2014 Pigeon Creek Watershed Management Plan

Steuben, LaGrange, DeKalb & Noble Counties
Indiana

NORTHWATER CONSULTING

Prepared By: Northwater Consulting

Steuben County Soil & Water Conservation District

Prepared For: Steuben County Soil and Water Conservation District

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STEUBEN COUNTY LAKES COUNCIL

NRCS Natural Resources Conservation Service

Steuben County Government

ANGOLA
City of Angola/Trine University MS4

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Project Contact Information:

Kayleen Hart
Administrative Coordinator
Steuben County Soil & Water Conservation District
Peachtree Plaza 200
1220 N 200 W
Angola, IN 46703
(260) 665-3211, X 3

List of Acronyms

AFO – Animal Feeding Operation
BMP – Best Management Practice
CAFO – Confined Animal Feeding Operation
CFO – Confined Feeding Operation
CFS - Cubic Feet Per Second
CSO – Combined Sewer Overflow
CRP – Conservation Reserve Program
CFU – Colony-Forming Unit
DO – Dissolved Oxygen
EQIP - Environmental Quality Incentives Program
EMC – Event Mean Concentration
EPA – Environmental Protection Agency
FEMA: Federal Emergency Management Agency
GIS – Geographical Information System
GLRI – Great Lakes Restoration Initiative
HEL – Highly Erodible Soils
HUC – Hydrologic Unit Code
IBI – Index of Biological Integrity
IDEM – Indiana Department of Environmental Management
IDNR – Indiana Department of Natural Resources
IBC – Impaired Biotic Community
LARE: Lake and River Enhancement Program
MS4 – Municipal Separate Storm Sewer System
MIBI – Macroinvertibrate Index of Biological Integrity
MGD – Million Gallons per Day
NPDES – National Pollutant Discharge Elimination System
NRCS: Natural Resources Conservation Service
NHD – National Hydrography Dataset
NPS – Nonpoint Source Pollution
N – Nitrogen
NWI – National Wetlands Inventory
P – Phosphorus
PCWMP – Pigeon Creek Watershed Management Plan
QHEI – Qualitative Habitat Evaluation Index
SCSWCD – Steuben County Soil and Water Conservation District
SCLC – Steuben County Lakes Council
SWAMM – Spatial Watershed Assessment and Management Model
STEPL – Spreadsheet Tool for Estimating Pollution Loading
TSS – Total Suspended Solids
TMDL – Total Maximum Daily Load
TSI - Trophic State index
TNC – The Nature Conservancy
T&E – Threatened and Endangered Species
USACE – U.S. Army Corps of Engineers
USLE – Universal Soil Loss Equation
USDA – U.S. Department of Agriculture
WLA - Waste Load Allocation
WWTP – Waste Water Treatment Plant
WQS – Water Quality Standards
WRP - Wetland Reserve Program
WASCOB – Water and Sediment Control Basin
WMP – Watershed Management Plan

Executive Summary

The Pigeon Creek Watershed

The Pigeon Creek watershed is 135,911 acres in size and located in the northeast corner of Indiana. Of this acreage, 71 percent is within Steuben County, and small sections of the watershed extend into three other counties; LaGrange (22 percent), DeKalb (6 percent), and Noble (0.5 percent). The Pigeon Creek watershed is primarily agricultural with three municipalities and small, unincorporated residential areas throughout. The lakes within the watershed are an important local resource for passive and active recreation, as well as for natural habitat.

The Pigeon Creek Watershed Management Plan

Reflecting the concerns of local residents and other area stakeholders about water quality and flooding, the goals of the *Pigeon Creek Watershed Management Plan* (WMP) are to reduce bacteria, nutrient, and sediment loads in the area's waterways, as well as to reduce and control flooding. High bacteria levels can harm human health and impact aquatic and recreational resources. Excessive sediment and nutrients have led to algae growth in the watershed's lakes and streams, and pose a concern for human health and aquatic resources. Besides damaging infrastructure, flooding contributes to excessive runoff and high levels of sediment, nutrients and bacteria entering the watershed's streams and lakes.

The 2014 WMP provides a framework for meeting these stated goals, while balancing the needs of the communities and stakeholders. As an update to the original WMP completed in 2006, it communicates the current health and function of the watershed, outlines the water quality and flooding issues, and defines the strategies to preserve and improve upon its current health. The WMP is the outcome of a comprehensive analysis that incorporates the 33-element checklist required by the Indiana Department of Environmental Management (IDEM) for WMP approval and eligibility for implementation funds under Section 319 of the Clean Water Act. Further, this plan exceeds the IDEM requirements by defining actionable implementation strategies, associated costs, and the expected resulting watershed benefits. The implementation strategies are directly tied to meeting the standards specified in the 2012 *Pigeon River Total Maximum Daily Load* (TMDL) *Plan*.

With the WMP in place, the Steuben County Soil and Water Conservation District (SCSWCD), adjoining counties and other watershed stakeholders have a mechanism to request and obtain funding to implement the suggested tools to accomplish the plan's goals for the public's health and quality of life.

The Results of the Watershed Assessment & Inventory

Since 1996, much work has been implemented in the watershed to reduce pollutants, including the installation of 140 treatment practices, as well as education and outreach campaigns and programs. This work demonstrates a willingness to address watershed concerns and achieve measurable success in improving water quality.

The 2014 watershed assessment and inventory, however, indicate that the watershed continues to produce high bacteria and nutrient loading, along with a moderate sediment load. *Loads* and *loading* refers to the amount of pollutants that enter a waterbody. Based on computer modeling, total loading estimated for phosphorus was 1.16 pounds from one acre of land per year; for nitrogen, 7.13 pounds; sediment, 0.94 tons; and bacteria, 2.72 billion colony-forming units. With the exception of sediment, all of these pollutants exceed state standards and require reductions established in the 2012 Pigeon River TMDL Plan.

In addition, water quality monitoring in the watershed shows that 269 of 627 samples exceed state standards for bacteria, 40 of 577 exceed the standard for phosphorus, 39 of 129 for nitrogen, and 46 of 574 for sediment. Nine of the watershed's 734 lakes and reservoirs and 179 of 257 stream-miles in the watershed are considered impaired by IDEM. The in-stream aquatic habitat in the watershed ranges from poor (low species diversity and sparse populations) to good (average species diversity with sufficient abundance). Flooding is also identified as an issue in the watershed. In 17 of the last 36 years, peak floodstage has been exceeded.

Most of the sediment and nutrients in the watershed originate from crop and pasture ground, whereas bacteria loads are believed to be the result of an estimated 1,365 failing septic systems, residential runoff, and concentrated animal waste. Wastewater discharges from the four treatment plants in the watershed are not the primary contributors to stream impairments. During the recreational months (April – October), when wastewater is being treated for bacteria (wastewater facilities do not treat for bacteria during the winter), monitoring results show these facilities to be operating within permitted limits. Conditions affecting flooding include changes in precipitation, soil types with high runoff potential, increases in impervious surfaces, and modifications to watershed hydrology such as channelization.

Recommendations to Meet Watershed Goals

Results of the planning process and a detailed assessment of the watershed indicate that specific Best Management Practices (BMPs) can reduce pollution loading, alleviate flooding, and meet stakeholder goals, if implemented on a large scale. Direct recommendations to meet the goals of the watershed plan include a wide range of improvement measures (Table 1).

These BMPs can be applied throughout the watershed; however, rather than leave these recommendations open-ended and for later study, this plan identifies a series of site-specific practices to treat 5,300 acres which can be implemented once the plan is finalized. Upon finalization of the plan, applications will be submitted to obtain grant funding for implementing these improvement measures.

Table 1 - Summary of Watershed Best Management Practices

Watershed Best Management Practices (BMPs)			
BMP	**Benefits**	**Rural**	**Urban**
Water and sediment control basins & terraces	Earthen berms constructed where water concentrates efficiently reduce sediment and phosphorus-loading and eliminate gully erosion.	✓	
Streambank stabilization	Rock placed along a streambank reduces or eliminates eroding stream banks.	✓	
Filter strips	Grass strips along a waterway efficiently reduce soil erosion and nitrogen runoff.	✓	
Cover crops on agricultural land	Temporary crops cost-effectively and efficiently reduce both sediment and nutrient loss.	✓	
Grassed waterways	Grassed channels or swales in a field stabilize gully erosion and manage runoff. Grassed waterways efficiently reduce nitrogen and sediment.	✓	
Tile inlet controls (blind inlets)	Restrictive plates installed on tile inlets (the entrance points to drain tiles) efficiently reduce phosphorus and sediment. Blind inlets (trenches filled with gravel or rock) replace open tiles and allow water to drain more slowly from a field.	✓	
Two-stage ditches	Two-stage ditches replace a traditional channelized ditch by extending out the banks and creating a "bench" or floodplain within the channel to improve water storage and capacity, and filter sediment and nutrients.	✓	
Bioreactors	A denitrifying bioreactor is a trench packed with carbonaceous material such as wood chips that allow colonization of soil bacteria that convert nitrates in drainage water to nitrogen gas. Installed before tile water enters a stream, bioreactors are extremely efficient at reducing nitrogen loading.	✓	
Pasture and livestock waste management	Pasture management and waste management can significantly reduce localized bacteria loading from livestock. If completed as a system, for an entire pasture and pastures across a watershed, these practices can substantially reduce sediment and nutrient runoff. Waste management systems include treating runoff and waste from small, non-permitted and concentrated feed areas. Pasture management includes rotating grazing areas, fencing off streams and crossings, diverting fresh water from entering already polluted water, and providing alternative water supplies for livestock fenced off from creeks.	✓	
Septic system inspections	This is recommended as a first step in addressing septic issues; identifying and repairing failing septic systems throughout the watershed.	✓	✓
Urban green infrastructure - rain barrels, rain gardens, and porous pavement	These urban BMPs reduce pollution loads from runoff and impervious surfaces (nonporous and paved). Reasonably efficient at reducing sediment, bacteria, and nutrient loads, primarily though reducing runoff, many urban BMPs (such as porous pavement) entail high costs associated with retrofitting or installation.		✓
Detention basins and ponds	Detention basins or ponds efficiently reduce sediments and nutrient and bacteria loads. In urban settings, they reduce stormwater runoff; in agricultural settings, they manage soil and nutrient loss or runoff from livestock waste.	✓	✓
Wetlands	Wetland restoration or creation is extremely efficient at reducing sediment, nutrient, and bacteria loads as wetlands act as natural filters and storage areas for runoff. Additional benefits include habitat for wildlife and passive recreation.	✓	✓

The Methodology; How the Assessments & Plan Were Completed

To complete the 33 elements that make up the IDEM's 33-element checklist, the detailed watershed assessment used a data-driven approach. All known and available information were gathered to verify and update the 2006 plan, as well as to generate new data and results. Methods comprised the latest technology such as Geographic Information Systems (GIS) and computer modeling to evaluate pollution causes and sources, along with conventional manual means such as direct observations of the watershed (through windshield surveys) and meetings with landowners. Independent assessments were made of water quality data, local soils, hydrology (water movement and drainage patterns), land use, precipitation, geology, and biology. A land-based pollution load model was developed to estimate annual and storm-event bacteria, nitrogen, phosphorus, and sediment loads. The windshield survey and landowner consultations resulted in identifying of a series of site-specific projects, and a GIS mapping platform and aerial image interpretation were used to further identify and delineate project areas, evaluate their drainage characteristics, and analyze data used to identify critical or priority subwatersheds.

These critical or priority subwatersheds were identified through applying a series of weighted criteria related to the plan's goals. In this way, the quality of each subwatershed could be scored and ranked. For example, the goal to reduce bacteria-loading was supported by assessing the data on total bacteria loads, acres of pasture, and number of bacteria impairments; the key indicators of bacteria issues. Each criterion was assigned a weight that was based on the quality of the data (for instance, whether the data source was a new sampling analysis or an older water quality analysis) and its relevance to the goal. The proportion of water quality samples in the watershed that exceed state standards was considered directly relevant; and broadly defined habitat areas for Threatened and Endangered (T&E) species or bacteria discharges within permitted limits would be less relevant.

Public input and participation is the foundation of this plan. The primary strategy for the 2014 update applied targeted personal-level meetings with key landowners, other watershed stakeholders, and local agency staff, such as from the Soil and Water Conservation Districts, the National Resources Conversation Service (NRCS), county assessor office, GIS Coordinator, and city governments. This approach verified that the information and concerns gathered at the public meetings originally held to develop the 2006 plan remain relevant today. The still-active Pigeon Creek Steering Committee, formed in 2006, updated the stakeholder concerns and facilitated further public participation in an April 9, 2013, meeting and in a later online posting of the results to garner additional input.

1.0 Introduction & Watershed Description

The 2014 Pigeon Creek Watershed Management Plan (WMP) is intended as a guide for the preservation and enhancement of the environment and quality of the watershed, while balancing the different uses and demands of the community and landowners. This current document is a comprehensive update to the 2006 WMP.

1.1 Introduction

Conservationists have developed comprehensive watershed management plans for the Pigeon Creek watershed since the mid-1960s. The 1967 *"Preliminary Investigation Report,"* a joint effort of the Steuben County and DeKalb County Soil and Water Conservation Districts (SWCD), was one of the first such plans for the watershed. The report identified the major watershed issues, such as frequent flood damage, inadequate drainage outlets, pollution of lakes and streams, and the necessity for additional fish and wildlife resources. A combination of land treatment and structural measures were proposed for implementation over a five-year period.

The Steuben County SWCD re-examined the watershed 20 years later, in 1987. The *"Watershed Protection Plan – Environmental Assessment for Pigeon Creek Watershed"* identified sheet and rill erosion as a major conservation, agricultural, and economic concern for the watershed. Through rain and shallow water flows, sheet erosion removes the thin layer of topsoil. When sheet flows begin to concentrate on the surface through increased water flow and velocity, rill erosion occurs. Rill erosion scours the land even more, carrying off rich nutrients and adding to the turbidity and sedimentation of waterways. These problems, along with sediment loads, have been abated somewhat with measures such as cover crops and tillage management, but they remain central concerns in the 2014 WMP.

The previous assessments, reports, and plans made important contributions to the watershed. The original 2006 Pigeon Creek WMP, however, was the first comprehensive assessment that fully engaged the public in a large concentrated and collaborative effort. The 2006 WMP laid the groundwork for securing funding for numerous on-the-ground and public education projects that have led to substantial watershed improvements. Since then, the 2012 *Pigeon River Watershed Total Maximum Daily Load (TMDL) Study* has complemented the WMP by providing additional goals to meet federally mandated load reduction targets.

This 2014 WMP, then, extends this series of watershed improvement efforts. In updating the 2006 WMP, it features these expanded benefits:

- ***Builds on past successes.*** This 2014 plan update summarizes BMP implementation, such as the 140 treatment practices installed since 2006 and the educational efforts over the past seven years.
- ***Reflects changes in the watershed***. The new treatment practices, as well as new sampling analyses and land uses, have created a different picture of the watershed from 2006 - revealing improvements as well as new impairments.

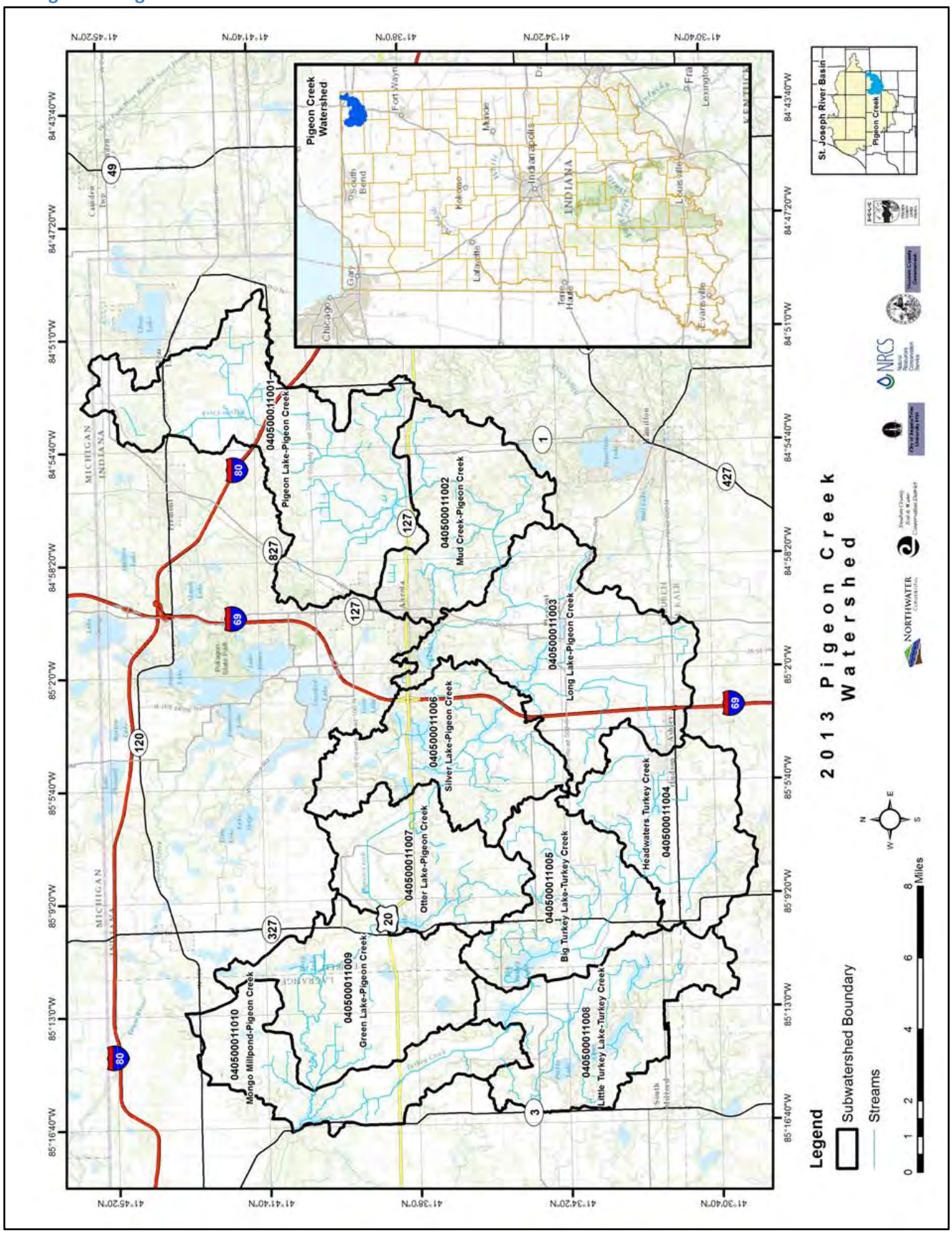
- ***Expands the geographic extent to include additional subwatersheds***. The 2006 WMP's watershed comprised 79,335 acres, mostly focused on Steuben County. Now it covers 135,911 acres and the watershed area that expands into the adjoining counties of DeKalb, Noble, and LaGrange. It is now geographically consistent with the federally designated hydrologic boundaries of Pigeon Creek (HUC 0405000110).
- ***Specifies actions to address water quality issues***. These actions are directly linked to load reduction targets defined in the 2012 *Pigeon River Watershed Total Maximum Daily Load* (TMDL) Study for *E. coli* and Impaired Biotic Community (IBC).
- ***Includes additional local stakeholder input and supplemental analysis***. The plan reflects changes in watershed goals identified by local stakeholders through the ongoing efforts of the Pigeon Creek Steering Committee.

Many of the historical planning documents, including the 2006 WMP, focused heavily on flooding. Although this plan addresses flooding, its focus is more concentrated on an integrated approach. This approach recognizes how water quality, flooding, and drainage are interrelated, so, for instance, management practices that reduce pollution loads can also achieve watershed goals related to flooding.

One of the plan's best management practices, for example, is the two-stage ditch that benefits both agriculture and the environment. The design of the two-stage ditch mirrors the natural processes of stable streams to reduce erosion, sediment and nutrients runoff, and flooding that conventional ditches can cause. The floodplain that runs alongside the ditch allows the water to have more area to spread out. This decreases the velocity of the flow while increasing the volume of water the ditch can process - improving drainage, water quality, and habitat and agricultural conditions.

Two-Stage Ditch; Pigeon Creek Watershed

Figure 1 - Pigeon Creek Watershed



1.2 General Watershed Description

The Pigeon Creek watershed is 135,911 acres and located in the northeast corner of Indiana. It is 71 percent within Steuben County, and small sections of the watershed extend into three other counties: LaGrange (22 percent), DeKalb (6 percent), and Noble (0.5 percent). The watershed is rural with predominant agricultural land use, and includes the small communities of Angola (population of 8,604), Ashley (population of 985), and Hudson (population of 516).

The watercourse includes seven reservoirs and generally flows westward for 31 miles across Steuben County, from its headwaters at Cedar Swamp to just beyond the border with LaGrange County where Pigeon Creek merges with Turkey Creek and other tributaries to form the Pigeon River at the Mongo Reservoir. Outside the watershed, the Pigeon River flows into the St. Joseph River, which flows into Lake Michigan. The watershed is in the Steuben Moranial Lake Physiographic region, characterized by rolling and hummocky or pot-hole topography. Most of the watershed soils are of sandy silt to silty clay composition. The mean annual temperature is 48°F with mean annual precipitation of 35 inches and monthly precipitation ranging from 2.3 to 3.6 inches.

The 2014 Pigeon Creek WMP consists of ten subwatersheds identified by a 12-digit Hydrologic Unit Code (HUC12) (Table 2).

Table 2 - 2014 & 2006 Pigeon Creek Watersheds

HUC 12 Subwatershed Codes	Total Watershed Area (acres)	Subwatershed Name	Portion of Subwatershed Assessed	
			2006 Plan	2014 Plan
040500011001	22,036	Pigeon Lake-Pigeon Creek	All	All
040500011002	11,641	Mud Creek-Pigeon Creek	All	All
040500011003	18,620	Long Lake-Pigeon Creek	Most	All
040500011004	11,798	Headwaters Turkey Creek	Portion	All
040500011005	11,015	Big Turkey Lake-Turkey Creek	Most	All
040500011006	12,954	Silver Lake-Pigeon Creek	All	All
040500011007	10,491	Otter Lake-Pigeon Creek	All	All
040500011008	13,255	Little Turkey Lake-Turkey Creek	Small Portion	All
040500011009	13,581	Green Lake-Pigeon Creek	Portion	All
040500011010	10,520	Mongo Millpond-Pigeon Creek	None	All

The watershed holds important recreational resources with permanent and seasonal residences around the open water lakes. Wildlife, fish, and game resources are also important within the watershed. The area's distinction noted in the 1967 *Preliminary Investigation Report* remains valid today: "Pigeon River and its watershed have been recognized over the years as one of the outstanding fish, game, and recreational areas of Indiana." Today, excellent fishing opportunities are available in various lakes and streams throughout the watershed. There is an abundance of wildlife in the watershed and large, contiguous blocks of habitat, primarily in the lower sections of Pigeon Creek, provide excellent hunting opportunities.

2.0 Plan Purpose & Public Participation

This section describes the reasons or motivation for this updated watershed management plan, the water quality concerns driving its development, and the key local leaders. It also describes the local Steering Committee and the public participation component that solicited the watershed concerns of local stakeholders. Much of the language found within this section is adapted from the 2006 WMP.

2.1 Plan Purpose

The decision to update the 2006 WMP was driven by the desire of local stakeholders to build upon the successes in the watershed and continue to seek funding resources for further improvement. Along with its purpose as a guide to protect and enhance the environment and quality of the Pigeon Creek watershed, the plan shall be used as a platform to request and obtain financial and technical resources to implement the recommended actions. Additional considerations include the need to expand the planning area to cover the entire Pigeon Creek watershed, including those subwatersheds within neighboring counties.

Local project partners felt that much of the work since the 2006 plan had been completed and the time was right to update the plan to establish a new direction for the watershed, identify new problems, assess changes in the watershed, and develop a site-specific plan with a vision more focused on water quality.

2.2 Watershed Steering Committee

For the 2006 watershed planning process, the Pigeon Creek WMP Steering Committee (Table 3) was formed to provide guidance and direction to the plan based on the members' broad array of experience to the planning process, including representation from conservationists, regulators, public officials, wastewater treatment facility operators, and other stakeholders. Meetings were open to the public and attended by state officials.

Despite some turnover in the Steering Committee membership, improvements realized by the implementation of watershed BMPs, and slightly less concern for flooding, local stakeholder concerns remain consistent with those originally identified in the 2006 WMP. The Steering Committee, therefore, continues to meet regularly to monitor and maintain watershed improvements.

Table 3 - Pigeon Creek Steering Committee Members

Name	Affiliation
Kayleen Hart	Steuben County SWCD
Chad Hoover	Steuben County GIS
Amanda Courtright/Zachary Martin	Steuben County SWCD
Brian Musser	Steuben Co. NRCS
Eric Henion	City of Angola
Representative	Steuben County Health Department
Bill Schmidt	Lakes Council
Bob Glick	Long Lake
Tom Green	Steuben County SWCD Chairman
Beth Warner	The Nature Conservancy
Ron Smith	County Commissioner
Leon Weaver	Pigeon Creek Dairy Owner
Pete Hippensteel	Pigeon Creek Landowner & Steuben County Lakes Council
Art & Sue Myers	Steuben County Lakes Council
Dana Slack	West Otter Lake
John & Nancy Williamson	West Otter Lake
Larry Gilbert	Steuben County Surveyor
Craig Williams	Angola Wastewater Treatment Plant
Lisa Ledgerwood	Wood Land Lakes
Jim Aikman	Hogback Lake
Kristy Clawson	Steuben County Emergency Management Director
Representative	Purdue Extension
Matt Meersman	Friends of the St. Joe
Frank Charlton	Steuben County Planning Commission

2.3 Stakeholder Concerns

As true for the results achieved from the 2006 WMP, this plan's success depends on continuing education, community involvement, and support from municipal, county, and state levels. During the 2006 planning process, the Steering Committee encouraged participation from a wide range of stakeholders in the watershed. Stakeholders included private landowners, operators or producers of large farmlands, governmental agencies, and industrial and commercial businesses. Environmental groups that monitor and promote habitat conservation within the area also continue to have a prominent interest in the watershed.

Given that watershed concerns have remained fairly constant, the Steering Committee decided to utilize and update what has already been gathered through previous and ongoing stakeholder participation meetings. To accomplish this, and build on the earlier public participation process, the Steering Committee held a formal open meeting on April 9, 2013, which was advertised locally through the Steuben County SWCD. The meeting focused on reviewing past stakeholder concerns, the goals identified in the 2006 plan, and changes in the watershed since then. Each of the 14 meeting participants completed a survey that listed each concern, problem, solution, and goal from the previous plan. Participants indicated whether each concern was still relevant and provided comments, when applicable. (The same handout was provided to the Steuben County SWCD Board on April 10, 2013,

which they completed and posted on the Steuben County website to garner additional input. Detailed results can be found in Appendix A.)

Table 4 lists the stakeholder responses, which indicate most of the concerns remain the same as in the 2006 plan. The highest and unanimous concerns related to water quality (pollution, bacteria) and soil erosion; the lowest concerns related to dying lakes and property values dropping because of retention ponds.

Overall, not much has changed since 2006. Table 4 lists stakeholder concerns compared with those noted in the 2006 plan.

Table 4 - Stakeholder Concerns

Concern (2006 Plan)	Still Concern (# yes)	Still Concern (# no)	New Concern
Little Long Lake Water Quality	7	1	Sedimentation
Water quality	4	0	*E. coli*, P, TSS
Water pollution	8	0	*E. coli*, P
Prevent West Otter Lake Flooding	3	1	
Unsewered areas / Nonpoint Source	6	1	*E. coli*
Pigeon Creek Dredging	4	3	
Flooding	7	1	
Angola bypass sewage to Pigeon	6	3	Still a concern but progress made
Opposition to maintaining regulated drains	2	3	
Broken Tile / Wetland	8	0	
Bacteria	9	0	Upper Pigeon
Soil erosion	8	0	
Common ground between humans and natural resources	3	4	
Nothing will be done	2	4	
Financial	7	1	
Less development	2	3	
Wildlife	6	1	
Hogback Lake Flooding	2	2	
Wetland enhancement	8	1	
Farm runoff	8	1	
Drainage – open ditch, highway, road	6	1	
Property values because of retention ponds	0	6	
Overextension of campgrounds	2	3	
Implement Plan	5	3	
Environmental Stewardship	4	1	
Dying lakes	0	6	
Spirit of cooperation	2	3	

During this same week in April, a small number of one-on-one meetings were held with willing landowners to identify and discuss additional concerns and potential project locations. The meetings included tours and evaluations of farming operations (such as row crops and pasture management for livestock), discussions of landowner concerns, and BMPs needed. Landowners expressed concerns

related to runoff, drainage, and local regulations. Project ideas were discussed and potential implementation sites were noted using GPS. These project locations are further discussed in Section 9.

Just one month earlier (March 13), the 2013 SWCD Board conducted a separate survey at its annual meeting (Appendix A). It included questions about the watershed, individual farming operations, resource concerns, and the SWCD in general. Results from this survey indicate the concerns shared with other stakeholders from the Steering Committee meeting, as well as a number of differences in perceptions of watershed quality and management:

- SWCD annual meeting participants believe water quality is excellent.
- The knowledge of conservation in the watershed has increased.
- Drainage is the number one resource concern.
- SWCDs are held in high regard, and individuals are very happy with the service they provide.
- Water quality should be addressed by a combination of landowners and communities.
- Tradition is a barrier to change.
- Crop rotation and no-till are the primary practices used to control erosion.

Drainage, erosion, and the importance of cooperation among the stakeholders are key shared concerns. A notable difference, however, lies in the perception of water quality; one of the primary goals of the 2014 WMP. The Board's survey indicates water quality as excellent, and the Steering Committee survey unanimously identifies it as the highest concern.

This difference highlights another important role of the 2014 WMP update. This update provides the comprehensive data and assessments - across the entire watershed - to reconcile perceptions with the scientific data and analysis. From site visits to GIS satellite imagery, the WMP has been able to identify the areas where water quality and drainage are acceptable, as well as specific impaired areas in a subwatershed that the BMPs can treat once the plan is finalized. The 2014 WMP provides, therefore, a systematic, comprehensive, and balanced assessment to benefit all stakeholders.

Overall, this 2014 plan applied a greater effort than in 2006 to interact one-on-one with private landowners, which generated very positive results and benefits. Some benefits include the engagement of large landowners and individuals unlikely to participate through an open public meeting, the identification of site-specific BMP opportunities, and the direct education and outreach to landowners regarding the benefits of conservation and BMP programs.

3.0 Part I: Watershed Inventory

Part I of the watershed inventory includes a detailed characterization of the entire Pigeon Creek watershed, including its history and unique watershed features. This section includes watershed-wide geology, topography, hydrology, resource use, soils, landuse/landcover and critical species. Also discussed are the many watershed success stories and previous planning efforts within the watershed. Where applicable, data has been summarized by subwatershed, along with a brief explanation of the data. Parts II and III of the watershed inventory provide a more thorough analysis of the data as it relates to watershed problems and solutions.

3.1 Physical Description

The Pigeon Creek watershed is located in the Indiana and Ohio Till Plain, and is part of the Steuben Morainal Lake physiographic region, which generally consists of rolling and hummocky or pot-hole topography formed by the recession of the Wisconsin-aged glaciers. See Figure 1 for the location of Pigeon Creek within the State of Indiana. Bedrock is located approximately 120-500 feet below the surface and does not significantly affect local topography, drainage, and soil development. The watershed can be naturally divided into three major drainages. The Upper watershed stretches from Cedar Swamp to the inlet to Long Lake. The Lake Chain watershed consists of the area from the Long Lake inlet to the outlet of Hogback Lake. The Lower watershed consists of the area from the Hogback Lake outlet to the western boundary of Steuben County and into LaGrange County where Pigeon Creek becomes the Pigeon River at Mongo Millpond within the Pigeon River Fish and Wildlife Area. The lower watershed also includes the drainages of Turkey Lake and Turkey Creek, which originate in DeKalb County and enter Pigeon Creek at the watershed outlet.

3.1.2 Topography

Percent slope was calculated for the watershed using a 1.5-meter digital elevation model (DEM). Average percent slope for the entire watershed is 13%. Table 5 lists average slope by subwatershed and Figure 2 illustrates percent slope for the watershed. The basin is generally flatter in the headwaters, gaining slope through the middle sections and Turkey Lake/Turkey Creek before flattening out again as Pigeon Creek becomes Pigeon River in LaGrange County.

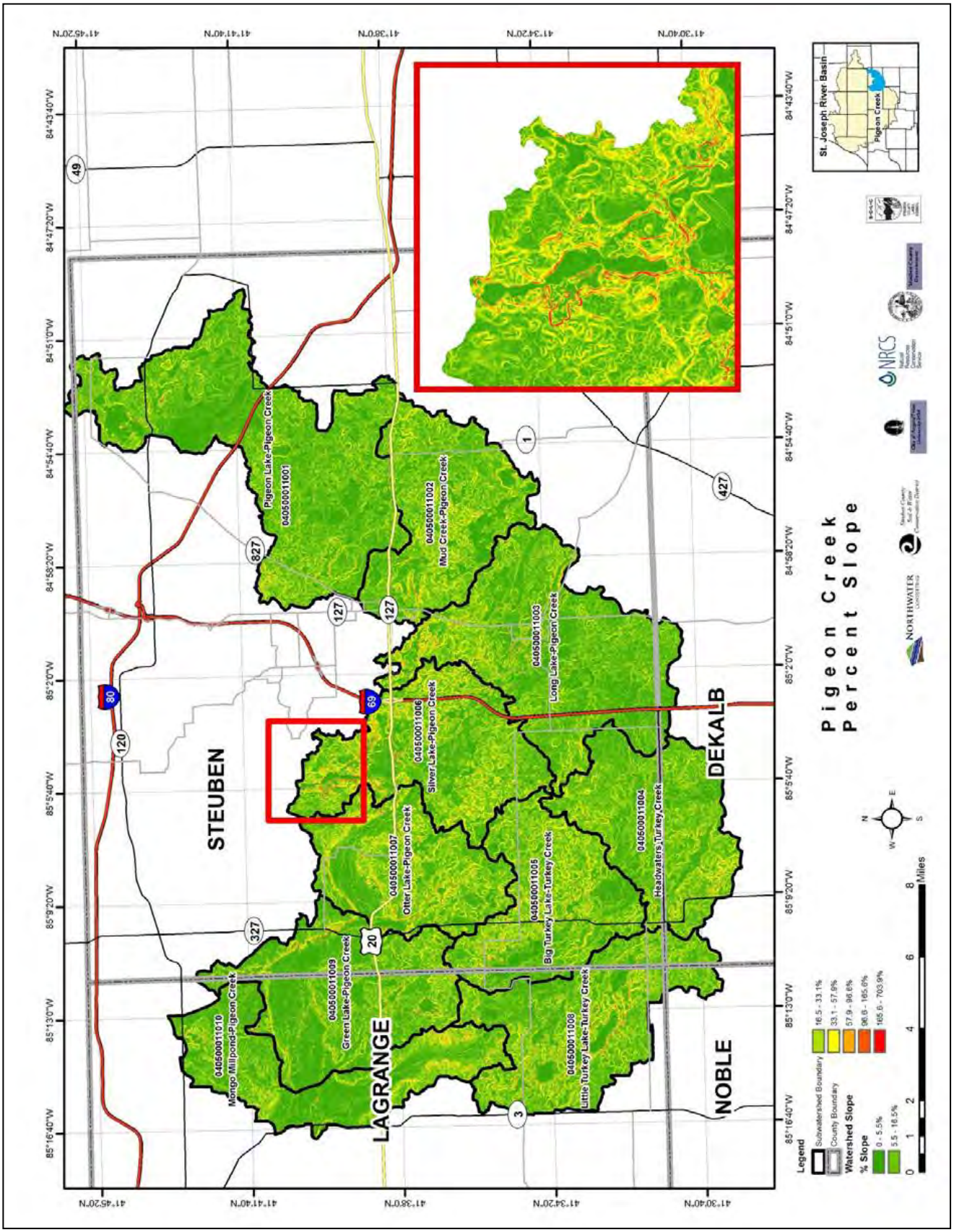
Table 5 - Subwatershed Percent Slope

HUC 12 Codes	HUC 12 Watersheds	Average Slope
40500011001	Pigeon Lake-Pigeon Creek	10.08%
40500011002	Mud Creek-Pigeon Creek	13.24%
40500011003	Long Lake-Pigeon Creek	11.75%
40500011004	Headwaters Turkey Creek	12.42%
40500011005	Big Turkey Lake-Turkey Creek	14.68%
40500011006	Silver Lake-Pigeon Creek	16.67%
40500011007	Otter Lake-Pigeon Creek	15.28%
40500011008	Little Turkey Lake-Turkey Creek	14.11%
40500011009	Green Lake-Pigeon Creek	10.61%
40500011010	Mongo Millpond-Pigeon Creek	10.97%

There is a range of 279 feet between the lowest and highest points in the watershed. The lowest and highest points are 893 and 1,172 feet above sea level, respectively.

No-till field; Pigeon Creek Watershed

Figure 2 - Watershed Slope



3.1.3 Geology

The watershed is primarily covered by a thick blanket of unconsolidated glacial drift resulting from the Wisconsin-age glaciation. Nearly 60% of the watershed consists of glacial tills with fine-grained materials including clay, silts and fine sands that were deposited at the edge or beneath glaciers. Approximately 30% of the watershed consists of glacial outwash sands and gravels. The outwash deposits resulted from glacial-melt and the glaciofluvial stream systems within and at the edges of the glaciers. Smaller areas of the watershed include organic muck (5%), aeolian dune sand (1%) and glacial lake sediment deposits (1%). The depth to bedrock in the watershed is documented to vary from 120 to nearly 500 feet.

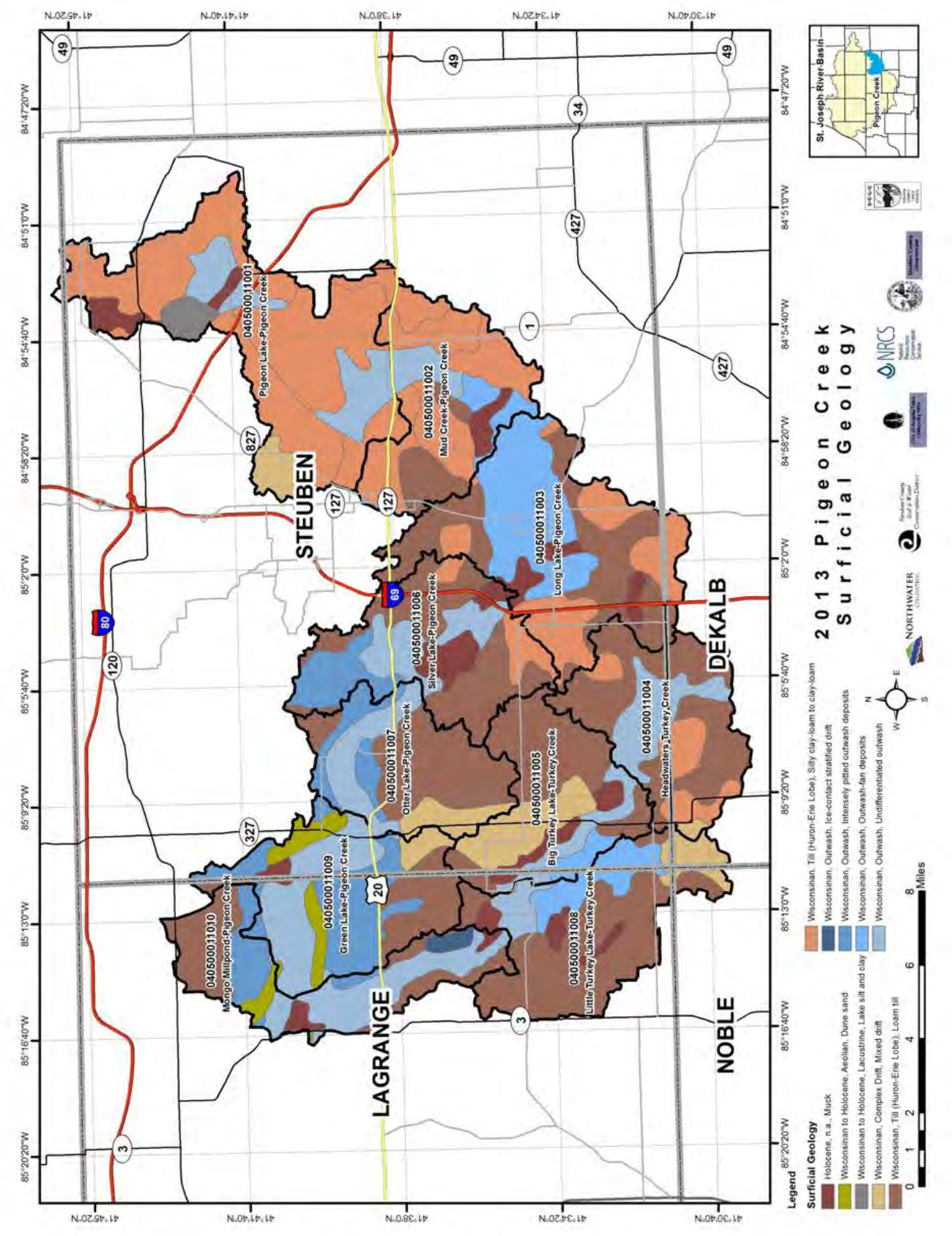
The bedrock geology beneath the glacial drift consists predominantly of Mississippian-aged Coldwater Shale, which can be greater than 500-feet thick. The Coldwater shale is a gray to greenish-gray silty shale. There are known to be lenses of brown dolomite and limestone throughout the unit. A distinctive red shale, up to 20-feet thickness, is at the base of the Coldwater.

The geology is important in the watershed, as the glacial drift topography created the lakes that dot the landscape. The unconsolidated and fine-grained nature of the surficial geology (Table 6 and Figure 3) is an important parent material for the productive soil development. However, the fine-grained nature of the geology also promotes a vulnerability to erosion and sedimentation in the watershed. The outwash deposits and other buried sands and gravels are important water supply sources for potable and non-potable needs throughout the watershed.

Table 6 - Watershed Surficial Geology

Age / Category	Description	Percent of watershed	Acres
Wisconsin Till	Loam till	34%	46,396
Wisconsin Till	Silty clay-loam to clay-loam	23%	31,221
Wisconsin Outwash	Undifferentiated outwash	16%	21,396
Wisconsin Outwash	Intensely pitted outwash deposits	8%	10,228
Wisconsin Outwash	Outwash-fan deposits	7%	9,676
Wisconsin Till and Outwash	Mixed drift	5%	7,152
Holocene-recent	Muck	5%	6,616
Wisconsin to Holocene, Aeolian	Dune sand	1%	1,901
Wisconsin Lacustrine	Lake silt and clay	1%	842
Wisconsin Till	Ice-contact stratified drift	0.3%	389

Figure 3 - Watershed Geology



3.2 Watershed Hydrology

This section provides an overview of lakes, streams, wetlands, groundwater, and flooding. Sections 3 and 4 (Part II and III of the Watershed Inventory) include detailed information and analysis of lake and river data. Watershed flooding is not directly addressed in subsequent sections as water quality is the primary focus of this plan, and any strategies aimed at addressing water quality will also have positive benefits that mitigate flooding.

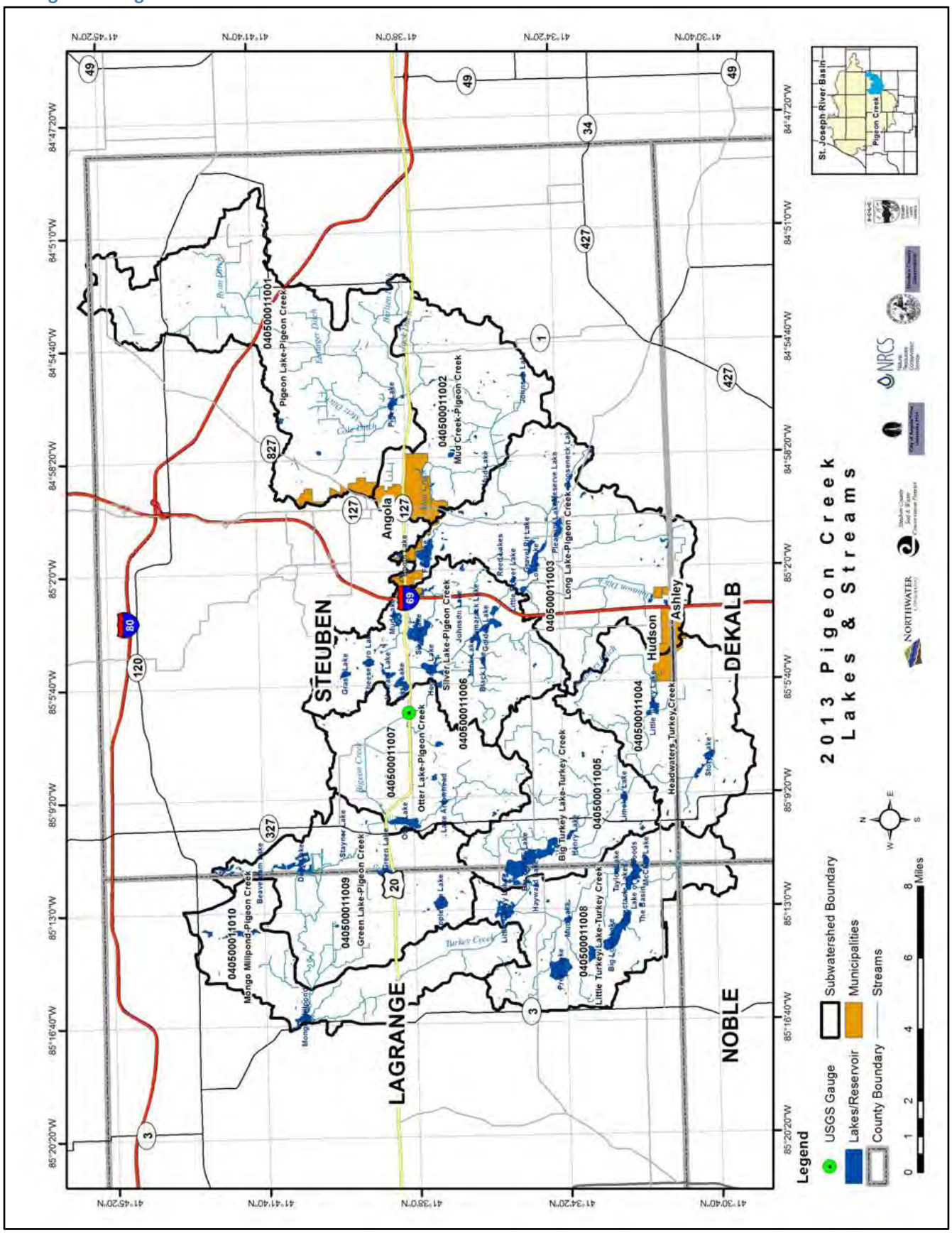
3.2.1 Streams & Rivers

According to the National Hydrography Dataset (NHD), the Pigeon Creek watershed includes 257 stream miles (1,357,047 feet.) Pigeon Creek is 37.5 miles (198,113 feet) in length and represents 15% of the entire stream length in the watershed. Table 7 shows stream length and drainage density by subwatershed and Figure 4 shows the spatial extent of streams and lakes in the watershed. As noted in Section 4.2.1, there are 179 miles (945,120 feet) of impaired streams; 70% of all stream miles in the watershed are considered to be impaired.

Table 7 - Watershed Streams

Subwatershed Name	HUC 12 Subwatershed Codes	Total Stream Feet	Stream Miles	Drainage Density
Pigeon Lake-Pigeon Creek	040500011001	228,433	43.3	10.4
Mud Creek-Pigeon Creek	040500011002	112,627	21.3	9.7
Long Lake-Pigeon Creek	040500011003	175,258	33.2	9.4l
Headwaters Turkey Creek	040500011004	95,415	18.1	8.1
Big Turkey Lake-Turkey Creek	040500011005	144,085	27.3	13.1
Silver Lake-Pigeon Creek	040500011006	152,758	28.9	11.8
Otter Lake-Pigeon Creek	040500011007	94,165	17.8	9.0
Little Turkey Lake-Turkey Creek	040500011008	145,242	27.5	11.0
Green Lake-Pigeon Creek	040500011009	122,094	23.1	9.0
Mongo Millpond-Pigeon Creek	040500011010	86,958	16.5	8.3
Grand Total		**1,357,047**	**257**	**10.0 (average)**

Figure 4 - Pigeon Creek Lakes & Streams



3.2.2 Lakes & Reservoirs

According to the NHD, there are 734 lakes and reservoirs within the watershed including 44 'named' lakes. Lakes and reservoirs within the watershed account for 4,102 surface acres; 3,160 acres of 'named' lakes and 942 acres of unnamed lakes and reservoirs (Table 8 and Figure 5).

Table 8 - Watershed Lakes & Reservoirs

Watershed/Lake	Qty	Area (acres)	Watershed/Lake	Qty	Area (acres)
Pigeon Lake-Pigeon Creek (040500011001)			**Otter Lake - Pigeon Creek (040500011007)**		
Named Lake/Reservoir			*Named Lake/Reservoir*		
Pigeon Lake		58	Otter Lake		119
Unnamed Lake/Reservoir	58	54	Lake Arrowhead		18
Mud Creek-Pigeon Creek (040500011002)			*Unnamed Lake/Reservoir*	83	68
Named Lake/Reservoir			**Little Turkey Lake-Turkey Creek (040500011008)**		
Johnson Lake		18	*Named Lake/Reservoir*		
Mud Lake		3.7	Big Long Lake		370
Unnamed Lake/Reservoir	64	90	Goose Pond		3.2
Long Lake-Pigeon Creek (040500011003)			Hayward Lake		8
Named Lake/Reservoir			Lake of the Woods		117
Booth Lake		9.1	Little Turkey Lake		134
Crockett Lake		4.7	McClish Lake		33
Fox Lake		141	Mud Lake		18
Gooseneck Lake		23	Pretty Lake		181
Gravel Pit Lake		27	Spectacle Lakes		2.3
Little Bower Lake		14	Taylor Lake		15
Long Lake		92	The Basin		5.4
Meserve Lake		18	*Unnamed Lake/Reservoir*	83	68
Pleasant Lake		51	**Green Lake-Pigeon Creek (040500011009)**		
Reed Lakes		4.8	*Named Lake/Reservoir*		
Unnamed Lake/Reservoir	123	180	Appleman Lake		79
Headwaters Turkey Creek (040500011004)			Beaverdam Lake		8.4
Named Lake/Reservoir			Deep Lake		110
Little Turkey Lake		61	Green Lake		67
Story Lake		72	Stayner Lake		2.6
Unnamed Lake/Reservoir	34	35	*Unnamed Lake/Reservoir*	66	116
Big Turkey Lake-Turkey Creek (040500011005)			**Mongo Millpond-Pigeon Creek (040500011010)**		
Named Lake/Reservoir			*Named Lake/Reservoir*		
Big Turkey Lake		442	Mongo Millpond		80
Henry Lake		22	*Unnamed Lake/Reservoir*	53	128
Limekiln Lake		25			
Unnamed Lake/Reservoir	64	63			
Silver Lake-Pigeon Creek (040500011006) - continued on next page					
Named Lake/Reservoir					
Bass Lake		59			
Black Lake		19			

Watershed/Lake	Qty	Area (acres)	Watershed/Lake	Qty	Area (acres)
Silver Lake-Pigeon Creek (040500011006) continued					
Cheeseboro Lake		35	Golden Lake		152
Hogback Lake		145	Grass Lake		28
Howard Lake		30	Johnson Lake		2.2
Mink Lake		5.3	Mud Lake		53
Silver Lake		183	Tamarack Lake		7.4
Unnamed Lake/Reservoir	97	137			

3.2.3 Hydrologic Modifications

Like most agricultural watersheds throughout the Midwest, the hydrology of Pigeon Creek has been altered to accommodate for urban development and agricultural production. Natural waterways have been modified or channelized, extensive underground tile systems installed and natural wetlands converted or impacted to improve drainage. Recent drought conditions and local soil conditions have also led to an increase in irrigation systems on agricultural land. Table 9 lists the extent of hydrologic modifications by subwatershed, length of channelized streams, length of known drainage tile lines, area of legal ditches, and the area of irrigated crop ground. It should be noted that legal ditches were available in a rough format and were modified or adjusted for the creation of a custom watershed landuse/landcover layer. As a result, only the total area is provided and the locations presented in Figures 5 and 6 may not represent the true extent of all legal ditches in the watershed. Figures provided for length of drainage tiles include only known/mapped lines, which greatly underestimates the total length of drainage tiles in the watershed.

The Pigeon Creek watershed has 177 miles of channelized ditches, 222 miles of mapped drainage tiles, 929 acres of legal ditches, and over 6,000 acres of irrigated agricultural ground. The length of channelized ditches in the watershed is roughly half of the total stream length within the watershed, indicating that channelization is extensive within the watershed and confirming stakeholder concerns over drainage of farm ground. Only 8.6 percent of the watershed's row crop acreage is irrigated, and the extent of area classified as a legal ditch is less than 1 percent of the entire watershed area.

Table 9 - Hydrologic Modifications

Subwatershed Names	HUC 12 Subwatershed Codes	Watershed Acres	Channelized (miles)	Drainage Tile (miles)	Legal Ditch (acres)	Irrigated Crop Ground (acres)
Pigeon Lake-Pigeon Creek	040500011001	22,036	39	64	303	1,185
Mud Creek-Pigeon Creek	040500011002	11,641	17	32	116	322
Long Lake-Pigeon Creek	040500011003	18,620	34	47	179	2,182
Headwaters Turkey Creek	040500011004	11,798	31	21	107	162
Big Turkey Lake-Turkey Creek	040500011005	11,015	13	19	75	0
Silver Lake-Pigeon Creek	040500011006	12,954	6	16	24	165
Otter Lake-Pigeon Creek	040500011007	10,491	6	10	13	504
Little Turkey Lake-Turkey Creek	040500011008	13,255	17	4.4	97	299
Green Lake-Pigeon Creek	040500011009	13,581	5	7.2	3.2	640
Mongo Millpond-Pigeon Creek	040500011010	10,520	9	1.6	10	731
Grand Total		**135,911**	**177**	**222**	**929**	**6,190**

Drainage Ditch; Upper Pigeon Creek Watershed

Figure 5 – Upper Pigeon Creek Hydrologic Modifications

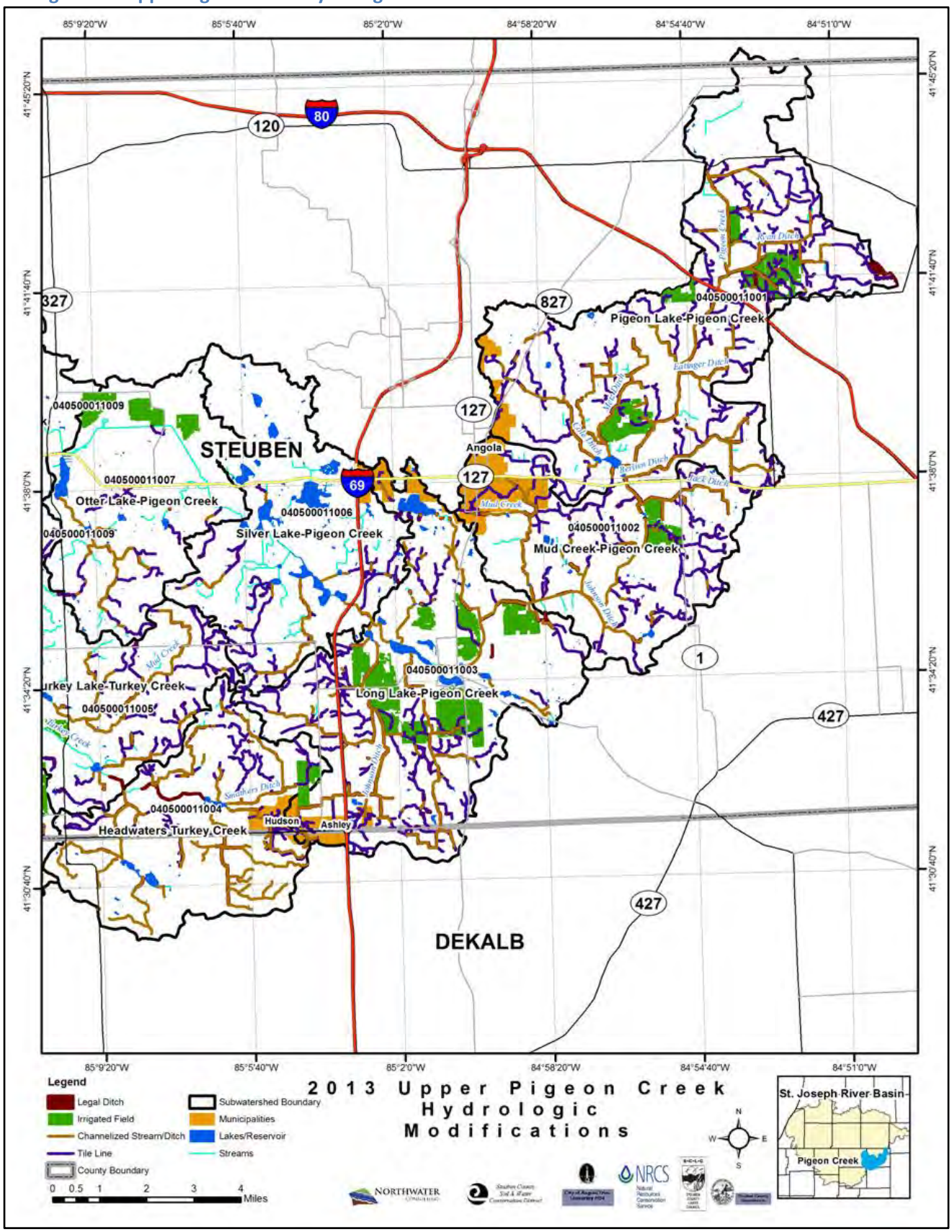
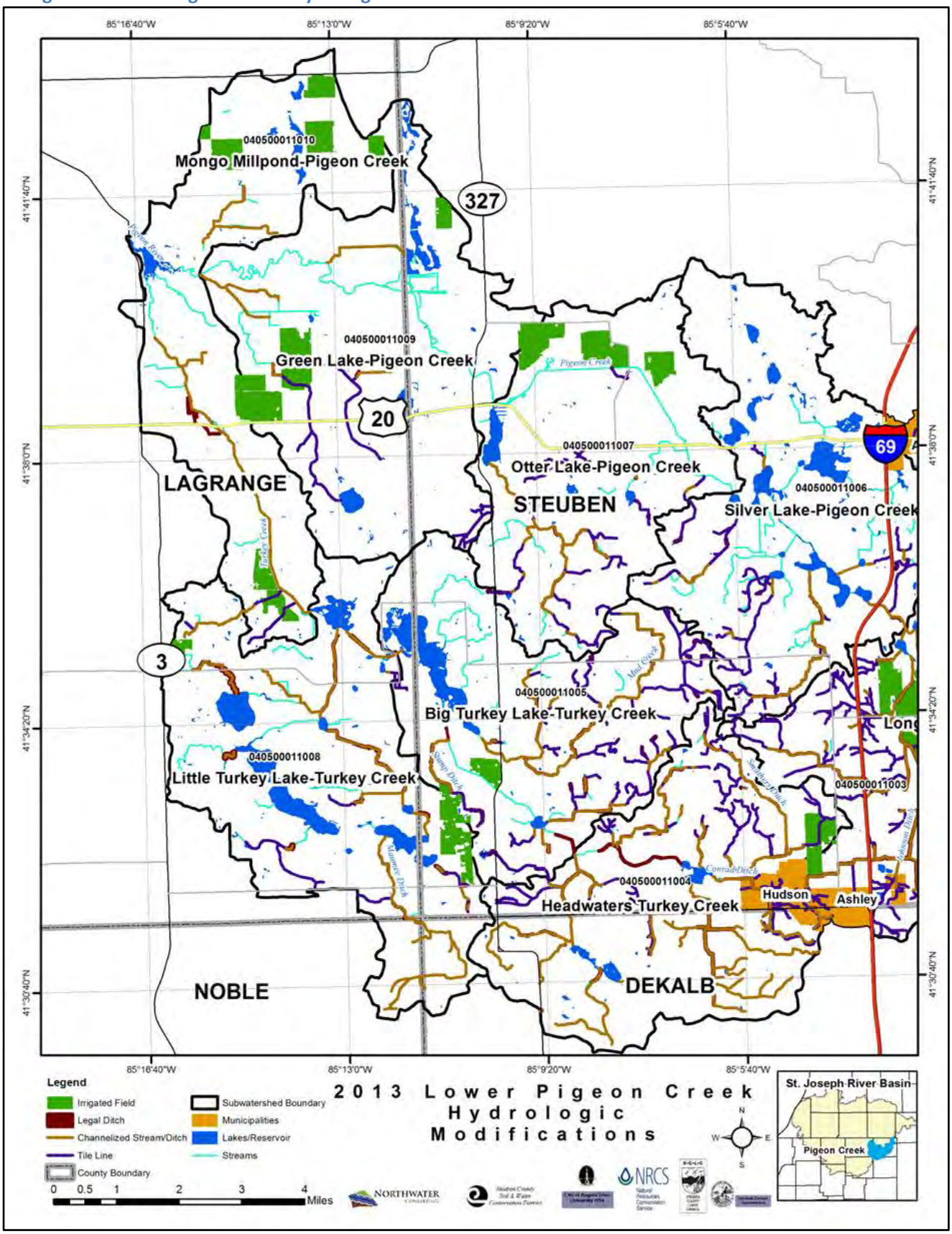


Figure 6 - Lower Pigeon Creek Hydrologic Modifications



3.2.4 Wetlands

Wetlands are scattered throughout the watershed, primarily at locations of hydric soils or low lying depressional areas. Wetlands reduce stormwater runoff and filter sediment and nutrients before reaching waterways. The vegetative communities within the wetlands bind excess nutrients within the living plant tissue while providing additional wildlife habitat. Wetlands should be protected and enhanced to provide both water quality, flooding and wildlife habitat benefits to the watershed.

In this section, wetlands are evaluated using a hybrid National Wetland Inventory (NWI) data set developed and provided by the Friends of the St. Joe River Association. This data set includes two distinct layers:

1. Current/PreSettlement Wetlands - current NWI wetlands along with the approximate location of wetlands prior to European settlement, including wetlands that are classified as lakes and rivers.
2. Current/Restoration Wetland Areas – wetlands classified as a priority for protection or restoration.

As noted in Table 10, there are currently 17,999 acres of wetlands in the watershed, or 13% of the total watershed area. Pre-settlement wetlands were estimated at 38,728 acres, or 28% of the watershed, indicating that total wetland area has been reduced by over 50% since pre-settlement times. Additionally, 13,262 acres of existing wetlands require protection and 23,939 acres of existing wetlands require restoration (Figures 7 and 8).

Table 10 - Pigeon Creek Wetlands

Subwatershed Name	HUC 12 Subwatershed Codes	Acres Current Wetlands	% of Watershed	Acres Pre-settlement Wetlands	% of Watershed	Acres Wetlands Needing Protection	% of Watershed	Acres Wetlands Needing Restoration	% of Watershed
Pigeon Lake-Pigeon Creek	040500011001	2,396	11%	7,174	33%	2,220	10%	5,108	23%
Mud Creek-Pigeon Creek	040500011002	1,552	13%	3,374	29%	1,345	12%	2,049	18%
Long Lake-Pigeon Creek	040500011003	1,759	9%	5,442	29%	1,176	6%	3,990	21%
Headwaters Turkey Creek	040500011004	813	7%	3,310	28%	637	5%	2,630	22%
Big Turkey Lake-Turkey Creek	040500011005	1,682	15%	3,498	32%	1,112	10%	1,982	18%
Silver Lake-Pigeon Creek	040500011006	2,497	19%	4,031	31%	1,417	11%	2,096	16%
Otter Lake-Pigeon Creek	040500011007	1,180	11%	2,200	21%	938	9%	1,276	12%
Little Turkey Lake-Turkey Creek	040500011008	2,312	17%	4,073	31%	1,282	10%	2,150	16%
Green Lake-Pigeon Creek	040500011009	2,568	19%	3,381	25%	2,085	15%	1,367	10%
Mongo Millpond-Pigeon Creek	040500011010	1,243	12%	2,245	21%	1,050	10%	1,289	12%
Grand Total		**17,999**	**13%**	**38,728**	**28%**	**13,262**	**10%**	**23,939**	**18%**

Figure 7 – Upper Pigeon Creek Wetlands

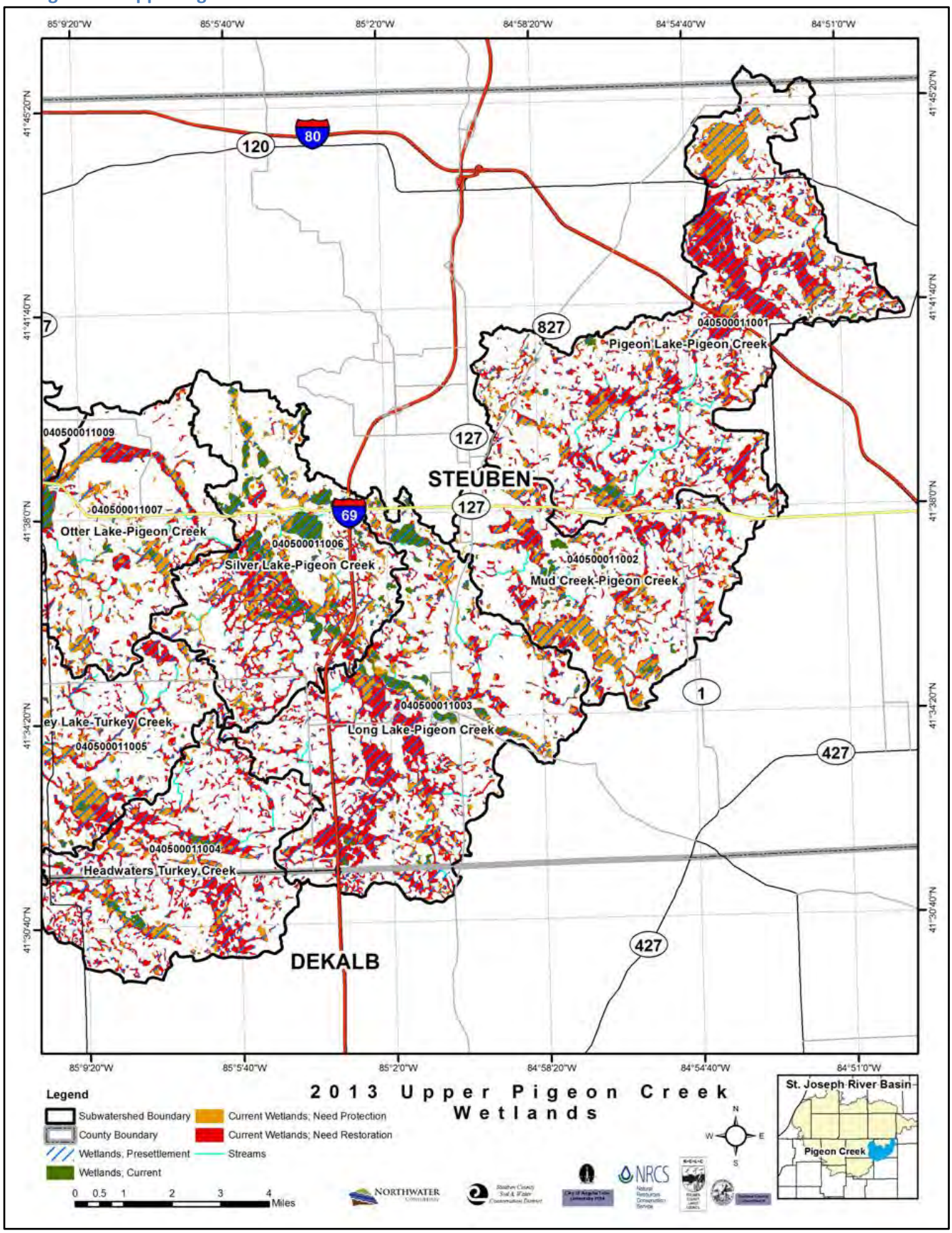
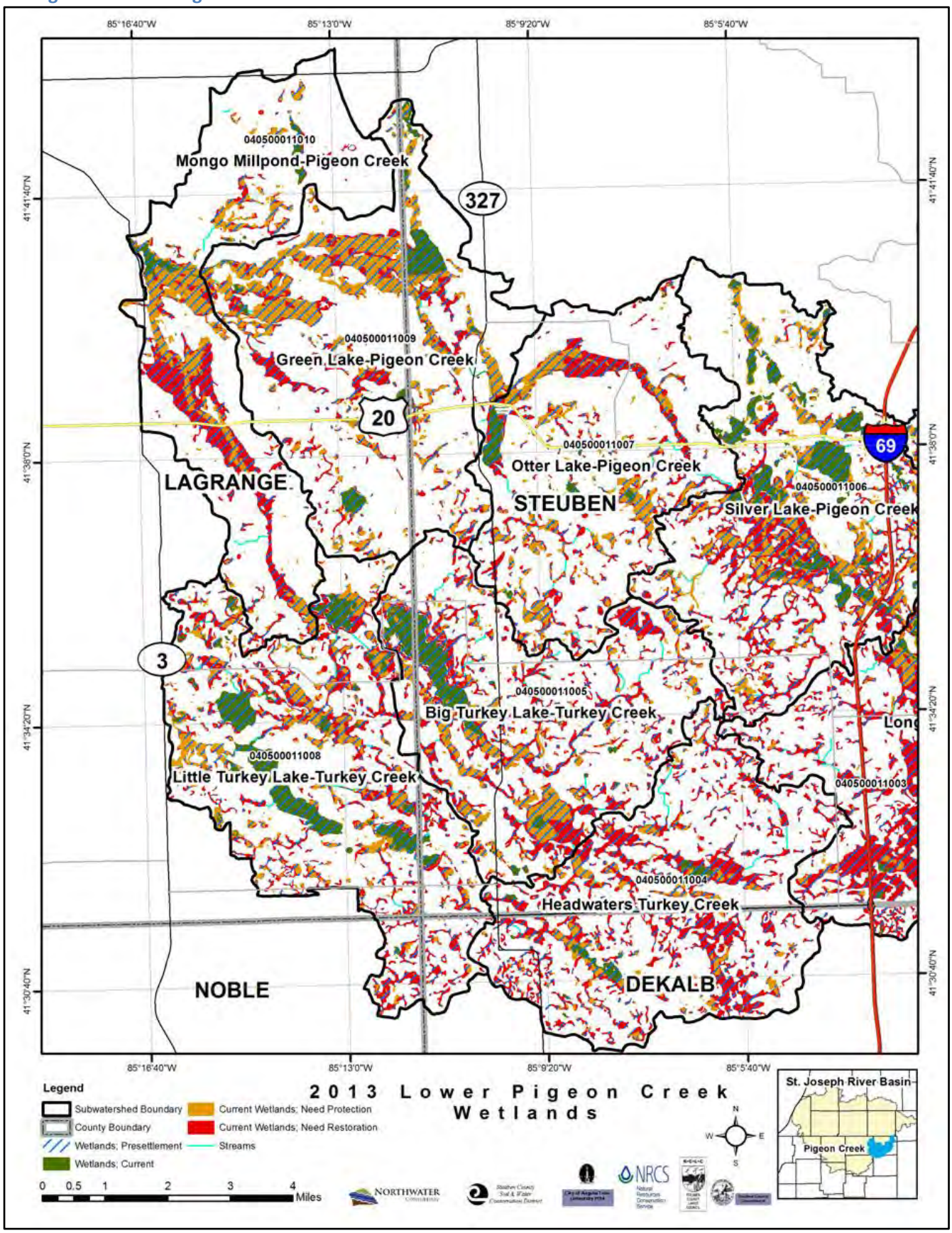


Figure 8 - Lower Pigeon Creek Wetlands



3.2.5 Flooding & Floodplain

The watershed has a continental climate, with cold winters and hot summers. The mean annual temperature at Angola is 48° F, but varies from a mean of 22° F in January to 72° F in July. Steuben County receives a mean annual precipitation of 35 inches. Frequent, short, but intense, rainfall events are common in spring and summer months, which produces high runoff volumes and flow rates. A significant amount of runoff is also generated during the annual spring snowmelt. Flooding has been a long-documented issue in the Pigeon Creek watershed. Originally, Pigeon Creek consisted of a series of meandering drainage ways but, in 1904, George Shrimplin Ditch was dredged to straighten the creek in order to provide greater conveyance capacity.

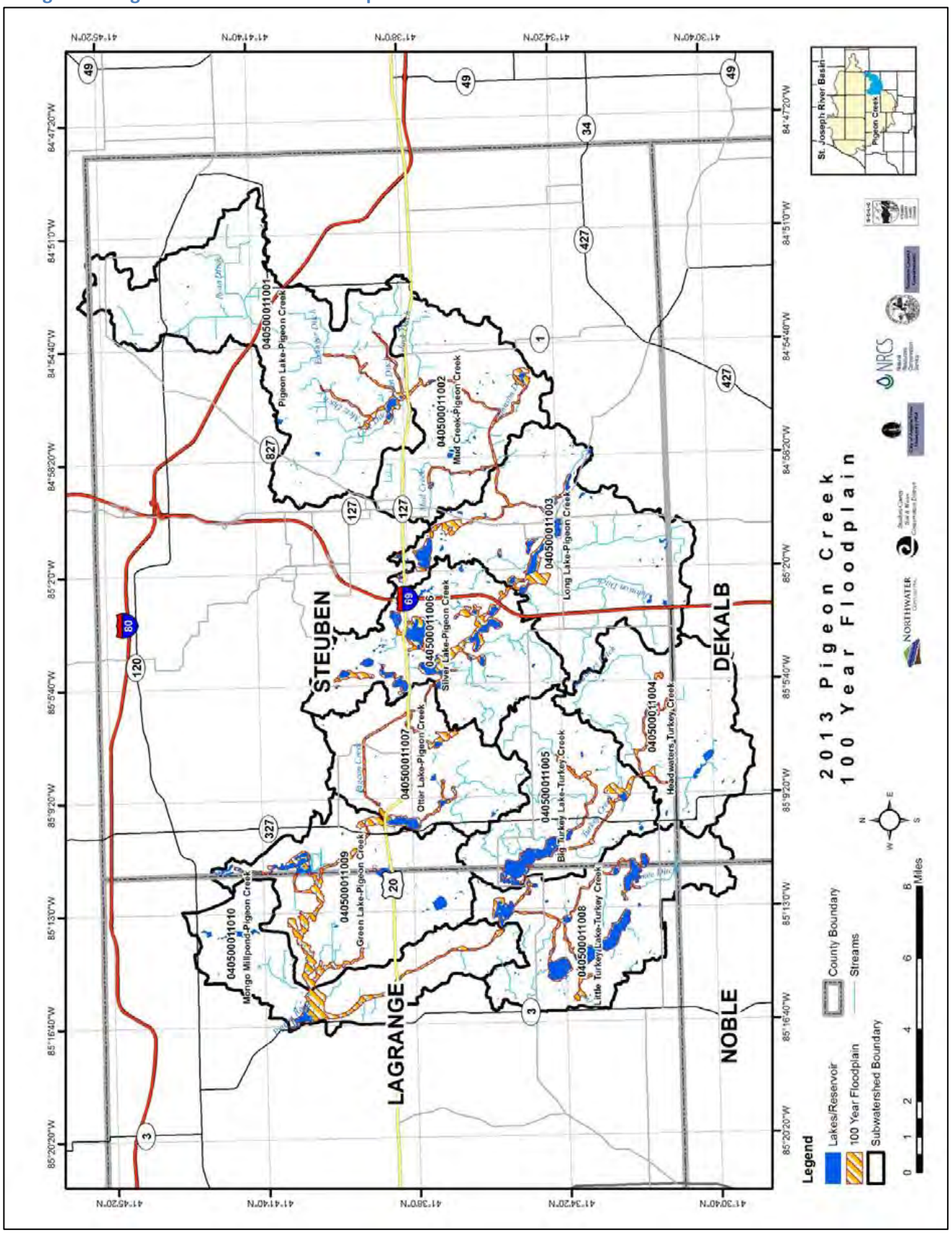
The chain of lakes along Pigeon Creek is heavily affected by extreme rainfall events. The 1967 *"Preliminary Investigation Report"* acknowledges the extreme fluctuation in lake levels after heavy rain events, which flooded cottages along Bower, Golden, Hogback, and Long Lakes. The report notes that the lake water level fluctuates at least five feet annually, where a rise of six feet is expected by a two-year rainfall event, and a rise of over seven feet is expected for a ten-year rainfall event. It is important to note that additional storage volume provided upstream in the watershed can have a substantial impact on decreasing flooding from frequent rainfall events.

The largest flood on record occurred March 22, 1982, due to extreme snowmelt. The winter of 1981-1982 generated 66 inches of snow, approximately 26 inches above average. As the snow melted, approximately 7 inches of runoff was created across the Pigeon Creek watershed. This resulted in lake levels 8.5 feet above normal stage with damage to 380 lakeside homes, however, minimal out-of-channel flood damage was reported. The total damage in the watershed was estimated at approximately $800,000 (1982 Dollars). If a similar flood were to occur today, the damage would be significantly higher due to both inflation and additional development along the lake chain. Figure 9 indicates the approximate areas of regulatory floodplain within the watershed that would be inundated by the 100-year flood. According to floodplain maps generated in 2004, there is a total of 8,643 acres of 100-year floodplain within the watershed. Floodplain areas are detailed by subwatershed in Table 11.

Table 11 - 100-Year Floodplain by Subwatershed

Subwatershed Name	HUC 12 Subwatershed Codes	Acres in 100 Year Floodplain	% of Watershed
Pigeon Lake-Pigeon Creek	040500011001	431	2%
Mud Creek-Pigeon Creek	040500011002	421	4%
Long Lake-Pigeon Creek	040500011003	1,038	6%
Headwaters Turkey Creek	040500011004	291	2%
Big Turkey Lake-Turkey Creek	040500011005	956	9%
Silver Lake-Pigeon Creek	040500011006	1,582	12%
Otter Lake-Pigeon Creek	040500011007	602	6%
Little Turkey Lake-Turkey Creek	040500011008	1,500	11%
Green Lake-Pigeon Creek	040500011009	1,152	8%
Mongo Millpond-Pigeon Creek	040500011010	670	6%
Grand Total		**8,643**	**6%**

Figure 9 - Pigeon Creek 100-Year Floodplain



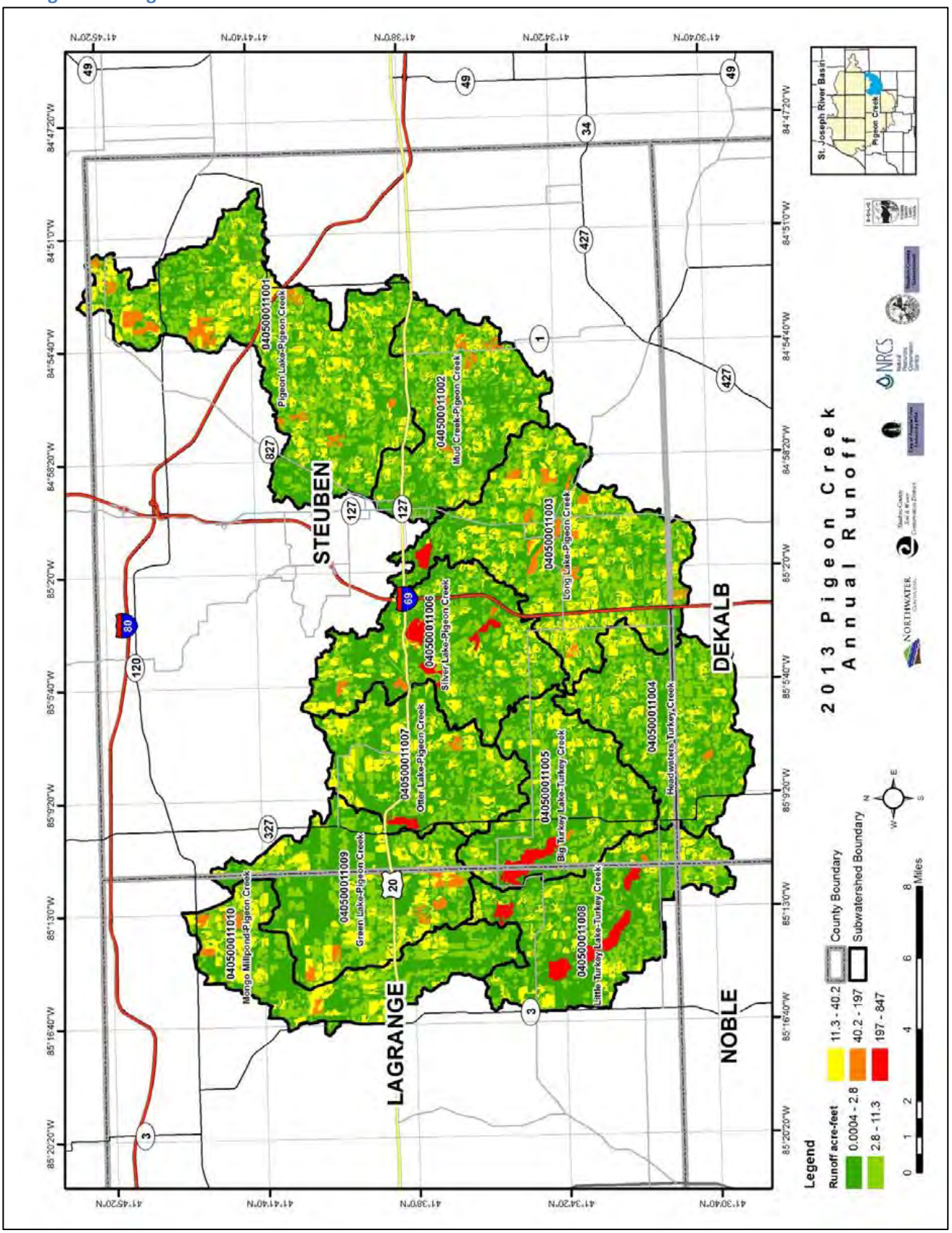
3.2.6 Annual Runoff

Watershed average annual runoff is estimated to be 97,419 acre-feet (Figure 10), or one foot of water covering over 97,000 acres (72%) of the entire watershed. Table 12 illustrates per-acre runoff is higher in urban areas with greater densities of impervious surface and on agricultural ground with hydrologic group C and D soils. The runoff was modeled using the SWAMM model outlined in Chapter 7. It is important to note that annual runoff values for each watershed are presented in total acre-feet and should be compared against subwatershed size. Although Mud Creek, for example, has a lower annual runoff total, it is also a relatively small watershed; Mud Creek has the highest percentage of impervious surface.

Table 12 - Modeled Runoff

Subwatershed Name	2012 HUC 12 Subwatershed Codes	Watershed Acres	Percent Impervious Surface	Percent C & D Soils	Annual Runoff (ac-ft)
Pigeon Lake-Pigeon Creek	40500011001	22,036	1.28	65.4	17,588
Mud Creek-Pigeon Creek	40500011002	11,641	3.83	68.9	9,741
Long Lake-Pigeon Creek	40500011003	18,620	2.64	48.4	15,491
Headwaters Turkey Creek	40500011004	11,798	1.62	37.9	8,794
Big Turkey Lake-Turkey Creek	40500011005	11,015	1.27	13.2	7,900
Silver Lake-Pigeon Creek	40500011006	12,954	1.76	31.9	9,331
Otter Lake-Pigeon Creek	40500011007	10,491	1.04	4.04	6,345
Little Turkey Lake-Turkey Creek	40500011008	13,256	1.06	19.7	9,905
Green Lake-Pigeon Creek	40500011009	13,581	0.89	3.4	6,635
Mongo Millpond-Pigeon Creek	40500011010	10,520	0.73	6.8	5,688
Total Watershed		**135,911**	**1.61**	**33.6%**	**97,419**

Figure 10 - Pigeon Creek Annual Runoff



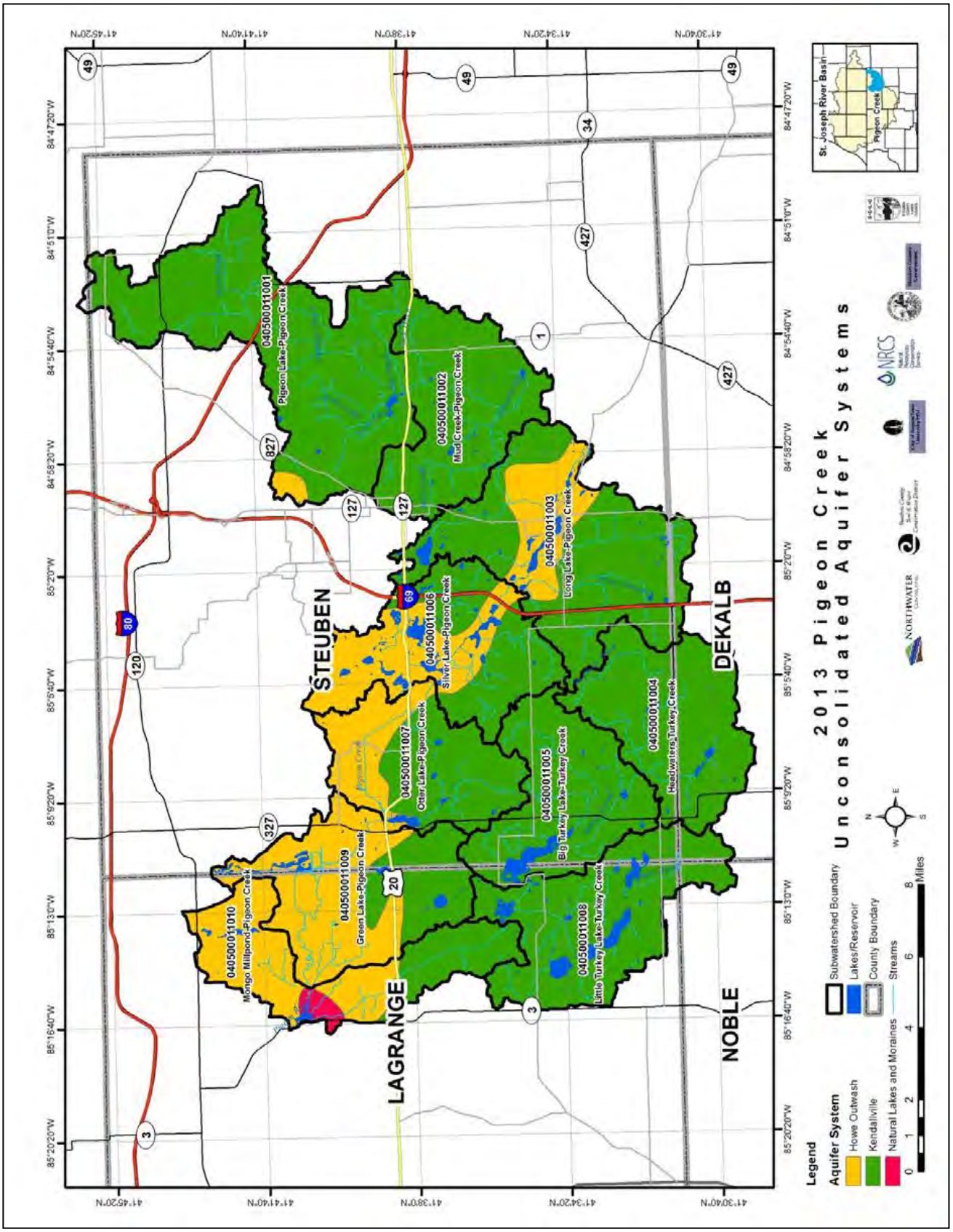
3.2.6 Aquifer Depth & Groundwater

In 2011, the IDNR, Office of Water published maps showing unconsolidated aquifer systems throughout the state. The maps, with accompanying text and tables, describe characteristics such as geologic materials, thickness of confining units, aquifer thickness, static water levels, well yield, typical well depths, and depth to the aquifer resource. According to the maps, there are three unique unconsolidated aquifer systems in the watershed: the Howe Outwash, Kendallville, and Natural Lakes and Moraines system. The Kendallville system covers 104,115 acres, or 76% of the watershed; the Howe Outwash system includes 31,079 acres, or 23%; and Natural Lakes and Moraines covers the remaining 1%, or 622 acres. Figure 11 shows the location on these unconsolidated aquifers in Pigeon Creek.

The Howe Outwash System consists of surficial outwash sand and gravel up to 145 feet thick overlying till with interbeds of sand and gravel. Aquifer thickness in the Howe Outwash system sand and gravel ranges from 15 – 50 feet; interbed sand and gravel typically 5 – 25 feet thick. Water yield can range from 10 gallons per minute to 1,200 gallons per minute in high-capacity wells. The Kendallville system consists of isolated near-surface sand and gravel, but mostly deeper interbed sand and gravel at various depths. In this system, aquifer depth ranges from 3 – 95 feet and commonly 5 – 20 feet. Aquifer yield ranges from 10 to 1400 gallons per minute for high-capacity wells. The Natural Lakes and Moraines system includes near surface sand and gravel, and deeper interbed sand and gravel. Near- surface depths range from 10 – 50 feet with deeper interbed depths of 10 – 30 feet. Aquifer yield ranges from 25 to 2000 gallons per minute for high-capacity wells.

Pigeon Creek

Figure 11 - Pigeon Creek Unconsolidated Aquifers



3.3 Watershed Soils

Soils in the Pigeon Creek watershed are mainly composed of sandy silts to silty clays resulting from the last glacial episode. In low-lying wetlands, organic soils are common due to decomposition of plant remains in a high water table environment. The dominant upland soils include well-drained Miami, Morley, and Kendallville, somewhat poorly drained Blount; and very poorly drained Pewamo. Well-drained Fox terrace soils are common in large areas in the lower reaches of the main watershed. Watershed soils primarily consist of muck, including the Houghton and Carlisle types, and sandy outwash soils of the Oshtemo, Brady, and Griffen varieties.

3.3.1 Soils; Hydrologic Groupings

The Natural Resource Conservation Service (NRCS) has classified soils into four hydrologic soil groups based on the infiltration capacity and runoff potential of the soil. The soil groups are identified as A, B, C, and D. Group A has the greatest infiltration capacity and least runoff potential, while group D has the least infiltration capacity and greatest runoff potential. Table 13 provides a breakdown of hydrologic groupings and Figures 12 and 13 indicate the distribution of hydrologic soil groups within the watershed. The Upper watershed primarily consists of group C and D soils; this portion of the watershed has a lower infiltration capacity and a greater runoff potential. The Lake Chain and lower half of the watershed primarily consist of group A and B soils, which are better at infiltration and less susceptible to runoff damage. Hydrologic group B and C soils make up the majority of the watershed.

Table 13 - Soil Hydrologic Groups

Subwatershed Name	HUC 12 Subwatershed Codes	A	B	C	D	Unclassified
Pigeon Lake-Pigeon Creek	040500011001	3,105	4,233	13,853	555	193
Mud Creek-Pigeon Creek	040500011002	1,612	1,645	7,549	481	354
Long Lake-Pigeon Creek	040500011003	2,931	5,983	8,520	483	703
Headwaters Turkey Creek	040500011004	2,326	4,804	3,942	534	191
Big Turkey Lake-Turkey Creek	040500011005	2,536	6,449	1,435	14	596
Silver Lake-Pigeon Creek	040500011006	3,563	4,298	3,589	544	960
Otter Lake-Pigeon Creek	040500011007	4,056	5,756	424	0	255
Little Turkey Lake-Turkey Creek	040500011008	2,981	6,629	2,606	0	1,038
Green Lake-Pigeon Creek	040500011009	9,251	3,588	456	0	286
Mongo Millpond-Pigeon Creek	040500011010	5,885	3,830	716	0	88
Grand Total		**38,245**	**47,216**	**43,091**	**2,612**	**4,664**
Percentage of Watershed		**28%**	**35%**	**32%**	**2%**	**3%**

Soils with high runoff potential have an influence on both flooding and the export of pollutants as a greater percentage of the precipitation that falls on these soils produces runoff. Stakeholder concerns related to flooding and pollution loading can be supported in areas of the watershed where C and D soils are more prevalent.

Figure 12 – Upper Pigeon Creek Soil Hydrologic Groups

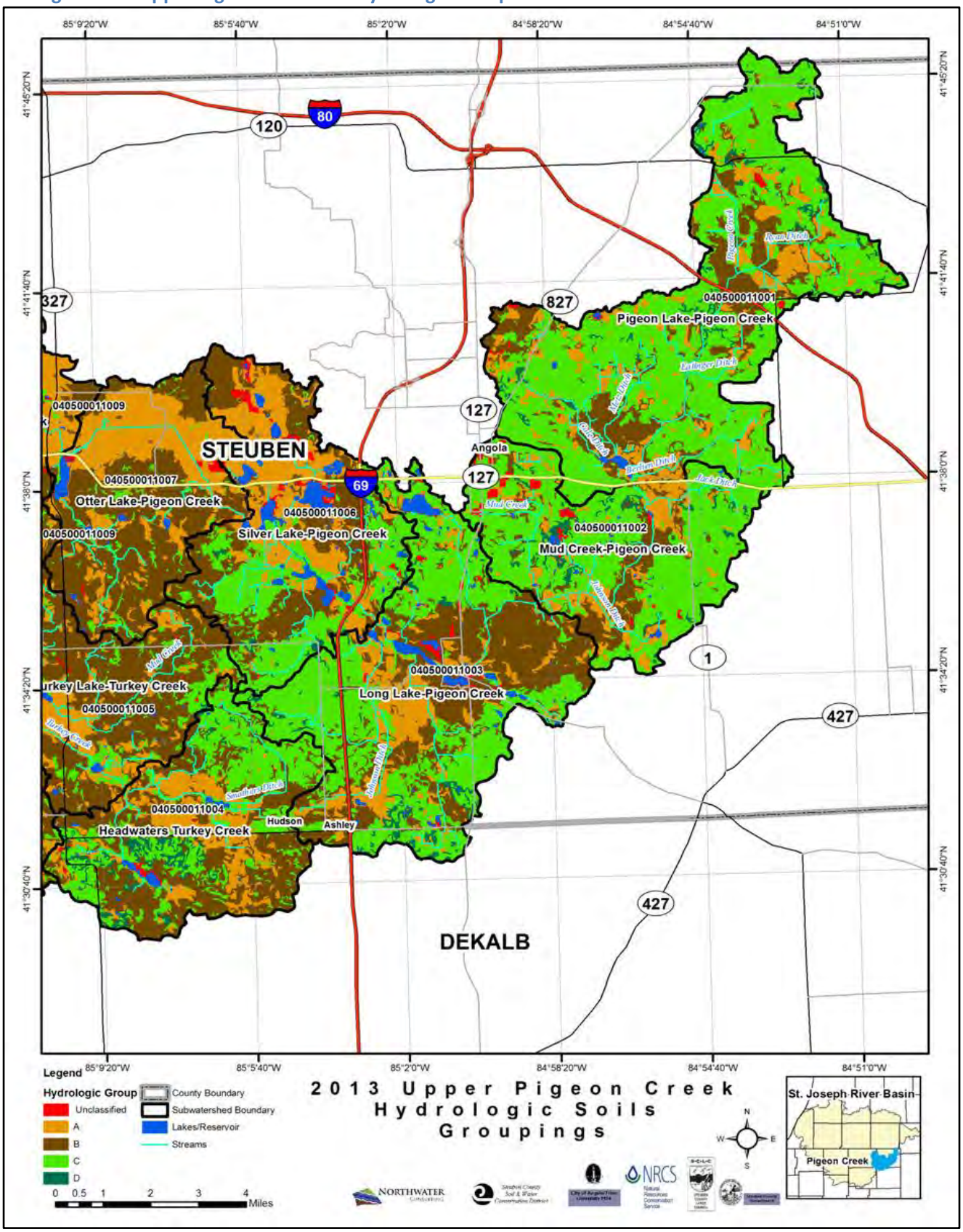
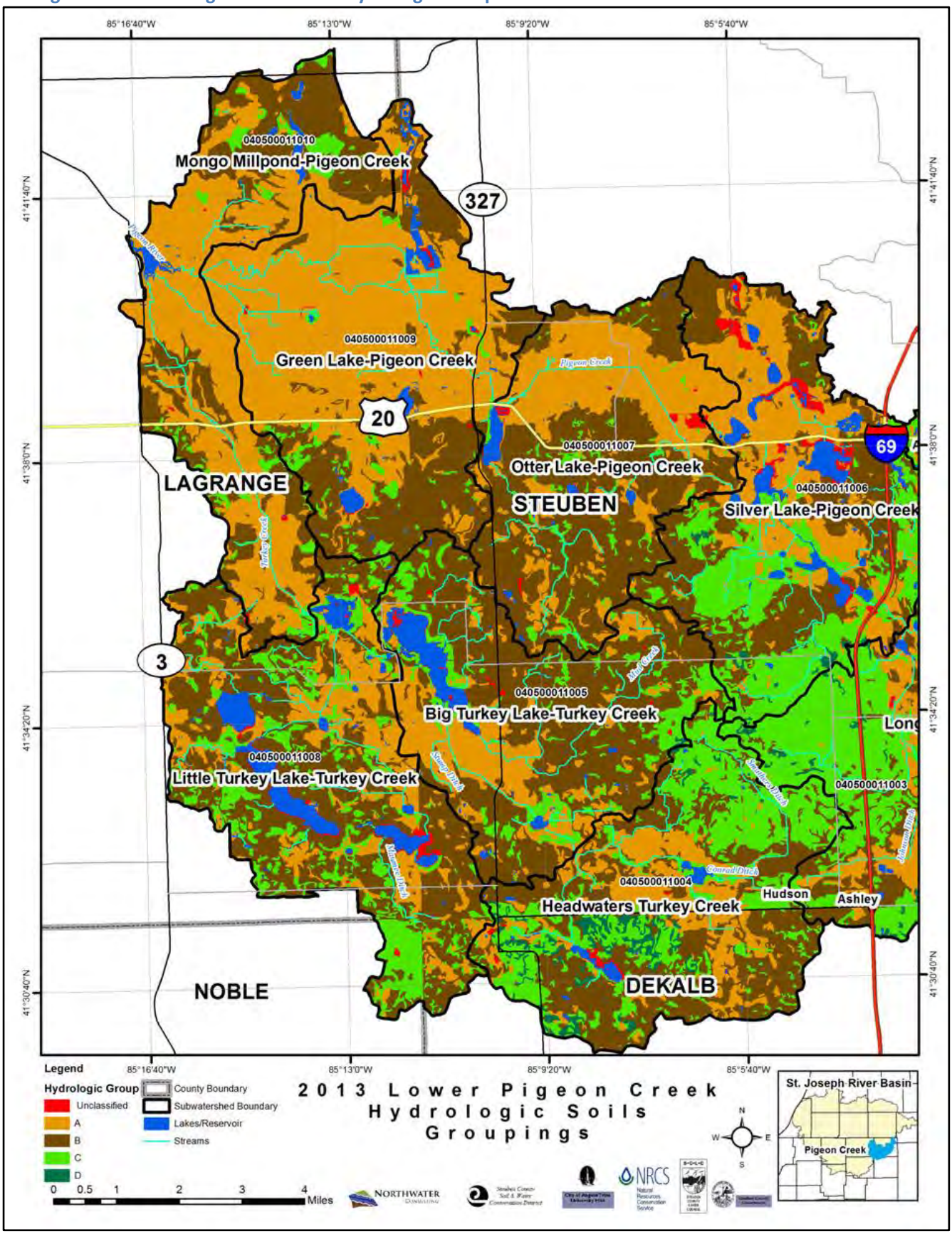


Figure 13 - Lower Pigeon Creek Soil Hydrologic Groups



3.3.2 Highly Erodible Soils

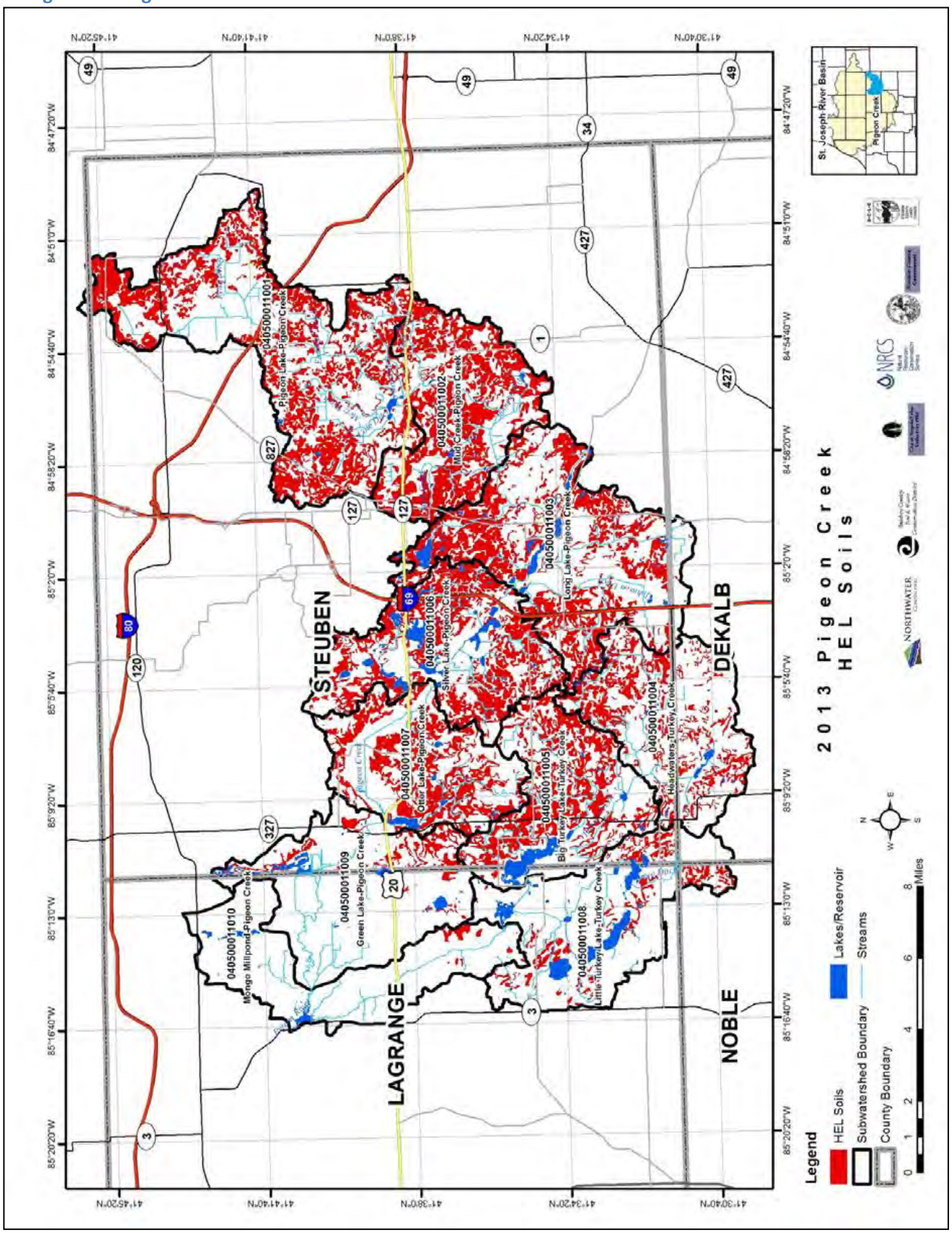
According to the NRCS, Highly Erodible Land (HEL) is cropland, hayland or pasture that can erode at excessive rates, containing soils that have an erodibility index of eight (8) or higher. If a producer has a field identified as highly erodible land and wishes to participate in a voluntary NRCS cost-share program, that producer is required to maintain a conservation system of practices that keeps erosion rates at a substantial reduction of soil loss. Fields that are determined not to be highly erodible land are not required to maintain a conservation system to reduce erosion. The Pigeon Creek watershed has 42,110 acres of such soils with the highest percentage occurring in the Mud Creek subwatershed (Table 14 and Figure 14). Along the Steuben County line and LaGrange County line and on into LaGrange, the extent of HEL soils drops off dramatically.

A more thorough analysis of HEL soils is presented in Section 7.1.3, which describes HEL soils on agricultural land. Of the 42,110 acres of HEL soils throughout the watershed, 22,767 (17% of the watershed) are located on crop ground. The amount of HEL soils in the watershed can also be tied back to stakeholder concerns relating to erosion and sedimentation.

Table 14 - HEL Soils

Subwatershed Name	HUC 12 Subwatershed Codes	Acres HEL Soils	Percent of Subwatershed
Pigeon Lake-Pigeon Creek	040500011001	9,185	42%
Mud Creek-Pigeon Creek	040500011002	6,368	55%
Long Lake-Pigeon Creek	040500011003	7,051	38%
Headwaters Turkey Creek	040500011004	3,059	26%
Big Turkey Lake-Turkey Creek	040500011005	4,097	37%
Silver Lake-Pigeon Creek	040500011006	5,768	45%
Otter Lake-Pigeon Creek	040500011007	3,847	37%
Little Turkey Lake-Turkey Creek	040500011008	1,458	11%
Green Lake-Pigeon Creek	040500011009	1,101	8%
Mongo Millpond-Pigeon Creek	040500011010	176	2%
Grand Total/Percent Entire Watershed		**42,110**	**31%**

Figure 14 - Pigeon Creek HEL Soils



3.3.3 Hydric Soils

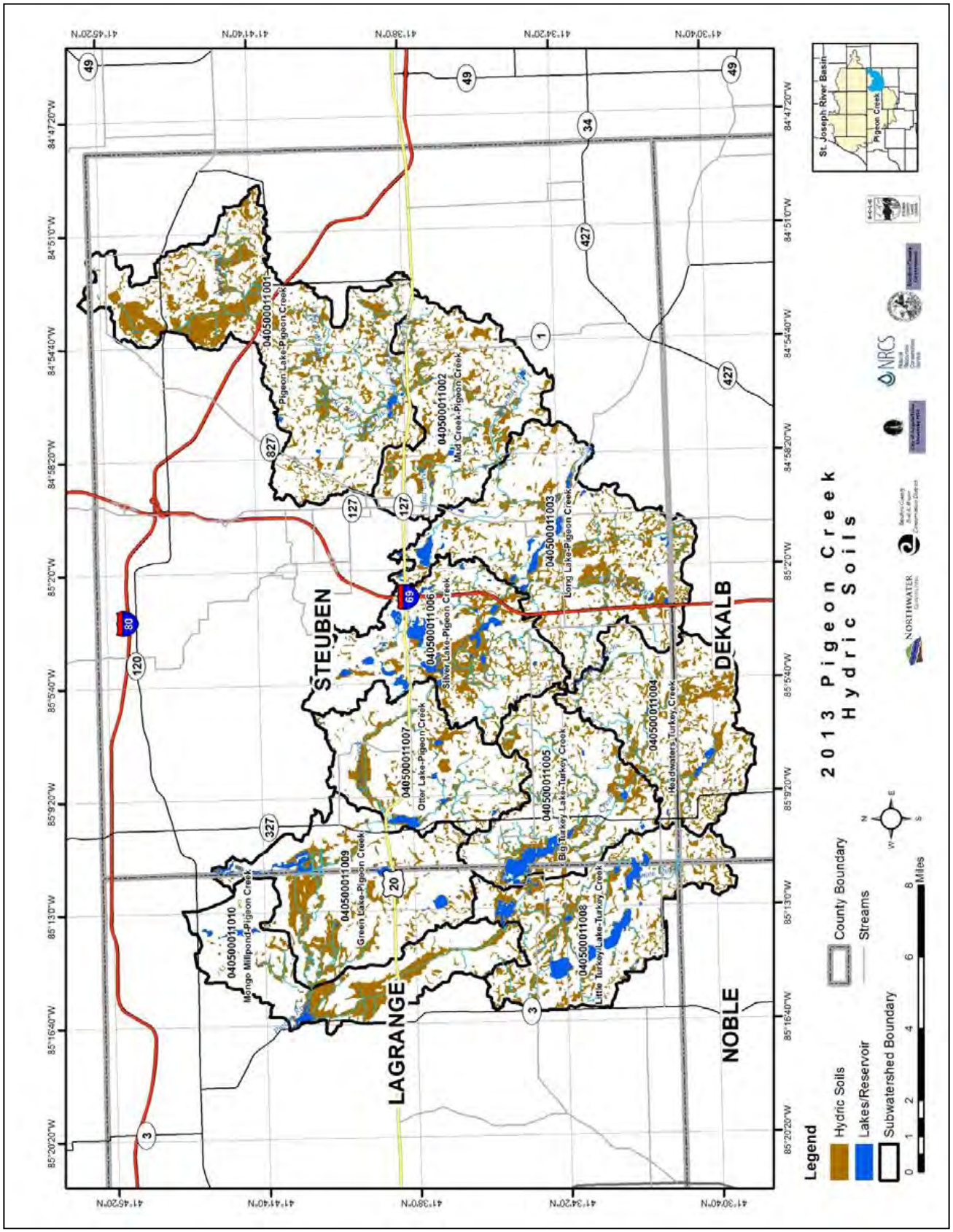
Hydric soils are scattered throughout the watershed and are an indicator of former wetlands and potential areas for wetland development. The greatest concentration of hydric soils are found along Pigeon Creek, at Cedar Swamp, along Long Lake and Hogback Lake, east of the crossing of Bill Deller Road and Pigeon Creek, and into the Pigeon River Fish and Wildlife Area in LaGrange County. Hydric soils are typically wet and will flood if proper drainage, overland or through field tiles, is not available. There are over 14 different hydric soils within the watershed totaling 34,993 acres. Table 15 provides a breakdown of the area of hydric soils by subwatershed and Figure 15 indicates the location of hydric soils within the watershed. Downstream in the watershed there is a decrease in hydric soils. The Pigeon Lake subwatershed has the highest overall percentage of hydric soils (32%) compared to 26% average for the entire watershed.

Table 15 - Hydric Soils

Subwatershed Name	HUC 12 Subwatershed Codes	Acres Hydric Soils	Percentage of Subwatershed
Pigeon Lake-Pigeon Creek	040500011001	7,075	32%
Mud Creek-Pigeon Creek	040500011002	3,244	28%
Long Lake-Pigeon Creek	040500011003	4,932	26%
Headwaters Turkey Creek	040500011004	3,176	27%
Big Turkey Lake-Turkey Creek	040500011005	2,931	27%
Silver Lake-Pigeon Creek	040500011006	3,261	25%
Otter Lake-Pigeon Creek	040500011007	2,008	19%
Little Turkey Lake-Turkey Creek	040500011008	3,103	23%
Green Lake-Pigeon Creek	040500011009	3,095	23%
Mongo Millpond-Pigeon Creek	040500011010	2,169	21%
Grand Total/Percent Entire Watershed		**34,993**	**26%**

As an indicator of the potential for wetland development, understanding where hydric soils are located can inform wetland restoration and creation activities. Local stakeholders are concerned about the loss of wetland habitat in the watershed and support projects focused on wetland restoration and creation.

Figure 15 - Pigeon Creek Hydric Soils



3.3.4 Septic System Suitability

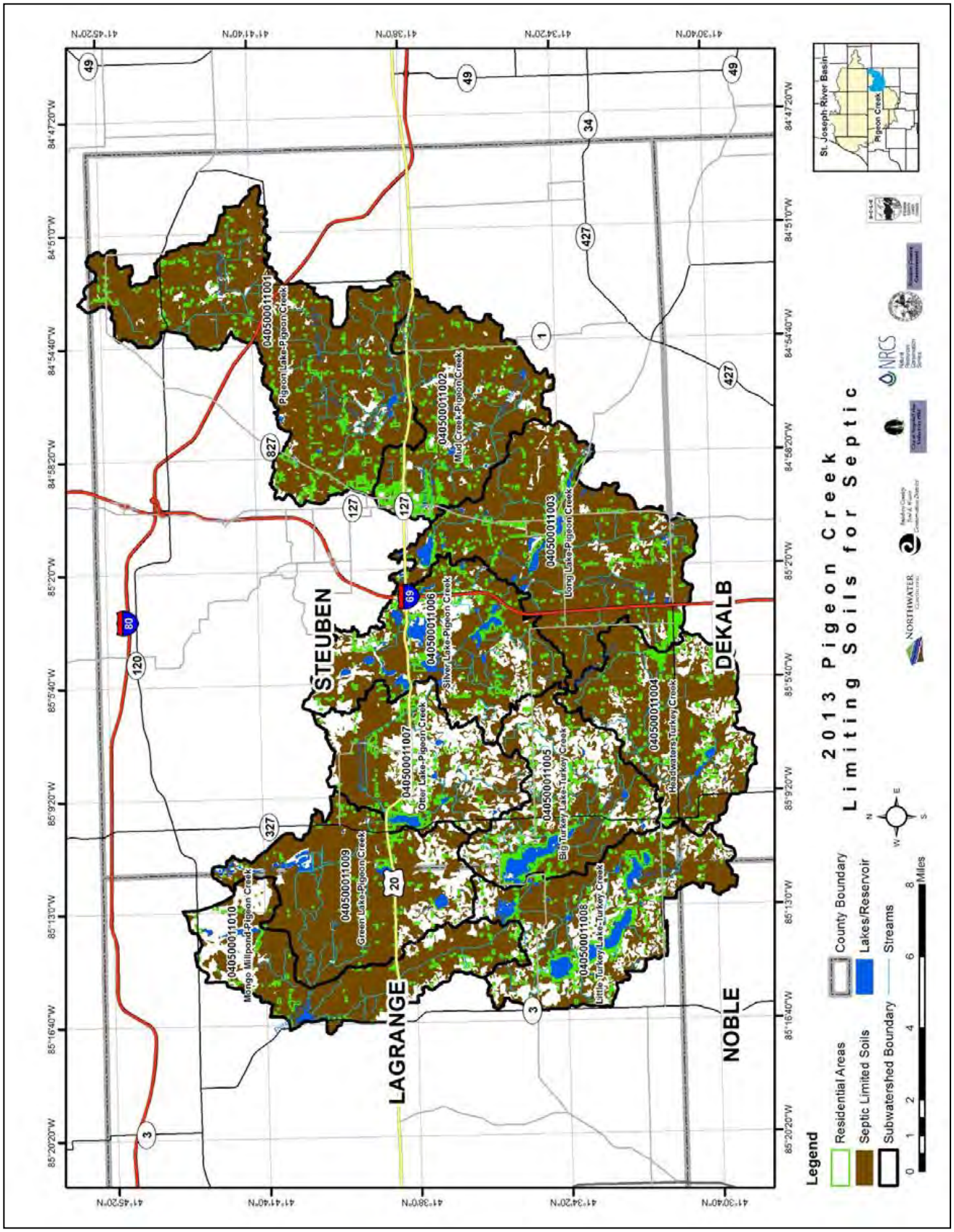
Outside of regional and municipal wastewater districts, residents within the Pigeon Creek watershed use septic systems to manage and treat wastewater. Over 95% of the watershed (129,934 acres) is outside of a wastewater district; a map of areas in the watershed that are served by a Wastewater Treatment Plant can be found in Section 7.1.2. Not all soil types support septic systems; improperly constructed systems can lead to failure and allow leaching of wastewater into groundwater and surrounding waterways. An analysis of the USDA national soils dataset indicates that 78%, or 105,488 acres (Table 16) of soils within the watershed, are classified as "very limited" with respect to septic suitability. The highest percentage falls within the Pigeon Lake subwatershed. This does not necessarily mean that all of these soils are unsuitable for septic but caution should be taken when establishing systems within most of the watershed. Figure 16 illustrates the extent of limiting soils for septic fields along with the location of residential areas within the watershed.

A more detailed analysis of potential septic problem areas can be found in Section 7.1.2, which notes that of an estimated 9,108 septic systems in the watershed, 1,365 are failing. Over 3,600 acres (2.68%) of all residential septic systems are on limiting soils and, of this acreage, 2,667 (73%) are within 500 feet of a stream. Considering that bacteria is the number one stakeholder concern, it is important to understand the relationship between water quality, soils suitable for septic systems, and improperly maintained or failing systems in the watershed.

Table 16 - Septic Suitability Soils

Subwatershed Name	HUC 12 Subwatershed Codes	Very Limited Soils	Percent of Subwatershed
Pigeon Lake-Pigeon Creek	040500011001	20,626	94%
Mud Creek-Pigeon Creek	040500011002	10,744	92%
Long Lake-Pigeon Creek	040500011003	16,893	91%
Headwaters Turkey Creek	040500011004	8,883	75%
Big Turkey Lake-Turkey Creek	040500011005	6,458	59%
Silver Lake-Pigeon Creek	040500011006	8,809	68%
Otter Lake-Pigeon Creek	040500011007	6,171	59%
Little Turkey Lake-Turkey Creek	040500011008	8,051	61%
Green Lake-Pigeon Creek	040500011009	11,302	83%
Mongo Millpond-Pigeon Creek	040500011010	7,552	72%
Grand Total/Percent Entire Watershed		**105,488**	**78%**

Figure 16 - Pigeon Creek Septic System Limiting Soils



3.3.5 Tillage Transect Survey Data

The Steuben County SWCD, along with the other counties in the watershed, performs annual transect surveys as part of the Indiana T by 2000, Watershed Soil Loss Transects Project. The most recent survey data from 2011 and 2012 included a total of 306 fields in the watershed. No survey sites fell within the Noble County portion of the watershed and LaGrange County was limited to 2011 data only. Compared to results presented in the previous plan, no-till remains the dominant tillage practice. Results also show a slight reduction in conventional tillage and a nominal increase in mulch-till. It should be noted that these results only represent those fields assessed and may not represent the watershed as a whole. Observations made during an April 2013 watershed windshield survey indicated a higher number of fields with conventional tillage, likely a result of the recent dry weather conditions, however, the majority of cropped HEL soils in the watershed are in no-till. Table 17 summarizes the data from the 2011 and 2012 surveys. Figures 17 and 18 show the distribution of tillage practices throughout the watershed.

Table 17 - 2011/2012 Transect Survey Data

Present Crop	Number of Fields	No-Till (>30% Residue) Total	Mulch-Till (30-75% Residue) Total	Reduced-Till (16-30% Residue) Total	Conventional (0-15% Residue) Total	Unknown Total
Corn	147	58	36	36	17	0
Soybeans	106	75	23	6	2	0
Small Grains	9	3	0	0	0	9
Hay	35	0	0	0	0	35
Specialty	3	0	0	0	3	0
CRP/Fallow	17	0	0	0	0	17

Pigeon Creek

Figure 17 – Upper Pigeon Creek Tillage

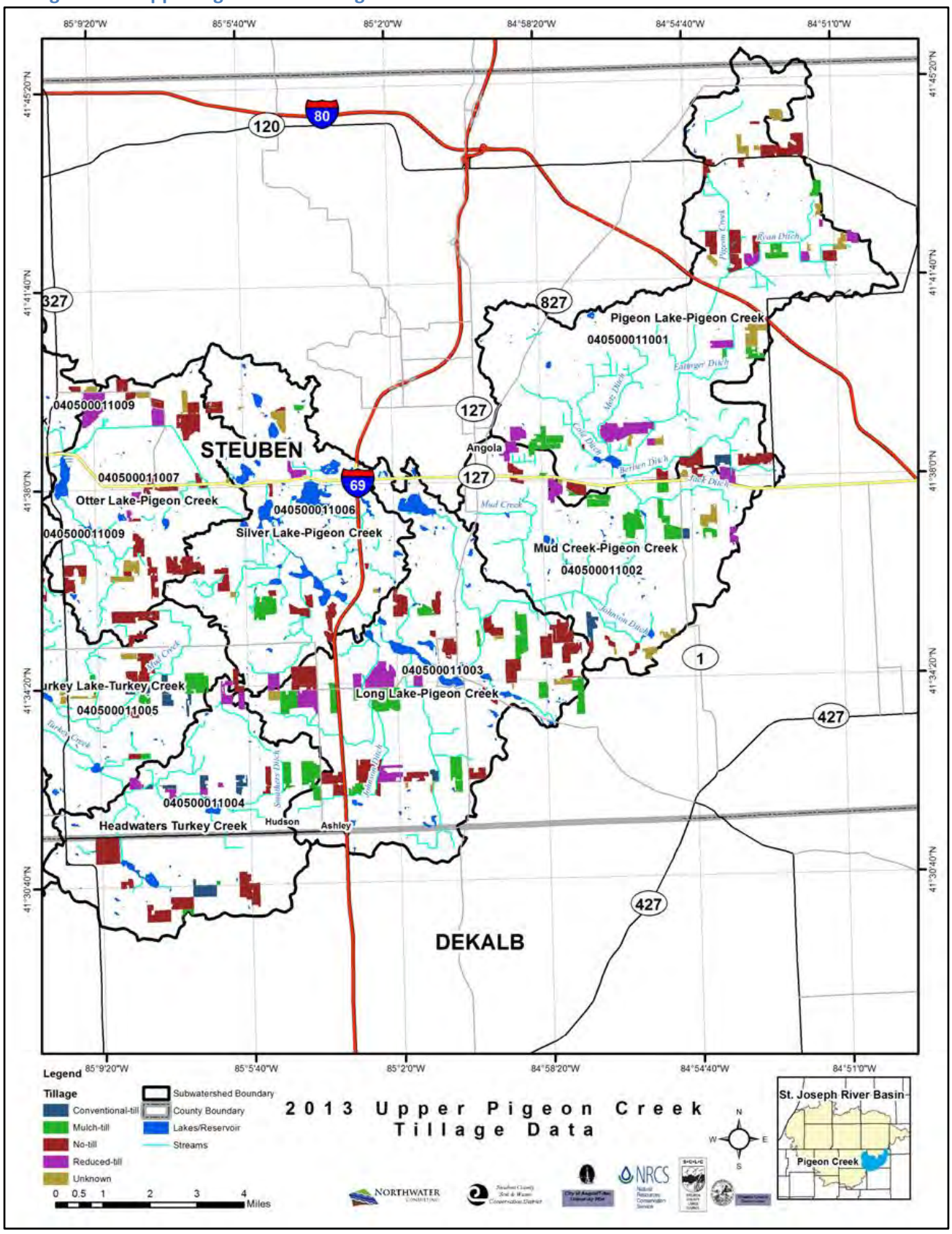
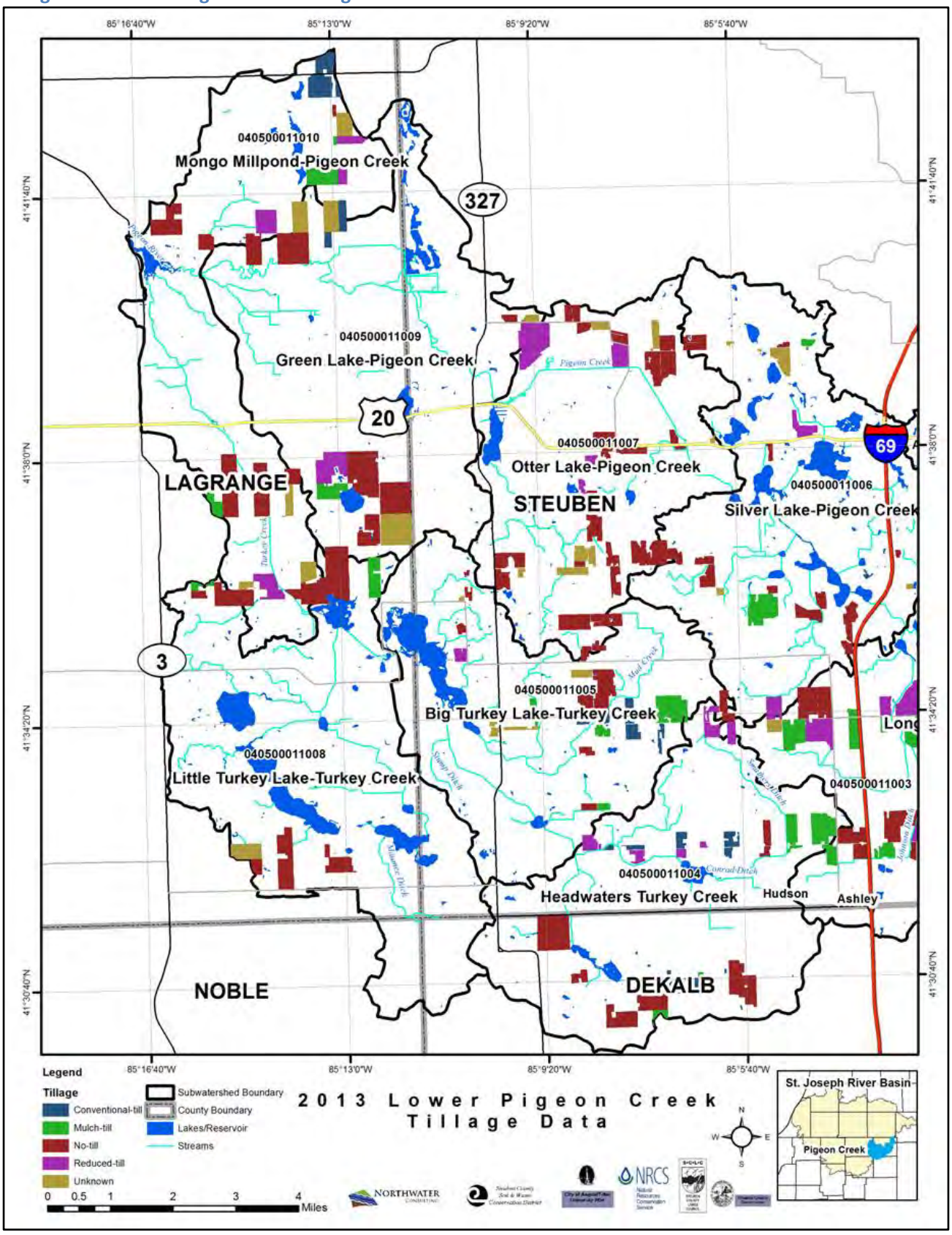


Figure 18 - Lower Pigeon Creek Tillage



3.4 Watershed Landuse/Landcover

A hybrid landuse/landcover GIS layer was created for the watershed using existing data provided by each county, analysis of recent aerial imagery and information collected during the windshield survey. This newly created layer represents a current snapshot of landuse and landcover in the watershed and is significantly more detailed than other national landcover datasets. Watershed-wide landuse statistics are provided in Table 18 and in Figures 19 and 20. Part II of the watershed inventory provides a more detailed explanation of landuse by subwatershed. Agricultural row crops encompass over 50% of the watershed and woodland and open space cover 25%. Wetlands, pasture, residential farm areas and open water are also of importance and account for 16% of the watershed area.

Table 18 - Watershed Landuse/Landcover

Landuse/Landcover Category	Acres	Percent of Watershed
Row Crop	69,396	51.05%
Woodland	22,120	16.27%
Open Space (grass or shrubs)	12,111	8.91%
Pasture	7,471	5.50%
Wetland	5,783	4.25%
Residential Farm	4,513	3.32%
Open Water Lake/Pond	3,752	2.76%
Road	3,236	2.38%
Residential (urban)	2,466	1.81%
Legal Ditch	929	0.68%
Primary Commercial/Industrial/Institutional	741	0.55%
Classified Wildlife Habitat	682	0.50%
Public Open Space (recreation)	651	0.48%
Classified Forest	523	0.38%
Farm Buildings and Barn Lots	378	0.28%
Railroad Right-of-Way	243	0.18%
Quarry	204	0.15%
Golf Course	149	0.11%
Open Water Stream/River	117	0.09%
Secondary Commercial/Industrial/Institutional	104	0.08%
Cemeteries	69	0.05%
Confinement	66	0.05%
Feed Area (non-barn)	60	0.04%
Agricultural Excess Area	47	0.03%
Feed Area Hogs	33	0.02%
Nursery	26	0.02%
Undeveloped Unusable Commercial/Industrial	23	0.02%
Undeveloped Usable Commercial/Industrial	17	0.01%
Vacant	13	0.01%
Cell Tower	4	0.003%
Public Utility Tower	0.12	0.0001%

Figure 19 – Upper Pigeon Creek Landuse/Landcover

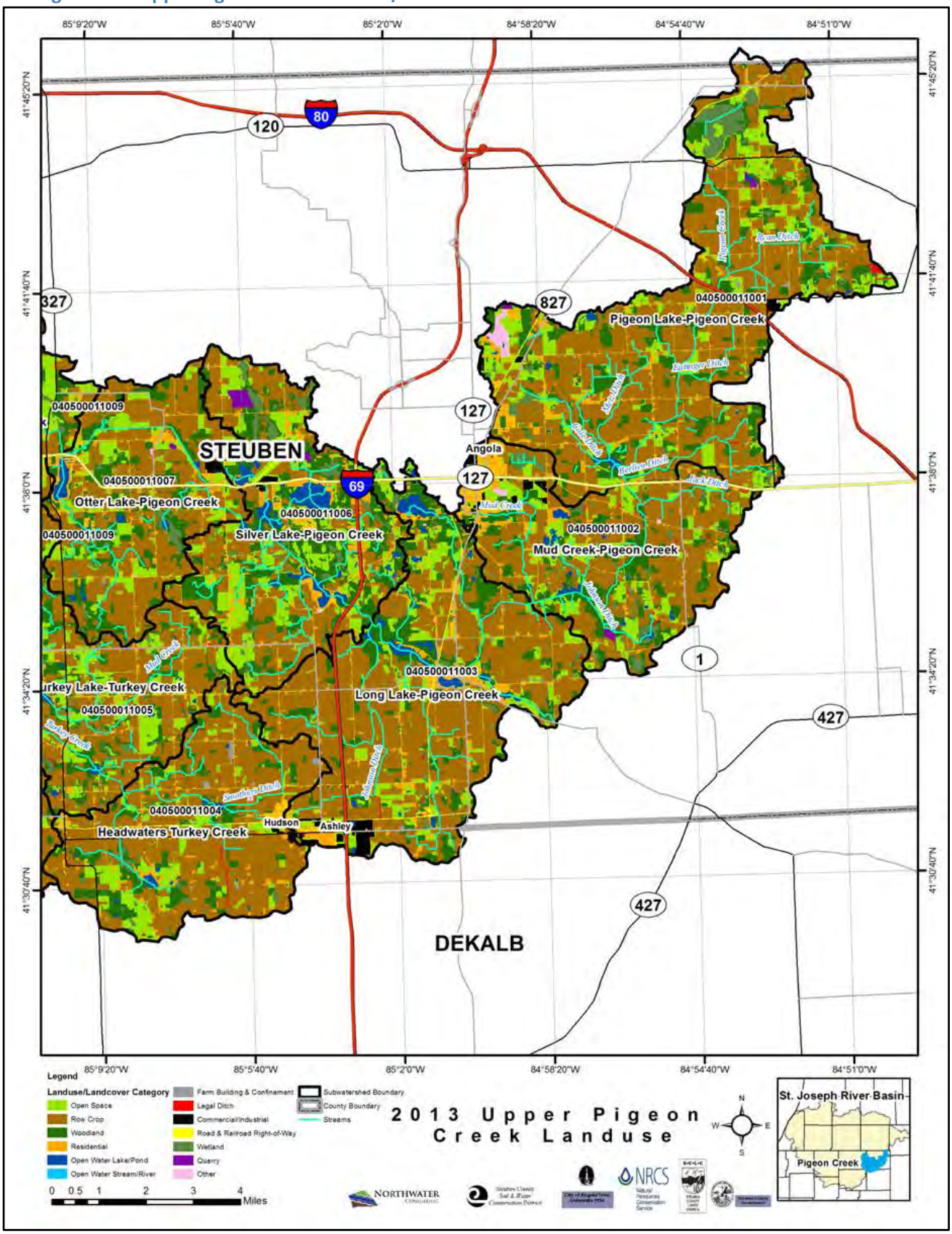
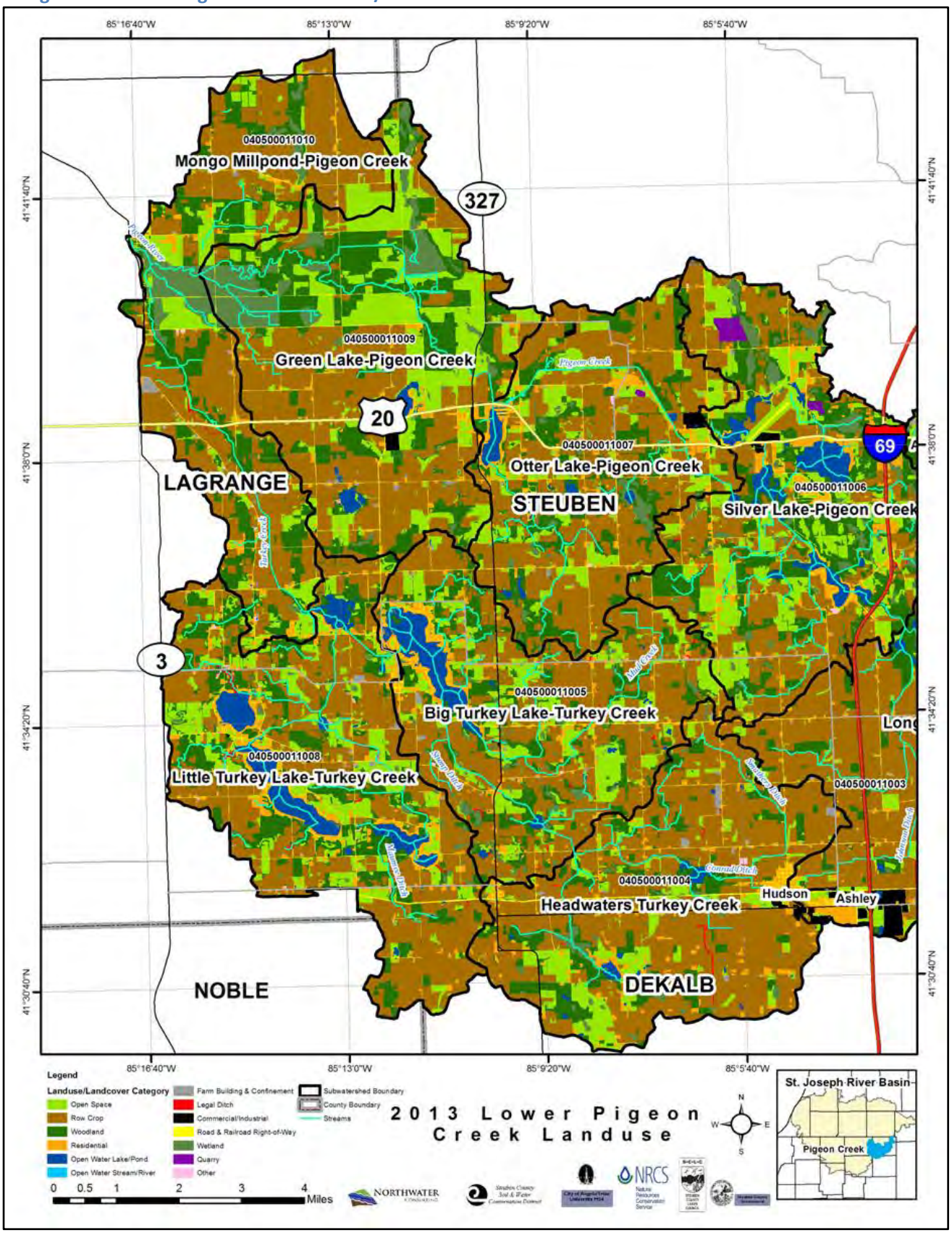


Figure 20 - Lower Pigeon Creek Landuse/Landcover



As noted in the 2006 plan:

> *"Steuben County economic income has long been based on agriculture with farming the primary historical land use. In 1995, approximately 70% of the watershed was classified as farmland (row crops and pasture.) The remainder of the watershed consists of small clusters of development primarily on the outskirts of Angola, forests, lakes, and other undeveloped land. Although the majority of Angola is outside of the Pigeon Creek watershed, the Angola Wastewater Treatment Plant discharges to a tributary of Pigeon Creek. Therefore, land use changes in the Angola vicinity will have an effect on the watershed."*

It is difficult to compare historical with current landuse using the 2006 plan as the dataset was from a national scale of lower resolution and the watershed planning areas are different between 2006 and 2014. Landuse/landcover from the 2006 plan is provided in Table 19; however, comparisons were not made due to the major difference in scale.

Table 19 - 1999 National Landcover Database Landuse/landcover

Land Use	Total Acres	Percent of Watershed
Row Crops	51,072	57.25
Pasture/Hay	12,450	13.95
Unclassified/Other	9,598	10.76
Deciduous Forest	9,152	10.26
Forested Wetlands	2,737	3.07
Open Water	1,991	2.23
Emergent Wetlands	883	0.99
Low Intensity Residential	694	0.78
Commercial/Industrial/Transportation	427	0.48
Evergreen Forest	95	0.11
4 remaining categories, each less than 0.1%	118	0.14
Totals	**89,216**	**100**

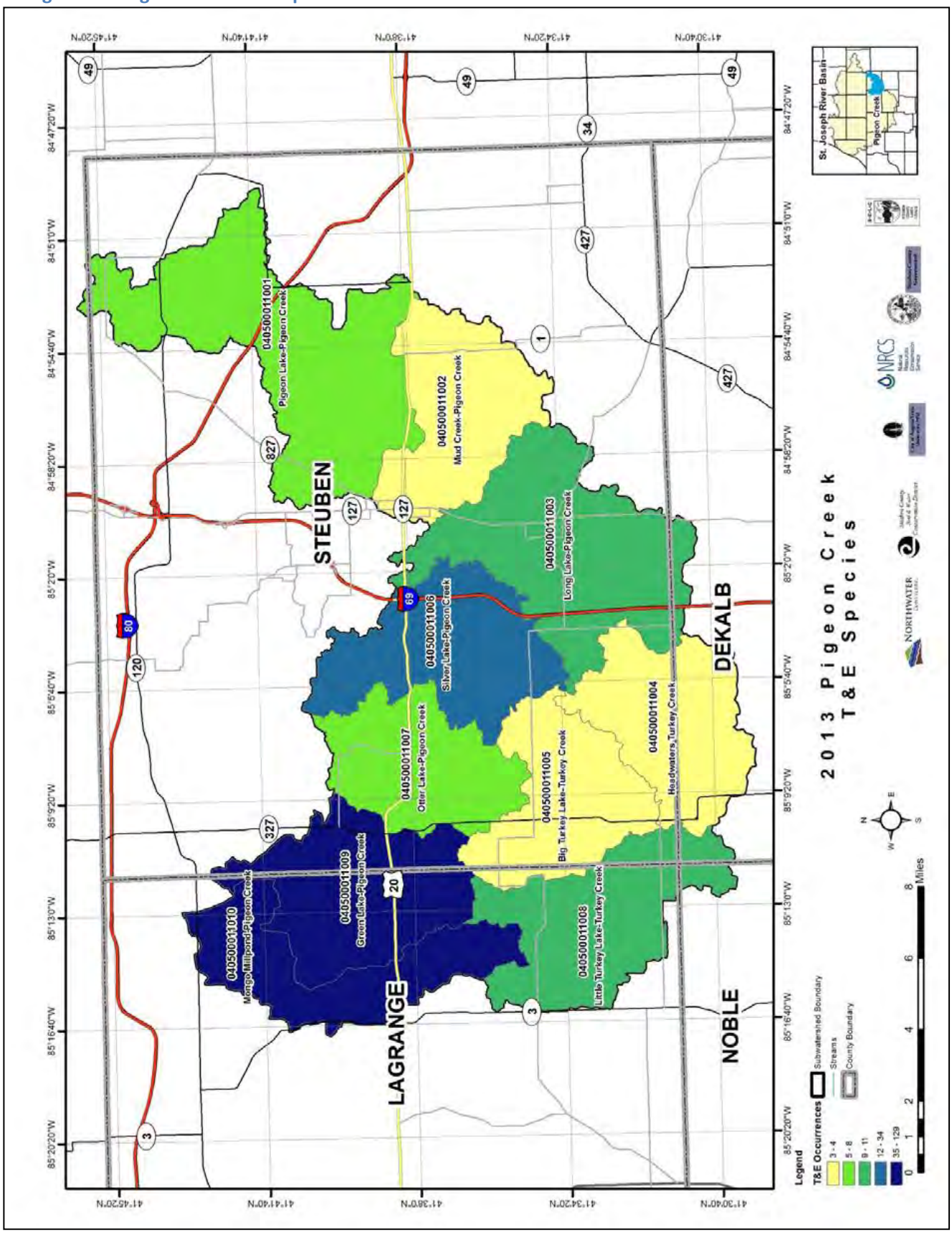
Landuse relating to confinement operations, small animal feeding operations, pasture, row crop agriculture, urban, and residential areas are further detailed in Sections 7.1.2 and 7.1.3. The Pigeon Creek watershed contains eight (8) regulated confinement operations that house 12,654 animals. There are eighty-five (85) small animal feeding locations totaling 161 acres and located an average of 577 feet from a stream or lake, and 7,471 acres of pasture of varying quality. Urban residential areas total 2,466 acres, residential farm sites make up 4,516 acres, commercial, industrial, and institutional landuses total 845 acres and farm buildings and barn lots are located on 370 acres throughout the watershed.

3.5 Threatened & Endangered Species

The 1987 *"Watershed Protection Plan"* indicated that the Indiana bat (*Myotis sodalist*) could be the only identified threatened or endangered species that may be present in the watershed. As part of the efforts to update the 2006 plan, a request was made to IDNR requesting information on the Threatened and Endangered (T&E) or rare species, high quality natural communities, and natural areas within the Pigeon Creek watershed. Table 20 and Figure 21 show the number of T&E species occurrences within each subwatershed. A detailed list by species is included in Appendix C; a list of T&E species is also available in the 2006 PCWMP (pages 47-50). As watershed improvement projects are designed and implemented, it is important to incorporate protective measures or avoidance of the species and areas that are listed. BMPs implementation and watershed improvement measures should consider the habitat requirements of T&E species.

Indiana Bat (photo credit: US Fish & Wildlife Survey)

Figure 21 - Pigeon Creek T&E Species Occurrences



There are 313 known occurrences of T&E species within the watershed that include 156 different species (Appendix C). The list includes 71 plants, 39 insects, 18 birds, 12 high quality natural communities, 5 mammals, 4 reptiles, 3 amphibians, 2 fish, and 2 mollusks. Amphibian species include the Northern Leopard Frog, Four-toed Salamander and the Blue-spotted Salamander. Fish species include the Cisco and the Greater Redhorse. The Cisco is a coldwater species found in lakes, and sometimes large rivers, and is a member of the trout/salmon family, resembling the lake whitefish. The Greater Redhorse is typically found in clear, relatively fast-moving rivers and in both shallow and deep waters in some lakes. Listed mollusks include the Snuffbox and the Ellipse. Both the Ellipse and the Snuffbox live in small to medium streams in gravel or mixed sand and gravel.

Table 20 - Threatened & Endangered Species

Subwatershed Name	HUC 12 Subwatershed Codes	Number of T&E Species Occurrences
Pigeon Lake-Pigeon Creek	040500011001	8
Mud Creek-Pigeon Creek	040500011002	3
Long Lake-Pigeon Creek	040500011003	11
Headwaters Turkey Creek	040500011004	3
Big Turkey Lake-Turkey Creek	040500011005	4
Silver Lake-Pigeon Creek	040500011006	34
Otter Lake-Pigeon Creek	040500011007	6
Little Turkey Lake-Turkey Creek	040500011008	10
Green Lake-Pigeon Creek	040500011009	129
Mongo Millpond-Pigeon Creek	040500011010	105
Grand Total		313

3.5.1 Indicator Species

The Cisco (*Coregonus artedi*) is a slender silver-colored fish that is a member of the salmon/trout family and is primarily found in glacial lakes. The southernmost range of the Cisco extends into northern Indiana. Cisco populations in Indiana have been declining and, in some cases, have disappeared completely. A layer of cold, well-oxygenated water is required by Cisco for survival. Lake eutrophication is caused by increased nutrient loading which results in the loss of oxygen from the deeper, cold water utilized by Cisco. Eutrophication is thought to be a cause for the decline in the Cisco populations of Indiana's lakes.

Gooseneck Lake and Meserve Lake are the only two lakes that had a Cisco population during the IDNR survey from 1990 to 1993, both within Steuben County and the Pigeon Creek watershed. There were four other lakes within Steuben County, not within the watershed, that had a Cisco population during the survey, including Failing Lake, McClish Lake, Lake Gage, and Seven Sisters Lakes.

The IDNR Division of Fish and Wildlife has stocked Cisco in Green Lake, which is within Steuben County and the watershed, but Green Lake does not have a direct surface water connection with Pigeon Creek.

The Cisco and other rare species can be used as an indicator of high-quality water bodies, thus populations should be closely monitored to forewarn of declining water quality.

3.6 Watershed Successes & Progress Made

After the 2006 plan was completed, Phase I Implementation of the plan commenced under funding from an IDEM Section 319 Nonpoint Source Management Program Grant. Phase I implementation was completed in 2008, and the Steuben County SWCD applied for the next phase of funding. The Phase II Implementation Grant was awarded from the IDEM Section 319 program in 2009 with grant work commenced on September 22, 2009. The goal of the Phase II project was to continue to improve the water quality of the watershed by working in critical areas identified in the 2006 plan, and to build on the success of Phase I. Goals and objectives of Phase II implementation included: increased adoption of agricultural and urban BMPs, greater public awareness of the importance of water quality, demonstration of the benefits of agricultural and urban BMPs, improved water quality and biotic communities from BMP implementation, and wetland/habitat restorations. In addition to Phases I and II, the Steuben County SWCD received complementary funding through the Indiana Lake and River Enhancement Program (LARE) to implement additional BMPs between 2007 and 2012.

Overall, substantial progress has been made to address goals identified during the 2006 plan, which include improved water quality, improved drainage, and regulated development. Specific progress included:

- A reduction in localized bacteria loads through the implementation of livestock BMPs (Sections 3.6.2 and 3.6.3 and Section 9).
- Reductions in sedimentation and nutrients have occurred through the implementation of agricultural and urban BMPs. Load reductions from these practices are summarized in Section 9.
- The number of Combined Sewer Overflow (CSO) events has been reduced in the City of Angola.
- Complaints and concerns at Steering Committee meetings related to flooding have been reduced.
- Development in Angola continues to be regulated and numerous urban BMPs have been implemented, such as rain gardens, porous pavement, rain barrels, and a large stormwater wetland restoration project.

3.6.1 PCWMP Phase I Implementation

After completion of the 2006 plan, the Phase I grant was applied for and awarded to the Steuben County Commissioners/GIS and administered through the County Surveyor's Department. The project included the hiring of a resource specialist to promote the installation of BMPs within the watershed. The role of the Steuben County SWCD was to assist the resource conservationist with project identification and planning, conservation planning, field checks, and education.

Phase I highlights included:

- Candidate sites identified within critical subwatersheds.

- An education campaign and materials covering: best lawn fertilizer practices, best crop and livestock practices, septic maintenance, car washing, pet waste, and urban construction practices.
- BMP implementation including: filter strips (28,150 ft), grassed waterways (3,350 ft), and water and sediment control basins (20 structures).

3.6.2 PCWMP Phase II Implementation

Phase II PCWMP implementation included the following:

- Development and promotion of a cost-share program to implement BMPs such as, but not limited to, conservation buffers, a constructed wetland, rain gardens, and green roofs all of which address the water quality concerns outlined in the 2006 plan.
- BMPs were implemented in critical areas as described in the 2006 plan.
    - 307 feet of streambank stabilization
    - 4,295 feet of exclusion fencing and rotational grazing
    - 15 acres of hay planting
    - 30 acres of tree planting
    - Commons Park/John Leach Drain 2.66-acre wetland restoration project
    - 43 rain barrels
    - 324 square feet of pervious concrete
    - 4,100 square feet bio-swale
    - 3 rain gardens in Angola
- Implementation of a water monitoring program to determine the source and fate of pollutants in the watershed and to guide future sampling and/or remediation of point and nonpoint source pollution. The monitoring program included:
    - Sampling for: Total Phosphorus, Total Suspended Solids, pH, Dissolved Oxygen, temperature, specific conductance, stream flow, and *E. coli*.
    - A minimum of ten (10) sites within the Pigeon, Hogback, Long, Center, Pleasant, Big Bower, and Golden Lakes for the aforementioned parameters and was to take place at least three (3) times between May and September of each year.
    - No less than four (4) sites within the Pigeon Creek for the aforementioned parameters at least three (3) times between May and September of each year.
    - The development of Quality Assurance Project Plan (QAPP) for the monitoring activities.
- An education and outreach program designed to bring about behavioral changes and encourage BMP implementation that would lead to reduced nonpoint source pollution in the watershed. Projects included:
    - a presentation educating the attendees on water quality issues at schools within the watershed each year
    - five (5) presentations educating the attendants on water quality issues
    - twelve (12) quarterly Steering Committee meetings
    - one (1) public meeting each year
    - three (3) project-related press releases to local media each year

- updates on the Steuben County SWCD website
- project promotion at city and county meetings
- signage at highly visible BMP sites throughout the watershed
- three (3) workshops on water quality issues
- development and dissemination of a brochure regarding septic maintenance to stakeholders throughout the watershed

3.6.3 PCWMP Supplemental Implementation

The Steuben County SWCD received two LARE grants to install additional agricultural BMPs in the watershed between 2007 and 2012. Completed practices installed (2007-2012) through this funding included:

- 683 acres of hay planting
- 20.6 acres of filter strips
- 36,832 feet of livestock fencing
- 4 livestock watering facilities
- 86 acres of tree planting
- 878 acres of cover crops
- 3,200 acres of grassed waterways
- 8.35 acres of critical area seeding

3.7 Previous Planning Efforts

It is important to understand the historical planning and assessment efforts conducted within the watershed (Table 21) to inform current planning efforts, avoid duplication of efforts, and to ensure a linkage with any higher level plans. Numerous planning projects, plans, and reports have been completed for the watershed in the last thirty years, including local watershed and city plans and numerous assessment reports. Each document represents a different snapshot in time, which provides insight into the current plan. Some of these plans are outdated but offer a historical perspective, and several existing watershed-wide plans, including the recent TMDL document, provide guidance that will drive components of the current planning effort.

Table 21 - Summary of Previous Planning Efforts

Plan Title	Plan Year	Plan Purpose	Notes/Relevance
Preliminary Investigation Report; Pigeon River Watershed	1967	Identify solutions to flooding	Includes watershed inventory and recommends land treatment and structural solutions
Feasibility Report; Pigeon Creek watershed	1983	To identify feasibility of a PL-566 flood control project	Updates, summarizes and reiterates recommendations in the 1967 report
Preauthorization Report; Pigeon Creek watershed	1984	To investigate solutions to upstream erosion issues and to justify funding through the PL-566 program	The report identifies watershed problems, specifically focusing on erosion and compares several treatment alternatives. Desired recommendations included a combination of land treatment practices.
Watershed Protection Plan – Environmental Assessment for Pigeon Creek watershed	1987	To justify land treatment in the watershed using Department of Agriculture programs	Locally led planning effort. Quantifies erosion problems and recommends a 10-year plan for land treatment and structural practices aimed at reducing soil erosion and flooding.
Northeast Indiana Erosion Study Report for Steuben County, Indiana	1987	Response to concerns over excessive soil erosion	Only for Steuben County. Average 17.7 tons/acre/year erosion. The document recommends land treatments
Pigeon River Flooding Study Phase I	1994	To Identify solutions to flooding	Similar to previous studies; recommends land treatment and some structural measures including using or enhancing existing recreational areas. Notes septic leachate as a problem during flood events
Lake Engineering Feasibility Studies	1991 & 2002	LARE Studies for evaluating the feasibility or alternatives for enhancing and protecting lake quality	Two plans exist for Big and Little Turkey Lakes, including a watershed feasibility study and an enhancement study. These studies outline strategies for enhancing and protecting lake quality and, although specific to those lakes, plan recommendations are similar to those outlined in the PCWMP. These documents can be used to further justify and seek funding for the Big and Little Turkey Lake Watersheds and should be consulted if work is planned in these areas.
St. Joseph River Basin Management Plan	2005	To address water quality issues and natural resource protection across jurisdictional boundaries	High level plan covering Pigeon Creek as a tributary to the St. Joseph River. Provides general implementation guidance; no specifics for Pigeon Creek. The plan goals are generally in line with the goals for Pigeon Creek. The plan should be used to justify funding requests.
City of Angola/Trine University; Storm Water Quality Management Plan; Municipal Separate Storm Sewer System (MS4)	2010	To reduce the discharge of pollutants to the "Maximum Extent Practicable" (MEP); To protect water quality; and; To satisfy the appropriate water quality requirements of the Clean Water Act.	The plan provides a framework for improving stormwater quality within MS4 boundaries. The document is relevant to the watershed planning process in that it establishes the need and guidance for practice implementation and action within city limits. It addresses public participation and education, illicit discharges, runoff and control measures. This document can be used to justify funding for implementation and further strengthens the Watershed Management Plan.

Plan Title	Plan Year	Plan Purpose	Notes/Relevance
Pigeon River Watershed Total Maximum Daily Load (TMDL) Study for *E. coli* and Impaired Biotic Community (IBC)	2012	To establish percentage load reductions for *E. coli* and Phosphorus needed to meet state standards and improve the impaired biotic community	This report establishes a baseline number from which to measure and reduce bacteria and nutrient/sediment loading to Pigeon Creek. The most important thing about a TMDL is that once in place, the assessed waterbody will receive priority for funding. A TMDL study is a mechanism to secure watershed improvement project funding. Often, once a TMDL study is completed, additional planning is required to identify specific implementation projects.
Pigeon Creek Watershed Management Plan Phase Two Implementation; Final Report	2012	To describe EPA Clean Water Act funding in the watershed from 2009-2012	The report provides details on specific watershed restoration practices installed using federal funds from 2009-2012. This document can be used to understand implementation efforts prior to the PCWMP update and is a testament to the many watershed accomplishments since 2006.
Various Aquatic Vegetation Management Plans	2006-2013	Plans that describe the condition of lake vegetation species and the treatment of aquatic invasive species	Over 25 plans (including plan updates) have been completed for lakes in the watershed. These documents are lake-specific and address vegetation management. These plans complement the PCWMP as vegetation management is not specifically addressed in this plan.
Lake Diagnostic Studies	1991-2013	Similar to Lake Engineering Feasibility Studies, LARE Lake Diagnostic Studies outline options and alternatives for addressing lake quality	Plans exist for Pretty Lake, McClish Lake, Lake of the Woods, and Fox Lake. These studies include a watershed evaluation and data collection and outline strategies for enhancing and protecting lake quality. Although specific to those lakes, plan recommendations are similar to those outlined in the PCWMP. These documents can be used to further justify and seek funding for the above-listed lake watersheds and should be consulted if work is planned in these areas.
City and County Comprehensive Plans	N/A	Comprehensive plans guide the type, location and timing of development	The Steuben County Comprehensive Plan covers unincorporated areas of Steuben County; this plan is implemented through the County Zoning Ordinance, the Subdivision Control Ordinance, and various policies and practices. Angola has adopted a Comprehensive Pan. This plan specifically addresses water and environmental quality; no other known comprehensive plans exist in the watershed. A town master plan does exist for Ashley. City and county planning generally occurs through zoning ordinances. These ordinances and other initiatives can support sound water quality management and, in the case of Angola, local efforts to control stormwater runoff are directly incorporated into the PCWMP. Other communities within the watersheds should be approached; similar work being implemented in Angola can occur in other urban areas.
Pigeon River Watershed Management Plan	2013	To address water quality issues in the Pigeon River watershed and expand implementation efforts.	The Pigeon Creek flows southwesterly through Steuben County and enters the east side of LaGrange County. Pigeon Creek turns into the Pigeon River once the creek meets the Mongo Millpond. The Pigeon River WMP, produced through the LaGrange County SWCD, also includes three subwatersheds within the extent of the

Plan Title	Plan Year	Plan Purpose	Notes/Relevance
Pigeon River Watershed Management Plan (Continued)	2013	To address water quality issues in the Pigeon River watershed and expand implementation efforts.	Pigeon Creek WMP; Little Turkey Lake – Turkey Creek (HUC 040500011008), Green Lake – Pigeon Creek (HUC 04050001009), and Mongo Millpond – Pigeon Creek (HUC 040500011010). Many of the water quality issues and solutions are similar between the Pigeon River and Pigeon Creek WMPs and, despite some overlap in watershed area, each plan addresses a different geographic area. Any work completed in the Pigeon Creek watershed will have positive benefits to Pigeon River. With both of these plans completed, significant opportunities now exist for Steuben and LaGrange Counties to coordinate on projects that are mutually beneficial to both watersheds, especially where subwatersheds and plan recommendations overlap. Relevant overlapping recommendations include the installation of buffer strips, limiting livestock access to streams, and management of livestock waste from small feed areas. Additional funds and technical resources could be leveraged through coordination.

Based on a review of historical planning projects, the Pigeon Creek watershed has received interest as early as 1967 when the first watershed assessment/investigation report was commissioned. Early reports and plans followed a similar structure as today's plan, focusing on identifying solutions to watershed and water quality problems. Most of the historical documents and plans focused on flooding and sedimentation of lakes. In each situation, planners identified watershed issues and made either site-specific or generalized recommendations to alleviate quantifiable problems. Similar to today, many of the recommendations to address both flooding and erosion focused on a combination of land treatment and structural practices. What is interesting about the planning history for the watershed is that, over the years, little has changed in terms of what conditions residents perceived as problems and what conditions the 'data' suggested were problems: flooding, erosion/sedimentation, and water quality.

After beginning these early land treatment projects, many of the watershed issues remain and many of the solutions are still very relevant. Regardless of the progress made to date in addressing watershed issues, these issues still do persist. This 2014 plan identifies where and which solutions are needed, along with the water quality benefits achieved as a result.

Lakes in the Pigeon Creek watershed have received significant attention in terms of historical planning and studies, especially through the Indiana LARE program. As noted in Table 21 above, numerous Aquatic Vegetation Management Plans, Lake Engineering Feasibility Studies, and Lake Diagnostic Studies have been completed. Big and Little Turkey Lakes have received the most attention as both lakes have all three of these documents in place. Similar to this watershed plan, diagnostic and feasibility studies include a watershed area assessment and evaluation, data collection, public participation and general

project recommendations. These documents do not replace the PCWMP; rather, they enhance the plan by reinforcing similar water quality issues at a more focused and local scale. Applicable LARE plans and studies should be consulted prior to initiating any work in those areas. This PCWMP acts as an overarching document, focused primarily on water quality at the basin scale; it supports these smaller, more localized efforts. The PCWMP also includes a set of unique and site-specific project recommendations, not found in previous studies. Stakeholders responsible for implementing existing LARE studies and plans can refer to the PCWMP for additional direction.

Planning has also been completed from the Pigeon Creek Watershed to the Pigeon River Watershed and into the St. Joseph River basin. These hydrologically connected systems share common water quality issues and each plan describes similar solutions. Goals outlined in the large-scale St. Joseph River Basin Plan are in line with those of Pigeon Creek. The recently completed Pigeon River Watershed Management Plan overlaps in both geography and water quality concerns. Progress made towards improving water quality in Pigeon Creek will have numerous benefits to the Pigeon River and significant opportunities now exist to coordinate implementation activities in both watersheds.

Furthermore, the existing Pigeon Creek/River TMDL plan and the City of Angola MS4 Storm Water Quality Management Plan are two very relevant documents that provide additional justification for improving water quality in the watershed. The TMDL plan establishes numerical load reduction targets required to address stream impairments. The PCWMP is directly tied to these targets in that it establishes site-specific treatment practices required to reasonably achieve the needed load reductions within the watershed. The simple fact that a TMDL plan exists will allow local watershed stakeholders to take advantage of water quality improvement funds and receive a much higher priority. The City of Angola's MS4 plan establishes the regulatory framework for addressing stormwater quality within the City's MS4 permitted area, and provides the continuity with urban water quality issues and solutions. The MS4 plan ensures that there is a willingness from Angola to make measurable efforts to address stormwater and water quality issues from the city. As in the case of the TMDL plan, it enhances access to water quality improvement funds as well as addressing project needs within the city.

3.7 Other Relevant Watershed Characteristics

The Pigeon Creek watershed includes a variety of unique features and a combination of both urban and rural areas. This section of the plan describes other relevant watershed characteristics, including public owned and protected land, watershed demographics, and urban areas.

3.7.1 Public Owned & Protected Land

There are 7,198 acres (5%) of the watershed that are owned by the State of Indiana, the largest area is the Pigeon River Fish and Wildlife Area which is 6,126 acres and located at the watershed's outlet. The entire Pigeon River Fish & Wildlife Area extends outside the watershed and includes 11,605 acres of land, 529 acres of lakes and impoundments and 17 miles of free-flowing river. It was established in 1956 when three impoundments in the Pigeon River Valley were transferred to state ownership. These included Mongo, Nasby and Ontario reservoirs. The state has continued to acquire additional land along the river valley.

Cedar Lake Wetland Conservation Area is 883 acres within the watershed, and an additional 51 acres outside the watershed. It is located in the headwaters of Pigeon Creek in the Northeast of the watershed. The Nature Conservancy (TNC) owns 118 acres in the Silver Lake subwatershed (HUC 040500011006). Figure 22 depicts the location of protected and public owned areas throughout the watershed and Table 22 breaks down acreage by subwatershed.

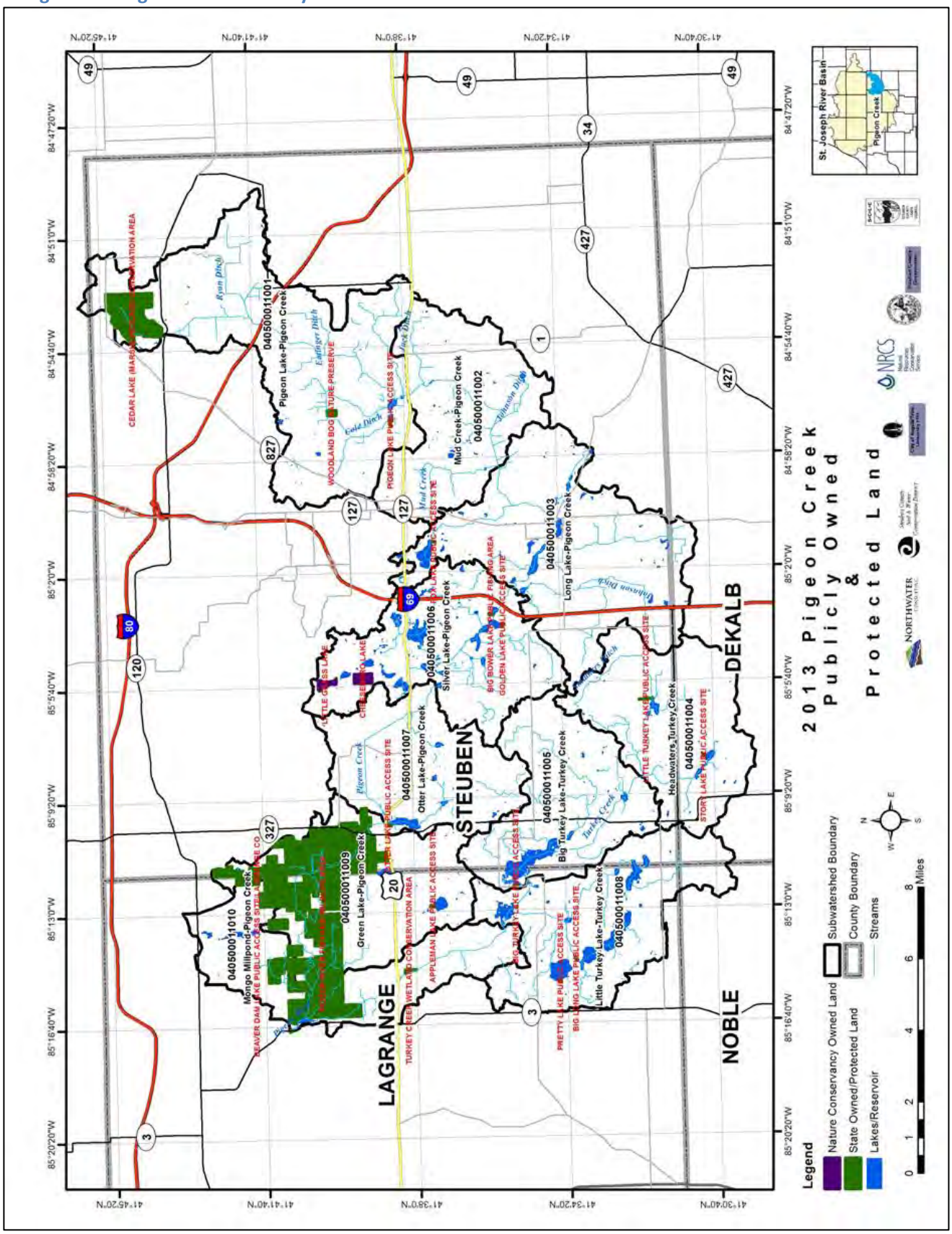
Table 22 - Public Owned Land

Subwatershed/Site Names	HUC 12 Subwatershed Codes	Area in Acres	Percent of Watershed
Pigeon Lake-Pigeon Creek	**040500011001**	**22,036**	
Cedar Lake (Marsh) Wetland Conservation Area		883	4.01%
Pigeon Lake Public Access Site		4	0.02%
Woodland Bog Nature Preserve		25	0.11%
Total		**912**	**4.14%**
Mud Creek-Pigeon Creek	**040500011002**	**11,641**	0
Long Lake-Pigeon Creek	**040500011003**	**18,620**	
Fox Lake Public Access Site		1	0.01%
Headwaters Turkey Creek	**040500011004**	**11,798**	
Little Turkey Lake Public Access Site		3	0.02%
Story Lake Public Access Site		2	0.01%
Total		**5**	**0.04%**
Big Turkey Lake-Turkey Creek	**040500011005**	**11,015**	
Big Turkey Lake Public Access Site		3	0.03%
Silver Lake-Pigeon Creek	**040500011006**	**12,954**	
Big Bower Lake Public Fishing Area		3	0.03%
Cheeseboro Lake		80	0.62%
Golden Lake Public Access Site		1	0.01%
Little Grass Lake		46	0.36%
Grass Lake Complex (TNC)		118	0.91%

Subwatershed/Site Names	HUC 12 Subwatershed Codes	Area in Acres	Percent of Watershed
Total		**249**	**1.92%**
Otter Lake-Pigeon Creek	**040500011007**	**10,491**	
Otter Lake Public Access Site		5	0.05%
Pigeon River Fish And Wildlife Area		3	0.03%
Total		**8**	**0.08%**
Little Turkey Lake-Turkey Creek	**040500011008**	**13,255**	
Big Long Lake Public Access Site		2	0.01%
Little Turkey Lake Public Access Site		1	0.004%
Pretty Lake Public Access Site		1	0.01%
Total		**4**	**0.03%**
Green Lake-Pigeon Creek	**040500011009**	**13,581**	
Appleman Lake Public Access Site		1	0.01%
Beaver Dam Lake Public Access Site/La Grange Co		1	0.01%
Pigeon River Fish And Wildlife Area		4,694	34.57%
Total		**4,697**	**34.58%**
Mongo Millpond-Pigeon Creek	**040500011010**	**10,520**	
Pigeon River Fish And Wildlife Area		1,429	13.59%
Turkey Creek Wetland Conservation Area		8	0.07%
Total		**1,437**	**13.66%**
Grand Total		7,316	5.4%

Pigeon Creek

Figure 22 - Pigeon Creek Publicly Owned & Protected Land



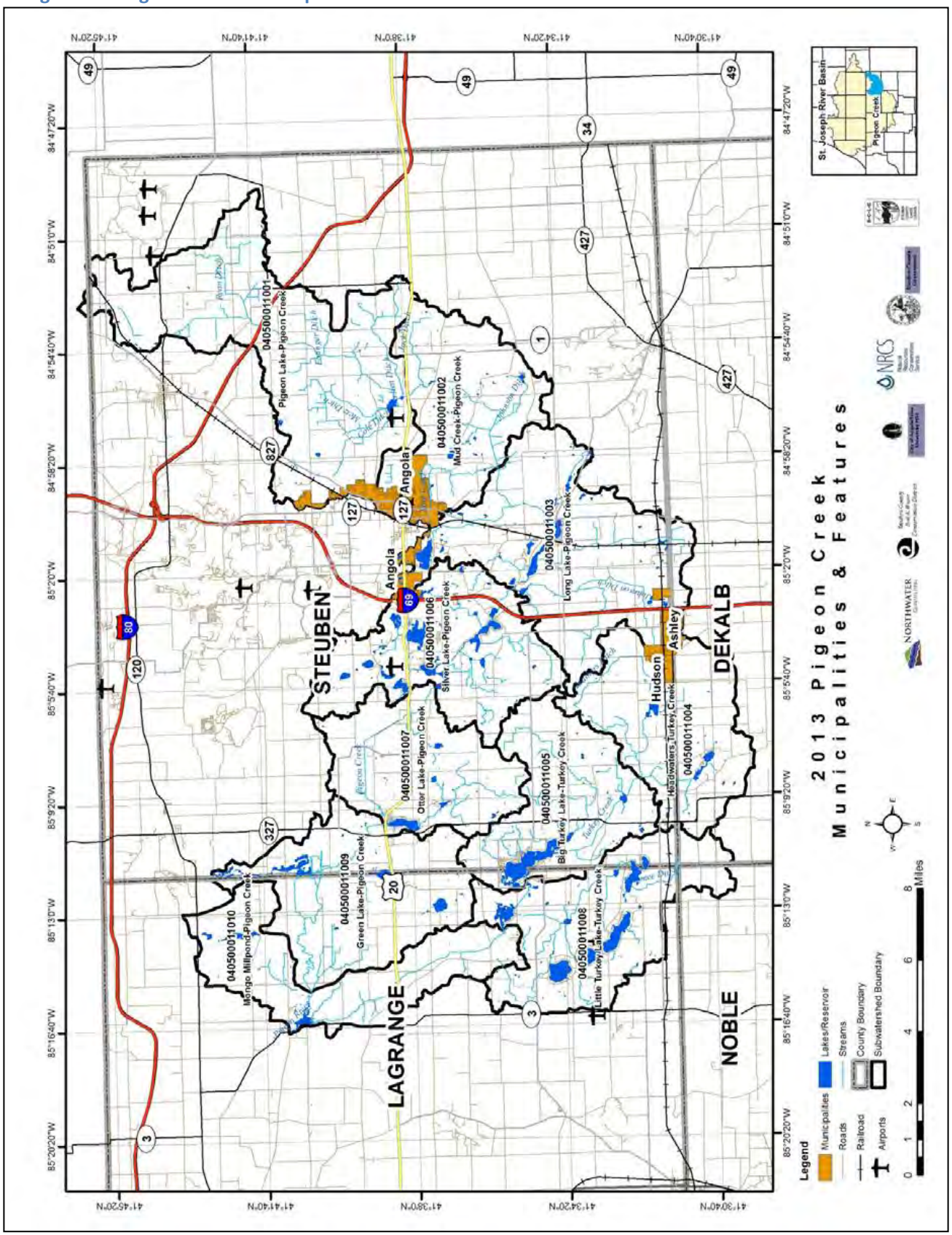
3.7.2 Watershed Demographics & Urban Areas

The Pigeon Creek watershed is primarily rural and includes three municipalities (Figure 23); Angola and Hudson (located in Steuben County) and Ashley (located in both Steuben and DeKalb Counties.) The City of Angola covers 4,002 acres, Ashley covers 686 acres and Hudson covers 858 acres within the watershed.

Angola has a 2012 population of 8,604, an increase of seventeen percent (17%) since 2000. Ashley has a current population of 985 and Hudson has 516 residents. An analysis of 2000 map-based Census data (2010 Census data is not currently available in map format) shows the watershed has a total population of approximately 27,528, with 10,249 households and an average median age of 35.4. Average watershed population density in 1890 was 16 persons per square kilometer compared to 36 in 2000, an increase of over one hundred percent (100%.) Despite consistent, small increases in population, the watershed has maintained its rural character. Local reports indicate that the population of Steuben County doubles during the summer due to lake-related recreation and seasonal housing.

2011 Volunteer Stream Clean-Up Day

Figure 23 - Pigeon Creek Municipalities & Features



4.0 Part II: Watershed Inventory

Part II of the watershed inventory includes detailed water quality and hydrology, landuse and biological information by subwatershed, applicable data sources, methodologies and targets. Part II provides specific information and a thorough scientific analysis of watershed data.

The Pigeon Creek watershed is mostly rural with three small municipalities; a total watershed area of over 135,000 acres. The gently sloping watershed has an average slope of 13% and landuse is primarily agriculture (row crops) and forest land. There are 257 miles of stream, 177 miles of which are considered channelized and 734 lakes and reservoirs. There are just over 6,000 acres of irrigated crop ground and 17,999 acres of wetland. Six percent of the watershed is in the 100-year floodplain and there are 3 unique, unconsolidated aquifer systems. Hydrologic group B and C soils make up over 60% of the watershed's soils and 34,993 acres are classified as hydric. Just over 31% of the watershed is considered highly erodible and almost 80% of the entire watershed is comprised of soils unsuitable for septic systems. Conventional tillage and no-till are the primary tillage practices in Pigeon Creek. There have been over 300 occurrences of T&E species and 5% of the watershed is in publicly owned and protected land.

To date, substantial implementation and planning has occurred, including a watershed plan completed in 2006, numerous flood studies and a TMDL. The Steuben County SWCD has worked to install numerous urban and agricultural BMPs and educate watershed stakeholders. An active watershed committee meets regularly and frequent water quality monitoring occurs at various sites throughout Pigeon Creek.

To support Part II of the watershed inventory, Pigeon Creek was evaluated in detail utilizing existing datasets, GIS information compiled by county and state sources, a watershed windshield survey, and site assessments on properties where willing landowners allowed access. Existing and historical water quality information was collected and assessed and followed by a detailed review of the 2012 Pigeon Creek TMDL.

4.1 Watershed Data & Sources

Data was compiled from existing databases and reports and analyzed spatially using GIS. Field assessments were conducted during a 2013 windshield survey that evaluated the watershed as well as individual land parcels. Almost every road within the watershed was covered and observations recorded using GPS. Individual property assessments were conducted on six properties where willing landowners participated. Water quality was analyzed by accessing data from existing surface water quality monitoring programs managed by IDEM and the Steuben County SWCD. Habitat and biological data was compiled from IDEM and IDNR databases and a wetland inventory was provided by the Friends of the St. Joe River Association. Parcel-specific watershed pollution loading was evaluated by building a GIS-based pollution load model, calibrated with existing water quality data.

Table 23 - Data Sources/Methodology

Data Set	Methodology/Source	Notes
Water Quality & Quantity	1. IDEM surface water quality data & TMDL 2. Steuben County SWCD, Lakes Council, and Surveyors office; chemistry and flow 3. 2012 TMDL - Emmons & Olivier Resources Inc. 4. Lake Trophic Status – Indiana University; Indiana Clean Lake Program 5. USGS Stream Gauge 6. NPDES permits	• Steuben Co. has implemented a stream monitoring program through a Phase II IDEM grant. Extensive water quality and flow data has been collected. Additional monitoring sites are funded through the Steuben County Lakes Council, COA, MS4, and the County Surveyor's office. • TMDL loading data were utilized for model calibration and point source loadings.
Habitat &Biological	1. Fish and Bugs - IDEM Assessment Information Management System 2. Wetlands – Friends of the St. Joe River Association 3. Threatened & Endangered Species – IDNR Natural Heritage Database	• Friends of the St. Joe River Association wetland layer; see layer description in section 3.2.3.
Landuse	1. GIS data – County and state GIS data centers 2. Previous projects and relevant planning documents - County SWCD offices and the City of Angola 3. Tillage Transect Data – County SWCD Offices 4. Landuse/Landcover – Northwater Consulting 5. Windshield Survey and BMPs – Northwater Consulting	• All existing GIS data obtained from state and county sources. • Previous implementation project locations provided by the Steuben SWCD. • Transect survey data obtained from the Steuben Co. SWCD and modified by Northwater Consulting. • A hybrid landuse/landcover layer was created by Northwater Consulting by interpreting the most recent aerial imagery and digitizing existing watershed features. • A windshield and individual landowner site survey was conducted by Northwater Consulting; data was collected using GPS: BMP type, gully dimensions (if applicable), condition of pasture, priority, severity and any relevant notes.
Pollution Loading	1. Spatial Watershed Assessment and Management Model (SWAMM) – Northwater Consulting 2. 2012 TMDL - Emmons & Olivier Resources Inc.	• SWAMM based on custom landuse layer, soils and precipitation. Results calibrated based on a watershed inventory and existing water quality data. • TMDL plan used for estimating septic system loading.

4.2 Water Quality & Stream Flow

Section 4.2 describes all relevant water quality and stream flow for the Pigeon Creek watershed. This section includes state-impaired streams and lakes, results of monitored water quality and flow data, and lake trophic status.

4.2.1 Impaired Lakes & Streams

Understanding the extent streams and lakes are impaired requires an understanding of state procedures. Waterbodies, such as streams and lakes, are monitored by the state to determine if they exceed state water quality standards and support what are called "designated uses." The federal Clean Water Act provides the underpinning for Indiana's Water Quality Standards (WQS), which are designed to ensure all waters of the state, unless specifically exempted, are safe for full body contact recreation and are protective of aquatic life, wildlife, and human health. These beneficial uses are described in the state's WQS as "designated" uses. IDEM monitors and assesses Indiana's surface waters to determine the extent to which they meet WQS. These surface waters must support designated uses and IDEM must identify, where possible, the sources of impairment for those waters that do not support one or more of these uses. The federal Environmental Protection Agency (EPA) describes designated uses as:

> *"The water quality standards regulation requires that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.*
>
> *Where water quality standards specify designated uses less than those which are presently being attained, the State or Tribe is required to revise its standards to reflect the uses actually being attained. A use attainability analysis must be conducted for any water body with designated uses that do not include the "fishable/swimmable" goal uses identified in section 101(a)(2) of the Act. Such water bodies must be reexamined every three years to determine if new information has become available that would warrant a revision of the standard. If new information indicates that "fishable/swimmable" uses can be attained, such uses must be designated."*

Indiana regulations list four designated uses and they include:

- Aquatic Life Use
- Fish Consumption Use
- Recreational Use
- Drinking Water Use

The designated uses outlined in Indiana's WQS with the narrative and numeric criteria to protect them provide the foundation for IDEM's 305(b) assessment process and 303(d) listing decisions. Water quality assessments are made by compiling existing and readily available data from site-specific chemical (water, sediment, and fish tissue), physical (habitat, flow data), and biological (fish community, macroinvertebrates, and *E. coli*) monitoring of Indiana's rivers, streams, and lakes by evaluating those data against Indiana's WQS. Waters identified as not meeting one or more of their designated uses are then placed on the Indiana's 303(d) List of Impaired Waters.

Interpretation of the data through the stream and lake assessment process and the subsequent 303(d) listing decisions are based in large part on U.S. EPA guidance. U.S. EPA's guidance calls for a comprehensive listing of all monitored or assessed waterbodies in the state. Prior to 2006, U.S. EPA required that states place each waterbody into only one category. U.S. EPA now encourages states to place waterbodies in additional categories, as appropriate, in order to more clearly illustrate where progress has been made in TMDL development and other restoration efforts. IDEM places each waterbody into one of five categories of the Consolidated List depending on the degree to which it supports the designated beneficial use in question. Since IDEM makes use of support assessments for three to four of the beneficial uses designated for each waterbody, a single waterbody may appear in one or more categories of the Consolidated List for different uses. Table 24 includes a listing of waterbody impairments by category:

Table 24 - Waterbody Impairment Categories

Category	Impairment Listing Description
1	Attaining the water quality standard for all designated uses and no use is threatened. Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology and support a determination that all WQS are attained and no designated use is threatened.
2	Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened. Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology to support a determination that some, but not all, designated uses are attained and none are threatened.
3	Insufficient data and information to determine if any designated use is attained. Little or no information is available with which to make an assessment. Waters should be listed in this category where the data or information to support an attainment determination for any designated use are not available or are not consistent with the requirements of the state's assessment and listing methodology. States should schedule monitoring on a priority basis to obtain data and information necessary to classify these waters as Category 1, Category 2, Category 4, or Category 5.
4	Impaired or threatened for one or more designated uses but does not require the development of a TMDL.
4A	A TMDL has been completed that results in attainment of all applicable WQS, and has been approved by the U.S. EPA. Monitoring should be scheduled for these waters to verify that the WQS are met when the water quality management actions needed to achieve all TMDLs are implemented.
4B	Other pollution control requirements are reasonably expected to result in the attainment of the WQS in a reasonable period of time. Consistent with the regulation under 130.7(b)(i),(ii), and (iii), waters should be listed in this subcategory where other pollution control requirements required by

Category	Impairment Listing Description
	local, state, or federal authority are stringent enough to achieve any water quality standard (WQS) applicable to such waters. Monitoring should be scheduled for these waters to verify that the WQS are attained, as expected.
4C	Impairment is not caused by a pollutant. Waters should be listed in this subcategory if the impairment is not caused by a pollutant but is attributed to other types of pollution for which a total maximum daily load cannot be calculated.
5	The water quality standard is not attained. Waters may be listed in both 5A and 5B depending on the parameters causing the impairment.
5A	The waters are impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. Waters should be listed in this category if it is determined, in accordance with the state's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause impairment. Where more than one pollutant is associated with the impairment of a single waterbody, the waterbody will remain in Category 5 until TMDLs for all pollutants have been completed and approved by the U.S. EPA.
5B	The waterbodies are impaired due to the presence of mercury or PCBs, or both, in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants. This category also composes a portion of the Section 303(d) list of impaired waters, but the state believes that a conventional TMDL is not the appropriate approach. The state will continue to work with the general public and the U.S. EPA on actual steps needed ultimately to address these impairments.

Only category 4 and 5 waterbodies make it on the 303(d) impaired waters list. In Indiana, a category 5 waterbody is reclassified as category 4 upon completion of a TMDL plan. These waterbodies will remain impaired under category 4 and 5 until such time that monitoring data warrants a delisting. Attention should be paid to those waterbodies on the 303(d) list, as well as any impaired waterbodies identified as part of a TMDL plan; these waterbodies will receive state and federal funding priority.

According to the State of Indiana's 2012 303(d) impaired streams list, the Pigeon River watershed contains 38 streams (179 miles) of category 4 and 5 impaired waterbodies. These waterbodies are impaired or threatened for the designated uses of aquatic life, fish consumption and recreation. Impairments are due to low Dissolved Oxygen (DO) concentrations (aquatic life), chloride (aquatic life), and high concentrations of *E.coli* (recreation). Additional impairments listed include Impaired Biotic Community (IBC). Table 25 summarizes the 2012 stream impairments.

In 2010, the impaired list included waterbodies impaired for *E. coli*, chloride, IBC and a waterbody impaired for total nitrogen and total phosphorus. Nitrogen and phosphorus are no longer impairments and DO is on the list in 2012 and was not in 2010. The 2012 impaired waters list includes all 2010 listed waterbodies plus nine additional impaired streams and eleven 2010 listed segments that include newly added impairments. Mud Creek (INJ01A5_T1001) is the only waterbody, which was delisted for IBC, nitrogen and phosphorus, but continues to be listed for *E. coli*.

Lakes in the Pigeon Creek watershed are also considered impaired. According to the 2012 impaired list, nine lakes (783 acres) are listed as impaired. These lakes are listed for IBC, mercury, PCBs, and phosphorus. No changes in lake impairments have occurred since publication of the 2010 impaired list. Table 25 lists all 2012 impaired stream segments and Table 26 lists all 2012 impaired lakes. Red highlighted waterbodies and impairments are additions from 2010; an "X" denotes waterbodies within the 2012 TMDL and all impairments are listed by year. Figure 24 shows impaired lakes and streams in Pigeon Creek.

Table 25 - 2012 Pigeon River Watershed 303(d) listed Impaired Streams

2012 AUID	2012 AUNAME	SIZE (MILES)	TMDL	*E. coli*	IBC[1]	Chloride	DO[2]	Nitrogen
INJ01A1_01	Pigeon Creek	13.95	X	2010				
INJ01A1_T1001	Ryan Ditch	7.60	X	2010				
INJ01A1_T1002	Metz Ditch	8.51	X	2010				
INJ01A1_T1003	Cole Ditch	3.07		2012				
INJ01A1_T1004	Berlien Ditch	5.44	X	2010				
INJ01A2_01	Pigeon Creek	6.92	X	2010				
INJ01A2_T1001	Jack Ditch	3.16	X	2010				
INJ01A2_T1002	Johnson Ditch	2.85		2012				
INJ01A2_T1003	Pigeon Creek - Unnamed Tributary	2.68	X	2010				
INJ01A2_T1004*	Mud Creek	5.06	X	2010	2010	2012		2010
INJ01A3_01**	Pigeon Creek	7.15	X	2010	2012			
INJ01A3_T1001	Pigeon Creek - Unnamed Tributary	3.18	X	2010				
INJ01A3_T1002	Pigeon Creek - Unnamed Tributary	2.39		2012	2012			
INJ01A3_T1003	Pigeon Creek - Unnamed Tributary	7.86	X	2010	2012			
INJ01A3_T1004	Johnson Ditch	5.56	X	2010	2012			
INJ01A3_T1005	Johnson Ditch - Unnamed Tributary	3.87	X	2010	2012			
INJ01A4_01	Smathers Ditch	4.15		2012	2012		2012	
INJ01A4_02	Turkey Creek	2.47	X	2010	2012		2012	
INJ01A4_T1001	Conrad Ditch	1.04		2012	2012		2012	
INJ01A4_T1002	Inlet To Little Turkey Lake	1.38		2012	2012		2012	
INJ01A4_T1003	Turkey Creek - Unnamed Tributary	3.05	X	2010	2012		2012	
INJ01A4_T1005	Deetz Ditch	3.23	X	2010	2012		2012	
INJ01A5_01	Turkey Creek	6.71	X	2010				
INJ01A5_T1001	Mud Creek	6.53	X	2010				
INJ01A5_T1002	Mud Creek - Unnamed Tributary	2.89	X	2010				
INJ01A6_T1002	Inlet To Golden Lake	4.78	X	2010				
INJ01A7_01	Pigeon Creek	3.08	X	2010				
INJ01A7_T1001	Inlet To Otter Lake	8.21	X	2010	2012			

2012 AUID	2012 AUNAME	SIZE (MILES)	TMDL	*E. coli*	IBC[1]	Chloride	DO[2]	Nitrogen
INJ01A8_T1001	Maumee Ditch	2.29	X	2010				
INJ01A8_T1002	Inlet To Mud Lake	2.16	X	2010	2012			
INJ01A8_T1002A	Inlet To Taylor Lake	0.55	X	2010				
INJ01A8_T1008	Inlet To Little Turkey Lake	1.65	X	2010				
INJ01A9_01*	Pigeon Creek	14.71	X	2010	2012			
INJ01A9_T1001**	Pigeon Creek - Unnamed Tributary	6.95		2012				
INJ01A9_T1001A	Pigeon Creek - Unnamed Tributary	0.55		2012				
INJ01AA_01**	Pigeon Creek	1.78		2012				
INJ01AA_02	Turkey Creek	3.71	X	2010				
INJ01AA_03	Turkey Creek	7.40	X	2010				

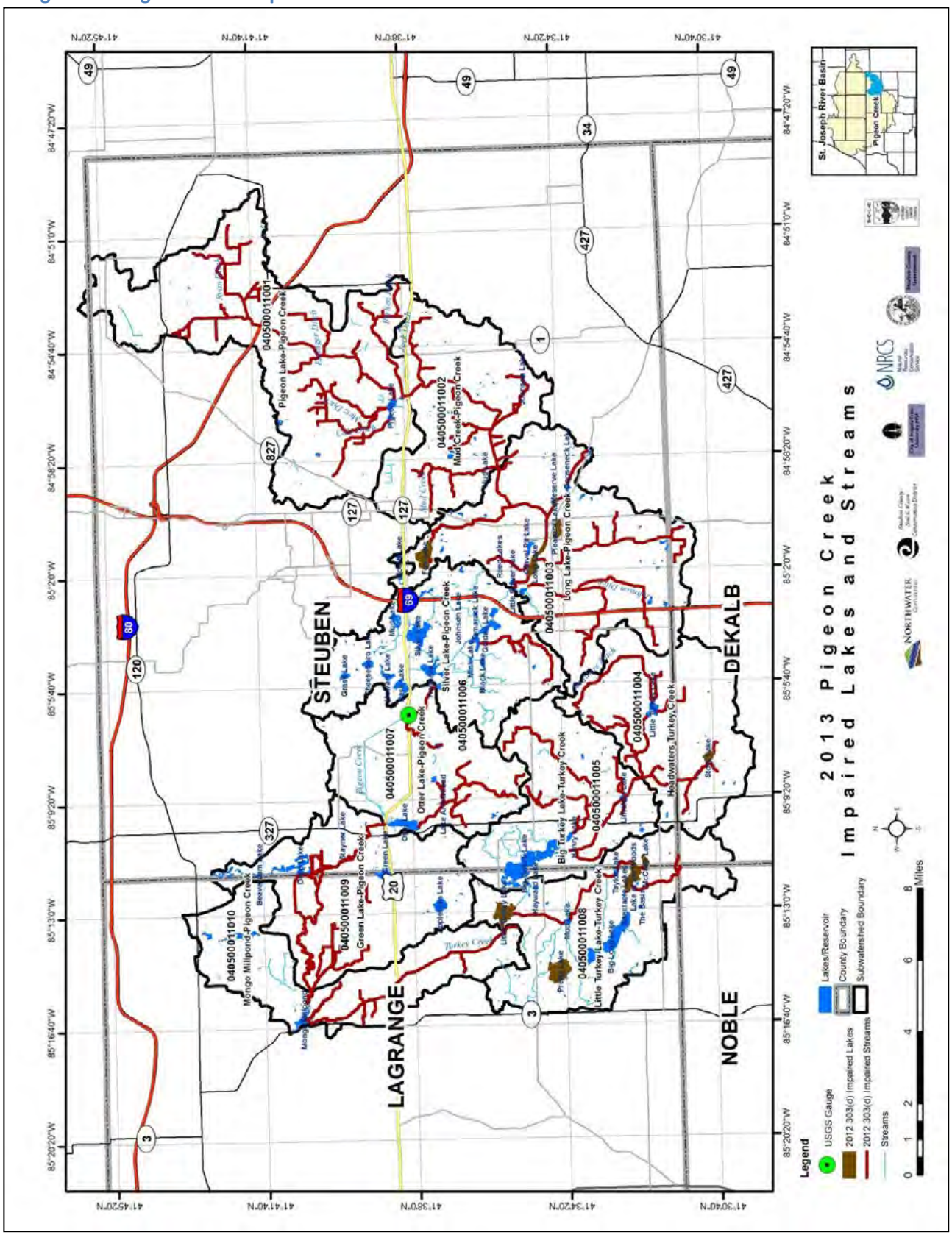
1IBC – Impaired Biotic Community
2DO – Dissolved Oxygen
*This reach was listed for IBC in 2010 under its original AUID but was not included in the TMDL.
**This reach was listed for *E. coli* in 2010 under its original AUID but was not included in the TMDL.

Table 26 - 2012 Pigeon River Watershed Impaired Lakes

Waterbody	2010 AUID	Impairments			
		Hg[1]	IBC[2]	Total P	PCB
Fox Lake	INJ01P1075_00	X			X
Upper Story Lake	INJ01P1088_00				X
Pretty Lake	INJ01P1098_00	X			
Meserve Lake	INJ01P1083_00		X		
Long Lake	INJ01P1080_00			X	
McClish Lake	INJ01P1091_00	X			
Pleasant Lake	INJ01P1082_00				X
Little Turkey Lake	INJ01P1101_00			X	
Lake of the Woods	INJ01P1093_00	X	X		

1Hg – Mercury
2IBC – Impaired Biotic Community

Figure 24 - Pigeon Creek Impaired Lakes & Streams



4.2.2 Water Quality Data

An analysis of existing water quality data was conducted for the Pigeon Creek watershed. Water quality data and trends are used as one of many tools to identify problems, causes and potential sources of pollution throughout the watershed. Results were also used in pollution load model calibration.

4.2.2.1 Water Quality Monitoring

Originally initiated by the Steuben County Lakes Council, the Steuben County SWCD implemented a 16-station monitoring program. Between 2009 and 2013, the Steuben County Lakes Council managed the monitoring effort with contributions from the SWCD. Data was used to provide general insight into water quality and trends in the Pigeon Creek watershed. Five sites were located at or near the outlet of each HUC 12 to allow for subwatershed-based diagnostics. Stations were also selected to include the confluence point and exit point of Pigeon Creek within each lake of the Pigeon Creek chain. Stations selected had a prior history of water quality issues, and were located immediately downstream of the confluence of major tributaries to the Pigeon. Fourteen of the stations were funded through the IDEM 319 Phase II project and the City of Angola/Trine University MS4 Program funded two stations.

In addition to the 16 Phase II monitoring sites, 14 additional monitoring sites were established through funding by the Steuben County Lakes Council and the Steuben County Surveyor's Office. Water quality data collected as part of the 2012 TMDL and by IDEM at the numerous sample sites throughout the watershed were also evaluated and are included in the overall water quality analysis.

Figures 25 and 26 show monitoring stations throughout the watershed. The 91 IDEM locations shown on the map include current and historical sites sampled for biological and water quality parameters, of which only a small selection provided biological data. Very little of the water quality data included flow measurements and, therefore, it was difficult to utilize the information in generating loading estimates, however, all available data was used and is included in Section 4.2.2.2.

4.2.2.2 Water Quality Data Analysis

Stream and river water quality sampling and monitoring has been ongoing throughout the watershed under several programs as outlined in section 4.2.2.1. Analysis was performed on a large water quality dataset provided by Steuben County SWCD and Emmons & Oliver Resources, Inc. The dataset is inclusive of monitoring programs funded by the City of Angola/Trine University, IDEM 319, the Steuben County Lakes Council (SCLC), and the 2012 TMDL process. It is important to note that sampling data illustrated is only intended to be a simple summary of a very large set of data.

Overall, 2,020 water quality samples were collected from 62 stations between the dates of 10/31/2001 and 10/29/2013. The data analysis is summarized by subwatershed in Table 28 through Table 33 and Figure 27 through Figure 30. The data was compared against water quality targets, which are outlined in Table 27.

Table 27 - Water Quality Targets

Parameter	Target	Source	Primary Impacts
E. coli Bacteria	Max: 235 CFU/ 100ml in a single sample	Indiana Administrative Code (327 IAC 2-1.5-8)	Human and ecological health risks from fecal bacteria from warm-blooded mammals
Total Phosphorus	Max: 0.3 mg/L	IDEM draft TMDL target	Algal blooms, aquatic health, recreational value of lakes and streams
Total Nitrogen	Max: 10.0 mg/L	IDEM draft TMDL target based on drinking water targets	Human health risk, potentially fatal risk to infants, if consumed. Aquatic health of lakes and streams
Total Suspended Solids	Max: 30 mg/L	IDEM draft TMDL target from NPDES rule 327 IAC 5-10-4	Aquatic and ecological health and recreational value of lakes and streams
Total Suspended Solids cont.	Range: 25.0-80.0 mg/L	Concentrations within this range reduce fish concentrations (Waters, T.F., 1995).	Aquatic and ecological health and recreational value of lakes and streams
Dissolved Oxygen	Min: 6.0 mg/L in coldwater fishery streams	Indiana Administrative Code (327 IAC 2-1.5-8)	Aquatic and ecological health and recreational value of lakes and streams
Dissolved Oxygen	Min: 4.0 mg/L Max: 12.0 mg/L in non coldwater fishery streams	Indiana Administrative Code (327 IAC 2-1.6)	Aquatic and ecological health and recreational value of lakes and streams
pH	6.0 – 9.0	Indiana Administrative Code (327 IAC 2-1.6(a))	Aquatic and ecological health and recreational value of lakes and streams
Specific Conductance	1,200 µs/cm at 25°C	Indiana Administrative Code (327 IAC 2-1.6)	Aquatic and ecological health and recreational value of lakes and streams

Figure 25 – Upper Pigeon Creek Monitoring Sites

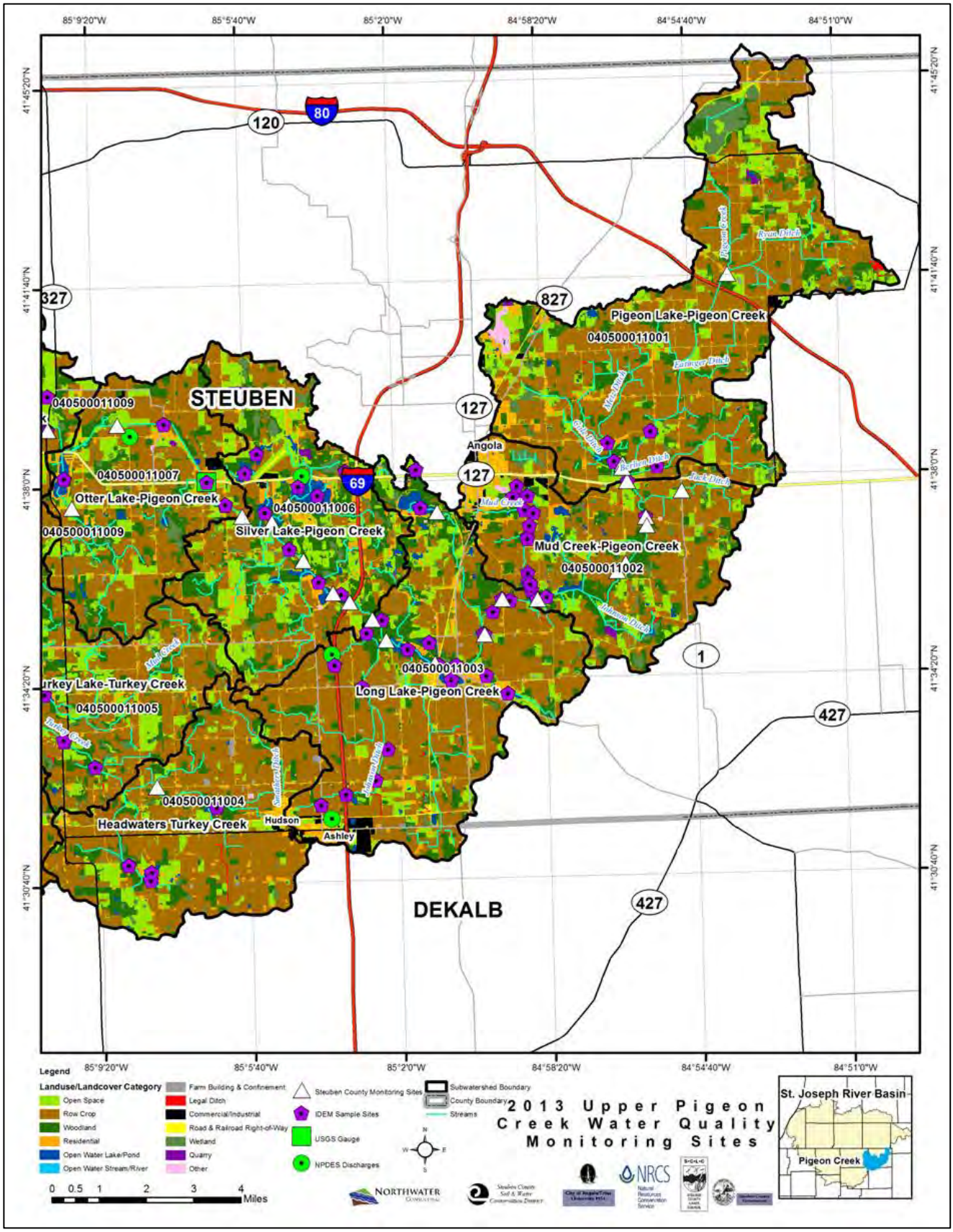


Figure 26 - Lower Pigeon Creek Monitoring Sites

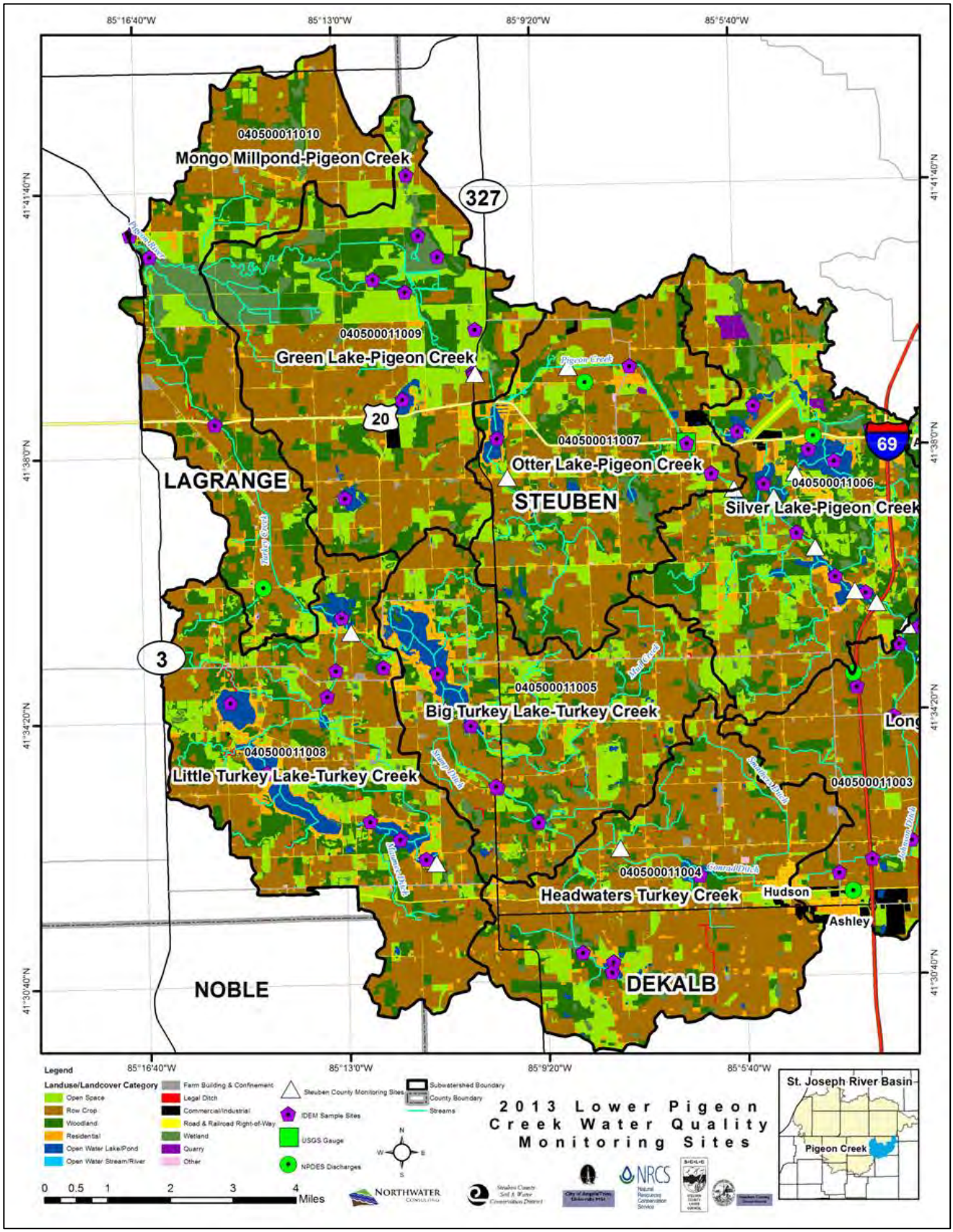


Table 28 - *E. coli* Bacteria Water Quality Data Summary

HUC 12 ID	HUC 12 Name	# Sampling Events	*E. coli* Bacteria - CFU/100 ml				Exceedences of 235 CFU/100 ml	
			Median	GeoMean	Max	Min	QTY	%
40500011001	Pigeon Lake-Pigeon Creek	77	29	263	27,500	1	42	55
40500011002	Mud Creek-Pigeon Creek	111	388	427	22,000	13	67	60
40500011003	Long Lake-Pigeon Creek	120	277	219	10,900	5	59	49
40500011004	Headwaters Turkey Creek	19	274	305	1,720	45	12	63
40500011005	Big Turkey Lake-Turkey Creek	65	178	167	2,733	18	27	42
40500011006	Silver Lake-Pigeon Creek	139	46	46	28,400	0	21	15
40500011007	Otter Lake-Pigeon Creek	29	158	160	8,700	1	12	41
40500011008	Little Turkey Lake-Turkey Creek	19	530	457	13,600	10	15	79
40500011009	Green Lake-Pigeon Creek	36	150	163	740	77	11	31
40500011010	Mongo Millpond-Pigeon Creek	12	155	124	290	27	3	25

Table 29 - Phosphorus Water Quality Data Summary

HUC 12 ID	HUC 12 Name	# Sampling Events	Phosphorus (mg/l)				Exceedences of 0.30 mg/l	
			Median	GeoMean	Max	Min	QTY	%
40500011001	Pigeon Lake-Pigeon Creek	71	0.03	0.04	0.60	0.01	25	35
40500011002	Mud Creek-Pigeon Creek	99	0.07	0.08	1.00	0.01	6	6
40500011003	Long Lake-Pigeon Creek	111	0.07	0.06	0.70	0.01	7	6
40500011004	Headwaters Turkey Creek	17	0.06	0.04	0.13	0.01	--	--
40500011005	Big Turkey Lake-Turkey Creek	60	0.03	0.03	0.18	0.01	--	--
40500011006	Silver Lake-Pigeon Creek	134	0.04	0.04	0.32	0.01	2	1
40500011007	Otter Lake-Pigeon Creek	26	0.07	0.07	0.80	0.01	4	15
40500011008	Little Turkey Lake-Turkey Creek	17	0.03	0.03	0.39	0.01	1	6
40500011009	Green Lake-Pigeon Creek	33	0.03	0.03	0.14	0.01	--	--
40500011010	Mongo Millpond-Pigeon Creek	9	0.01	0.01	0.08	0.01	--	--

Samples collected between 10/31/2007 - 10/29/2013

Table 30 - Nitrogen Water Quality Data Summary

HUC 12 ID	HUC 12 Name	# Sampling Events	Total Nitrogen (mg/l)				Exceedences of 10 mg/l	
			Median	GeoMean	Max	Min	QTY	%
40500011001	Pigeon Lake-Pigeon Creek	31	4.7	4.9	25.4	0.9	9	29
40500011002	Mud Creek-Pigeon Creek	49	5.4	4.9	18.9	0.8	11	22
40500011003	Long Lake-Pigeon Creek	44	5.4	5.0	19.2	0.9	4	9
40500011004	Headwaters Turkey Creek	6	3.6	4.6	25.1	1.4	2	33
40500011005	Big Turkey Lake-Turkey Creek	23	4.1	4.5	25.1	1.2	4	17
40500011006	Silver Lake-Pigeon Creek	45	4.8	4.6	10.6	1.3	6	13
40500011007	Otter Lake-Pigeon Creek	9	2.2	2.2	3.6	1.3	--	--
40500011008	Little Turkey Lake-Turkey Creek	6	1.7	2.4	7.4	1.2	--	--
40500011009	Green Lake-Pigeon Creek	17	2.6	2.8	8.1	1.3	--	--
40500011010	Mongo Millpond-Pigeon Creek	9	1.9	2.7	13.6	1.0	3	33

Samples collected between 6/16/2010 - 10/29/2013

Table 31 - Total Suspended Sediment Water Quality Data Summary

HUC 12 ID	HUC 12 Name	# Sampling Events	Total Suspended Sediment (mg/l)				Exceedences of 30 mg/l	
			Median	GeoMean	Max	Min	QTY	%
40500011001	Pigeon Lake-Pigeon Creek	72	9.0	10	212	0.5	11	15
40500011002	Mud Creek-Pigeon Creek	98	11	11.5	188	0.5	13	13
40500011003	Long Lake-Pigeon Creek	111	13	11.4	187	0.5	17	15
40500011004	Headwaters Turkey Creek	17	5.0	3.3	20	0.5	--	--
40500011005	Big Turkey Lake-Turkey Creek	58	3.9	3.1	20	0.5	--	--
40500011006	Silver Lake-Pigeon Creek	134	6.5	6.1	108	1.0	5	4
40500011007	Otter Lake-Pigeon Creek	26	4.0	2.7	15	0.5	--	--
40500011008	Little Turkey Lake-Turkey Creek	17	4.0	3.8	45	0.5	1	6
40500011009	Green Lake-Pigeon Creek	32	4.5	3.2	26	0.5	--	--
40500011010	Mongo Millpond-Pigeon Creek	9	0.5	1.1	7.0	0.5	--	--

Samples collected between 10/31/2007 - 10/29/2013

Table 32 - Dissolved Oxygen & pH Water Quality Summary

HUC 12 ID	HUC 12 Name	Dissolved Oxygen (DO)				pH			
		Median	Geomean	Max	Min	Median	Geomean	Max	Min
40500011001	Pigeon Lake-Pigeon Creek	7.93	7.77	15.	5.1	7.82	7.43	8.35	7.09
40500011002	Mud Creek-Pigeon Creek	6.59	6.20	8.97	4.1	7.74	7.42	8.13	7.02
40500011003	Long Lake-Pigeon Creek	7.16	7.12	12.3	4.0	7.87	7.68	8.93	7.35
40500011004	Headwaters Turkey Creek	6.26	5.10	9.2	2.94	7.49	6.11	7.85	6.83
40500011005	Big Turkey Lake-Turkey Creek	7.26	6.91	12.1	4.29	7.85	7.46	8.39	7.10
40500011006	Silver Lake-Pigeon Creek	7.69	7.64	16.2	4.12	8.04	7.88	10.3	7.31
40500011007	Otter Lake-Pigeon Creek	6.45	6.03	11.3	5.34	7.77	6.76	8.14	7.32
40500011008	Little Turkey Lake-Turkey Creek	6.77	6.01	7.5	5.82	7.48	6.12	7.85	7.06
40500011009	Green Lake-Pigeon Creek	7.67	6.92	9.96	6.12	7.78	7.03	8.18	7.45
40500011010	Mongo Millpond-Pigeon Creek	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 33 - Temperature & Specific Conductance Water Quality Summary

HUC 12 ID	HUC 12 Name	Temp - C				Specific Conductance (µs/cm)			
		Median	Geomean	Max	Min	Median	Geomean	Max	Min
40500011001	Pigeon Lake-Pigeon Creek	19.5	19.8	28.1	12.2	658	640	794	384
40500011002	Mud Creek-Pigeon Creek	21.5	20.9	24.8	11.6	675	645	830	358
40500011003	Long Lake-Pigeon Creek	21.6	20.2	30.6	11.4	731	626	976	449
40500011004	Headwaters Turkey Creek	20.8	15.9	28.2	18.5	590	297	659	359
40500011005	Big Turkey Lake-Turkey Creek	22.4	20.82	29.8	15.1	572	481	670	461
40500011006	Silver Lake-Pigeon Creek	23.6	21.6	30.3	8.5	646	549	781	44
40500011007	Otter Lake-Pigeon Creek	21	17.3	27.1	15.1	521	505	596	427
40500011008	Little Turkey Lake-Turkey Creek	17.9	14.2	23.8	16.6	724	362	745	526
40500011009	Green Lake-Pigeon Creek	21.2	16.9	25.6	11.2	644	417	677	521
40500011010	Mongo Millpond-Pigeon Creek	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Figure 27 - Pigeon Creek Water Quality Exceedences Bacteria

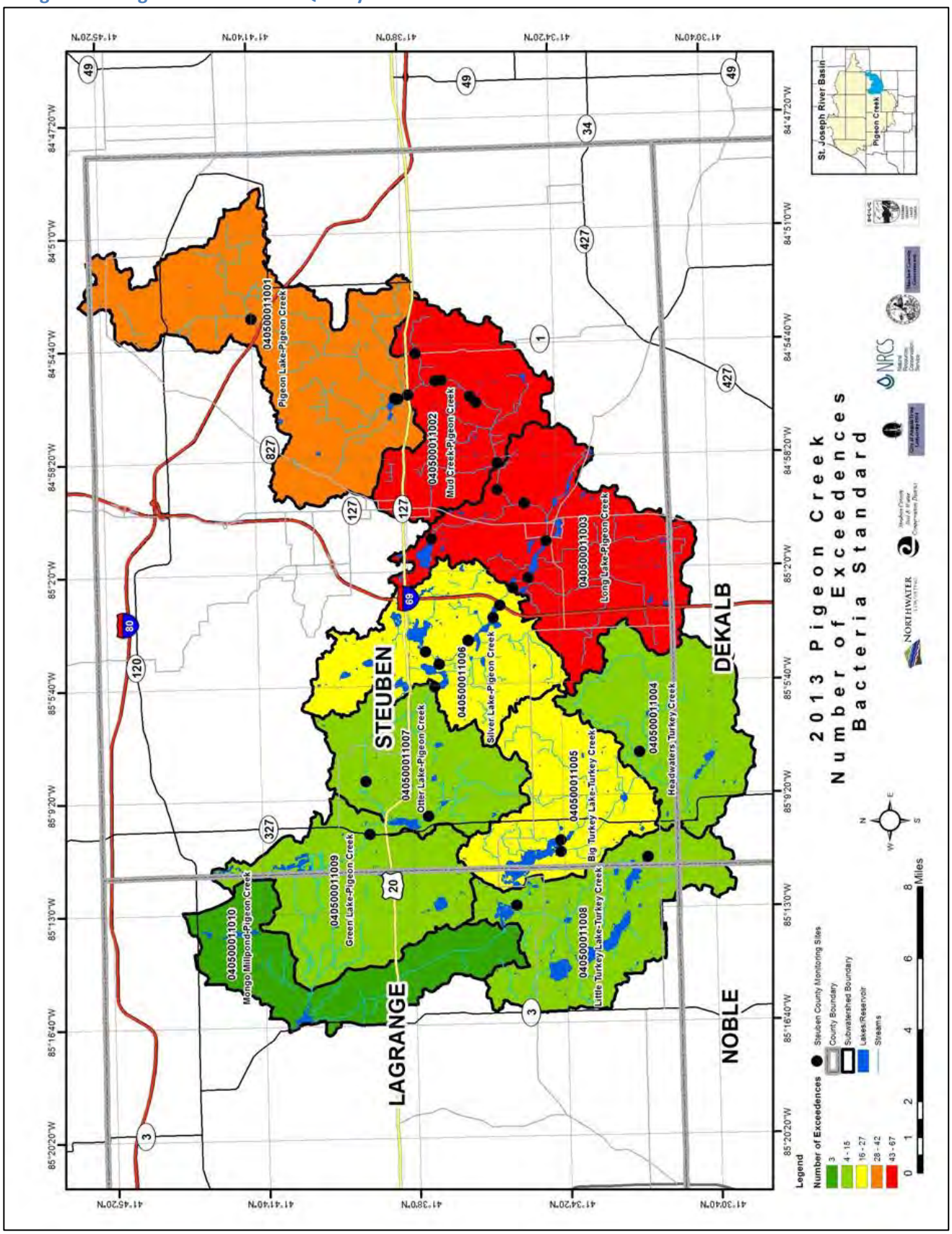


Figure 28 - Pigeon Creek Water Quality Exceedences Phosphorus

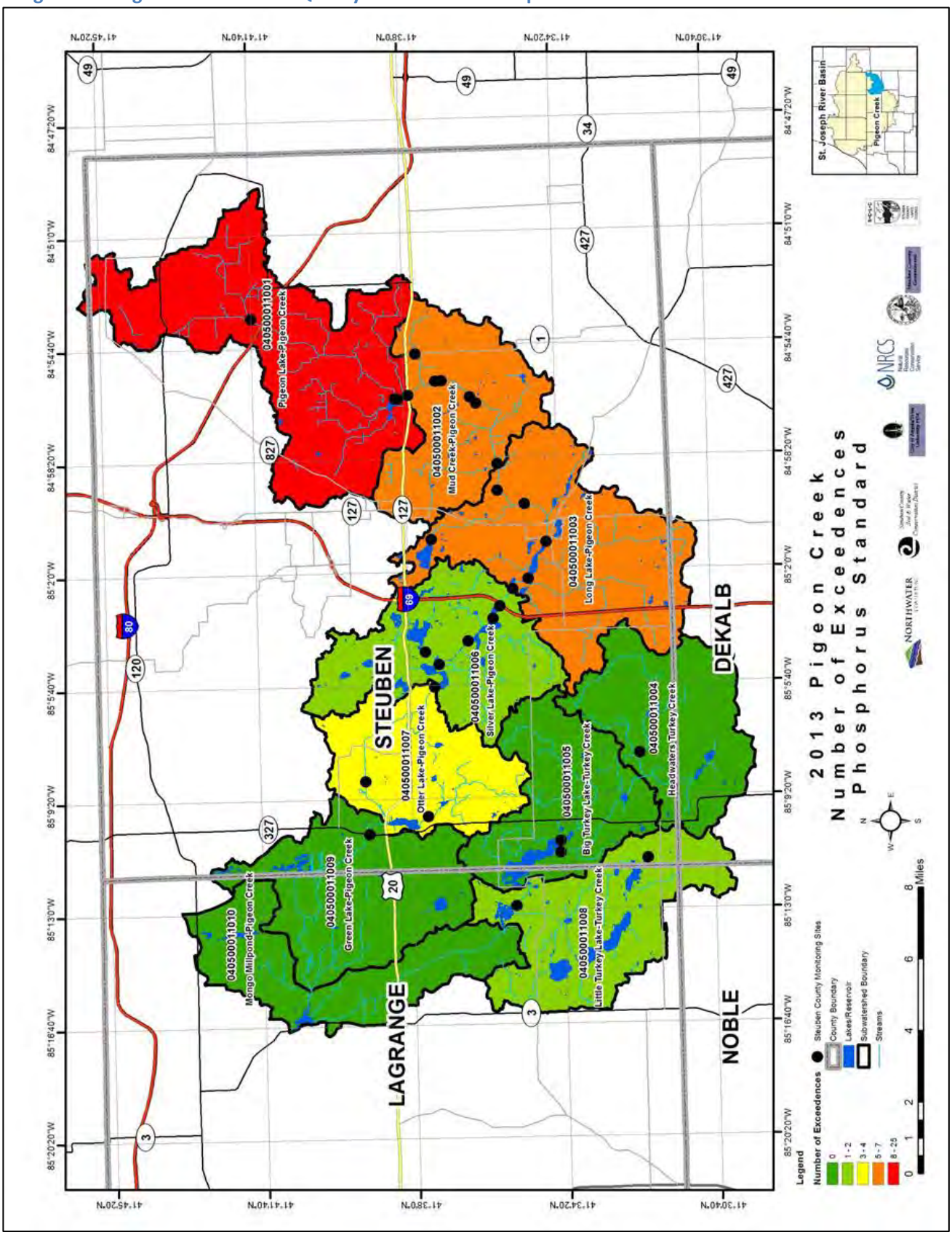


Figure 29 - Pigeon Creek Water Quality Exceedences Nitrogen

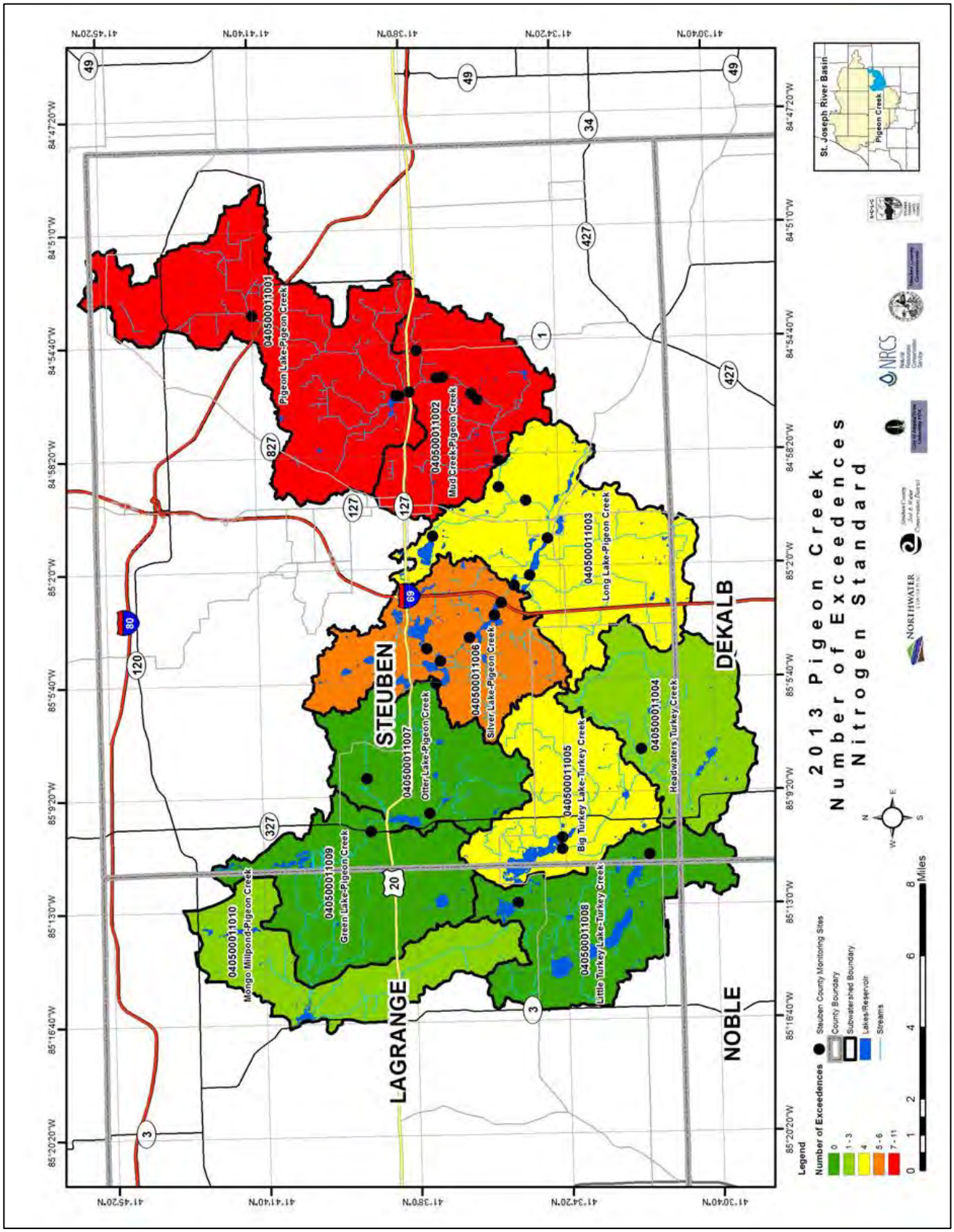
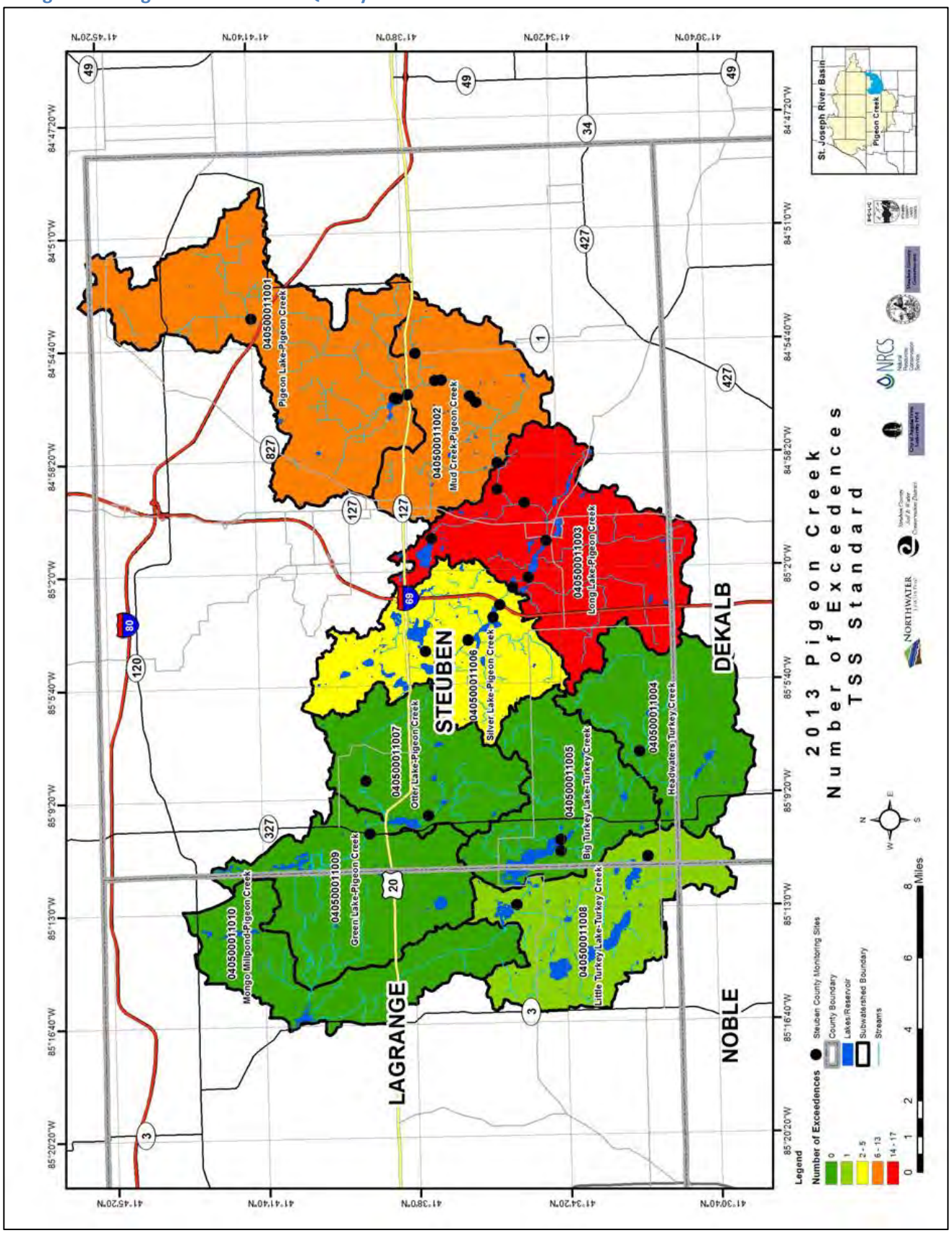


Figure 30 - Pigeon Creek Water Quality Exceedences Sediment



4.2.2.3 Water Quality Data Discussion

Table 34 summarizes the water quality parameters that are of concern in the each of the ten subwatersheds based on the analysis of water quality data. The only constituent that appears to be a watershed-wide issue is *E. coli* bacteria. Total phosphorus, total nitrogen and total suspended solids are issues that are primarily focused in a select 6 to 7 subwatersheds. The water quality data did not illustrate any issues in the watershed with total dissolved solids (specific conductance) and ph. Only one subwatershed is a potential concern regarding dissolved oxygen (Headwaters- Turkey Creek), however, this is based only on a few sampling events and additional monitoring is required to properly assess the condition.

Approximately 70% of the sampling events occurred during base flow conditions, so the data as analyzed holds a bias towards baseflow conditions and, in our opinion, did not represent a wide enough range of flows. Sediment, nitrogen and phosphorus concentrations are largely affected by flow rates in streams and river systems, and concentrations are generally higher following storm events. *E. coli* bacteria concentrations, on the other hand, are more diluted during higher flow events and have lower concentrations. These factors should be considered in applying this analysis and it is important to derive water quality conclusions not only from this data, but also the pollutant load modeling (Section 7.2) and other components of the watershed inventory.

Table 34 - Subwatersheds with Water Quality Problems Based on Monitoring Data

HUC 12 ID	HUC 12 Name	Water Quality Problems Based on Monitoring Data
40500011001	Pigeon Lake-Pigeon Creek	*E.Coli* bacteria, phosphorus, nitrogen, sediment
40500011002	Mud Creek-Pigeon Creek	*E.Coli* bacteria, phosphorus, nitrogen, sediment
40500011003	Long Lake-Pigeon Creek	*E.Coli* bacteria, phosphorus, nitrogen, sediment
40500011004	Headwaters Turkey Creek	*E.Coli* bacteria, nitrogen, dissolved oxygen
40500011005	Big Turkey Lake-Turkey Creek	*E.Coli* bacteria, nitrogen
40500011006	Silver Lake-Pigeon Creek	*E.Coli* bacteria, phosphorus, nitrogen, sediment
40500011007	Otter Lake-Pigeon Creek	*E.Coli* bacteria, phosphorus
40500011008	Little Turkey Lake-Turkey Creek	*E.Coli* bacteria, phosphorus, sediment
40500011009	Green Lake-Pigeon Creek	*E.Coli* bacteria
40500011010	Mongo Millpond-Pigeon Creek	*E.Coli* bacteria, nitrogen

***E. coli* Bacteria** - Samples collected ranged from non-detect to a maximum of 28,400 CFU/100 mL. The geometric mean for the entire watershed was 202 CFU/100 mL. The three subwatersheds with the highest geometric mean were Mud Creek-Pigeon Creek (427), Little Turkey Lake-Turkey Creek (457), and Headwaters Turkey Creek (305). There were 269 of 627 (43%) total samples that exceeded the reference limit of 235 CFU/100 mL. The three subwatersheds with the greatest proportion of samples above the reference limit were Mud Creek-Pigeon Creek (60%), Long Lake-Pigeon Creek (49%), and Pigeon Lake-Pigeon Creek (55%).

It is important to note that only 3% of the sampling events were outside the recreational season of April 1 – October 31, and these sampling events did not adversely skew the statistical results for *E. coli*. This is significant because the wastewater treatment plants do not have *E. coli* permit limits or reporting

requirements outside of this period. The data analyzed is reflective of the periods when the treatment plants are operating as permitted.

Phosphorus - Samples collected ranged from 0.01 mg/L to a maximum of 1.00 mg/L. The geometric mean for the entire watershed was 0.04 mg/L. The three subwatersheds with the highest geometric mean were Mud Creek-Pigeon Creek (0.08), Otter Lake-Pigeon Creek (0.07), and Long Lake-Pigeon Creek (0.06). There were 40 of 577 (7%) total samples that exceeded the reference limit of 0.30 mg/L. The three subwatersheds with the greatest proportion of samples above the reference limit were Pigeon Lake-Pigeon Creek (39%), Long Lake-Pigeon Creek (6%), and Mud Creek-Pigeon Creek (6%).

Nitrogen - Samples collected ranged from 0.77 mg/L to a maximum of 25.44 mg/L. The geometric mean for the entire watershed was 3.8 mg/L. The three subwatersheds with the highest geometric mean were Silver Lake-Pigeon Creek (5.68), Pigeon Lake-Pigeon Creek (4.9), and Mud Creek-Pigeon Creek (4.9). There were 39 of 239 (16%) total samples that exceeded the reference limit of 10 mg/L. The two subwatersheds with the greatest proportion of samples above the reference limit were Mud Creek-Pigeon Creek (22%), and Pigeon Lake-Pigeon Creek (29%).

Nitrogen is a serious public health concern, and many of the results far exceed the 10 mg/L target. This target is a drinking water standard primarily because elevated concentrations of nitrates can lead to methemoglobinemia, or blue baby syndrome and cause death to infants. Depending upon the interactions between surface water and groundwater in the watershed, this could potentially affect private drinking water wells; this would be potentially most relevant in shallow alluvial aquifers.

Total Suspended Solids (TSS) - Samples ranged from 0.5 mg/L to a maximum of 212 mg/L. The geometric mean for the entire watershed is 7.5 mg/L. The three subwatersheds with the highest geometric means were Mud Creek-Pigeon Creek (11.5), Long Lake-Pigeon Creek (11.4), and Pigeon Lake-Pigeon Creek (10). There were 46 of 574 (8%) total samples that exceeded the reference limit of 30 mg/L limit. The three subwatersheds with the greatest proportion of samples above the reference limit were Long Lake-Pigeon Creek (15%), Mud Creek-Pigeon Creek (13%), and Pigeon Lake-Pigeon Creek (15%).

Dissolved Oxygen (DO) – The geometric mean and median values of dissolved oxygen only fell below the reference minimum of 6.0 mg/L for one subwatershed (Headwaters-Turkey Creek). However, each watershed resulted in sampling events that reported DO below the 6.0 mg/L reference limit. Headwaters-Turkey Creek exhibits the worst DO conditions in the watershed with a minimum reported value of 2.94 and a geometric mean of 5.10. Headwaters-Turkey Creek was the only subwatershed that resulted in any results below the alternate 4.0 mg/L minimum reference. Low dissolved oxygen can lead to kills of fish and aquatic organisms and habitat degradation.

pH - No subwatershed had a geometric mean or even minimum pH level falling below 6.0. No geometric mean was above the maximum limit of 10; Silver Lake-Pigeon Creek had a maximum recording of 10.25. According to the Indiana Administrative Code (327 IAC 2-1.6(a)), pH levels can exceed 9.0 if it is correlated with photosynthetic activity; however, this was not verified for the sample results that exceeded 10. Levels of pH this high have been known to stress the physiological symptoms of aquatic organisms and can lead to lower levels of reproduction which, in turn, could lower stream diversity.

Specific Conductance – There were no statistics that exceeded the reference limit for specific conductance, also indicative of total dissolved solids. The geomean for the three subwatersheds with the highest specific conductance were Otter Lake-Pigeon Creek (683.92 µs/cm), Mud Creek-Pigeon Creek (645.0 µs/cm, and Pigeon Lake-Pigeon Creek (640.3 µs/cm). The highest specific conductance sample collected was from the Long Lake-Pigeon Creek subwatershed (976 µs/cm).

4.2.3 Stream Flow Data

To measure stream flow on Pigeon Creek, the USGS installed a stream gauge downstream of Hogback Lake in 1946 that continuously records depth and flow measurements in the channel. The gauge has a tributary drainage area of approximately 106 square miles. The Pigeon Creek station is located about five miles west of the City of Angola and has average daily flow of 87 cubic feet per second (1946-2012). The low flow recorded at this station for the period of record is 3.4 cubic feet per second (cfs) on October 25th, 1964, and the high flow was 996 cfs recorded on May 21st, 1996.

The overbank flood stage of the gauge is 11 feet, or an estimated 525 cfs. Figure 32 illustrates the annual peak streamflow from 1946 through 2012. During the past 36 years, peak streamflow has exceeded the flood stage in 17 (48%) of those years. Between 1946 and 1975, it was exceeded in only three years (10%). Figure 32 clearly illustrates that annual peak streamflow events have increased since 1976, indicating that flooding is a problem in the watershed, especially when compared to historical conditions.

Figure 31 - Mean Monthly Flow at USGS Angola Station (2002 - 2012)

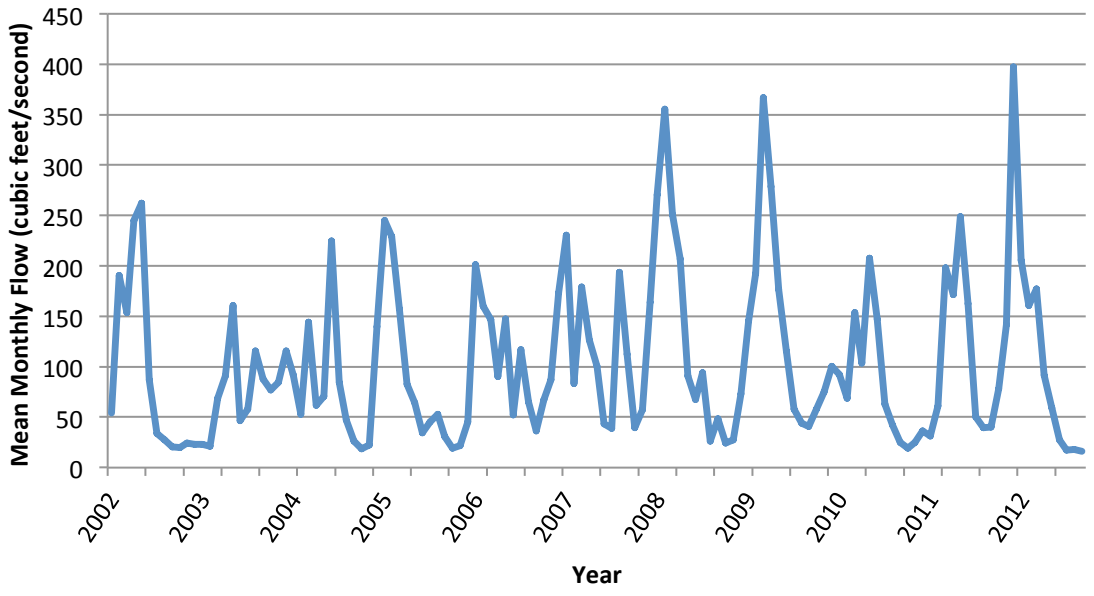
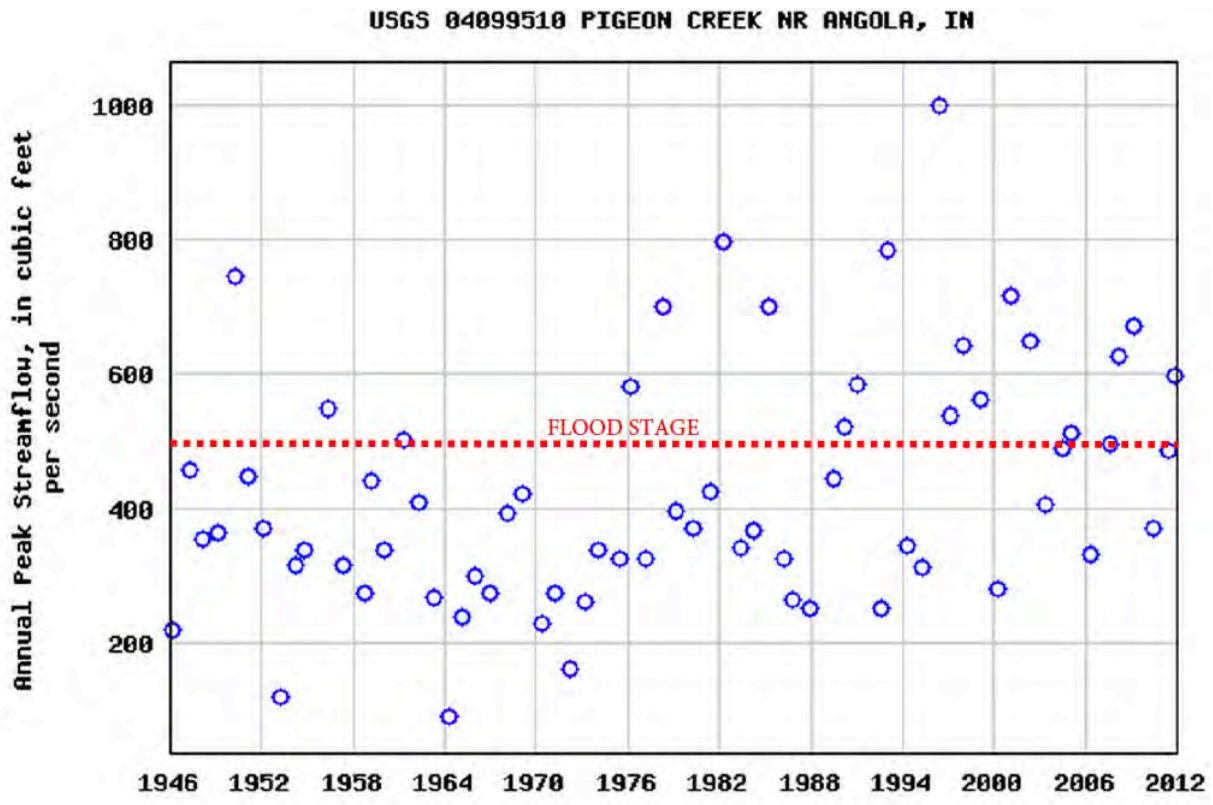


Figure 32 – Annual Peak Streamflow at USGS Angola Station (1946 – 2012)



4.2.4 Lake Trophic Status

Through IDEM, the Indiana Clean Lakes Program and Indiana University track lake trophic status of lakes in the state as an indicator of biologic activity, oxygen content and overall lake health. Indiana uses a "trophic state index" (TSI) to help identify the status of lakes. Indiana's TSI uses a set of parameters to which an index, or eutrophy number, is assigned. The TSI results in the sum of the individual eutrophy points and varies from 0 to 75. TSI ranges from oligotrophic (low nutrients – low plants and fish) to hypereutrophic (high in nutrients – support large amounts of plants and fish). Eutrophy points are evaluated for the following parameters: total phosphorus, soluble phosphorus, organic nitrogen, nitrate, ammonia, DO (both % saturation at 5 feet and % through water column >1.0 mg/L), light penetration, light transmission and total plankton.

High levels of phosphorus and nitrogen contribute to the eutrophic and hypereutrophic conditions within Big Bower Lake, Golden Lake, Hogback Lake, Little Bower Lake, Long Lake, Little Turkey Lake (Steuben and LaGrange Counties) and Pigeon Lake. It is important to note that Big Bower, Golden Lake, Hogback, and Long Lake have seen eutrophic or hypereutrophic conditions consistently since 2002 and should be focused on for reductions in nutrients. Table 35 presents a list of lake trophic status (for those lakes assessed) and trends for years 2002 through 2011; the highlighted waterbodies indicate a negative trend.

Table 35 - Lake Trophic Levels

Waterbody Name	2002 Trophic Status	2004 Trophic Status	2010-2011 Trophic Status
Appleman	N/A	N/A	Oligotrophic
Bass Lake	Oligotrophic	N/A	N/A
Beaver Dam Lake	Oligotrophic	Oligotrophic	N/A
Big Bower Lake	Eutrophic	Eutrophic	N/A
Booth Lake	Mesotrophic	Mesotrophic	N/A
Fox Lake	Mesotrophic	Mesotrophic	N/A
Golden Lake	Eutrophic	Hypereuthrophic	Eutrophic
Green Lake	Mesotrophic	Oligotrophic	Mesotrophic
Hogback Lake	Hypereuthrophic	Hypereuthrophic	Eutrophic
Little Bower Lake	Eutrophic	N/A	N/A
Little Turkey (Steuben)	N/A	N/A	Eutrophic
Little Turkey (LaGrange)	N/A	N/A	Eutrophic
Long Lake	Eutrophic	Hypereuthrophic	Eutrophic
Mud Lake	Mesotrophic	N/A	N/A
Pigeon Lake	Eutrophic	Mesotrophic	N/A
Pretty Lake	N/A	N/A	Mesotrophic
Silver Lake	Oligotrophic	Mesotrophic	N/A
Stayner Lake	Oligotrophic	Oligotrophic	N/A
West Otter Lake	Mesotrophic	Mesotrophic	N/A

4.3 Habitat & Biological Information

The Pigeon Creek watershed is rich in wildlife habitat and biological resources. There are large, contiguous blocks of protected wildlife habitat and many existing wetlands. Data exist on the quality of aquatic species, including fish and aquatic macroinvertebrates or insects. Section 4.3 evaluates the quality and extent of terrestrial wildlife habitat and aquatic species in the watershed.

4.3.1 Habitat

The amount of habitat within the watershed can be expressed by evaluating the acreage and quality of protected areas and/or natural habitat, wetlands and T&E species occurrences. As noted in Section 3.2.4, current wetlands cover 17,999 acres (13%) compared to 38,728 acres of wetlands (28%) prior to human settlement, a reduction of 20,729 acres (50%) of wetland habitat. An analysis of wetland data provided by Friends of the St. Joe River Association indicates that 13,262 acres of existing high-quality wetlands require protection and an additional 24,939 acres of degraded or converted wetlands require some form of restoration.

There are 7,316 acres (5.4%) of the total watershed area in state-owned and protected land. Green Lake, Mongo Millpond, and Pigeon Lake subwatersheds house the largest total acreage of protected land in the watershed. There are 313 occurrences and 156 known T&E species within the watershed, well over half being in the Mongo Millpond and Green Lake subwatersheds.

Efforts to protect, restore or create wildlife habitat will provide multiple benefits to the watershed and have a positive effect on water quality. Focus should be on expanding and improving existing habitat areas and then identifying strategic opportunities to add additional acreage and restore isolated

remnants. Table 36 provides some guidance for targeting habitat restoration/protection activities within the watershed. Results are based on an analysis of existing protected habitat, wetland restoration and protection needs, and T&E species occurrences using the following assumptions:

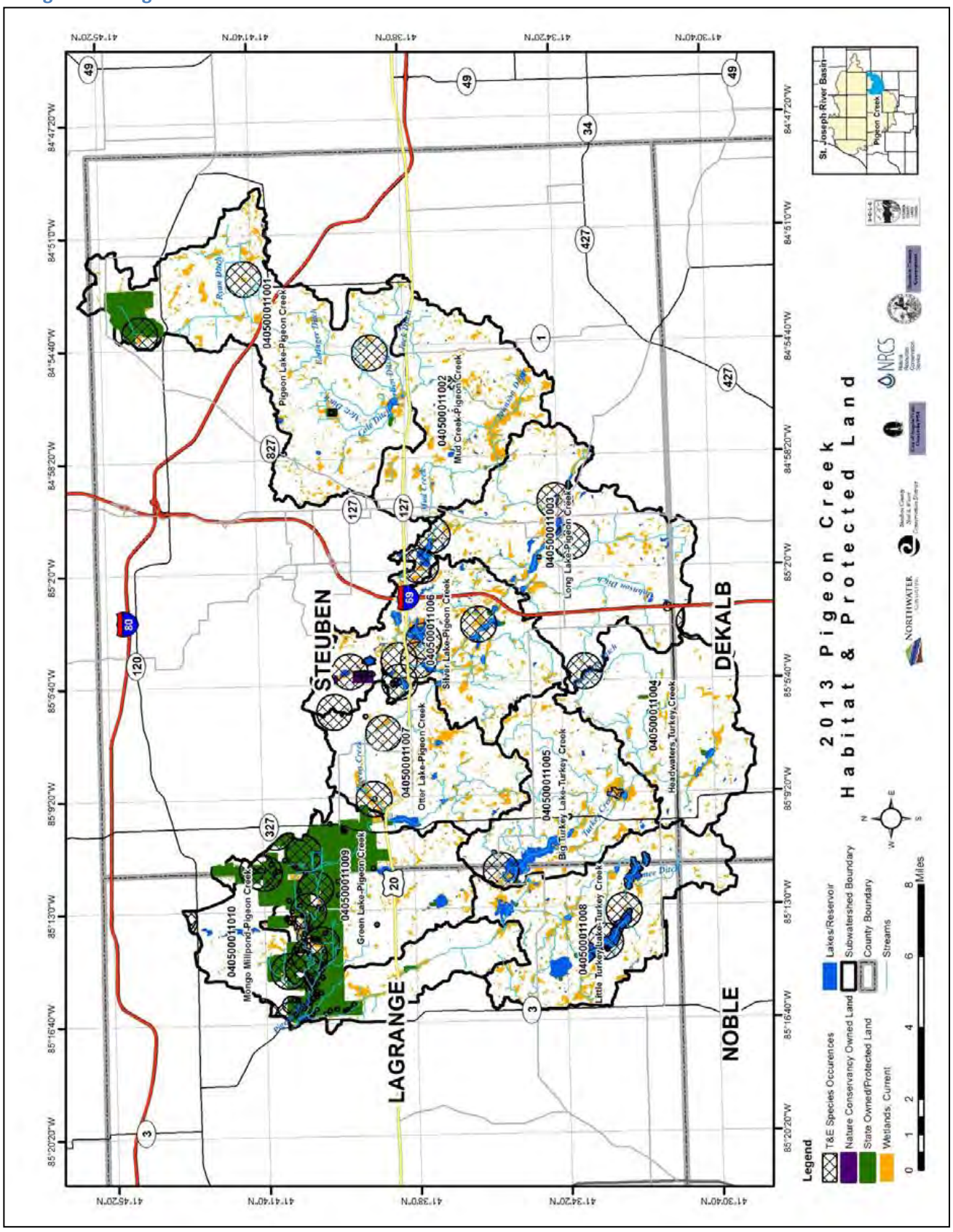
- Expanding existing protected areas may be more feasible and realistic to attain.
- Restoring or improving existing protected habitat is more economical.
- Wetland restoration efforts should be targeted to areas with the greatest percentage decline in pre-settlement wetland area.
- T&E species occurrences are indicators of habitat availability and restoration potential.
- Existing, high-quality wetlands should be protected.

Table 36 - Habitat Restoration & Protection Options

Subwatershed Name	HUC 12 Subwatershed Codes	Improve/Expand Existing State Owned/Protected Habitat	Add Additional Protected Habitat Acreage	Target Wetland Protection	Target Wetland Restoration
Pigeon Lake-Pigeon Creek	040500011001	X			X
Mud Creek-Pigeon Creek	040500011002			X	
Long Lake-Pigeon Creek	040500011003				X
Headwaters Turkey Creek	040500011004				X
Big Turkey Lake-Turkey Creek	040500011005				
Silver Lake-Pigeon Creek	040500011006		X		
Otter Lake-Pigeon Creek	040500011007				
Little Turkey Lake-Turkey Creek	040500011008				
Green Lake-Pigeon Creek	040500011009	X		X	
Mongo Millpond-Pigeon Creek	040500011010	X			

The subwatersheds of Pigeon Lake, Mud Creek, Long Lake, Headwaters of Turkey Creek, Green Lake, and Mongo Millpond may offer the most potential for habitat restoration and protection. Silver Lake may provide more opportunities to add additional protected habitat corridors or areas; TNC-owned Grass Lake complex (Silver Lake-Pigeon Creek subwatershed) could be expanded through the purchase of adjacent ground. Figure 33 shows the location of protected land, existing habitat areas and T&E occurrences.

Figure 33 - Pigeon Creek Habitat



4.3.2 Biological

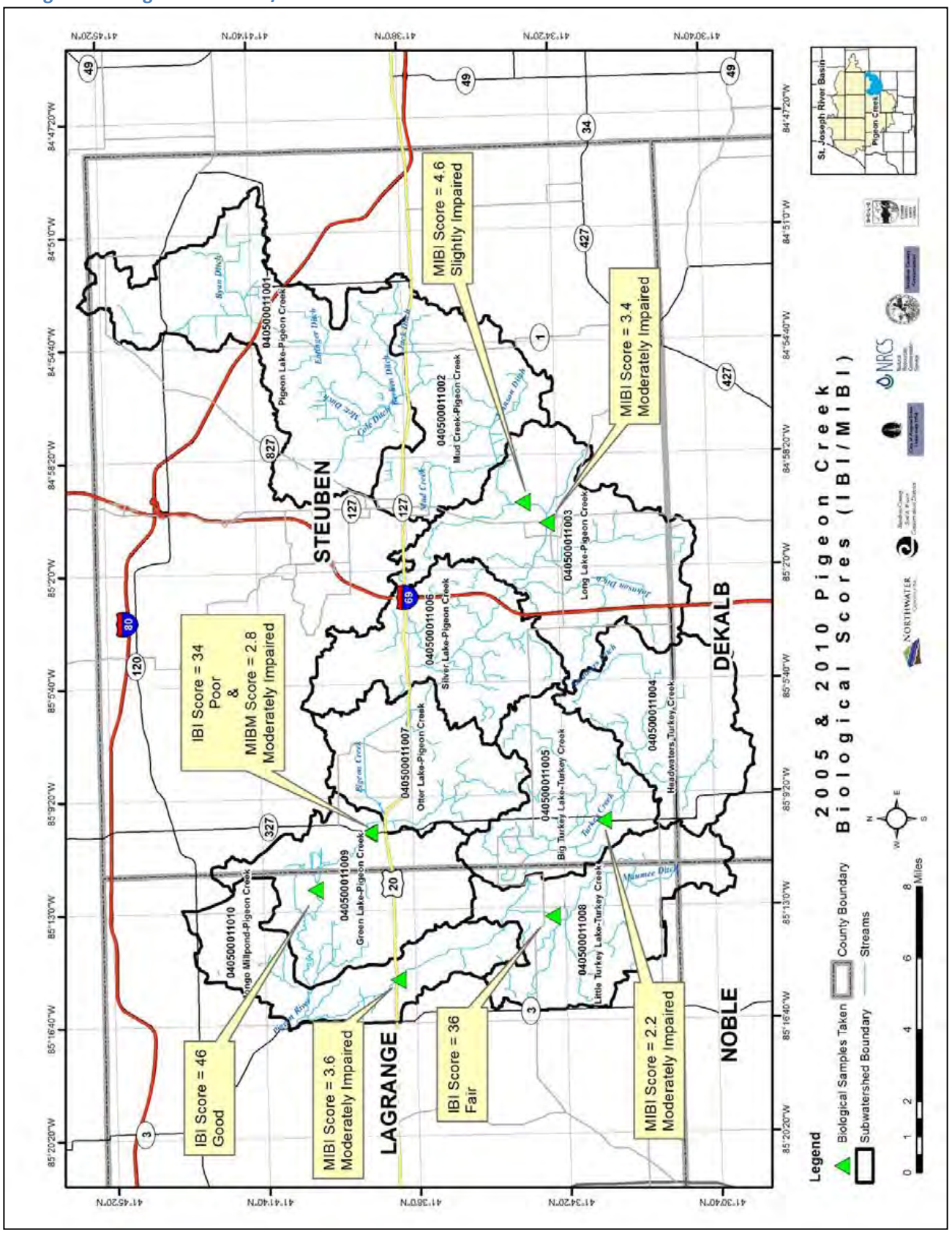
Water quality can be evaluated using biological indicators such as fish and macroinvertebrates. IDEM completed biological sampling in 2005 for Turkey Creek, and in 2010 for Pigeon Creek. A total of 3 sites were sampled for fish and 5 for macroinvertebrates. Table 37 lists the results of these samples in terms of their Index of Biological Integrity (IBI) and macroinvertebrate Index of Biological Integrity (mIBI) scores. Fish quality scores range from poor to good and macroinvertebrate scores from slight to moderately impaired. Figure 34 shows biological sample sites and the corresponding index scores.

Table 37 - IBI & mIBI Scores

Stream Name	Station Code	IBI	mIBI	Rating
Turkey Creek	LMJ110-0080	36	N/A	Fair (35-44)
Pigeon Creek	LMJ110-0003	34	N/A	Poor (23-34)
Pigeon Creek	LMJ110-0128	46	N/A	Good (45-52)
Pigeon Creek	LMJ110-0001	N/A	4.6	Slightly Impaired (4-6)
Pigeon Creek	LMJ110-0026	N/A	3.4	Moderately Impaired (2-4)
Turkey Creek	LMJ110-0027	N/A	3.6	Moderately Impaired (2-4)
Pigeon Creek	LMJ110-0028	N/A	2.8	Moderately Impaired (2-4)
Turkey Creek	LMJ110-0025	N/A	2.2	Moderately Impaired (2-4)

Pigeon Creek

Figure 34 - Pigeon Creek IBI/mIBI Scores



4.4 Landuse Information

Before settlement, Steuben County was primarily a hunting ground for the Potawatomi Indians. Originally a part of LaGrange County, Steuben County was settled in 1834 in the current town of Orland. The town was settled as the "Vermont Settlement," as many of the first settlers originated from Vermont. In the early 1900s, the county gained prominence for its 101 lakes. In addition to full-time residents, several thousand part-time residents and tourists reside in the watershed during the summer months.

Row crop agriculture makes up the largest percentage area in the watershed at approximately 50%. Woodland and open space (grassland) make up 25% of the watershed. Agricultural products are primarily corn and soybean, with livestock grazing operations throughout. Landuse information is important because many stakeholder concerns that relate to sediment, nutrient, and bacteria loading are tied to contributions from row crop agriculture, pasture, and residential areas. Table 38 lists the top five landuses by subwatershed. The headwaters of Turkey Creek has the highest percentage of row crops; Silver Lake, the highest percentage of woodland; Green Lake, the highest percentage of open space (grassland); Big Turkey Lake, the highest percentage of pasture; and Green Lake, the highest percentage of wetlands.

Although not listed in the table below, the Little Turkey Lake subwatershed has the highest percentage of open water at 936 acres (7%). Silver Lake has the second most open water with 811 acres (6%). Residential landuse is highest in Mud Creek with 590 acres (5%) and residential farm areas are highest in Otter Lake and Silver Lake with 472 acres (4.5%) and 568 acres (4.3%), respectively. Also notable, Silver Lake has the greatest area of roads at 454 acres (3.51%). It is important to note when referencing Table 38, that the percentage landuse type listed represents the percentage of that individual subwatershed and not the Pigeon Creek watershed as a whole.

Table 38 - Top Five Landuses by Subwatershed

Subwatershed Name	HUC 12 Subwatershed Codes	Acres Row Crop	% Row Crop	Acres Woodland	% Woodland	Acres Open Space	% Open Space	Acres Pasture	% Pasture	Acres Wetland	% Wetland
Pigeon Lake-Pigeon Creek	040500011001	12,721	57.73%	3,043	13.81%	1,888	8.57%	874	3.97%	960	4.36%
Mud Creek-Pigeon Creek	040500011002	5,642	48.47%	1,770	15.21%	958	8.23%	533	4.58%	587	5.04%
Long Lake-Pigeon Creek	040500011003	10,783	57.91%	2,377	12.76%	1,271	6.82%	558	3.00%	397	2.13%
Headwaters Turkey Creek	040500011004	**7,643**	**64.78%**	1,397	11.84%	683	5.79%	608	5.16%	276	2.34%
Big Turkey Lake-Turkey Creek	040500011005	5,472	49.68%	1,661	15.08%	855	7.76%	**954**	**8.66%**	431	3.92%
Silver Lake-Pigeon Creek	040500011006	4,209	32.49%	**2,745**	**21.19%**	1,508	11.64%	1,007	7.77%	747	5.76%
Otter Lake-Pigeon Creek	040500011007	5,618	53.55%	1,882	17.94%	794	7.57%	615	5.86%	274	2.61%
Little Turkey Lake-Turkey Creek	040500011008	6,303	47.55%	2,285	17.24%	922	6.95%	1,142	8.62%	167	1.26%
Green Lake-Pigeon Creek	040500011009	5,371	39.55%	2,869	21.12%	**2,214**	**16.30%**	774	5.70%	**1,287**	**9.48%**
Mongo Millpond-Pigeon Creek	040500011010	5,635	53.56%	2,090	19.87%	1,020	9.69%	406	3.86%	657	6.25%