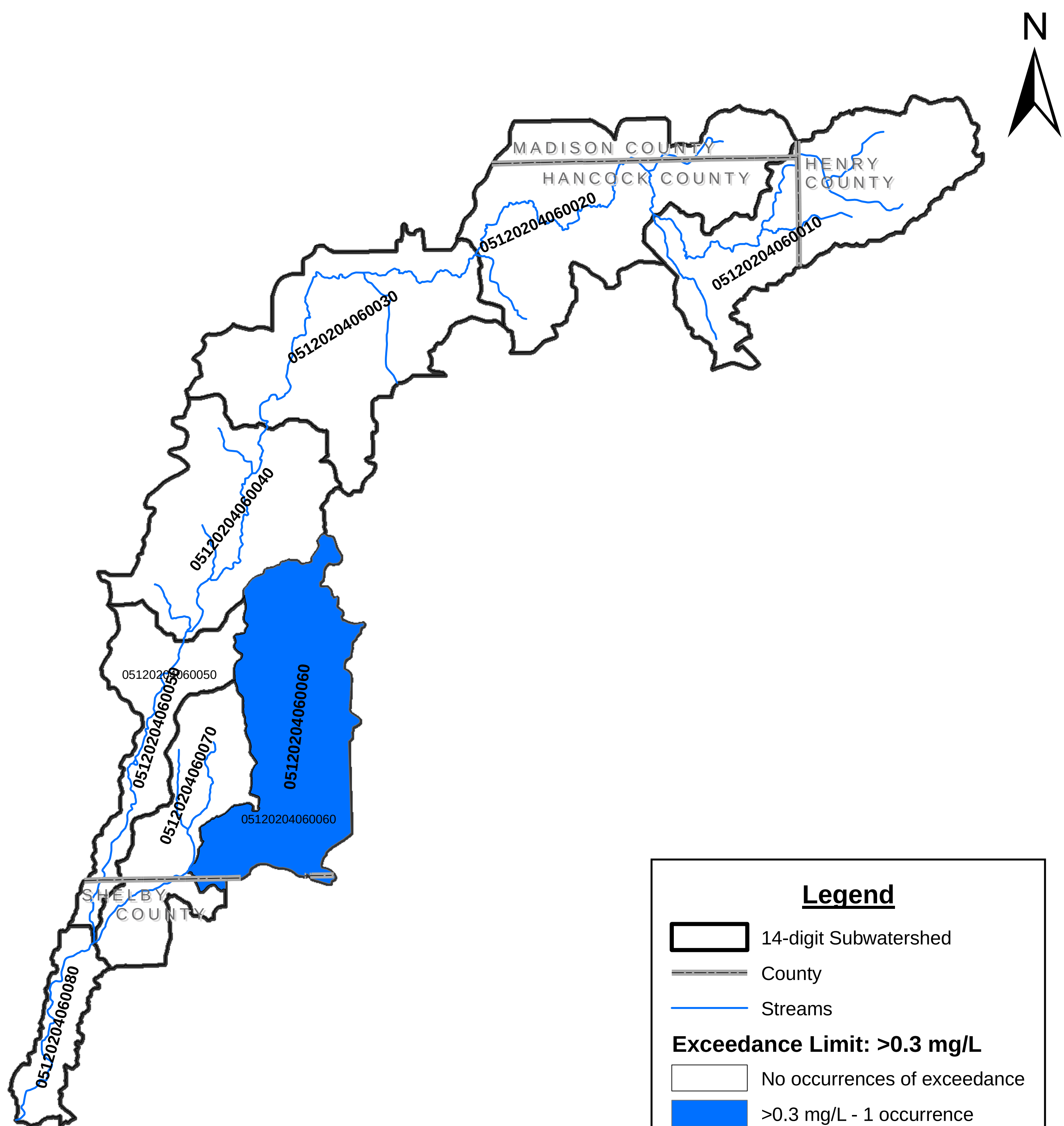
The water quality parameters which have standard limits associated with them were screened to determine which priorities for subwatersheds demonstrated impairments or degradations. V3 water quality results were not included in these exhibits to distinguish between historical and current trends in impairment. The water quality parameters evaluated from the historical data set and their suggested limits include:

- Total Phosphorus (Exhibit 27), values which exceed 0.3 mg/L
- Total Nitrate and Nitrite (Exhibit 28), values which exceed 10 mg/L
- DO (Exhibit 29), values less than 5 mg/L & greater than 12 mg/L
- *E. coli* (Exhibit 30), values greater than 235 CFU/100 mL
- Arsenic (Exhibit 31), values greater than 0.5 μg/L

Exhibits 27-31 are presented in the 14-digit HUC subwatershed boundary because that was the boundary used when the study was conducted. Sugar Creek historical water quality results demonstrated impairment or degradation throughout the watershed. Infractions on suggested limits/standards for nitrate/nitrite and arsenic were present at one of the eight 14-digit HUC subwatersheds (05120204060050). One infraction was noted for phosphorus exceedance at the 05120204060060 HUC subwatershed. Four of the eight subwatersheds demonstrated an impairment or degradation with respect to DO levels and *E. coli* concentrations. Subwatersheds which had DO levels in exceedance include 05120204060010, 05120204060020, 05120204060030 and 05120204060050. Subwatersheds which had *E. coli* concentration exceedances include 05120204060010, 05120204060030, 05120204060040, and 05120204060050.

V3 performed monthly water quality sampling at eight stations for a period of one year, and was complete as of May 2008. Monthly sampling was performed as part of the preparation of this WMP. The water quality result summary tables are shown in Appendix C. Water quality parameters evaluated from the V3 data set include:

- Total Phosphorus (Exhibit 32), values which exceed 0.3 mg/L
- Total Nitrate and Nitrite (Exhibit 33), values which exceed 10 mg/L
- DO (Exhibit 34), values less than 5 mg/L & greater than 12 mg/L
- *E. coli* (Exhibit 35), values greater than 235 CFU/100 mL
- pH (Exhibit 36), values greater than 8.7



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
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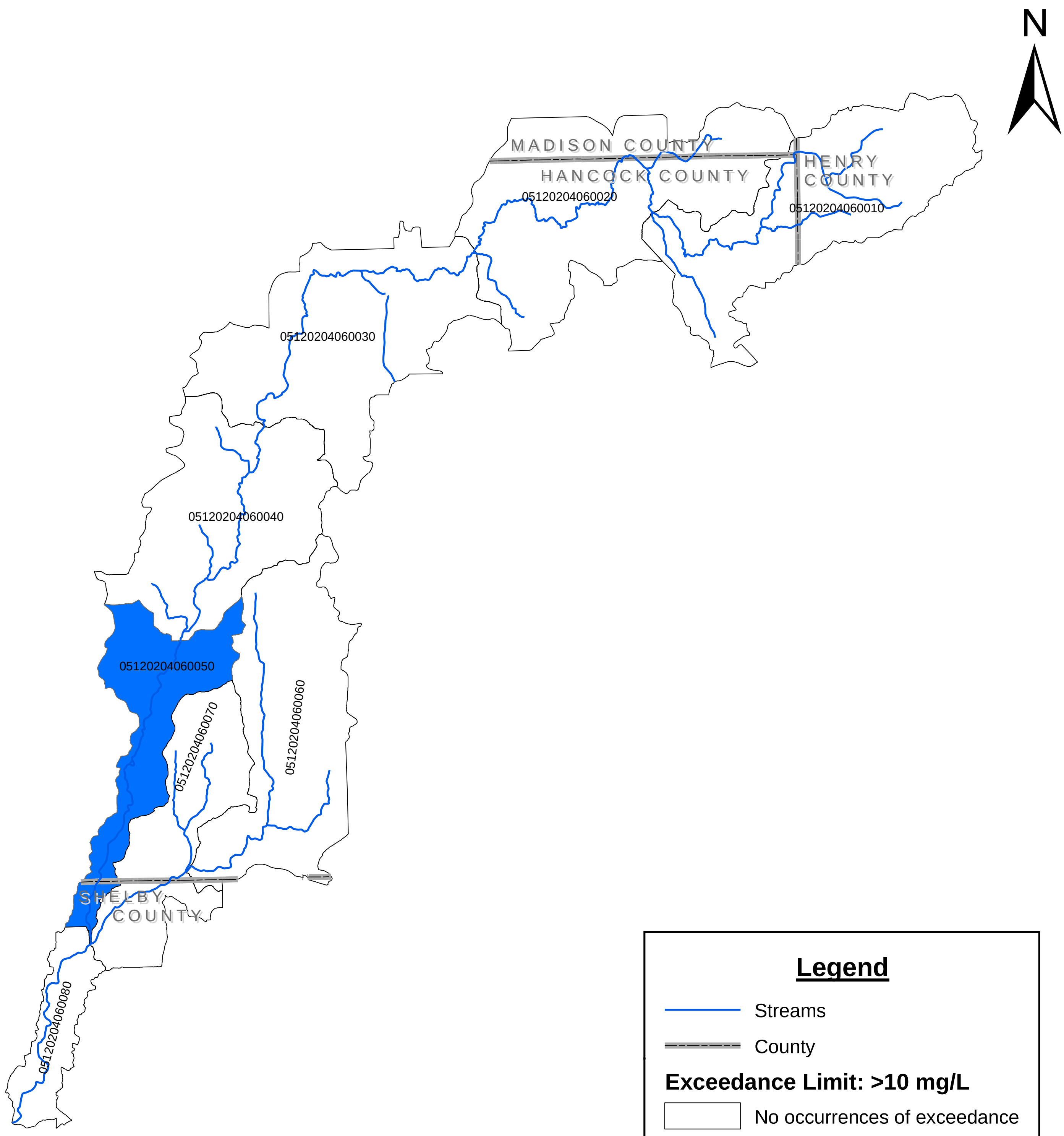
TITLE: **Phosphorus Exceedance**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 27	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



Legend

Streams

County

Exceedance Limit: >10 mg/L

No occurrences of exceedance

>10 mg/L - 1 occurrence

*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
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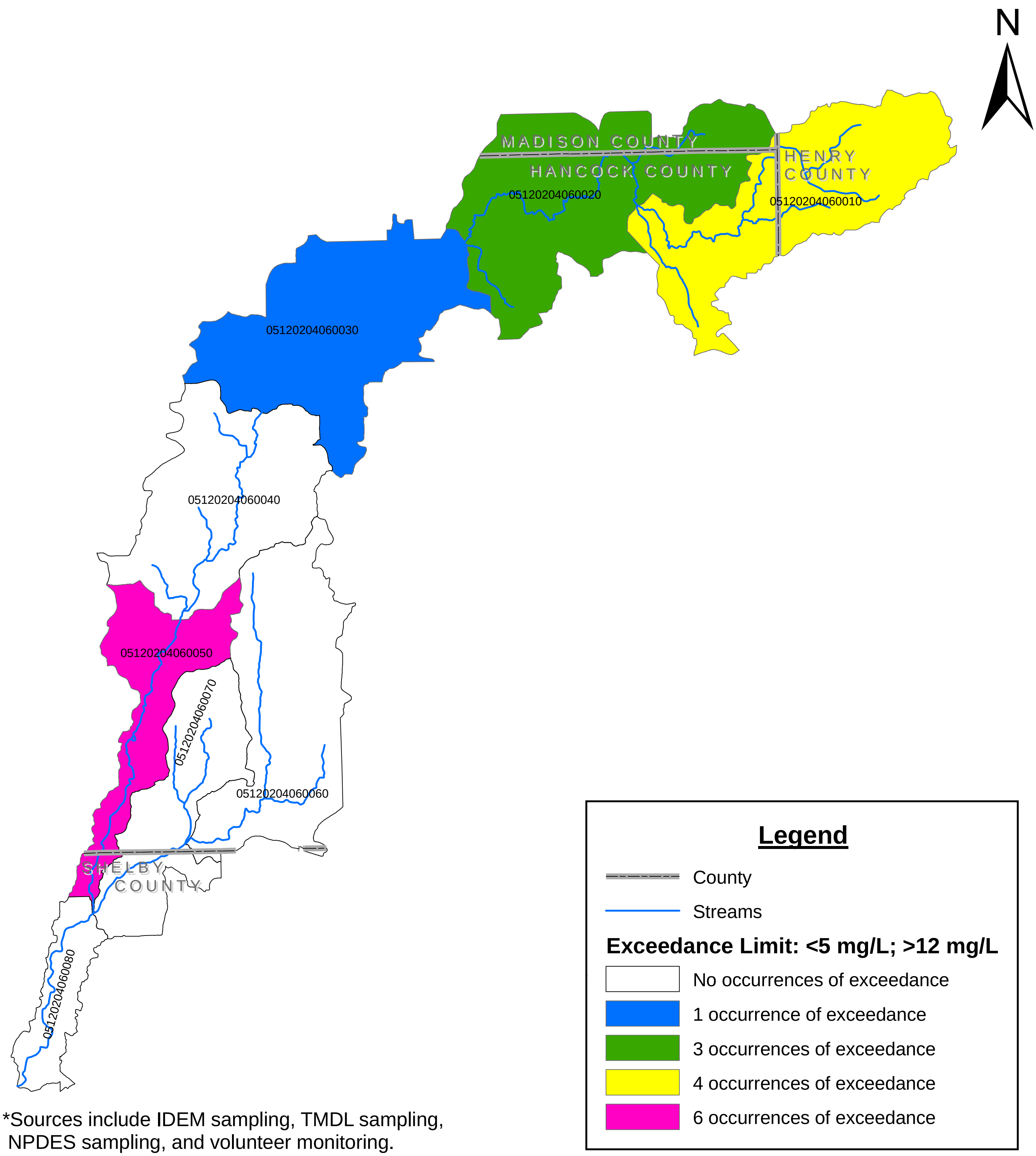
630.724.9202 fax
www.v3co.com

TITLE: **Nitrate and Nitrite Exceedance**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 28	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
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630.724.9202 fax
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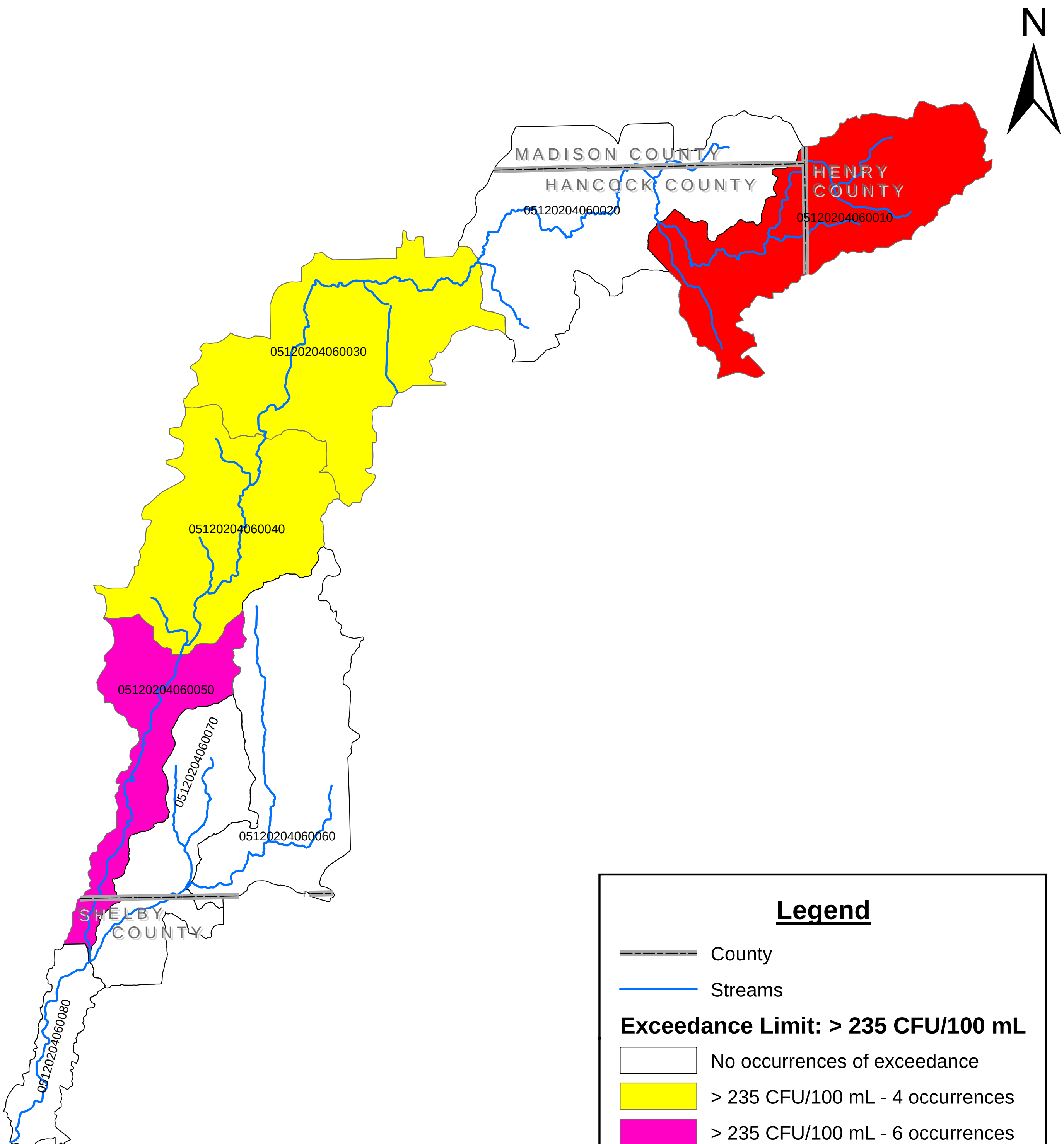
TITLE: **Dissolved Oxygen Exceedance**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 29	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

Legend

County

Streams

Exceedance Limit: > 235 CFU/100 mL

No occurrences of exceedance

> 235 CFU/100 mL - 4 occurrences

> 235 CFU/100 mL - 6 occurrences

> 235 CFU/100 mL - 10 occurrences

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TITLE: **E. coli Exceedance**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: N/A

PROJECT NO. 07065

EXHIBIT: 30

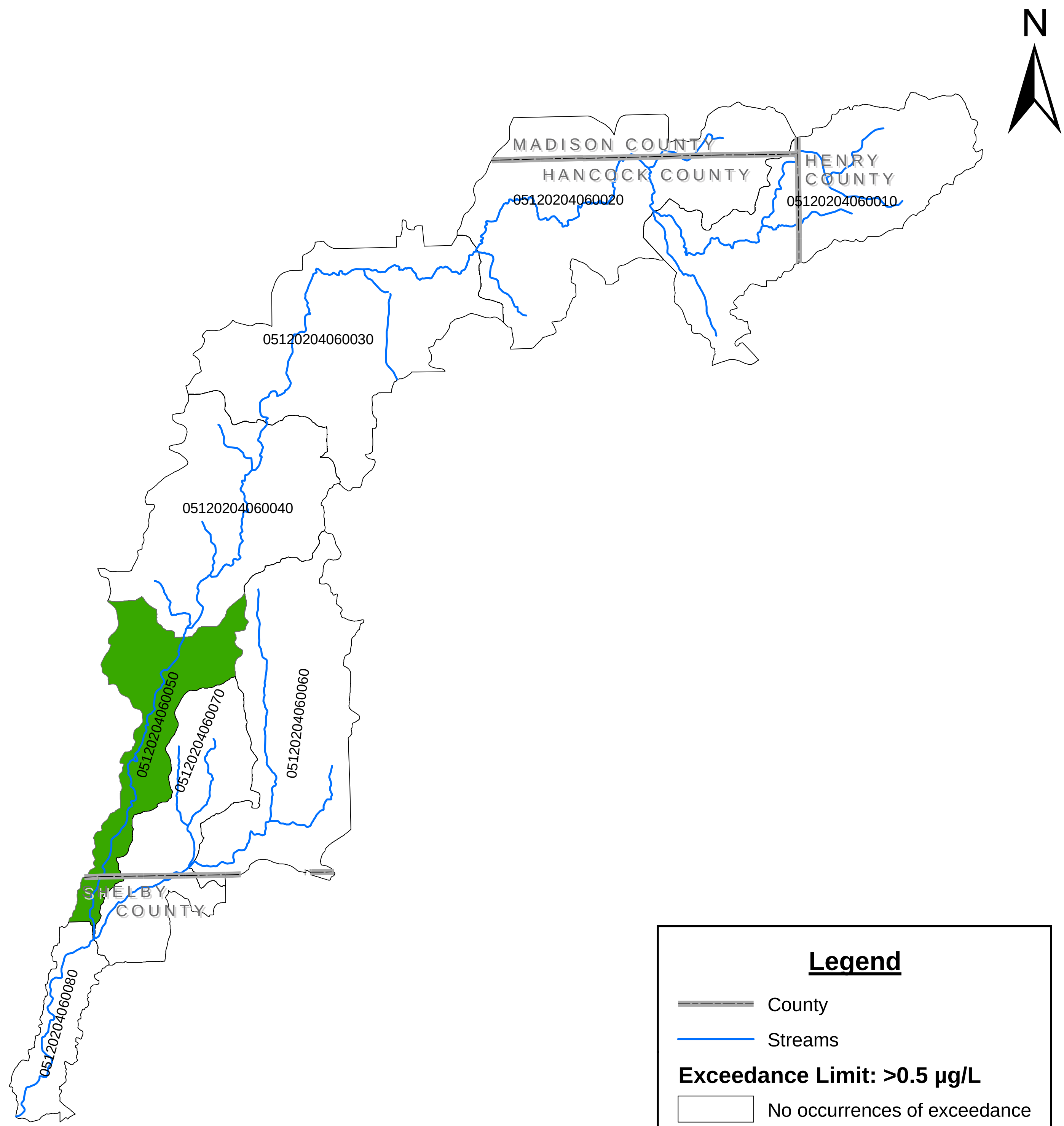
SHEET: 1 OF: 1

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

QUADRANGLE: N/A

DATE: 12/11/07

SCALE: NTS



*Sources include IDEM sampling, TMDL sampling, NPDES sampling, and volunteer monitoring.

Legend

County

Streams

Exceedance Limit: >0.5 µg/L

No occurrences of exceedance

>0.5 µg/L - 3 occurrences

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630.724.9202 fax
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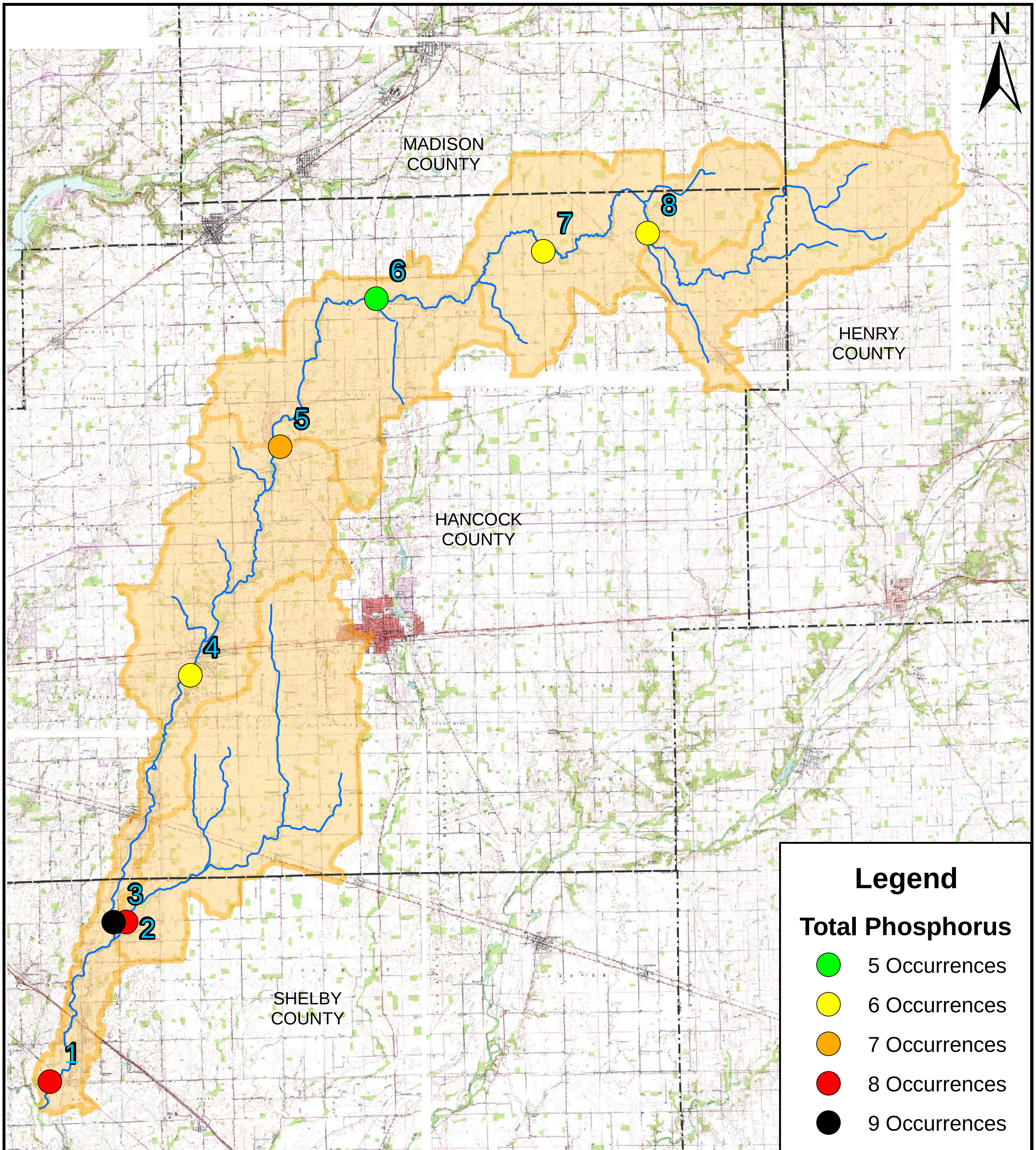
TITLE: **Arsenic Exceedance**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 31	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 12/11/07	SCALE: NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
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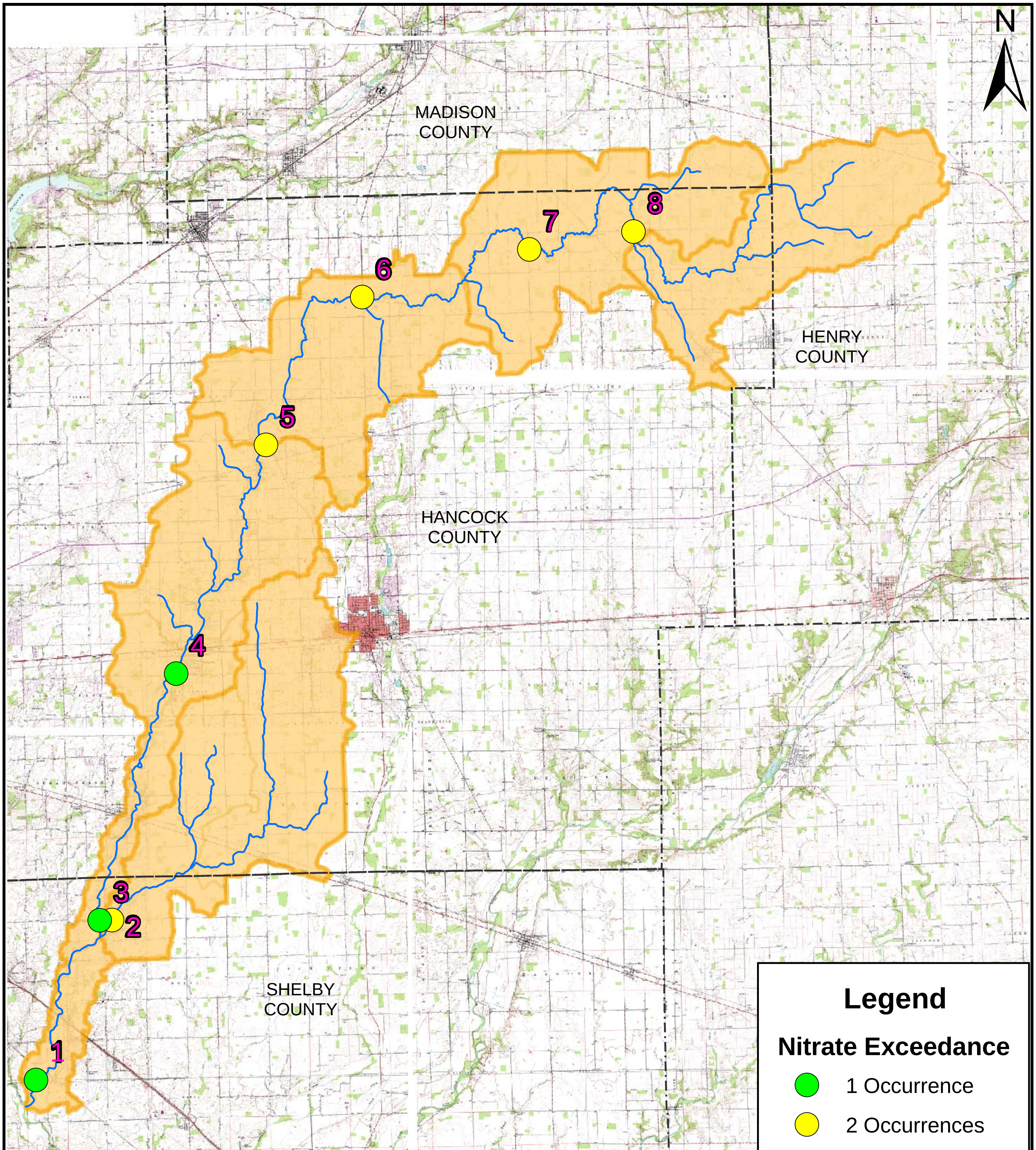
630.724.9202 fax
www.v3co.com

TITLE: Total Phosphorus Exceedances at V3 Sampling Stations	PROJECT: Sugar Creek Watershed Project
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	EXHIBIT: 32
	SHEET: 1 OF: 1
	QUADRANGLE: N/A
	DATE: 4/29/08
	SCALE: NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
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630.724.9202 fax
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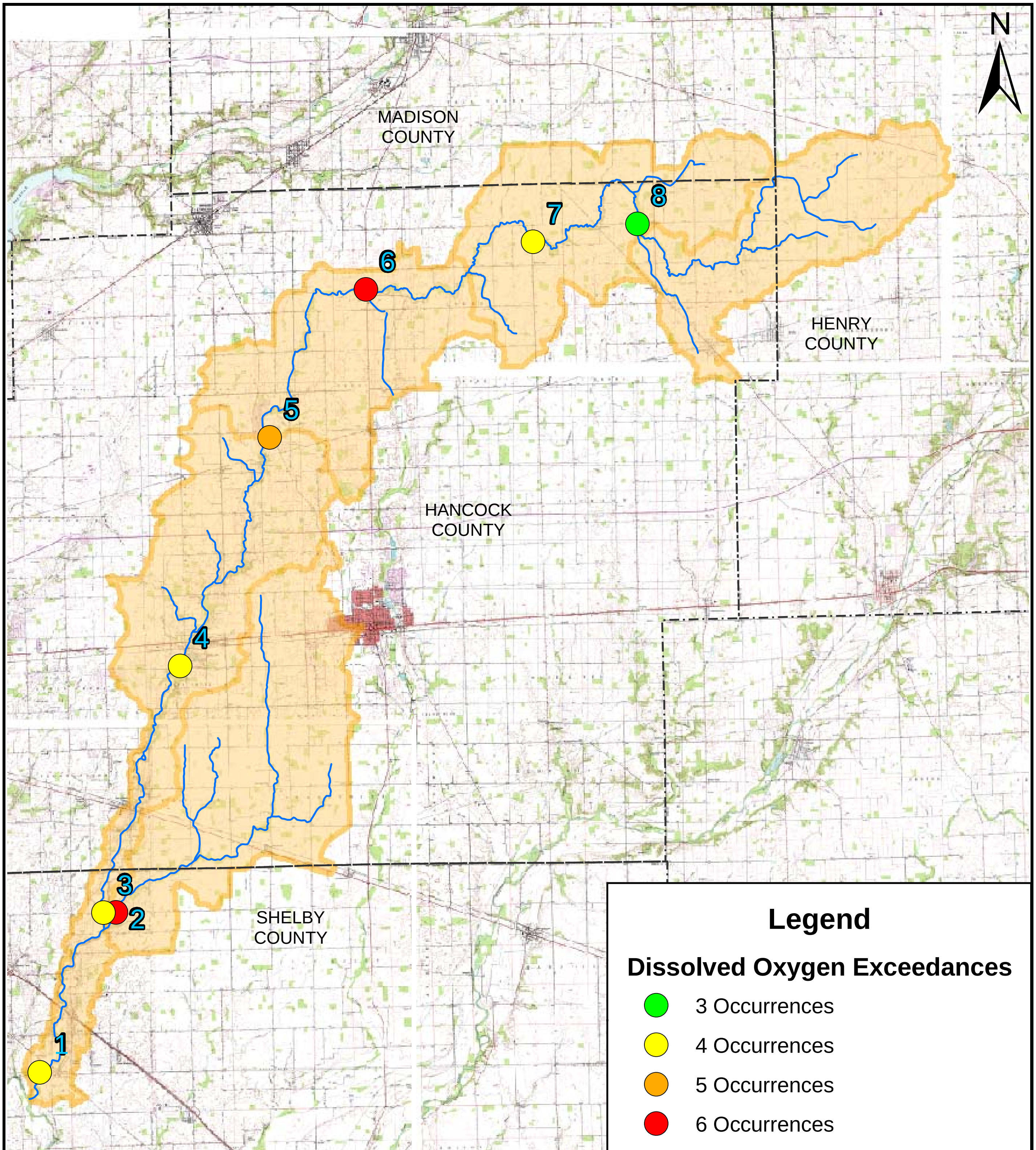
TITLE: **Nitrate Exceedances at V3 Sampling Stations**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: USGS Topographic Map

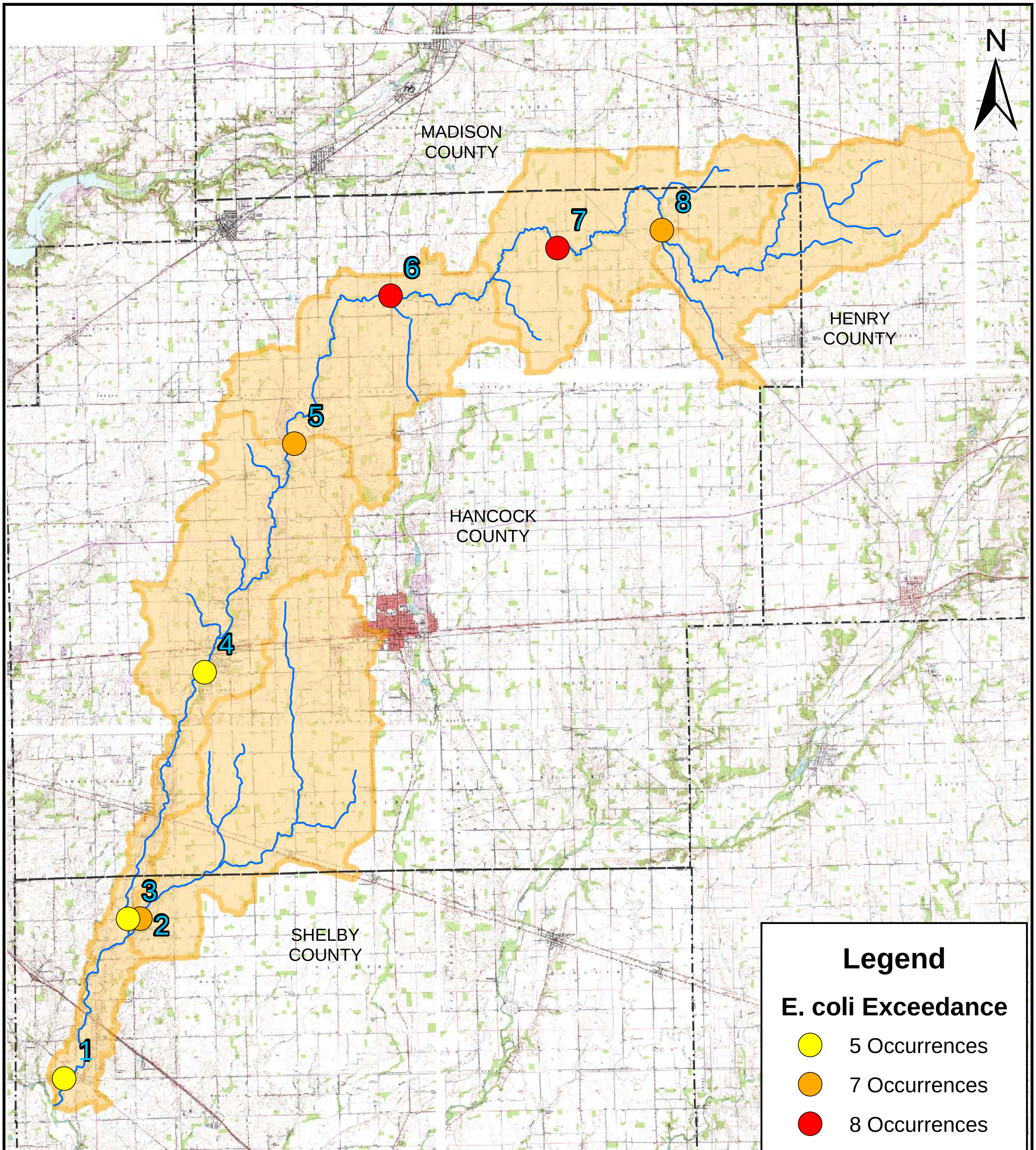
CLIENT: Hancock County SWCD
1101 West Main St., Ste. N
Greenfield, IN 46140

PROJECT NO.	EXHIBIT:	SHEET: 1 OF: 1
07065	33	
QUADRANGLE:	DATE:	SCALE:
N/A	10/29/08	NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: Dissolved Oxygen Exceedances at V3 Sampling Stations	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 34	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/28/08	SCALE: NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
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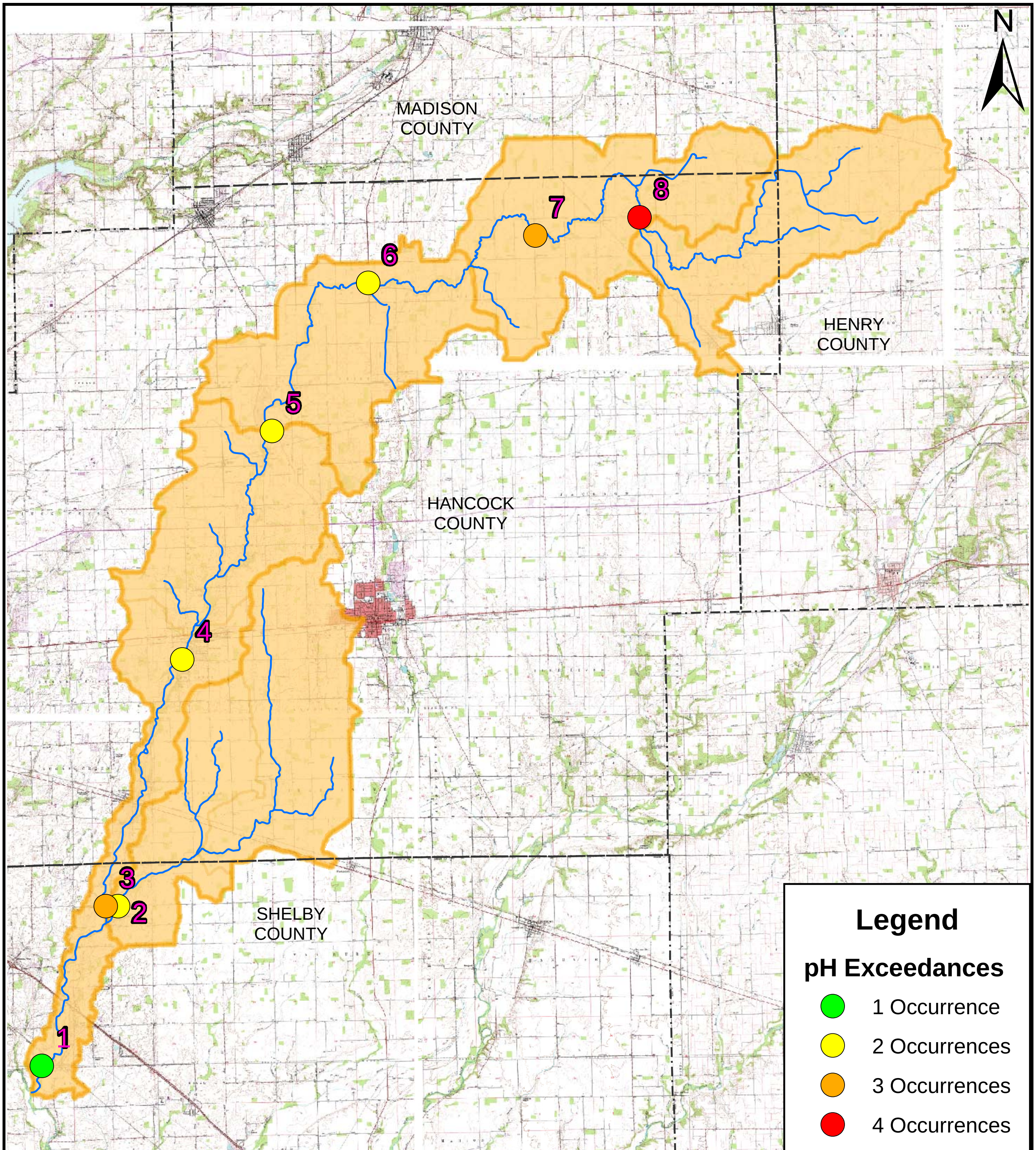
TITLE: E.coli Exceedances at V3 Sampling Stations	PROJECT: Sugar Creek Watershed Project
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065 / EXHIBIT: 35 / SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A / DATE: 4/29/08 / SCALE: NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
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TITLE: **pH Exceedances at V3 Sampling Stations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: USGS Topographic Map	PROJECT NO. 07065	EXHIBIT: 36	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 West Main St., Ste. N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 4/29/08	SCALE: NTS

Sediment is another parameter of concern within the Sugar Creek Watershed, not only due to the impacts of the sediment itself, but of the contaminants that often bind with, or otherwise reside in the sediment. Evidence from the windshield survey supports severe erosion from land surface and stream banks throughout the watershed that contribute to the excessive load of sediment within Sugar Creek. Suspended sediments is a component of the amount of particulate matter in the water column and contributes to increases in the turbidity values, making it more difficult and often times impossible for fish and aquatic macroinvertebrates to live. The sediment itself can smother aquatic habitat and therefore negatively affect the aquatic flora and fauna. Sediment can also transport nutrients, especially phosphorus that tends to adhere to sediment particles causing excess algal growth leading to the large swings in DO as discussed above. *E. coli* has also been found to live, and under certain conditions, grow within sediments.

Metals data did not show any values of concern, and pesticide data was not collected by IDEM in the Watershed. In addition, most areas studied had good habitat and healthy aquatic communities, so enhancement and preservation of the resource rather than restoration may be the strategy needed in many portions of the Watershed. One area that should be further evaluated is on Sugar Creek near New Palestine.

E. coli has been found to be a persistent and ubiquitous problem. In evaluating IDEM's data, many sites in the Watershed violated Indiana's standards for *E. coli* as was verified by the Sugar Creek TMDL study conducted by IDEM in 2007. In response, many streams within the basin are listed on IDEM's 303(d) list of impaired waterbodies (Exhibit 30 and Exhibit 35; Table 25). Because this is such a widespread issue, it must be addressed in many parts of the Watershed.

Table 25 2006 303(d) Stream Impairments within Sugar River Watershed									
Segment ID	**Segment Name**	**County**	**Miles** (Length of NHD reach)	**Segment Size** (Length of ADB assessment unit in miles)	**HUC14**	**Impairment Total** (Total # of impairments for ADB assessment unit segment)	**FCA HG** (Waterbody impaired- has Fish Consumption Advisory for mercury)	**FCA PCBS** (Waterbody impaired- has a Fish Consumption Advisory for PCBs)	***E. coli*** (Waterbody is impaired for *E. coli*)
INW0461_T1028	Sugar Creek (Upstream of Grain Ditch)	Hancock	3.54	4.39	05120204060010	1.00	Yes	No	No
INW0461_T1028	Sugar Creek (Upstream of Grain Ditch)	Hancock	2.08	4.39	05120204060010	1.00	Yes	No	No
INW0461_T1028	**Total**			**8.78**					
INW0461_T1029	Sugar Creek (Downstream of Grain Ditch)	Hancock	4.39	5.62	05120204060010	1.00	No	No	Yes
INW0462_T1029	Sugar Creek	Hancock	7.74	8.97	05120204060020	1.00	Yes	No	No
INW0462_T1029	Sugar Creek	Hancock	1.23	8.97	05120204060020	1.00	Yes	No	No
INW0462_T1029	**Total**			**23.56**					
INW0463_T1030	Sugar Creek	Hancock	6.40	10.03	05120204060030	2.00	Yes	No	Yes
INW0463_T1030	Sugar Creek	Hancock	3.63	10.03	05120204060030	2.00	Yes	No	Yes
INW0463_T1030	**Total**			**20.06**					
INW0464_T1003	Kirkhoff Ditch	Hancock	1.80	1.58	05120204060040	1.00	No	No	Yes
INW0464_T1003	**Total**			**1.58**					
INW0464_T1031	Sugar Creek	Hancock	0.25	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	1.68	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	3.62	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.31	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.46	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	Sugar Creek	Hancock	0.61	6.93	05120204060040	2.00	Yes	No	Yes
INW0464_T1031	**Total**			**41.58**					
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	3.48	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	5.01	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	0.11	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	Sugar Creek Smith-Johnson Ditch	Shelby	0.22	8.84	05120204060050	2.00	Yes	No	Yes
INW0465_T1032	**Total**			**35.36**					
INW0466_T1026	Little Sugar Creek	Hancock	3.00	3.00	05120204060060	2.00	Yes	Yes	No
INW0466_T1026	**Total**			**3.00**					
INW0468_T1033	Sugar Creek-Sugar Creek (Town)	Shelby	5.92	5.92	05120204060080	2.00	Yes	Yes	No
INW0468_T1033	**Total**			**5.92**					
Grand Total				**139.84**					

Analysis of Information Related to the USGS NAWQA Studies and Water-Quality Analysis of Leary-Weber Ditch

Between 1991 and 2001 the US Geological Survey (USGS) completed the National Water-Quality Assessment (NAWQA) study to help support local, regional, and national information needs related to water-quality management and policy. The goal was to create a baseline understanding of water-quality conditions throughout the nation to aid decisions and policy recommendations affecting this vital resource. USGS plans on continuing studies from 2001 – 2012, to address five national priority topics to establish links between sources of contaminants and the fate and transport of these contaminants. Priorities include:

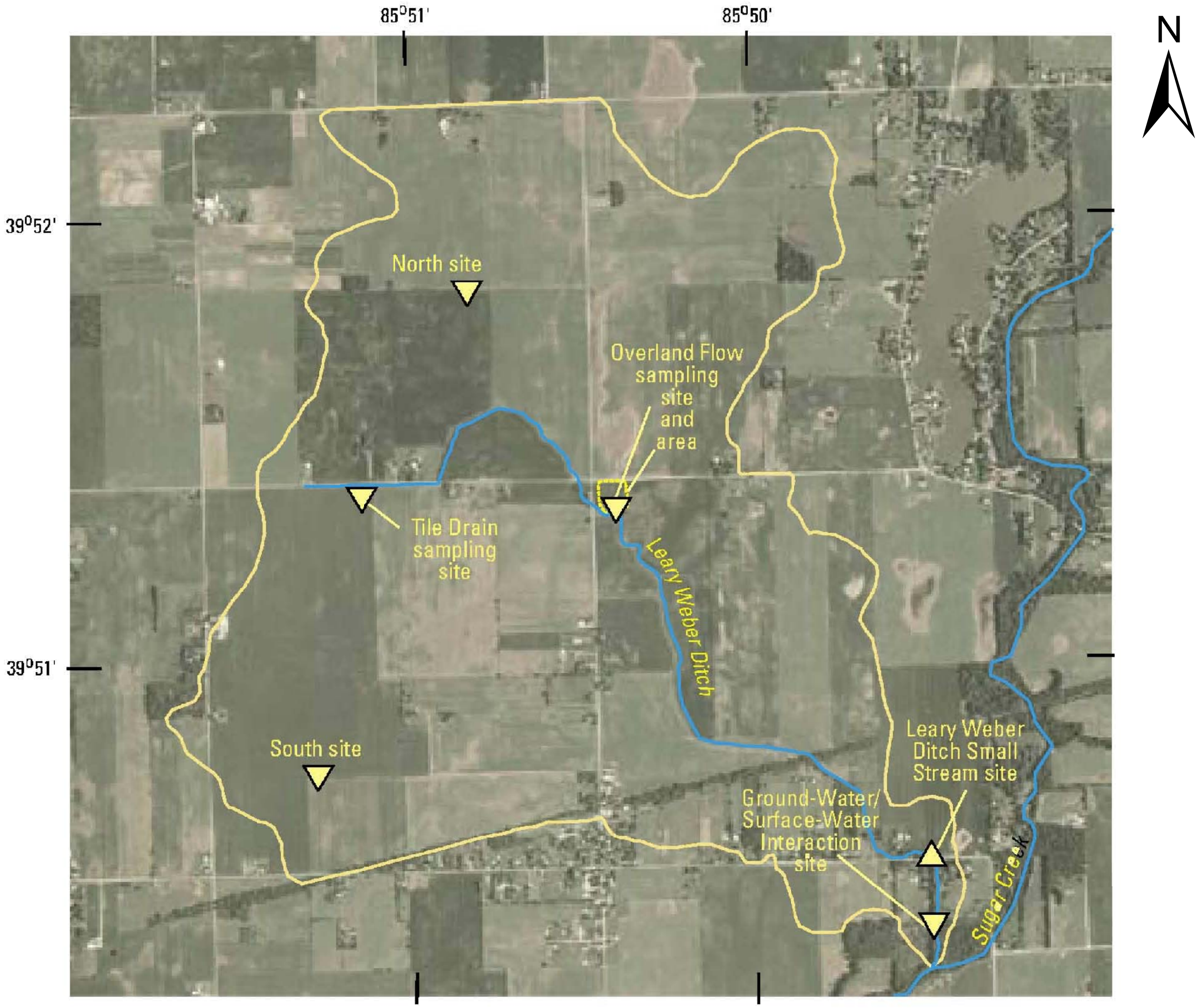
1. Fate of agricultural chemicals
2. Effects of urbanization on stream ecosystems
3. Bioaccumulation of mercury in stream ecosystems
4. Effects of nutrient enrichment on aquatic ecosystems
5. Transport of contaminants to public-supply wells

As part of this mission the USGS conducted a study on the source, transport, and fate of agricultural chemicals in Leary Weber Ditch which is located in the Sugar Creek Watershed in Hancock County. Hydrologic and chemical analysis indicated that the lowest concentrations of pesticides and nutrients were found in rain water, soil water, and ground water, whereas the highest concentrations were found in tile drain water, overland flow, and in samples of Leary Weber Ditch itself. Contamination to the stream from overland flow was only a problem during high-intensity rain events (0.75 inches of rain/hour or greater). These events were rare, so the majority of the impact, both during rain events and between rain events is due to tile flow. Specifically looking at nutrients, nitrate is transported to the greatest amount through tile drains, and orthophosphate has its highest concentration in overland flow. This study will provide insight to possible sources of contaminants with the Sugar Creek Watershed.

Summary of the National Water-Quality Assessment Program's Environmental Setting of the Sugar Creek and Leary Weber Ditch Basins, Indiana, 2002-04 Report

In the Sugar Creek and Leary Weber Ditch Basins, the study was designed to develop an understanding of the sources, pathways, and transformational processes that water and selected chemicals undergo during movement from a local field to a large river. Comparing findings in a nested small basin like Leary Weber Ditch basin to those in a larger basin like Sugar Creek Basin, effects of agricultural chemicals and hydrologic transport at larger geographic scales can be better understood.

The Leary Weber Ditch Basin is a small, intermittent stream that is located 20 miles east of Indianapolis in Hancock County. The ditch is characterized by a clay and muck bottom in its upstream segment, with a more cohesive sand and gravel bottom toward its mouth. The Leary Weber Ditch Basin is primarily an agricultural area and most chemical inputs are the result of crop production. In the Leary Weber Ditch 87% of the total basin is used for row crops. Modifications to natural hydrology of Leary Weber Ditch include subsurface drainage (tile drains) which have been installed to improve the soils for farming and improve yields. Drains greatly increase the rate of water exiting the field and subsequently speed the transport of chemicals and nutrients contained in the soils. At Leary Weber Ditch, there is little to no streamflow when tile drains run dry and at baseflow there is little to no ground-water input. Samples were collected from each environmental compartment within Leary Weber Ditch-precipitation, tile drains, overland flow, unsaturated zone, surface water, ground water, and the ground-water/surface-water interface (Exhibit 37).



Base From U.S. Department of Agriculture, 2003 National Agricultural Imagery Program, County Tiles for Indiana, Hancock, County. Universal Transverse Mercator projection, Zone 16, North American Datum, 1983

EXPLANATION

Leary Weber Ditch Basin

△ U.S. Geological Survey streamflow-gaging station

▽ U.S. Geological Survey water-quality station

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: **Leary Weber Ditch Sampling Locations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 37	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 West Main St., Ste. N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 7/1/08	SCALE: NTS

Summary of Occurrence and Transport of Agricultural Chemicals in Leary Weber Ditch Basin, Hancock County, Indiana, 2003- 2004

An understanding of water movement and chemical properties is necessary for understanding how agricultural chemicals (nutrients and pesticides) move from the field surfaces to streams and ground water. Leary Weber Ditch Basin is one of seven first order basins selected from across the United States as part of the Agricultural Chemicals: Source, Transport, and Fate study. Agricultural chemicals were detected in Leary Weber Ditch and in every hydrologic unit code during 2003 - 2004. Pesticides were detected more frequently in samples collected from overland flow and the ditch rather than ground water samples. The highest concentrations of pesticides and nutrients were detected in samples of tile-drained water, overland flow, and water from Leary Weber Ditch. Overland flow is an important agricultural-chemical transport pathway during high intensity rainfall; however may be sporadic throughout the year.

A conservative mixing analysis, using potassium as a tracer, was used to determine relative contributions of overland flow and tile drain discharge to Leary Weber Ditch during seven storm events in 2003 and 2004. Results of the mixing analysis suggests that overland flow may be a significant contributor of water to Leary Weber Ditch during periods of high intensity rainfall and when soil conditions favor surface runoff. During most storms and between storms tile drains are the most important contributor for the movement of agricultural chemicals to Leary Weber Ditch. Based on the hydrologic contributions of overland flow water and tile drain water to Leary Weber Ditch, tile drains are the primary agricultural chemical transport mechanism.

Analysis of Information Related to USGS Water Quality in White River Basin

From 1992 to 1996 the USGS gathered water quality data within the White River Basin as part of the NAWQA program. There was one sampling station (number 15) located along Sugar Creek in this study (Exhibit 38). This study disclosed several water quality issues directly related to Sugar Creek. From 1992 to 1995, 28 percent of atrazine samples exceeded the USEPA Maximum Contaminant Level (MCL) of 3 μg/L. One probable cause is that during 1993, atrazine had been applied to 90 percent of the corn crop in central and southern Indiana. Pesticides from this evaluation were found more frequently in the surface water of streams than in the ground water. This study also found that the Sugar Creek Watershed had a lower concentration of pesticides than levels found in other watersheds. The lower concentration is attributed to the poorly drained soils characteristic of the Sugar Creek Watershed. Well drained soils have less time for pesticides to break down and are transported to the stream faster. Table 26 shows several parameters of water quality sampling that were collected during the study and how the parameter's results rank compared nationally to other watersheds in the NAWQA program. In the display of this table, it is best to have a lower ranking, meaning the stream is less impaired.

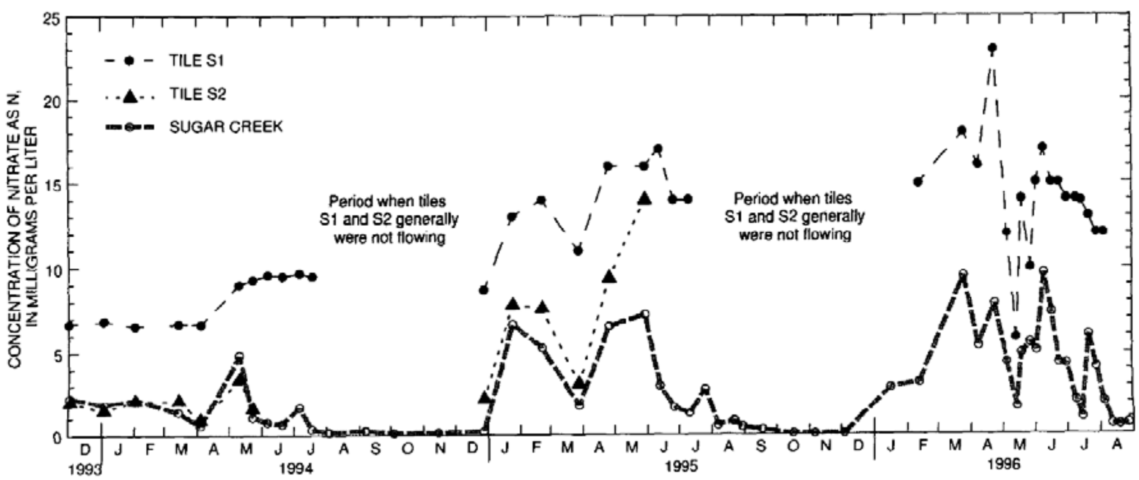
Table 26: Comparison of Sugar Creek to National Water-Quality Assessment (NAWQA) findings (USGS 1998)

Sample Type	Source	Percentile
Nutrients	surface water	50 to 75
Pesticides	surface water	50 to 75
PCBs and Organic Chlorines	streambed sediment	50 to 75
Semivolatile Organic Compounds (SVOCs)	streambed sediment	50 to 75
Fish Communities Degradation	stream	0 to 25
Stream Habitat Degradation	stream	0 to 25

Analysis of Information Related to the USGS Transport of Agrichemicals to Ground and Surface Water in a small Central Indiana Watershed

This study was conducted by Fenelon and Moore in 1998. From 1992 to 1996, nitrate and 82 pesticides and pesticide metabolites were monitored at two drain tiles, eleven wells, and several surface water sampling locations along Sugar Creek. This study concluded that nitrogen and atrazine levels within drain tiles correlate to stream levels of nitrogen and atrazine. When the drain tiles are not carrying flow with nitrate or pesticides, the stream level concentrations of nitrogen and atrazine drop to trace levels. This demonstrates that drain tiles are an important, and often overlooked, pathway for these and other constituents that are applied to agricultural fields. Figure 1 shows the correlation of Nitrate in two tiles and Sugar Creek from December 1993 to August 1996. This study also demonstrated that aquifers which are confined by more than 6m of clay-loam (the primary source of potable drinking water supply in the study area) are protected by the clay-loam layer and are not likely to be contaminated by pesticides or nitrogen. In contrast, the unconfined alluvial aquifers are subjected to contamination from nitrogen and pesticides.

Figure 1. Relation of nitrate concentrations in tile drains and Sugar Creek to time (USGS Fenelon and Moore 1998).



Analysis of Information Related to Indiana State Fish Consumption Advisory

Each year the Indiana State Department of Health in conjunction with the Indiana Department of Natural Resources and IDEM published a fish consumption advisory for Indiana. Advisories are based on actual fish tissue data collected from Indiana's rivers, lakes, and reservoirs. Guidelines are then published so that the public can make informed decisions based on what type of fish they would like to eat, and the amount of fish that is safe to consume within a given time period.

Advisories are based on specific contaminants that can bio-accumulate in fish tissue, polychlorinated biphenyls (PCBs), pesticides, and heavy metals such as mercury. Stream reaches with fish consumption advisories related to Mercury are demonstrated in Exhibit 25 and include two stream reaches located in the northern portion of the Watershed. Stream reaches with fish consumption advisories related to PCB's are demonstrated in Exhibit 26 and also include two stream reaches located in the southern portion of the Watershed. Criteria for these advisories were developed by the Great Lakes Sport Fish Advisory Task Force. Advisories fall in one of the five categories listed in Table 27. Advisories are different for specific high risks groups such as pregnant women, women who are breastfeeding and children under the age of 15. Fish consumption advisories for the Sugar Creek Watershed include the species listed in Table 28.

Table 27: Advisory Groups of the Indiana Fish Consumption Advisory	
Group Number	**Definition**
Group 1	Unrestricted Consumption **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 2	Limit to one meal per week (52 meals per year) for adult males and females. **One meal per month for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 3	Limit to one meal per month (12 meals per year) for adult males and females. **Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 do not eat.**
Group 4	Limit to one meal every 2 months (6 meals per year) for adult males and females. **Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 do not eat.**
Group 5	**No consumption (DO NOT EAT).**

Data from 2008 Indiana Fish Consumption Advisory

Table 28: Fish Consumption Advisory by Species				
Species	**Size Class (inches)**	**Contaminant**	**Advisory****	**Waterbody Name and County**
Creek Chub	All	PCBs	Group 3	Little Sugar Creek/East Fork White River (Hancock County)
Black Redhorse	9-16		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	Up to 24	Mercury	Group 2	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	24+	Mercury	Group 3	Sugar Creek (Hancock/Johnson/Shelby Counties)
Longear Sunfish	Up to 5		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Northern Hogsucker	Up to 11		Group 1	Sugar Creek (Hancock/Johnson/Shelby Counties)
Common Carp	15 - 20	PCBs	Group 3	All rivers and streams
Common Carp	20 - 25	PCBs	Group 4	All rivers and streams
Common Carp	25+	PCBs	Group 5	All rivers and streams

*Data from 2008 Indiana Fish Consumption Advisory

**Any fish not specifically listed in the table should be considered a Group 2 advisory.

The supporting baseline data supports the stakeholder concerns that were gathered from the initial public meeting held on October 11, 2007. The public voiced their concerns with respect to priority resource issues within the watershed including the categories of Agricultural, Pollution, Development/Urban, Recreational, Wildlife/Habitat, and Other Issues and Concerns. The same concerns voiced by the public, were again demonstrated by the observation results of our Windshield Survey performed by the Steering Committee volunteers. Our analysis of the available biological, habitat and water quality data from IDEM, USGS, the National Water-Quality Assessment Program and the Indiana Department of Health, as well as the biological, habitat and water quality data from V3's evaluation effort during this project, similarly supports the same concerns with the validation that these are existing issues within our watershed. We identified *E. coli*, nutrients, sedimentation and flooding throughout various publications and studies from Pages 42 through 105. The beginning portion of Section 2 provided the details of Identifying Problems and Causes of Pollution. The following Pages 106 through 116 streamline this information in a summary narrative for the reader of this Watershed Management Plan to easily understand the relevance of problems throughout the Sugar Creek Watershed. The Sugar Creek Steering Committee discussed the problems and causes of watershed degradation. This discussion included overviews of maps with data summary tables which were presented for interpretation and discussion by the committee. All of this information, through several monthly steering committee meetings, provided the condensed summary here in.

Identify Problems in the Watershed Based on the Information Gathered

On January 10, 2008, the steering committee utilized the windshield survey data that was collected within the Watershed in combination with the current and historical water quality data presented by V3 to assess the potential critical areas of concern within the Sugar Creek Watershed. The steering committee identified the seven most critical water quality components of degradation to the Sugar Creek Watershed as *E. coli*, nutrients, erosion and sedimentation, excessive flow rates and volumes during storm events, lack of open space, lack of stakeholder knowledge regarding impacts, and lack of stakeholder awareness of planning process.

The members of the steering committee suggested that the following contribute to each of the most critical components. *E. coli* problems in the Watershed are caused by the following: livestock, septic systems, Confined Feeding Operations (CFO's), Confined Animal Feeding Operations (CAFO's), wildlife waste, wastewater treatment plants, and package plants. Nutrient problems in the Watershed are caused by the following: agricultural practices and failing septic systems. Sediment problems in the Watershed are caused by the following: streambank erosion, construction sites, home sites, and agricultural practices. The following list of issues is from a public meeting held July 17, 2007 and includes edits and revisions from subsequent steering committee meetings.

Agricultural Issues:

- Drainage – need to maintain proper drainage for farming
- Log Jams – issues related to proper drainage
- Beaver – damming up drainage ways
- Flooding Impacts

Pollution Issues:

- Wildlife Effects on Water Quality
- Streambank Erosion – sediment and associated nutrients
- Trash/Illegal dumping
- Water Clarity
- Health Issues with bacteria – is it safe to swim and fish in Sugar Creek?
- Fish Consumption Advisories (Mercury)
- Cattle in the stream –health issues (*E. coli* etc.)
- Chemical concerns
- Failing Septics

Development/Urban Issues:

- Land Use Changes – increased urbanization
- Stormwater Management
- Flooding Impacts

Recreational Issues:

- Log Jams – issues related to canoeing
- Beaver – desired for wildlife viewing
- Canoeing and fishing, swimming (is it safe- bacterial problems)
- Identify hunter-friendly farms

Wildlife/Habitat Issues:

- Proper Wildlife Management – balance of diversity
- Sandbars (erosion and hydrologic modification)
- Habitat and Wildlife preservation, conservation
- Cattle in the stream – destruction of habitat

Other Issues and Concerns:

- Streams are more wide and shallow – what is the cause?
- Changes in weather patterns – effect on watershed
- Land Use Changes – Large Farms converted to Mini Farms
- Greenways along the river – desire to create parks and work through private property issues
- Finances – how do we pay for the changes that need to be made?
- Preservation – acquire land along streams from willing sellers

The concerns listed above from the public meeting held on October 11, 2007 were evaluated with information and data gathered during the management planning process (Table 29). The collection and analysis of the information/data validate some of the concerns and invalidated some of the concerns. Some of the listed concerns were not capable of being addressed under the proposed scope of this watershed management plan. Problem statements that are included in Table 29 are discussed in detail in the subsequent section.

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
AGRICULTURAL ISSUES:				
DRAINAGE	3, 4	Broken tile, lack of storage, storm water runoff as evidenced by the windshield survey.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Added storage; decrease volume of runoff
LOG JAMS	3, 4	Bank erosion; lack of maintenance as substantiated by the windshield survey and habitat quality data.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Removal of log jams, stream bank stabilization
BEAVER	3, 4	Conflict with human activity and nature as it was identified by attendees at the Sugar Creek Public Meeting.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education and remedy
FLOODING IMPACTS	3, 4, 5	Lack of storage upstream, lack of conveyance downstream based on flood observations from water quality sampling as well as concerns voiced by attendees at the Sugar Creek Public Meeting.	Loss of crops, loss of soil, visual assessment, communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Added storage, field buffers, education
POLLUTION ISSUES:				
WILDLIFE EFFECTS	1, 2, 5	Animal waste as evidenced by water quality data.	*E. coli* values that exceed state standard of 235 CFU. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
POLLUTION ISSUES CONTINUED:				
STREAMBANK EROSION	3, 4	Bank erosion; lack of maintenance as supported by habitat quality data and windshield survey.	Visual assessment; communication with landowners. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization, slow stream velocity
TRASH/ILLEGAL DUMPING	6	Conflict with human activity as identified by stakeholders at the Sugar Creek Public Meeting and watershed clean up efforts.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	More cleanup days, education
WATER CLARITY	2, 3	Suspended sediments from eroding stream banks as supported by water quality data.	Visual assessment, monitoring results. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization and buffers and created wetlands
HEALTH ISSUES	1, 2, 5	Animal waste and human waste as evidenced by the Indiana State Department of Health.	*E. coli* values that exceed state standard of 235 CFU. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands, fishable, swimmable conditions and education
FISH CONSUMPTION	1, 5	PCB, Mercury contamination as evidenced by the Indiana State Department of Health.	Fish Consumption Advisory. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education
CATTLE IN THE STREAM	1, 2, 3	Animal waste as supported by windshield survey and observations during water quality sampling.	*E. coli* values that exceed state standard of 235 CFU, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Exclusionary fencing, increase buffers and wetlands, and education

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
DEVELOPMENT/URBAN ISSUES:				
LAND USE CHANGES	5, 6	Increased urbanization, poor construction practices as identified by stakeholders at the Sugar Creek Public Meeting.	Aerial photography, visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, sustainable development, windfarms, farmland protection
STORMWATER MANAGEMENT	5, 6	Increased urbanization, poor construction practices, untreated storm water runoff as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, wetlands, storm drain markers, increase infiltration, outreach on homeowner practices
FLOODING IMPACTS	3, 4, 5	Increased urbanization, poor construction practices as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders, insurance claims. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Education, increase green space, created wetlands, increased storage

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
RECREATIONAL ISSUES:				
LOG JAMS RELATED TO CANOEING	3, 4	Bank erosion; lack of maintenance supported by habitat quality data and windshield survey.	Visual assessment; communication with landowners and boaters. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Removal of log jams, stream bank stabilization
BEAVER	3, 4	Reduced beaver population as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Habitat preservation and protection and increased trails and open spaces
CANOEING; FISHING; SWIMMING	1, 2, 5	Animal waste and human waste as supported by water quality sampling.	*E. coli* values that exceed state standard of 235 CFU, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Increase buffers and wetlands, fishable, swimmable conditions and education
*IDENTIFY HUNTER FRIENDLY FARMS	NA	Lack of awareness of available farms for hunting as identified by stakeholders at the Sugar Creek Public Meeting.	Communication with stakeholder.	Create a brochure

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
WILDLIFE/HABITAT ISSUES:				
*PROPER WILDLIFE MGMT.	NA	Lacking balance of diversity as evidenced by stakeholder concerns voiced at the Sugar Creek Public Meeting.	Communication with stakeholder.	Healthy biodiversity checked by inventories
SANDBARS	3, 4, 5	Erosion and hydrologic modification supported by habitat quality data and windshield survey.	Visual assessment; communication with stakeholders, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Stream bank stabilization, bedload at equilibrium
HABITAT AND WILDLIFE PRESERVATION AND CONSERVATION	5, 6	Lack of awareness and stewardship as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders	Increased awareness of preservation and conservation programs
CATTLE IN THE STREAM	1, 2, 3	Destruction of habitat from free access to the stream as identified in the windshield survey and observations during water quality sampling.	Visual assessment; communication with stakeholders, areas where livestock have stream access. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Exclusionary fencing, alternative watering systems, education

Table 29. Problems and Concerns within the Sugar Creek Watershed, tied to Benchmarks, Indicators and Goals				
What are the problems/concerns in the watershed?	**What Problem Statement(s) aligns with problems/ concerns**	**What do you think caused the problems? (Using Benchmark and Baseline Information)**	**How can we assess current conditions? (Indicators)**	**What would you like to see for your watershed? (Goals)**
OTHER ISSUES AND CONCERNS:				
STREAMS ARE MORE WIDE AND SHALLOW	3, 4, 5	Lack of streambank stabilization supported by windshield survey and observations during water quality sampling.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Streambank stabilization, increase buffers
*CHANGES IN WEATHER PATTERNS	NA	Natural fluctuations of the weather as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders	N/A (Consistency with Farmers Almanac)
LAND USE CHANGES	5, 6	Large farms converted to mini farms as evidenced by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Farm land preservation
GREENWAYS ALONG THE RIVER	3, 5	Lack of open space as supported by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders. Supported by observations in HUC-12 subwatersheds: 051202040401, 051202040402, 051202040403, 051202040405.	Create parks and trail systems
FINANCES	6, 7	Lack of funding source awareness as identified by stakeholders at the Sugar Creek Public Meeting.	Communication with stakeholders	Research Grant and Funding opportunities
PRESERVATION	6, 7	Lack of awareness and stewardship as identified by stakeholders at the Sugar Creek Public Meeting.	Visual assessment; communication with stakeholders.	Increased awareness of preservation, conservation, and land trusts programs

** Problem or concern that is out of scope for this study.*

Developing Problem Statements

Problem statement development occurred through the planning process in an effort to link watershed stakeholders' concerns with existing and historical water quality data, the 5 identified critical areas, and the 7 major concern categories developed by the Steering Committee. Details regarding stressors, pollutant sources, areas where sources have been observed, and the stakeholders' concerns are listed for each problem statement.

Problem Statement 1

E. coli/pathogen levels in the Sugar Creek Watershed regularly exceed the state standard of 235 CFU/100ml, based on current and historical water quality data results, and often exceed safety standards for allowing Sugar Creek to be fishable and swimmable.

<u>Stressor:</u> *E. coli* bacteria

<u>Source:</u> animal waste, human waste, failing septic systems, point sources, package plants, maintaining proper drainage from farmlands, flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to Sugar Creek and its tributaries, land use changes, stormwater management, lack of proper wildlife management

<u>Areas Where Sources Have Been Observed:</u> Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, Heartland Resort, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision

Problem Statement 2

Excessive nutrient levels, documented in historic and recent water quality sampling, are negatively affecting the Sugar Creek Watershed.

<u>Stressor:</u> Nutrients, including Nitrate (NO_3), Nitrite (NO_2) and Phosphorus.

<u>Source:</u> Flooding impacts, wildlife effects on water quality by contributing nutrient load through their waste, streambank erosion, cattle access to the stream, failing septic systems, land use changes, stormwater management

<u>Areas Where Sources Have Been Observed:</u> Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, and Heartland Resort

Problem Statement 3

Excessive soil erosion and sedimentation associated with agricultural lands, urban lands, and development sites is degrading the Sugar Creek Watershed and limiting the aesthetics, recreational access, wildlife habitat, and drainage of Sugar Creek.

Stressor: Silt and sediment, nutrients that bind to sediment, pathogens that bind to sediment

Source: Flooding impacts, proper drainage from agricultural lands, streambank erosion, cattle access to the stream, land use changes, stormwater management, log jams, beaver, wildlife effects on water quality by contributing to nutrients through their waste, lack of proper wildlife management, presence of existing sandbars

Areas Where Sources Have Been Observed: Livestock stream access throughout Sugar Creek Watershed, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision

Problem Statement 4

Excessive flow rates and volumes of water during large precipitation events are causing crop damage and loss within the Sugar Creek Watershed.

Stressor: damaging flood levels

Source: Lack of proper drainage in the Watershed, log jams, beaver creating log jams, flooding impacts, streambank erosion, cattle access to the stream, land use changes, stormwater management, presence of existing sandbars

Areas Where Sources Have Been Observed: Urban areas surrounding Eden, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, Arrowhead Mobile Park, and the Sugar Creek Watershed along Sugar Creek between 200 S to 600 S

Problem Statement 5

There is a lack of open space/greenways along Sugar Creek and its tributaries. Pollutants are allowed to enter Sugar Creek and its tributaries without any filtration process.

Stressor: unfiltered stormwater run-off

Source: lack of filter strips and Best Management Practices, lack of native vegetation, lack of greenway corridor along Sugar Creek, Preservation areas that are not maintained

Areas Where Sources Have Been Observed: Areas void of open space and greenway along the Sugar Creek corridor

Problem Statement 6

Stakeholders in the Sugar Creek Watershed are not knowledgeable about their daily impact on the Sugar Creek Watershed and its water quality.

Stressor: Lack of education and outreach with regard to the Watershed health and condition

Source: Lack of sponsored workshops within the Watershed, lack of interest from the Stakeholders, lack of media coverage about the detrimental effects of humans and their daily activities on the Watershed

Target Audience: Stakeholders, local groups

Problem Statement 7

Stakeholders in the Sugar Creek Watershed are not aware of the watershed planning process or the existence of the watershed group.

Stressor: Lack of education and interest with regard to the Watershed health and condition

Source: Lack of time and commitment

Target Audience: Neighborhood groups, stakeholders, schools, local newspapers, local radio, local television

SECTION 3: IDENTIFY SOURCES

Sources of Key Pollutants or Conditions

It is evident through evaluations of the data that a variety of pollutants are threatening the designated uses in the Sugar Creek Watershed. Agricultural uses comprise approximately 80% of the 84,750 acre watershed. Through evaluations of several groups and agencies, pathogens (*E. coli*), sediment, nutrients and flooding have been indicated to be problematic in the Watershed. Although these pollutants and conditions may be a problem throughout the Watershed, they are not necessarily problematic in all portions of the 5 (12-digit) subwatersheds. Each subwatershed has different challenges to address sources associated with these pollutants and conditions in order to improve overall water quality. Probable causes and sources identified are listed on a watershed scale and have been assumed to be present based on a general knowledge of the environmental systems under this watershed study. Pathogens (*E. coli*), sediment, nutrients and flooding are the four most significant pollutants and conditions within the Sugar Creek Watershed.

Sediment

Excess sediment is an issue in the Sugar Creek Watershed. The Boyd Ditch subwatershed contributes the highest amount of sediment, as it had the most significant TSS load from this studies modeling effort. The second most significant TSS modeling load was generated by the Marsh & Trees Ditch subwatershed. Excess sediment causes unsightly turbid water, smothers and destroys aquatic habitats necessary for fish and macroinvertebrate growth and development, impedes navigation, changes stream geomorphology, decreases flood storage capacity, and acts as a delivery system for nutrients, pathogens and other contaminants.

Sediment can come from in-stream sources, river bank erosion, and erosion occurring throughout the Watershed. The presence of highly erodible soils and potentially highly erodible soils are discussed earlier in this report and are shown on Exhibit 9. These locations depicted on this exhibit showing where highly erodible soil locations overlap with surface water runoff depicts specific locations where river bank erosion would be most extreme. The total acreage of highly erodible soil accounts for 15% of the total watershed. These soil types, coupled with slopes of more than 3:1 ratio, and the presence of a stream or tributary drainageway would provide the most sediment load.

Sources of sediment transport are found in both urban and rural environments. Sources of sediment in the Sugar Creek Watershed include bank erosion and lack of a stable buffer between human activities and the stream itself. Very few row cropped agricultural lands within the watershed have a buffer of 50 to 100 feet between the surface water stream and the production crop land. Exhibit 3 shows the locations of where these sources are emanating. The acreages of land use are depicted on Table 3, demonstrating how much of the land is in production agriculture. Specific to our windshield survey effort, how much of the subwatersheds are identified as lacking a stable buffer found the Boyd Ditch subwatershed to be the portion of the watershed representing the largest source.

Other sources include uncontrolled sheet flow across the land surface and runoff from existing construction sites. In urban areas, this stormwater flow can include a large variety of pollutants and toxins that are a by-product of urban life. On agricultural croplands, a lack of proper erosion control methods (conservation tillage, cover crops, etc.) contribute to sedimentation and related nutrients in the runoff that flows overland to Sugar Creek and associated ditches and tributaries. Similarly on pasturelands, a lack of proper erosion control methods, such as exclusionary fencing, contributes to livestock degrading streambanks and adding sediment load to the watershed. Livestock having direct access to the stream was documented to include cattle, hogs and horses. The most significant subwatershed for contributing to the source of this problem is the Pee Dee Ditch subwatershed. Target areas for sediment identified by the steering committee based on the windshield survey data collected provided more than 30% of the survey stations as having severe conditions of erosion.

Pathogens (E. coli)

Pathogens, or disease causing organisms in the water, include bacteria, viruses, and protozoa. Since *E. coli* bacteria are found in the intestines of humans and other warm blooded mammals, it is the indicator species used in the state to denote the possibility of other pathogens that may be present in the aquatic system. CFOs contribute to the E. coli load within the watershed from these agricultural livestock feeding operations. The Pee Dee Ditch subwatershed and the Boyd Ditch subwatershed possess the most CFOs in the watershed. E. coli concentrations that exceeded the state standard during the TMDL evaluation had the most exceedances within the Boyd Ditch Subwatershed (39% of the sampling stations) and the second most significant contributing subwatershed was the Marsh & Tree Ditch, with 33% of the sampling stations. The data from V3, IDEM, NPDES permits, and volunteer efforts corresponded with the TMDL data in finding Boyd Ditch subwatershed as having the highest amount of *E. coli* concentrations. This study identifies the Boyd Ditch subwatershed as the most significant source location for *E. coli*. There is only one CAFO within the Sugar Creek Watershed, it is located in Hancock County along the border of Henry County within the Pee Dee Ditch subwatershed. As there is only one location, which was installed during our watershed management planning process, the overall magnitude from the contribution of *E. coli* from CAFOs is yet to be determined.

As is apparent from the information mentioned previously, this organism has been found to be present in numbers that exceed the state's water quality standards, and thus indicate a potential health risk. *E. coli* has been indicated as a problem in the 2007 IDEM TMDL report for Sugar Creek. Sources of *E. coli* include both human and animal origins and can emanate from both point and non-point sources of pollution. Sources in the Sugar Creek Watershed include: failing septic systems, package plants, discharge of inadequately treated wastewater, wild and domestic animal waste, livestock in the stream, runoff from pasture lands without proper erosion control measures. The Pee Dee Ditch subwatershed was identified as the location within the watershed as having the most significant contribution. Approximately 30% of the windshield survey stations within this subwatershed identified livestock access gates to the stream for cattle, hogs and horses, which provides a direct source of *E. coli* from animal waste.

E. coli growth occurring in sediment, and E. coli from Combined Sewer Overflows (CSOs) are also problematic sources within the Sugar Creek Watershed. New Palestine is the main source of CSO in the Sugar Creek Watershed. The contribution of E. coli within the watershed as a whole from CSOs is slight. Soil types have the ability to provide septic tanks with suitable locations. There are no locations in the Sugar Creek Watershed where ideal soils for septic tanks can be found. Exhibit 8 shows the Septic Tank Suitability, with 95% of the watershed being mapped as "very limited" and 5% being "not rated". Any septic tank location has the potential to be a contributing source of *E. coli* to the watershed. This is identified as a significant problem within the watershed.

Target areas for *E. coli* identified by the steering committee based on the windshield survey data collected and the available water quality data include: Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch, Heartland Resort, S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park, and The Overlook Subdivision.

Nutrients

Nutrients are naturally occurring in the environment, but in excess can cause major problems in aquatic ecosystems. Our modeling effort identified the Boyd Ditch subwatershed as being the most significant source of nitrogen and phosphorus loads. The V3 collected water quality data provided the Barrett Ditch subwatershed as the most significant source of nitrate and the Boyd Ditch subwatershed as the most significant source of phosphorus to the surface water issues within the Sugar Creek Watershed. Data analysis of nitrate-nitrite exceedances of the 10 mg/L value from IDEM, TMDL, NPDES permits, and volunteer monitoring all indicate the Boyd Ditch subwatershed as having the most significant source of nutrients to the watershed.

In the Sugar Creek Watershed, phosphorus is a possible limiting nutrient. If Phosphorus is present in large amounts, it can cause excessive aquatic plant growth which leads to large fluctuations in the amount of oxygen in the water, referred to as dissolved oxygen (DO). This can alter the aquatic community and favor more of the tolerant, low quality organisms and decrease biodiversity. The problem is amplified in downstream lakes and impoundments where the water slows and nutrients drop out with the sediments. The sediment then becomes a major source of nutrient flow throughout the aquatic ecosystem. Many nutrient sources are the same as those that contribute to *E. coli* contamination and include: CFOs, failing septic systems, package plants, discharge of inadequately treated wastewater, overflow from manure storage facilities, and fertilizer applications. According to the USGS the primary concern with Nitrate levels is causing algal blooms in the Sugar Creek Watershed and contributes to hypoxia in the Gulf of Mexico. Target areas for problematic nutrient loading includes: areas where livestock have stream access, Pee Dee Ditch and urban areas surrounding Warrington, urban areas surrounding Nashville, urban areas surrounding Eden, urban areas surrounding Mohawk, Mohawk Campground, Conservation Club, Leary Weber Ditch, and Heartland Resort.

Flooding

Flooding is a natural component of the floodplain, but flooding can cause major problems in aquatic ecosystems in addition to causing damage to property. Floodplain areas within the watershed are demonstrated in Exhibit 12. The subwatershed location with the most damage from flooding is the Boyd Ditch subwatershed. The source of flooding originating in the headwaters identifies the Pee Dee Ditch subwatershed as the most significant source. How much of a problem flooding causes is shown on Table 13b where the Marsh & Tree Ditch subwatershed has the most identified flooding problems (up to 33% of the survey stations).

Land use changes with increased development results in less open space and more impervious cover in a watershed. Undeveloped open land is able to infiltrate rainfall into the ground, and ponded runoff is stored in numerous natural depressions in the landscape. Vegetation also reduces the amount of surface runoff by intercepting rainfall and through evapotranspiration. Development reduces the capacity of the land to hold water by compacting soils when grading for construction, removing natural vegetation and adding impervious cover such as rooftops, driveways, streets and parking lots. Impervious cover directly influences streams by dramatically increasing surface runoff. According to the Importance of Imperviousness, T. Schueler, *Watershed Protection Techniques,* 1995, the result has been that traditional development significantly increases the volume and accelerates the rate of rainfall runoff.

Log jams can impede the conveyance of water through the watershed and disruption to this flow path results in additional flooding problems to the surrounding land uses. Three of the four subwatersheds surveyed during the windshield survey identified Pee Dee Ditch, Marsh & Tree Ditch, and Boyd Ditch as having stations (from 21% to 50%) with log and debris blockages making sources for flooding issues.

Land use has a direct effect on flood damage in the Watershed. The most obvious way land development results in flood damage, is the location of homes, buildings, development and infrastructure in the floodplain. Less obvious, but of equal significance, is the impact an increased volume of runoff generated from upland development has on expanding the floodplain and causing localized flooding problems. Peak flows in Sugar Creek will increase and overbank and localized flooding will worsen without adequate stormwater infiltration, runoff detention, appropriate best management practices (BMPs), and/or wetlands.

Understanding flooding involves both hydrology and hydraulics. Hydrology refers to the way that water behaves from its beginning as precipitation, through its movement on or beneath the land surface, to its entry into drain tiles, storm sewers, streams, lakes, oceans and its return to the atmosphere. Hydraulics addresses how water flows over the land surface, within storm sewers and stream channels, over and under bridges and dams and through culverts, wetlands, lakes and impoundments (detention basins and reservoirs).

The types of flooding within the Sugar Creek Watershed include the following:

Depressional flooding - flooding that results from stormwater collecting in a depressional area of the landscape that either has no outlet for the water to drain, or an insufficiently sized outlet to efficiently drain the amount of collected run-off. Common form of flooding that causes crop loss.

Local drainage problems - drainage problems that result from nearby development creating more stormwater run-off in a localized area, from poorly located or designed developments that eliminate or alter the natural water storage or drainage system, or from inadequate drainage system infrastructure.

Overbank flooding - flooding caused by water elevations that exceed the banks of a lake, river, stream or other channel and overflows onto adjacent lands, typically within the flood plain. Common form of flooding that causes property damage and crop loss.

Septic system failure - when a septic field becomes saturated or flooded to the extent that it cannot adequately accept or process the wastewater it receives.

SECTION 4: IDENTIFY CRITICAL AREAS

Estimating Critical Loads - Non-point Source Pollution Modeling

Nonpoint source pollution is a type of the pollution generated from diffused sources in both: public and private domains. As defined by EPA, the pollution from nonpoint sources originates from urban runoff, construction activities, manmade modification of hydrologic regime of a watercourse (i.e. retention, detention, channelization, etc.), silviculture, mining, agriculture, irrigation return flows, solid waste disposal, atmospheric deposition, stream bank erosion, and individual or zonal sewage disposal. Therefore, nonpoint pollution sources have their origin in a wide spectrum of public and private activities and, when not known or properly controlled, could affect, in a large percentage, the water and quality of living in a certain area.

Nonpoint source pollution management is highly dependent on hydrologic simulation models, and use of computer modeling is often the only viable means of providing useful input information for adopting the best management decisions.

As previously mentioned, the nonpoint pollution sources are generated by activities that are spatially distributed on the analyzed watershed or study area. Due to this spatial distribution of nonpoint pollution sources, the computation models used to study pollutant transport and stream bank erosion require large amounts of data for analysis in even a small watershed.

Since runoff from the rainfall flows over or through the land and collects pollutants and nutrients prior to entering waterways, the overall characteristics and land use types of a watershed greatly influences the water quality. Each land use type includes the cumulative effects of various land covers, and natural and man-made activities. Therefore, each land use type can have an adverse affect on water quality, by contributing different pollutant amounts and concentrations. The cumulative effect of this pollution throughout the watershed represents the contribution of nonpoint source pollution.

For the Sugar Creek Watershed, a tabular based non-point source pollution loading model was used to assess the nonpoint source pollution of three main pollutant parameters that have been identified as elements of concern by both stakeholders and water sampling events. This model is known as the L-THIA Estimate Non-Point Source Pollutant model using Event Mean Concentration created by Kyoung Lim and Bernard Engel. The three main pollutant parameters analyzed are:

- Total Nitrogen
- Total Phosphorus
- Total Suspended Solids (TSS)

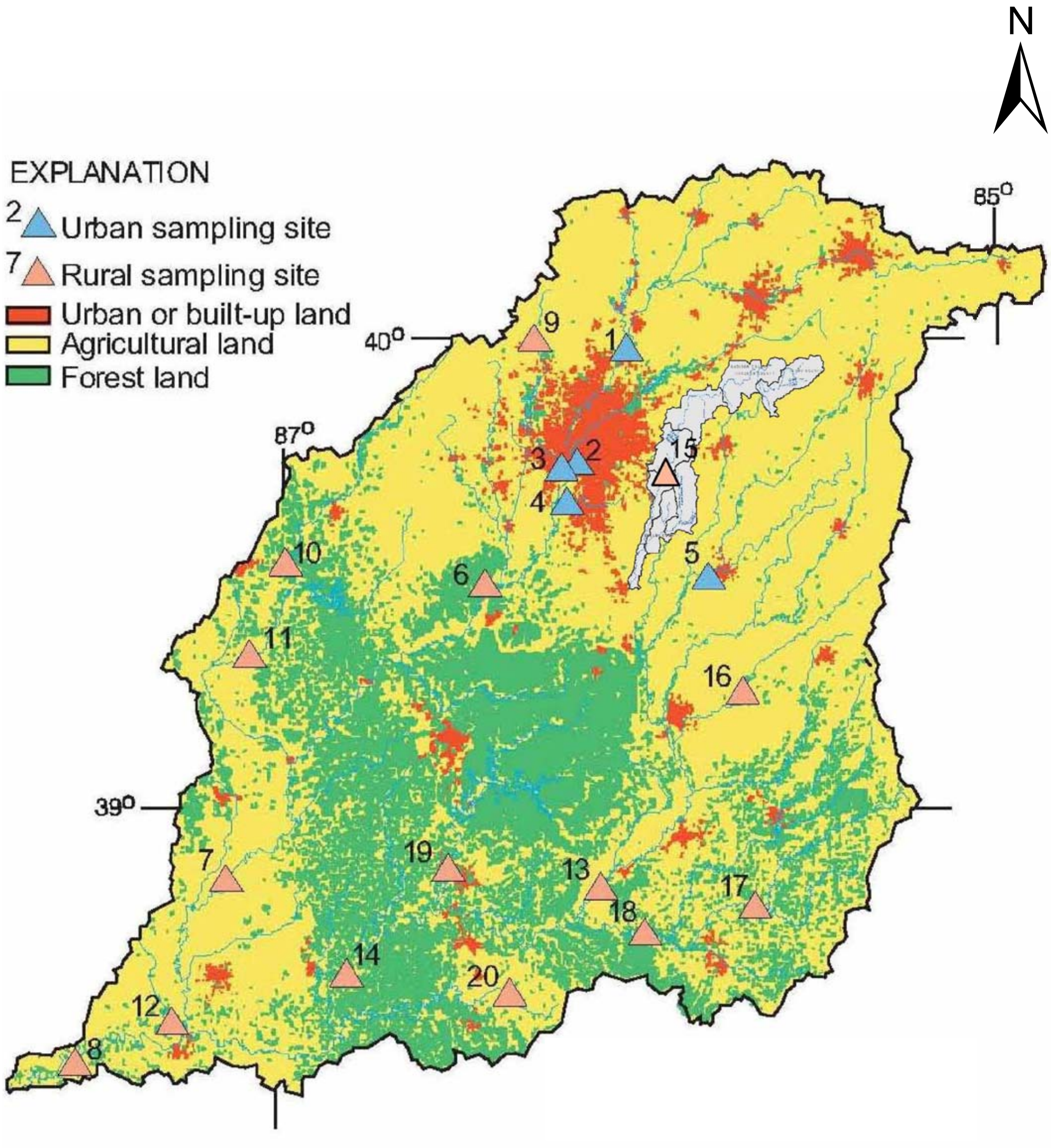
The L-THIA model estimates the runoff volume and nonpoint source pollutant loadings. Non-point source pollutant masses are computed by multiplying runoff depth for a land use area of that land use and the appropriate Event Mean Concentration (EMC) value and converting units. The EMC data used was compiled by the Texas Natural Resource Conservation Commission (Baird and Jennings, 1996).

Land use categories were defined by Baird and Jennings and divided into eight categories including: 1) industrial, 2 transportation, 3 commercial, 4) residential, 5) agricultural cropland (dry land and irrigated), 6) range land, 7) undeveloped/open, and 8) marinas. The total pollutant load for various non-point source pollutants divided by the runoff volume during a runoff event yields the EMC. With some pollutant concentrations varying over time for rainfall events, flow averaged sample values are used as EMC. Therefore, EMCs should be reliable for determining average concentrations and calculating constituent loads.

The L-THIA model was executed for each HUC 12 subwatershed within the Sugar Creek Watershed. The results are illustrated graphically in Exhibits 39 through 42 (4 total exhibits) and in Table 30. It should be noted that all computation models have assumptions and limitations. The conditions of the model, based on mathematical computations, provide useful information for targeting and prioritizing subwatersheds.

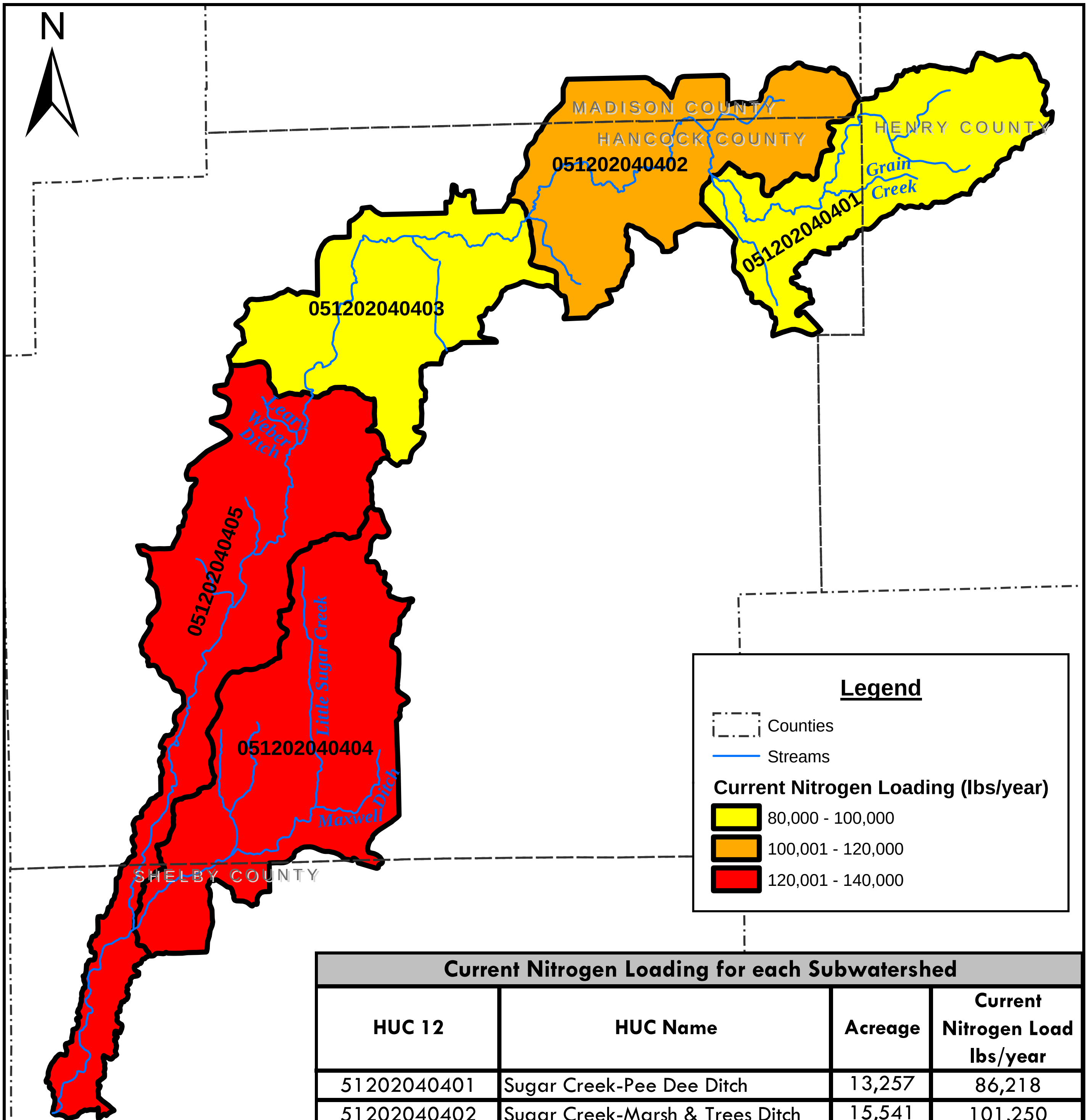
Table 30. Current Loads for Each Subwatershed

HUC 12	HUC Name	Acreage	Current Nitrogen Load lbs/year	Current Phosphorus Load lbs/year	Current TSS Load tons/year
051202040401	Sugar Creek-Pee Dee Ditch	13,257	86,218	3,379	1,393
051202040402	Sugar Creek-Marsh & Trees Ditch	15,541	101,250	3,970	1,638
051202040403	Sugar Creek-Barrett Ditch	14,091	86,718	3,391	1,396
051202040404	Little Sugar Creek - Wilson Ditch	20,290	127,849	5,005	2,073
051202040405	Sugar Creek - Boyd Ditch	21,571	123,884	4,827	1,987



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: **USGS White River Basin Study Locations**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 38	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 7/8/08	SCALE: NTS



Current Nitrogen Loading for each Subwatershed

HUC 12	HUC Name	Acreage	Current Nitrogen Load lbs/year
51202040401	Sugar Creek-Pee Dee Ditch	13,257	86,218
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	101,250
51202040403	Sugar Creek-Barrett Ditch	14,091	86,718
51202040404	Little Sugar Creek - Wilson Ditch	20,290	127,849
51202040405	Sugar Creek - Boyd Ditch	21,571	123,884

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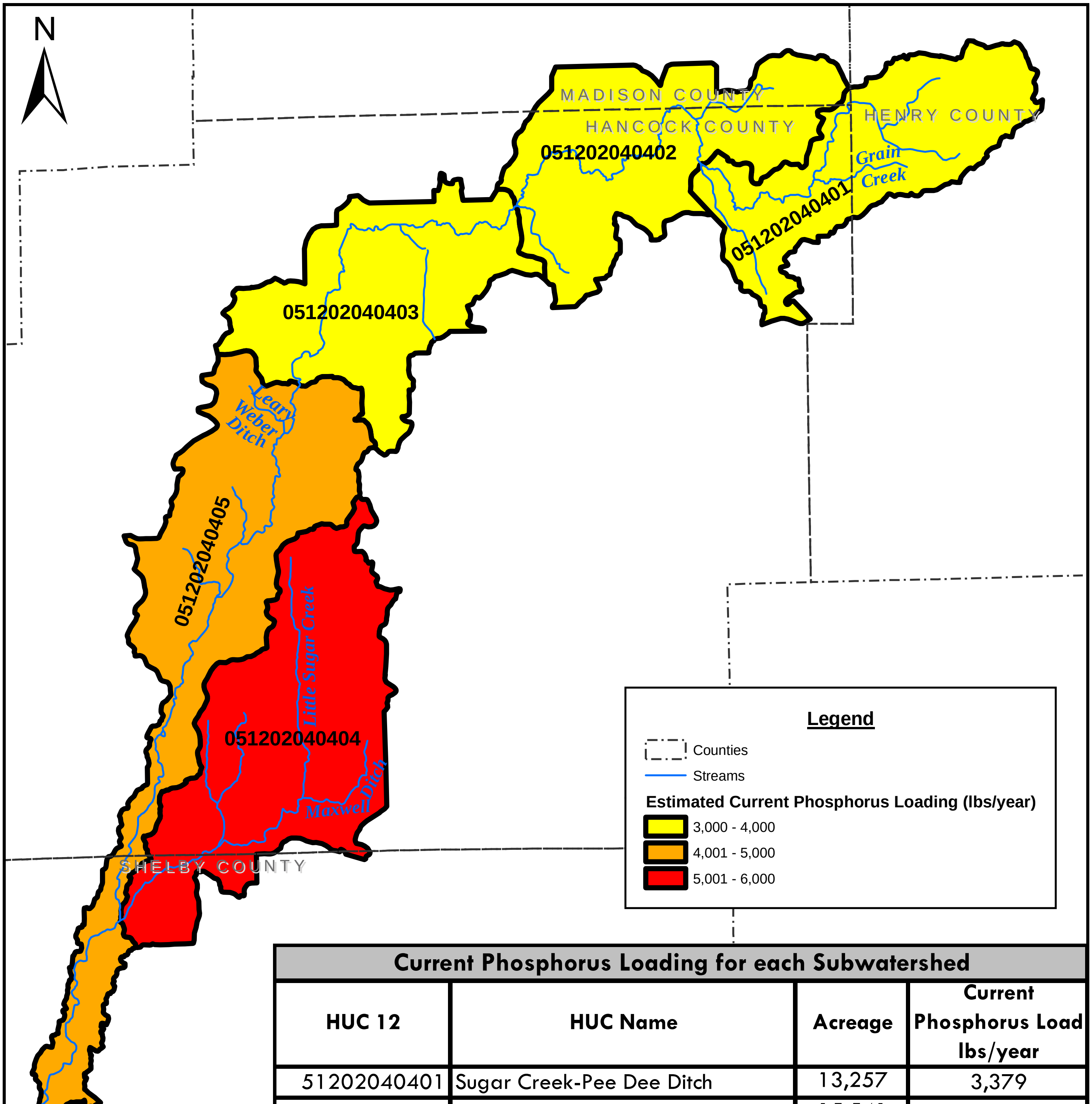
TITLE: Estimated Nitrogen Loading	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 39	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 3/1/09	SCALE: NTS



Current Phosphorus Loading for each Subwatershed			
HUC 12	HUC Name	Acreage	Current Phosphorus Load lbs/year
51202040401	Sugar Creek-Pee Dee Ditch	13,257	3,379
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	3,970
51202040403	Sugar Creek-Barrett Ditch	14,091	3,391
51202040404	Little Sugar Creek - Wilson Ditch	20,290	5,005
51202040405	Sugar Creek - Boyd Ditch	21,571	4,827

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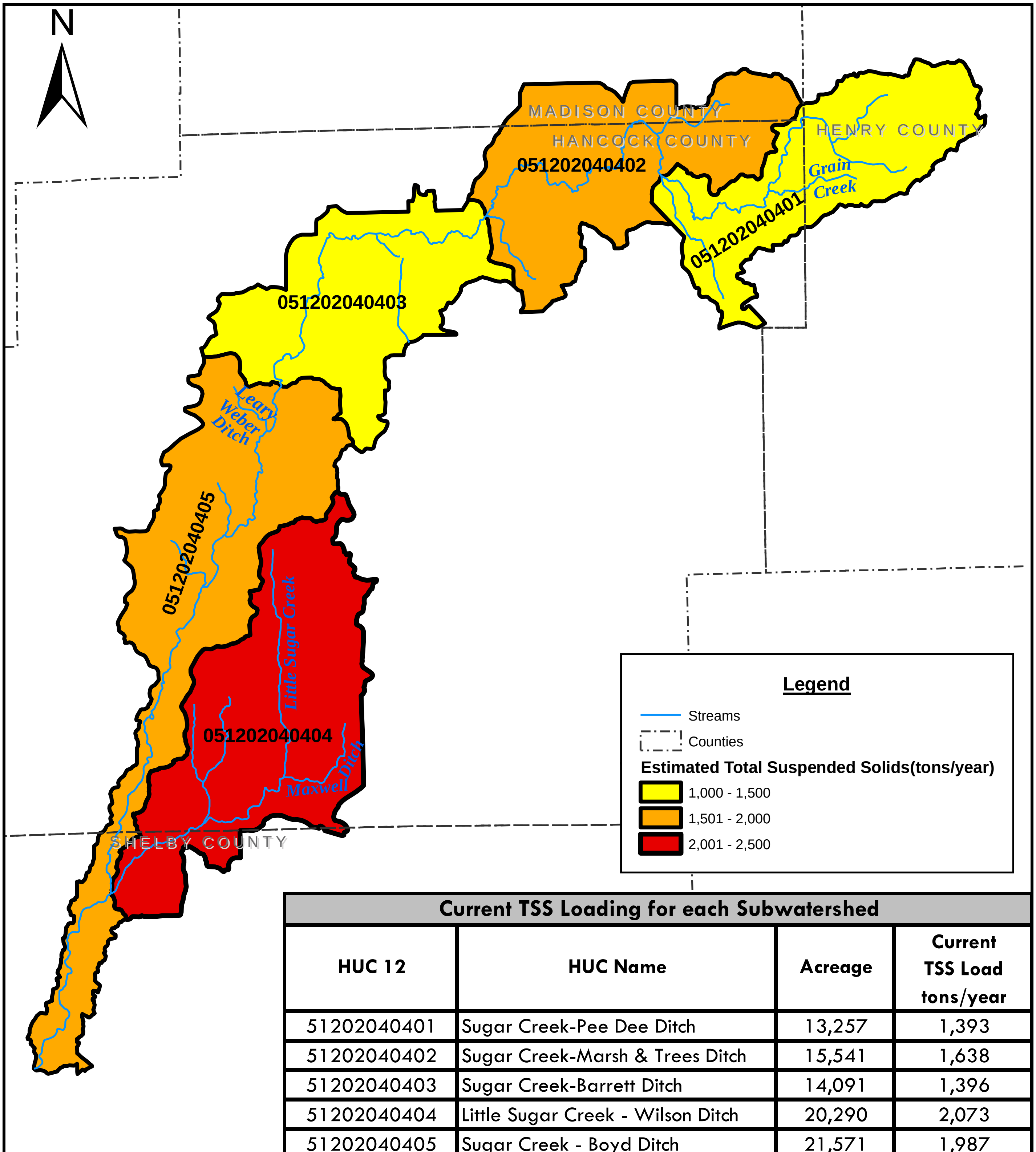
www.v3co.com

TITLE: Estimated Phosphorus Loading	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 40	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 3/1/09	SCALE: NTS



Current TSS Loading for each Subwatershed

HUC 12	HUC Name	Acreage	Current TSS Load tons/year
51202040401	Sugar Creek-Pee Dee Ditch	13,257	1,393
51202040402	Sugar Creek-Marsh & Trees Ditch	15,541	1,638
51202040403	Sugar Creek-Barrett Ditch	14,091	1,396
51202040404	Little Sugar Creek - Wilson Ditch	20,290	2,073
51202040405	Sugar Creek - Boyd Ditch	21,571	1,987

V3 Companies
7325 Janes Avenue
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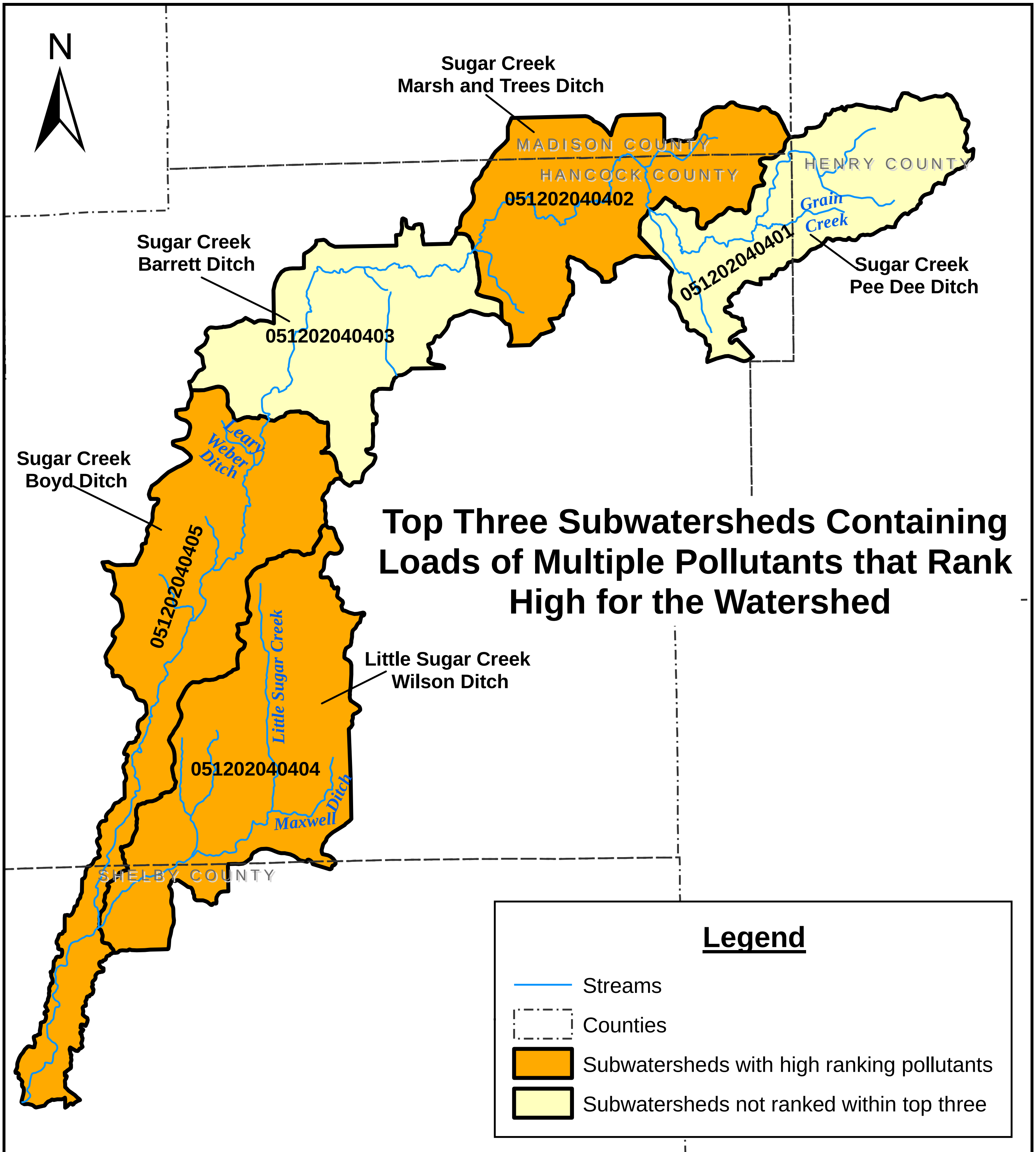
www.v3co.com

TITLE: Estimated Total Suspended Solids	PROJECT: Sugar Creek Watershed Project
BASE LAYER: N/A	PROJECT NO. 07065
	EXHIBIT: 41
	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A
	DATE: 7/8/08
	SCALE: NTS



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: **Top Ranked Subwatersheds for Containing High Loads of Multiple Pollutants**	PROJECT: **Sugar Creek Watershed Project**			
BASE LAYER: N/A	PROJECT NO. 07065	EXHIBIT: 42	SHEET: 1 OF: 1	
CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 3/1/09	SCALE: NTS	

Total Nitrogen

The nitrogen load model results are shown spatially in Exhibit 39. Table 30 presents the model tabular results. The *Little Sugar Creek-Wilson Ditch* subwatershed and the *Sugar Creek-Boyd Ditch* subwatershed contribute the two highest nitrogen loadings within the entire Watershed at 127,849 lbs/year and 123,884 lbs/year respectively. The subwatershed of *Sugar Creek-Marsh and Trees Ditch* contributes the third highest nitrogen loading in the Watershed at 101,250 lbs/year. The lowest nitrogen loading exists at the *Sugar Creek-Pee-Dee Ditch* subwatershed (86,218 lbs/ year).

Total Phosphorus

The phosphorus load model results are shown in Exhibit 40 and Table 30. The pollution load results show a very similar trend to that of nitrogen. The *Little Sugar Creek-Wilson Ditch* subwatershed and the *Sugar Creek-Boyd Ditch* subwatershed contribute the two highest Phosphorus loadings within the entire Watershed at 5,005 lbs/year and 4,827 lbs/year respectively. The subwatershed of *Sugar Creek-Marsh and Trees Ditch* contributes the third highest Phosphorus loading in the Watershed at 3,970 lbs/year. The lowest phosphorus loading exists at the *Sugar Creek-Pee-Dee Ditch* subwatershed (3,379 lbs/ year).

Total Suspended Solids (TSS)

Exhibit 41 and Table 30 show the TSS model results. The sediment model results range from 1,393 to 2,073 tons/year for the HUC 12 subwatersheds. The *Little Sugar Creek-Wilson Ditch* subwatershed had the highest TSS loading within the entire watershed and contributes approximately 2,073 tons/year. The *Sugar Creek-Boyd Ditch* subwatershed contribute the second highest TSS loadings within the entire Watershed at 1,987 tons/year followed by the subwatershed of *Sugar Creek-Marsh and Trees Ditch* at 1,683 tons/year. The lowest TSS loading exists at the *Sugar Creek-Pee-Dee* subwatershed (1,393 tons/ year).

Pollutant loads are represented in the WMP by lbs/year. It is necessary to represent loading in lbs/year as it will be used in discussing improvement in each critical area. The use of lbs/acre/year demonstrates loading differences between critical areas of varying sizes, as critical areas are not a uniform size.

Overall Summary

The top 40% highest loading subwatersheds based on each pollutant category were tabulated and statistically cross referenced to each other in order to provide an overall nonpoint source evaluation of the Watershed. All of the subwatersheds that had at least two of the three modeled pollutants within the upper 40% rank were used from the data sets. The three HUC 12 subwatersheds that met this criterion and represent the most significant nonpoint source contributions from multiple modeled pollutants are illustrated in Exhibit 42.

Sugar Creek Watershed Critical Areas

On May 13, 2008, the Sugar Creek Watershed's Steering Committee identified 9 critical areas which are located in Appendix F and depicted on Exhibit A. Appendix F also contains a table with acreages of each critical area and the parameters of concern. V3 presented a summary of the existing water quality data, Hancock County SWCD presented the findings of the windshield survey (Exhibit 15) and the Steering committee identified the four most critical water quality components of degradation to the Sugar Creek Watershed as *E. coli*, sediment, nutrients and flooding.

The steering committee members were asked to locate specific sites within the watershed that would function as the critical areas of the Sugar Creek WMP as they relate to each of the causes of the four most significant problems. This accounted for the identification of nine preliminary critical areas. The nine preliminary critical areas account for approximately 15,385 total acres (livestock stream access did not contribute acreages), which is approximately 18% of the Watershed by area. Each of these preliminary critical areas is discussed on the following pages. Preliminary Critical Areas were identified within three of the four counties within the Sugar Creek Watershed being Hancock County, Shelby County, and Madison County. Exhibits identifying each critical area are located in Appendix F.

The Critical Area discussion continued to mature as the sources of the problems in the watershed were tied to specific critical locations. The sources of excess sediment include in-stream sources, river bank erosion, stream flows which scour around log jams, and erosion occurring throughout the Watershed. Sources of sediment in the Sugar Creek Watershed also include the lack of a stable buffer between human activities and the stream itself. Other sources include uncontrolled sheet flow across the land surface and runoff from existing construction sites. Sources specific to agricultural croplands include a lack of proper erosion control methods such as conservation tillage or cover crops which contribute to sedimentation in the runoff that flows overland. Similarly on pasturelands, a lack of proper erosion control methods, such as exclusionary fencing, contributes to livestock degrading streambanks and adding sediment load to the watershed.

E. coli bacteria are found in the intestines of humans and other warm blooded mammals, it is the indicator species used to denote the possibility of other pathogens that may be present in the aquatic system. Sources of *E. coli* include both human and animal origins and can emanate from both point and non-point sources of pollution. Sources in the Watershed include: failing septic systems, package plants, discharge of inadequately treated wastewater, wild and domestic animal waste, domestic animal waste runoff from CAFOs, manure storage facilities, livestock in the stream, runoff from pasture lands without proper erosion control measures, *E. coli* growth occurring in sediment, and from Combined Sewer Overflows (CSOs).

Nutrients are naturally occurring in the environment, but in excess can cause major problems in aquatic ecosystems. Sediments which carry an ion charge can link or bond to nutrients which also carry an ion charge. The loading of sediments throughout the Watershed then becomes a major source of nutrient input throughout the aquatic ecosystem. Many nutrient sources are the same as those that contribute to *E. coli* contamination and include: CAFOs, CFOs, failing septic systems, package plants, discharge of inadequately treated wastewater, overflow from manure storage facilities, and fertilizer applications.

Flooding is a natural component of the floodplain, but flooding can cause major problems in aquatic ecosystems in addition to causing damage to property. Land use changes with increased development results in less open space and more impervious cover in a watershed. Undeveloped open land is able to infiltrate rainfall into the ground, and ponded runoff is stored in numerous natural depressions in the landscape. Vegetation also reduces the amount of surface runoff by intercepting rainfall and through evapotranspiration. Development reduces the capacity of the land to hold water by compacting soils when grading for construction, removing natural vegetation and adding impervious cover such as rooftops, driveways, streets and parking lots. Impervious cover directly influences streams by dramatically increasing surface runoff. The most direct source of flood damage potential is the location of homes, buildings, development and infrastructure in the floodplain. The counties and communities need to abide by proper stormwater management plans. Less obvious, but of equal significance, is the impact an increased volume of runoff generated from upland development has on expanding the floodplain and causing localized flooding problems. Impedance of Sugar Creek's ability to convey stormwater runoff downstream through log jam blockages and lack of proper drainage adds to flooding damages within the watershed.

Critical Area #1, shown on Exhibit A-1, is Pee Dee Ditch and urban areas surrounding Warrington, which are both located in Hancock County. Pee Dee Ditch, a tributary to Sugar Creek, is identified as being a critical area because it contributes to the problem of nutrients, *E. coli*, and sediment. Urban areas associated with Warrington are identified as critical because it contributes to the problem of nutrients, *E. coli*, and sediment. The steering committee noted problems with potential failing septic systems and livestock stream access as contributing to nutrients, *E coli* and sediment. There are 1,678 acres of critical area and approximately 5.4 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #2, shown on Exhibit A-2, consists of the urban area associated with Nashville. Nashville is identified as a critical area as it contributes to the problem of nutrients, *E. coli*, and sediment. The steering committee noted problems with potential failing septic systems. There are 2,242 acres of critical area and approximately 2.5 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #3, shown on Exhibit A-3, consists of the urban area surrounding Eden. Eden is located in Hancock County. This area is identified as critical because it contributes to the problem of nutrients, *E. coli*, sediment, and flooding. The steering committee noted problems with potential failing septic systems. There are 2,420 acres of critical area and approximately 4.2 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #4, shown on Exhibit A-4, consists of the urban area associated with Mohawk and Mohawk Campground, Conservation Club, and Leary Weber Ditch all of which are located in Hancock County. Both the town of Mohawk and the Mohawk Campground have been identified as contributors to the problem of nutrients, *E. coli*, and sediment. The steering committee noted problems with potential failing septic systems. There are 2,334 acres of critical area and approximately 2.6 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #5, shown on Exhibit A-5, is the Heartland Resort, located immediately south of the town of Mohawk, Indiana. Heartland Resort is identified as a contributor to the problem of nutrients and *E. coli*. The steering committee noted problems with potential failing septic systems. There are 128 acres of critical area and approximately 0.6 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #6, shown on Exhibit A-6, consists of the S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park. S&H Campground is located north of the town of Philadelphia, Indiana. These areas have been identified as being critical areas as they contribute to the problems of *E. coli*, sediment and flooding. The steering committee noted problems with potential failing septic systems. There are 5,568 acres of critical area and approximately 6.9 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #7, shown on Exhibit A-7, is the Overlook Subdivision, located north of New Palestine. The Overlook Subdivision is identified as being a critical area as it contributes to the problems of *E. coli* and sediment. There are 29 acres of critical area and 0.15 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #8, shown on Exhibit A-8, consists of the area located between 200 S and 600 S along Sugar Creek. This area is identified as being a critical area as it contributes to the problems of *E. coli*, sediment and flooding. The steering committee noted flood damage and a need for streambank stabilization. There are 838 acres and approximately 5.0 miles of waterways where the implementation of BMPs would improve the condition of the watershed.

Critical Area #9, not shown on an exhibit, is the livestock stream access critical area. Areas in the watershed where livestock have direct access to the stream are identified as being critical as they contribute to the problems of *E. coli* and sediment. Addressing these concerns will also impact concerns regarding streambank degradation. The implementation of BMPs such as exclusion fencing and alternative water supply would improve the condition of the Watershed.

Subsequent discussions between V3, Hancock County SWCD, IDEM and the Steering Committee attempted to correlate BMP implementation project placement to solving the problems and causes of pollutant loading sources. These discussions tied in the findings of the Steering Committee's volunteers through the interpretation of results from the Windshield Surveys. Several of the monthly steering committee meetings focused on defining our targeted critical areas which would encapsulate the locations within the watershed where the sources of pollutant loads are causing the greatest damage through degradation of water quality. The watershed land use best management conservation practices would provide the most significant impact in reduction of pollutant loading when implementation of BMPs and improved responsible land use and homeowner practices are performed in these targeted critical areas.

Several redefined critical area maps, most not displayed in this final report, were developed by the Steering Committee. Some of the additional areas included: larger urban areas surrounding Warrington and Nashville; and the Sugar Creek corridor area between 200 S and 600 S. Exhibits B and B-1 which are located in Appendix F, represent the critical areas as of August 2008 which included the floodplain areas plus 100 foot buffers along Sugar Creek between Nashville and Eden. During these discussions, V3 had updated the HUC boundaries from the previous 14 digit HUC distinction to the required 12 digit HUC distinction. It was clear to the steering committee that the Little Sugar Creek subwatershed HUC-12 number 051202040404 did not possess any preliminarily identified critical areas (Exhibit A and Exhibit B, Appendix F). The final targeted critical areas are listed in Table 31 and depicted on Exhibit 43. The final five critical areas account for approximately 64,460 total acres (livestock stream access did not contribute acreages), which is approximately 76% of the Watershed by area.

Critical Area #1, HUC-12 number 051202040401, includes Pee Dee Ditch, Grain Ditch and urban areas surrounding Warrington. This critical area is 13,257 acres and is located in both Hancock and Henry Counties. Pee Dee Ditch, Grain Ditch, and four other tributaries to Sugar Creek, along with Sugar Creek itself combine for a total of 18 miles of stream reach. This area has been identified as being a critical area because it is a significant contributor of nutrient loading (both nitrogen and phosphorus) within the watershed. Critical Area #1 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where field drain tiles discharge into Sugar Creek or its tributaries

Critical Area #2, HUC-12 number 051202040402, includes the urban area associated with Nashville and the problematic floodplain area between Nashville and Eden. The critical area is 15,541 acres and is located in both Hancock and Madison Counties. Marsh & Trees Ditch combine with all the other surface water drainageways for a total of 13 miles. This area has been identified as being a critical area because it similarly is a significant contributor of both nitrogen and phosphorus. Critical Area #2 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where water is stagnant
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where field drain tiles discharge into Sugar Creek or its tributaries

Critical Area #3, HUC-12 number 051202040403, includes the urban area associated with Eden and the problematic floodplain area between Nashville and Eden. The critical area is 14,091 acres and is located in Hancock County. Barrett Ditch and three other tributaries, along with Sugar Creek combine for a total of 16 miles of stream reach. This area has been identified as being a critical area because implementing BMPs to control the source of sediment loads and nutrient loads will reduce the amount of TSS, nutrients and phosphorus in the streams. Critical Area #3 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

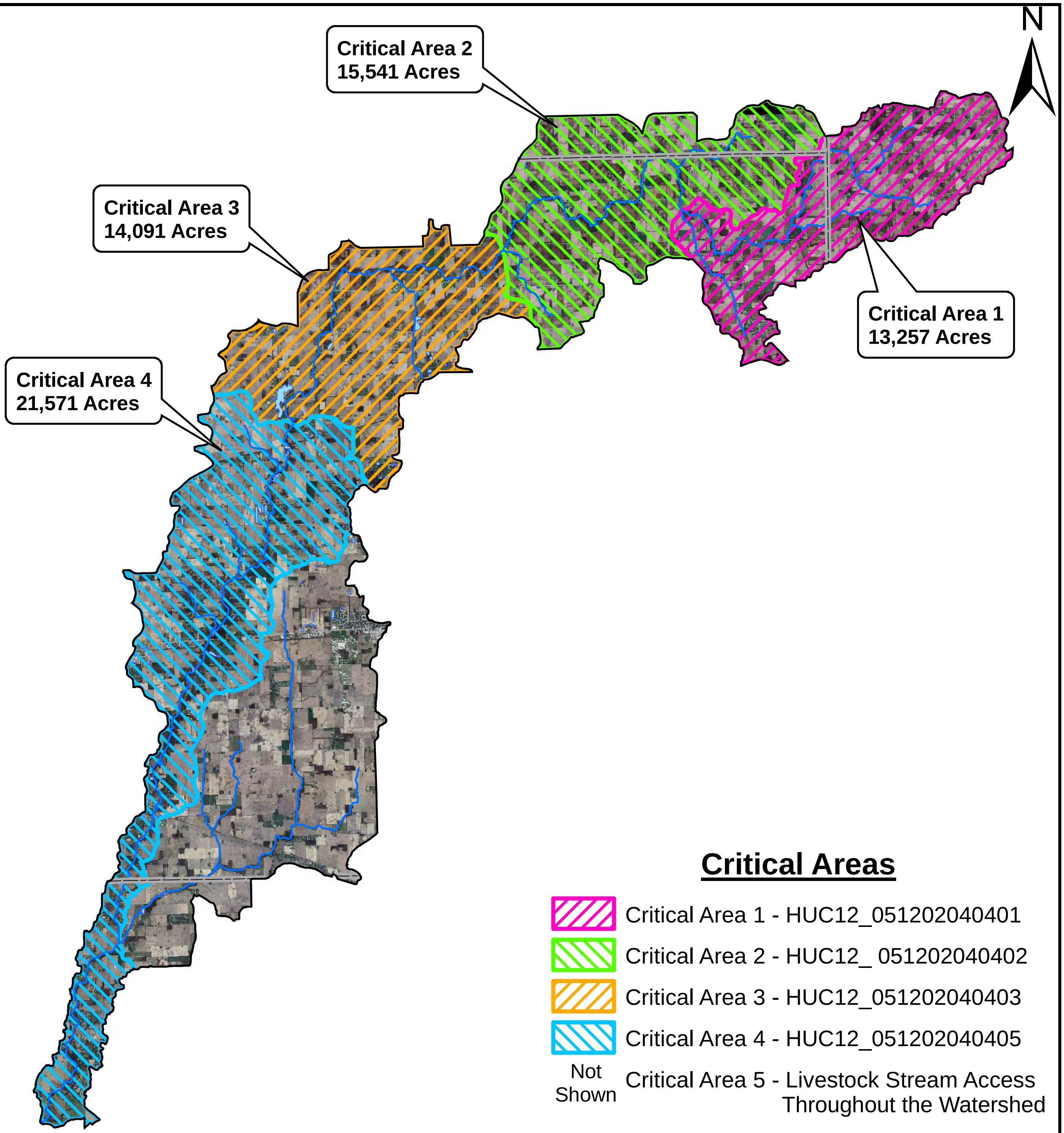
- Areas of sedimentation
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries

Critical Area #4, HUC-12 number 051202040405, includes: the urban area associated with Mohawk and Mohawk Campground, Conservation Club; the Leary Weber Ditch; the Heartland Resort; the S&H Campground; urban areas surrounding Philadelphia; the Wildwood Subdivision; urban areas surrounding Spring Lake; the Arrowhead Mobile Park; the Overlook Subdivision; and the problematic floodplain corridor along Sugar Creek between 200 S and 600 S. The critical area is 21,571 acres which includes 38 miles of waterway and is located in Hancock and Shelby Counties. Both the town of Mohawk and the Mohawk Campground have been identified as contributors to the problem of nutrients, *E. coli*, and sediment. The Heartland Resort, located immediately south of the town of Mohawk, is identified as a contributor to the problem of nutrients and *E. coli*. The steering committee noted this subwatershed as the most significant contributor of *E. coli*. through failing septic systems. Critical Area #4 possesses locations which have the following problems observed by the Steering Committee during the Fall 2007 and Spring 2008 Windshield Surveys:

- Areas of sedimentation
- Log jams
- Areas where bank protection and stabilization are needed
- Areas where excessive streambank erosion is occurring
- Areas where flooding occurs
- Areas where livestock have direct access to Sugar Creek or its tributaries
- Areas where excessive trash and debris are located
- Areas where septic system pipes discharge into Sugar Creek or its tributaries
- Areas where vegetated buffer is lacking along a waterway within the Watershed

Critical Area #5, not shown on an exhibit, is the livestock stream access critical area. Areas in the watershed where livestock have direct access to the stream are identified as being critical as they contribute to the problems of *E. coli* and sediment. Addressing these concerns will also impact concerns regarding streambank degradation. The implementation of BMPs such as exclusion fencing and alternative water supply would improve the condition of the Watershed.

Table 31. Finalized Critical Area Locations within the Sugar Creek Watershed							
Critical Area #	**Name**	**County(s)**	***E. coli***	**Sediment**	**Nutrients**	**Flooding**	**Critical Area Acreage**
1	Pee Dee Ditch –Sugar Creek	Hancock and Henry Counties	X	X	X	X	13,257
2	Marsh and Trees Ditch – Sugar Creek	Hancock and Madison Counties	X	X	X	X	15,541
3	Barrett Ditch – Sugar Creek	Hancock County	X	X	X	X	14,091
4	Boyd and Leary Weber Ditch - Little Sugar Creek	Hancock and Shelby Counties	X	X	X	X	21,571
5	Livestock Stream Access	Hancock, Henry, Madison and Shelby Counties	X	X	X	X	-
		Totals:	5	5	5	5	64,460



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **Final Nutrient, E. Coli, Sediment, and Flooding Critical Areas**	PROJECT: **Sugar Creek Watershed Project**			
	BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: 43	SHEET: 1 OF: 1	
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/8/08	SCALE: NTS	

Linking Stakeholder Concerns and Critical Areas

The beginning of the planning process included a public meeting held July 17, 2007 where stakeholders voiced their opinions with regards to concerns and problems within the Sugar Creek Watershed. The list of concerns and problems was presented in Section 2 (pg. 42) of this WMP. This process identified six sub-groups of issues which included: Agricultural Issues, Pollution Issues, Development/Urban Issues, Recreational Issues, Wildlife/Habitat Issues, and Other Issues and Concerns. A total of 28 issues/concerns have remained the focus of the Steering Committee with regards to identifying critical areas and setting the goals for this WMP.

Based on the list of concerns provided by the stakeholders, the historical water quality data analyzed within the watershed, the 2007/2008 collected water quality samples, and the Steering Committee's local knowledge of the watershed, the 9 critical areas, as identified in Section 4 (pg. 121) of this WMP, were characterized into 7 major concern categories consisting of:

1) Flooding,
2) *E. coli*,
3) Nutrient Loading,
4) Sedimentation/Erosion,
5) Steering Committee,
6) Education and Outreach, and
7) Preservation/Restoration of open space within the Sugar Creek Watershed.

To develop goals for the WMP, the stakeholder concerns were evaluated and placed into one or more of the seven categories in order to develop problem statements.

Linking Sources and Critical Areas

Through evaluations of several groups and agencies, pathogens (*E. coli*), sediment, nutrients and flooding have been identified as the most significant pollutant and condition in the Sugar Creek Watershed. The Sugar Creek Watershed is composed of five subwatersheds that each has unique challenges in relation to pathogens (*E. coli*), sediment, nutrients and flooding. Pathogens (*E. coli*), sediment, nutrients and flooding have been identified as an issue in each of the four critical areas that are represented by HUC-12 subwatersheds of 051202040401, 051202040402, 051202040403, and 051202040405. The magnitude of each pollutant or condition within these subwatersheds is discussed to determine the extent of the issue within each of the critical areas.

Sources of sediment have been identified as bank erosion, lack of stable buffer, uncontrolled sheet flow, and runoff from existing construction sites.

Sources of pathogens (*E. coli*) have been identified as: failing septic systems, package plants, discharge of inadequately treated wastewater, wild and domestic animal waste, livestock in the stream, runoff from pasture lands without proper erosion control measures, *E. coli* growth occurring in sediment, and from Combined Sewer Overflows (CSOs).

Many nutrient sources are the same as those that contribute to *E. coli* contamination and include: CFOs, failing septic systems, package plants, discharge of inadequately treated wastewater, overflow from manure storage facilities, and fertilizer applications.

Flooding becomes more problematic as land use within the Watershed changes to less open space and more impervious cover as a result of increased development.

SECTION 5: SET GOALS AND SELECT INDICATORS

Setting the Goals

The Steering Committee evaluated the priority resource concerns that were gathered from stakeholders throughout the Sugar Creek Watershed, evaluated the problem statements, and examined the mission statement of the Sugar Creek WMP. With this information in mind, seven goals were developed, which the committee hopes to achieve through the implementation of the Sugar Creek WMP. The number in parentheses listed with each goal corresponds to the problem statement to which that goal applies. The complete listing of the Sugar Creek WMP's goals is as follows:

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

Objectives:

- Meet as a Committee on a quarterly basis,
- Increase involvement and participation with the planning process from Stakeholders within the Watershed,
- Pursue and implement watershed improvement projects,
- Sustaining active subcommittees.

Goal #2: Reduce *E. coli* concentrations to meet state standard of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices,
- Reduce the amount of *E. coli* runoff from urban lands,
- Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants, and
- Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders.

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

Objectives:

- Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology,
- Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers,
- Increase the riparian buffer zone using filter strips and grassed waterways,

- Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology,
- Discourage the Fall and Winter application of fertilizer,
- Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.),
- Encourage lower application rates of fertilizers within the watershed through education workshops and field days.

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Objectives:

- Reduce soil erosion and sedimentation from agricultural lands,
- Reduce soil erosion and sedimentation from urban lands, and
- Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed,
- Protect and restore floodplain functions,
- Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding,
- Create and restore wetland areas to increase storage within the Watershed.

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Objectives:

- Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members,
- Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors,
- Promote sustainable drainage practices,
- Educate homeowners in urban communities about the use of fertilizers,

- Educate stakeholders using septic systems about the importance of septic system maintenance,
- Establish a legislative liaison,
- Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed,
- Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed,
- Educate homeowners within the Watershed about the Storm Drain Marking Program.

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

Objectives:

- Increase acquisition of land to be dedicated to open space and greenways,
- Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed,
- Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed,
- Encourage farmland preservation within the Watershed.

To help achieve these goals, eight Sub-committees have been formed to spearhead and guide the activities necessary to achieve the aforementioned goals. These sub-committees include:

1) Education Sub-Committee
2) Recreation Sub-Committee
3) Legislative/ Local Advocacy Sub-Committee
4) Research/Grant-Writing Sub-Committee
5) Media/Marketing/Website Sub-Committee
6) Monitoring Sub-Committee
7) Urban Sub-Committee
8) Agricultural Sub-Committee

The Education Sub-Committee will work with local schools, corporations, and government bodies to assist with natural resource education. Members of this committee will research and provide or create educational materials that promote watershed awareness. The Education Sub-Committee will host a Hoosier Riverwatch training within the Sugar Creek Watershed as well as coordinate field days and other educational events. Members of the Education Sub-Committee will assist in the design of presentation and display materials as well as promotional materials that are provided by the Media/Marketing/Website Sub-Committee. Assistance will be given to the agricultural and urban Sub-Committees by members of the Education Sub-Committee. The Monitoring Sub-Committee will work closely with the Education Sub-Committee to keep data current in educational materials.

The Recreation Sub-Committee effort is focused on the creation of recreational opportunities and events for stakeholders of Sugar Creek. Members of the Recreation Sub-Committee will coordinate the removal of trash from Sugar Creek, its tributaries, and riparian corridors with the intention that cleaning efforts will promote recreational uses such as canoeing and fishing.

The Recreation Sub-Committee will sponsor a recreational activity including but not limited to birding, hiking as well as identify navigable reaches within Sugar Creek.

The tasks of the Legislative/Local Advocacy Sub-Committee include identification and establishment of collaborative relationships with entities whom have potential influence on water quality. Members of the Legislative/Local Advocacy Sub-Committee will contact legislators and other influential members of local government to inform of current Sugar Creek Watershed activities and issues. The Research/Grant-Writing Sub-Committee will help prepare, review and submit grant applications. One member of the Research/Grant-Writing Sub-Committee will act as a liaison to appropriate applications. All members of the Research/Grant-Writing Sub-Committee will network with universities, schools, government entities and other groups in order to coordinate, communicate, and participate in ongoing water quality research activities that are applicable within the Sugar Creek Watershed. Members of the Research/Grant-Writing Sub-Committee will research additional grant sources and opportunities for the Sugar Creek Watershed.

The Media/Marketing/Website Sub-Committee will create and maintain a Sugar Creek Watershed website as well as create an active site for data sharing. Members of this Sub-Committee will assist other sub-committee groups with preparation, distribution and review of materials related to the Sugar Creek Watershed. Members of the Media/Marketing/Website Sub-Committee will develop relationships with local electronic media and individual reporters. Watershed newspaper articles will be prepared and submitted to inform the public about the watershed and the planning process.

The Monitoring Sub-Committee will work with local agencies to provide updated water quality data as it is collected. Members of the Monitoring Sub-Committee will coordinate and conduct water quality sampling to provide information to the general public through the Hoosier Riverwatch volunteer monitoring program as well as recruit volunteers to monitor various sites throughout the Watershed. Future fish and macroinvertebrate sampling within Sugar Creek will be coordinated by members of the Monitoring Sub-Committee.

The Urban and Agricultural Sub-Committee will establish relationships with entities within urban and agricultural areas throughout the Watershed that could have a potential influence on water quality. Members of these committees will build relationships in order to promote protection and improvement of the Sugar Creek Watershed. Best Management Practices specific to urban or agricultural areas will be promoted as impairments to the Watershed are discussed.

The establishment and specific tasks assigned to each of the Sub-Committee groups will allow for multiple avenues of watershed improvement to be pursued. Awareness of issues and impairments within the Watershed will increase stakeholder participation and will hopefully increase membership of the Sugar Creek Watershed Steering Committee.

Prioritization of Objectives within the 7 Goals of the Watershed Management Plan

Objectives were prioritized by the Steering Committee at the July 9, 2008, meeting. Priorities were identified as Short-Term or Long-Term. Short-Term priorities are those which the Steering Committee would like to accomplish within the first five years (2009 - 2014) of implementing the WMP. Long-Term priorities are also those which the Steering Committee would like to accomplish within twenty-one years (2009 - 2030) of implementing the WMP. These priority rankings of objectives are presented on Table 32a through g.

Programmatic Action Plan

The following itemized action plan for each of the seven goals was established by the Steering Committee. The actions described in this implementation plan can be found on Tables 32a through 32g. The tables identifies the objectives, the action items, assign a priority ranking, identifies the responsible party or parties involved with the implementation of the actions, and outlines both the technical and financial assistance for each action item. Goal #1 is to sustain the Sugar Creek Watershed stakeholder group. The objectives and action items outlined in goal #1 are to be accomplished within the short term. Goal #2 is to reduce *E. coli* concentrations to meet the state standard of 235 CFU per 100 ml in the Sugar Creek Watershed by 2030. The objectives and action items outlined in Goal #2 are prioritized to be accomplished within the short term. Goal #6 is to Develop and implement watershed education and outreach programs in the Sugar Creek Watershed. Similarly, all of the objectives and action items outlined in Goal #6 are intended to be accomplished within the short term. This makes priority of accomplishing the actions items of Goals 1, 2 and 6 all within the first five years.

Goals # 5 and 7 are intended to have their objectives and action items accomplished within the first twenty-one years. Goal #5 is to Reduce flood damage in the Sugar Creek Watershed. Goal #7 is to increase preservation and restoration of open space within the Sugar Creek Watershed. Goal #3 is to reduce the maximum concentration so that there are no exceedances of nitrate plus nitrite of 10 mg/L total phosphorus of 0.3 mg/L. Goal #4 is to reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Interim Measurable Milestones

Table 32a through 32g lists the measurable milestones for each of the seven goals identified by the Steering Committee. Each goal is divided into two categories consisting of: Short Term Milestones and Measurable Goals and Long Term Milestones and Measurable Goals. These milestones have been suggested in order to help track the process of implementing action items within the first five years for Short Term Measurable Milestones, within the first twenty-one years for Long Term Measureable Milestones.

Short-Term Priority Objectives

The following are Short-Term priority objectives that the Steering Committee will address in the years 2009-2014:

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

Objectives:

- Meet as a Committee on a quarterly basis,
- Increase involvement and participation with the planning process from Stakeholders within the Watershed,
- Pursue and implement watershed improvement projects,
- Sustaining active subcommittees.

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Objectives:

- Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members,
- Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors,
- Promote sustainable drainage practices,
- Educate homeowners in urban communities about the use of fertilizers,
- Educate stakeholders using septic systems about the importance of septic system maintenance,
- Establish a legislative liaison,
- Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed,
- Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed,
- Educate homeowners within the Watershed about the Storm Drain Marking Program.

Long-Term Priority Objectives

The following are Long-Term priority objectives that the Steering Committee will address in the years 2009-2030:

Goal #2: Reduce *E. coli* concentrations to meet state standard of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices,
- Reduce the amount of *E. coli* runoff from urban lands,
- Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants, and
- Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders.

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

Objectives:

- Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology,
- Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers,
- Increase the riparian buffer zone using filter strips and grassed waterways,
- Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology,
- Discourage the Fall and Winter application of fertilizer,
- Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.),
- Encourage lower application rates of fertilizers within the Watershed through education workshops and field days.

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Objectives:

- Reduce soil erosion and sedimentation from agricultural lands,
- Reduce soil erosion and sedimentation from urban lands, and
- Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Objectives:

- Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed,
- Protect and restore floodplain functions,
- Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding,
- Create and restore wetland areas to increase storage within the Watershed.

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

Objectives:

- Increase acquisition of land to be dedicated to open space and greenways,
- Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed,
- Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed,
- Encourage farmland preservation within the Watershed.

Table 32a Priority Ranking of Objectives: **Goal #1:** Sustain the Sugar Creek Watershed Stakeholder Group. All action items are short-term measureable milestone priorities.				
Objective	**Action Item**	**Responsible Party**	**Technical Assistance**	**Financial Assistance**
Meet as a Committee on a quarterly basis	Retain active committee participants and acquire new committee members.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
Increase involvement and participation with the planning process from Stakeholders within the Watershed	Expand responsibilities and stewardship of active committee participants and stakeholders with the planning process.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
	Research local stakeholder groups with similar missions or interest within the Watershed.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
	Network with related stakeholder groups and use public forums as recruiting opportunities	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Pursue and implement watershed improvement projects	Promote urban BMPs by pursuing funding, implementing urban BMP demonstration projects and providing field day tours of implementation sites.	**Research/Grant Writing; Media/Marketing/Website; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote rural BMPs by pursuing funding, implementing rural BMP demonstration projects and providing field day tours of implementation sites.	**Research/Grant Writing; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Sustaining active subcommittees	Retain active subcommittee participants and acquire new subcommittees and subcommittee members.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations

Table 32b Priority Ranking of Objectives:
Goal #2: Reduce *E. coli* concentrations to meet state standards of 235 CFU/100 ml in the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices	Promote and provide technical assistance to implement exclusionary fencing installation which would prevent livestock from having access to the stream.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to implement alternative water supplies for livestock in order to replace direct access to the stream.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to educate and implement manure management practices.	**Education; Media/Marketing/Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Reduce the amount of *E. coli* runoff from urban lands	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants	Educate stakeholders about the detrimental impacts to water quality from point sources, failed septic systems and package plants.	**Steering Committee**	Volunteers, SWCDs	Volunteer/Donations
	Encourage regular maintenance and repair of failing septic systems.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding

Table 32c Priority Ranking of Objectives:
Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology	Educate farmers, home owners, landscaping companies, stakeholders about the proper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Utilize and promote the Farm Bill Program.	**Steering Committee**	SWCDs, NRCS	Grant Funding
Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers	Educate farmers, home owners, landscaping companies, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of excessive fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Increase the riparian buffer zone using filter strips and grassed waterways	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Promote filter strips and grassed waterways as BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology	Promote and provide technical assistance to implement appropriate BMPs.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
	Promote BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Discourage the Fall and Winter application of fertilizer	Educate farmers, home owners, landscaping companies, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.)	Promote and provide technical assistance to encourage more soil testing to optimize nitrogen application.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding
Encourage lower application rates of fertilizers within the Watershed through education workshops and field days	Educate farmers, home owners, landscaping companies, stakeholders through workshops and field days about the impacts to water quality (both groundwater and surface water) from the improper application of fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/Grant Funding

Table 32d Priority Ranking of Objectives: **Goal #4:** Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030. All action items are long-term measureable milestone priorities.				
Objective	**Action Item**	**Responsible Party**	**Technical Assistance**	**Financial Assistance**
Reduce soil erosion and sedimentation from agricultural lands	Promote and provide technical assistance to implement appropriate agricultural land BMPs.	**Education; Media/ Marketing/ Website; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote agricultural land BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Education; Research/ Grant Writing; Agricultural Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Utilize and promote the Farm Bill Program.	**Steering Committee**	SWCDs, NRCS	Grant Funding
	Designate a volunteer for specific areas throughout the Watershed as the main contact for reporting violations.	**Steering Committee**	Volunteers, Steering Committee	Volunteers
Reduce soil erosion and sedimentation from urban lands	Promote and provide technical assistance to implement appropriate urban land BMPs.	**Education; Media/ Marketing/ Website; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Promote urban land BMPs by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Education; Research/ Grant Writing; Urban Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Designate a volunteer for specific areas throughout the Watershed as the main contact for reporting violations.	**Steering Committee**	Volunteers, Steering Committee	Volunteers
Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed	Work with permitting entities to adopt building permit ordinances with more conservative erosion control practices.	**Legislative/ Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Work with permitting entities to adopt more stringent enforcement of erosion control practices.	**Legislative/ Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Establish a volunteer group that will monitor construction sites for violations.	**Monitoring; Legislative/ Local Advocacy Sub-Committees**	Volunteers, Steering Committee	Volunteers

Table 32e Priority Ranking of Objectives:
Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed	Work with permitting entities to adopt stormwater permit ordinances with more conservative stormwater runoff rate and volume limits.	**Legislative/Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote and provide technical assistance to implement appropriate BMPs within developed areas to reduce stormwater runoff flow rates and volumes.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote BMPs within developed areas to reduce stormwater runoff flow rates and volumes by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Protect and restore floodplain functions	Promote and provide technical assistance to protect and restore floodplain functions within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote the protection and restoration of floodplain functions by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding	Promote and provide technical assistance for maintenance and management practices which will result in reducing flood damage within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
Create and restore wetland areas to increase storage within the Watershed	Promote and provide technical assistance to implement wetland creation and restoration projects to increase storage.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding
	Promote wetland creation and restoration projects by pursuing funding, implementing demonstration projects and providing field day tours of implementation sites.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, County Surveyor	Volunteer/Donations/ Grant Funding

Table 32f Priority Ranking of Objectives:
Goal #6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed. All action items are short-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members	Promote the effective use of media (TV, newspaper, newsletters and radio) to share and communicate watershed improvement activities.	**Media/Marketing/Website Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors	Promote activities to recruit and train volunteers for monitoring watershed conditions including biological, physical and chemical parameters.	**Education; Monitoring Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
	Provide training and educational opportunities for volunteer monitors.	**Education; Monitoring Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Promote sustainable drainage practices	Encourage implementation of sustainable drainage practices throughout the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate homeowners in urban communities about the use of fertilizers	Educate home owners, stakeholders about the impacts to water quality (both groundwater and surface water) from the improper application of excessive fertilizers.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate stakeholders using septic systems about the importance of septic system maintenance	Encourage regular maintenance and repair of failing septic systems.	**Steering Committee**	Volunteers, SWCD	Volunteer/Donations
Establish a legislative liaison	Promote the establishment of a legislative liaison with a prime directive of improving the water quality of the Sugar Creek Watershed.	**Legislative/Local Advocacy Sub-Committees**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed	Promote awareness of detrimental effects on the health of the Watershed from ATV use in and along Sugar Creek.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed	Encourage stakeholder awareness with respect to studies conducted within the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding
Educate homeowners within the Watershed about the Storm Drain Marking Program	Promote implementing a Storm Drain Marking Program throughout the Watershed.	**Steering Committee**	Volunteers, SWCDs, NRCS, IDNR, IDEM, Consultant	Volunteer/Donations/ Grant Funding

Table 32g Priority Ranking of Objectives:
Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030. All action items are long-term measureable milestone priorities.

Objective	Action Item	Responsible Party	Technical Assistance	Financial Assistance
Increase acquisition of land to be dedicated to open space and greenways	Promote greenway corridors	**Steering Committee**	Parks Departments, Volunteers	Volunteer/Donations/ and Grants
	Promote park expansion and use of public land	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Connect open spaces with conservation corridors.	**Steering Committee**	Volunteers, Consultants	Volunteers/ Donations/ and Grants
	Identify current and future recreational needs and match with appropriate open space within the Watershed.	**Steering Committee**	Volunteers	Volunteers/ Donations
Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed	Identify natural resources, ecological areas, and unique habitats to be preserved and protected.	**Steering Committee**	IDEM, DNR, Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Promote awareness of invasive species and their impact on native ecosystems.	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Promote awareness of threatened and endangered species throughout the Watershed. Encourage and educate the public on ways they can protect these species.	**Steering Committee**	Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
	Manage current open spaces for invasive species.	**Steering Committee**	Parks Departments, DNR, Volunteers	Volunteers/ Donations/ and Grants
	Support wetland, prairie and woodland restoration.	**Steering Committee**	IDEM, DNR, Parks Departments, Volunteers	Volunteers/ Donations/ and Grants
Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed	Educate stakeholders on management practices which simulate natural processes such as burning or thinning.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants
	Use native vegetation extensively in BMPs to enhance wildlife habitat.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants
Encourage farmland preservation within the Watershed	Promote the preservation of farmland within the Watershed.	**Steering Committee**	Volunteers	Volunteers/ Donations/ and Grants

Selecting the Indicators for the Goals

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

In order to sustain the Sugar Creek Watershed Stakeholder Group, the short term objectives for goal #1 will need to be met. The short term goals include meeting as a group on a quarterly basis, increasing involvement and participation with the planning process from Stakeholders within the Watershed, pursuing and implementing watershed improvement projects, and sustaining active subcommittees. Achieving goal #1 will require active committee participants to continue membership and attain new committee members. Members of the Sugar Creek Watershed Stakeholder Group will expand their responsibilities and stewardship of active committee participants and stakeholders with the planning process. Members will also research and network with related stakeholder groups with similar missions or issues within the Watershed and use public forums as recruiting opportunities. Educating and obtaining the interest of landowners will be very important in sustaining the Stakeholder Group as well as promoting urban and agricultural BMPs. The promotion of urban and agricultural BMPs will include implementing BMP demonstration projects and providing field day tours of implementation sites.

Goal #2: Reduce *E. coli* concentrations to meet state standards of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

The reduction of levels of *E. coli* are not based on modeling of water quality, so indicators for this goal can be expanded to evaluate the implementation of BMPs to reach nutrient loading and erosion goals. The measured presence of *E. coli* in values less than the state standard is desired to provide primary and secondary contact waters at fishable and swimmable levels without risk of illness. Achieving goal #2 will require successful outreach and education about the detrimental impacts to water quality from point sources, failed septic systems and package plants. Educational outreach will emphasize the importance of regular maintenance of septic systems and repair of failing septic systems. Promotion of exclusionary fencing to prevent livestock from having stream access, alternative water supplies, and manure management is vital in reducing *E. coli* concentrations. Providing technical assistance for exclusionary fencing installation, alternative water supply implementation, and participation in manure management practices will increase awareness of *E. coli* concentrations and methods of reduction within the Watershed. Educational outreach concerning the importance of *E. coli* concentration reductions will further reduce *E. coli* from infiltrating the Watershed from agricultural lands, urban lands and rural residential lands.

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

The selected water quality indicator for accomplishing the indicators for achieving goal #3 is based on the measurable improvements to the pollutant concentrations for nitrate, nitrite and total phosphorus load reduction modeling. Educating farmers, home owners, landscaping companies and stakeholders within the Watershed about the proper application of fertilizer and the impacts to water quality when fertilizer is applied incorrectly will reduce the amount of nutrients in the Watershed. Promotion of soil tests will optimize the effectiveness of nitrogen application in the Watershed. BMP practices will be promoted with emphasis on filter strips and grassed waterways by pursuing funding and creation of implementation projects that will be used during field day tours. Technical assistance will be provided to those interested in implementing BMP and information regarding the Farm Bill Program will be provided in applicable cases. As the implementation of urban and agricultural BMPs takes place within the Watershed, improvements to the nutrient loads can be projected; examples of accepted removal rates are discussed in Section 6. Targets have been established for load reduction values, which are to be discussed in Section 7.

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

The selected water quality indicator for accomplishing the indicators for reducing Total Suspended Solids (TSS) is based on the measurable improvements to the pollutant concentrations in the TSS load reduction modeling. Erosion enforcement will be achieved through the establishment of a volunteer group that will monitor construction sites for violations and a main contact will be designated for specific areas throughout the watershed for reporting violations. Achieving goal #4 will require partnership with permitting entities in order to adopt more stringent enforcement of erosion control practices as well as adopting building permit ordinances with more conservative erosion control practices. Technical assistance will be provided to those interested in implementing urban and agricultural BMPs and promotion and utilization of the Farm Bill Program will be applied in appropriate cases. As the implementation of urban and agricultural BMPs takes place within the Watershed, improvements to the TSS loads can be projected; examples of accepted removal rates are discussed in Section 6. Targets have been established for load reduction values, which are to be discussed in Section 7.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Flood insurance property and crop damage claims due to flooding can be compared to previous year's claims for tracking trends in flood damage. Promotion and implementation of BMPs within developed areas of the Watershed will reduce stormwater runoff flow rates and volumes as well as working with permitting entities to adopt stormwater permit ordinances with more conservative stormwater runoff rates and volume limits is necessary to achieve a reduction in flood damage throughout the Watershed. Wetland creation and restoration projects will be promoted as they increase storage and can reduce flood damage. Advocating for increased maintenance and management of drainageways will reduce flood damage. Achieving goal #5 will require the pursuing funding for the promotion and implementation of demonstration projects that will provide field day tours of implementation sites such as wetland and floodplain restoration. The number and amount of property and crop damage claims can vary greatly from one year to another based on the amount and frequency of precipitation, so years with similar weather should be compared if possible. The USGS website, http://waterdata.usgs.gov/nwis/uv?site_no=03361650, can also be accessed to show staff gauge and flow of Sugar Creek. This data can show trends in water levels, volume, and duration of flooding events.

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Indicators for achieving the development and implementation of watershed education and outreach programs can be identified by the successful accomplishment of the short-term priority action items for this goal. Educational materials concerning the impacts to water quality from the improper application and excessive use of fertilizer as well as watershed improvement activities will be provided to stakeholders through effective use of media. Promotion of training activities and education opportunities throughout the watershed will be used to recruit new volunteers that can participate in monitoring watershed conditions including biological, chemical and physical parameters. Awareness of current and past studies of the watershed will be achieved through outreach. Sustainable drainage practices throughout the Watershed and maintenance and repair of failing septic systems will be promoted and encouraged through educational outreach programs. All terrain vehicle impacts will be discussed as it has a detrimental impact to the Watershed when used in and along Sugar Creek. A member of the Sugar Creek Watershed Stakeholder Group will serve as a legislative liaison with their prime directive being improvement of the water quality of the Sugar Creek Watershed. Other ways of measuring success could be performed by tracking public involvement in volunteer programs (such as Hoosier Riverwatch) over time, tracking the number of people that attend volunteer programs, and tabulating attendance at Watershed Steering Committee meetings to see if attendance is increasing over time. Implementation of a storm drain marking program within the Watershed will be an indicator for achievement of goal #6. Short-term action items discussion is also located in Section 5.

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

An indicator of accomplishing the preservation and restoration of open space can involve the general inventory of lands held within preservation and open space land uses as it changes through 2030. Identification of current and future recreational needs will be matched with appropriate open space which will promote the preservation and protection of unique habitats and ecological areas within the Watershed. Education of stakeholders regarding the presence of threatened and endangered species within the Watershed encourage stakeholders to participate in activities that will protect these species. Achieving goal #7 will require the expansion of greenway corridors, park land and use of public land, and connection of open spaces with conservation corridors. Indicators of successful restoration of uplands, wetlands, streambanks and stream channels are all positive indicators of reaching this goal. Native vegetation will be used extensively in BMPs and restoration to enhance wildlife habitat. Management of invasive species within open space will be necessary to promote native vegetation growth and support wetland, prairie and woodland restoration. Restoration efforts will be combined with educational outreach to promote management activities that simulate natural processes such as thinning and burning. Money spent through 2030 on preservation and restoration is also an indicator of accomplishing this goal. Reduction of the amount of flood damage to crops, buildings and infrastructure is also an indicator of how much restoration has occurred in the Watershed.

SECTION 6: CHOOSE MEASURES/BMPS TO APPLY

Improve Water Quality

The Steering Committee has identified the most significant causes of impairment to the Sugar Creek Watershed as excessive concentrations of sediment, *E. coli*, nutrient loads, and excessive flooding during precipitation events. The most significant identified sources of impairment to streams include row cropping practices, livestock directly accessing the waterways, municipal point sources, land development/construction, urban runoff/storm sewers. In general, the diverse and diffuse nature of nonpoint pollutant sources presents a challenge for improving water quality.

Determine BMPs to Achieve Load Reductions

The watershed restoration and management techniques described in this section, when applied to the Sugar Creek Watershed, can help achieve the Watershed goals and objectives to decrease the concentrations of sediment, *E. coli*, nutrient loads and flooding identified in this WMP. Selecting measures and BMPs for improvement are categorized as being either preventative or remedial in nature.

Preventative measures reduce the likelihood that new watershed problems such as water quality degradation will arise or that existing problems will worsen. Preventative techniques generally target new development in the Watershed and are geared toward protecting and preventing degradation of existing resources. Planning, regulatory, and administrative programs and alternative site designs are examples of preventative measures. Prevention also includes measures that protect the natural drainage system through land acquisition and conservation management.

Potential Preventative BMPs include:

- Exclusion Fencing
- Rotational Grazing
- Nutrient Management Plan
- Manure Management Plan
- Alternative Watering System
- No-till/Reduced Till (Conservation Tillage)
- Grassed Waterways
- Buffers/Filter Strips
- Cover Crop
- Rain Barrel/Rain Gardens
- Pervious Paving Options
- Soil Infiltration Trench
- Natural Stream Buffer

Remedial measures are used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion. Water quality problems can be addressed by installing measures that improve infiltration and reduce runoff. Examples include disconnecting downspouts from storm sewers, installing biofilters, and re-landscaping with deep-rooted native vegetation. Other remedial techniques range from stabilizing eroded streambanks to restoring wetlands.

Potential Remedial BMPs include:

- Grade-Stabilization Structures
- Wetland Restoration
- Naturalized Wet-bottom Detention Basin
- Filtration Basin
- Sand Filter
- Bioretention Practices

To choose an appropriate BMP, it is essential to determine in advance the objectives to be met by the BMP and to calculate the cost and related effectiveness of alternative BMPs. Once a BMP has been selected, expertise is needed to insure that the BMP is properly installed, monitored, and maintained over time. BMPs to consider for the Sugar Creek Watershed and their potential effectiveness in meeting water quality objectives are found in Table 33.

Table 33. BMP effectiveness toward meeting watershed objectives.								
BMP EFFECTIVENESS								
BEST MANAGEMENT PRACTICE	**Goal(s) Addressed**	**Runoff Rate Control**	**Runoff Volume Control**	**Physical Habitat Preservation**	**Sediment Pollution Control**	**Nutrient Control**	**BOD Control**	**Other* Pollutant Control**
Impervious Area Reduction	4, 5, 6	2	2	2	2	2	2	2
Filter Strips	2, 3, 4, 6, 7	2	2	2	2	2	2	2
Swales	2, 3, 4, 6, 7	2	2	1	2	2	2	2
Infiltration Devices	2, 3, 4, 5, 6	2	3	1	3	3	3	3
Porous Pavement	2, 3, 4, 5, 6	2	2	1	3	3	3	3
Wet Detention	2, 3, 4, 5, 6, 7	3	1	2	3	2	3	2
Wetland Detention	2, 3, 4, 5, 6, 7	3	1	2	3	2	3	2
Dry Detention	4, 5, 6	2	1	1	2	1	1	1
Settling Basins	2, 3, 4, 5, 6	2	1	1	2	2	2	2
Sand Filters	2, 3, 4, 6	1	1	1	3	2	2	2
Rock Outlet Protection	4, 6	1	1	2	2	1	1	1
Storage Area Cover	3, 4, 6	1	1	1	2	2	1	2-3
Source Controls	2, 3, 6	1	1	1	1	2	2	2
Stream Protection/ Restoration	2, 3, 4, 5, 6, 7	2	1	3	2	2	2	1

Effectiveness Key:

3 = Fully achieves objective, 2 = Partially achieves objective, 1 = Does not achieve objective

* Other pollutants include toxic compounds such as heavy metals and pesticides, fecal bacteria, petroleum based hydrocarbons and deicing materials such as salt. A "2" in this column indicates that the BMP controls some of these pollutants but not others. Source: Dreher (1994)

Tables 34 through 36 depict percentage pollutant removal rates for different BMPs from data collected and reported by the Center for Watershed Protection (CWP) in June 1997. These removal efficiencies are based on one hundred twenty-three performance-monitoring studies that the CWP compiled into a database. Because performance can be extremely variable within a group of BMPs, estimates of BMP performance should be considered as a long-term average, not as a fixed or constant value.

Table 34. Comparison of Median Pollutant Removal Efficiencies among selected BMP groups: Conventional pollutants.

		Median Stormwater Pollutant Removal Rate (%)					
Best Management Practice	**Goal(s) Addressed**	**Total Suspended Solids**	**Total Phosphorus**	**Soluble Phosphorus**	**Total Nitrogen**	**Nitrate**	**Organic Carbon**
Detention pond	2, 3, 4, 5, 6, 7	7	10	2	5	3	(-1)
Dry Extended Detn. Pond	2, 3, 4, 5, 6, 7	61	19	(-9)	31	9	25
Wet pond	3, 4, 5, 6, 7	77	47	51	30	24	45
Wet Extended Detn. Pond	3, 4, 5, 6, 7	60	58	58	35	42	27
PONDS [A]	3, 4, 5, 6, 7	67	48	52	31	24	41
Shallow marsh	2, 3, 4, 5, 6, 7	84	38	37	24	78	21
ED* wetland	2, 3, 4, 5, 6, 7	63	24	32	36	29	ND
Pond/wetland	2, 3, 4, 5, 6, 7	72	54	39	13	15	4
WETLANDS	2, 3, 4, 5, 6, 7	78	51	39	21	67	28
Surface sand filters	3, 4, 6	83	60	-37	32	(-9)	67
FILTERS [B]	2, 3, 4, 6	87	51	-31	44	(-13)	66
SWALES [C]	2, 3, 4, 6, 7	81	29	34	ND	38	67

[A] Excludes conventional and dry Extended Detention ponds.

[B] Excludes vertical sand filters and vegetated filter strips

[C] Includes biofilters, wet swales and dry swales

- A negative number indicates that there is an increase in the amount of pollutant present in the water

ND – no data
Source: Center for Watershed Protection (CWP) in June 1997

Table 35. Potential Pollutant Removal Capability of Urban Stream Buffers	
Pollutant	**Potential Removal Rate***
Sediment	75%
Total nitrogen	40%
Total phosphorus	50%
Trace metals	60-70%
Hydrocarbons	75%

Source: Schueler (1995).

*Potential removal rate based on combined 25-foot grass strip in outer zone and 75 foot forested buffer in middle and streamside zone.

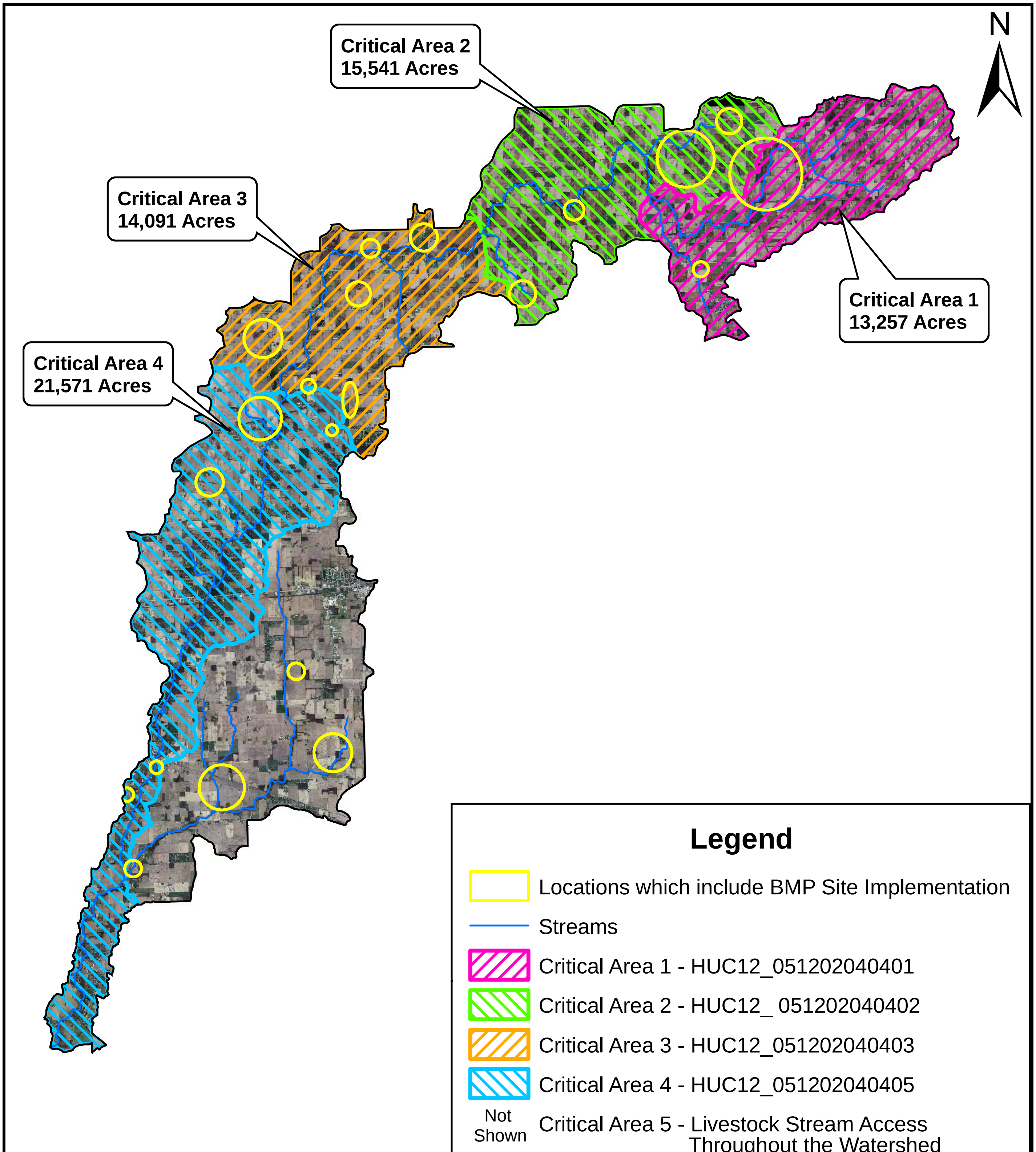
Table 36. Potential Pollutant Removal Capability of Agricultural Stream Buffers	
Pollutant	**Potential Removal Rate***
Sediment	75%
Total nitrogen	40%
Total phosphorus	50%
Trace metals	60-70%
Hydrocarbons	75%

Source: Schueler (1995).

*Potential removal rate based on combined 25-foot grass strip in outer zone and 75 foot forested buffer in middle and streamside zone.

Current BMP Practices within the Sugar Creek Watershed

Numerous nonpoint source pollution reducing best management conservation practices have been installed within the Sugar Creek Watershed. Some of these practices are being implemented by a good stewardship approach and by conservation minded individuals. Often times these practices take place outside of any formal means of documentation or quantifiable means of record keeping. Some participants work with the various county, state and federal agencies to participate within funded programs. The U.S. Farm Bill provides a significant amount of funding to implement several BMP practices from reducing nonpoint source pollution to the surface waterbodies within the watershed. This report contains an illustrated distribution of current BMP practices within the Sugar Creek watershed as shown on Exhibit 44. Please note that there is an even distribution of BMPs throughout the watershed. There is also representation among all of the critical areas defined by the Sugar Creek Steering Committee with respect to current BMP practice implementation.



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TITLE: **Existing Best Management Practices (BMP) in the Watershed**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

PROJECT NO.	EXHIBIT:	SHEET: 1 OF: 1
07065	44	
QUADRANGLE: N/A	DATE: 3/1/09	SCALE: NTS

BMP Selection Discussed by the Steering Committee

Based on what is in the best interest of improving water quality conditions, reducing pollutant loading and enhancing land use practices, the Steering Committee has elected to pursue implementation of all of the available technologies for implementation of BMPs. These BMPs will help achieve the Watershed goals and objectives by decreasing the concentrations of TSS, *E. coli*, nitrate plus nitrite, total phosphorus and the damage caused by flooding.

Examples of Implementing Agricultural Practices

Current land use data indicate that 83.9% of the Sugar Creek Watershed is used for agricultural purposes. The Natural Resource Conservation Service (NRCS) publishes guidelines for farmers to prevent soil erosion and to improve or protect water quality and water resources. The following information was taken from the NRCS Field Office Technical Guide (FOTG). Several of these practices described as follows are similar to BMPs for riparian sites (such as filter strips and buffers), but specific suggestions are given for agricultural sites.

1. Exclusion Fencing

The impacts of livestock grazing riparian areas include manure and urine deposited directly into or near surface waters where leaching and runoff can transport nutrients and pathogens into the water. Unmanaged grazing may accelerate erosion and sedimentation into surface water, change stream flow, and destroy aquatic habitats. Improper grazing can reduce the capacity of riparian areas to filter contaminates, shade aquatic habitats, and stabilize stream banks.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc) installed to exclude livestock from streams and areas, not intended for grazing. This will reduce erosion, TSS, *E. coli* concentrations, nutrient loading, and improve the quality of surface water. Exclusion fencing can be promoted through education and outreach programs directed at promoting agricultural practices that have less ecological impacts.

2. Rotational Grazing

Intensive grazing management is the division of pastures into multiple cells that receive a short but intensive grazing period followed by a period of recovery of the vegetative cover. Pasture management practices that include the use of rotational grazing systems are beneficial for water and soil quality. Systems that include the riparian area as a separate pasture are beneficial because livestock access to these areas is controlled to limit the impact on the riparian plant communities.

This practice has the ability to reduce erosion and TSS by not grazing areas to the point that they are bare. This will also aid in removal of nutrients and *E. coli* through more effective filtering before it reaches the creek. Education and outreach programs focusing on rotational grazing are important in the success of this BMP.

3. Nutrient Management Plan

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil.

Nutrient management plans are developed with assistance from NRCS. A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater. This BMP will help to decrease nutrient and TSS loading in the Watershed. Education and outreach programs should involve nutrient management plans to inform interested farmers.

4. Manure Management Planning

Animal waste is a major source of pollution to waterbodies. To protect the health of aquatic ecosystems and meet water quality standards, manure must be safely managed. Good management of manure keeps livestock healthy, returns nutrients to the soil, improves pastures and gardens, and protects the environment, specifically water quality. Poor manure management may lead to sick livestock, unsanitary and unhealthy conditions for humans and other organisms, and increased insect and parasite populations. Proper management of animal waste can be done by implementing BMPs, through safe storage, by application as a fertilizer, and through composting. Proper manure management can effectively reduce *E. coli* concentrations, nutrient levels and sedimentation. Manure management can also be addressed in education and outreach to encourage farmers to participate in this BMP.

4.1 Manure Management

Proper storage of manure is extremely important. There are many different types of manure storage facilities ranging from solid manure storage systems to lagoons or slurry systems. Different types of storage systems are site-specific depending on the site's nutrient concentrations, proximity to water sources, type of livestock, availability of land application equipment, and manure form and consistency. Prevailing wind direction, slope of ground, and soil type should also be considered when selecting a manure storage facility. By properly and safely storing animal waste, the input of toxic materials, such as fecal coliforms, to nearby streams and rivers will decrease.

4.2 Application and Spreading

Manure is full of vital nutrients (nitrogen, potassium, and phosphorous) required for soil fertility and plant growth. Simple reapplication of manure may also eliminate the need for expensive storage facilities. For safe application, manure should be applied away from natural drainage ways, a minimum of 100 ft away from a water source, and incorporated into the soil as soon as possible. Manure can be a beneficial resource when it is used as efficient fertilizer.

4.3 Composting

The addition of manure to other decaying organic matter to compost is another valuable and safe practice to manage animal waste. Composting reduces the volume of manure, kills parasites, reduces weed seeds, provides slow release fertilizer, reduces odor, and increases soil fertility. Compositing requires 2/3 oxygen, 50% moisture, 30:1 carbon to nitrogen ratio, and warm temperatures.

5. Alternative Watering System

Alternative watering systems (e.g. nose pumps or gravity flow systems) protect surface water by eliminating livestock's direct access to the stream. Providing an alternative watering source for livestock reduces soil erosion and sedimentation and improves surface water quality by reducing *E. coli* concentrations and nutrient loading. Alternative watering systems help to provide additional bank stabilization and assist in the preservation of riparian buffers through a reduction in compaction.

6. No-till/Reduced Till (Conservation Tillage)

6.1 Residue Management, No-till/Strip Till

This practice manages the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while growing crops planted in narrow slots or tilled, residue free strips previously untilled by full-width inversion implements. The purpose of this conservation practice is to reduce sheet and rill erosion thereby promoting improved water quality by reducing TSS and nutrient loading in the waterways. Additional benefits of this practice are to reduce wind erosion, to maintain or improve soil organic matter content and tilth, to conserve soil moisture, to manage snow, to increase plant available moisture or reduce plant damage from freezing or desiccation, and to provide food and escape cover for wildlife. This technique includes tillage and planting methods commonly referred to as no-till, zero till, slot plant, row till, direct seeding, or strip till.

Residue management is when loose residues are left on the field, and then uniformly distributed on the soil surface to minimize variability in planting depth, seed germination, and emergence of subsequently planted crops. When combines or similar machines are used for harvesting, they are equipped with spreaders capable of distributing residue over at least 80% of the working width. No-till or strip till may be practiced continuously throughout the crop sequence, or may be managed as part of a system which includes other tillage and planting methods such as mulch till (as follows). Production of adequate amounts of crop residues is necessary for the proper functioning of this conservation practice and can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacings.

Maintaining a continuous no-till system will maximize the improvement of soil organic matter content. Also, when no-till is practiced continuously, soil reconsolidation provides additional resistance to sheet and rill erosion. The effectiveness of stubble to trap snow or reduce plant damage from freezing or desiccation increases with stubble height. Variable height stubble patterns may be created to further increase snow storage.

6.2 Residue Management, Mulch till

Mulch tillage manages the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting. The purpose of this conservation practice is to reduce sheet and rill erosion, which leads to improved water quality. Additional benefits are the same as no-till practices. It applies to stubble mulching on summer-fallowed land, to tillage for annually planted crops, and to tillage for planting perennial crops. Mulch till may be practiced continuously throughout the crop sequence, or may be used as part of a residue management system that includes other tillage methods such as no-till. Like no-till, mulch till requires production of adequate amounts of crop residue to function properly.

7. Grassed Waterways

Grassed waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels. This BMP can reduce TSS concentrations of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality (impacting the aquatic habitat) due to its nutrient removal (nitrogen, phosphorus, herbicides and pesticides) and *E. coli* removal through plant uptake and absorption by soil. The waterways can also provide wildlife corridors and allows more land to be natural areas. Implementation of grassed waterways is part of the Conservation Reserve Program (CRP) program and assistance may be provided to eligible projects.

8. Buffers/Filter Strips

8.1 Buffer

Creating and maintaining buffers along stream and river channels and lakeshores increases open space and can reduce some of the water quality and habitat degradation effects associated with increased imperviousness and runoff in the Watershed. Buffers provide hydrologic, recreational, and aesthetic benefits as well as water quality functions, and wildlife habitat. TSS, phosphorus, and nitrogen are at least partly removed from water passing through a naturally vegetated buffer. *E. coli* concentrations are also reduced with buffers. The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width. Buffers need to be a minimum of 30 feet wide to be eligible for most USDA programs. Education is important in teaching farmers what options they have for funding. Several state and federal programs exist to provide incentives for maintaining riparian buffers. The Wetlands Reserve Program (WRP) makes funding available for the purchase and restoration of wetlands and riparian buffer connections between wetlands.

8.2 Filter Strip

A filter strip is an area of permanent herbaceous vegetation situated between environmentally sensitive areas and cropland, grazing land, or otherwise disturbed land. Filter strips reduce TSS, particulate organic matter, sediment adsorbed contaminants, and dissolved contaminant loadings in runoff to improve water quality. Filter strips also restore or maintain sheet flow in support of a riparian forest buffer, and restore, create, and enhance herbaceous habitat for wildlife and beneficial insects.

The filter strip flow length is determined based on the field slope percent and length, filter strip slope percent, erosion rate, amount and particle size distribution of TSS delivered to the filter strip, density and height of filter strip vegetation, and runoff volume associated with erosion producing events.

Filter strips should be permanently designated plantings to treat runoff and should not be part of the adjacent cropland's rotation. Overland flow entering the filter strip should be primarily sheet flow. If there is concentrated flow, it should be dispersed so that it creates sheet flow. Filter strips cannot be installed on unstable channel banks that are eroding due to undercutting of the toe bank. Permanent herbaceous vegetation should consist of a single species or a mixture of grasses, legumes and/or other forbs (an herbaceous plant other than a grass) adapted to the soil, climate, and farm chemicals used in adjacent cropland. Filter strips must be properly maintained so that they function properly.

Filter strips should be located to reduce runoff and increase infiltration and groundwater recharge throughout the Watershed. Filter strips should also be strategically placed to intercept contaminants, thereby enhancing the water quality in the Watershed. Filter strip sizes should be adjusted to accommodate planting, harvesting, and maintenance equipment. Filter strip widths greater than that needed to achieve a 30 minute flow-through time at ½-inch depth will not likely improve the effectiveness of the strip in addressing water quality concerns created by TSS, particulate organics, and sediment adsorbed contaminants. Like buffers; filter strips decrease TSS and nutrient loading, reduce *E. coli* concentrations, and increase open space. Education will help to teach farmers where these practices should be applied and sources of possible funding. Implementation of filter strips is part of the CRP program and assistance may be provided to eligible projects.

8.3 Contour Buffer Strip

Contour buffer strips are narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel, wider cropped strips. Crop strips are alternated with buffer strips down the hill slope. Normally a crop strip will occupy the area at the top of the hill. Contour buffer strips reduce sheet and rill erosion, reduce transport of sediment and other water-borne contaminants, and enhance wildlife habitat. This practice applies to cropland and is most suitable on uniform slopes ranging from 4 to 8 percent with slopes less than the Critical Slope Length (the length of slope above which contouring loses its effectiveness).

The buffer strips are generally of equal width, unless a varying width buffer strip is needed to keep either a cropped strip adjacent to it of uniform width or to maintain the strip boundary grades within NRCS criteria. Width of buffer strips at their narrowest point shall be no less than 15 feet for grasses or grass legume mixtures and no less than 30 feet when legumes are used alone. Contour filter strips help to reduce TSS and nutrient loading, reduce *E. coli* concentrations, and increase open space. Education will help to teach farmers where these practices should be applied and sources of possible funding.

9. Grade-Stabilization Structures

Grade-stabilization structures are permanent structures, which stabilize grades in natural or artificial channels by carrying runoff from one grade to another. These structures include vertical drop structures, chutes, pipe drop structures, and downdrains. They may be made of rock riprap, concrete, metal, wood, and/or heavy plastic.

Grade-stabilization structures are designed to prevent banks from slumping, reduce the velocity with which water runs off the land, and prevent erosion of a channel that results from excessive grade in the channel bed. Proper grade-stabilization, combined with adequately protected outlet structures, can reduce the likelihood that soil will be detached and transported to surface water decreasing TSS concentrations. Education programs should be conducted in order to educate farmers when to use grade-stabilization structures

10. Cover Crop

Cover crops can be legumes or grasses, including cereals, planted or volunteered vegetation established prior to or following a harvested crop primarily for seasonal soil protection and nutrient recovery. Cover crops protect soil from erosion decreasing TSS concentrations in the creek and recover/recycle phosphorus in the root zone. They are grown for one year or less.

Cover crops are established during the non-crop period, usually after the crop is harvested, but can be interseeded into a crop before harvest by aerial application or cultivation. Cover crops reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops. The soil tilth also benefits from the increase of organic material added to the surface. Growing vegetation promotes infiltration, and roots enhance percolation of water supplied to the soil. This reduces surface runoff. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field.

11. Wetland Restoration

Because agriculture and urbanization have destroyed or degraded many of the remaining wetlands in the Sugar Creek Watershed, wetland enhancement projects are necessary to improve the diversity and function of these degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benefits. Wetland restoration is the process of establishing a wetland on a site that is not currently a wetland, but once was prior to conversion. Restoring wetlands can address many of the concerns of the Sugar Creek Stakeholders. Wetlands have the ability to reduce *E. coli* concentrations, nutrient loading, TSS concentrations, and flood damage. Wetlands can be used to teach landowners about their importance with respect to plants and animals and also increases the amount of open space in the watershed.

Wetland functional values vary substantially from wetland to wetland; they receive special consideration because of the many roles they play. Because of the wetland protection laws currently in place, the greatest impact on wetlands from future development in the Sugar Creek Watershed will likely be a shift in the types of wetlands. Often in mitigation projects, various types of marshes, wet prairies, and other wetlands are filled and replaced elsewhere, usually with existing open water wetlands. This replacement may lead to a shift in the values served by the wetland communities due to a lack of diversity of wetland types. The wetland restorations that are proposed in the Sugar Creek Watershed should include a variety of different wetland types to increase the diversity of wetlands in the Watershed. The restoration of wetlands can decrease flood damage by providing new stormwater storage areas, will improve water quality by treating stormwater runoff, and will create new plant and wildlife habitat. In addition to these values, wetlands can be part of regional greenways or trail networks. They can be constructed with trails to allow the public to explore them more easily, and they can be used to educate the public through signs, organized tours, and other techniques. Wetland restorations are an exceptional way to meet multiple objectives within a single project.

12. Soil Infiltration Trench

Soil infiltration trenches are excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil. Phosphorus from agricultural areas is primarily from animal manure either directly washing into streams and rivers or washing off from farm fields. Soil infiltration trenches can be especially beneficial as concrete feed-lots, barns, confined livestock areas, CAFOs, and other agricultural areas can carry excess food and waste materials towards the adjacent stream through stormwater runoff. Installing soil infiltration trenches where runoff is concentrated will maximize the benefit of contaminant removal.

Infiltration trenches remove fine sediment and the pollutants associated with them. Soil infiltration trenches can be effective at reducing TSS concentrations and nutrient loading. Soluble pollutants can be effectively removed if detention time is maximized. The degree to which soluble pollutants are removed is dependent primarily on holding time, the degree of bacterial activity, and chemical bonding with the soil. The efficiency of the trench to remove pollutants can be increased by increasing the surface area of the trench bottom. Infiltration trenches can provide full control of peak discharges for small sites. They provide groundwater recharge and may augment base stream flow.

Examples of Implementing Urban Practices

Several examples of BMPs that assist in the reduction of sediment, *E. coli*, nutrients, and phosphorus in urban areas are discussed as follows.

1. Rain Barrel/Rain Garden

A rain barrel is a container that collects and stores rainwater from your rooftop (via your home's disconnected downspouts) for later use on your lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems.

Rain gardens are small-scale bioretention systems that be can be used as landscape features and small-scale stormwater management systems for single-family homes, townhouse units, and some small commercial development. These units not only provide a landscape feature for the site and reduce the need for irrigation, but can also be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event. In addition, these features can be designed to provide a significant improvement in the quality of the stormwater runoff. These units can also be integrated into the design of parking lots and other large paved areas, in which case they are referred to as bioretention areas.

2. Naturalized Wet-bottom Detention Basin

Naturalized wet-bottom detention basins are used to temporarily store runoff and release it at a reduced rate. Naturalized wet-bottom detention basins are better than traditional detention basins because they encourage water infiltration, and thereby recharge groundwater tables. Native wetland and prairie vegetation also help to improve water quality by trapping sediment and other pollutants found in runoff, and are aesthetically pleasing. Naturalized wet-bottom detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes. Naturalized wet-bottom detention basins can help to achieve most of the goals set by the Sugar Creek WMP including; reducing *E. coli* concentrations, nutrient loading, TSS concentrations, flood damage, and increasing open space.

3. Filtration Basin

Filtration basins provide pollutant removal (including TSS, nutrients, and *E. coli*) and reduce volume of stormwater released from the basin. These basins utilize sand filters to filter stormwater runoff through a sand layer within an underdrain system that conveys the treated runoff to a detention facility or to the ultimate point of discharge. The sand-bed filtration system consists of an inlet structure, sedimentation chamber, sand bed, underdrain piping, and liner to protect against infiltration.

4. Pervious Paving

Pervious pavement has the approximate strength characteristics of traditional pavement but allows rainfall and runoff to percolate through it. This decreases TSS concentrations and flood damage in the Watershed by slowing the water from entering the creek. The key to the design of these pavements is the elimination of most of the fine aggregate found in conventional paving materials. Pervious pavement options include porous asphalt and pervious concrete. Porous asphalt has coarse aggregate held together in the asphalt with sufficient interconnected voids to yield high permeability. Pervious concrete, in contrast, is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that also yields interconnected voids for the passage of air and water. Underlying the pervious pavement is a filter layer, a stone reservoir, and filter fabric. Stored runoff gradually drains out of the stone reservoir into the subsoil.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area.

5. Soil Infiltration Trench

Soil infiltration trenches are excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil.

Infiltration trenches remove fine sediment and the pollutants associated with them. Soil infiltration trenches can be effective at reducing TSS concentrations and nutrient loading. Soluble pollutants can be effectively removed if detention time is maximized. The degree to which soluble pollutants are removed is dependent primarily on holding time, the degree of bacterial activity, and chemical bonding with the soil. It is important to remember that if stormwater runoff contains high amounts of soluble contaminants, groundwater contamination can occur. If soluble contaminants are known to be present, either pretreatment or source elimination of the contaminants must be pursued. The efficiency of the trench to remove pollutants can be increased by increasing the surface area of the trench bottom. Infiltration trenches can provide full control of peak discharges for small sites. They provide groundwater recharge and may augment base stream flow. They are effective at replacing infiltration lost due to the addition of impervious areas, and may be used strictly as a means to maintain the hydrologic balance after stormwater runoff has been treated by other means.

6. Sand Filter

Sand filters are devices that filter stormwater runoff through a sand layer into an underdrain system that conveys the treated runoff to a detention facility or to the ultimate point of discharge. The sand-bed filtration system consists of an inlet structure, sedimentation chamber, sand bed, underdrain piping, and liner to protect against infiltration. In general, sand filters take up little space and can be used on highly developed sites and sites with steep slopes. They can be added to retrofit existing sites. This BMP is not recommended where high sediment loads are expected, unless pretreatment (e.g. for sedimentation) is provided, since fine sediments clog sand filters, or where the runoff is likely to contain high concentrations of toxic pollutants (e.g. heavy industrial sites).

7. Bioretention Practices

Bioretention practices (including bioinfiltration or biofiltration) are primarily used to filter runoff stored in shallow depressions by utilizing plant uptake and soil permeability. This practice utilizes combinations of flow regulation structures, a pretreatment grass channel or other filter strip, a sand bed, a pea gravel overflow treatment drain, a shallow ponding area, a surface organic mulch layer, a planting soil bed, plant material, a gravel underdrain system, and an overflow system to promote infiltration. Bioinfilitration systems such as swales are used to treat stormwater runoff from small sites such as driveways, parking lots, and roadways. They provide a place for stormwater to settle and infiltrate into the ground. Biofiltration swales are a relatively low cost means of treating stormwater runoff for small sites typifying much of the urban environment, such as parking, roadways, driveways, and similar impervious features. They provide areas for stormwater to slow down and pollutants to be filtered out. Careful attention to location and alignment of swales can lend a pleasing aesthetic quality to sites containing them. Bioretention is similar to a rain garden but applied to a larger, non-residential site.

In general, bioretention practices are highly applicable to residential uses in community open space or private lots. The bioretention system is very appropriate for treatment of parking lot runoff, roadways where sufficient space accommodates off-line implementation, and pervious areas such as golf courses. This BMP is not recommended for highly urbanized settings where impervious surfaces comprise 95% or more of the area due to high flow events and limited storage potential. This BMP can address most of the WMP goals including; reducing concentrations of *E. coli*, TSS, and nutrients. Bioretention practices can also decrease flooding by storing stormwater and increase open space.

8. Natural Stream Buffer

Natural stream buffers provide multiple benefits, including erosion control, removal of nutrients and sediment from runoff, minimization of runoff volume, and wildlife habitat. Seeding with native grasses, legumes (nitrogen fixing plants) and forbs (broad leaved plants, including wildflowers) is an inexpensive method to quickly cover a site. Native grasses and forbs are adapted to regional conditions of climate and disease and are relatively low maintenance. Attention to species selection can provide an added benefit of aesthetic quality to sites containing natural stream buffers.

Once established, native plants will reseed themselves, although they may require protection from exotic or invasive species. If left unmanaged trees and shrubs will usually establish in the buffer. If managed by mowing and/or burning, the native annuals and perennials will persist. Some species of native grasses, legumes, and forbs are relatively easy to grow. These species frequently dominate the mixtures used for roadside plantings. Other species may require more intensive management to promote establishment but will provide a more complete and natural mixture. Seed mixtures can be prepared that will be appropriate for wet, dry, or mesic sites and for a variety of sun exposure regimes.

Linking BMPs to Issues within the Sugar Creek Watershed

Water quality is significantly degraded in situations where livestock have access to waterways. Livestock destroy streambank habitat and increase erosion when accessing the stream. Waste excreted by livestock contains *E. coli* and nutrients which degrade water quality and can restrict recreational access due to health concerns. Implementing best management practices such as exclusion fencing, manure management plans, and alternative watering systems are most effective in improving water quality when used in conjunction.

Approximately 80% (68,789 acres) of the Sugar Creek Watershed is row crop production. Best management practices for row crop production include erosion control measures along with nutrient management. Implementing best management practices collectively is the most effective way to manage erosion and nutrient loading in areas of row crop production. Best management practices such as conservation tillage, creating a nutrient management plan, grassed waterways, filter strips, cover crops, and natural stream buffers are all practices that will enhance water quality throughout the watershed.

Hancock County is the third fastest growing county in the state and has seen a dramatic increase in population and urban development. As urban development increases within the watershed best management practices can be implemented to protect natural resources and their recreational uses. Best management practices such as pervious paving, wetland restoration, naturalized wet-bottom detention basins, filtration basins, and bioretention practices can all be used in combination to maximize the effectiveness of BMP pollutant removal.

Issues within the Sugar Creek Watershed were discussed throughout the watershed management planning process. Through evaluations of several groups and agencies, pathogens (*E. coli*), sediment, nutrients and flooding have been indicated to be problematic in the Watershed. Best management practice implemented throughout the watershed should address these parameters of concern. Table 37 demonstrates the relationship between BMP selection and addressing the parameters of concern within the Sugar Creek Watershed.

Table 37. Best Management Practices and their relationship to reducing nutrients, E. coli, sediment, and flooding within the Sugar Creek Watershed.				
Best Management Practice	**Nutrients**	***E. coli***	**Sediment**	**Flooding**
Exclusionary Fencing	Preventing livestock from directly excreting waste containing nutrients into stream.	Preventing livestock from directly excreting waste containing *E. coli* into stream.	Livestock buffered from streambank do not contribute to sediment load from streambank degradation	NA
Rotational grazing	Rotating grazing pressure will aid in removal of nutrients by allowing vegetation to recover for more effective filtering before nutrients reach the creek.	Rotating grazing pressure will aid in removal of *E. coli* by allowing vegetation to recover for more effective filtering before nutrients reach the creek.	This practice has the ability to reduce erosion and total suspended solids by not grazing areas bare exposing soil to wind and water erosion.	NA
Nutrient Management System	Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients which maximizes productivity and decreases the transport of excess nutrients to surface water.	NA	This practice will decrease the transport of sediment to surface water caused by improper nutrient application.	NA
Manure Management System	Proper management of animal waste prevents nutrients within the waste to enter streams.	Properly and safely storing animal waste reduces the input of fecal coliforms such as *E. coli*.	NA	NA
Alternative Watering System	Alternative water sources deter livestock from entering the stream for water where they may excrete waste containing nutrients into the stream.	This practice provides an alternative water source for livestock which may excrete waste containing *E. coli* into the stream while accessing the resource for water.	An alternative watering source for livestock reduces soil erosion and sedimentation by deterring livestock from accessing the stream for water which degrades streambank quality and compacts soil.	NA
No-till/Reduced Till (Conservation Tillage)	This conservation practice reduces nutrient loading in waterways by reducing soil erosion which carries nutrients.	NA	This conservation practice reduces sheet and rill erosion as well as wind erosion thereby promoting improved water quality by reducing total suspended solids.	NA
Grassed Waterways	Grassed waterways are efficient for nutrient removal (nitrogen, phosphorus, herbicides and pesticides) as this practice uses vegetation to slow water flow and allow plant uptake and absorption by the soil.	*E. coli* removal is achieved by grassed waterways as *E. coli* is removed through plant uptake and soil absorption.	This practice prevents rill and gully formations by using vegetative cover to slow water flow which minimizes channel surface erosion.	Grassed waterways can safely transport large water flows downslope which aids in conveyance.
Buffers/Filter Strips	Nutrients are removed in part from water passing through a naturally vegetated buffer. The amount of nutrients removed involves many factors such as buffer width, vegetation type, slope and adjacent land use.	*E. coli* concentrations are also reduced with buffers as native vegetation filters runoff before entering the waterway.	This practice reduces total suspended solids, particulate organic matter, by filtering sediments as sheet flow moves over native vegetation.	NA
Cover Crop	Cover crops reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached.	The roots of a cover crop make soil surfaces more permeable so water, nutrients, and *E. coli* (found in manure) are able to infiltrate and be taken up by the cover crop. This uptake reduces the amount of *E. coli* entering the stream through runoff.	Cover crops protect soil from erosion decreasing total suspended solids that enter the stream.	NA

Table 37 (Continued). Best Management Practices and their relationship to reducing nutrients, E. coli, sediment, and flooding within the Sugar Creek Watershed.				
Best Management Practice	**Nutrients**	***E. coli***	**Sediment**	**Flooding**
Rain Barrel/Rain Gardens	Rain gardens can improve the water quality of stormwater runoff as rainwater is filtered through vegetation within the rain garden.	NA	NA	Rain gardens that are integrated into stormwater management systems can maximize depression storage, pretreatment of stormwater runoff, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event.
Pervious Paving Options	Nutrients that accumulate on pavement surfaces are able to infiltrate to subsoil in pervious paving systems during rain events instead of being washed directly in waterways as in traditional paving systems.	Pervious paving systems allow *E. coli* (found in pet waste) to infiltrate to subsoil during rain events instead of being washed into waterways as in traditional paving systems.	Pervious pavement allows rainfall and runoff to infiltrate which decreases the amount of total suspended solids entering the creek.	Pervious pavement allows rainfall and runoff to percolate through the surface which decreases flood damage in the Watershed by slowing the water from entering the creek.
Soil Infiltration Trench	Infiltration trenches remove fine sediment and the pollutants associated with them. Soil infiltration trenches are effective at reducing nutrient loading.	*E. coli* found in waste can be removed as runoff is filtered through infiltration trenches.	Infiltration trenches remove fine sediment and are effective at reducing total suspended solids as runoff is temporarily stored.	Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil which can relieve waterways during peak flow.
Natural Stream Buffer	Natural stream buffers provide removal of nutrients through filtering runoff.	Natural stream buffers provide removal of *E. coli* that may be present in runoff through utilizing native vegetation filtering properties.	Natural stream buffers provide multiple benefits, including erosion control and removal of sediment from runoff.	Natural stream buffers provide minimization of runoff volume which reduces flooding.
Grade-Stabilization Structures	NA	NA	Grade-stabilization structures prevent banks from eroding and reduce the velocity with which water runs off the land.	NA
Wetland Restoration	Wetlands have the ability to reduce nutrient loading as nutrients entering the wetland are filtered by the plant community with the wetland.	Wetlands have the ability to reduce *E. coli* concentrations as they act as a sponge and filter stormwater runoff.	Wetlands have the ability to reduce total suspended solids, such as sediment, by filtering and slowing the water flow.	Wetlands have the ability to reduce flood damage by acting as a sponge and creating additional storage during peak flows. Wetlands also increase the amount of open space and pervious surfaces throughout the watershed.
Naturalized Wet-bottom Detention Basin	Naturalized wet-bottom detention basins encourage water infiltration; basins with native wetland and prairie vegetation also trap nutrients found in runoff.	Naturalized wet-bottom detention basins encourage water infiltration, recharge groundwater tables, and trap *E. coli* found in runoff.	Naturalized wet-bottom detention basins encourage water infiltration; Native wetland and prairie vegetation also help trap sediments entering the basin through runoff.	Naturalized wet-bottom detention basins provide additional storage which can reduce flooding.
Filtration Basin	Filtration basins provide nutrient removal by utilizing sand-bed filtration and underdrain system that conveys stormwater runoff.	Filtration basins provide pollutant removal (including *E. coli*) by utilizing sand filters.	Filtration basins provide sediment removal by utilizing sand-bed filtration.	Filtration basins reduce volume of stormwater released from the basin and reduce flooding.
Sand Filter	Sand filters provide nutrient removal by utilizing sand-bed filtration and underdrain system that conveys stormwater runoff.	Sand filters provide pollutant removal (including *E. coli*) by utilizing underdrain systems.	Sand filters provide sediment removal by utilizing sand-bed filtration and underdrain system that conveys stormwater runoff.	NA
Bioretention Practices	Bioretention practices provide nutrient removal by utilizing plant uptake and soil permeability.	Bioretention practices are used to remove *E. coli* by utilizing plant uptake and soil permeability.	Bioretention practices are primarily used to filter runoff and reduce sediment loading through soil permeability and plant uptake.	Bioretention practices can decrease flooding by storing stormwater and increasing open space.

Preventative Measures: Natural Resources Protection

Protecting Open Space and Natural Areas

Several techniques can be used for protecting natural areas and open space in both public and private ownership. The first step in the process is to identify and prioritize properties for protection. The highest priority natural areas should be permanently protected by the ownership or under the management of public agencies or private organizations dedicated to land conservation. Other open space can be protected using conservation design development techniques, and is more likely to be managed by homeowner associations.

Protected Ownership

There are several options for land transfer ranging from donation to fee simple land purchase. Donations can be solicited and encouraged through incentive programs. Unfortunately, while preferred by money-strapped conservation programs, land donations are often not adequate to protect high priority sites. A second option is outright purchase (or fee simple land purchase). Outright purchase is frequently the least complicated and most permanent protection technique, but is also the most costly. A conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Conservation Design Developments

The goal of conservation design development is to protect open space and natural resources for people and wildlife, while at the same time allowing development to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space. They are density neutral, allowing the same density as in conventional developments, but that density is realized on smaller areas of land by clustering buildings and infrastructure. In addition to clustering, conservation design developments incorporate natural riparian buffers and setbacks for streams, wetlands, other waterbodies, and adjacent agricultural land (Dreher and Price 1997; Terrene Institute 1994; Schueler 1995; Arendt 1996).

The first and most important step in designing a conservation development is to identify the most essential lands to preserve in conservation areas. Natural features including streams, wetlands, lakes, steep slopes, mature woodlands, native prairie, and meadow (as well as significant historical and cultural features) are included in conservation areas. Clustering is a method for preserving these areas. Clustered developments allow for increased densities on less sensitive portions of a site, while preserving the remainder of the site in open space for conservation and recreational uses (such as trails, soccer or ball fields).

Clustering can be achieved in a planned unit development (PUD) or planned residential development (PRD). PUDs contain a mix of zoning classifications that may include commercial, residential, and light industrial uses, all of which are blended together. Well-designed PUDs usually locate residences and offices within walking distance of each other to reduce traffic. Planned residential developments (PRDs) apply similar concepts to residential developments.

Threatened and Endangered (T&E) Species

Threatened and endangered species are those plant and animal species whose survival is in peril. Both the federal government and the state of Indiana maintain lists of species that meet threatened or endangered criteria within their respective jurisdictions. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana.

Considerations in protecting endangered species include:

- Making sure there is sufficient habitat available - food, water, and "living sites". For animals, this means areas for making nests and dens and evading predators. For plants, it refers to availability of preferred substrate and other desirable growing conditions.
- Providing corridors for those species that need to move between sites.
- Protecting species from impacts due to urbanization.

Several techniques can be used to protect T&E species. One technique is to acquire sites where T&E species occur. Purchase and protection of the site where the species is located (with adequate surrounding buffer) may be sufficient to protect that population. In some instances it is not feasible or possible to buy the needed land. Where the site and buffer area is not available for purchase, where an animal's range is too large of an area (or migrates between sites), or where changes in hydrology or pollution from outside the site affect the species, other techniques must be used to protect the T&E species.

Developing a resource conservation or management plan for the species and habitat of concern is the next step. Resource plans consider the need for buffer areas and habitat corridors, and consider watershed impacts from hydrology changes or pollutant loadings. The conservation plan will include recommendations for management specific to the species and its habitat, whether located on private or public lands. The conservation plan will guide both the property owner and the local unit of government that plans and permits adjacent land uses and how to manage habitat to sustain the species.

Greenways and Trails

Greenways can provide a large number of functions and benefits to nature and the public. For plants and animals, greenways provide habitat, a buffer from development, and a corridor for migration. Greenways located along streams include riparian buffers that protect water quality by filtering sediments and nutrients from surface runoff and stabilizing streambanks. By buffering the stream from adjacent developed land use, riparian greenways offset some of the impacts associated with increased impervious surface in a watershed. Maintaining a good riparian buffer can mitigate the negative impacts of approximately 5% additional impervious surface in the Watershed (Schueler 1995).

Greenways also provide long, linear corridors with options for recreational trails. Trails along the river provide watershed stakeholders with an opportunity to exercise and enjoy the outdoors. Trails allow users to see and access the river, thereby connecting people to their river and the overall watershed. Trails can also be used to connect natural areas, cultural and historic sites and communities, and serve as a safe transportation corridor between work, school, and shopping destinations.

Techniques for establishing greenways and trails involve the development of a plan that proposes general locations for greenways and trails. In the case of trails, the plan also identifies who the users will be and provides direction on trail standards. Plans can be developed at the community and/or county level, as well as regionally, statewide, and in a few cases, at the national level. Public and stakeholder input are crucial for developing successful greenway and trail plans.

Several techniques can be used for establishing greenways and trails. Greenways can remain in private ownership, they can be purchased, or easements can be acquired for public use. If the lands remain in private ownership, greenway standards can be developed, adopted, and implemented at the local level through land use planning and regulation. Development rights for the greenway can be purchased from private landowners where regulations are unpopular or not feasible.

If the greenways will include trails for public use, the land for trails is usually purchased and held by a public agency such as a forest preserve district or local park system. In some cases, easements will be purchased rather than purchasing the land itself. Usually longer trail systems are built in segments, and completing connections between communities depends heavily on the level of public interest in those communities.

In new developing areas, the local planning authority can require trails. Either the developer or the community can build the trails. In some cases, the developer will voluntarily plan and build a trail connection through the development and use this as a marketing tool to future homebuyers. In other cases, the local planning authority may require the developer to donate an easement for the trail. To install trails through already developed areas, land can be purchased by a community agency with a combination of local, state, and federal funds. Impediments to land purchase can significantly slow up trail connections in already established areas.

Wetlands

Wetlands provide a multitude of benefits and functions. Wetlands improve water quality by removing suspended sediment and dissolved nutrients from runoff. They control the rate of runoff discharged from the Watershed and reduce flooding by storing rainfall during storm events. Wetlands also provide habitat for plants and animals including many of those that are threatened and endangered.

- ***No-Net-Loss/Wetland Mitigation***

Since the 1970s, wetlands have been regulated through a permit program administered by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act. In the 1990s, the Federal government adopted a policy of no-net-loss of wetlands to stem the tide of continued wetland losses. The no-net-loss policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations can be replaced.

- ***Wetland/Stream Buffers***

Wetland buffers protect a wetland from water quality and hydrologic impacts resulting from adjacent land uses. In addition, if vegetated and managed properly, buffers can provide considerable wildlife habitat. Buffers should be comprised of native, unmowed vegetation that is periodically managed for non-native and invasive species.

Remedial Measures: Restore/Enhance Natural Resources

Septic Tank Maintenance and Repair

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment in the unincorporated parts of the Sugar Creek Watershed. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-$15,000 per unit.

Property owners are responsible for their septic systems. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources, provide conditions favorable to insect vectors such as flies and mosquitoes, and contribute significant amounts of nitrogen and phosphorus to the Watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up or will not drain, the system is failing.

The proper feeding and maintenance of the septic system is crucial to its operation.

- Have the tank pumped every 3-5 years. An experienced septic maintenance operator will check the depth of the sludge in the tank and make pumping schedule recommendations. Depending on an individual's wastewater usage, pumping may be necessary more or less frequently. Sludge, if not pumped out will eventually spill out in to the absorption field, clogging it and causing failure.
- How long the absorption field lasts is basically a function of the volume and strength of water an individual puts into the system. Individuals should make a considerable effort to conserve water at every step. Hydraulic overloading is a main cause of early system failure. Install low flow shower heads, toilets and washing machines. Don't use a garbage disposal (or use it rarely). Composting your garbage is recommended instead.
- Do not use system additives (chemical or biological)
- Do not construct pools or other structures over any part of your system
- Do not flush anything that won't quickly decompose
- Do not plant trees or bushes in the area of your tank or absorption field
- Do not run clear water drains (i.e. foundation / basement drains) into your septic system
- Do not discharge water softener to the septic system. Sodium can corrode concrete and may interferer with the proper functioning of your septic tank. If the softener must discharge to the septic system, set it to cycle less frequently. This will minimize the amount of sodium going to the septic.
- The use of antibacterial products (including soaps) will negatively affect the functioning of the septic tank
- Install a septic tank effluent filter on the septic tank's outlet. These keep suspended materials from getting out into the absorption field, thus increasing the life of the system. These filters are inexpensive and easy to maintain.

Usage is an important factor, especially for smaller lots common in lake areas. In general, homeowners should try to conserve water and avoid surge loading (i.e., many consecutive loads of laundry). Homeowners should never dispose of chemicals; food products, such as those produced by trash disposals; or materials that are not readily degradable, such as condoms and cigarette butts through a septic system. It is especially important that clearwater discharges from sumps or water softeners not be directed into the septic system. Routine use of most household chemicals should not harm the system.

To protect the seepage system, homeowners should avoid traffic and excessive cutting or filling over the system. Grass cover should be maintained for insulation and warm season evapotranspiration (the total moisture that leaves an area by evaporation from soil, snow, and water surfaces plus that transpired by plants). Stormwater flows overland or from sumps and gutters should not be discharged across the seepage areas.

Stream Restoration

Stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. For urban stream reaches, restoration to natural conditions may not be possible or feasible. For instance, physical constraints due to adjacent development may limit the ability to re-meander a stream. In addition, the natural stream conditions may not be able to accommodate the increased volume of flow from the developed Watershed.

Even in cases where restoring the stream to its natural condition is not possible, the stream can still be naturalized and improved by reestablishing riparian buffers, performing stream channel maintenance, stabilizing streambanks using bioengineering techniques, and, where appropriate, by removing manmade dams and installing pool/riffle complexes. Stream restoration projects may be one component of floodplain restoration projects, and can be supplemented with trails and interpretive signs, providing recreational and educational benefits to the community.

Pool/Riffle Complexes

Establishing pool/riffle complexes in the streambed is another method for restoring stream conditions. Pools and riffles naturally occur in streambeds in a sequence that follows the meander of the stream. However, pool/riffle sequences are usually lost when streams are channelized.

Riffle restoration is usually done with rock weirs placed in sequences at spacing intervals determined by the bankfull width of the stream. The cobble and boulder weirs are spaced so a distance of approximately six bankfull widths separates them. Pools develop between the riffles. The pool/riffle sequences benefit fish and macroinvertebrates by aerating the water during low flow conditions and by providing more diverse substrate and deeper water for habitat.

The placement of the stone for the riffles can also reduce streambank erosion immediately downstream as stream flow is funneled through the center of the stream channel and away from the banks. Pool/riffle complexes are often installed in conjunction with the other streambank stabilization techniques described previously for even better stream restoration results (Illinois State Water Survey 1998).

Incentives and Cost-Share Opportunities

There are a number of incentive programs to implement BMP projects. Fund sources for wetland protection and restoration, as well as technical assistance, are available from programs at the local, regional, state, and federal levels of government including USEPA Section 319 grants.

U.S. Army Corps of Engineers (USACE) Continuing Authorities Program

At the Federal level, the USACE Continuing Authorities Program (CAP) from Section 206 of the 1996 Water Resources Development Act targets wetland restoration. This section, also known as the "Aquatic Ecosystem Restoration" program gives the USACE the authority to carry out aquatic ecosystem restoration and protection if the projects will improve the quality of the environment, are in the public interest, and are cost effective. The objective of section 206 is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded and more natural condition. The local sponsors of aquatic ecosystem restoration projects are required to contribute 35% towards the total project cost.

U.S Environmental Protection Agency (USEPA) Section 205(j) Grants

Section 205 of the Clean Water Act provides funding for water quality management planning, and are used to determine the nature, extent and causes of point and nonpoint source pollution problems. An in-kind or cash match is not required. Municipal governments, county governments, regional planning commissions, and other public organizations are eligible to participate in this program.

U.S Environmental Protection Agency (USEPA) Section 319 Grants

Section 319 of the Clean Water Act provides funding for projects that work to reduce nonpoint source water pollution. IDEM administers funds from the Section 319 program which are used to create watershed management plans, demonstrate new technology, provide education and outreach on pollution prevention, conduct assessments, develop and implement Total Maximum Daily Loads (TMDLs), and provide technical assistance. Organizations that are eligible for funding include nonprofit organizations, universities, and local, State or Federal government agencies. An in-kind or cash match of the total project cost must be provided.

Lake and River Enhancement (LARE) Program

LARE grants are available on a competitive basis for several actions that can address the ecology and management of public lakes and their watersheds. All grants require a local cost share. The goal of the Division of Fish and Wildlife's Lake and River Enhancement Section is to protect and enhance aquatic habitat for fish and wildlife, to insure the continued viability of Indiana's publicly accessible lakes and streams for multiple uses, including recreational opportunities. This is accomplished through measures that reduce non-point sediment and nutrient pollution of surface waters to a level that meets or surpasses state water quality standards. Funding for the LARE program is provided by an annual fee charged to boat owners. LARE grants are available for preliminary lake studies, engineering feasibility studies of pollution control measures, design engineering of control measures, and performance appraisals of a constructed pollution measure. The projects listed above are considered "traditional" projects and the deadline to submit applications is January 31st. Approved projects are awarded grant money in the month of July. Additionally, LARE sets aside one-third of its annual funds for sediment removal or exotic species control.

Agricultural Incentives and Cost-Share Opportunities

There are several federally-funded programs for soil and water conservation in agricultural watersheds, including the Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), and the Wetlands Reserve Program. These programs assist in managing water quality in the Sugar Creek Watershed.

U.S. Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS) – Farm Service Agency (FSA) Programs

The 2008 Farm Bill Conservation Title invests in conservation programs that preserve natural resources. The bill increases total spending on conservation programs by 7.9 billion dollars. The USDA-NRCS has four incentive programs that may apply in the Sugar Creek Watershed: the Conservation Reserve Program (CRP), the Wetland Reserve Program (WRP), the Environmental Quality Incentives Program (EQIP), and the Wildlife Habitat Incentive Program (WHIP).

The CRP is a voluntary program encouraging landowners for long-term conservation of soils, water, and wildlife resources. CRP is the US Department of Agriculture's single largest environmental improvement program and is administered through the Farm Service Agency (FSA) with 10 to 15 year contracts. The goal of the CRP program (and CREP - Conservation Reserve Enhancement Program) is to give incentives to landowners who take frequently flooded and environmentally sensitive land out of crop production and plant specific types of vegetation. Participants earn annual rental payments and sign-up incentives. This program offers up to 90% cost share. Rental payments are boosted by 20% for projects such as installation of riparian buffers and filter strips. Windbreaks, contour buffer strips, and shallow water areas are additional funded practices. The WHIP program is available for private landowners to make improvements for wildlife on their property. This program offers up to 75% cost share. This grant program is competitive and funding depends on the project's ranking compared to others in the state.

EQIP is accommodating to grass-roots conservation and is another voluntary USDA conservation program for farmers faced with threats to soil, water, and related natural resources. Typically EQIP monies will fund 75% of land improvements and installation of conservation practices such as grade stabilization structures, grassed waterways, and filter strips adjacent to water resources (including wetlands). The goal of WRP is to restore and protect degraded wetlands such as farmed wetlands. WRP provides technical and financial assistance to eligible landowners to restore, enhance and protect wetlands. At least 70% of each project area will be restored to natural site conditions to the extent practicable. WRP has three options available: permanent easements, 30-year easements and restoration agreements. The NRCS will reimburse the landowners for easements on the property plus a portion of the restoration costs based on the type of easement agreed to by the landowner. EQIP and WRP are only applicable to agricultural lands.

Indiana Farm Service Agency (FSA) supports farmers through a variety of Credit and Commodity Programs designed to stabilize and enhance rural landscape. The FSA administers and manages farm commodity, credit, disaster and loan programs, and conservation as laid out by Congress through a network of federal, state and county offices. Programs are designed to improve economic stability of the agricultural industry and to help farmers adjust production to meet demand. Economically, the desired result of these programs is a steady price range for agricultural commodities for both farmers and consumers.

SECTION 7: CALCULATING LOAD REDUCTIONS

Load reduction calculations were estimated for nitrogen, phosphorus and Total Suspended Solids (TSS) based on the potential BMPs that can be implemented within the Sugar Creek Watershed. Nitrogen and phosphorus compose the nutrient loading portion of this plans analysis and TSS loading composes the sediment loading estimates. The four critical areas were identified by the Steering Committee as having existing nitrogen, phosphorus and TSS loading problems based on nutrient and sediment issues. Total loads of nitrogen, phosphorus and TSS were modeled for each critical area using L-THIA. Pollution load reductions were estimated for nitrogen, phosphorus and TSS. The L-THIA model estimates the runoff volume and nonpoint source pollutant loadings.

Resulting loads were established for each critical area in units of pounds for nutrients and tons for sediment. For each critical area, the total load per year and the total load per acre per year are provided (Exhibits 39 through 42). Table 38 shows current loads and target loads for each of the critical areas. Based on the results of the pollution load modeling of existing conditions, calculations were then made to project what load per year of total nitrogen, total phosphorus and TSS would exist in the year 2030 if all of the target concentration goals were achieved. A linear transgression was used to denote what loading targets would be needed to achieve five and ten year goals based on the Steering Committee's approach for implementing pollutant load reductions in a consistently linear fashion over time.

Tables 39 through 41 portray the pollutant load reductions and BMP costs to achieve the reductions for each critical area over time. The reductions were calculated by applying all of the 20 BMPs selected by the Steering Committee to three primary landcover types (urban, pastureland, and cropland) in proportions appropriate to the corresponding proportions of landcover in each critical area. An average BMP reduction value was derived from eight BMPs for urban areas and from twelve BMPs for agricultural areas. Agricultural areas were derived by combining both cropland and pasture land. Drainage areas were assumed for necessary BMPs, as site specific values could not be measured. Cost estimates of BMPs needed to be implemented within each of the critical areas in order to accomplish the five, ten, and twenty year goals were determined using the lowest cost BMPs for each landcover; $400/acre for urban, $20/acre for pasture, and $10/acre for cropland. The costs and reductions were also calculated assuming that many of the applied BMPs benefit an upland drainage area. Cost estimates are valued in current 2009 pricing, and do not have a multiplier to reflect inflation over time. This decision was made so that the costs provided by this plan can be interpreted accurately in the future without having to calculate off of inaccurate inflation rate projections.

Margin of Safety (MOS) corrections were applied to values of phosphorus and TSS, so that practical cost estimates to accomplish these goals could be forecast. There was no MOS applied to the modeling values of nitrogen loading estimates.

Table 38. Current and Target Loads for Each Critical Area								
Critical Area	Name	Acreage	Current Nitrogen Load lbs/year	Target Nitrogen Load lbs/year	Current Phosphorus Load lbs/year	Target Phosphorus Load lbs/year	Current TSS Load tons/year	Target TSS Load tons/year
1	Sugar Creek – Pee Dee Ditch	13,257	86,218	64,664	3,379	2,703	1,393	1,045
2	Sugar Creek – Marsh & Trees Ditch	15,541	101,250	75,938	3,970	3,176	1,638	1,228
3	Sugar Creek – Barrett Ditch	14,091	86,718	65,038	3,391	2,713	1,396	1,047
4	Sugar Creek – Boyd and Leary Weber Ditch	21,571	123,884	92,913	4,827	3,862	1,987	1,490

Table 39. Five Year Loading Objectives to be Achieved by 2015

		Nitrogen							Phosphorus							Total Suspended Sediment						
		Total Nitrogen Load	Reduction to Meet Objective*	BMPs Required to meet Nitrogen Goals (acres)					Total Phosphorus Load	Reduction to Meet Objective*	BMPs Required to meet Phosphorus Goals (acres)					TSS Load	Reduction to Meet Objective	BMPs Required to meet TSS Goals (acres)				
Critical Area	Acreage	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	tons/year	tons/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost
1	13,257	86,218	16,166	104	1,629	39	1,772	$58,770	3,379	676	25	431	9	465	$14,298	1,393	261	132	2,062	50	2,244	$74,415
2	15,541	101,250	18,985	123	1,913	46	2,081	$69,045	3,970	794	29	497	11	537	$16,685	1,638	307	155	2,417	59	2,630	$87,238
3	14,091	86,718	16,260	105	1,638	40	1,782	$59,070	3,391	678	26	455	10	491	$15,148	1,396	262	140	2,191	53	2,385	$79,073
4	21,571	123,884	23,228	137	2,088	61	2,285	$76,695	4,827	966	36	1,405	23	1,464	$28,805	1,987	373	176	2,631	113	2,919	$99,055
							7,920	$263,580						2,957	$74,936						10,178	$339,781

Table 40. Ten Year Loading Objectives to be Achieved by 2020

		Nitrogen							Phosphorus							Total Suspended Sediment						
		Total Nitrogen Load	Reduction to Meet Objective*	BMPs Required to meet Nitrogen Goals (acres)					Total Phosphorus Load	Reduction to Meet Objective*	BMPs Required to meet Phosphorus Goals (acres)					TSS Load	Reduction to Meet Objective	BMPs Required to meet TSS Goals (acres)				
Critical Area	Acreage	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	tons/year	tons/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost
1	13,257	86,218	32,332	209	3,257	79	3,544	$117,540	3,379	1,352	49	863	19	930	$28,595	1,393	523	264	4,123	100	4,487	$148,830
2	15,541	101,250	37,969	245	3,825	92	4,162	$138,090	3,970	1,588	58	994	22	1,073	$33,370	1,638	614	310	4,834	117	5,260	$174,475
3	14,091	86,718	32,519	210	3,276	79	3,565	$118,140	3,391	1,357	52	911	20	982	$30,295	1,396	524	281	4,383	106	4,769	$158,145
4	21,571	123,884	46,457	273	4,176	122	4,571	$153,390	4,827	1,931	72	2,810	46	2,927	$57,610	1,987	745	353	5,261	225	5,839	$198,110
							15,842	$527,160						5,912	$149,870						20,355	$679,560

Table 41. Twenty Year Objectives to be Achieved by 2030

		Nitrogen							Phosphorus							Total Suspended Sediment						
		Total Nitrogen Load	Reduction to Meet Objective*	BMPs Required to meet Nitrogen Goals (acres)					Total Phosphorus Load	Reduction to Meet Objective*	BMPs Required to meet Phosphorus Goals (acres)					TSS Load	Reduction to Meet Objective	BMPs Required to meet TSS Goals (acres)				
Critical Area	Acreage	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	lbs/year	lbs/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost	tons/year	tons/year	Urban	Cropland	Pasture	Total BMP Acres	Total Cost
1	13,257	86,218	64,664	417	6,514	157	7,088	$235,080	3,379	2,703	98	1,725	37	1,860	$57,190	1,393	1,045	528	8,246	200	8,974	$297,660
2	15,541	101,250	75,938	490	7,650	184	8,324	$276,180	3,970	3,176	115	1,988	43	2,146	$66,740	1,638	1,228	619	9,667	234	10,520	$348,950
3	14,091	86,718	65,038	419	6,552	158	7,129	$236,280	3,391	2,713	104	1,821	39	1,964	$60,590	1,396	1,047	561	8,765	212	9,538	$316,290
4	21,571	123,884	92,913	546	8,352	243	9,141	$306,780	4,827	3,862	143	5,620	91	5,854	$115,220	1,987	1,490	705	10,522	450	11,677	$396,220
							31,682	$1,054,320						11,824	$299,740						40,709	$1,359,120

* Margin of Safety (MOS) was applied in calculating these values.

SECTION 8: MONITORING EFFECTIVENESS

This framework of indicators for success functions as the monitoring plan. A monitoring plan is needed to track the indicators and evaluate the effectiveness of the implementation efforts over time. Indicators of success established by the Sugar Creek Steering Committee are listed for each of the seven goals. Tables 42a through 42g provide the estimate of financial and technical assistance needed to implement all of the watershed management plan objectives by goal, these tables include costs associated with administrative expenses and education/outreach efforts.

Goal #1: Sustain the Sugar Creek Watershed Stakeholder Group.

Indicators of Success:

- Having quarterly Steering Committee Meetings,
- Completing grant applications and receiving funding,
- Implementing watershed improvement projects,
- Having active subcommittees.

Goal #2: Reduce *E. coli* concentrations to meet state standard of 235 CFU/100 ml in the Sugar Creek Watershed by 2030.

Indicators of Success:

- Number of Agricultural BMPs installed, e.g. exclusionary fencing, alternative water supplies, implementation of manure management practices,
- Number of Urban BMPs installed, e.g. increasing infiltration and decreasing stormwater runoff washing pet waste into surface water bodies,

Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030.

Indicators of Success:

- Number of Agricultural BMPs installed, participation in CRP, both programs include filter strips and grassed waterways,
- Number of independent participants using cover crops, grid mapping, variable rate technology, soil testing, and low application rates of fertilizers,
- Number of Urban BMPs installed,
- Number of independent participants using rain gardens, rain barrels, no phosphorus fertilizer,
- Nitrogen model demonstrating Load Reduction,
- Phosphorus model demonstrating Load Reduction

Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030.

Indicator of Success:

- Number of Agricultural BMPs installed, participation in CRP, both programs include filter strips, grassed waterways and field borders,
- Number of independent participants using cover crops and grid mapping,
- Number of Urban BMPs installed,
- Number of construction sites using proper erosion control procedures,
- Total Suspended Solids model demonstrating Load Reduction.

Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030.

Indicator of Success:

- Number of new development sites which have incorporated appropriate volume of stormwater retention and/or detention,
- Increase acreage of new floodplain storage and develop new wetland areas,
- Prevent further development within the floodplain,

Goal # 6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed.

Indicator of Success:

- Number of events including: workshops, field days, educational display booth events, river clean-up days,
- Number of people involved categories includes: steering committee member participation, general public attendance, number of volunteers at clean up events, number of river watch participants in the watershed,

Goal #7: Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030.

Indicator of Success:

- Number of acres dedicated to open space and greenways,
- Number of acres for the preservation of wildlife habitat and protected areas, within the Sugar Creek Watershed,

Table 42a Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan: **Goal #1:** Sustain the Sugar Creek Watershed Stakeholder Group. Column specific costs are shown as annual estimates. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.									
Objective	**Administrative Costs**	**Personnel Costs Fulltime Watershed Coordinator**	**Travel**	**Equipment**	**Supplies**	**Contractual**	**Cost-Share**	**Total Cost for 5 years**	**Total Cost for 20 years**
Meet as a Committee on a quarterly basis	$158	$2,880	n/a	n/a	n/a	n/a	n/a	$16,630	$66,520
Increase involvement and participation with the planning process from Stakeholders within the Watershed	$158	$2,880	n/a	n/a	n/a	n/a	n/a	$16,630	$66,520
Pursue and implement watershed improvement projects	$812	$12,500	$625	$1,250	$625	n/a	n/a	$85,310	$341,240
Sustaining active subcommittees	$158	$2,880	n/a	n/a	n/a	n/a	n/a	$16,630	$66,520

Table 42b Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan: **Goal #2:** Reduce *E. coli* concentrations to meet state standards of 235 CFU/100 ml in the Sugar Creek Watershed by 2030. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.									
Objective	**Administrative Costs**	**Personnel Costs Fulltime Watershed Coordinator**	**Travel**	**Equipment**	**Supplies**	**Contractual**	**Cost-Share**	**Total Cost for 5 years**	**Total Cost for 20 years**
Reduce the amount of *E. coli* runoff from agricultural lands through the encouragement of exclusionary fencing installation, the promotion of alternative water supplies, and the education and implementation of manure management practices	$406	$11,250	$312	$625	$312	$27,620	Program Dependant	$41,150	$823,000
Reduce the amount of *E. coli* runoff from urban lands	$406	$1,250	$312	$625	$312	$540	Program Dependant	$4,070	$81,396
Reduce the amount of *E. coli* runoff from point sources, failed septic systems, and package plants	$173	$2,880	$288	n/a	n/a	n/a	Program Dependant	$18,145	$72,580
Reduce the amount of *E. coli* in Sugar Creek to allow the waters to be fishable and swimmable for all stakeholders	$81	$1,250	$62	$125	$62	$2,816	Program Dependant	$14,080	$452,180

Table 42c Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan:
Goal #3: Reduce the maximum concentration so that there are no exceedances of Nitrate plus Nitrite of 10 mg/L and Total Phosphorus of 0.3 mg/L by 2030. Column specific costs are shown as annual estimates. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.

Objective	Administrative Costs	Personnel Costs Fulltime Watershed Coordinator	Travel	Equipment	Supplies	Contractual	Cost-Share	Total Cost for 5 years	Total Cost for 20 years
Improve the efficiency of urban and agricultural fertilizer application using grid mapping, and variable rate technology	$10,990	$1,785	$90	$250	$125	$217,540	Program Dependant	$1,153,900	$4,615,600
Educate the public/Stakeholders (urban and agricultural) of the importance of reduced application of fertilizers	$112	$1,785	$90	$250	$125	n/a	n/a	$11,810	$47,240
Increase the riparian buffer zone using filter strips and grassed waterways	$3,498	$1,785	$90	$250	$125	$67,703	Program Dependant	$367,255	$1,469,020
Increase the amount of BMPs used in the Sugar Creek Watershed including but not limited to: cover crops in the winter, grid mapping, and variable rate technology	$10,990	$1,785	$90	$250	$125	$217,540	Program Dependant	$1,153,900	$4,615,600
Discourage the Fall and Winter application of fertilizer	$94	$1,785	$90	n/a	n/a	n/a	n/a	$9,845	$39,380
Encourage more soil testing to optimize Nitrogen application (Home owners, farmers, etc.)	$94	$1,785	$90	n/a	n/a	n/a	n/a	$9,845	$$39,380
Encourage lower application rates of fertilizers within the Watershed through education workshops and field days	$112	$1,785	$90	$250	$125	n/a	n/a	$11,810	$47,240

Table 42d Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan:
Goal #4: Reduce soil erosion/sedimentation from agricultural and urban lands to meet 80 mg/L of total suspended solids (TSS) by 2030. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.

Objective	Administrative Costs	Personnel Costs Fulltime Watershed Coordinator	Travel	Equipment	Supplies	Contractual	Cost-Share	Total Cost for 5 years	Total Cost for 20 years
Reduce soil erosion and sedimentation from agricultural lands	$3,318	$4,167	$208	$625	$208	$61,160	Program Dependant	$348,430	$1,393,720
Reduce soil erosion and sedimentation from urban lands	$12,004	$4,167	$208	$625	$208	$6,796	Program Dependant	$120,040	$480,160
Encourage enforcement of erosion control practices associated with the issuance of building permits within the Watershed	$229	$4,167	$208	n/a	$208	n/a	n/a	$24,060	$96,240

Table 42e Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan:
Goal #5: Reduce flood damage in the Sugar Creek Watershed by 2030. Column specific costs are shown as annual estimates. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.

Objective	Administrative Costs	Personnel Costs Fulltime Watershed Coordinator	Travel	Equipment	Supplies	Contractual	Cost-Share	Total Cost for 5 years	Total Cost for 20 years
Reduce flow rates and volumes from existing developed areas and prevent increases in flow rates and volumes from new development within the Watershed	$187	$3,125	$156	$312	$156	n/a	n/a	$19,680	$78,720
Protect and restore floodplain functions	$187	$3,125	$156	$312	$156	n/a	n/a	$19,680	$78,720
Encourage the maintenance and management of the Sugar Creek corridor and other drainageways to minimize flooding	$187	$3,125	$156	$312	$156	n/a	n/a	$19,680	$78,720
Create and restore wetland areas to increase storage within the Watershed	$187	$3,125	$156	$312	$156	n/a	n/a	$19,680	$78,720

Table 42f Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan:
Goal #6: Develop and implement watershed education and outreach programs in the Sugar Creek Watershed. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.

Objective	Administrative Costs	Personnel Costs Fulltime Watershed Coordinator	Travel	Equipment	Supplies	Contractual	Cost-Share	Total Cost for 5 years	Total Cost for 20 years
Effectively use forms of media (TV, newspaper, newsletters and radio) to share and communicate past, current, and future activities of the Sugar Creek Steering Committee with the media, public, and current and potential Sugar Creek Steering Committee members	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Recruit and train volunteers to monitor at a minimum, each of the subwatersheds, obtaining both wet and dry weather data at each site at least twice each year, and provide continuing education opportunities for volunteer monitors	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Promote sustainable drainage practices	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Educate homeowners in urban communities about the use of fertilizers	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Educate stakeholders using septic systems about the importance of septic system maintenance	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Establish a legislative liaison	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Educate stakeholders and landowners about the detrimental effects that All Terrain Vehicles (ATV's) have on the Sugar Creek Watershed	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Educate the stakeholders in the Watershed about other efforts and studies conducted within the Watershed	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140
Educate homeowners within the Watershed about the Storm Drain Marking Program	$129	$1,389	$350	$139	$700	n/a	n/a	$13,535	$54,140

Table 42g Total Projected Costs Associated with Complete Implementation of the Watershed Management Plan: **Goal #7:** Increase preservation and restoration of open space within the Sugar Creek Watershed by 2030. Column specific costs are shown as annual estimates. Five and twenty year projections are shown in todays dollars and are not adjusted to reflect changes over time.									
Objective	**Administrative Costs**	**Personnel Costs Fulltime Watershed Coordinator**	**Travel**	**Equipment**	**Supplies**	**Contractual**	**Cost-Share**	**Total Cost for 5 years**	**Total Cost for 20 years**
Increase acquisition of land to be dedicated to open space and greenways	$75	$1,250	$62	$125	$62	n/a	n/a	$7,870	$31,480
Increase the preservation of wildlife habitat and protected areas within the Sugar Creek Watershed	$75	$1,250	$62	$125	$62	n/a	n/a	$7,870	$31,480
Encourage the utilization of proper wildlife management practices within the Sugar Creek Watershed	$75	$1,250	$62	$125	$62	n/a	Program Dependant	$7,870	$31,480
Encourage farmland preservation within the Watershed	$75	$1,250	$62	$125	$62	n/a	n/a	$7,870	$31,480

SECTION 9: ADAPTATION

This Management Plan is meant to be a flexible tool to achieve water quality improvements within the Sugar Creek Watershed. The WMP will be evaluated by assessing the progress made on each of the seven goals. The evaluation and adaptation of the plan will be the responsibility of the Steering Committee.

The plan should be evaluated every five years to assess the progress made as well as to revise the plan, if appropriate, based on the progress achieved. The plan will also have a comprehensive review every 15 years. Amendments and changes may be made more frequently as laws change or new information becomes available that will assist in providing a better outlook for the Sugar Creek Watershed. As goals are accomplished and additional information is gathered, efforts may need to be shifted to watershed issues of higher priority.

GLOSSARY

Aquatic habitat: The lakes, streams and other watercourses in which an organism normally lives or occurs. A habitat includes both living and nonliving components. The habitat of an organism includes its sources of food and shelter.

Base flood elevation (BFE): The elevation delineating the level of flooding resulting from the 100-year flood frequency elevation. (See also Floodplain.)

Base flow: The flow that a perennially flowing stream reduces to during the dry season. It is supported by groundwater seepage into the channel.

Benthic: Bottom dwelling.

Biodiversity: The variety of organisms (plants, animals and other life forms) that includes the totality of genes, species and ecosystems in a region.

Bio-infiltration (rain gardens): Excavated depressional areas where stormwater runoff is directed and allowed to infiltrate back into groundwater rather than allowing to runoff. . Infiltration areas are planted with appropriate vegetation. Rain gardens are especially suitable because they are aesthetically pleasing.

Biochemical oxygen demand (BOD): The amount of dissolved oxygen that is required by microscopic organism (e.g. bacteria) to decompose organic matter in waterbodies.

Buffer: An area of vegetated land to be left open adjacent to drainageways, wetlands, lakes, ponds or other such surface waters for the purpose of eliminating or minimizing adverse impacts to such areas from adjacent land areas.

Buffering Capacity: The waters ability to keep the pH stable as acids and bases are added to it.

Best management practices (BMPs): Practices or programs that are used to prevent or ameliorate damage to natural resources, water quality or from flooding. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

Bioengineering (or Soil Bioengineering): Also referred to as biotechnical slope protection. Techniques for stabilizing eroding or slumping stream banks that rely on the use of plants and plant materials such as live willow posts, brush layering, coconut logs and other “greener” or “softer” techniques. This is in contrast to techniques that rely on creating “hard” edges with riprap, concrete and sheet piling (metal and plastic).

Channel: Any river, stream, creek, brook, branch, natural or artificial depression, ponded area, lakes, flowage, slough, ditch, conduit, culvert, gully, ravine, swale, wash, or natural or man-made drainageway, in or into which surface or groundwater flows, either perennially or intermittently.

Channelized stream: A stream that has been artificially straightened, deepened, or widened to accommodate increased stormwater flows, to increase the amount of adjacent land that can be developed or used for urban development, agriculture or for navigation purposes. In addition to being unsightly, channelized streams have a uniform gradient, no riffle and pool development, no meanders (curves) and very steep banks. The vegetation is frequently removed and replaced with riprap, concrete or other hard surfaces. During low flow periods in the summer, many channelized streams have low dissolved oxygen levels, in part due to shallow, slow-moving water. Under these conditions, they provide poor habitat for fish or other stream organisms such as benthic macroinvertebrates.

Conservation development: A development designed to protect open space and natural resources for people and wildlife while at the same time allowing building to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space.

Conservation easement: The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to property owners who do not want to sell their land at the present time, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Discharge (streamflow): The volume of water passing through a channel during a given time, usually measured in cubic feet per second.

Dissolved oxygen (DO): The amount of oxygen in water, usually measured in milligrams/liter.

Ecosystem: Combination of living things and the physical systems (geology, topography, moisture, climate, etc.) within which they must live.

EPT: The *Ephemeropteran*, *Plecopteran*, and *Trichopteran* orders

Erosion: Displacement of soil particles on the land surface due to water or wind action.

Evapotranspiration: The total water loss from a particular area, being the sum of evaporation from the soil and transpiration from vegetation.

Filter strip: A long narrow portion of vegetation used to retard water flow and collect sediment for the protection of watercourses, reservoirs, or adjacent properties.

Flood Insurance Rate Map (FIRM): A map prepared by the Federal Emergency Management Agency that depicts the special flood hazard area (SFHA) within a community. The FIRM includes zones for the 100-year and 500-year floodplains and may or may not depict Regulatory Floodways.

Floodplain (100-year): Land adjoining the channel of a river, stream, watercourse, lake or wetland that has been or may be inundated by floodwater during periods of high water that exceed normal bank-full elevations. The 100-year floodplain has a probability of 1% chance per year of being flooded.

Geographic information system (GIS): A computer system that inputs, assembles, stores, manipulates and displays (usually in the form of maps) geographically referenced information.

Greenways: A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Provides wildlife corridors and recreational trails.

Hydraulic structures: Low head dams, weirs, bridges, levees, and any other structures along the course of the river.

Hydric soil: A soil that is saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile.

Hydrologic soil groups: Soils are classified based on their infiltration and transmission rates into groups.

Impervious surfaces: The land in a watershed, expressed in an area or percentage, covered by hard surfaces that prevent the infiltration of water into the soil. Impervious surfaces are the asphalt or concrete roads, parking lots, buildings, compacted lawns or other surfaces that are relatively impenetrable to the movement of water.

Index of Biotic Integrity (IBI): The IBI is based on fish surveys with the rating dependent on the abundance and composition of the fish species in a stream. Fish communities are useful for assessing stream quality because fish represent the upper level of the aquatic food chain and therefore reflect conditions in the lower levels of the food chain. Fish population characteristics are dependent on the physical habitat, hydrologic and chemical conditions of the stream, and are considered good indicators of overall stream quality because they reflect stress from both chemical pollution and habitat perturbations. For example, the presence of fish species that are intolerant of pollution are an indicator that water quality is good. The IBI is calculated on a scale of 12 to 60, the higher the score the better the stream quality.

Illicit connections: Any discharge to a municipal separate stormsewer that is not composed entirely of stormwater, not due to fire fighting activities or stormwater discharged to a sanitary line.

Infiltration: That portion of rainfall or surface runoff that moves downward into the subsurface soil.

Invasive species: Species that are not native to an area and tend to out-compete native species and dominate an area.

Macroinvertebrates: Invertebrates that can be seen by the unaided eye (macro). Most benthic invertebrates in flowing water are aquatic insects or the aquatic stage of insects, such as stonefly nymphs, mayfly nymphs, caddisfly larvae, dragonfly nymphs and midge larvae. They also include such things as clams and worms. The presence of benthic macroinvertebrates that are intolerant of pollutants is a good indicator of good water quality.

Macroinvertebrate Index of Biotic Index (mIBI): The mIBI is designed to assess biotic integrity directly through ten metrics which evaluate a macroinvertebrate community's species richness, evenness, composition, and density within the stream. These metrics include the family-level HBI (Hilsenhoff's Family Biotic Index), number of taxa, number of individuals, Percent Dominant Taxa, EPT index, EPT count, EPT count to total number of individuals, EPT count to Chironomid count, Chironomid count, and number of individuals per number of squares sorted. Values for the ten metrics are compared with corresponding ranges and a rating of 0, 2, 4, 6, or 8 is assigned to each metric. The average of these ratings gives a total mIBI score.

Meander (stream): A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other (point bars).

Mitigation: Measures taken to eliminate or minimize damage from development activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.

National Pollutant Discharge Elimination System (NPDES): Acronym for the National Pollutant Discharge Elimination System, which regulates point source and stormwater discharges.

Native vegetation: Plant species that have historically been found in an area.

Nonpoint source pollution: Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.

Non-structural flood control: Practices including acquisition or relocation of floodprone buildings, floodproofing and use of runoff reduction techniques such as native landscaping.

Nutrients: Substances needed for the growth of aquatic plants and animals. The addition of too many nutrients (such as from sewage dumping and over fertilization) will cause problems in the aquatic ecosystem through excess algae growth and other nuisance vegetation.

Organic matter: Decomposing vegetative litter and animal matter.

Point Source: Refers to discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.

Pool: A location in an active stream channel usually located on the outside bends of meanders, where the water is deepest and has reduced current velocities.

Preventative measures: Actions that reduce the likelihood that new watershed problems such as flooding or pollution will arise, or that those existing problems will worsen. Preventative techniques generally target new development in the watershed and are geared toward protecting existing resources and preventing degradation.

Regulatory Floodplain: Regulatory Floodplains may be either riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography delineates floodplain boundaries. A flood-prone area is Regulatory Floodplain if it meets any of the following descriptions:

1. Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
2. Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.
3. Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map and located with the best available topography to be inundated by the base flood.

Reach (Stream): A stream segment having fairly homogenous hydraulic, geomorphic and riparian cover and land use characteristics (such as all ditched agriculture or all natural and wooded). Reaches generally should not exceed 2,000 feet in length.

Remedial measures: Used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion.

Retrofit: Refers to modification of existing stormwater control structures such as detention basins and conveyance systems such as ditches and stormsewers. These structures were originally designed to improve drainage and reduce flood risk, but they can also be retrofitted to improve water quality. Seeks to improve existing problems.

Riffle: Shallow rapids, usually located at the crossover in a meander of the active channel.

Riparian: Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation.

Riverine: Relating to, formed by, or resembling a stream (including creeks and rivers).

Sediment: Soil particles that have been transported from their natural location by wind or water action.

Sedimentation: The process that deposits soils, debris, and other materials either on other ground surfaces or in bodies of water or watercourses.

Silt: Fine mineral particles intermediate in size between clay and sand.

Source reduction: Changing everyday practices to reduce the quantity of pollutants that end up on the land and in the water.

Substrate (stream): The composition of the bottom of a stream such clay, silt or sand.

Structural flood control: Man-made reservoirs, levees, diversions or other structures that provide flood protection. Flood control measures are used to prevent floodwaters from reaching properties, thus preventing flood damage.

Stream monitoring: Chemical, biological and physical monitoring used to identify the causes and sources of pollution in the river and to determine the needs for reduction in pollutant loads, streambank stabilization, debris removal and habitat improvement.

Streambank stabilization: Techniques for stabilizing eroding or slumping streambanks to reduce erosion.

Swale: A vegetated channel, ditch or low-lying or depressional tract of land that is periodically inundated by conveying stormwater from one point to another.

Steering committee: An executive committee, which forms the core leadership and decision-making group of stakeholders in the watershed management practices and policies of the action plan.

Stormwater management: A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control and pollutant reduction in runoff.

Total suspended solids (TSS): A measure of the particulate matter suspended in a water sample. Used to estimate sedimentation rates.

Trash rack: A barrier placed at the upstream end of a culvert to trap debris but allow water to flow through.

Turbidity: Refers to the clearness or clarity of the water, which is a function of how much material including sediment is suspended in the water.

Urban runoff: Water from rain or snow events that runs over surfaces such as streets, lawns, parking lots and directly into storm sewers before entering the river rather than infiltrating the land upon which it falls.

Velocity (of water in a stream): The distance that water can travel in a given direction during a period of time. Usually expressed in feet per second.

Watershed: An area confined by topographic divides that drains a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.

Wetland: A wetland is considered a subset of the definition of the Waters of the United States. Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, do support a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) hydric soils and 3) hydrophytic vegetation.

Watershed Stakeholder: A person who has a personal, professional, legal, or economic interest in the watershed and the outcome of the watershed planning process.

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ACRONYMS AND ABBREVIATIONS

A

ACOE – Army Corps of Engineers
ATV – All Terrain Vehicles

B

BFE- Base Flood Elevation
BOD-Biochemical Oxygen Demand
BMP- Best Management Practices

C

CAFO – Confined Animal Feeding Operations
CAP – Continuing Authorities Program
CFO – Confined Feeding Operation
CFU- Colony Forming Units
CR- County Road
CREP- Conservation Reserve Enhancement Program
CRP- Conservation Reserve Program
CSOs- Combined Sewer Overflows
CWA- Clean Water Act
CWP- Center for Watershed Protection

D

DO- Dissolved Oxygen

E

EMC- Event Mean Concentration
EPA- Environmental Protection Agency
EPT- Ephemeroptera (mayfly), Plecoptera (stonefly), and Tricoptera (caddisfly)
EQIP - Environmental Quality Incentives Program

F

FCA- Fish Consumption Advisory
FEMA- Federal Emergency Management Agency
FIRM- Flood Insurance Rate Maps
FOTG- Field Office Technical Guide
FSA – Farm Service Agency

H

HBI- Hilsenhoff Biotic Index
HEL- Highly Erodible Land
HUC- Hydrologic Unit Code

I

IBI – Index of Biotic Integrity
IDEM – Indiana Department of Environmental Management
IDNR – Indiana Department of Natural Resources
INDOT – Indiana Department of Transportation

ISDA – Indiana State Department of Agriculture

L

LARE – Lake and River Enhancement Program
L-THIA – Long-Term Hydrologic Impact Assessment

M

mg/L- milligrams per liter
mIBI- Macroinvertebrate Index of Biotic Integrity
MOS- Margin of Safety

N

NAWQA - National Water-Quality Assessment
NLCD – National Land Cover Data
NPDES- National Pollutant Discharge Elimination System
NPS- Nonpoint Source
NRCS- Natural Resource Conservation Service

P

Pb- Lead
PCB - Polychlorinated Biphenyls
ppm – Parts per Million
ppt – Parts per Thousand
PRD- Planned Residential Developments
PUD- Planned Unit Developments

Q

QHEI- Qualitative Habitat Evaluation Index

S

SVOCs – Semivolatile Organic Compounds
SWCD- Soil & Water Conservation District

T

T&E- Threatened and Endangered
TKN- Total Kjeldahl Nitrogen
TMDL- Total Maximum Daily Load
TSS- Total Suspended Solids

U

ug/L- Micrograms per Liter
USACE – U.S Army Core of Engineers
USGS-United States Geological Survey

W

WHIP- Wetland Habitat Incentive Program
WMP- Watershed Management Plan
WRP- Wetland Reserve Program

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APPENDIX A

LIST OF STAKEHOLDERS

LIST OF STAKEHOLDER GROUPS		
Organization Name	**Inputs/Outputs**	**Match Type**
Local Homeowners and Farmers	Views/Concerns & history of water sources	In-Kind
SWCD Board of Supervisors	Views/Concerns and history of water sources Supervisor of Watershed Coordinator	In-Kind
County Surveyors	Drainage, tile problems, maps	In-Kind
Drainage Board Members	Drainage information	In-Kind
County & Municipal Planners and Engineers	Comprehensive Plan - Technical	In-Kind
County Health Departments	Septic Systems information – Technical	In-Kind
County GIS Department	Maps	In-Kind
County & City School Systems	Education Storm Drain Stenciling Program	In-Kind
County Solid Waste Districts	Educational Assistance & Database info	In-Kind
City, County, Town Boards	Information, Contacts	In-Kind
Purdue Cooperative Extension	Expertise, Land Use/Tillage	In-Kind
Environmental Organizations	Expertise, Views/Concerns	In-Kind
Crop Mate and AG One CO-OP	Fertilizer Information	In-Kind
Indiana and US Geological Survey	Expertise, Data	
Indiana Department of Natural Resources (IDNR)	Expertise, Technical – Biological E&T	In-Kind
Indiana State Department of Agriculture (ISDA)	Expertise, Technical	In-Kind
Natural Resources Conservation Services (NRCS)	Expertise, Technical	-
Army Corps of Engineers	Technical Info, Permitting Guidance	-
City and County Park Systems	Educational Outreach	In-Kind
Farm Service Agency	Crop Rotation, Farm Statistics	-
Eli Lilly Corporation	Potential Funding/Testing	-
Hancock Regional Hospital	Water Testing Information/Meeting location	In-Kind

APPENDIX B

WINDSHIELD SURVEY DATA

site_id	date	latitude	longitude	time	team	weather_past_24_hrs	weather_current	wildlife_notes	water_odors	water_color_appearance	algae	stream_buffer	buffer width_estimated	land_use	needs
1	9/17/2007	39.41545	-85.53398	9:00 AM	Beckner/Schakel	Clear	Clear	Locust, Flies, Butterflies, raccoon tracks, minnows, fish, turtles, water striders, birds dragonflies	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	NE 25, NW 50, SE 20, SW 100	AG - row crop, resident	Sediment bars
2	9/17/2007	39.42523	-85.53084	9:10 AM	Beckner/Schakel	Clear	Clear	Locust, Flies, Butterflies, raccoon tracks, minnows, fish, turtles, water striders, birds dragonflies	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	NE 35, NW 10, SE 50, SW 300	New Palestine, Commercial	Yards
3	9/17/2007	39.43398	-85.52443	9:25 AM	Beckner/Schakel	Clear	Clear	Locust, Flies, Butterflies, raccoon tracks, minnows, fish, turtles, water striders, birds dragonflies	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	NE none, NW 50, SE 50, SW 50	AG, Resident	
4	9/17/2007	39.441423	-85.525809	9:36 AM	Beckner/Schakel	Clear	Clear	Birds, Locust, Striders, several fish	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	SE 500+ ft, NE 10- 300 ft, SW 10-50 ft, NW 10 - 50+	AG - row crop, resident - The Overlook	Bank protection
5	9/17/2007	39.443234	-85.523739	9:45 AM	Beckner/Schakel	Clear	Clear	Birds, Locust, Striders, raccoon tracks, several fish	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	SE 20 ft, NE 50 ft, SW 500+, NW 300+	AG - row crop, no-till and resident, naturalized drainage systems	NW - Streambank stabilization
6	9/17/2007	39.452522	-85.521174	9:55 AM	Beckner/Schakel	Clear	Clear	Locust, Flies, Butterflies, raccoon tracks, minnows, fish, turtles, water striders, birds dragonflies	Normal	Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, Installed and natural	NE 50, NW 10, SE 150+, SW 150+	AG - Hay, Notill beans, Resident, row crops	TIRE removal, Streambank needed N E&W, S E&W, large trees - SW, trees S&N growing over the creek
7	9/17/2007	39.461829	-85.514227	10:00 AM	Beckner/Schakel	Intermittent	Rain - intermittent, and clear	Locust, raccoon tracks, fish	Normal	Clear, slightly murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses, and natural	SE 200+, SW 500+, NE 500+, NW 75	Resident, Row crops	Sediment bars, log jam, tire, pipe
8	9/17/2007	39.463849	-85.513025	10:10 AM	Beckner/Schakel	Intermittent	Rain - intermittent, and clear	Locust, raccoon tracks, fish	Normal	Clear, slightly murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses, and natural	SE 200+, SW 10+, NE 500+, NW 75	Spring Lake	Streambank Stablization
9	9/17/2007	39.475427	-85.51112	10:25 AM	Beckner/Schakel	Clear	Rain - intermittent, and clear	Striders, locust, minnows, fish, robins, raccoon tracks, squirrel, dragonflies	Normal	Clear	Attached to substrate, limited growth	Present: trees, shrubs, grasses, modified and natural	NE 500+, NW 50, SE 50+, SW 50+	S&H Campground, Resident, AG row crop	Log Jam, Bales along creek bank for flooding
10	9/17/2007	39.48921	-85.502448	10:40 AM	Beckner/Schakel	Clear	Rain - intermittent, and clear	Turtle, Striders, fish, bumblebees	Normal	Green, Murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	NE 500+, NW 50, SE 500+, SW 200	Resident, man-made stabilization	Roadside trash, sediment bars, sink, metal junk, log jams
11	9/17/2007	39.484764	-85.494683	10:55 AM	Beckner/Schakel	Clear	Rain - intermittent, and clear	Lots of turtles, locust, raccoon tracks, dragonflies	Normal	Brown, murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses, modified and natural	NE 20, NW 5-10, SE 50, SW 200	Resident, Pasture - cattle have access	Cattle issue
12	9/17/2007	39.491326	-85.494652	11:00 AM	Beckner/Schakel	Clear	Overcast	none noted	Normal	Clear	Attached - moderate growth	Present: trees, shrubs, grasses, modified and natural	NE 10, NW 5-10, SE 50, SW 200	Heartland Campground	Campground issues
13	9/17/2007	39.494009	-85493968	11:10 AM	Beckner/Schakel	Clear	Overcast	Ducks, fish, turtles, muskrat trace, locust, waterstriders, butterflies	Normal	Clear, slightly murky	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, modified and natural	NE 500, NW 150, SE 500, SW 20	Row crops, go cart paths, campgrounds golf course	Sediment bars, trash - car parts
14	9/17/2007	39.50223	-85.49181	1:25 PM	Beckner/Schakel	Overcast	Overcast	Locust, Insects, ducks, butterflies, dragonflies, fish	Normal	Green, Murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses, and natural	NE 100, NW 200, SE 50, SW 100	Crop, Resident, Conservation Club	TV, trash
15	9/17/2007	39.51174	-85.49019	1:40 PM	Beckner/Schakel	Overcast	Overcast	Striders, insects, raccoon tracks, dragonflies	Normal	Clear	Attached to substrate, limited growth	Present: trees, shrubs, grasses, and natural	NE 20, NW 200, SE 100, SW 20	Resident	Split stream to the north, limbs needed cleared, tire
16	9/17/2007	39.52176	-85.48285	1:52 PM	Beckner/Schakel	Overcast	Overcast/ windy	Cattle, striders, hawk, woodpecker, crows, raccoon tracks	Normal	Clear, brown, murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses, and natural	NE - none, NW 100, SE 200, SW 150	Resident, pasture, crop	Metal cattle gate - cattle have access to the SE

17	9/17/2007	39.53107	-85.48116	2:07 PM	Beckner/Schakel	Overcast	Overcast	Muskrat path, birds, striders, fish - lots, raccoon tracks, mussels, deer tracks	Normal	Clear	Limited growth	Present: trees, shrubs, grasses, and natural	NE 150, NW 300, SE 75, SW 200	Resident, hay field, cemetery	Sediment big bar
18	9/17/2007	39.54033	-85.47551	2:24 PM	Beckner/Schakel	Overcast	Overcast	Squirrel, Carp, Catfish, deer tracks, muskrat hole, minnows	Normal	Green, Brown, Murky and Black to the SE	Attached to Substrate, Moderate Growth	Present: trees, shrubs, grasses, and natural	NE 10, NW 5-10, SE 100 +, SW 20	Resident	SE needs streambank stablization
19	9/17/2007	39.54301	-85.46149	2:30 PM	Beckner/Schakel	Overcast	Overcast	Fish, raccoon tracks, turtle, muskrat tracks, mussell shells	Normal, sewage, fishy	Clear	Limited growth	Present: trees, shrubs, grasses and natural	NE 300, NW 200 SE 10, SW 50	AG row crop, Resident, Eden Elementary	Foaming stuff, sediment bar
20	9/17/2007	39.5418	-85.44378	2:49 PM	Beckner/Schakel	Overcast	Overcast	Striders, birds, catfish, hawk, raccoon tracks, fleas	Normal	Clear, Oily Sheen	Attached to substrate, limited growth	Present: trees, shrubs, grasses and natural	NE 10, NW 15, SE 10, SW 25	Resident, AG, Pasture	Horses, stream access
21	9/17/2007	39.54228	-85.43502	3:05 PM	Beckner/Schakel	Overcast	Overcast	Fish, tracks - multi, insects, frogs, waterbirds	Normal	Clear	NONE	Present: trees, shrubs, grasses and natural	NE 50, NW 200, SE 20, SW 75	Resident	Streambank Stablization
22	9/17/2007	39.5458	-85.4315	3:14 PM	Beckner/Schakel	Overcast	Partly Cloudy	Striders, fleas, hawk, minnows, small fish, insects, butterflies, large fish	Normal	Green, Murky	NONE	Present: trees, shrubs, grasses and natural	NE 50, NW 10, SE 10, SW 10	AG, Resident	Trash
23	9/17/2007	39.55411	-85.42395	3:25 PM	Beckner/Schakel	Overcast	Partly Cloudy	Blue Heron, minnows, fish, dragonflies,	Normal	Green, murky, oily sheen	Limited growth	Present: trees, shrubs, grasses and natural	NE 500, NW 10, SE 20, SW 150	AG Pasture	Streambank Stablization, hog panels, flood gate washed out
24	9/17/2007	39.55286	-85.41317	3:34 PM	Beckner/Schakel	Overcast	Partly Cloudy	Minnows, fish, frog, turtles	Normal	Clear, Green	Attached to substrate, limited growth	Present: trees, shrubs, grasses and natural	NE none, NW 150, SE none, SW 10	Pasture	Cattle issue
25	9/17/2007	39.5528	-85.40397	3:44 PM	Beckner/Schakel	Overcast	Partly Cloudy	Big fish, turtle, muskrat tracks, beaver dam??	Normal	Greenish, murky, oily sheen, pooling	NONE	Present: trees, shrubs, grasses and natural	NE 5, NW 20, SE 50, SW 200	Pasture, resident, AG	log jam, beaver dam,
26	10/15/2007	39.5549	-85.39422	9:20 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Striders	Normal	Murky, oily sheen		Present: trees, shrubs, grasses and natural	NE 25, NW 200, SE 200, SW 200	AG, Resident	No water movement, trash, pond area
27	10/15/2007	39.56267	-85.39302	9:44 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	fish	Normal	Clear	Floating, moderate growth	Absent, unknown, grasses	NE 20, NW 300, SE 100, SW 300	pasture, AG	low level, bank stablization, 4-wheeler tracks, cattle access, trees cut for powerlines?
28	10/15/2007	39.56445	-85.38569	10:00 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Birds, tracks	Normal	Green, murky	Attached to substrate, limited growth	Absent, unknown, grasses	NE 50, NW 100, SE 500, SW none	pasture, AG	log jam, cattle gates, duckweed
29	10/15/2007	39.55523	-85.38323	10:10 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Birds, striders	Normal	Green, murky	Attached to substrate, limited growth	Present: trees, shrubs, grasses and natural	NE 300, NW 50, SE 20, SW 150	AG	Lots of Sediment bars, very little movement, log jams
30	10/15/2007	39.55316	-85.38038	10:20 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Birds, tracks	Normal	Clear, Oily Sheen	Floating, Attached to substrate, limited growth	Present: trees, shrubs, grasses and natural	NE 20, NW 100, SE 25 SW 300	State Road 109 AG, Hort Garden	Cattle gate, bank assistance
31	10/15/2007	39.55000	-85.37412	10:30 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Ducks, wildlife tracks, squirrel	Normal	Clear, Brown	NONE	Present: trees, shrubs, grasses and natural	NE 25, NW 75, SE 200, SW 300	AG, Resident	pooled water, no movement, logs, limbs, sediment bar
32	10/15/2007	39.55524	-85.35101	10:40 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Minnows, fish, cat	Normal	Really Clear	Floating, Attached to substrate, limited growth	Present: trees, shrubs, grasses, modified and natural	NE none, NW 25, SE 25 SW none	AG, Resident	Hog operation NE 1/4 mile
33	10/15/2007	39.5645	-8534384	10:50 AM	Beckner/Schakel	Partly Cloudy	Partly Cloudy	Skunk, minnows, tracks of wildlife, striders	Normal	Clear, Oily Sheen	Floating, Attached to substrate, limited growth	Present: trees, shrubs, grasses, modified and natural	NE 150, NW 50, SE 25, SW 25	AG, Resident	low water, Hog operation SW of creek

site_id	date	latitude	longitude	team	water_odors	water_color_ appearance	needs	Other items noted in watershed
1	4/16/2008	39.41545	-85.53398	Newkirk Bogemann	Normal	Murky	Sediment bars flooding issues?	pipe into creek, cemetery, trash
2	4/16/2008	39.42523	-85.53084	Newkirk Bogemann	Normal	Murky	Yards log jams	
3	4/16/2008	39.43398	-85.52443	Newkirk Bogemann	Normal	Murky		major erosion in fields
4	4/16/2008	39.441423	-85.525809	Newkirk Bogemann	Normal	Murky	Bank protection	
5	4/16/2008	39.443234	-85.523739	Newkirk Bogemann	Normal	Murky	NW - Streambank stabilization	major animal populations - needs buffer, major erosion
6	4/16/2008	39.452522	-85.521174	Newkirk Bogemann	Normal	Murky	TIRE removal, Streambank needed N E&W, S E&W, large trees - SW, trees S&N growing over the creek	
7	4/16/2008	39.461829	-85.514227	Newkirk Bogemann	Normal	Clear, slightly murky	Sediment bars, log jam, tire, pipe	When did Spring Lake become Spring Lake???
8	4/16/2008	39.463849	-85.513025	Newkirk Bogemann	Normal	Clear, slightly murky	Streambank Stabilization	animals on feed, pipes into creek, horses cemetery, animals access to creek, S&H Campground
9	4/16/2008	39.475427	-85.51112	Newkirk Bogemann	Normal	Clear	Log Jam, Bales along creek bank for flooding	
10	4/16/2008	39.48921	-85.502448	Newkirk Bogemann	Normal	Green, Murky	Roadside trash, sediment bars, sink, metal junk, log jams	Sediment bars, horse farm on creek, walking path to creek
11	4/16/2008	39.484764	-85.494683	Newkirk Bogemann	Normal	Brown, murky	Cattle issue	
12	4/16/2008	39.491326	-85.494652	Newkirk Bogemann	Normal	Clear	Campground issues	
13	4/16/2008	39.494009	-85493968	Newkirk Bogemann	Normal	Clear, slightly murky	Sediment bars, trash - car parts	
14	4/16/2008	39.50223	-85.49181	Newkirk Bogemann	Normal	Green, Murky	TV, trash	Major erosion in front of Mohawk Campgrounds, trash, cattle have access
15	4/16/2008	39.51174	-85.49019	Newkirk Bogemann	Normal	Clear	Split stream to the north, limbs needed cleared, tire	
16	4/16/2008	39.52176	-85.48285	Newkirk Bogemann	Normal	Clear, brown, murky	Metal cattle gate - cattle have access to the SE	canoe access; goes through Spring Lake - possible cattle access
17	4/16/2008	39.53107	-85.48116	Newkirk Bogemann	Normal	Clear	Sediment big bar	Major cattle confined - 700 N
18	4/16/2008	39.54033	-85.47551	Newkirk Bogemann	Normal	Green, Brown, Murky and Black to the SE	SE needs streambank stabilization	

19	4/16/2008	39.54301	-85.46149	Newkirk Bogemann	Normal, sewage, fishy	Clear	**Foaming stuff, sediment bar**	
20	4/16/2008	39.5418	-85.44378	Newkirk Bogemann	Normal	Clear, Oily Sheen	**Horses, stream access**	**2 houses with possible septic issues, horses fenced off, lots of paths across the water, cattle on feed and creek access, wetlands, wooded cemetery, gates to water bales in creek, Eden road is good road to check - don't think it is Eden School.**
21	4/16/2008	39.54228	-85.43502	Newkirk Bogemann	Normal	Clear	**Streambank Stabilization**	**cattle may have access, cemetery, digging on creek, trash at farm site**
22	4/16/2008	39.5458	-85.4315	Newkirk Bogemann	Normal	Green, Murky	**Trash**	**ducks, squirrels, wetlands, no major animals 9600 huge house**
23	4/16/2008	39.55411	-85.42395	Newkirk Bogemann	Normal	Green, murky, oily sheen	**Streambank Stabilization, hog panels, flood gate washed out**	
24	4/16/2008	39.55286	-85.41317	Newkirk Bogemann	Normal	Clear, Green	**Cattle issue**	**cattle has access, flooded wetlands, very rusty scum**
25	4/16/2008	39.5528	-85.40397	Newkirk Bogemann	Normal	Greenish, murky, oily sheen, pooling	**log jam, beaver dam,**	**Murky, wooded, septic drains, not all that bad, wide at bridge, deer tracks, cemetery,**
26	4/16/2008	39.5549	-85.39422	Newkirk Bogemann	Normal	Murky, oily sheen	**No water movement, trash, pond area**	
27	4/16/2008	39.56267	-85.39302	Newkirk Bogemann	Normal	Clear	**low level, bank stabilization, 4-wheeler tracks, cattle access, trees cut for powerlines?**	
28	4/16/2008	39.56445	-85.38569	Newkirk Bogemann	Normal	Green, murky	**log jam, cattle gates, duckweed**	**County Line - three bridges cattle access, wetlands, tires, 2 drain tile, good flow, sediment, ripples, not as clear, major flooding, oily brown scum, major wetlands with water issues, horses and trash**

29	4/16/2008	39.55523	-85.38323	Newkirk Bogemann	Normal	Green, murky	**Lots of Sediment bars, very little movement, log jams**	**not as clear, oily brownish scum pooled, drain pipes, big land sediment with flow on both sides, major washed off field**
30	4/16/2008	39.55316	-85.38038	Newkirk Bogemann	Normal	Clear, Oily Sheen	**Cattle gate, bank assistance**	**Fenced off animals, clear, looks good, new pond, ripples, smells good**
								log jams between, sediments
31	4/16/2008	39.55000	-85.37412	Newkirk Bogemann	Normal	Clear, Brown	**pooled water, no movement, logs, limbs, sediment bar**	**erosion, donkeys, ripples, drain pipe, cattle, streambank stabilization, Swindels dumps in to the creek, wetlands**
32	4/16/2008	39.55524	-85.35101	Newkirk Bogemann	Normal	Really Clear	**2 CAFO's in area, tile drains, low flow**	
33	4/16/2008	39.5645	-8534384	Newkirk Bogemann	Normal	Clear, Oily Sheen	**2 CAFO's in area, tile drains, low flow**	

APPENDIX C

V3 WATER CHEMISTRY DATA SUMMARY TABLES

Water Quality Data from Sugar Creek Station 1																
Date	**Time**	**Air Temp.**	**Water Temp.**	**Diss. Oxygen**	**pH**	**Conduct.**	**Specific Conduct.**	**Sal.**	**Turb.**	**Flow**	**Nitra.**	**Ortho-Phosph.**	**Total Phosp.**	**BOD**	**E. Coli**
	(24:00)	**(°C)**	**(°C)**	**(mg/L)**		**(mhos)**	**(mhos)**	**(ppt)**	**(NTU)**	**ft³/sec**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(CFU/100ml)**
6/4/2007	13:05	24.6	22.0	8.80	8.38	625	658	0.3	8.21	28.17	0.0	0.30	<0.3	<4.00	178
7/3/2007	13:30	23.8	21.7	9.10	8.43	566	604	0.3	5.62	-	1.3	0.32	0.54	<2.00	240
8/15/2007	13:00	26.4	24.6	8.09	8.46	490	493	0.4	3.60	-	0.8	0.16	0.86	<2.00	139
9/10/2007	13:40	25.1	23.5	7.54	8.45	354.2	364.6	0.2	7.05	-	0.0	0.32	0.50	<3.00	210
10/29/2007	11:45	10.0	9.9	9.04	8.60	448.1	630	0.3	2.20	6.28	0.1	0.30	0.32	<2.00	38
11/27/2007	14:40	3.3	5.7	13.68	8.71	401.2	633	0.3	2.90	-	0.4	0.24	0.20	<2.00	107
12/18/2007	12:15	0.0	1.4	14.63	7.88	342.3	N/A	0.3	10	-	1.9	0.4	0.42	<2.00	172
1/17/2008	13:50	3.0	3	13.77	8.57	355.7	613	0.3	12	-	1.6	0.49	0.29	<2.00	291
2/18/2008	14:00	2.0	4.4	12.8	6.96	311.1	513	0.2	76	-	9.1	1.01	0.78	<2.00	980
3/20/2008	13:00	11.0	5.6	11.55	7.22	144.8	229.4	0.1	130	-	*	2.48	0.64	<2.00	798
4/14/2008	13:10	6.0	9	11.86	6.88	364.3	525	0.3	10.1	-	0.2	0.31	0.324	<2.00	204
5/14/2008	15:20	13.3	13.7	9.21	8.12	388.4	434.6	0.2	50	-	0.7	0.32	1.05	2.93	>2419
7/21/2008	8:30	24.6	22.5	7.49	7.11	356	375	0.2	12	-	-	-	-	-	-
10/6/2008	10:45	17.1	13.7	9.40	7.77	523	668	0.3	1.98	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 2

Date	Time	Air Temp.	Water Temp.	Diss. Oxygen	pH	Conduct.	Specific Conduct.	Sal.	Turb.	Flow	Nitra.	Ortho-Phosp.	Total Phosph.	BOD	E. Coli
	(24:00)	(°C)	(°C)	(mg/L)		(mhos)	(mhos)	(ppt)	(NTU)	ft^3/sec	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(CFU/100ml)
6/4/2007	12:15	24.3	20.7	11.34	8.23	645	702	0.3	3.73	6.80	0.6	0.26	<0.3	<4.00	105
7/3/2007	13:00	21.8	22.1	12.31	8.42	280.3	296.8	0.1	4.20	-	0.9	0.17	0.41	<2.00	167
8/15/2007	12:30	25.0	23.2	9.09	8.32	699	726	0.4	3.60	-	0.8	0.16	0.43	<2.00	326
9/10/2007	13:10	25.2	22.9	8.90	8.29	740	772	0.4	4.11	-	0.0	0.37	0.58	<3.00	152
10/29/2007	10:15	7.6	8.4	11.30	9.10	179.7	263.6	0.1	3.10	2.07	1.1	0.00	0.23	<2.00	99
11/27/2007	13:55	3.3	7.3	13.18	8.80	399.6	611	0.3	3.90	-	0.9	0.38	0.44	<2.00	93
12/18/2007	12:00	0.0	2.4	13.93	7.73	349.8	610	0.3	7.4	-	1.1	0.52	0.34	<2.00	260
1/17/2008	13:30	3.0	4.6	12.29	8.58	325.8	533	0.3	8.8	-	1.9	0.29	0.28	<2.00	345
2/18/2008	13:30	2.0	4.3	12.46	7.05	269.2	443.9	0.2	85	-	8.6	1.18	0.95	<2.00	488
3/20/2008	12:35	11.0	5	11.85	7.18	159.3	258.1	0.1	89	-	*	2.06	0.67	<2.00	836
4/14/2008	12:45	6.0	8.9	13.02	6.86	383.2	553	0.3	5	-	1.1	0.16	0.272	3.99	517
5/14/2008	14:45	13.3	12.9	9	8.4	360.7	389.4	0.2	81	-	11.1	1.62	1.89	4.11	>2419
7/21/2008	10:15	24.5	21.3	7.29	7.25	364.1	391	0.2	45	-	-	-	-	-	-
10/6/2008	9:00	11.0	12.8	9.01	7.91	547	708	0.3	2.48	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 3															
Date	Time	Air Temp.	Water Temp.	Diss. Oxygen	pH	Conduct.	Specific Conduct.	Sal.	Turb.	Flow	Nitra.	Ortho-Phosph.	Total Phosp.	BOD	E. Coli
	(24:00)	(°C)	(°C)	(mg/L)		(mhos)	(mhos)	(ppt)	(NTU)	ft^3/sec	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(CFU/100ml)
6/4/2007	11:50	26.8	22.6	7.95	8.31	627	662	0.3	9.16	26.34	0.8	0.36	0.43	<4.00	210
7/3/2007	12:30	21.3	20.8	8.26	8.36	562	611	0.3	6.42	-	1.5	0.30	0.56	<2.00	201
8/15/2007	12:05	23.9	23.7	7.19	8.40	488	500	0.2	5.58	-	1.7	0.52	0.78	<2.00	156
9/10/2007	12:50	25.1	24.1	7.37	8.36	620	630	0.3	5.84	-	0.5	0.68	0.84	<3.00	122
10/29/2007	10:45	9.7	9.3	10.27	8.64	429.7	612	0.3	2.60	3.01	0.7	0.50	0.50	<2.00	40
11/27/2007	14:10	1.6	5.5	14.20	8.73	407.9	648	0.3	2.90	-	0.4	0.17	0.24	<2.00	152
12/18/2007	11:30	-0.55	1.2	14.31	7.86	326.5	N/A	0.3	11	-	1.4	0.62	0.33	<2.00	260
1/17/2008	13:15	2	2.9	10.23	8.75	351.2	606	0.3	14	-	2.9	0.33	0.29	<2.00	261
2/18/2008	13:15	2	4.6	11.93	7.08	331.6	543	0.3	50	-	6.2	0.58	0.55	<2.00	461
3/20/2008	12:15	11	5.3	12.42	7.56	112.3	199	0.1	150	-	*	2.73	0.67	7.25	554
4/14/2008	12:30	5	8.7	12	6.93	359.5	522	0.3	9.2	-	0.3	0.11	0.26	<2.00	178
5/14/2008	14:20	13.3	14	7.97	8	387.9	422.6	0.2	38	-	0.4	0.34	1.18	3.73	2419
7/21/2008	12:00	24.6	23.5	7.49	7.3	564	579	0.3	11	-	-	-	-	-	-
10/6/2008	8:20	10	14	8.63	8.38	551	698	0.3	4.58	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 4															
Date	Time	Air Temp.	Water Temp.	Diss. Oxygen	pH	Conduct.	Specific Conduct.	Sal.	Turb.	Flow	Nitra.	Ortho-Phosph.	Total Phosph.	BOD	E. Coli
	(24:00)	(°C)	(°C)	(mg/L)		(mhos)	(mhos)	(ppt)	(NTU)	ft^3/sec	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(CFU/100ml)
6/4/2007	11:15	25.3	21.7	7.79	8.29	603	646	0.3	7.61	27.54	0.1	0.22	<0.3	<4.00	219
7/3/2007	11:50	20.5	20.4	7.73	8.35	549	602	0.3	7.35	-	0.3	0.22	0.30	<2.00	225
8/15/2007	11:35	23.8	23.3	7.04	8.39	473	490	0.2	5.98	-	1.0	0.21	0.44	<2.00	135
9/10/2007	12:15	24.6	22.1	7.03	8.30	554	587	0.3	4.45	-	0.0	0.22	0.25	<3.00	219
10/29/2007	12:30	10.5	10.5	10.32	8.54	447.3	619	0.3	5.20	5.32	0.5	0.20	0.22	<2.00	291
11/27/2007	13:05	1.6	6.2	13.77	8.89	406.8	633	0.3	3.80	-	0.8	0.18	0.09	<2.00	172
12/18/2007	11:00	-0.55	1.7	13.25	7.74	334	N/A	0.3	14.0	-	1.5	0.28	0.3	<2.00	219
1/17/2008	12:15	3	3.3	11.7	8.83	344	588	0.3	15.0	-	1.8	0.36	0.26	<2.00	260
2/18/2008	12:40	2	4.7	12.25	7.23	310	507	0.2	80.0	-	7.6	1.2	0.79	<2.00	517
3/20/2008	11:40	11	5.1	12.21	7.6	114.9	185.4	0.1	170.0	-	*	3.16	0.72	<2.00	537
4/14/2008	11:50	5	8.2	12.83	6.93	358.3	532	0.3	6.8	-	0.1	0.13	0.195	<2.00	140
5/14/2008	12:40	13.3	13.7	8.19	8.21	368.5	431.7	0.2	34.0	-	0.2	0.2	0.649	<2.00	>2419
7/21/2008	15:00	25.5	24.1	8.02	6.8	595	605	0.3	13.0	-	-	-	-	-	-
10/6/2008	12:20	21	14.2	10.62	7.92	509	642	0.3	1.83	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 5															
Date	**Time**	**Air Temp.**	**Water Temp.**	**Diss. Oxygen**	**pH**	**Conduct.**	**Specific Conduct.**	**Sal.**	**Turb.**	**Flow**	**Nitra.**	**Ortho-Phosph.**	**Total Phosph.**	**BOD**	**E. Coli**
	(24:00)	**(°C)**	**(°C)**	**(mg/L)**		**(mhos)**	**(mhos)**	**(ppt)**	**(NTU)**	**ft³/sec**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(CFU/100ml)**
6/4/2007	10:30	22.3	21.2	6.79	8.27	590	638	0.3	9.89	15.98	0.0	0.19	<0.3	<4.00	120
7/3/2007	11:15	19.3	20.7	7.34	8.52	543	592	0.3	17.50	-	0.7	0.17	0.39	<2.00	248
8/15/2007	11:00	24.8	23.2	6.09	8.39	488	507	0.2	15.30	-	0.3	0.22	0.39	<2.00	285
9/10/2007	11:45	23.2	22.5	6.98	8.30	302.3	320	0.2	7.47	-	0.0	0.19	0.33	<3.00	411
10/29/2007	13:00	10.5	9.5	10.51	8.44	385.9	548	0.3	4.20	1.46	0.8	0.00	0.23	<2.00	146
11/27/2007	12:10	1.6	4.8	13.11	9.03	395.5	644	0.3	9.10	-	0.9	0.18	0.19	<2.00	1414
12/18/2007	10:35	-0.55	1.6	13.93	7.64	332.9	N/A	0.3	7.4	-	1.9	0.31	0.257	<2.00	153
1/17/2008	11:55	1	3.3	12.63	8.95	354.3	605	0.3	11	-	2.1	0.27	0.34	<2.00	199
2/18/2008	11:45	2	4.5	11.88	7.33	297.4	488.8	0.2	115	-	8.4	1.23	0.979	<2.00	649
3/20/2008	11:25	11	4.7	12.23	7.82	99.3	140.7	0.1	140	-	*	2.68	0.63	3.38	495
4/14/2008	11:25	5	7.6	12.18	6.94	360.4	540	0.3	6.1	-	0.3	0.04	0.159	<2.00	186
5/14/2008	12:20	13.3	13.5	8.14	7.87	367.9	439	0.2	45	-	*	0.47	0.738	<2.00	1986
7/21/2008	17:00	25.5	24.9	7.61	6.67	644	645	0.3	13	-	-	-	-	-	-
10/7/2008	10:00	16	14.7	8.24	7.8	518	644	0.3	3.84	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 6															
Date	**Time**	**Air Temp.**	**Water Temp.**	**Diss. Oxygen**	**pH**	**Conduct.**	**Specific Conduct.**	**Sal.**	**Turb.**	**Flow**	**Nitra.**	**Ortho-Phosph.**	**Total Phosph.**	**BOD**	**E. Coli**
	(24:00)	**(°C)**	**(°C)**	**(mg/L)**		**(mhos)**	**(mhos)**	**(ppt)**	**(NTU)**	**ft^3/sec**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(CFU/100ml)**
6/4/2007	9:50	20.1	20.8	7.09	8.28	570	619	0.3	12.50	12.58	0.2	0.29	<0.30	<4.00	345
7/3/2007	10:45	19.2	20.7	7.65	8.55	536	584	0.3	12.70	-	0.1	0.19	0.30	<2.00	345
8/15/2007	10:25	23.1	22.9	6.62	8.33	502	521	0.2	11.00	-	1.2	0.24	0.33	<2.00	525
9/10/2007	11:15	24.2	22.8	7.14	8.31	559	585	0.3	5.04	-	0.3	0.19	0.29	<3.00	548
10/29/2007	13:30	11.0	9.8	10.31	8.42	425.4	599	0.3	2.40	1.14	0.2	0.00	0.20	<2.00	47
11/27/2007	11:30	1.6	5.2	13.57	9.22	391.5	628	0.3	7.40	-	0.8	0.19	0.17	<2.00	816
12/18/2007	10:10	-0.55	1.6	14.01	7.66	328.5	N/A	0.3	5.4	-	1.9	0.3	0.23	<2.00	121
1/17/2008	11:30	1	3.1	13.23	9.15	341.3	587	0.3	9.8	-	1.3	0.25	0.26	<2.00	114
2/18/2008	11:15	2	4.3	12.08	7.59	262.3	432.4	0.2	160	-	8	1.9	1.24	<2.00	727
3/20/2008	11:00	11	4.2	12.48	7.89	108.5	180.1	0.1	124	-	*	2.7	0.61	<2.00	504
4/14/2008	11:00	5	7	12.65	7.01	348.7	531	0.3	5.8	-	0.1	0.18	0.17	<2.00	156
5/14/2008	12:00	13.3	13.5	8.78	8.47	401.8	483.6	0.2	17	-	*	*	0.419	<2.00	980
7/22/2008	9:30	24.4	21.7	7.22	7.77	537	573	0.3	21	-	-	-	-	-	-
10/7/2008	8:40	13	14.4	8.06	8.11	501	630	0.3	2.86	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 7															
Date	**Time**	**Air Temp.**	**Water Temp.**	**Diss. Oxygen**	**pH**	**Conduct.**	**Specific Conduct.**	**Sal.**	**Turb.**	**Flow**	**Nitra.**	**Ortho-Phosph.**	**Total Phosph.**	**BOD**	**E. Coli**
	(24:00)	**(°C)**	**(°C)**	**(mg/L)**		**(mhos)**	**(mhos)**	**(ppt)**	**(NTU)**	**ft³/sec**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(CFU/100ml)**
6/4/2007	9:20	21.5	20.6	5.10	8.29	543	594	0.3	8.54	6.59	0.2	0.23	<0.3	<4.00	687
7/3/2007	10:05	19.3	20.1	8.23	8.73	513	563	0.3	6.35	-	2.7	0.15	0.41	<2.00	1553
8/15/2007	9:55	22.4	21.8	6.65	8.36	254.7	271.4	0.1	7.33	-	0.5	0.25	0.46	<2.00	>2419
9/10/2007	10:50	24.6	21.7	8.03	8.25	543	579	0.3	3.19	-	0.5	0.23	0.34	<3.00	2419
10/29/2007	14:00	11.3	10.5	10.27	8.39	444.3	613	0.3	2.50	0.34	1.7	0.25	0.25	<2.00	162
11/27/2007	10:08	0.5	5.8	12.76	10.52	379.8	600	0.3	11.00	-	1.2	0.33	0.18	<2.00	>2419
12/18/2007	9:50	-1.11	2.3	13.36	7.27	188.4	332.7	0.2	5.1	-	3.1	0.33	0.19	<2.00	179
1/17/2008	11:05	0	3.7	10.83	9.5	218.4	370.4	0.2	8.3	-	1.1	0.36	0.19	<2.00	96
2/18/2008	10:55	2	3.9	12.15	7.9	255.9	427.5	0.2	110	-	14.4	0.77	1.04	<2.00	816
3/20/2008	10:35	10	3.5	12.85	8.28	105.2	193.5	0.1	148	-	*	2.31	0.61	<2.00	464
4/14/2008	10:30	5	7.1	11.45	7.21	285	432.6	0.2	5	-	0.2	0.07	0.20	<2.00	228
5/14/2008	11:35	13.3	13.3	8.54	7.82	392.6	452.4	0.2	33	-	0.3	0.18	0.81	<2.00	1120
8/5/2008	13:00	24.1	22.8	7.3	7.42	543	567	0.3	20	-	-	-	-	-	-
10/6/2008	15:10	25	16.9	10.35	7.78	534	632	0.3	3.48	-	-	-	-	-	-

Spring flow was taken on June 4 and 5

*Fall flow was taken on October 15 and 16

* Value exceeds test range

Water Quality Data from Sugar Creek Station 8															
Date	**Time**	**Air Temp.**	**Water Temp.**	**Diss. Oxygen**	**pH**	**Conduct.**	**Specific Conduct.**	**Sal.**	**Turb.**	**Flow**	**Nitra.**	**Ortho-Phosph.**	**Total Phosph.**	**BOD**	**E. Coli**
	(24:00)	**(°C)**	**(°C)**	**(mg/L)**		**(mhos)**	**(mhos)**	**(ppt)**	**(NTU)**	**ft³/sec**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(CFU/100ml)**
6/4/2007	8:55	19.7	20.4	5.12	8.70	346.1	379	0.2	7.71	4.24	0.6	0.18	<0.3	<4.00	435
7/3/2007	9:50	19.8	19.7	7.14	8.84	432.1	480.9	0.2	6.68	-	0.0	0.25	0.54	<2.00	1300
8/15/2007	9:42	22.5	23.2	6.11	8.57	422.6	437.4	0.2	6.05	-	0.7	0.23	0.34	<2.00	387
9/10/2007	10:30	25.6	22.3	7.09	8.12	345.7	363.3	0.2	6.75	-	0.4	0.20	0.35	<3.00	192
10/29/2007	14:30	11.5	10.6	10.10	8.39	485	673	0.3	3.20	0.26	0.0	0.00	0.25	<2.00	162
11/27/2007	10:50	0.5	6.5	12.42	9.56	398.1	617	0.3	7.80	-	1.4	0.11	0.18	<2.00	921
12/18/2007	9:30	-1.11	2.3	13.36	7.27	188.4	332.7	0.2	5.1	-	3.6	0.39	0.18	<2.00	199
1/17/2008	10:50	0	3.5	11.88	10.26	366.2	618	0.3	5.9	-	1.5	0.25	0.21	<2.00	140
2/18/2008	10:30	2	3.9	10.7	8.35	261	440.6	0.2	60	-	10.1	1.07	0.81	<2.00	299
3/20/2008	10:00	10	3.6	12.41	8.76	134	226.5	0.1	130	-	*	2.67	0.84	<2.00	341
4/14/2008	10:10	5	7.1	11.31	7.76	305.6	468.4	0.2	5	-	0.0	0.04	0.231	<2.00	99
5/14/2008	11:15	13.3	12.8	8.42	8.6	344.6	397.6	0.2	40	-	0.8	0.44	1.17	<2.00	2419
8/5/2008	14:30	24.4	21.9	7.53	7.74	425.3	450.7	0.2	47.9	-	-	-	-	-	-
10/6/2008	14:30	24	15.1	7.83	7.62	624	773	0.4	21.3	-	-	-	-	-	-

Spring flow was taken on June 4 and 5
*Fall flow was taken on October 15 and 16
* Value exceeds test range

APPENDIX D

SAMPLING STATION PHOTOGRAPHS

PHOTO 1

Date: 10/29/07

Picture of the upstream portion of Station 1 taken while collecting water chemistry samples.

PHOTO 2

Date: 6/5/07

Downstream picture of Station 2 taken while collecting macroinvertebrate samples.

PHOTO 3

Date: 6/5/07

Picture of the downstream potion of Station 3. Notice the heavy erosion on the outside bank. It drops approximately two to three feet into the water.

PHOTO 4

Date: 6/4/07

Picture of Station 4 taken while collecting water chemistry.

PHOTO 5

Date: 11/27/07

Upstream view of Station 5 taken while collecting water chemistry.

PHOTO 6

Date: 6/4/07

Upstream picture of Station 6 taken while collecting macroinvertebrates.

PHOTO 7

Date: 11/27/07

Picture from the bridge on CR 600 E facing upstream at Station 7.

PHOTO 8

Date: 11/27/07

Upstream view of Station 8 taken while collecting water chemistry.

APPENDIX E

MACROINVERTEBRATE PHOTOGRAPHS AND PURDUE UNIVERSITY LETTER

visio The vision
vertere to transform
virtute with excellence

December 19, 2007

Mr. Arwin Provonsha
Department of Entomology
901 W. State Street
West Lafayette, IN 47907-2089

Re: Invertebrate Voucher Specimens
Sugar Creek Watershed
Henry, Madison, Hancock, and Shelby counties, Indiana

Dear Mr. Provonsha:

Enclosed you will find forty-nine (49) representative macroinvertebrate specimens in individually labeled vials. The accompanying photo-documentation of each provides location and taxonomic identification. Also enclosed is a station location map and table. This voucher collection is being submitted to Purdue University Department of Entomology as part of the Sugar Creek Watershed Study. This project is being done for the Hancock County Soil and Water Conservation District. It would be greatly appreciated if our identification of these specimens could be verified.

Please contact me at 630-729-6290 if you have any questions or concerns. Thank you very much.

Sincerely,

V3 COMPANIES, LTD.

Walter Levernier
Ecologist

WGL/

Attachments

cc: Cindy Beckner, Hancock County Soil and Water Conservation District
V3 File

April 20, 2009

Mr. Arwin Provonsha
Department of Entomology
901 W. State Street
West Lafayette, IN 47907-2089

Re: Invertebrate Voucher Specimens
Sugar Creek Watershed
Henry, Madison, Hancock, and Shelby counties, Indiana

Dear Mr. Provonsha:

Enclosed you will find two (2) representative macroinvertebrate specimens in individually labeled vials. The accompanying photo-documentation of each provides location and taxonomic identification. This voucher collection is being submitted to Purdue University Department of Entomology as part of the Sugar Creek Watershed Study. This project is being done for the Hancock County Soil and Water Conservation District. It would be greatly appreciated if our identification of these specimens could be verified.

Please contact me at 630-729-6168 if you have any questions or concerns. Thank you very much.

Sincerely,

Jessica L. Dunn

Jessica Dunn
Ecologist

V3 Macroinvertebrate Spring Species List 2007										
			Number of individuals							
			Station Number							
ORDER	FAMILY	VIAL NUMBER	1	2	3	4	5	6	7	8
Nematomorpha		47	-	-	-	-	-	-	-	-
Hydracarina-Trombidiformes		17	5	4	-	-	-	1	1	-
Turbellaria		33	-	-	-	6	-	4	-	-
Pelecypoda	Corbiculidae	6	1	-	4	-	-	-	1	5
Gastropoda	Ancylidae	32	-	-	-	2	3	-	-	-
	Physidae	27	-	-	-	-	4	2	4	2
	Pleuroceridae	16	2	-	8	11	4	1	7	-
Annelida	Oligochaeta	45	-	-	-	-	-	-	-	-
Decapoda	Cambaridae	5	1	1	3	5	-	2	3	-
Amphipoda	Talitridae	41	-	-	-	-	-	2	1	-
Ephemeroptera	Polymitarcyidae	14	26	-	8	1	1	-	-	-
	Caenidae	9	2	3	3	-	-	6	4	-
	Baetidae	11	9	22	12	11	19	9	7	35
	Heptageniidae	12	12	6	12	13	27	6	4	2
	Tricorythidae	8	1	-	-	-	3	-	-	-
	Isonychiidae	13	4	1	5	13	7	-	3	-
Coleoptera	Dytiscidae	23	-	1	-	-	-	-	-	-
	Gyrinidae	39	-	-	-	-	1	-	-	-
	Haliplidae	44	-	-	-	-	-	-	1	-
	Dryopidae	21	-	-	-	-	-	-	-	-
	Scirtidae	48	2	-	-	-	-	-	-	-
	Elmidae	20, 38	9	8	17	18	8	26	14	12
	Psephenidae	28	-	-	1	16	8	3	21	-
	Hydrophilidae	24, 46	-	1	-	1	2	3	2	1
Trichoptera	Helicosychidae	34	-	-	-	2	2	3	9	-
	Hydropsychidae	15	39	25	28	31	20	13	21	28
	Leptoceridae	36	-	-	-	1	-	-	-	-
	Odontoceridae	37	-	-	-	4	6	-	3	-
	Philopotamidae	35	-	-	-	1	-	-	-	-
	Polycentropodidae	29	-	-	6	-	2	-	-	-
Hemiptera	Belostomatidae	43	-	-	-	-	-	2	-	-
	Corixidae	22	-	4	-	-	7	1	1	-
	Gerridae	40	-	-	-	-	2	-	-	-
	Nepidae	30	-	-	-	1	-	-	-	-
	Veliidae	19	3	1	4	1	5	-	-	-
Plecoptera	Perlidae	18	8	2	-	5	3	6	20	4
Odonata-Anisoptera	Aeshnidae	1	2	1	3	1	1	1	-	2
	Gomphidae	2	3	-	-	-	-	-	-	-
	Libellulidae	49	-	-	-	-	-	-	-	-
Odonata-Zygoptera	Calopterygidae	3	-	2	1	1	2	1	1	1
	Coenagrionidae	4	3	-	2	-	1	4	2	1
Diptera	Blood-red Chironomidae	7	7	26	8	2	11	20	18	20
	Other Chironomidae	10	6	13	12	7	6	18	24	13
	Culicidae	26	-	4	-	-	-	-	-	-
	Simuliidae	25	-	9	-	1	-	-	9	19
	Tipulidae	31	-	-	-	1	3	3	1	3
	Tabanidae	42	-	-	-	-	-	2	-	-

V3 Macroinvertebrate Fall Species List 2007										
			Number of individuals Station Number							
ORDER	**FAMILY**	**VIAL NUMBER**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nematomorpha		47	-	-	-	-	-	-	-	1
Hydracarina-Trombidiformes		17	5	8	-	4	4	5	2	27
Turbellaria		33	-	-	-	-	2	1	5	-
Pelecypoda	Corbiculidae	6	4	-	-	4	1	3	-	-
Gastropoda	Ancylidae	32	3	3	14	9	1	9	-	7
	Physidae	27	-	-	-	3	-	2	-	-
	Pleuroceridae	16	1	-	4	-	-	-	-	-
Annelida	Oligochaeta	45	2	4	-	4	1	-	-	6
Decapoda	Cambaridae	5	-	-	-	-	-	2	-	-
Amphipoda	Talitridae	41	-	1	-	3	-	1	-	-
Ephemeroptera	Polymitarcyidae	14	-	-	-	-	-	-	-	1
	Caenidae	9	1	10	-	-	3	-	2	70
	Baetidae	11	27	15	22	21	14	15	10	21
	Heptageniidae	12	18	4	17	36	47	25	7	5
	Tricorythidae	8	-	-	5	17	10	-	-	-
	Isonychiidae	13	17	3	21	-	-	12	10	-
Coleoptera	Dytiscidae	23	-	-	-	4	-	-	-	-
	Gyrinidae	39	-	-	-	-	-	-	-	-
	Haliplidae	44	-	-	-	-	-	-	-	-
	Dryopidae	21	-	-	-	-	-	-	-	1
	Scirtidae	48	-	-	-	-	-	-	-	-
	Elmidae	20, 38	15	15	21	6	14	5	8	1
	Psephenidae	28	2	-	5	5	17	13	13	1
	Hydrophilidae	24, 46	-	-	-	-	-	-	1	-
Trichoptera	Helicosychidae	34	-	1	7	4	2	6	23	1
	Hydropsychidae	15	61	102	69	26	49	65	52	1
	Leptoceridae	36	-	-	-	-	-	-	-	1
	Odontoceridae	37	-	-	-	2	-	5	-	-
	Philopotamidae	35	3	4	1	2	9	8	9	-
	Polycentropodidae	29	-	-	-	-	-	-	-	-
Hemiptera	Belostomatidae	43	-	-	-	-	-	-	-	-
	Corixidae	22	-	-	-	-	-	-	-	-
	Gerridae	40	-	-	-	-	-	-	-	-
	Nepidae	30	-	-	-	-	-	-	-	-
	Veliidae	19	-	-	-	-	-	-	-	-
Plecoptera	Perlidae	18	1	-	3	-	-	-	-	-
Odonata-Anisoptera	Aeshnidae	1	5	1	1	1	-	1	-	-
	Gomphidae	2	-	-	-	-	-	1	-	3
	Libellulidae	49	-	-	-	-	-	-	-	1
Odonata-Zygoptera	Calopterygidae	3	1	1	1	1	2	1	-	-
	Coenagrionidae	4	3	-	1	2	1	4	1	-
Diptera	Blood-red Chironomidae	7	-	5	3	2	7	2	18	-
	Other Chironomidae	10	-	-	3	-	6	1	7	-
	Culicidae	26	-	-	-	1	-	-	-	1
	Simuliidae	25	-	1	2	2	-	3	1	-
	Tipulidae	31	-	1	-	-	-	-	-	2
	Tabanidae	42	-	5	1	1	1	2	5	4

V3 Macroinvertebrate Spring Species List 2008										
			Number of individuals							
			Station Number							
ORDER	**FAMILY**	**VIAL NUMBER**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nematomorpha		47	-	-	-	-	-	-	-	-
Hydracarina-Trombidiformes		17	2	4	-	3	-	2	2	-
Turbellaria		33	-	-	-	-	-	-	-	-
Pelecypoda	Corbiculidae	6	1	2	-	6	4	1	4	11
Gastropoda	Ancylidae	32	-	-	1	-	4	-	1	-
	Physidae	27	-	-	-	3	3	3	5	-
	Pleuroceridae	16	-	-	-	-	-	-	-	-
Annelida	Oligochaeta	45	3	7	-	2	2	1	3	6
Decapoda	Cambaridae	5	-	-	-	1	1	-	-	-
Amphipoda	Talitridae	41	-	-	-	-	-	-	-	-
Ephemeroptera	Polymitarcyidae	14	-	-	15	1	-	-	-	-
	Caenidae	9	-	1	11	5	2	2	20	5
	Baetidae	11	7	63	3	2	8	11	39	3
	Heptageniidae	12	10	1	38	6	19	2	37	4
	Tricorythidae	8	1	-	-	-	7	-	-	-
	Isonychiidae	13	1	-	-	36	1	5	-	-
Coleoptera	Dytiscidae	23	-	-	-	-	-	-	-	-
	Gyrinidae	39	-	-	-	-	-	-	-	-
	Haliplidae	44	-	-	-	-	-	-	-	-
	Dryopidae	21	-	-	2	1	-	-	-	-
	Scirtidae	48	-	-	-	-	-	-	-	-
	Elmidae	20, 38	5	10	25	17	22	26	40	4
	Psephenidae	28	-	-	4	41	16	1	8	-
	Hydrophilidae	24, 46	-	-	-	-	-	-	-	-
Lepidoptera	Pyralidae	51	-	-	-	-	-	-	1	-
Trichoptera	Helicosychidae	34	-	-	-	-	-	-	2	-
	Hydropsychidae	15	69	38	39	76	58	78	20	-
	Leptoceridae	36	-	-	-	-	-	-	-	-
	Odontoceridae	37	-	-	-	2	26	2	7	-
	Philopotamidae	35	-	-	-	-	-	-	-	-
	Polycentropodidae	29	-	-	-	-	-	-	-	-
Megaloptera	Corydalidae	50	1	-	-	-	-	-	-	-
Hemiptera	Belostomatidae	43	-	-	-	-	-	-	-	-
	Corixidae	22	-	-	-	-	-	-	-	-
	Gerridae	40	-	-	-	-	-	-	-	-
	Nepidae	30	-	-	-	-	-	-	-	-
	Veliidae	19	-	-	-	-	-	-	-	-
Plecoptera	Perlidae	18	-	-	-	-	1	-	-	-
Odonata-Anisoptera	Aeshnidae	1	-	-	-	-	-	-	-	-
	Gomphidae	2	-	-	-	-	-	-	-	-
	Libellulidae	49	-	-	-	-	-	-	-	-
Odonata-Zygoptera	Calopterygidae	3	-	-	-	-	-	-	1	-
	Coenagrionidae	4	-	-	-	-	-	-	-	-
Diptera	Blood-red Chironomidae	7	1	-	-	-	-	-	-	-
	Other Chironomidae	10	9	112	51	11	27	21	21	60
	Culicidae	26	-	1	-	-	-	-	-	1
	Simuliidae	25	4	3	2	16	2	30	2	-
	Tipulidae	31	-	-	6	4	6	2	-	-
	Tabanidae	42	-	3	-	2	-	-	-	1

V3 Macroinvertebrate Fall Species List 2008										
			Number of individuals Station Number							
ORDER	**FAMILY**	**VIAL NUMBER**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nematomorpha		47								-
Hydracarina-Trombidiformes		17	1	2	1	1	-	2	2	-
Turbellaria		33	-	-	-	-	-	-	-	-
Pelecypoda	Corbiculidae	6	3	-	-	6	2	-	-	-
Gastropoda	Ancylidae	32	-	4	10	6	2	2	2	-
	Physidae	27	-	-	1	8	1	-	2	-
	Pleuroceridae	16	-	-	-	-	-	-	-	-
Annelida	Oligochaeta	45	2	5	1	-	-	4	-	-
Decapoda	Cambaridae	5	-	1	-	1	-	-	1	-
Amphipoda	Talitridae	41	-	1	-	-	-	-	-	-
Ephemeroptera	Polymitarcyidae	14	-	-	-	-	-	-	-	-
	Caenidae	9	14	4	-	-	15	2	4	-
	Baetidae	11	39	37	17	14	8	12	19	-
	Heptageniidae	12	38	17	35	53	7	24	5	-
	Tricorythidae	8	3	19	11	2	-	-	-	-
	Isonychiidae	13	-	-	11	22	16	5	15	-
Coleoptera	Dytiscidae	23	-	-	-	-	-	-	-	-
	Gyrinidae	39	-	-	-	-	-	-	-	-
	Haliplidae	44	-	-	-	-	-	-	-	-
	Dryopidae	21	2	1	-	-	-	-	-	-
	Scirtidae	48	-	-	-	-	-	-	-	-
	Elmidae	20, 38	11	15	19	18	30	46	34	-
	Psephenidae	28	3	1	11	2	9	14	31	-
	Hydrophilidae	24, 46	-	-	-	-	1	-	-	-
Lepidoptera	Pyralidae	51	-	-	-	-	-	-	1	-
Trichoptera	Helicosychidae	34	-	-	-	-	-	-	-	-
	Hydropsychidae	15	44	117	48	84	126	51	97	-
	Leptoceridae	36	-	-	-	-	-	-	-	-
	Odontoceridae	37	-	-	-	-	3	1	-	-
	Philopotamidae	35	3	2	1	4	5	7	3	-
	Polycentropodidae	29	-	-	-	1	-	-	-	-
Hemiptera	Belostomatidae	43	-	-	-	-	-	-	-	-
	Corixidae	22	-	-	-	-	-	-	-	-
	Veliidae	19	-	-	-	-	-	1	-	-
Plecoptera	Perlidae	18	13	-	-	-	-	-	-	-
Odonata-Anisoptera	Aeshnidae	1	-	-	-	-	-	-	-	-
	Gomphidae	2	-	-	-	-	-	-	-	-
	Libellulidae	49	-	-	-	-	-	2	-	-
Odonata-Zygoptera	Calopterygidae	3	-	-	-	-	-	3	2	-
	Coenagrionidae	4	1	-	-	-	-	-	-	-
Diptera	Blood-red Chironomidae	7	1	-	-	-	-	-	-	-
	Other Chironomidae	10	18	3	33	4	13	13	38	-
	Culicidae	26	-	2	1	-	-	3	-	-
	Simuliidae	25	3	2	-	11	4	5	1	-
	Tipulidae	31	4	-	-	1	1	1	2	-
	Tabanidae	42	2	1	1	12	-	1	1	-

Sugar Creek
Macroinvertebrates
Vial 1

Family: *Aeshnidae*
Common Name:
Darner Dragonflies

Stations:
Spring '07: 1, 2, 3, 4, 5, 6, 8
Fall '07: 1, 2, 3, 4, 5, 6

Sugar Creek
Macroinvertebrates
Vial 2

Family: *Gomphidae*
Common Name:
Clubtail Dragonflies

Stations:
Spring '07: 1
Fall '07: 6, 8

Sugar Creek
Macroinvertebrates
Vial 3

Family: *Calopterygidae*
Common Name:
Broad-Winged Damselflies

Stations:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 1, 2, 3, 4, 5, 6
Spring '08: 7
Fall '08: 6, 7

Sugar Creek
Macroinvertebrates
Vial 4

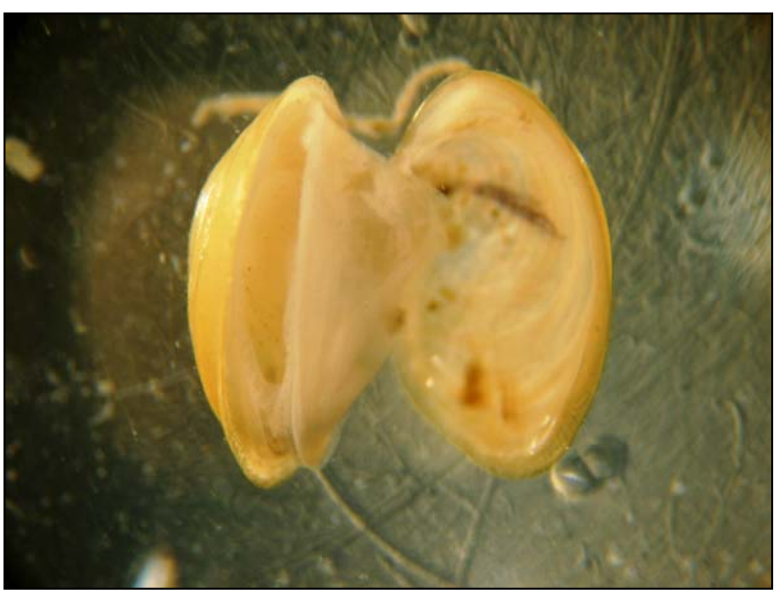
Family: *Coenagrionidae*
Common Name:
Narrow-Winged
Damselflies

<u>Stations</u>:
Spring '07: 1, 3, 5, 6, 7, 8
Fall '07: 1, 2, 3, 4, 5, 6, 7
Fall '08: 1

Sugar Creek
Macroinvertebrates
Vial 5

Family: *Cambaridae*
Common Name:
Crayfish

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 2, 6
Spring '08: 4, 5
Fall '08: 2, 4, 7



Sugar Creek
Macroinvertebrates
Vial 6

Family: *Corbiculidae*
Common Name:
Asian Clam

<u>Stations</u>:
Spring '07: 1, 3, 7, 8
Fall '07: 1, 4, 5, 6, 7
Spring '08: 1, 2, 4, 5, 6, 7, 8
Fall '08: 4, 5

Sugar Creek
Macroinvertebrates
Vial 7

Family: "Red" *Chironomidae*
Common Name:
Non-Biting Midges

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 2, 3, 4, 5, 6, 7
Spring '08: 1
Fall '08: 1

Sugar Creek
Macroinvertebrates
Vial 8

Family: *Tricorythidae*
Common Name:
Little Stout Crawler
Mayflies

<u>Stations</u>:
Spring '07: 1, 5
Fall '07: 3, 4, 5
Spring '08: 1, 5
Fall '08: 1, 3, 4, 5

Sugar Creek
Macroinvertebrates
Vial 9

Family: *Caenidae*
Common Name:
Small Square-Gill Mayflies

<u>Stations</u>:
Spring '07: 1, 2, 3, 6, 7
Fall '07: 1, 2, 5, 7, 8
Spring '08: 2, 3, 4, 5, 6, 7, 8
Fall '08: 1, 2, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 10

Family: *Chironomidae*
Common Name:
Non-Biting Midges

Stations:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 3, 5, 6, 7
Spring '08: 1, 2, 3, 4, 5, 6, 7, 8
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 11

Family: *Baetidae*
Common Name:
Small Minnow Mayflies

Stations:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 1, 2, 3, 4, 5, 6, 7, 8
Spring '08: 1, 2, 3, 4, 5, 6, 7, 8
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 12

Family: *Heptageniidae*
Common Name:
Flathead Mayflies

Stations:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 1, 2, 3, 4, 5, 6, 7, 8
Spring '08: 1, 2, 3, 4, 5, 6, 7, 8
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 13

Family: *Isonychiidae*
Common Name:
Brush-Legged Mayflies

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 7
Fall '08: 1, 2, 3, 4, 6, 7
Spring '08: 1, 4, 5, 6
Fall '08: 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 14

Family: *Polymitarcyidae*
Common Name:
Pale Burrowing Mayflies

<u>Stations</u>:
Spring '07: 1, 3, 4, 5
Fall '07: 8
Spring '08: 3, 4

Sugar Creek
Macroinvertebrates
Vial 15

Family: *Hydropsychidae*
Common Name:
Net-Spinner Caddisflies

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '07: 1, 2, 3, 4, 5, 6, 7, 8
Spring '08: 1, 2, 3, 4, 5, 6, 7
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 16

Family: *Pleuroceridae*
Common Name:
Freshwater Snails

<u>Stations</u>:
Spring '07: 1, 3, 4, 5, 6, 7
Fall '07: 1, 2, 3, 5

Sugar Creek
Macroinvertebrates
Vial 17

Order: *Hydracarina*
Common Name:
Water Mite

<u>Stations</u>:
Spring '07: 1, 2, 3, 6, 7
Fall '07: 1, 2, 3, 5
Spring '08: 1, 2, 4, 6, 7
Fall '08: 1, 2, 3, 4, 6, 7

Sugar Creek
Macroinvertebrates
Vial 18

Family: *Perlidae*
Common Name:
Common Stonefly

<u>Stations</u>:
Spring '07: 1, 2, 4, 5, 6, 7, 8
Fall '07: 1, 3
Spring '08: 5
Fall '08: 1

Sugar Creek
Macroinvertebrates
Vial 19

Family: *Veliidae*
Common Name:
Broad-Shouldered
Water Strider

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 7
Fall '08: 6

Sugar Creek
Macroinvertebrates
Vial 20

Family: *Elmidae*
Common Name:
Riffle Beetles

<u>Stations</u>:
Spring '07: 1, 2, 3, 4, 5, 6, 7, 8
Fall '08:1, 2, 3, 4, 5, 6, 7, 8
Spring '08: 1, 2, 3, 4, 5, 6, 7
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 21

Family: *Dryopidae*
Common Name:
Long Toed Water Beetles

<u>Stations</u>:
Spring '07: 1
Spring '08: 3, 4
Fall '08: 1, 2

Sugar Creek
Macroinvertebrates
Vial 22

Family: *Corixidae*
Common Name:
Water Boatmen

<u>Stations</u>:
Spring '07: 2, 5, 7

Sugar Creek
Macroinvertebrates
Vial 23

Family: *Dytiscidae*
Common Name:
Predaceous Diving Beetles

<u>Stations</u>:
Spring '07: 2

Sugar Creek
Macroinvertebrates
Vial 24

Family: *Hydrophilidae*
Common Name:
Water Scavenger Beetles

<u>Stations</u>:
Spring '07: 2, 4, 5, 6, 7, 8

Sugar Creek
Macroinvertebrates
Vial 25

Family: *Simuliidae*
Common Name:
Black Flies, Buffalo Gnats

<u>Stations</u>:
Spring '07: 2, 4, 7, 8
Fall '07: 2, 3, 4, 6, 7
Spring '08: 1, 2, 3, 4, 5, 6, 7
Fall '08: 1, 2, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 26

Family: *Culicidae*
Common Name:
Mosquitoes

<u>Stations</u>:
Spring '07: 2
Fall '07: 2, 4, 8
Spring '08: 2, 8
Fall '08: 2, 3, 6

Sugar Creek
Macroinvertebrates
Vial 27

Family: *Physidae*
Common Name:
Tadpole Snails

<u>Stations</u>:
Spring '07: 2, 5, 6, 7, 8
Fall '07: 4, 6
Spring '08: 4, 5, 6, 7
Fall '08: 3, 4, 5, 7

Sugar Creek
Macroinvertebrates
Vial 28

Family: *Psephenidae*
Common Name:
Water Pennies

<u>Stations</u>:
Spring '07: 3, 4, 5, 6, 7
Fall '07: 1, 3, 4, 5, 6, 7, 8
Spring '08: 3, 4, 5, 6, 7
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 29

Family: *Polycentropodidae*
Common Name:
Tube-Making and
Trumpet-Net Caddisflies

<u>Stations</u>:
Spring 07': 3, 5
Fall '08: 4

Sugar Creek
Macroinvertebrates
Vial 30

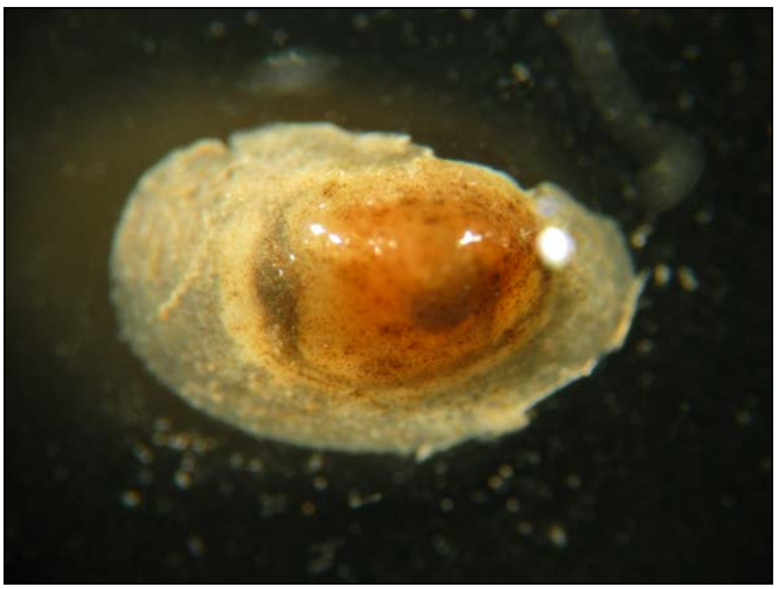
Family: *Nepidae*
Common Name:
Water Scorpions

<u>Stations</u>:
Spring '07: 4

Sugar Creek
Macroinvertebrates
Vial 31

Family: *Tipulidae*
Common Name:
Crane Flies

<u>Stations</u>:
Spring '07: 4, 5, 6, 7, 8
Fall '07: 2, 8
Spring '08: 3, 4, 5, 6
Fall '08: 1, 4, 5, 6, 7



Sugar Creek
Macroinvertebrates
Vial 32

Family: *Ancylidae*
Common Name:
Limpets

<u>Stations</u>:
Spring '07: 4, 5
Fall '07: 1, 2, 3, 4, 5, 6, 8
Spring '08: 3, 5, 7
Fall '08: 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 33

Class: *Turbellaria*
Common Name:
Planarians, Flatworms

<u>Stations</u>:
Spring '07: 4, 6, 7
Fall '07: 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 34

Family: *Helicopsychidae*
Common Name:
Snail Case-Maker
Caddisflies

<u>Stations</u>:
Spring '07: 4, 5, 6, 7
Fall '07: 2, 3, 4, 5, 6, 7, 8
Spring '08: 7

Sugar Creek
Macroinvertebrates
Vial 35

Family: *Philopotamidae*
Common Name:
Finger-Net Caddisflies

<u>Stations</u>:
Spring '07: 4
Fall '07: 1, 2, 3, 4, 5, 6, 7
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 36

Family: *Leptoceridae*
Common Name:
Long-Horned Caddisflies,
Case-Maker Caddisflies

<u>Stations</u>:
Spring '07: 4
Fall '07: 8

Sugar Creek
Macroinvertebrates
Vial 37

Family: *Odontoceridae*
Common Name:
Strong-Case Caddisflies

<u>Stations</u>:
Spring '07: 4, 5, 7
Fall '07: 4, 6
Spring '08: 4, 5, 6, 7
Fall '08: 5, 6

Sugar Creek
Macroinvertebrates
Vial 38

Family: *Elmidae*
Common Name:
Riffle Beetles

<u>Stations</u>:
Spring '07: 4, 5, 6, 7, 8
Fall '07: 1, 2, 4, 5, 6, 7
Spring '08: 1, 2, 3, 4, 5, 6, 7, 8
Fall '08: 1, 2, 3, 4, 5, 6, 7

Sugar Creek
Macroinvertebrates
Vial 39

Family: *Gyrinidae*
Common Name:
Whirligig Beetles

<u>Stations</u>:
Spring '07: 5

Sugar Creek
Macroinvertebrates
Vial 40

Family: *Gerridae*
Common Name:
Water Striders

<u>Stations</u>:
Spring '07: 5

Sugar Creek
Macroinvertebrates
Vial 41

Family: Talitridae
Common Name:
Scuds

<u>Stations</u>:
Spring '07: 6, 7
Fall '07: 4, 6, 8
Fall '08: 2

Sugar Creek
Macroinvertebrates
Vial 42

Family: *Tabanidae*
Common Name:
Horse Flies, Deer Flies

<u>Stations</u>:
Spring '07: 6
Fall '07: 1, 2, 3, 4, 5, 6, 7, 8
Spring '08: 2, 4, 8
Fall '08: 1, 2, 3, 4, 6, 7

Sugar Creek
Macroinvertebrates
Vial 43

Family: *Belostomatidae*
Common Name:
Giant Water Bugs

<u>Stations</u>:
Spring '07: 6

Sugar Creek
Macroinvertebrates
Vial 44

Family: *Haliplidae*
Common Name:
Crawling Water Beetles

<u>Stations</u>:
Spring '07: 7

Sugar Creek
Macroinvertebrates
Vial 45

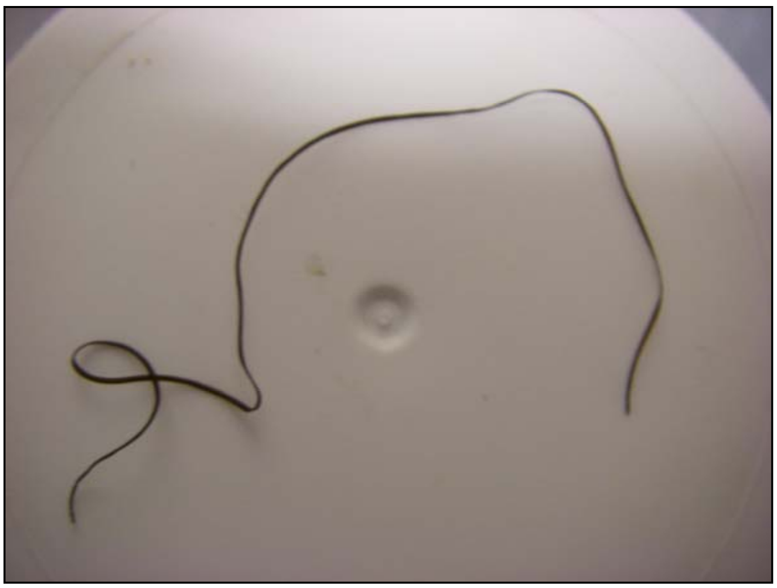
Class: *Oligochaeta*
Common Name:
Earthworms

<u>Stations</u>:
Fall '07: 1, 2, 4, 5, 6, 7, 8
Spring '08: 1, 2, 4, 5, 6, 7, 8
Fall '08: 1, 2, 3, 6

Sugar Creek
Macroinvertebrates
Vial 46

Family: *Hydrophilidae*
Common Name:
Water Scavenger Beetles

<u>Stations</u>:
Fall '07: 7
Fall '08: 5



Sugar Creek
Macroinvertebrates
Vial 47

Phylum: *Nematomorpha*
Common Name:
Horse Hair Worms

<u>Stations</u>:
Fall '07: 8

Sugar Creek
Macroinvertebrates
Vial 48

Family: *Scirtidae*
Common Name:
Marsh Beetles

<u>Stations</u>:
Fall '07: 8

Sugar Creek
Macroinvertebrates
Vial 49

Family: *Libellulidae*
Common Name:
Emerald Dragonflies and
Green-Eyed Skimmers

Stations:
Fall '07: 8
Fall '08: 6

Sugar Creek
Macroinvertebrates
Vial 50

Family: *Corydalidae*
Common Name:
Hellgrammite

Station:
Spring '08: 1

Sugar Creek
Macroinvertebrates
Vial 51

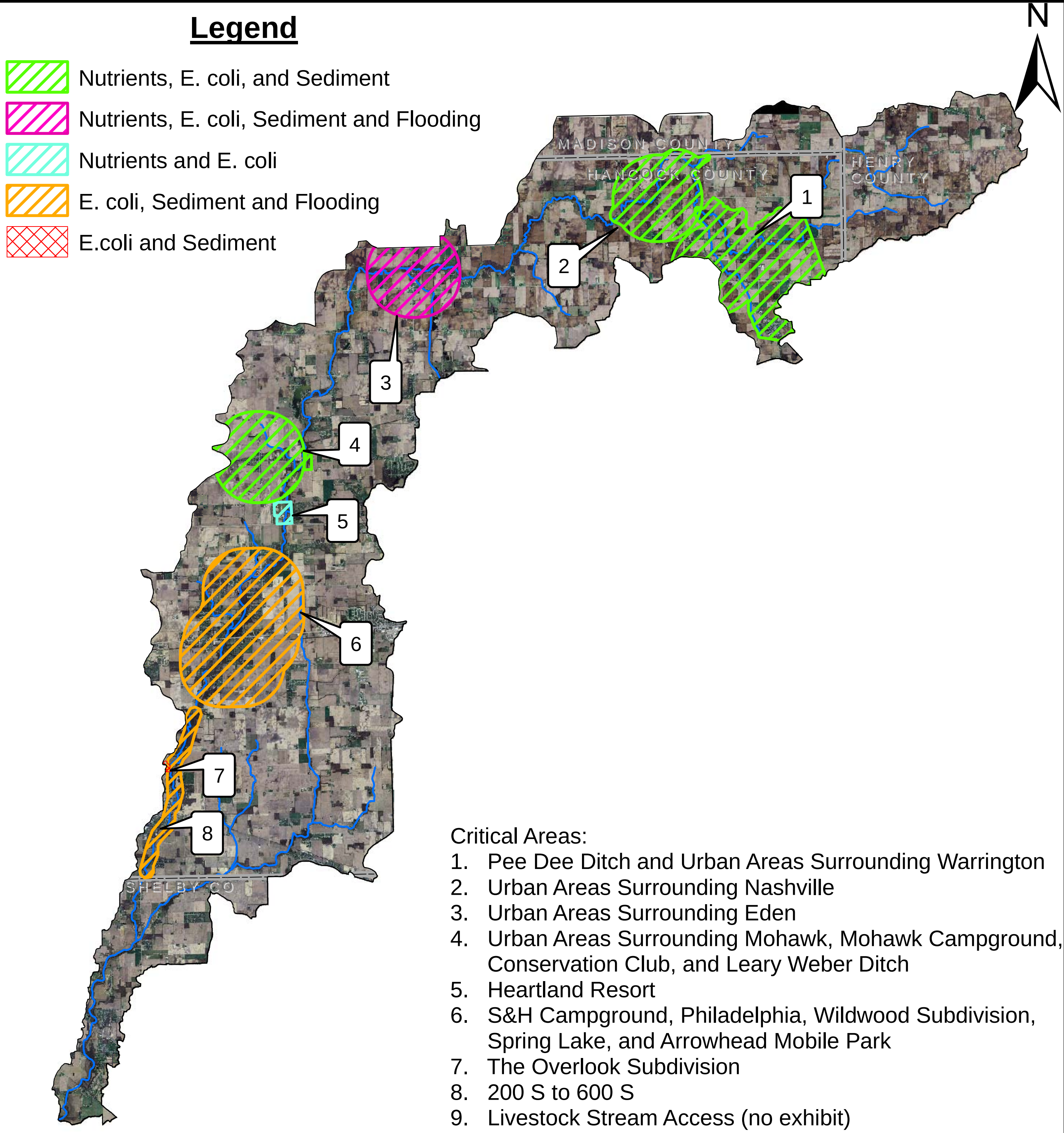
Family: *Pyralidae*
Common Name:
Moths

Stations:
Spring '08: 7
Fall '08: 7

APPENDIX F

THE HISTORY OF THE SUGAR CREEK STEERING COMMITTEE DETERMINING CRITICAL AREA LOCATIONS

Summary of Previous Critical Area Locations within the Sugar Creek Watershed									
Critical Area #	**Exhibit #**	**Name**	**County(s)**	**Township(s)**	***E. coli***	**Sediment**	**Nutrients**	**Flooding**	**Critical Area Acreage**
1	A-1	Pee Dee Ditch and Urban Areas Surrounding Warrington	Hancock County	Brown Township	X	X	X		4,029
2	A-2	Urban Areas Surrounding Nashville	Hancock and Madison Counties	Adams and Brown Townships	X	X	X		2,430
3	A-3	Urban Areas Surrounding Eden	Hancock County	Green Township	X	X	X	X	2,420
4	A-4	Urban Areas Surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch	Hancock County	Buck Creek Township	X	X	X		2,334
5	A-5	Heartland Resort	Hancock County	Buck Creek Township	X		X		128
6	A-6	S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park	Hancock County	Buck Creek and Sugar Townships	X	X		X	5,568
7	A-7	The Overlook Subdivision	Hancock County	Sugar Creek Township	X	X			29
8	A-8	200 S to 600 S	Hancock and Shelby Counties	Sugar Creek Township	X	X		X	838
9	N/A	Livestock Stream Access	Hancock, Madison and Shelby Counties	Throughout Watershed	X	X			-
				TOTAL:	**9**	**8**	**5**	**3**	**17,776**



Critical Areas:

1. Pee Dee Ditch and Urban Areas Surrounding Warrington
2. Urban Areas Surrounding Nashville
3. Urban Areas Surrounding Eden
4. Urban Areas Surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch
5. Heartland Resort
6. S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, and Arrowhead Mobile Park
7. The Overlook Subdivision
8. 200 S to 600 S
9. Livestock Stream Access (no exhibit)

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630.724.9202 fax
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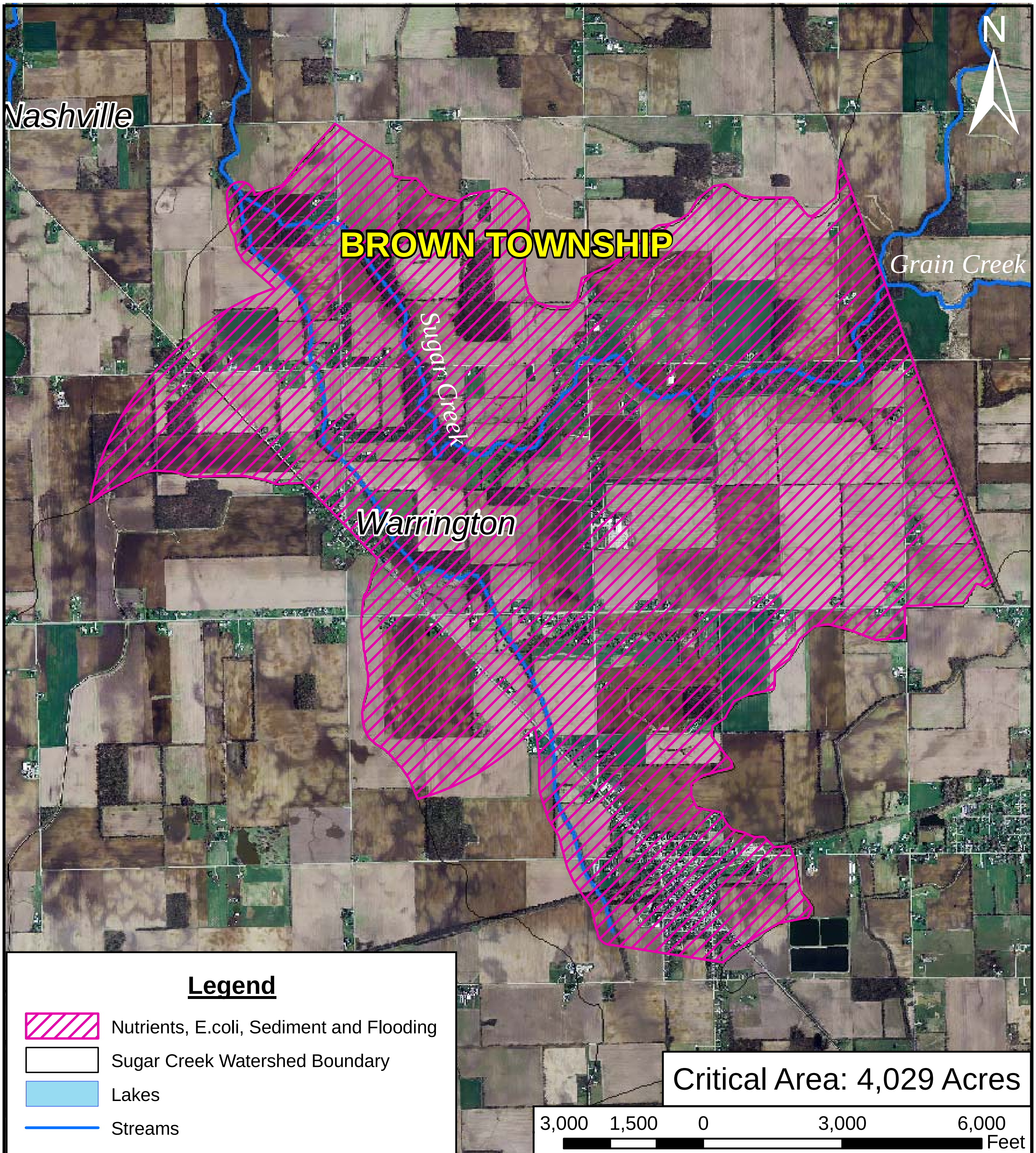
TITLE: **Previous Critical Areas**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 5/10/08	SCALE: NTS



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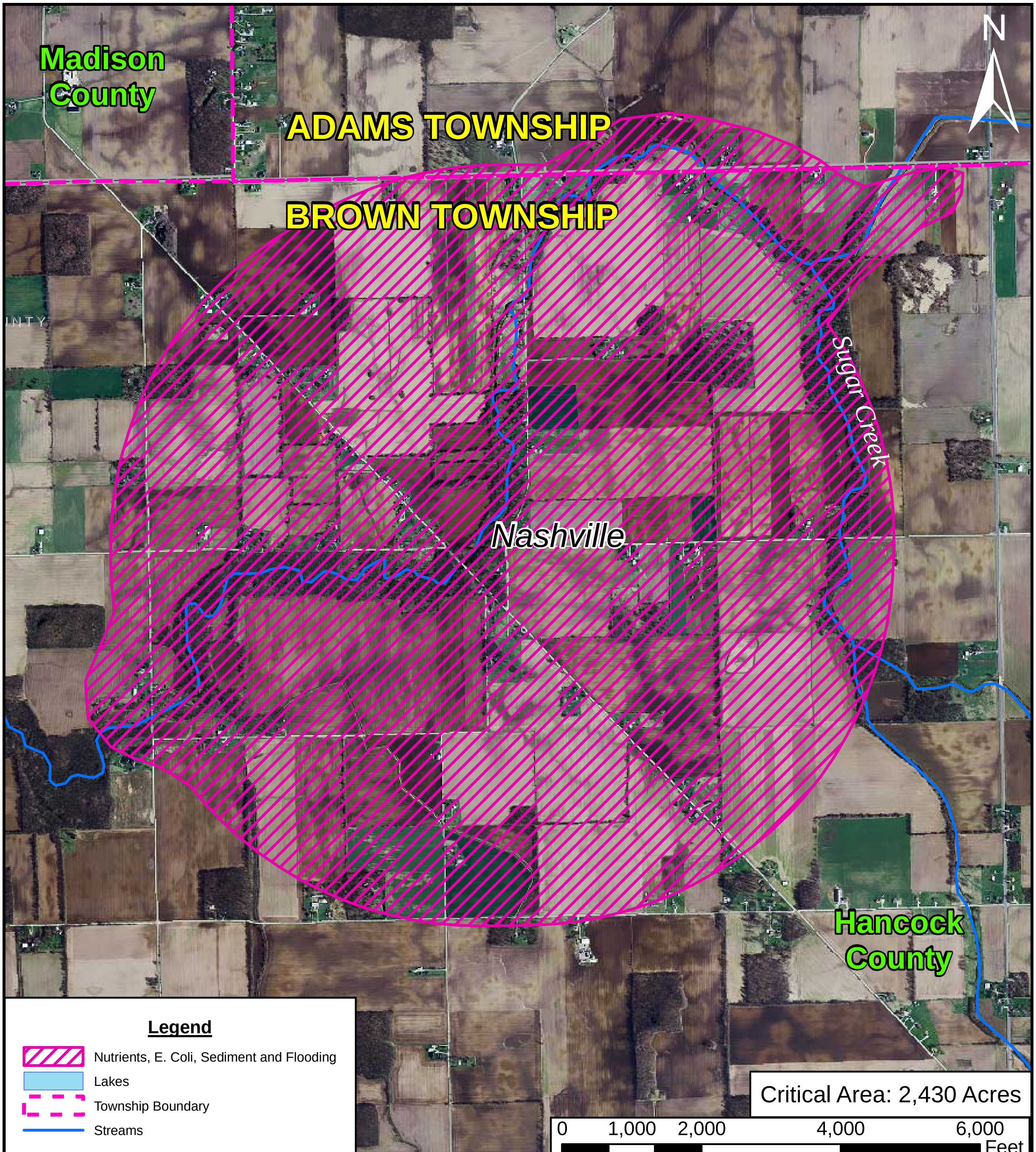
TITLE: 1 **Pee Dee Ditch and Urban Areas Surrounding Warrington Critical Area**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A - 1	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/18/08	SCALE: See Above



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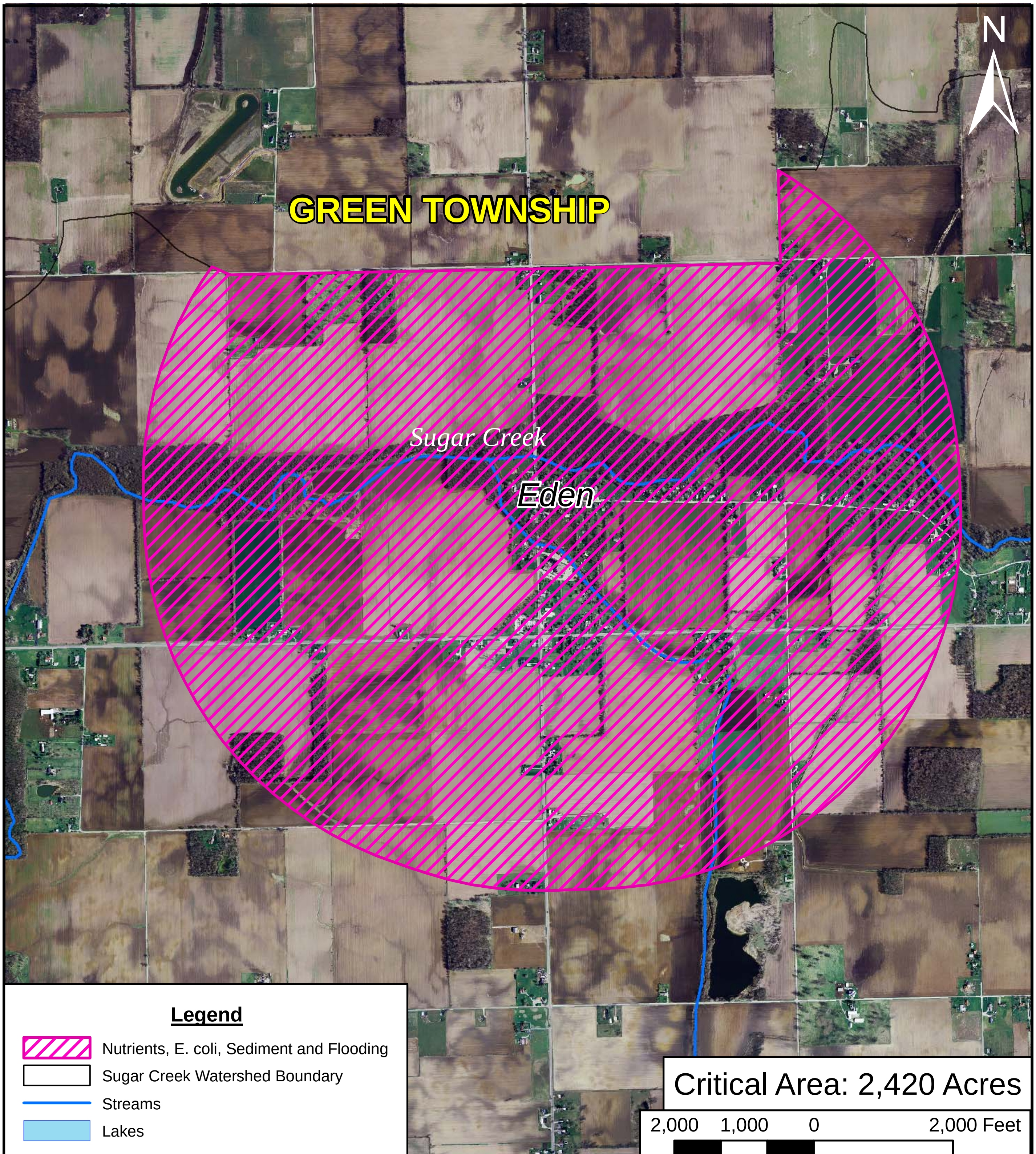
TITLE: 2 **Urban Areas Surrounding Nashville Critical Area**

PROJECT: **Sugar Creek Watershed Project**

BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal

CLIENT: Hancock County SWCD
1101 W. Main Street, Ste N
Greenfield, IN 46140

PROJECT NO.	EXHIBIT:	SHEET: 1 OF: 1
07065	A - 2	
QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above



Legend

- Nutrients, E. coli, Sediment and Flooding
- Sugar Creek Watershed Boundary
- Streams
- Lakes

Critical Area: 2,420 Acres

2,000 1,000 0 2,000 Feet

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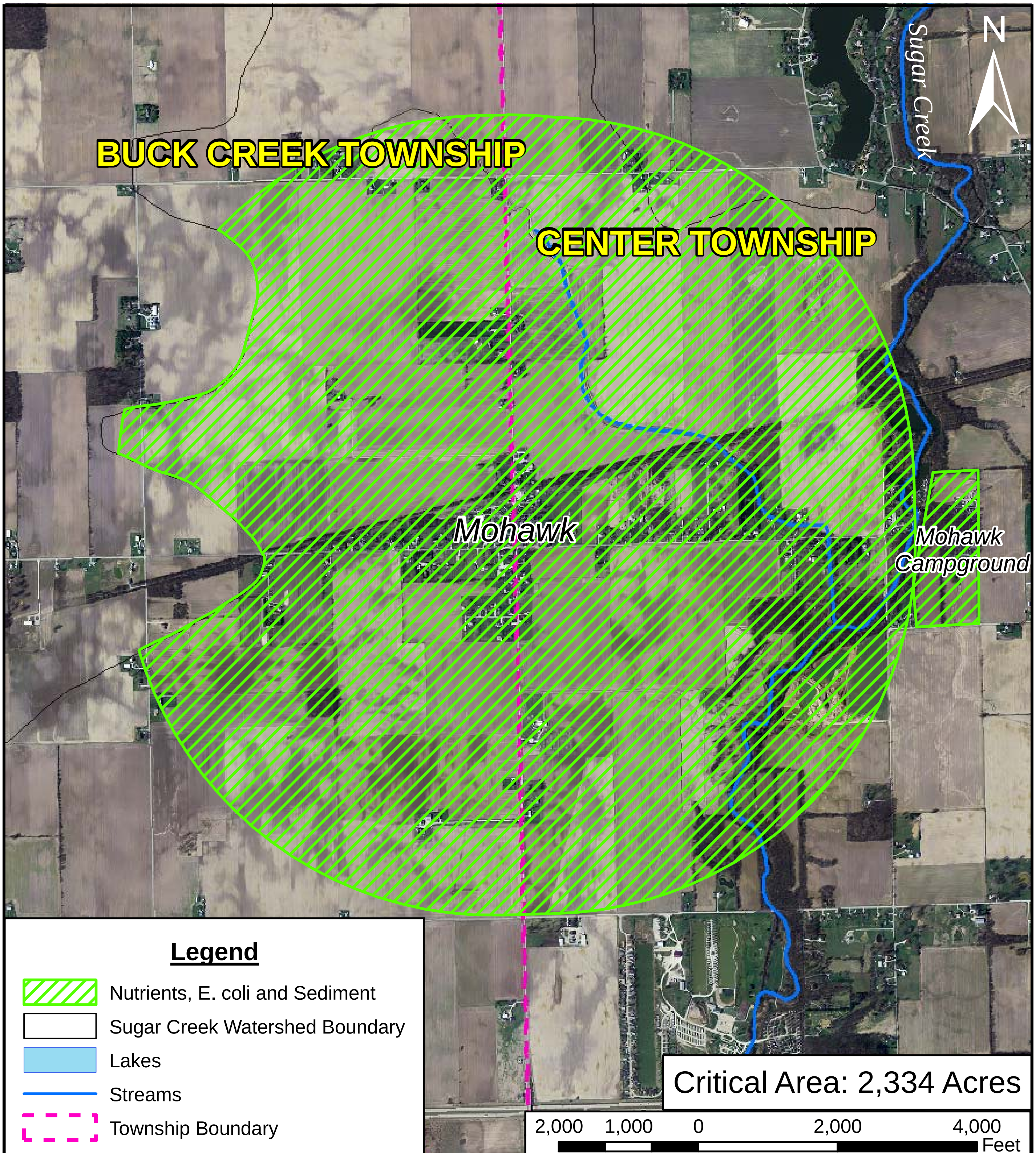
TITLE: 3 **Urban Areas Surrounding Eden Critical Area**

BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal

CLIENT: Hancock County SWCD, 1101 W. Main Street, Ste N, Greenfield, IN 46140

PROJECT: **Sugar Creek Watershed Project**

PROJECT NO.	EXHIBIT:	SHEET: 1 OF: 1
07065	A - 3	
QUADRANGLE: N/A	DATE: 6/11/08	SCALE: See Above



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630.724.9202 fax
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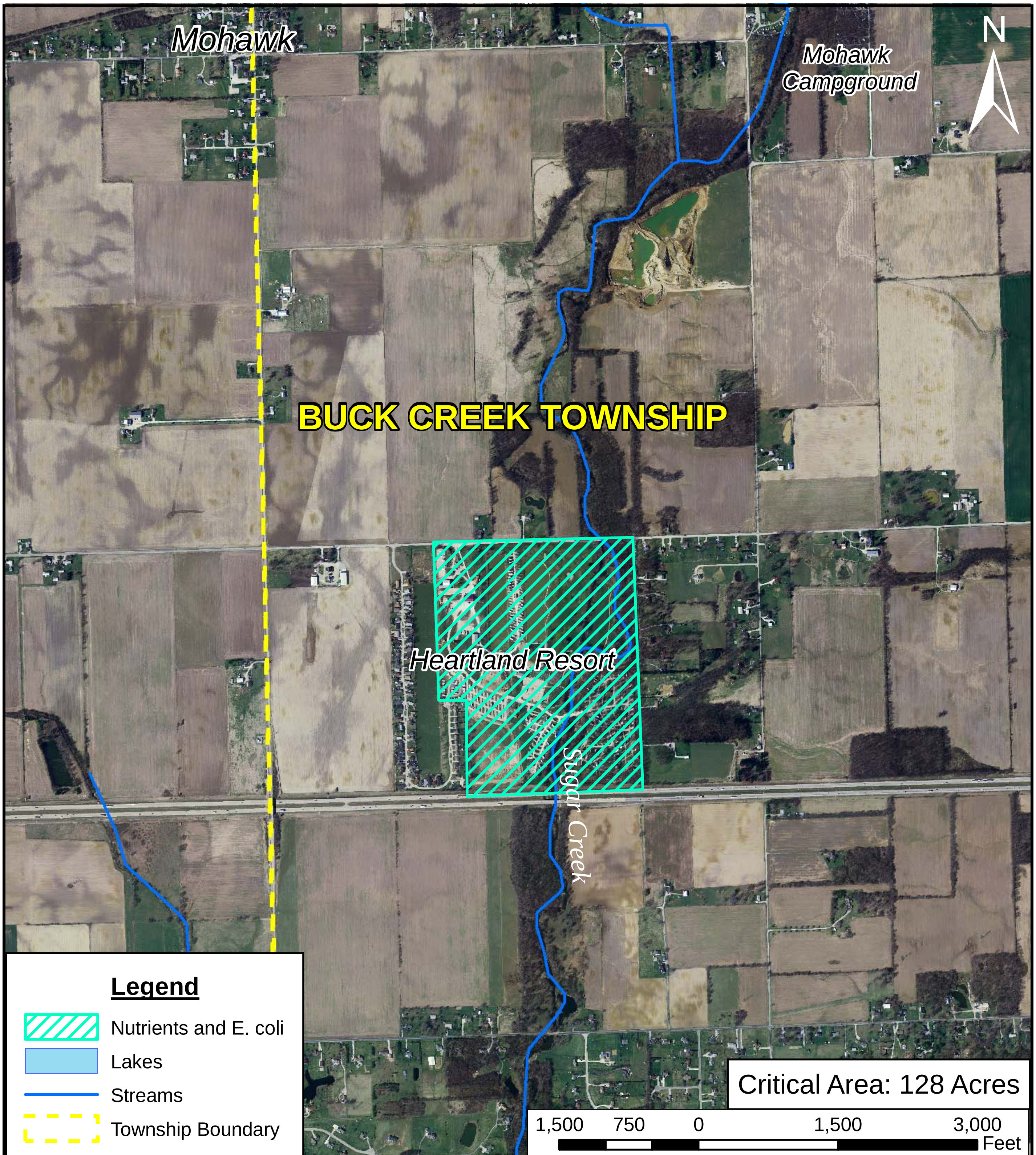
TITLE: 4 Urban Areas Surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch	PROJECT: Sugar Creek Watershed Project		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A - 4	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above



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630.724.9202 fax
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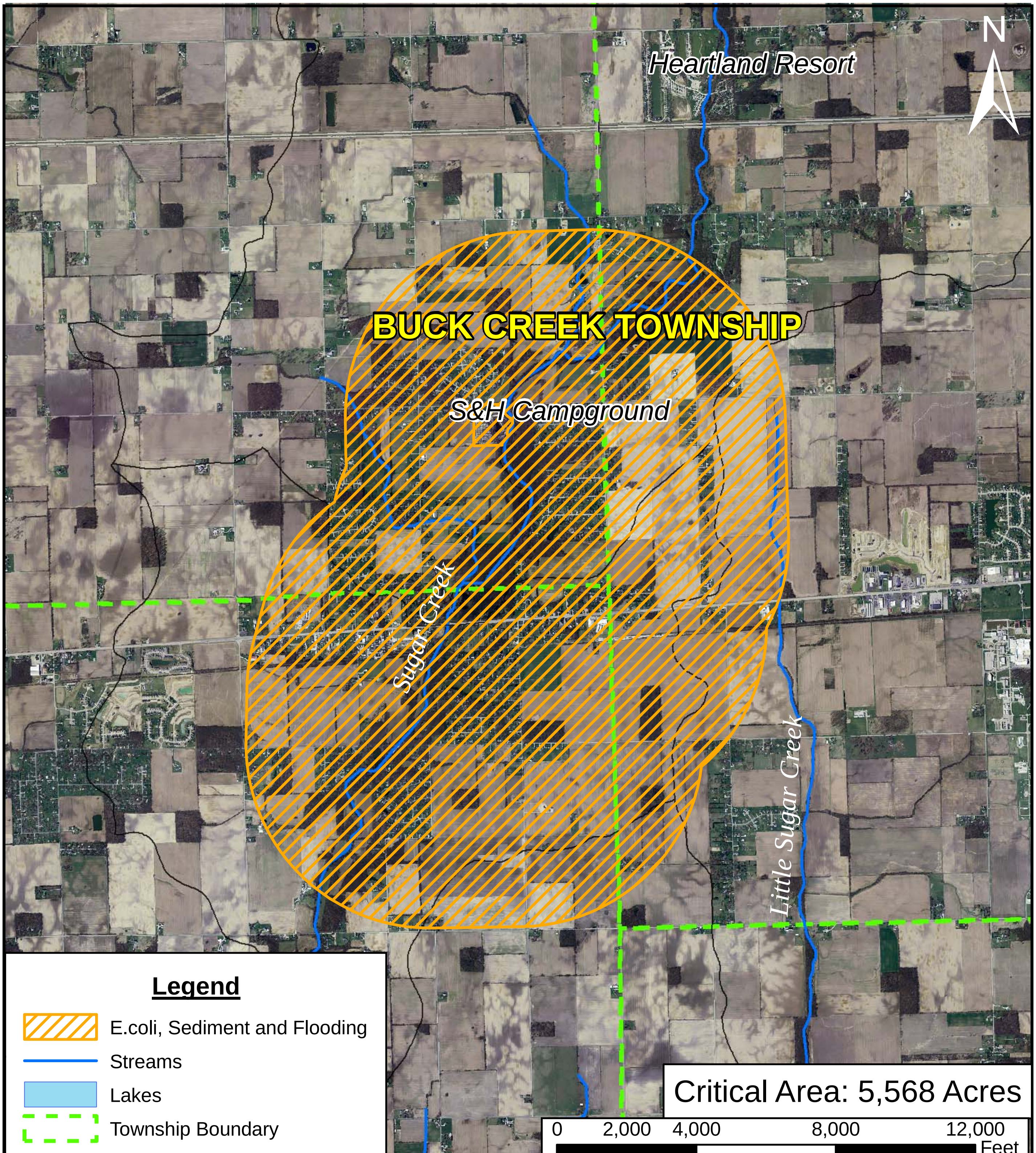
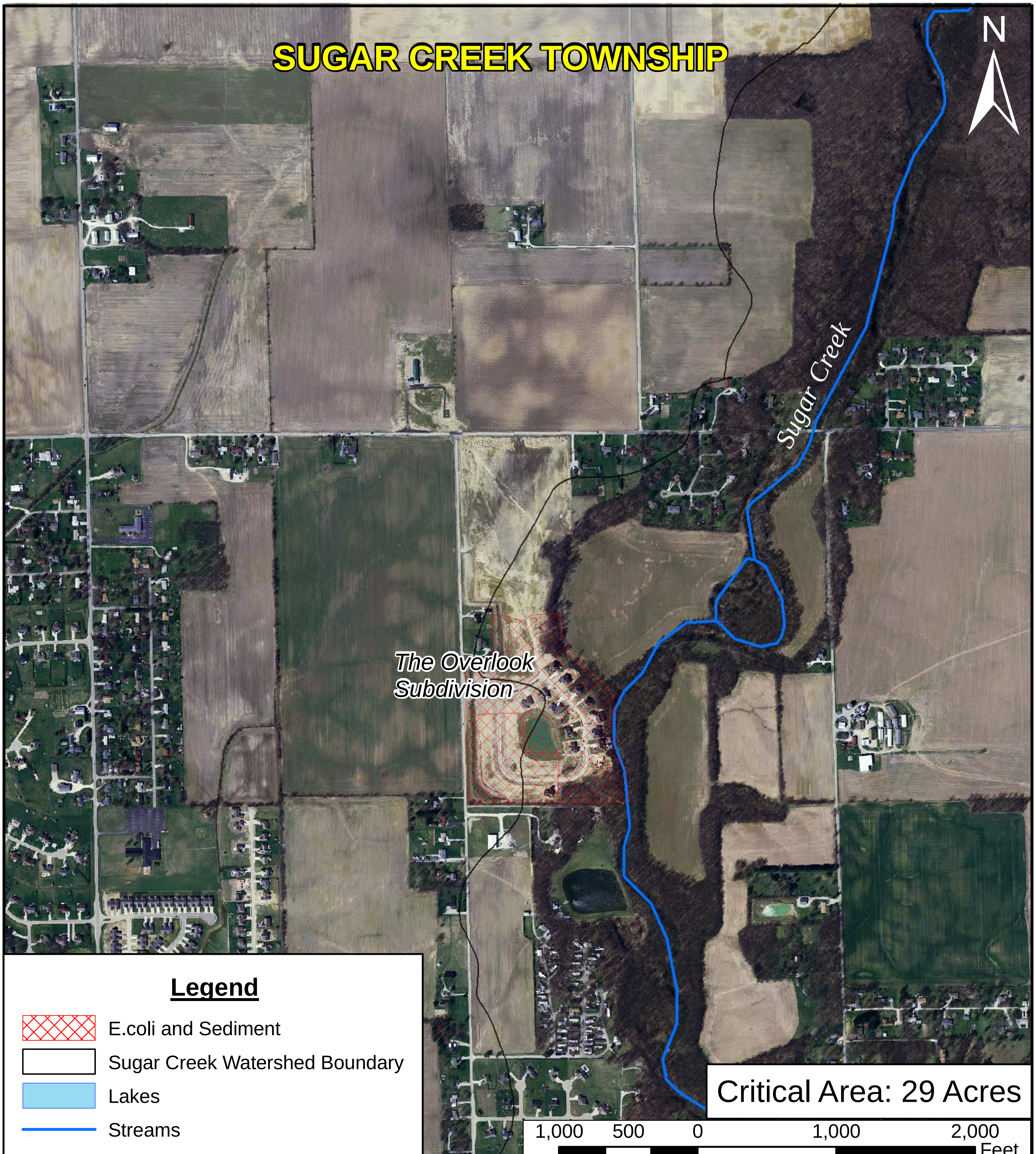
TITLE: 5 **Heartland Resort Critical Area**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A - 5	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: 6 S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake, Arrowhead Mobile Park Critical Area	PROJECT: Sugar Creek Watershed Project	
	BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A - 6	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above



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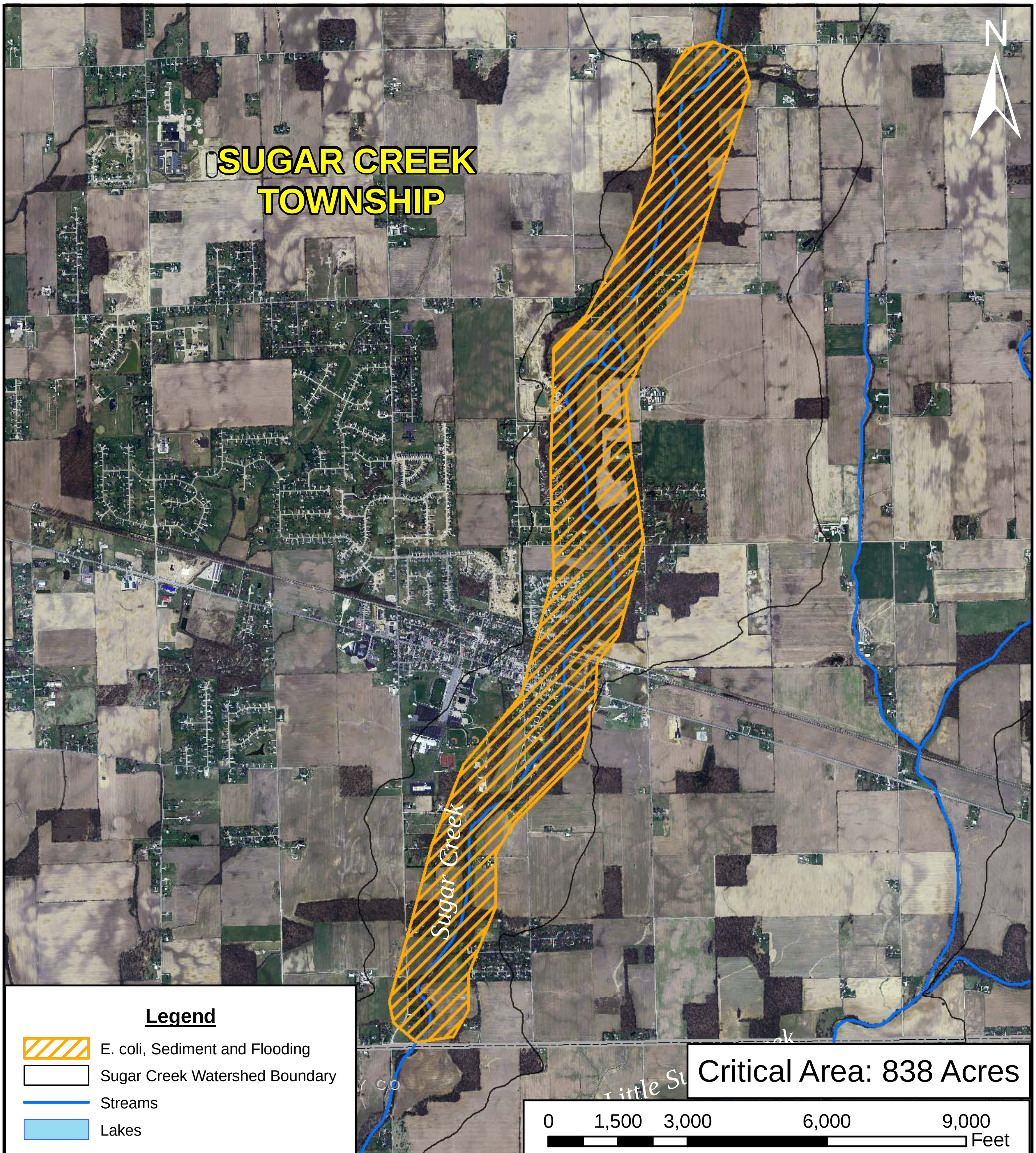
TITLE: 7 **The Overlook Subdivision Critical Area**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: A - 7	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above



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630.724.9202 fax
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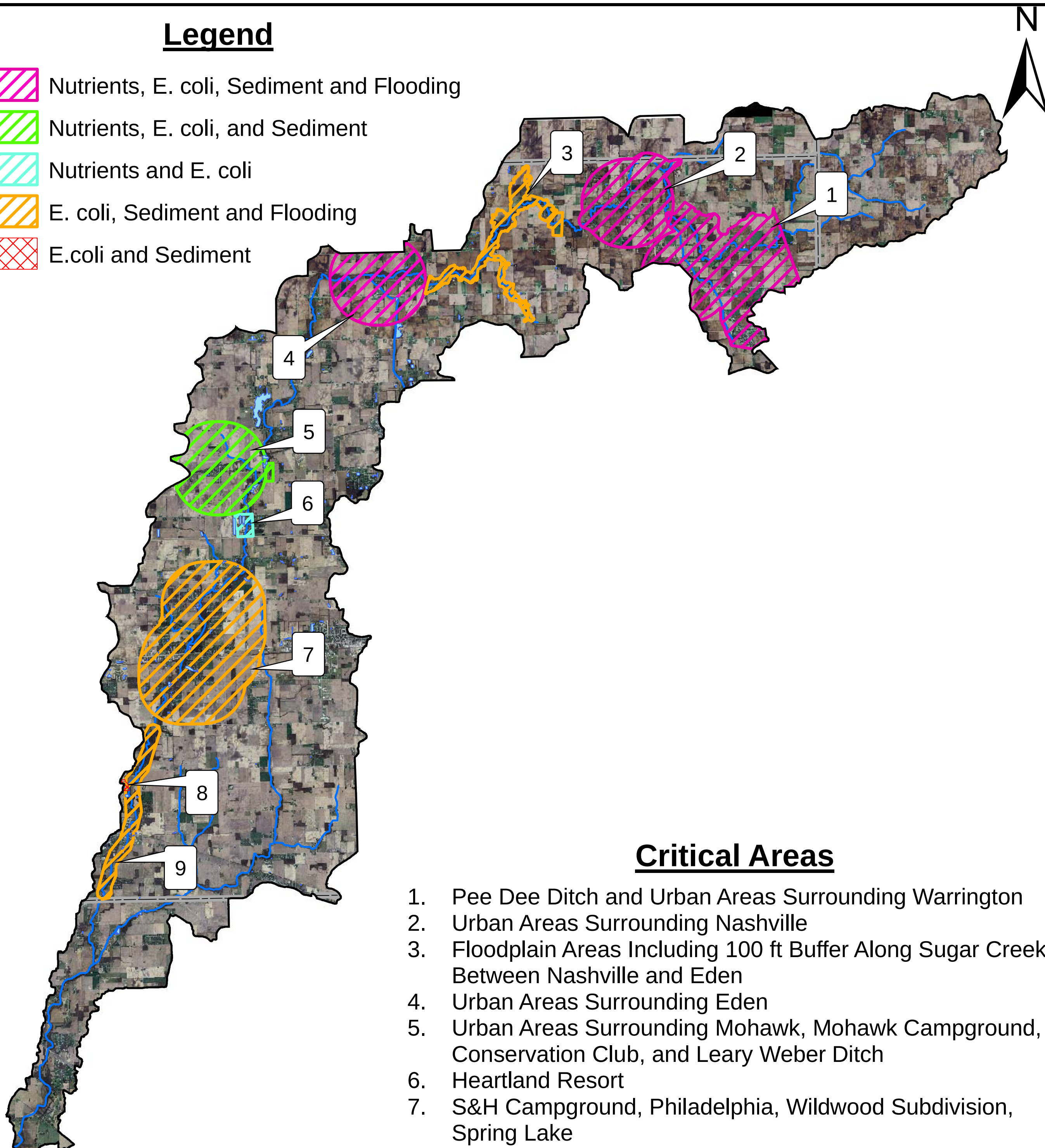
TITLE: 8	200 S to 600S Critical Area
BASE LAYER:	2005 Aerial Indiana University Spatial Data Portal
CLIENT:	Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140
PROJECT:	Sugar Creek Watershed Project
PROJECT NO.	07065
EXHIBIT:	A - 8
SHEET:	1 OF: 1
QUADRANGLE:	N/A
DATE:	6/12/08
SCALE:	See Above

Legend

- Nutrients, E. coli, Sediment and Flooding
- Nutrients, E. coli, and Sediment
- Nutrients and E. coli
- E. coli, Sediment and Flooding
- E.coli and Sediment



Critical Areas

1. Pee Dee Ditch and Urban Areas Surrounding Warrington
2. Urban Areas Surrounding Nashville
3. Floodplain Areas Including 100 ft Buffer Along Sugar Creek Between Nashville and Eden
4. Urban Areas Surrounding Eden
5. Urban Areas Surrounding Mohawk, Mohawk Campground, Conservation Club, and Leary Weber Ditch
6. Heartland Resort
7. S&H Campground, Philadelphia, Wildwood Subdivision, Spring Lake
8. The Overlook Subdivision
9. 200 S to 600 S
10. Livestock Stream Access (no exhibit)

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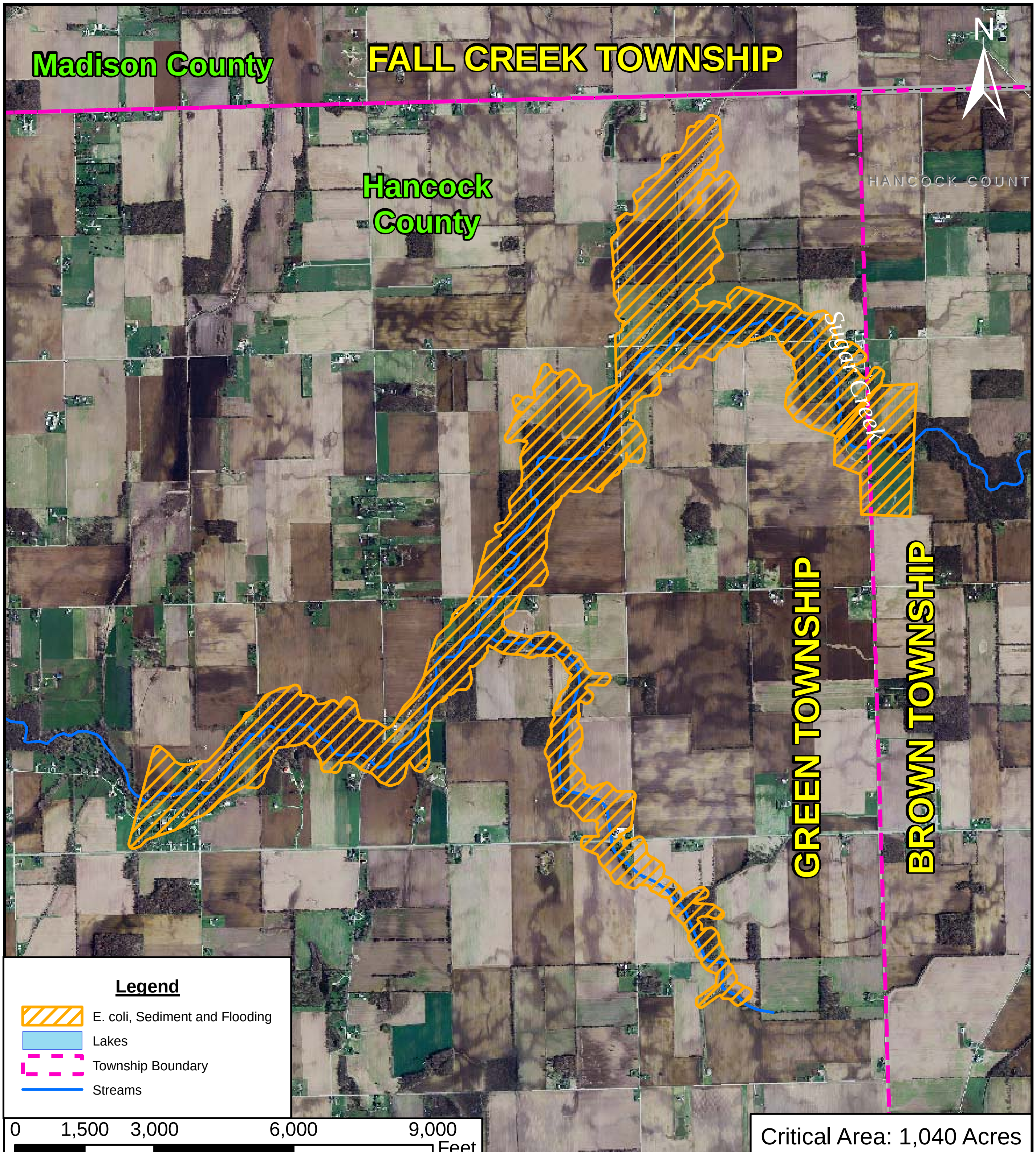
TITLE: **Critical Area Map as of August 2008**	PROJECT: **Sugar Creek Watershed Project**		
BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: B	SHEET: 1 OF: 1
CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 9/8/08	SCALE: NTS



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: 3 **Floodplain Areas Including 100 ft Buffer along Sugar Creek between Nashville and Eden**	PROJECT: **Sugar Creek Watershed Project**		
	BASE LAYER: 2005 Aerial Indiana University Spatial Data Portal	PROJECT NO. 07065	EXHIBIT: B - 1	SHEET: 1 OF: 1
	CLIENT: Hancock County SWCD 1101 W. Main Street, Ste N Greenfield, IN 46140	QUADRANGLE: N/A	DATE: 6/12/08	SCALE: See Above