Bear Lake - Little Wolf River Watershed Management Plan

Waupaca County Land and Water Conservation Department, Natural Resources Conservation Service, and Golden Sands RC&D

2017

Waupaca County Est. 1851 Wisconsin

Golden Sands Resource Conservation & Development Council, Inc.

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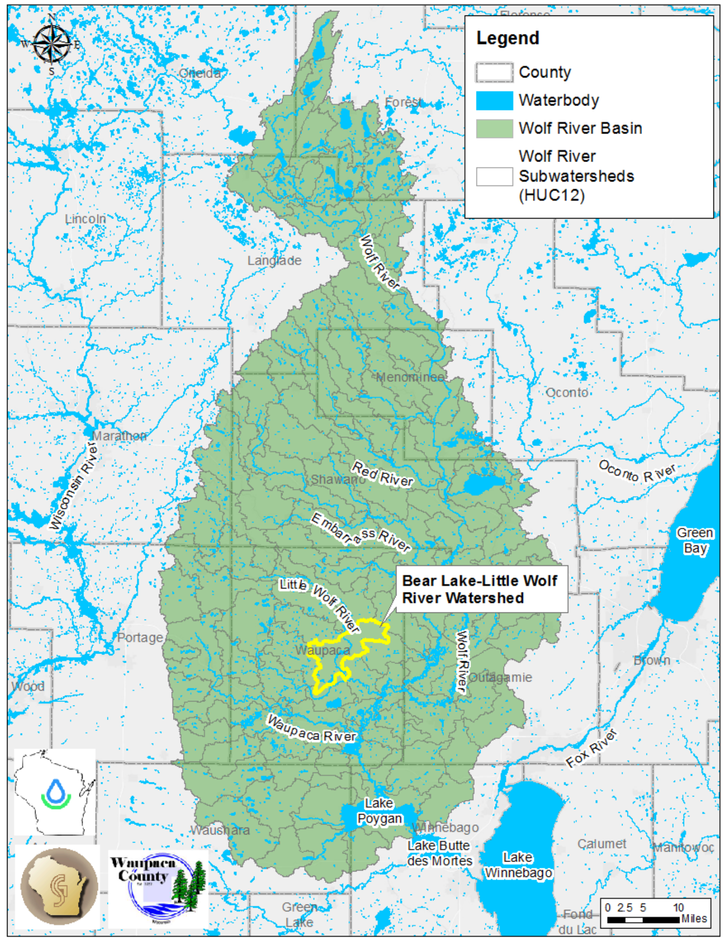
Executive Summary



The Bear Lake-Lower Little Wolf River Watershed is a subwatershed of the Wolf River Basin in Wisconsin. The Bear Lake-Lower Little Wolf River Watershed is centrally located in Waupaca County, Wisconsin. There are seven named lakes (Vesey Lake, Fox Lake, Wood North Lake, Bear Lake, Driscol Lake, Mountain Lake, and Manawa Millpond) and four tributary creeks (Spiegelberg Creek, Fountain Creek, Thiel Creek, and Little Creek) to the Lower Little Wolf River located in the watershed. The watershed drains a total area of 28,260 acres and is located northwest of New London.

Historically, the land in the area was covered with forests, prairie and wetlands. Waupaca County was home to the Menominee Indian Tribe before Europeans began to settle in the area in the early 1800's. The farming and forestry industry in the area has led to clearing of forests and natural areas and draining of wetlands in the watershed. Farming, industry, and urban development have led to a decrease in water quality in the watershed.

Waters in the Wolf River Basin are impaired due to excess phosphorus and total suspended solids. The Federal Clean Water Act requires states and authorized tribes to identify and restore impaired water bodies. A Total Maximum Daily Load (TMDL) plan is currently being developed for the Upper Fox and Wolf Basins to identify the sources of pollutants and the reductions necessary to address water quality impairments. The TMDL is expected to be completed in 2018. Addressing water quality in the Upper Fox and Wolf basins is also necessary for restoring water quality in the Lower Fox Basin.

The Bear Lake Little Wolf River Watershed plan provides a framework to accomplish the following goals:

Goal #1: Improve surface water quality to achieve Wisconsin Department of Natural Resources/Environmental Protection Agency water quality standards.

Goal #2: Increase citizens' awareness of water quality issues and active participation in stewardship of the watershed.

Goal #3: Reduce runoff volume and flood levels during peak storm events.

Goal #4: Conserve and restore aquatic and terrestrial habitat.

Challenges and sources in the watershed:

The dominant land use in the watershed is agriculture and is responsible for approximately 78% of the phosphorus load and 86% of the sediment load in the watershed. Wetlands and forest land have been cleared and drained to increase agricultural production in this area. A predominant focus on maximum production of all available acreage combined with a lack of awareness of the need for conservation practices and sustainable management of farmland in this area has led to significant sediment and nutrient loss from agricultural land.

Watershed Implementation Plan:

In order to meet the goals for the watershed a 10 year implementation plan was developed. The action plan recommends best management practices, information and education activities and needed restoration to achieve the goals of the watershed project. The plan includes estimated costs, potential funding sources, agencies responsible for implementation and measures of success.

Recommended Management Practices:

- Reduced Tillage Methods (Strip/Zone till, No till, Mulch till)
- Cover Crops
- Vegetated buffers
- Wetland restoration/creation
- Grassed Waterways
- Nutrient Management
- Low Disturbance Manure Injection
- Water and Sediment Control Basins
- Critical Area Planting
- Tree Plantings/Conservation Cover/Habitat


Interseeded cover crop into corn

restoration
- Barnyard Runoff Management
- Waste Storage
- Prescribed Grazing

Information and Education Recommendations:

- Provide educational workshops, field demonstrations and tours on how to implement best management practices.
- Engage landowners in planning and implementing conservation on their land and by providing information on the technical tools and financial support available to them.
- Provide information on water quality and conservation practices to landowners in the watershed area.
- Newsletters and/or webpage with watershed project updates and other pertinent conservation related information.


Photo credit: Lower Fox Demonstration Farms

Conclusion

Meeting the goals for the Bear Lake- Little Wolf River watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for “noncompliant” sites that will need to be supported by focused technical and financial assistance. It will require widespread cooperation and commitment of the watershed community to improve the water quality and condition of the watershed. This plan needs to be adaptable to the many challenges, changes and lessons that will be found in this watershed as implementation moves forward.

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1. Background and Purpose

This watershed plan was developed by the Waupaca County Land & Water Conservation Department (LWCD), Golden Sands Resource Conservation and Development Council (RC&D) and the Natural Resources Conservation Service (NRCS) to more effectively implement conservation work on agricultural lands in the Bear Lake- Little Wolf River Watershed. The Bear Lake- Little Wolf River Watershed is in the Wolf River Basin which is currently in the process of Total Maximum Daily Load[1] (TMDL) development for phosphorus and sediment. As a result of the pending TMDL and available NRCS funding, the NRCS and Waupaca County LWCD have decided to develop a watershed assessment plan that will identify where conservation implementation will have the greatest impact on improving water quality.

The information in the watershed plan will be used by conservation professionals in the watershed to identify priority farms and fields for further resource assessment and implementation of conservation practices.

Plan Development

Partnerships with the community and local organizations are important in developing and implementing a successful watershed implementation plan. A technical advisory team was created to identify stake holders, review available information and data, identify goals, and provide review and comment during the drafting of the plan. The technical advisory team member participants include:

Brian Haase- Waupaca County LWCD
Dan McFarlane-Waupaca County LWCD
Stefan Stults- Waupaca County LWCD
Lisa Neuenfeldt- Natural Resources Conservation Service
Derrick Raspor- Natural Resources Conservation Service
Greg Blonde- University of Wisconsin- Extension
Sarah Francart- Golden Sands RC&D
Jeff Polenske-Tilth Agronomy
Paul Knutzen- Knutzen Crop Consulting
Todd Schaumberg- Tilth Agronomy
Mike Kiddy-Kiddy Crop Consulting
Ty Larson- Natural Resources Conservation Service
David Bohla- Wisconsin Department of Natural Resources
Eric Evenson-Wisconsin Department of Natural Resources
Ben Gierach- Buttles Custom Ag LLC

[1] Additional information on TMDL can be found at http://dnr.wi.gov/topic/tmdls/.

2. Watershed Characterization

2.1 Bear Lake-Little Wolf River Watershed Setting

The Bear Lake-Lower Little Wolf River Watershed is a subwatershed of the Wolf River Basin. The Wolf River Basin encompasses 11 counties in Wisconsin starting in the north in Forest and Oneida Counties draining south to Waushara and Winnebago Counties draining into Lake Poygan (Figure 1). The Bear Lake- Little Wolf River Watershed is centrally located in Waupaca County. There are seven named lakes (Vesey Lake, Fox Lake, Wood North Lake, Bear Lake, Driscol Lake, Mountain Lake, and Manawa Millpond) and four tributary creeks (Spiegelberg Creek, Fountain Creek, Thiel Creek, and Little Creek) to the Lower Little Wolf River located in the watershed (Figure 2). Spiegelberg Creek flows north out of Bear Lake to the Little Wolf River, Thiel Creek Flows Southeast to the Little Wolf River and Fountain Creek flows south into Little Creek which then flows Southwest in the Little Wolf River in the watershed. The Little Wolf River flows south through the watershed changing direction to the southeast at the outlet of the watershed eventually out letting to the Wolf River. The watershed drains a total area of 28,260 acres and is located northwest of New London.

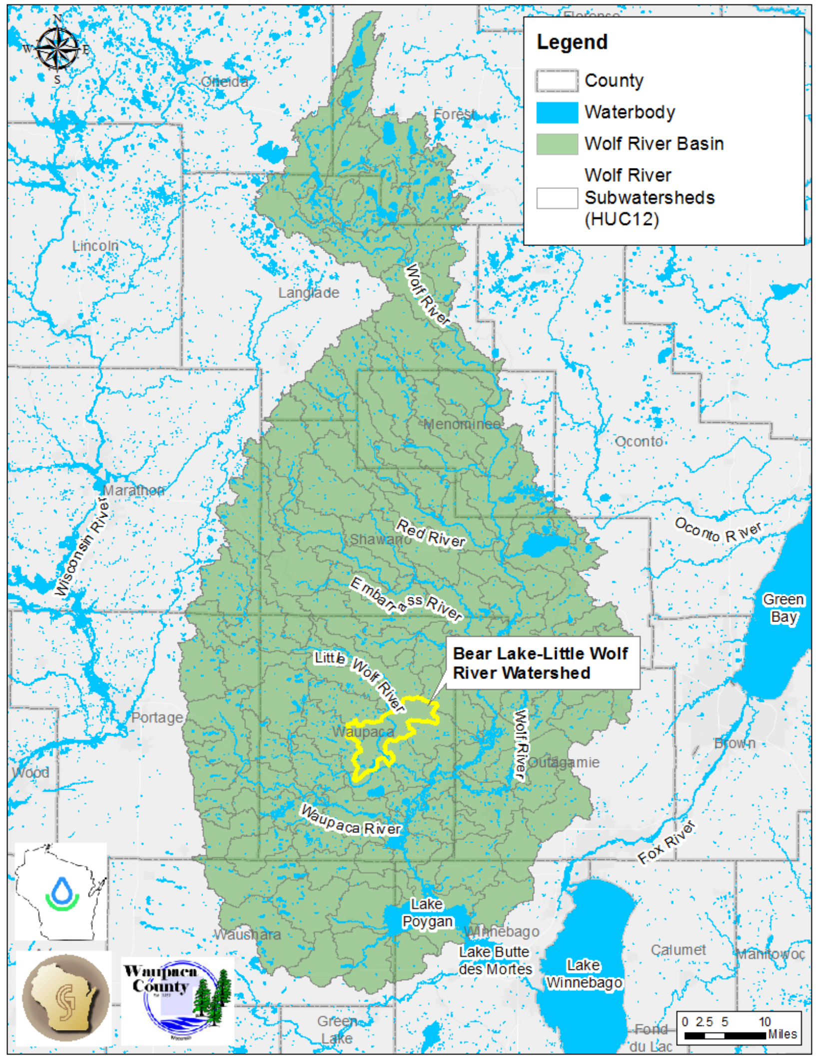

Figure 1. Wolf River Basin.

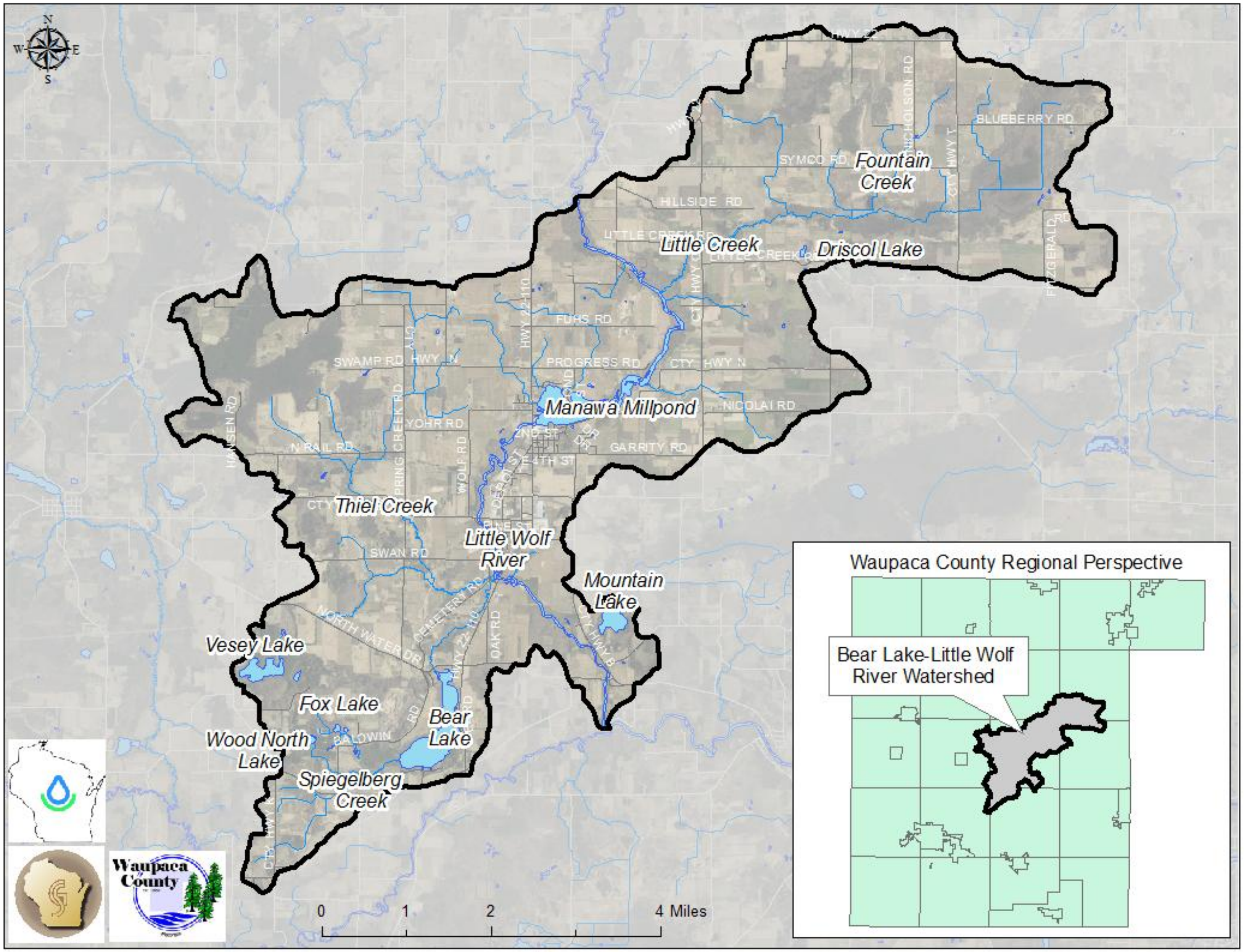

Figure 2. Bear Lake-Little Wolf River Watershed.

2.2 Prior Studies, Projects and Existing Resource Management and Comprehensive Plans.

Various studies have been completed in the Wolf River Basin and Lake Michigan Basin describing and analyzing conditions in the area. Several management and comprehensive plans as well as monitoring programs have already been developed for the Wolf River Basin and Lake Michigan Basin. A list of known studies, plans and monitoring programs are listed below:

<u>Nonpoint Source Control Plan for the Lower Little Wolf River Priority Watershed Project-1997</u>

Nonpoint source watershed plan developed for the Lower Little Wolf River Priority Watershed that focused on phosphorus and sediment reduction. The Wisconsin Nonpoint Source Water Pollution Abatement Program provided cost sharing to landowners who voluntarily implemented best management practices in priority watershed areas. Plan implementation began in 1997 and ended in 2008. The BMPs that were implemented during the Priority Watershed Project were nutrient management, residue management, barnyard-runoff management, streambank restoration, and manure storage throughout the watershed.

<u>Waupaca County Land and Water Resource Management Plan-2012</u>

A 10 year comprehensive plan to work with the citizens of Waupaca County to improve the water quality and natural resources of Waupaca County. The plan has specific goals, objectives and actions to achieve that mission.

<u>The State of the Wolf Basin-2001</u>

The State of the Wolf Basin Report identified the status of resources in the basin and articulated WDNR and partner goals and objectives to maintain, restore and protect ecosystem health. This plan serves as an update to the Wolf River Basin Water Quality Management Plan. Four priority areas identified in the plan are: water pollution, loss of shoreline habitat, hunting, fishing, trapping and recreational uses, and need for an inventory of basin resources. Other concerns identified include: preservation and protection of wetlands, exotic species, pressures from development, and land use and smart growth.

<u>Lower Little Wolf River Targeted Watershed Assessment Water Quality Management Plan-2017</u>

A study that was done by WDNR in 2015 to evaluate water quality improvements in the Lower Little Wolf River Watershed from implementation of conservation practices from 1997-2008 as a result of the priority watershed project. The project determined if the goals of the priority watershed project to protect and improve water quality were met by collecting fish, aquatic macroinvertebrate, habitat, temperature, and inorganic chemistry information throughout the watershed and comparing it to pre-implementation water quality data. The study demonstrated that there had been improvements (Spiegelberg Creek) and declines (Thiel Creek) in water quality since the watershed project. Many of the practices implemented during the watershed project were soft practices (tillage and nutrient management) that may have been discontinued. Other changes in farming practices since the end of the watershed project have also impacted water quality since the end of the watershed project. The study concluded that the monitoring in 2015 does not solely reflect the changes in the watershed from the Priority Watershed Project implementation. In addition to comparing 2015 TP results to historic data, an impairment assessment was also conducted to verify if tributaries in the watershed met water quality criteria for Total Phosphorus. Two of the tributaries (Little and Thiel Creeks) exceeded the criteria and have been recommended for the 2018 impaired waters listing. The study concluded that there is still a need for water quality improvements in the watershed.

An Evaluation of Past and Present Water Quality Conditions in Bear Lake, Waupaca County, Wisconsin-2002

The University of Wisconsin-Stevens Point, the WDNR and the Bear Lake Association conducted a study of the physical, chemical and biological characteristics of Bear Lake and the watershed feeding it. Results of the study were compared to results of a study conducted in the late 70's and early 80's to determine if changes were occurring in the lake. Results of the study showed that water clarity and chlorophyll a (measure of algae) had improved since the data from the late 70's and early 80's. Nutrient concentrations appeared to have remained fairly constant in the bottom of the lake. At the time of the study a survey of citizens in the watershed revealed that 95% were using lawn and garden fertilizer. The study also found that approximately 20% of shallow groundwater sites that were sampled appeared to be influenced by septic system impacts.

The study made several recommendations that could improve the water quality of Bear Lake. The study recommended efforts to reduce and eliminate use of lawn and garden fertilizers, recreating riparian buffers near shore, site future septic systems as far from the lake as possible, and agricultural best management practices such as nutrient management, cover crops, buffers, fencing animals from streams, and maintaining vegetative cover in pastures.

2.3 Wisconsin Ecoregions

Ecoregions are based on abiotic and biotic factors such as climate, geology, vegetation, wildlife, and hydrology. The mapping of ecoregions is beneficial in the management of ecosystems and has been derived from the work of James M. Omernik of the USGS. The Bear Lake-Little Wolf River watershed is located in the North Central Hardwood Forest ecoregion and in the Green Bay Till and Lacustrine Plain sub ecoregion. The North Central Hardwood ecoregions is transitional between predominately forested ecoregions to the north and the agricultural ecoregions to the south. The land use/cover in this region consists of a variety of forests, wetlands, lakes, and agriculture. The Green Bay Till and Lacustrine Plain sub ecoregion is characterized by outwash and loamy recessional moraines in the northwest and lake plains and ground moraines in the south. The growing season is favorable to agriculture in this sub ecoregion and much of the natural vegetation has been cleared for agriculture.

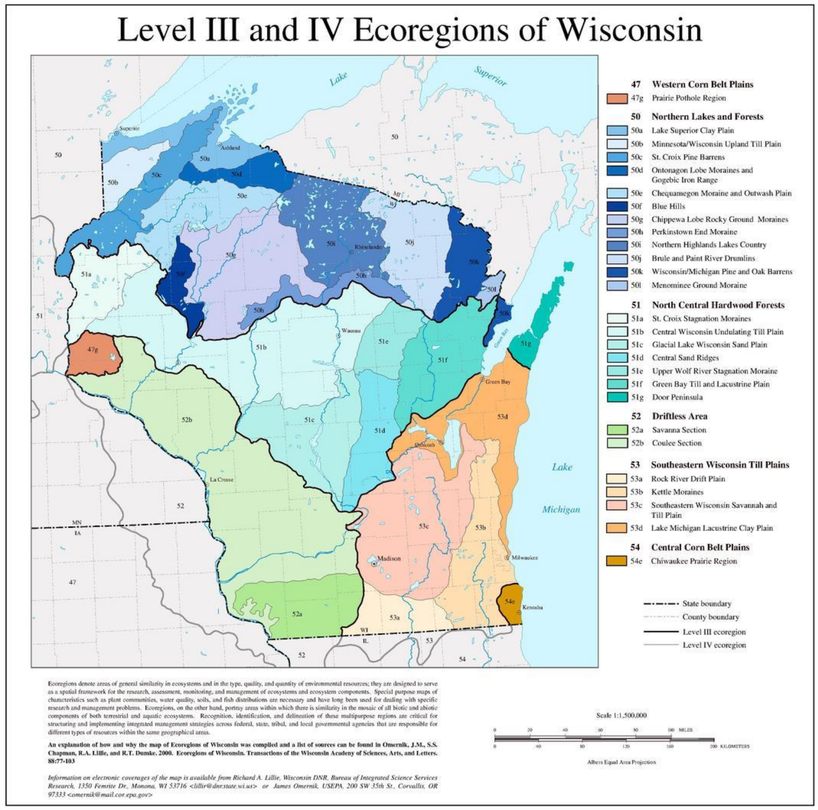

Figure 3. Map of Ecoregions of Wisconsin. Source: Omernik et al 2000.

2.4 Climate

Wisconsin has a continental climate that is affected by Lake Michigan and Lake Superior. Wisconsin typically has cold, snowy winters and warm summers. The average annual temperature ranges from 39^{o}F in the north to about 50^{o}F in the south. Temperatures can reach minus 30^{o}F or colder in the winter and above 90^{o}F in the summer. Average annual precipitation is about 31 inches a year of rain and snow in the watershed area. The majority of precipitation occurs in the form of storm events during the growing season (May-September). Most runoff occurs in February, March, and April when the land surface is frozen and soil moisture is highest. The climate in central and southern Wisconsin is favorable for dairy farming, where corn, small grains, hay, and vegetables are the primary crops.

2.5 Geology, geomorphology and topography.

The Bear Lake- Little Wolf River watershed lies in the Eastern Ridges and Lowlands geographical province of Wisconsin. The watershed area was part of the glaciated portion of Wisconsin. During the last Ice Age the Laurentide Ice Sheet began to advance into Wisconsin where it expanded for 10,000 years before it began to melt back after another 6,500 years. Glaciers have greatly impacted the geology of the area. The topography is generally smooth and gently sloping with some slopes steepened by post glacial stream erosion. The main glacial landforms are ground moraine, outwash, drumlins, and lake plain. The region contains numerous marshes, wetlands, and scattered lakes. The highest point in the watershed area is 1,024 ft above sea level and the lowest point in the watershed is 780 feet above sea level (Figure 5). There is a 244 foot change in elevation from highest and lowest point in the watershed.

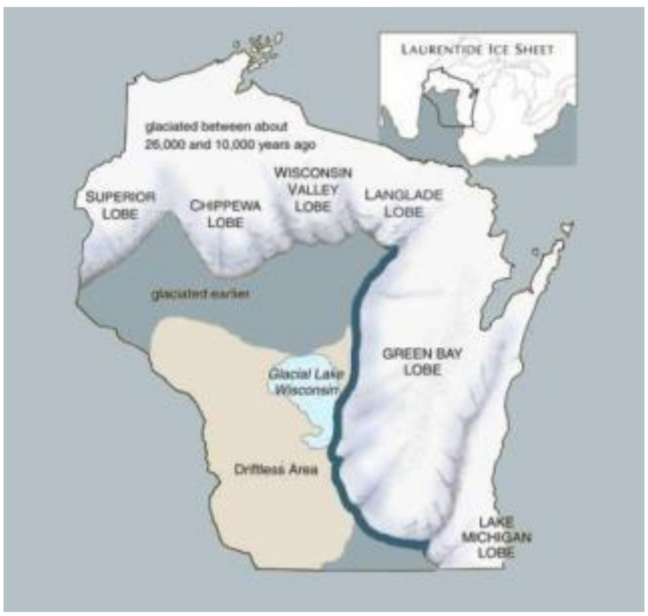

Figure 4. Ice Age Geology of Wisconsin. ©Mountain Press, 2004.

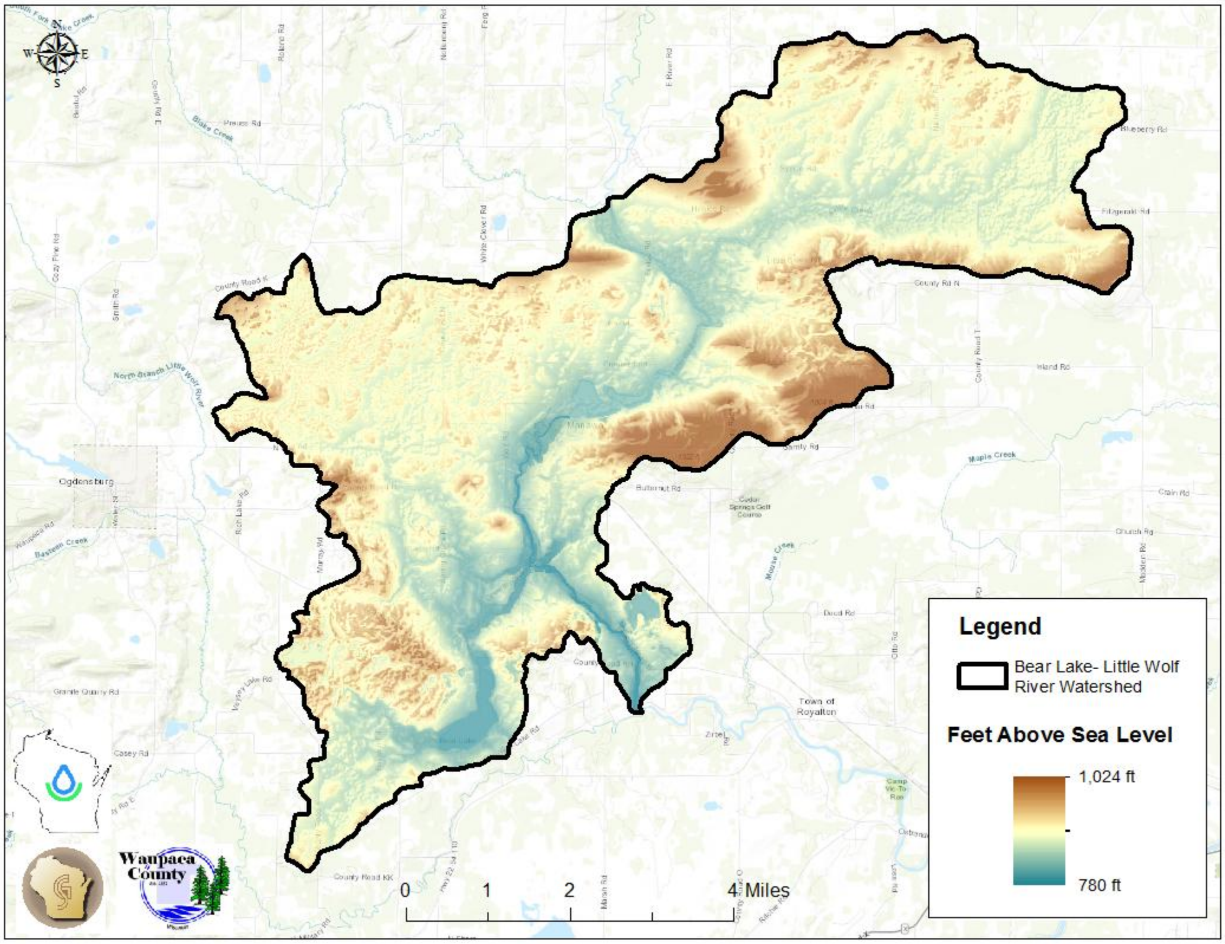

Figure 5. Digital elevation model.

The geology of the watershed consists of Pleistocene materials covering Cambrian sandstone and Precambrian crystalline rock. The bedrock topography slopes generally to the southeast. Pleistocene-aged materials were deposited by the Green Bay lobe ice moving from the east across crystalline rock, sandstone, dolostone, and limestone. Pleistocene materials in the watershed are mainly tills and glaciofluvial deposits. Tills consist of clay, silt, sand, gravel, and boulders. Tills are usually associated with the hillier parts of the landscape such as moraines and drumlins. Glaciofluvial deposits are material that were sorted and stratified by melt water from glaciers. Glaciofluvial materials are generally found on flatter parts of the landscape, frequently following the channels and flood plains of modern streams.

2.6 Soil Characteristics

Soil data for the watershed was obtained from the Natural Resources Conservation Service (SSURGO) database. The type of soil and its characteristics are important for planning management practices in a watershed. Factors such as erodibility, hydric group, slope, and hydric rating are important in estimating erosion and runoff in a watershed.

The dominant soil types in the watershed are Hortonville fine sandy loam (31.6%), Symco loam (15%), Hortonville loam (12.6%), Seelyeville muck (8.8%), Angelica Silt Loam (6%), and Cathro and Markey Mucks (4.9%).

Hydrologic Soil Group

Soils are classified into hydrologic soil groups based on soil infiltration and transmission rate (permeability). Hydrologic soil group along with land use, management practices, and hydrologic condition determine a soil's runoff curve number. Runoff curve numbers are used to estimate direct runoff from rainfall. There are four hydrologic soil groups: A, B, C, and D. Descriptions of Runoff Potential, Infiltration Rate, and Transmission rate of each group are shown in Table 1. Some soils fall into a dual hydrologic soil group (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and water table depth when drained. The first letter applies to the drained condition and the second letter applies to the undrained condition. The dominant hydrologic soil group in the watershed is Group C (59%) (Figure 6). Group C soils have moderately high runoff potential and low infiltration and transmission rates.

Table 1. Hydrologic soil group description.

HSG	Runoff Potential	Infiltration Rate	Transmission Rate
A	Low	High	High
B	Moderately Low	Moderate	Moderate
C	Moderately High	Low	Low
D	High	Very Low	Very Low

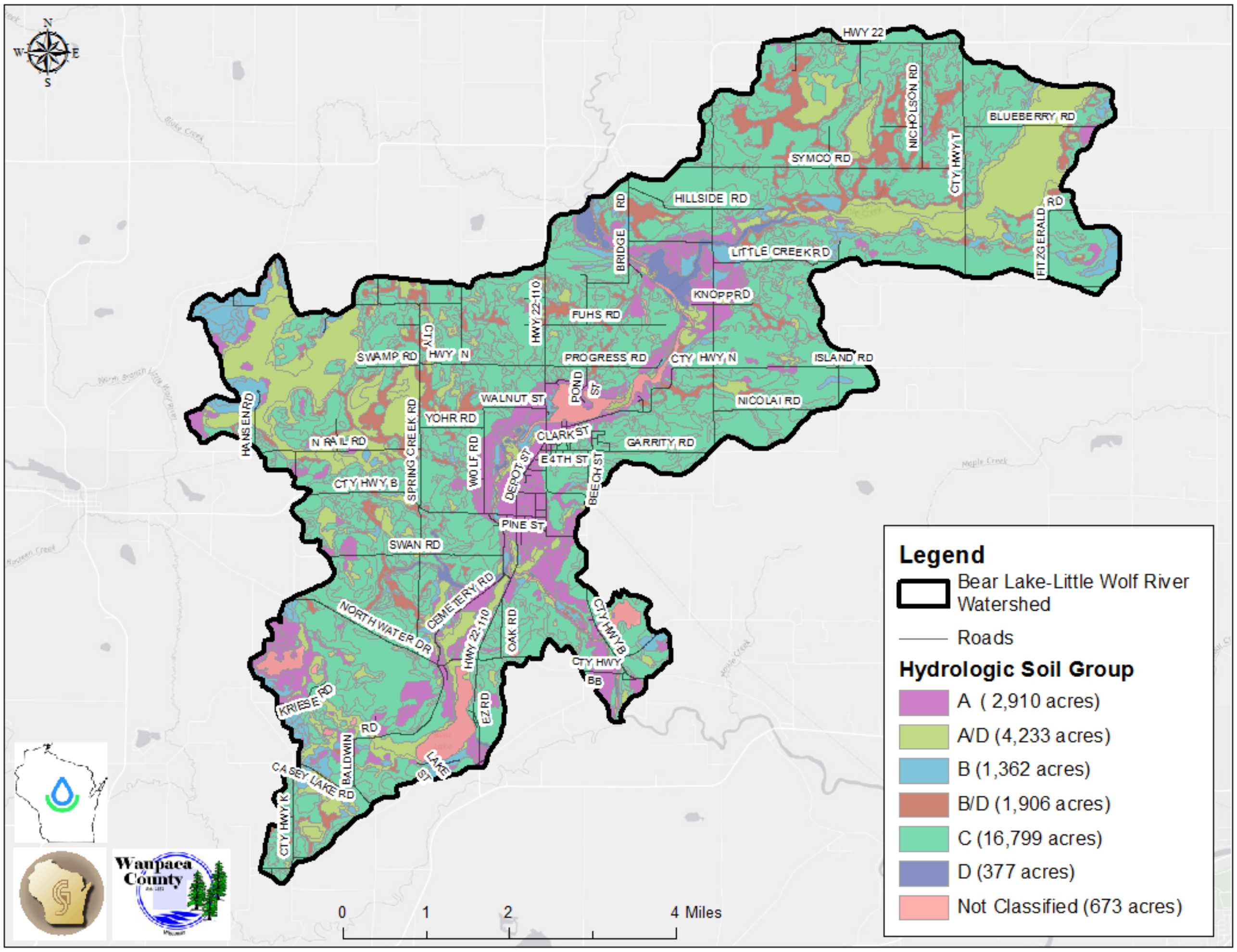

Figure 6. Hydrologic soil groups.

Soil Erodibility

The susceptibility of a soil to wind and water erosion depends on soil type and slope. Course textured soils, such as sand, are less susceptible to erosion than fine textured soils such as silt. The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. It is one of the six factors used in the Revised Universal Soil Loss Equation (RUSLE)[2] to predict the average annual rate of soil loss by sheet and rill erosion in tons/acre/year. Values of K range from 0.02 to 0.55. Soil erodibility factors for Bear Lake-Little Wolf River Watershed are shown in Figure 7, soils with high erodibility are indicated by orange and red.

[2] USLE refers to the Universal Soil Loss Equation that estimates average annual soil loss caused by sheet and rill erosion base on the following factors: rainfall and runoff (A), soil erodibility factor (K), slope factor (LS), crop and cover management factor (C), and conservation practice factor (P).

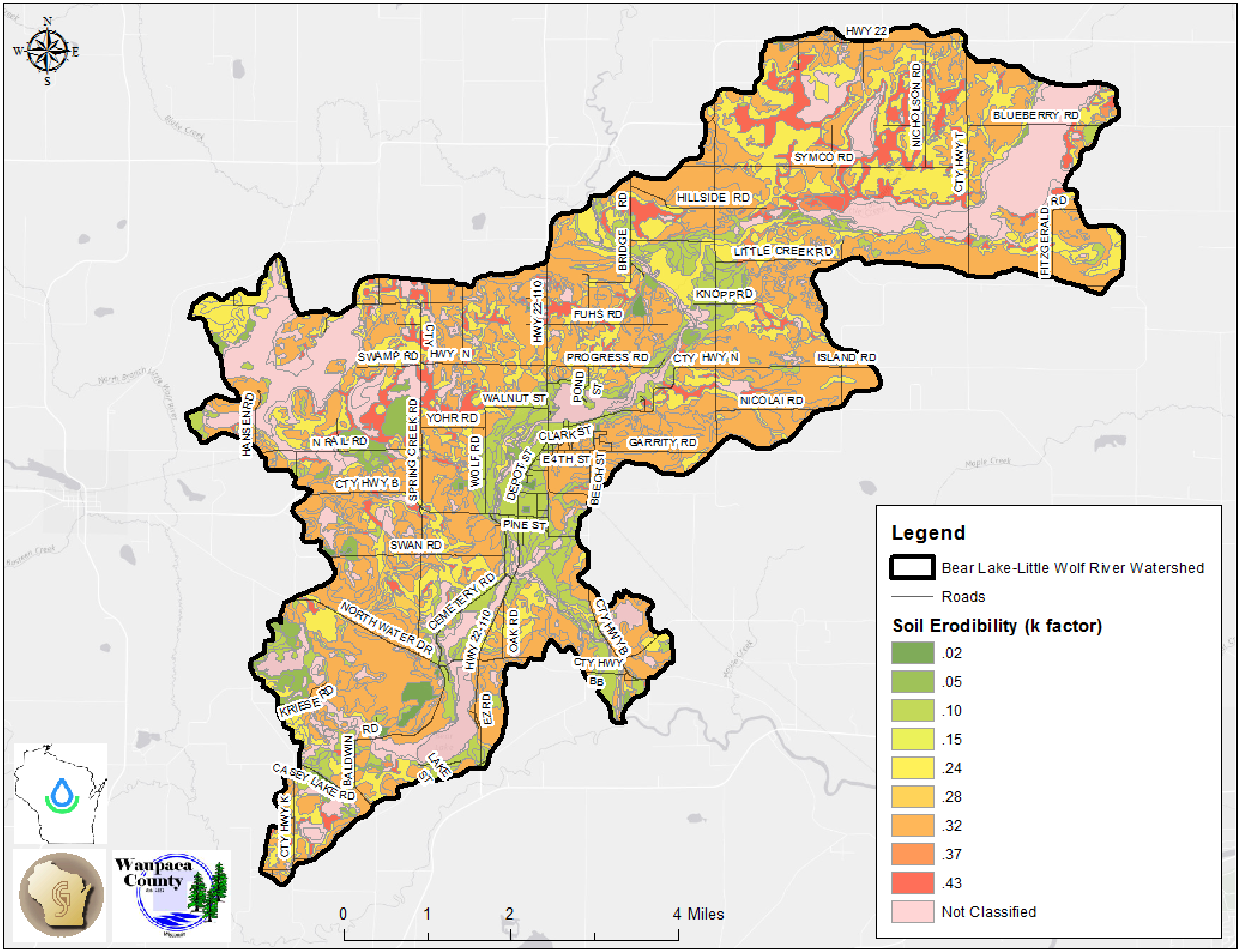

Figure 7. Soil erodibility.

2.7 Land Cover/Land Use

2.7.1 Land Cover/Land Use

Existing land use data was determined by using the Waupaca County 2015 Land Use data set and aerial imagery. Land use was broken out into four categories: natural background (forests, wetlands, grassland), urban (industrial, transportation, developed, residential), agriculture, and water. Agriculture is the dominant land use in the watershed at 51.2 % followed by natural background at 36.5%.

Table 2. Summary of land use in Bear Lake-Little Wolf River Watershed.

Land Use/Land Cover	Area (Acres)	Percent
Agriculture	14,476	51.2
Natural Background (forests, wetlands, grassland)	10,303	36.5
Urban (industrial, transportation, developed, residential)	2,606	9.2
Water	876	3.1
Total	**28,261**	**100.0**

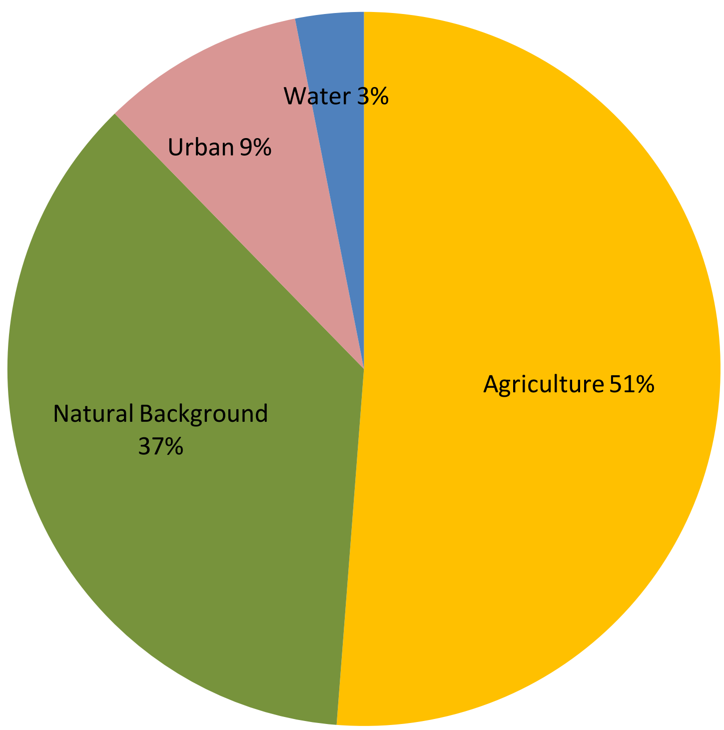

Figure 8. Summary of land use in Bear Lake-Little Wolf River Watershed**.**

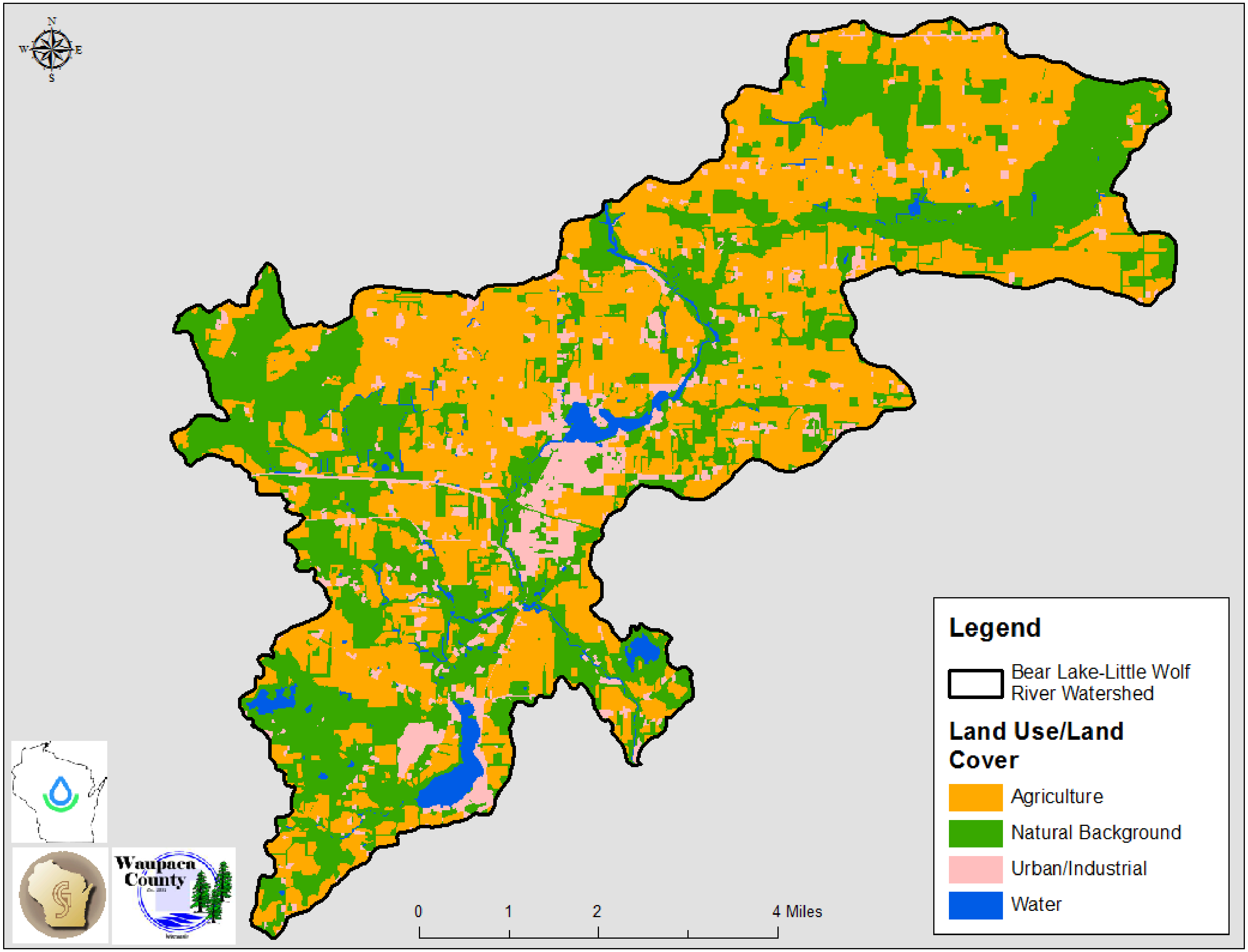

Figure 9. Bear Lake- Little Wolf River Watershed land use.

2.7.2 Crop Rotation

Cropland data was obtained from the USDA National Agriculture Statistics Service (NASS). NASS produces the Cropland Data Layer using satellite images at 30 meter observations, Resourcesat-1 Advanced Wide Field Sensor, and Landsat Thematic mapper. Data from 2009 to 2016 was analyzed using the WDNR EVAAL[3] tool to obtain a crop rotation. Crop rotations for the watershed are shown in Table 3 and Figure 10.

Dairy rotation is the dominant rotation in the watershed at 67 % with cash grain rotation following at 19.8%. Different crop rotations can affect the amount of erosion and runoff that is likely to occur on a field. Corn is often grown in dairy rotations and harvested for corn silage; harvesting corn silage leaves very little residue left on the field making the field more susceptible to soil erosion and nutrient loss. Changing intensive row cropping rotations to a conservation crop rotation can decrease the amount of soil and nutrients lost from a field. Increasing the conservation level of crop rotation can be done by adding years of grass and/or legumes, add diversity of crops grown or add annual crops with cover crops.

Table 3. Crop rotation summary.

Crop Rotation	Acres	Percent
Pasture/Hay/Grassland	1,290	9.1
Dairy Rotation	9,516	67.0
Cash Grain	2,817	19.8
Continuous Corn	588	4.1
Total	**14,211**	**100**

[3] Additional information on EVAAL can be found at http://dnr.wi.gov/topic/nonpoint/evaal.html.

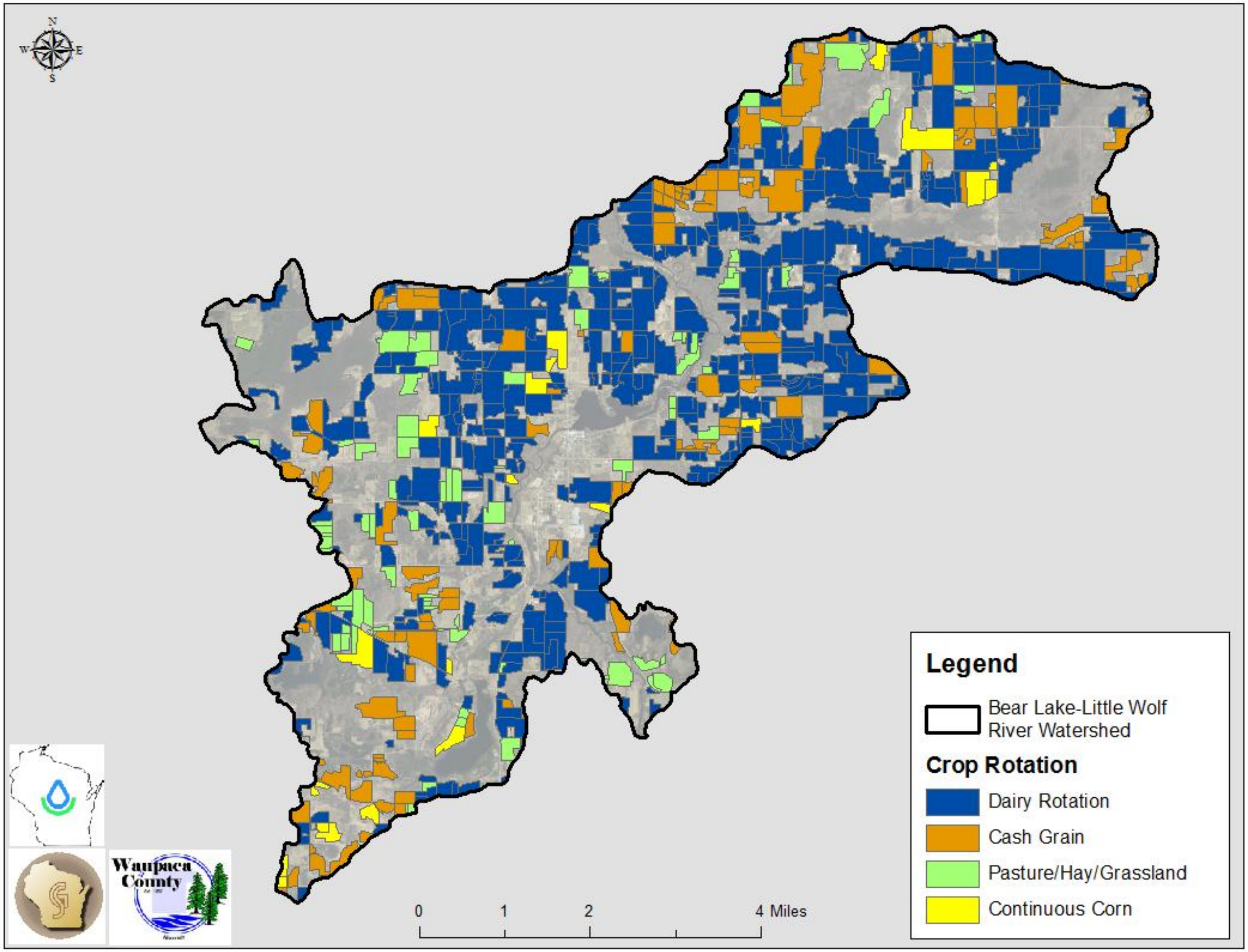

Figure 10. EVAAL crop rotation analysis by field.

2.8 Watershed Jurisdictions

The Bear Lake-Little Wolf River Watershed is located entirely in Waupaca County. The Towns of Little Wolf, Lebanon, Royalton, Waupaca, St. Lawrence, Union, and Bear Creek as well as the City of Manawa are located in the watershed area.

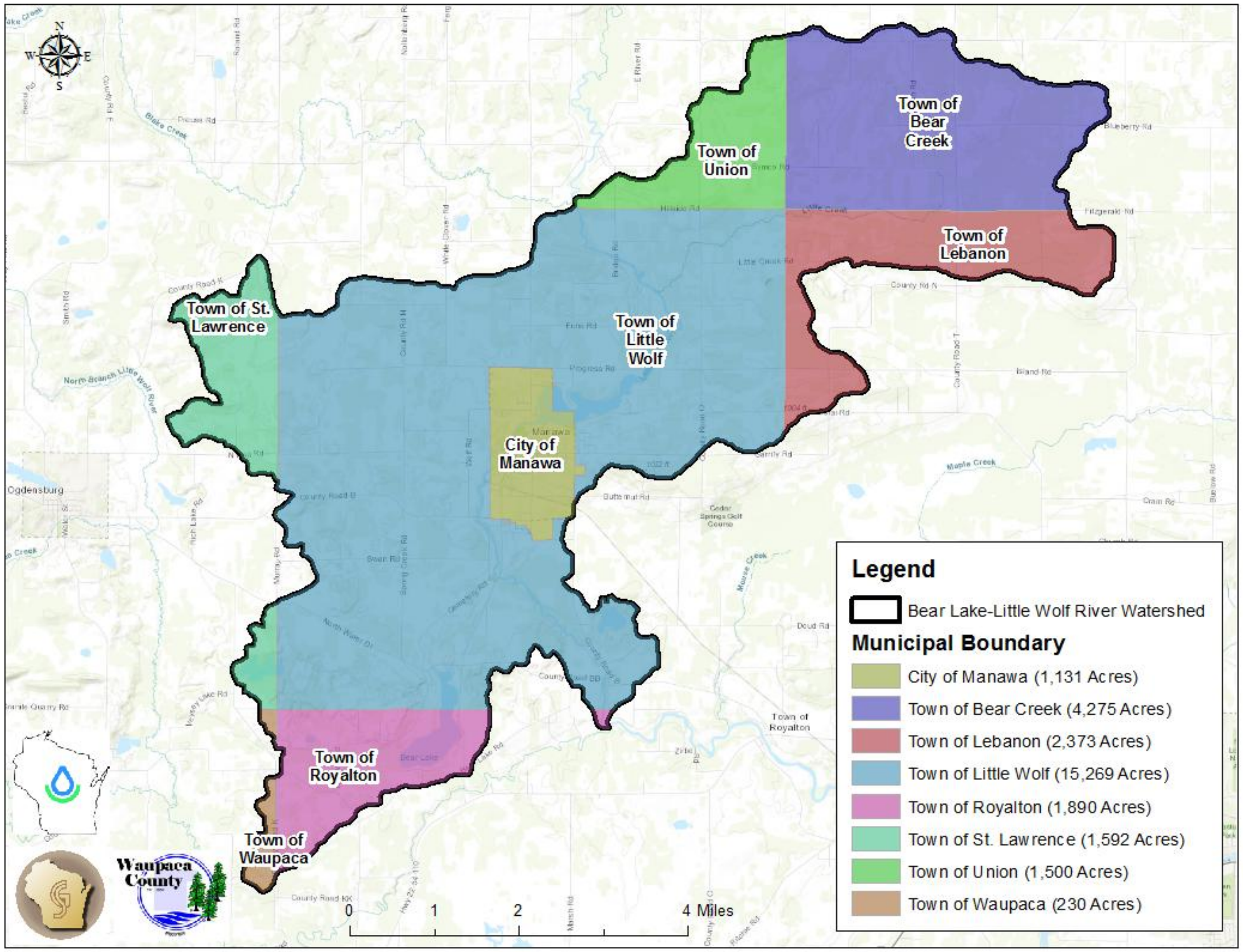

Figure 11. Municipal jurisdictions.

2.9 Jurisdictional Roles and Responsibilities

Natural resources in the United States are protected to some extent under federal, state, and local law. The Clean Water Act is the strongest regulating tool at the national level. In Wisconsin, the Wisconsin Department of Natural Resources has the authority to administer the provisions of the Clean Water Act. The U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers work with the WDNR to protect natural areas, wetlands, and threatened and endangered species. The Safe Drinking Water Act also protects surface and groundwater resources.

Counties and other local municipalities in the watershed area have already established ordinances regulating land development and protecting surface waters. All municipalities have ordinances relating to Shoreland and Wetland Zoning, Erosion Control, and Stormwater. Municipalities have to meet the minimum requirements of County ordinances; however, they have the ability to adopt higher levels of protection. In addition to urbanization-level regulations Waupaca County has the implementation of the Working Lands Initiative program to provide additional watershed protection above and beyond existing ordinances under local municipal codes.

Other governmental and private entities with watershed jurisdictional or technical advisory roles include: Natural Resources Conservation Service, Department of Agriculture, Trade, and Consumer Protection, East Central Wisconsin Regional Planning Commission, and Department of Transportation.

2.10 Population and Economic Demographics

The Bear Creek- Little Wolf Creek Watershed is rural and has a very low population. The City of Manawa, located entirely in the watershed, is the most populated area in the watershed with an estimated population of 1,332. The majority of the population in the watershed area is employed in agriculture, manufacturing, health services and construction. The median household income of the townships within the watershed ranges from $49,635 to $62,727.

Table 4. Population and median household income (US Census Bureau).

Jurisdiction	**Population**	**Income ($)**
Municipality		
Town of Little Wolf	1,358	55,147
Town of Lebanon	1,655	61,935
Town of Royalton	1,428	55,278
Town of Waupaca	1,111	62,727
Town of St. Lawrence	808	52,794
Town of Union	880	54,861
Town of Bear Creek	765	60,104
City of Manawa	1,332	49,635
County		
Waupaca	52,125	51,994

3.0 Hydrology and Water Quality Characterization

3.1 Hydrology

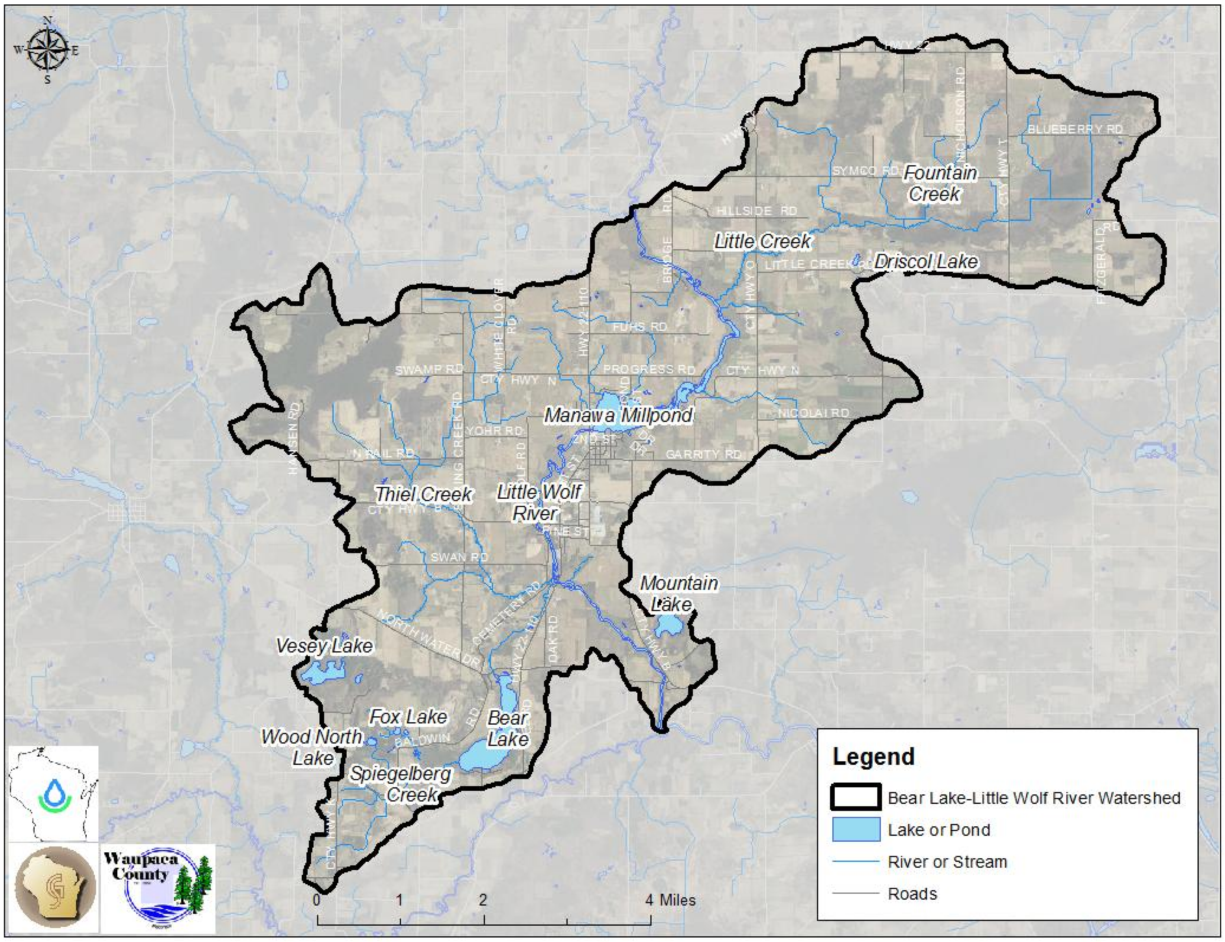

Figure 12. Surface waters in Bear Lake-Little Wolf River Watershed (WDNR 24K Hydrology).

<u>Surface Waters</u>

Rivers and Streams

The Little Wolf River enters the watershed north of the City of Manawa and winds southward through Manawa and leaves the watershed near Heinke Drive where the South Branch Little Wolf River empties into the Little Wolf. There are four small tributaries in the watershed Little Creek, Thiel Creek, Fountain Creek, and Spiegelberg Creek.

<u>Thiel Creek:</u> Thiel Creek is a 6.7 mile long creek that flows southward parallel to the Little Wolf River. The creek empties into the Little Wolf River just south of Manawa. The creek is classified as macroinvertebrate, warm headwater, cool-warm Headwater under the state's Natural Community Determinations. Its current use designation is for warm water dependent forage fishery.

Fountain Creek: A 2.26 mile long creek that is a tributary to Little Creek. The creek is classified as a macroinvertebrate, cool-warm headwater under the state's Natural Community Determinations. Its current use designation is for Fish and Aquatic Life.

Little Creek: A 5.89 mile creek that starts in the northeast part of the watershed and flows eastward toward the Little Wolf River. The creek is classified as a macroinvertebrate, cool-warm headwater under the state's Natural Community Determination. Its current use designation is for warm water dependent forage fishery.

Spiegelberg Creek: A 4.65 mile creek that starts in the most south east corner of the watershed that flows northeast through Bear Lake meeting up with the Little Wolf River south of Manawa. Spiegelberg Creek is classified as a warm headwater, cool-warm headwater under the state's Natural Community Determinations. Its current use designation is for warm water dependent forage fishery.

Tributaries and streams in the Bear Lake-Little Wolf River Watershed have been significantly altered from their natural state. Ditching and straightening of streams is evident throughout the watershed. Straightening of streams increases velocity of water which can lead to increased bed scour and bank erosion. Straightening of streams and ditching also results in loss of habitat, increased flooding downstream and a decrease in water quality.

Lakes

There are several lakes in the Bear Lake- Little Wolf River Watershed ranging from 4 acres in size to 200 acres in size. Lakes located in this watershed include Vesey Lake, Fox Lake, Wood North Lake, Bear Lake, Driscol Lake, Mountain Lake and Manawa Millpond. The WDNR classifies lakes into four categories: Seepage, Drainage, Spring and Drained. Descriptions of the four categories can be found in Appendix A.

Bear Lake: Bear Lake is the largest lake in the watershed at 200 acres. The maximum depth of the lake is 62 ft and the mean depth is 24 ft. Bear Lake is a drainage lake with Spiegelberg Creek as its inlet and outlet. The bottom of the lake is comprised of 15% Sand and 85% Muck. The lake's trophic status is mesotrophic.

Manawa Mill Pond: The Manawa Mill Pond is the second largest lake at 180 acres. The maximum depth is 12 ft with a mean depth of 6 feet. Manawa Mill Pond is drainage lake with the Little Wolf River as its inlet and outlet. The bottom of the lake is comprised of 60% sand and 40 % muck. The lake has low water clarity and is eutrophic.

Vesey Lake: Vesey Lake is a 54 acre lake with a maximum depth of 8 ft. It is a seepage lake with a bottom of 40% gravel, 40% sand, and 20% muck.

Fox Lake: Fox Lake is small spring fed 4 acre lake. The maximum depth is 14 feet and the bottom of the lake is 99% muck.

Driscol Lake: Driscol Lake is small 4 acre seepage lake. The maximum depth is 10 ft and the bottom of the lake is 99% muck.

Woodnorth Lake: Woodnorth Lake is a small 5 acre spring fed lake with a maximum depth of 27 feet. Woodnorth Lake is the headwaters of Spiegelberg Creek.

Mountain Lake: Mountain Lake is 42 acre seepage lake with a maximum depth of 7 feet. The bottom of the lake is 85% muck and 15% gravel.

Groundwater

Lake levels and base stream flows are directly related to local ground water supplies in the watershed. The average depth to the water table in the watershed is 0-20 feet in the majority of the watershed. The majority of the bedrock in the watershed is categorized as igneous, metamorphic and volcanic except in the eastern part of the watershed which has shale bedrock. Shale bedrock is very close to impermeable while igneous, metamorphic and volcanic rock is less permeable than carbonates and sandstone, the rock tends to be fractured. The depth to bedrock for the majority of the watershed is 50 to 100 ft from the land surface. The greater the depth to bedrock, the more likely the water table is located above the bedrock layer. The majority of the soils in the watershed are fine textured and have low permeability. Surficial deposits in the watershed include sand and gravel along the Little Wolf River, loam covering the rest of the watershed with some clay deposits in the southeast portions. The Wisconsin DNR's groundwater contamination susceptibility model estimates groundwater susceptibility based on several characteristics such as bedrock type and depth, water table depth, soil characteristics and type of surficial deposits. Figure 13 shows groundwater contamination susceptibility in the watershed. Areas along the Little Wolf River and the areas in northeast and west of the watershed are the most susceptible to groundwater contamination.

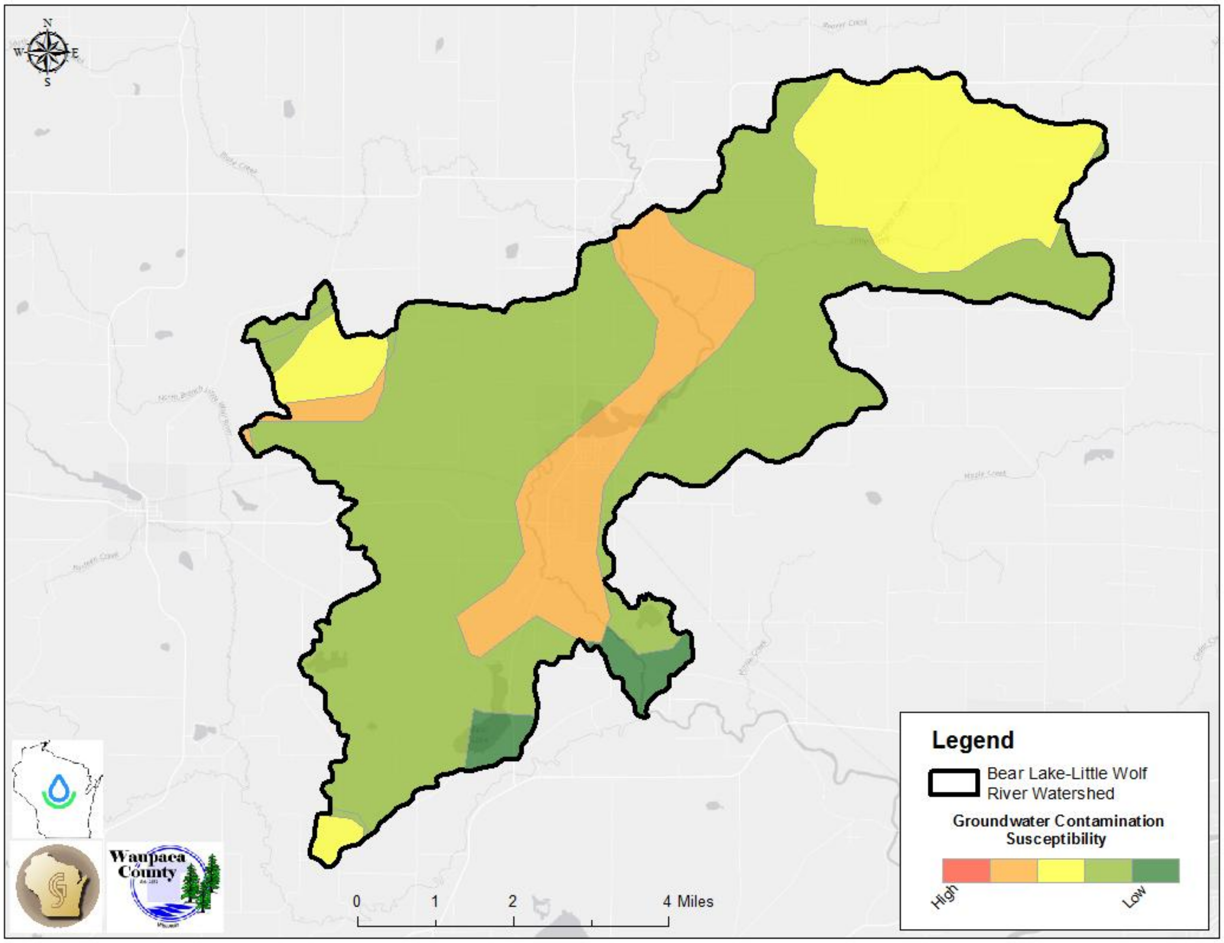

Figure 13. WDNR groundwater contamination susceptibility.

3.2 Water Quality

3.2.1 Point Sources

Point sources of pollution are discharges that come from a pipe or point of discharge that can be attributed to a specific source. In Wisconsin, the Wisconsin Pollutant Discharge Elimination System (WPDES) regulates and enforces water pollution control measures. The WI DNR Bureau of Water Quality issues the permits with oversight of the US EPA. There are four types of WPDES permits: Individual, General, Stormwater, and Agricultural permits.

Individual

Individual permits are issued to municipal and industrial waste water treatment facilities that discharge to surface and/or groundwater. WPDES permits include limits that are consistent with the approved TMDL Waste Load Allocations. There is one municipal WPDES permit holder, Manawa Waste Water Treatment Facility, in the watershed. According to the WDNR the average annual phosphorus load from the Manawa Waste Water Treatment Facility is 221 lbs per year.

Agricultural

State and federal laws also require that Concentrated Animal Feeding Operations (CAFO) have water quality protection permits. An animal feeding operation is considered a CAFO if it has 1,000 animal units or more. A smaller animal feeding operation may be designated a CAFO by the DNR if it discharges pollutants to a navigable waters or groundwater. There are currently no permitted CAFO's in the watershed area. Permits for CAFO's require that the production area has zero discharge.

General/Storm Water

To meet the requirements of the federal Clean Water Act, the DNR developed a state Storm Water Permits Program under Wisconsin Administrative Coded NR 216. A Municipal Separate Storm Sewer System (MS4) permit is required for a municipality that is either located within a federally designated urbanized area, has a population of 10,000 or more, or the DNR designates the municipality for permit coverage. A MS4 permit is also required for certain counties if they have a population greater than 100,000. Municipal permits require storm water management programs to reduce polluted storm water runoff. The general permit requires an MS4 holder to develop, maintain, and implement storm water management programs to prevent pollutants from the MS4 from entering state waters. Waupaca County is under the population limit for a general permit and has no municipal MS4's either.

3.2.2 Nonpoint Sources

The majority of pollutants in the Bear Lake-Little Wolf River watershed come from nonpoint sources. A nonpoint source cannot be traced back to a point of discharge. Runoff from agricultural and urban areas is an example of nonpoint source. Agriculture is the dominant land use in the watershed and accounts for approximately 78% of the total phosphorus loading and 86% of the total suspended sediment loading. Nonpoint sources in the watershed include:

- Erosion/Runoff from agricultural lands
- Tile drainage
- Fertilizer/Manure Application
- Erosion from stream banks and construction sites
- Runoff from lawns and impervious surfaces
- Failing Septic Systems
- Pet/animal waste

In 2010, new state regulations in Wisconsin went into effect that restricts the use, sale, and display of turf fertilizer that is labeled as containing phosphorus or available phosphorus (Wis.Stats.94.643). The law states that turf fertilizer that is labeled containing phosphorus or available phosphate cannot be applied to residential properties, golf courses, or publicly owned land that is planted in closely mowed or managed grass. The exceptions to the rule are as follows:

- Fertilizer that is labeled as containing phosphorus or available phosphate can be used for new lawns during the growing season in which the grass is established.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be used if the soil is deficient in phosphorus, as shown by a soil test performed no more than 36 months before the fertilizer is applied. The soil test must be done by a soil testing laboratory.
- Fertilizer that is labeled as containing phosphorus or available phosphate can be applied to pastures, land used to grow grass for sod or any other land used for agricultural production.

Wisconsin also has state standards pertaining to agricultural runoff. Wisconsin State Standards, Chapter NR 151 subchapter II describes Agricultural Performance Standards and Prohibitions. This chapter describes regulations relating to phosphorus index, manure storage & management, nutrient management, soil erosion, tillage setback as well as implementation and enforcement procedures for the regulations.

3.3 Precipitation- Runoff Budget

The STEPL V4.4[4] (Spreadsheet Tool for Estimating Pollutant Loads) model was used to estimate runoff and infiltration for the watershed. The model uses local climate data, land uses and soil types to model runoff and pollutant loads in a watershed. The STEPL inputs for Waupaca County were an annual rainfall of 31 inches per year and 117 rain days with an average rain event of 0.561 inches. The STEPL model uses rain correction factors based on the local weather station that is selected. Correction factors used were Rainfall Correction Factor (the percentage of events that exceed 5mm per event): 0.837 and Rain Day Correction Factor (percentage of events that generate runoff): 0.397. The STEPL model also accounts for irrigation, but irrigation is not used in the watershed area. It is estimated that 19 % of the crop fields are tile drained in this watershed (Figure 29) which is not accounted for in the calculation of runoff and infiltration in STEPL. Annual runoff and infiltration by land use is shown in Table 5 & 6.

[4] More information on STEPL can be found at http://it.tetratech-ffx.com/steplweb/default.htm.

Table 5. STEPL modeled annual runoff by land use/cover.

Land Use	Urban	Cropland	Pastureland	Natural Background	Total Runoff
Annual Runoff (ac-ft)	2,522.4	5,835.6	130.3	3,560.5	12,048.9

Table 6. STEPL modeled annual infiltration by land use/cover.

Land Use	Urban	Cropland	Pastureland	Natural Background
Annual Infiltration (ac-ft)	324.9	4,607.1	93.7	3,353.4

There is a USGS gage station located just south of the watershed on the Little Wolf River in the Town of Royalton, WI (Figure 14). This site has been collecting discharge data since 1915 to present. Table 7 shows annual average discharge in cubic feet per second at the gauging station from 2009 to 2016 and Figure 15 shows monthly average discharge values from 2009-2016. On average the amount of discharge is the highest in the months of March and April. The average runoff volume at the site from 1914-2016 is .807 cubic feet per second from each square mile drained (CFSM) and 1.11(CFSM) in 2016. This calculation assumes the runoff is evenly distributed uniformly in time and area. The annual runoff in inches (the depth to which the drainage area would be covered if all of the runoff for a given time period were uniformly distributed on it) from 1914-2016 was 11 inches and 15.1 inches in 2016.

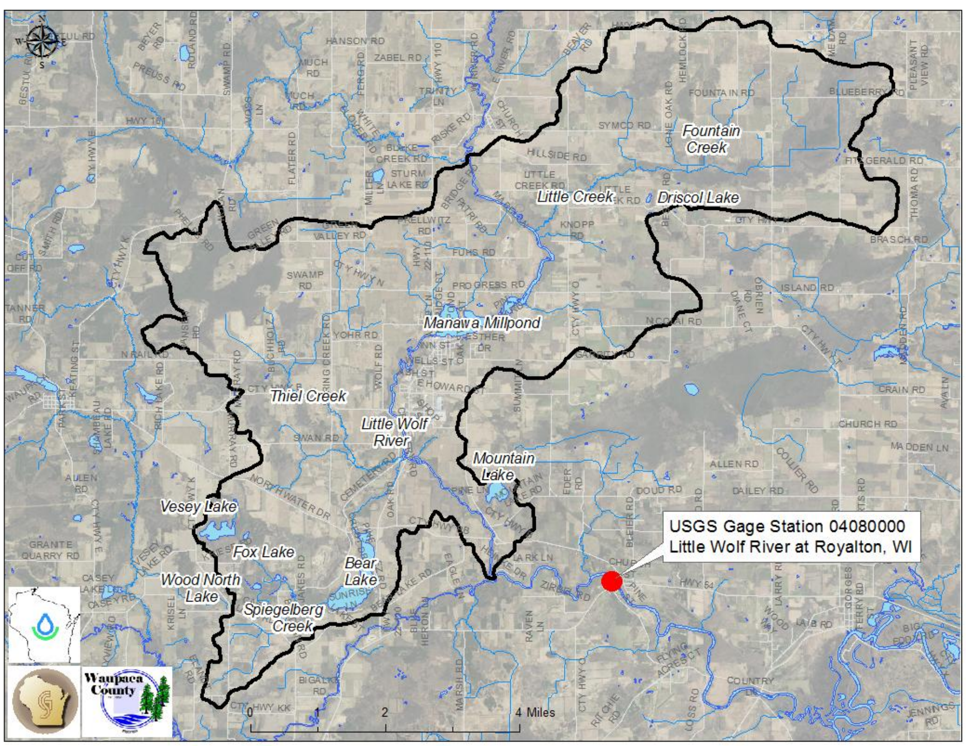

Figure 14. USGS gage station 04080000 Little Wolf River at Royalton, WI.

Table 7. Annual average discharge from 2009 -2016 at USGS Gage Station 04080000 Little Wolf River @ Royalton, WI.

Year	Discharge (cfs)
2009	275.1
2010	413.1
2011	604
2012	377.8
2013	398.7
2014	449.7
2015	405.3
2016	561.7

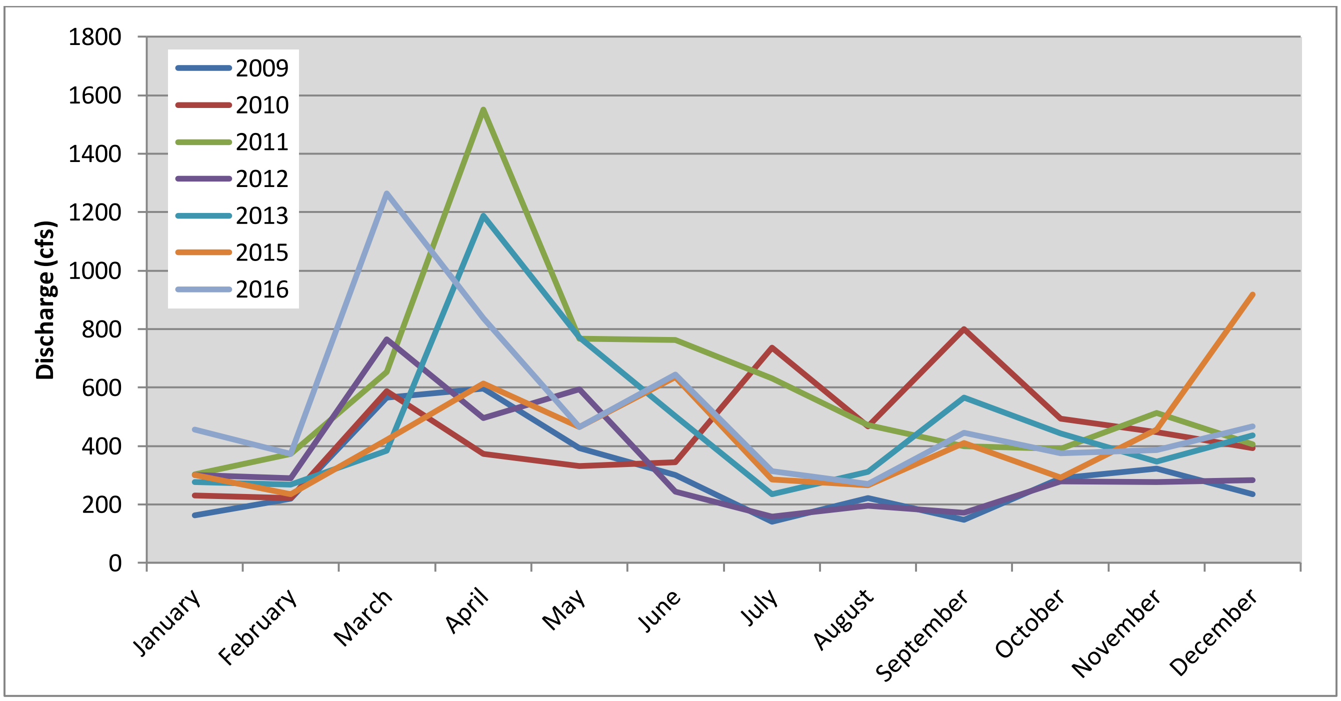

Figure 15. Monthly average discharge from 2009 -2016 at USGS Gage Station 04080000 Little Wolf River @ Royalton, WI.

3.4 Water Quality Monitoring

The Bear Lake- Little Wolf River Watershed was recently evaluated for water quality conditions by the DNR in 2015 as part of their Targeted Watershed Approach Monitoring[5] program. The study was done to see if there had been water quality improvements from the Best Management Practices implemented from 1997 to 2008 as part of the priority watershed program. Seven creek and river locations in the watershed were sampled for macroinvertebrate and fish biotic integrity indices, nitrogen, phosphorus, and sediment. Locations of sample sites are shown in Figure 16.

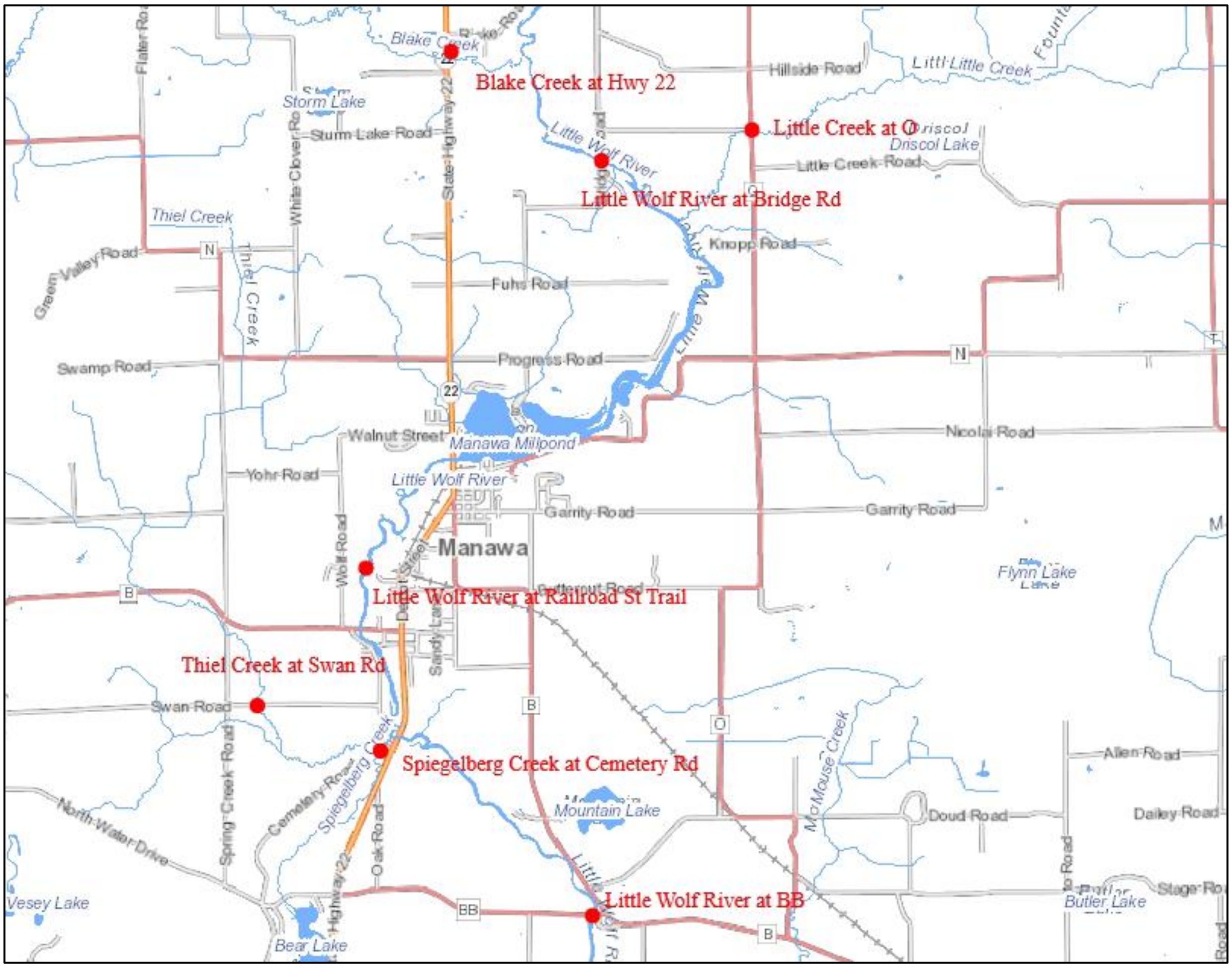

Figure 16. Water quality sampling locations in 2015 (WDNR).

[5] For more information on WDNR Targeted Watershed Approach go to http://dnr.wi.gov/topic/surfacewater/monitoring/twa.html .

Total phosphorus concentrations exceeded the water quality criteria threshold of 0.075 mg/l for all months sampled at Thiel Creek at Swan Rd and Little Creek at HWY O in 2015(Figure 17). All three sampling sites on the Little Wolf River exceeded the total phosphorus criteria in the month of June. Spiegelberg Creek was the only sample site that did not exceed the TP water quality criteria in 2015. Wisconsin does not currently have a water quality standard for Total Suspended Sediment; however, this data provides useful information about the watershed and background information for future comparison. The WDNR uses this data as additional support for adding these systems to the CWA 303d list for habitat degradation. TSS concentrations for 2015 are shown in Figure 18.

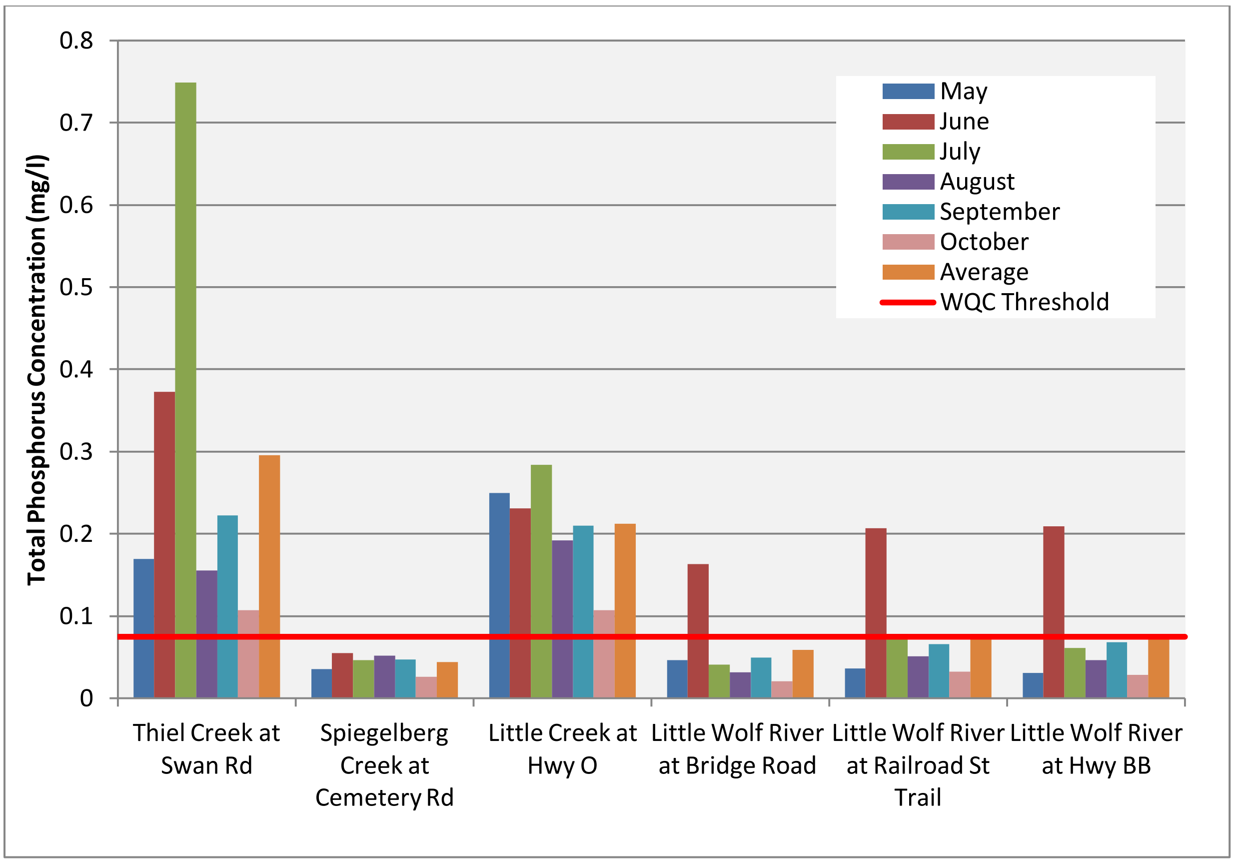

Figure 17. Total Phosphorus concentrations (mg/l) at sample sites in Bear Lake-Little Wolf River Sample Sites (2015).

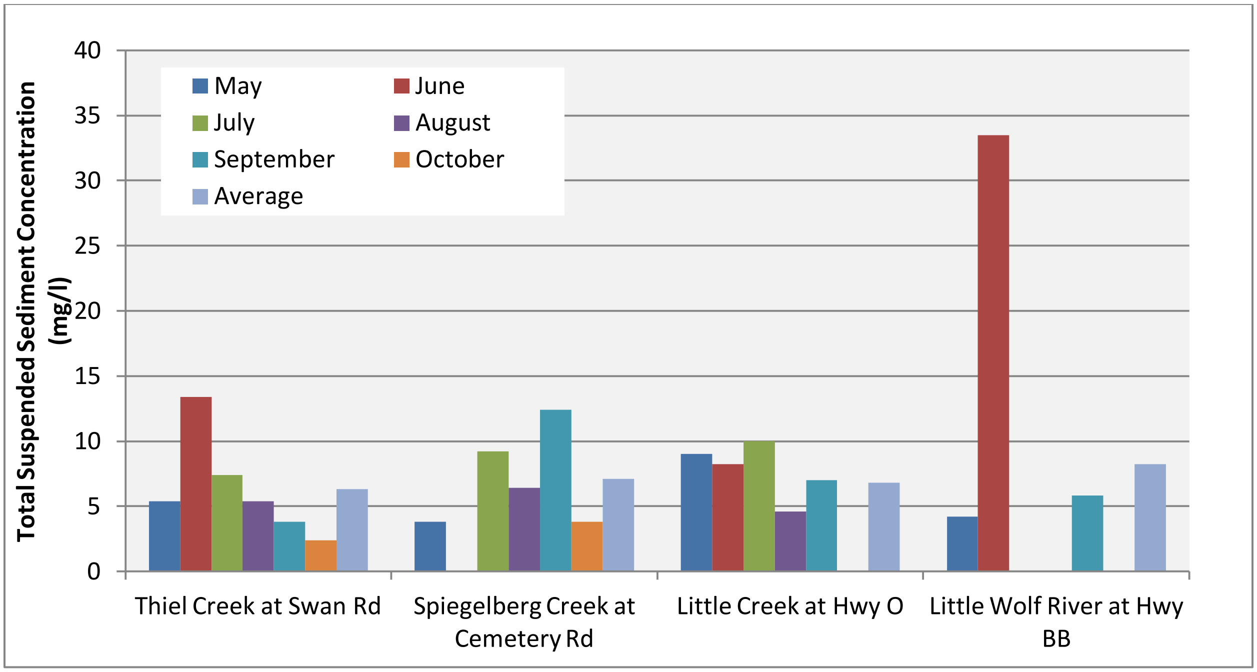

Figure 18. Total Suspended Sediment concentrations (mg/l) at sample sites in Bear Lake-Little Wolf River Sample Sites (2015).

The WDNR identifies the attainment of Fish and Aquatic Life uses for a given stream by reviewing the type, number, and presence of aquatic macroinvertebrate species and fish species. All of the sample sites sampled for Macroinvertebrate IBI were ranked fair to excellent (Table 8). The sample sites at Thiel Creek at Swan Rd. and Little Creek at HWY O were rated poor for Fish IBI (Table 9). Spiegelberg creek was rated fair and the Little Wolf River was rated excellent for Fish IBI.

Table 8. Macroinvertebrate Index of Biotic Integrity at sample sites in Bear Lake- Little Wolf River Watershed (2015).

SWIMS Station ID	Stream Name and Location	Macroinvertebrate IBI Score	Condition Category
693141	Little Wolf River at Cth BB	8.3	Excellent
693143	Thiel Creek at Swan Rd	4.83	Fair
693142	Spiegelberg Creek at Cemetery Rd	6.13	Good
693145	Little Creek at Cth O	3.63	Fair

Table 9. Fish Index of Biotic Integrity at sample sites in Bear Lake-Little Wolf River Watershed (2015).

SWIMS Station ID	Site Name	Fish IBI Score	Condition Category	Natural Community
693141	Little Wolf River at Cth BB	90	Excellent	Cool-Warm Mainstem
693143	Thiel Creek at Swan Rd	20	Poor	Cool-Warm Mainstem
693142	Spiegelberg Creek at Sh22 Wayside and Cemetery Rd	30	Fair	Cool-Warm Mainstem
693145	Little Creek at Cth O	20	Poor	Cool-Warm Mainstem

Water quality sampling was also conducted during the summer of 2017 by the WDNR as a continuation of the Targeted Watershed Assessment program at several locations during the development of the watershed plan. Samples collected were analyzed for total suspended solids and total phosphorus. Results from the water quality sampling are shown in Table 10. Sample site locations are shown below in Figure 19. All samples collected at Little Creek and Thiel Creek in 2017 exceeded total phosphorus criteria of 0.075 mg/l for all months sampled. Five out of six samples taken at Fountain Creek, which is a tributary to Little Creek, also exceeded total phosphorus criteria.

Table 10. WDNR Total Phosphorus and Total Suspended Sediment water quality data for 2017.

Location	May A TP (mg/l)	May B TP (mg/l)	June A TP (mg/l)	June B TP (mg/l)	July TP (mg/l)	October TP (mg/l)	May A TSS (mg/l)	May B TSS (mg/l)	June A TSS (mg/l)	June B TSS (mg/l)	July TSS (mg/l)	October TSS (mg/l)
Fountain Creek at Symco Road	0.0458	0.0926	0.236	0.188	0.516	0.0912	ND	ND	11	10.8	109	ND
Little Creek at Cattle Crossing 3200m US County O	0.0984	0.113	0.386	0.364	0.358	0.165	ND	ND	ND	5.14	ND	ND
Little Creek at County O	0.117	0.126	0.288	0.24	0.327	0.173	7.25	8	7	10.5	16.7	5
Thiel Creek at Swan Rd	0.201	0.219	0.27	0.328	0.311	0.274	3	6.5	7.8	7	7.04	4.4
Thiel Creek at North Rail Rd	0.365	0.341	1.04	0.991	2.59	0.478	ND	ND	5.67	4.25	25.1	ND
Thiel Creek at County N	0.357	0.63	0.713	0.974	1	0.746	11.3	ND	4.8	3.00	4.79	ND
Unnamed Trib to Little Wolf River at County O	0.0474	0.0604	0.0441	0.0506	0.0523	0.025	3.75	3.75	5	6	5.14	ND
Unnamed Trib to Little Wolf River at County N	0.447	0.0728	0.135	0.118	0.138	0.0621	2.5	15.3	11	11	7.43	ND
Unnamed Wetland Ditch to Spiegelberg Cr at Cemetery Rd	0.112	0.111	0.143	0.114	0.161	0.183	3.75	2.5	3.2	3.75	3.94	7.4

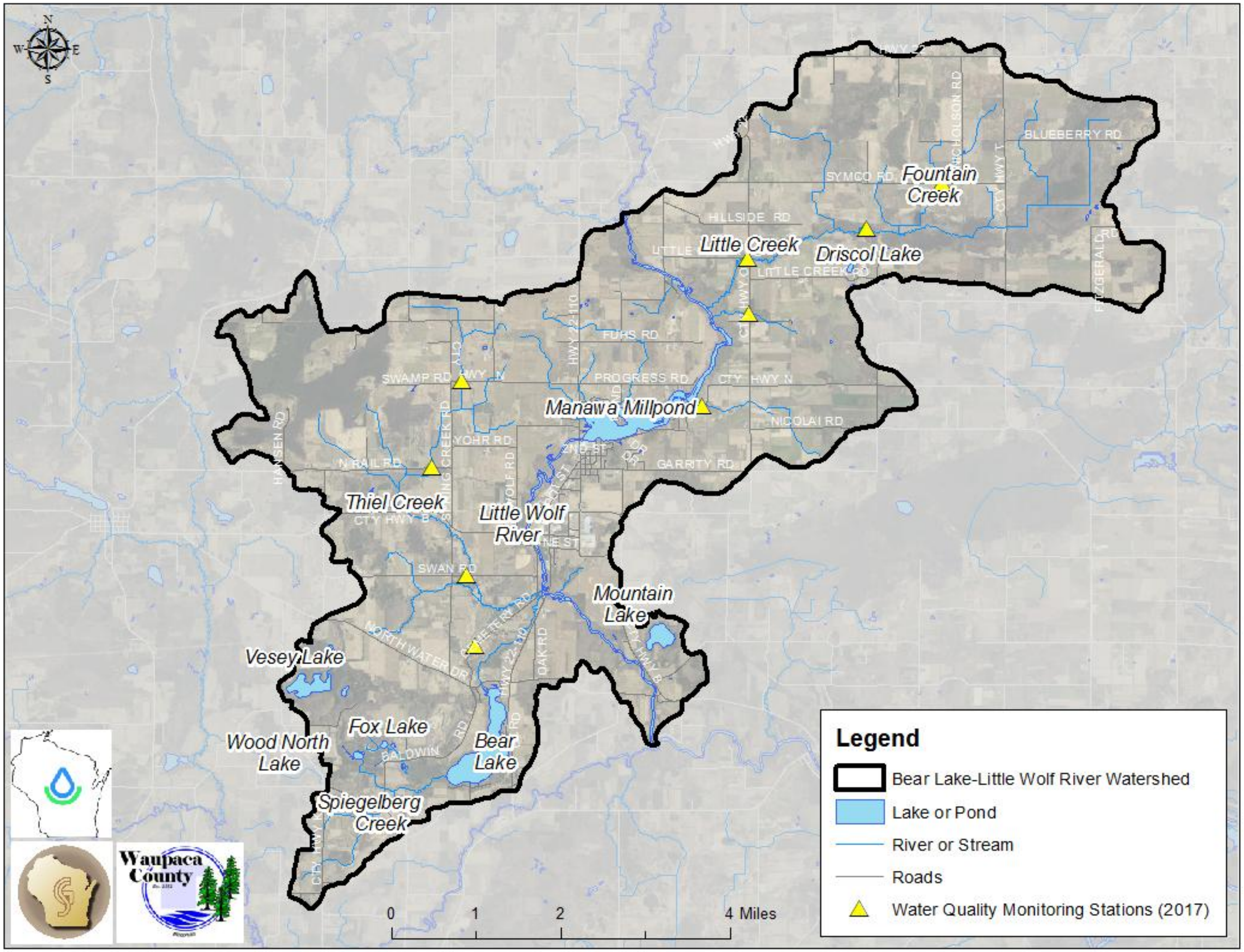

Figure 19. WDNR TWA monitoring locations in 2017.

Lake Water Quality

Water quality of Bear Lake is monitored by the WDNR through their volunteer monitoring program. Volunteers monitor water clarity with a black and white secchi disk. Secchi disk data is used to determine trophic status of a lake. According to the WDNR, Bear Lake's average summer trophic state for the last 5 years was 43 (Mesotrophic), which is considered excellent for a deep lowland lake. WDNR also uses satellite water clarity observation data in monitoring lake quality. The average summer trophic state for the last 5 years for Manawa Millpond was 54 (Eutrophic) based on satellite water clarity data. WDNR considers this good for an impounded flowing water lake.

3.5 Impaired Waters

The federal Clean Water Act requires states to adopt water quality criteria that the EPA publishes under 304 (a) of the Clean Water Act, modify 304 (a) criteria to reflect site-specific conditions, or adopt criteria based on other scientifically defensible methods. Water quality standards require assigning a designated use to the water body. A 303 (d) list is comprised of waters impaired or threatened by a pollutant, and needing a TMDL. States submit a separate 303 (b) report on conditions of all waters. EPA recommends that the states combine the threatened and impaired waters list, 303(d) report, with the 303(b) report to create an "integrated report". Thiel Creek and Little Creek have been proposed for the 2018 impaired waters list based on 2017 water quality data showing high phosphorus concentrations that overwhelmingly exceed the Wisconsin's Consolidated Assessment and Listing Methodology(WisCALM)[6] criteria for Fish and Aquatic Life use (Figure 20). Biological impairment was also observed in Little Creek.

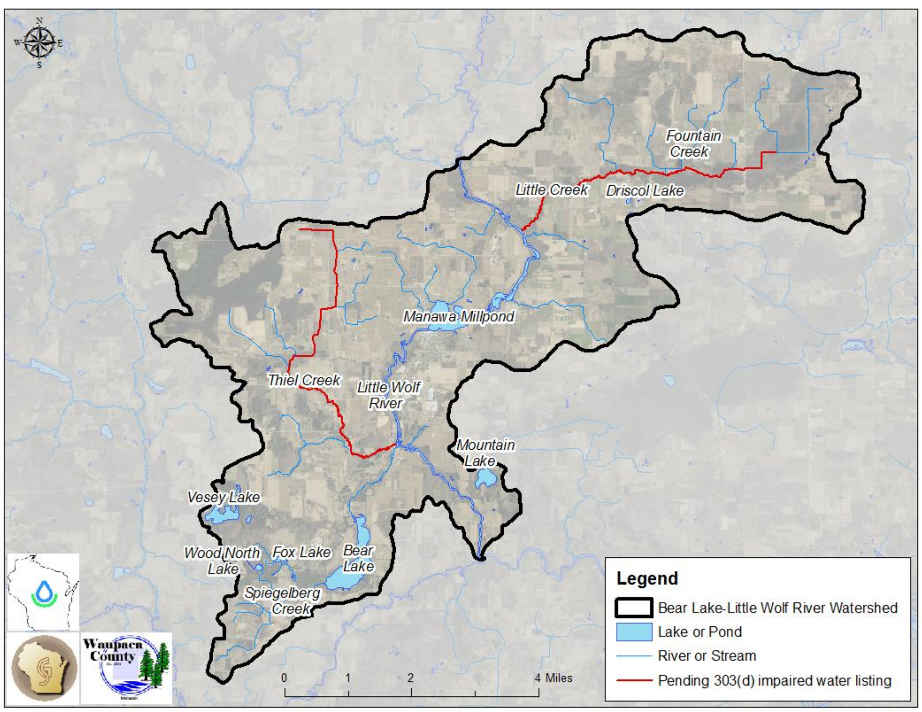

Figure 20. Proposed 303 (d) impaired water listing.

[6] Additional information on WDNR WisCALM criteria can be accessed at http://dnr.wi.gov/topic/surfacewater/assessments.html .

4.0 Resource Analysis/Source Assessment

4.1 Pollutant Load Model

To characterize the loading from agriculture, natural background, and urban land use based on current conditions in the Bear Lake-Little Wolf River Watershed, the STEPL V4.4 model was used. STEPL (Spreadsheet Tool for Estimating Pollutant Load) is a watershed model that calculates nutrient loads based on land use, soil type, and agricultural animal concentrations. Baseline condition inputs for the STEPL model can be found in Appendix B. The NRCS BARNY model was also used to estimate phosphorus loading from barnyards in the watershed. Point source data was obtained from the WDNR.

The Bear Lake-Little Wolf River Watershed contributes an estimated 14,867 lbs of phosphorus and 2,323 tons of sediment to the Little Wolf River per year. Agriculture including pasture land, gully erosion, and barnyards contributes 78% of the phosphorus loading and 86% of the sediment loading in the Bear Lake-Little Wolf River Watershed.

Table 11. Pollutant load estimates.

Sources	P Load (lb/yr)	Sediment Load (t/yr)
Urban	1,983	297
Cropland	10,455	1,717
Pastureland	121	12
Natural Background	1,007	32
Feedlots	941	NA
Gully	139	265
Point Sources(Manawa WWTF)	221	NA
Total	**14,867**	**2,323**

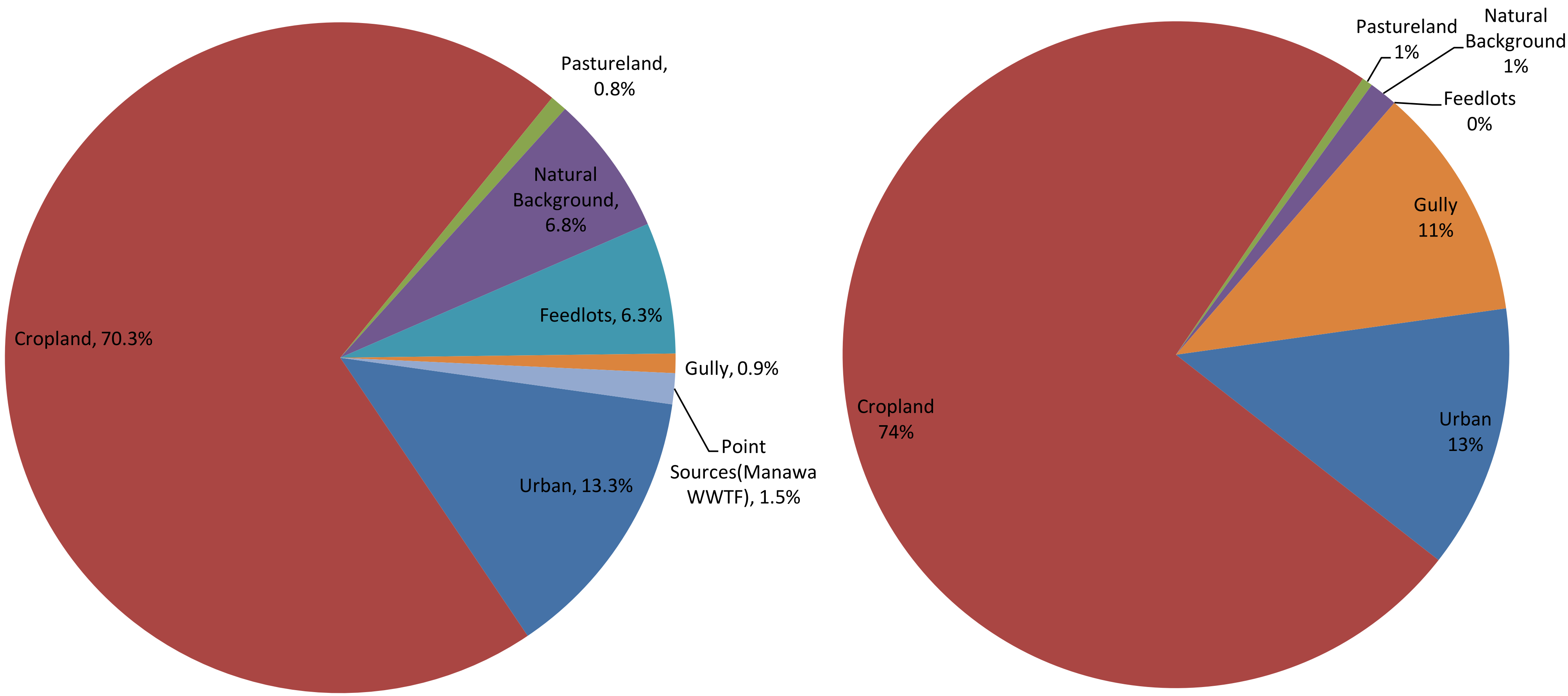

Figure 21. Total Phosphorus (left) and Total Sediment Load (right) to Little Wolf River.

4.2 Watershed Inventory/Source Assessment

4.2.1 Barnyard Inventory

Location and data on current livestock operations was compiled through existing NRCS and Waupaca County LWCD data, air photo interpretation, land owner contacts and windshield surveys. There are a total of 46 active livestock operations with an estimated 5,000 animal units (AU) including dairy and beef farms. Locations of livestock operations in the watershed are shown in Figure 22. There were 8 farms identified as high priority and 12 farms identified as medium priority for needing conservation practices such as barnyard runoff management or waste management practices. The NRCS BARNY model was used to estimate phosphorus loading from livestock facilities in the watershed area. It is estimated that livestock facilities contribute 941 lbs P/year to the Lower Wolf River which is about 6% of the total phosphorus load. Many of these sites can reduce their load with low cost practices such as fencing, vegetative filter strips, and critical area plantings. Several of the high priority sites will require more expensive barnyard runoff management systems and waste storage to reduce their phosphorus load.

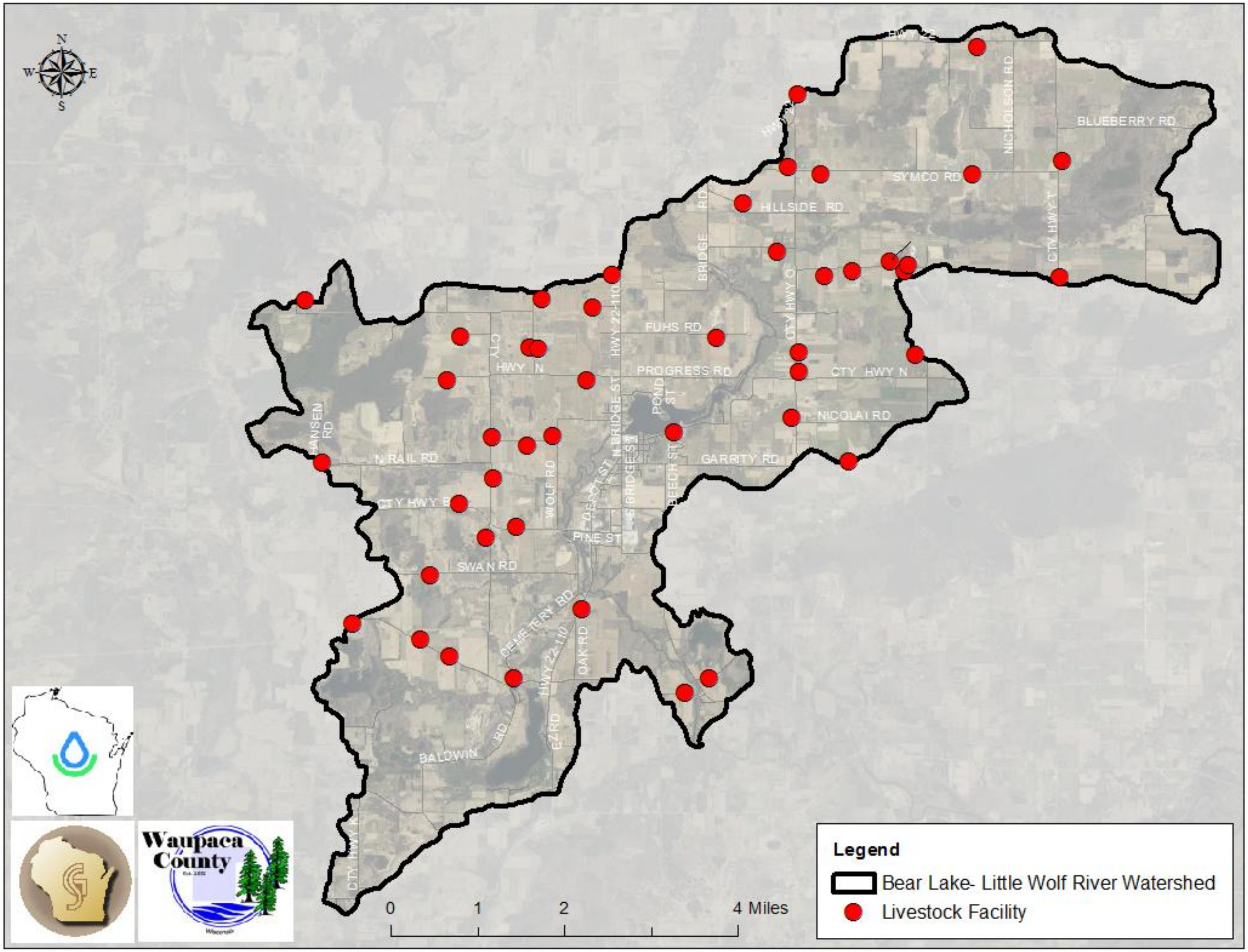

Figure 22. Livestock facilities in Bear Lake-Little Wolf River Watershed.

4.2.2 Streambank Inventory

Several locations at road crossings of the tributary streams in the watershed were visited and walked to see if there was significant streambank erosion occurring. There were some areas of slight erosion but streambanks appeared to be stable at all the sites visited. Based on site visits streambank erosion is not a significant source of sediment and nutrients in this watershed.

Figure 23. Spiegelberg Creek upstream of Cemetery Rd.

4.2.3 Upland Inventory

Agricultural land was inventoried and analyzed to determine current tillage practices, identify priority locations for best management practice, and to identify the extent of current BMP implementation in the watershed. Agricultural uplands were inventoried by windshield survey, use of GIS data and tools and with aerial photography. The use of the WDNR EVAAL (Erosion Vulnerability Assessment for Agricultural Lands) and USDA-ARS ACPF [7](Agricultural Conservation Planning Framework) toolsets were used to determine priority areas for best management practices in the watershed.

Erosion Vulnerability

The EVAAL (Erosion Vulnerability Analysis for Agricultural Lands) tool was used to determine areas in the watershed that are more prone to sheet, rill, and gully erosion. The tool analyzes the watershed based on precipitation, land cover, crop rotation, soils and elevation data. The resulting outputs of the tool are an Erosion Score, Stream Power Index, and Soil Loss Index. Figure 24 shows the EVAAL erosion score indicating which fields are more susceptible to erosion based on USLE, SPI, and internally draining areas. By running the EVAAL tool twice for the USLE and using the high C-factor for “worst case” and low C-factor for “best case” scenarios, the worst case can be subtracted from the best case which indicates areas with the greatest potential for improvement (Figure 25). The ACPF (Agricultural Conservation Planning Framework) tool also provides a similar output that identifies fields with the highest runoff risk

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[7] Additional information on ACPF can be found at http://northcentralwater.org/acpf/

(Appendix C). These maps are an important tool in indicating which fields are contributing the most sediment and phosphorus in comparison to other fields in the watershed, therefore indicating where best management practices are going to benefit the most in the watershed.

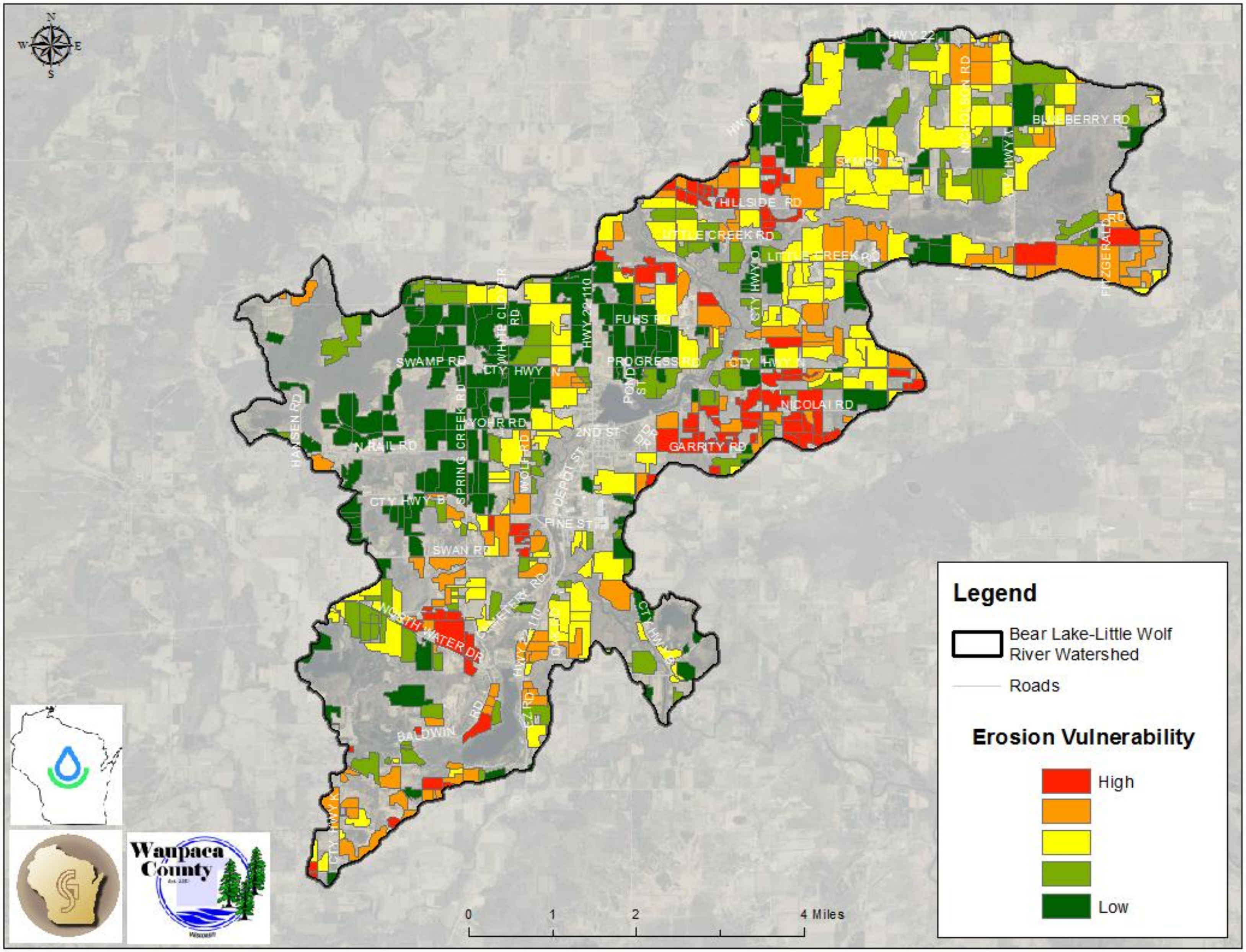

Figure 24. EVAAL erosion score by field.

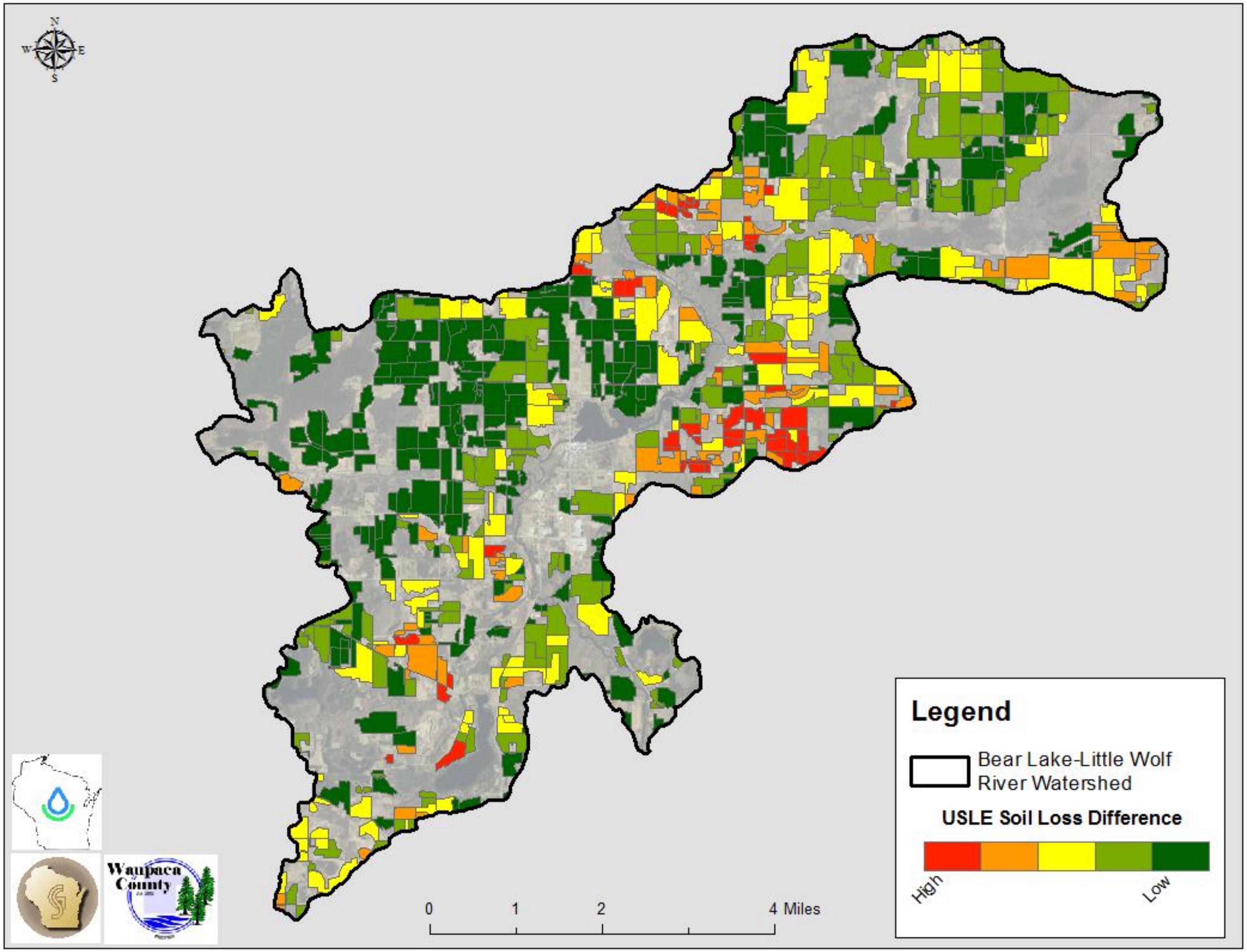

Figure 25. Soil loss difference.

Nutrient Management Planning

Nutrient management plans are conservation plans specific to anyone applying manure or commercial fertilizer. Nutrient management plans address concerns related to soil erosion, manure management, and nutrient applications. Nutrient management plans must meet the standards of the Wisconsin NRCS 590 standard.

Landowners are required to turn in a copy of their nutrient management plans to County Land & Water Conservation departments if they have a manure storage permit, received cost sharing for nutrient management, or if they participate in the Working Lands Initiative program.

Waupaca County tracks nutrient management plans by field using GIS. Nutrient Management Coverage for the watershed is shown in Figure 26. Tracking nutrient management plan coverage by GIS is beneficial in identifying landowners in the watershed that still need nutrient management. Approximately 7,021 acres in the watershed are covered by a nutrient management plan, which is about 50% of the total cropland in the watershed area.

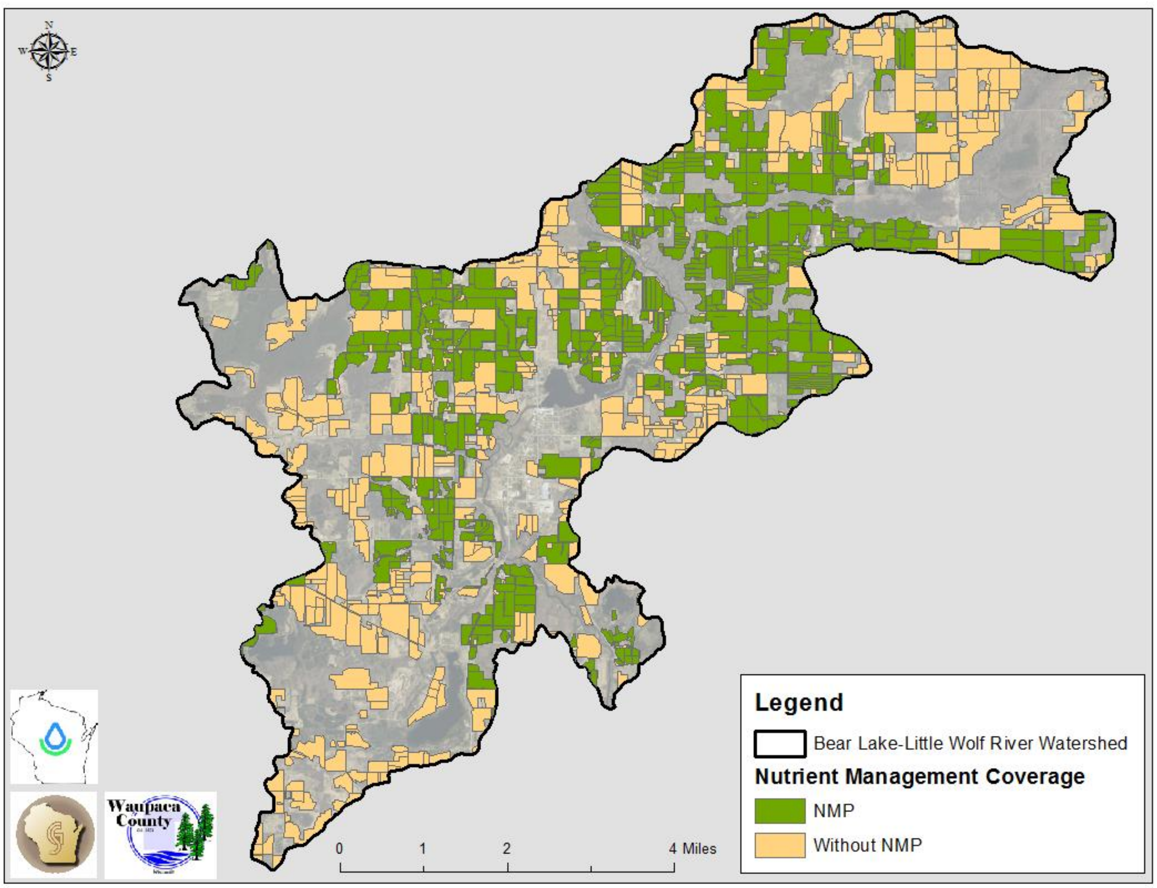

Figure 26. Nutrient management coverage.

Tillage Practices and Residue Management

Crop residue levels and tillage intensity can be analyzed from readily available satellite imagery. Since tillage takes place at different times a series of satellite images were chosen for analysis. Landsat 8 satellite photos from April and November 2016 were used to calculate a minimum Normalized Difference Tillage Index (minNDTI). The NDTI estimates crop residue levels based on shortwave infrared wavelengths. The mean minNDTI values per agricultural field for 2016 are shown in Figure 27. The mean minNDTI can help easily identify fields that would be good candidates for implementation of reduced tillage practices and cover crops. This analysis of imagery can also be used as a way to track implementation of cropping practices as more years of imagery is collected, since satellites regularly circle the earth. Field verification of crop residue levels can be correlated to the NDTI to more accurately correlate NDTI values to tillage intensity in the watershed.

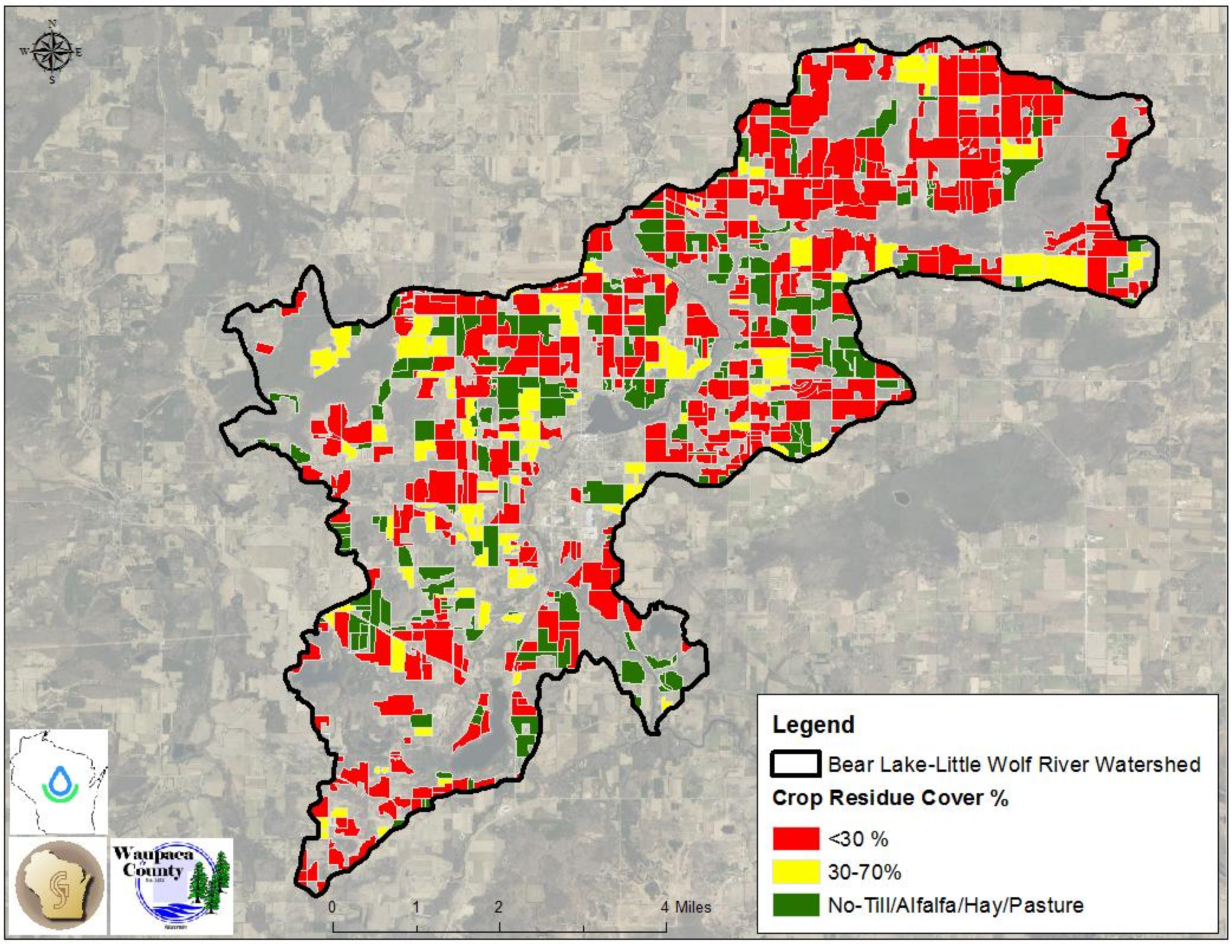

Figure 27. Crop residue cover estimates based on Normalized Difference Tillage Index (April 2016 & November 2016).

Grazing/Pastureland Management

Land used for pasture was analyzed using recent aerial imagery of the watershed area and using the NASS cropland data layer. Approximately 300 acres (0.6%) in the watershed are currently being used as pasture for livestock. Most of the farmers that do pasture their livestock in the watershed do it for exercise and not as a means of forage with the exception of a few smaller hobby farms with horses and beef cattle. The STEPL model estimated 121 lbs of phosphorus/year and 12 tons of sediment per year can be attributed to the pasture land use category. Encouraging farms to convert cropland or land used for hay to managed grazing land will help in reducing pollutant loads from cropland. Grazing can also benefit farmers financially by saving them money on fuel costs associated with harvesting, planting, and transportation. Better management of current pastureland can reduce pollutant loading as well.

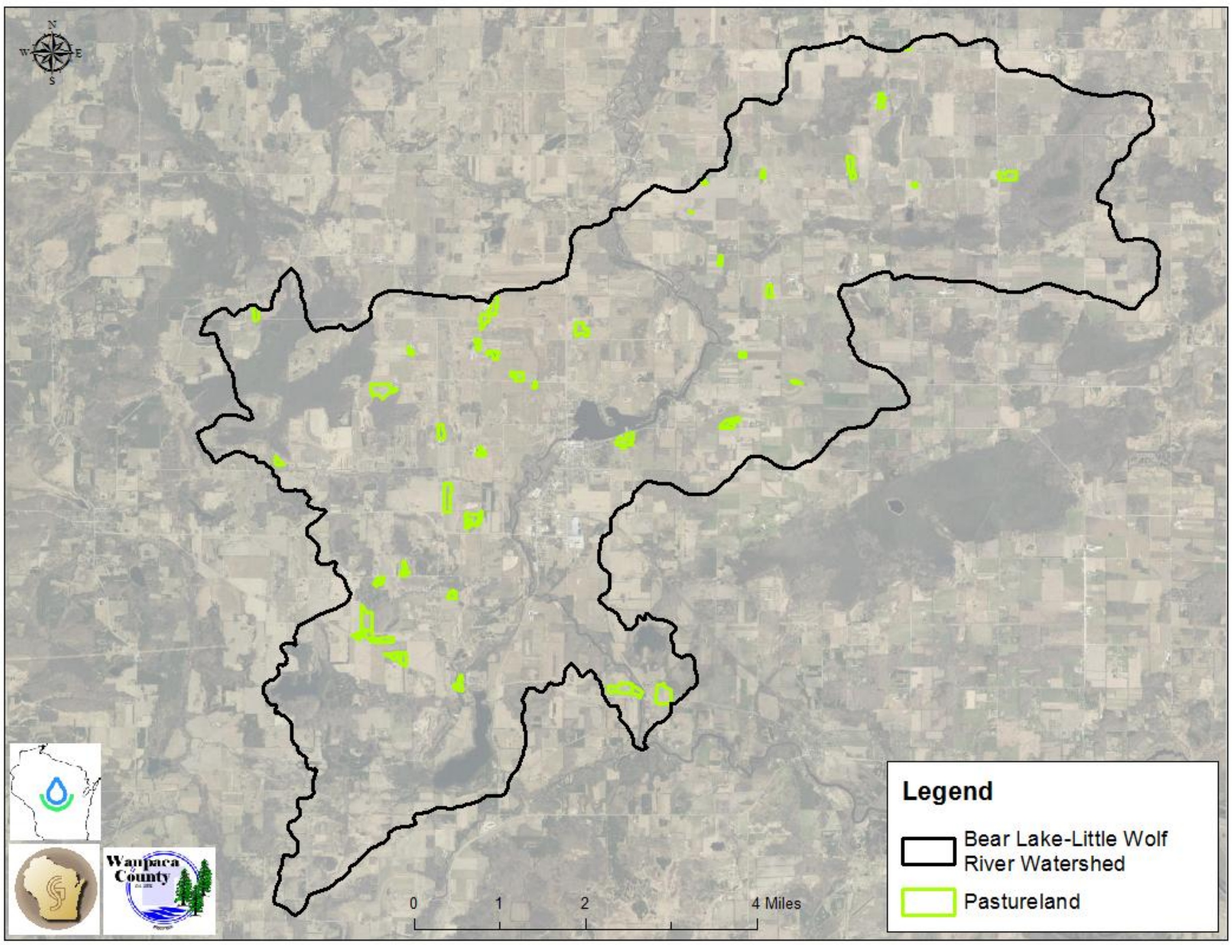

Figure 28. Land used for pasture/grazing.

Tile Drainage

Fields with tile drainage were inventoried by using aerial imagery and then mapped using ArcGIS®. There were 2,640 acres of fields that had visible signs of tile drainage in the watershed area (Figure 29), which is approximately 19% of the cropland in the watershed. Tile drains in fields can act as a conduit for nutrient transport to streams if not managed properly. Fields that are tile drained should be further evaluated in this watershed as potential sources of phosphorus and nitrogen loading that may need tile drainage management practices. Some options for treating tile drainage at the outlet include constructing a treatment wetland, saturated buffers, phosphorus removal structures, and installation of water control structures to stop the flow of drainage water during poor conditions.

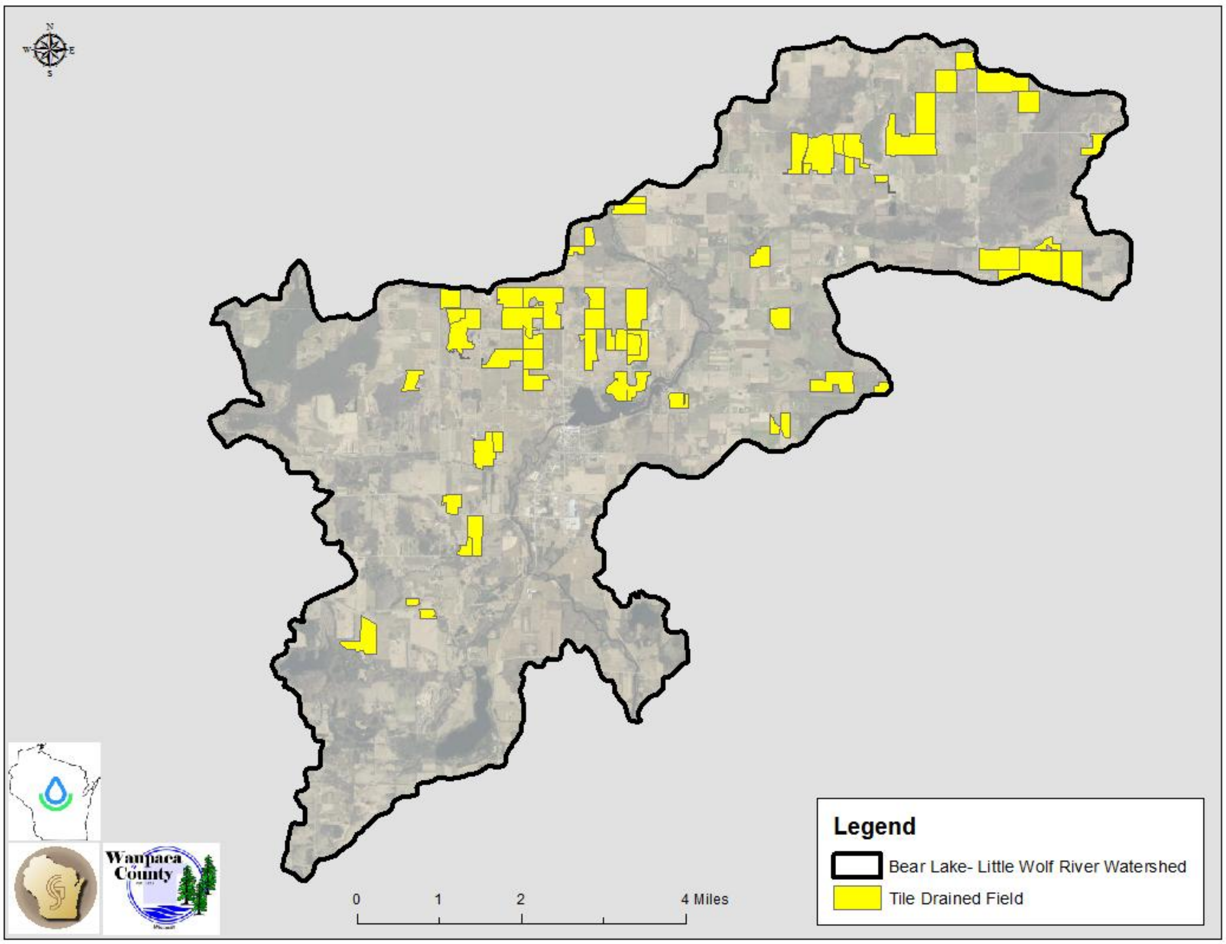

Figure 29. Tile drained fields.

Vegetative Filter Strips

Vegetative filter strips also known as buffers filter out sediment and nutrients from water before reaching a stream channel. Filter strips also reduce the amount of runoff volume, provide wildlife habitat, and help regulate stream temperature. A minimum 35 ft buffer for streams is generally recommended for water quality protection. Priority filter strip areas were determined using aerial photography, the DNR 24K Hydrography data set, and USGS topography maps (Figure 30). Drainage areas to the buffers were determined using ArcHydro[8]. Priority filter strips should be designed to NRCS Standards requiring a minimum 20 ft for sediment and 30 ft for dissolved contaminants that may need to be extended up to a maximum of 120 ft to provide necessary reductions in pollutant loads based on the WI NRCS Technical Standard 393 for filter strips.

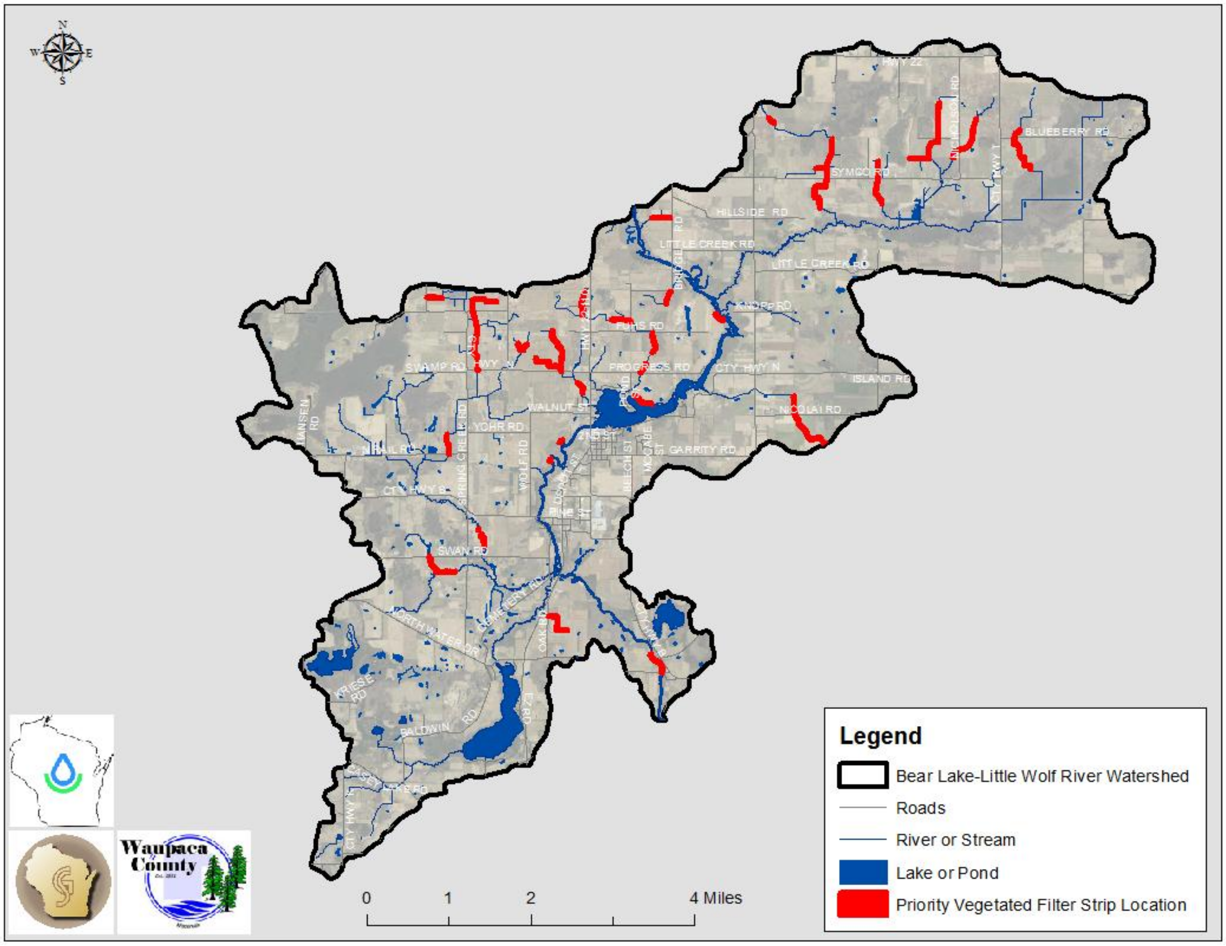

Figure 30. Priority vegetative filter strip locations.

[8] ArcHydro is an ESRI data model complemented by a set of tools that is used to perform advance water resource functions (e.g. watershed delineation and characterization). For more info go to http://www.esri.com/library/fliers/pdfs/archydro.pdf .

Gully and Concentrated Flow Stabilization

Gullies and concentrated flow areas were determined by GIS analysis and by windshield survey. Elevation and flow direction data is used to develop a stream power index (SPI) that can indicate areas of concentrated flows that might be gullies. High stream power values are shown in Figure 31. A high stream power index along with air photo interpretation was used to determine where gully and concentrated flow stabilization practices may be necessary in the watershed.

Recommended gully and concentrated flow stabilization practices include grassed waterways, water and sediment control basins (WASCOB), and critical area plantings. Other practices that may also be used to stabilize gully erosion include lined waterways, grade stabilization, and terraces. A grassed waterway is a shaped or graded channel that is established with vegetation to convey surface water to prevent erosion. Water and sediment control basins usually consist of an earth embankment or a combination ridge and channel generally constructed across the slope and minor water courses to form a sediment trap and water detention basin. The Agricultural Conservation Planning Framework WASCOB tool was used to site areas for Water and Sediment Control Basins. The tool evaluates potential WASCOB locations approximately every 200 ft along flow paths within a drainage range of 2-50 acres (Porter et al. 2015). Concentrated flow areas that have less severe erosion should also be stabilized may not necessarily require a grassed waterway or WASCOB. To stabilize these less severe concentrated flow areas while still promoting productive agricultural practices, these areas should be seeded with permanent cover. Unlike a grassed waterway, crops can still be planted in the concentrated flow area seeding but the area cannot be tilled. Priority areas for gully and concentrated flow stabilization determined by GIS methods and windshield survey are shown in Figure 32.

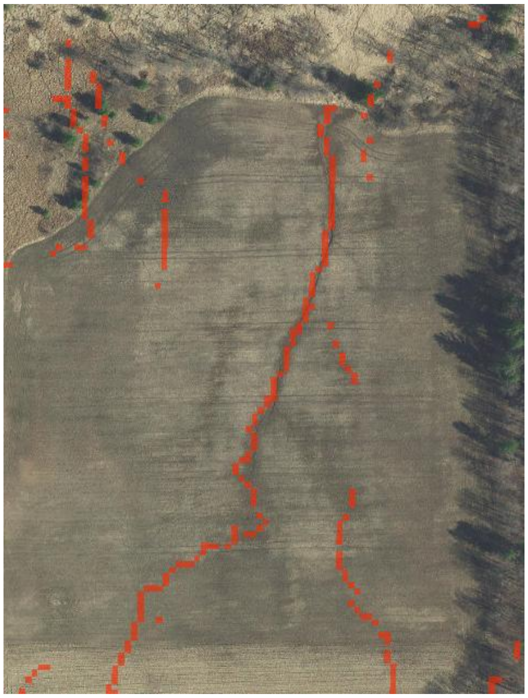

Figure 31. High stream power index indicating potential gully erosion.

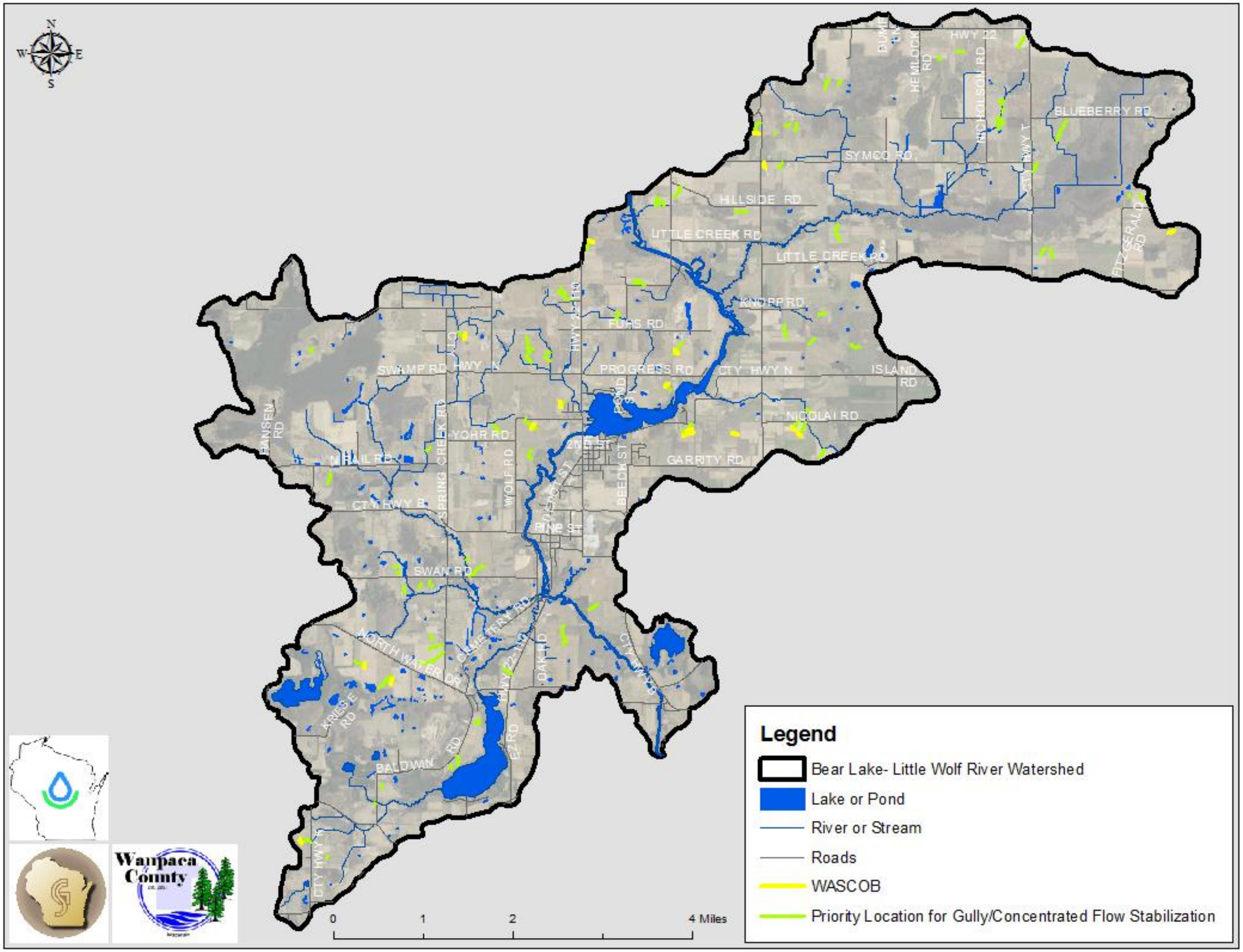

Figure 32. Priority locations for gully and concentrated flow stabilization practices (Water and Sediment Control Basin, Critical Area Plantings, Grassed Waterway, etc).

4.2.4 Wetland Inventory

Wetlands are an important feature of a watershed. Wetlands provide a number of benefits such as water quality improvement, wildlife habitat, and flood control. According to the USEPA a typical one acre wetland can store about 1 million gallons of water (USEPA 2006). Restoring wetlands and constructing designed wetlands in the watershed area will provide water storage and reduce sediment and phosphorus loading. Constructed treatment wetlands can be used to treat water from tile drains, barnyards, upland runoff, and wastewater.

Existing wetland and potentially restorable wetland GIS spatial data was obtained from the Wisconsin Department of Natural Resources (WDNR) and from the US Fish & Wildlife Service National Wetland Inventory (Figure 33). A restorable wetland is any wetland that was historically a wetland but has since been drained due to tiling and ditching or has been filled in. The WDNR considers an area a potentially restorable wetland (PRW) if it meets hydric soil criteria and is not in an urban area. There are 5,028 acres of existing wetlands and 2,724 acres of potentially restorable wetlands in the Bear Lake-Little Wolf River watershed according to the US FWS National Wetland Inventory and WDNR potentially restorable wetland layer. The US EPA has created a potentially restorable wetlands on agricultural lands data set that classifies PRW’s on their restoration potential based on soils, a wetness index and suitable land cover (Figure 34). This data set will be beneficial in prioritizing PRW’s for restoration.

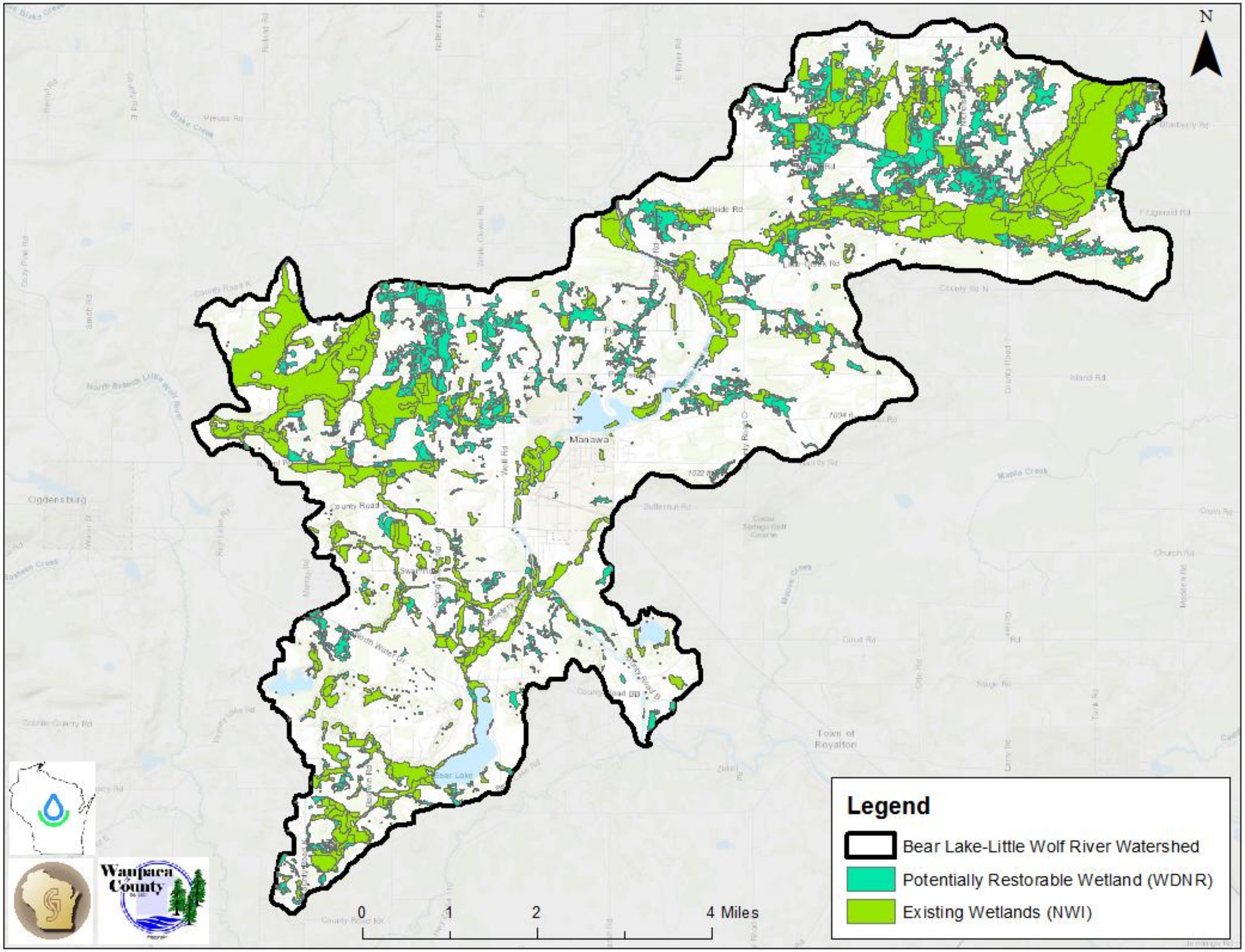

Figure 33. Existing and potentially restorable wetlands.

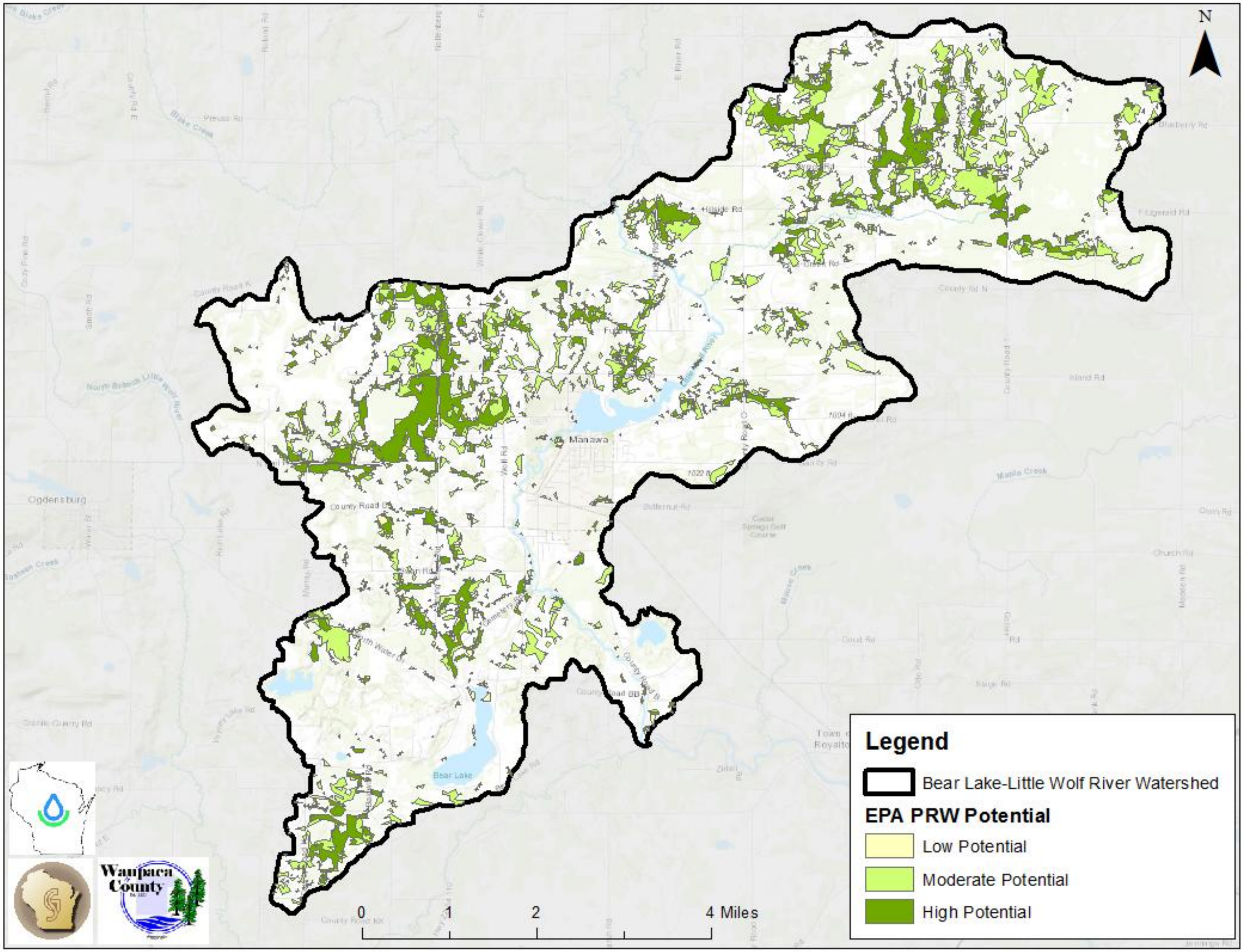

Figure 34. EPA potentially restorable wetlands on agricultural land.

4.2.5 Current Management Practices/Projects

Waupaca County LWCD and the NRCS have been working with farmers in Bear Lake- Little Wolf River Watershed for an extended period of time. The watershed was previously part of the Lower Little Wolf River Priority Watershed Project which ran from 1997-2008. Over time many contracts have expired and some of the practices have either been discontinued or not maintained. Table 12 provides the number of practices installed with NRCS support in the last 5 years and Table 13 provides the number of practices implemented by the Waupaca County LWCD using local and state funds from 2011-2017.

Table 12. NRCS practices implemented in the Bear Lake-Little Wolf River Watershed, 2012-2016.

Practice Group	Practice Code	Practice Name	Units	Quantity
Farmstead	313	Waste Storage Facility	no	1
	CAP102	Comprehensive Nutrient Management Plan	no	3
	561	Heavy Use Area Protection	sq ft	1111
	558	Roof Runoff Structure	no	1
	367	Roofs and Covers	no	1
	620	Underground Outlet	sq ft	250
Pasture	382	Fence	ft	4210
	512	Forage and Biomass Planting	ac	5.4
	516	Livestock Pipeline	ft	1087
	528	Prescribed Grazing	ac	47.4
Agronomic (Cropland)	340	Cover Crop	ac	123
	441	Irrigation System, Microirrigation	ac	0.1
	590	Nutrient Management	ac	650.7
	325	Seasonal High Tunnel System for Crops	sq ft	5040
	612	Tree/Shrub Establishment	ac	2.4
	620	Underground Outlet	ft	1850
	638	Water and Sediment Control Basin	no	6
Other Rural Land	658	Wetland Creation	ac	1

Table 13. Conservation practices implemented by Waupaca County LWCD using state and local funds from 2011-2017.

Practice Name	Units	Quantity	Funding
Animal lot abandonment/relocation	each	1	TRM
Animal Walkway	each	1	LWRM
Barnyard Runoff Control	each	1	TRM
Critical Area Seeding	acre	1	NOD
Feed Lot Runoff Control	each	1	NOD
Filter strip	each	1	LWRM
Roof Runoff	each	1	LWRM
Underground Outlet	each	9	NOD, LWRM
Waste Storage	each	2	TRM
Waste Transfer	each	7	TRM
Water and Sediment Control Basin	each	10	NOD, LWRM

5. Phosphorus and Sediment Reduction and Practice Implementation Goals

5.1 Watershed Goals and Management Objectives

Waters in the Upper Fox and Wolf Basin are currently impaired due to excess phosphorus and sediment. To restore the waters in the basin a TMDL is being developed for phosphorus and sediment. A TMDL identifies the sources of pollutants and reductions necessary to address water quality impairments. Currently impaired waters in the Upper Fox and Wolf Basin are shown in Appendix D. TMDL development for the Upper Fox and Wolf Basin began in 2014 and is expected to be finalized in 2018. Preliminary TMDL SWAT model estimates show the Bear Lake-Little Wolf River subwatershed in the top 10% of watersheds for high phosphorus loading from agriculture in the Wolf River Basin. Draft TMDL total phosphorus and total sediment yields are shown in Figure 35. Current reduction goals for this plan are 50% reduction in phosphorus and sediment loads from agricultural nonpoint sources. These reduction goals will need to be adjusted based on final TMDL analysis and results.

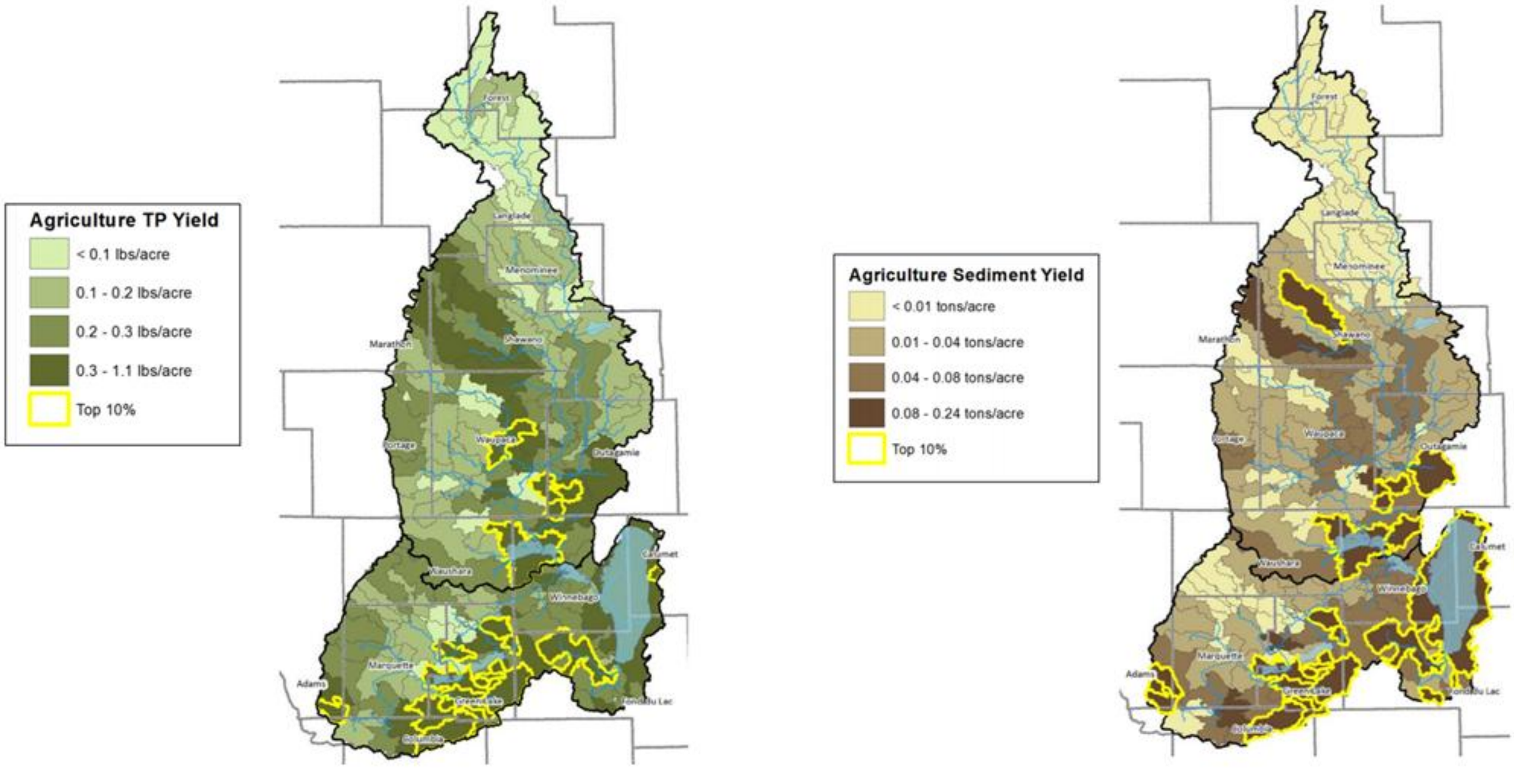

Figure 35. Draft TMDL SWAT model total phosphorus (left) and sediment (right) yields for agriculture.

The main focus of the watershed plan is to improve and protect water quality and to meet the limits set by the Wolf River and Upper Fox Basin TMDL. Additional goals were set that address critical issues in the watershed area based on watershed inventory results (Table 14). Management objectives address the sources that need to be addressed in order to meet the watershed goals.

Table 14. Watershed goals and management objectives.

Goal	Indicators	Cause or Source of Impact	Management Objective
Improve water quality to achieve DNR/EPA water quality standards.	Total Phosphorus, Total Suspended Sediment	High phosphorus levels causing algal growth and decreased dissolved oxygen. Runoff from cropland, barnyards, and urban areas. Cropland erosion.	Reduce the amount of sediment and phosphorus loads from cropland and barnyard runoff.
Citizens of the watershed area are aware of water quality issues and are involved in the stewardship of the watersheds.	Survey results, Current agricultural management/operation practices	Lack of awareness of environmental issues and their impact.	Increase public awareness of water quality issues and increase participation in watershed conservation activities.
Reduce the flood levels during peak storm events.	Peak flow discharges and flash flooding of the creeks and their tributaries occurring during heavy precipitation events.	Increased impervious area, tile drainage and ditching. Inadequate storm water practices. Poor soil health.	Reduce the flow of runoff from upland areas to streams. Improve soil health and increase soil infiltration.
Conserve and restore aquatic and terrestrial habitat.	Populations of plant and animal species. Connectivity, aerial extent, patch size.	Wetland and natural area degradation due to development and agriculture.	Restore wetlands to improve habitat and increase infiltration of runoff. Increase, improve and maintain upland habitat.

5.2 Individual practice and practice system efficiencies

The EPA's STEPL (Spreadsheet Tool for Estimating Pollutant Loads) tool was used to determine practice system efficiencies for best management practices. STEPL comes with BMP efficiencies for many practices; a literature review was done to determine estimated efficiencies for practices not included in the tool. The tool comes with a BMP Calculator that estimates the combined efficiency of two or more practices when used together. This tool was run to get several practice system efficiencies such as using cover crops and reduced tillage together as a system. Individual practice and practice system efficiencies are shown in Appendix E.

5.3 Planned Practice Implementation

The Bear Lake-Little Wolf River Watershed plan presents the following recommended plan of actions needed over the next 10 years in order to achieve water quality targets and watershed goals. The plan implementation matrix provides a guideline to what kinds of practices are needed in the watershed and to what extent they are needed to achieve the watershed goals (Table 15). The plan provides a timeline for which practices should be completed, possible funding sources, and agencies responsible for implementation.

Existing runoff management standards have been established by the State of Wisconsin. Chapter NR 151 provides runoff management standards and prohibitions for agriculture. This plan recommends enforcement of the state runoff standards when implementing the plan. Chapter NR 151.005 (Performance standard for total maximum daily loads) states that a crop producer or livestock producer subject to this chapter shall reduce discharges of pollutants from a livestock facility or cropland to surface waters if necessary to meet a load allocation in a US EPA and state approved TMDL. Local ordinances and regulations will also be used to implement conservation practices and compliance. Waupaca County LWCD and NRCS will work with landowners to implement conservation practices. Landowners will be educated on programs and funding available to them as well as current state and local agricultural regulations.

Table 15. 10 Year Management Measures Implementation Matrix.

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
1) Management Objective: Reduce the amount of sediment and phosphorus loading from agricultural land.							
a) Application of conservation practices to cropland. These practices include[1]: • Increase acreage of conservation tillage (No till, Strip till, Mulch Till) in watershed area. Fields must meet 30% residue. • Implement use of cover crops. • Use of low disturbance manure injection on fields with cover crops & reduced tillage. • Prescribed grazing • Nutrient Management	7,800 acres cropland with conservation practices applied	2,400	4,000	1,400	0-10 years	EQIP, TRM, GLRI, CSP, AM, WQT, MDV, LWRM	NRCS, LWCD
b) Stabilization of gullies and concentrated flow paths (Critical Area Planting, Grassed/Lined Waterway, WASCOB, etc).	# of linear feet stabilized	14,000	20,780	10,000	0-10 years	EQIP, CREP, AM, WQT, MDV, LWRM	NRCS, LWCD
c) Critical area plantings to stabilize concentrated flow areas.	# acres of critical area plantings	6	10	4	0-10 years	GLRI, EQIP, MDV, LWRM	NRCS, LWCD

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
d) Installation of vegetative filter strips along perennial and intermittent streams.	# acres of filter strips installed	30	33	20	0-10 years	CREP/CRP, EQIP, GLRI, AM, WQT, MDV, LWRM	NRCS, LWCD
e) Nutrient Management: Sign up remaining landowners for nutrient management.	# of landowners signed up for nutrient management plans	6	10	4	0-10 years	EQIP, TRM, SEG, AM, WQT, MDV, LWRM	NRCS, LWCD
f) Checks to make sure installed practices and management plans are being maintained and properly followed.	# of farms checked	10	10	10	0-10 years	N/A	LWCD
2) Management Objective: Slow the flow of runoff from upland areas to watershed streams and lakes.							
a) Increase water storage by restoring/creating wetlands.	# of acres of wetlands restored/created	5	5	5	0-10 years	EQIP, CREP/CRP, WQT, AM, MDV	NRCS, LWCD
b) Install Water and Sediment Control basins to store and slow flow of runoff.	# of WASCOBS installed	7	8	5	0-10 years	EQIP, AM, WQT, GLRI,TRM, MDV	NRCS, LWCD
c) Increase soil infiltration by implementing practices (a-f) under Management Objective 1.	_	-_	_	_	_	_	_

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
3) Management Objective: Reduce phosphorus runoff from barnyards.							
a) Retrofit barnyard sites with necessary runoff control structures (roof runoff management, vegetated treatment area, clean water diversions, heavy use area protection, fencing, waste treatment, maintenance/repair of existing practices, etc)	# of barnyard sites addressed and retrofitted with necessary runoff control measures	8	11	0	0-7 years	EQIP, AM, WQT, TRM, MDV, LWRM	NRCS, LWCD
b) Manure management on livestock operation sites.	# of new or updated manure storage facilities	4	5	0	0-7 years	EQIP, AM, WQT, TRM, MDV, LWRM	NRCS, LWCD
4) **Management Objective:** Conserve and restore aquatic and terrestrial habitat.							
a) Restore wetlands to improve habitat.	# of acres of wetlands restored	See 2 (a)	See 2 (a)	See 2 (a)	0-10 years	EQIP, CREP/CRP, WQT, AM, MDV	NRCS,LWCD
b) Create or improve habitat for wildlife and restore or maintain native plant communities.	# of acres of habitat created or improved	10	15	5	0-10 years	EQIP, CREP/CRP	NRCS, LWCD

10 Year Management Measures Plan Matrix							
Recommendations	*Indicators*	*Milestones*			*Timeline*	*Funding Sources*	*Implementation*
		0-3 years	*3-7 years*	*7-10 years*			
c) Installation of vegetative filter strips along intermittent and perennial streams	# of acres of vegetative filter strips installed	See 1 (d)	See 1 (d)	See 1 (d)	0-10 years	CREP/CRP, EQIP, GLRI, AM, WQT, MDV, LWRM	NRCS, LWCD

1. *A combination of the listed practices will be applied to agricultural fields to get the desired reductions. Not all practices listed will be applied to each field. The combinations of practices applied will vary by field. In most cases just applying one practice to a field will not get desired reductions and a combination of 2-3 practices will be necessary to get desired reductions. See Appendix F.*

5.4 Estimated Load Reduction

Load reductions for agricultural best management practices were estimated using STEPL (Spreadsheet Tool for Estimating Pollutant Loading) and the NRCS BARNY model. Percent reduction was based on the STEPL model agricultural baseline loading of 11,656 lbs TP/yr and 1,994 tons TSS/year. An estimated 65% reduction in TP and 62% reduction in TSS from agricultural sources are expected for planned management measures in the Bear Lake- Little Wolf River watershed. Expected load reductions from planned activities are shown in Table 16.

A challenge that presents itself in achieving phosphorus reductions is legacy phosphorus in the soil and in stream. In recent years scientists and watershed managers are finding that water quality is not responding as well as expected to implemented conservation practices (Sharpley et al 2013). They are attributing this slower and smaller response to legacy phosphorus. Legacy phosphorus is used to describe the accumulated phosphorus that can serve as a long- term source of P to surface waters. Legacy phosphorus in a soil occurs when phosphorus in soils builds up much more rapidly than the decline due to crop uptake. In stream channels, legacy phosphorus can result from sediment deposition of particulate phosphorus, sorption of dissolved phosphorus onto riverbed sediments or suspended sediments, or by incorporation into the water column (Sharpley et al 2013). Therefore, water quality may not respond to implementation of conservation practices in a watershed as quickly as expected due to remobilization of legacy phosphorus hot spots.

Table 16. Estimated load reductions.

Management Measure Category	Total Units (size/length)	Total Cost($)	Estimated Load Reduction			
			TP (lbs/yr)	Percent	TSS (t/yr)	Percent
Vegetative Riparian Buffers	83 acres	332,000.00	1,491.0	12.8	194.0	9.7
Farmstead Practices *(vegetated treatment area, waste storage including transfer, clean water diversions, fencing, waste treatment, roof runoff management, critical area plantings maintenance/repair of existing*	20 Sites	3,640,000.00	771.0	6.6	NA	NA
Practices applied to Cropland *(Conservation Tillage/Residue Management, Cover Crops, Nutrient Management, Low Disturbance Manure Injection, Prescribed Grazing)* [1]	7,800 acres	1,613,350.00	4,970.0	42.6	750.0	37.6
Gully/Concentrated Flow Stabilization *(Grassed Waterways, Critical Area Planting, Lined Waterway, WASCOBs, etc)*	44,781 ft/ 20 WASCOBs	170,000.00	132.0	1.1	252.0	12.6
Wetland Restoration/Creation	15 acres	225,000.00	170.0	1.5	44.0	2.2
Upland Habitat Restoration *(Conservation cover and tree plantings)*	30 acres	18,600.00	24.0	0.2	5.0	0.3
Total		**5,998,950.00**	**7,558.0**	**64.8**	**1,240.0**	**62.2**

1. *This category does not indicate that all these practices will be applied to all 7,800 acres of cropland. A combination of conservation practices applied to a majority of the cropland most vulnerable to erosion and runoff in the watershed is necessary to get the desired pollutant load*

reductions. It is also important to note that not all fields will need to apply more than one practice to meet desired reduction goals. The BMP Efficiency Calculator was used to determined efficiencies of different combinations of practices such as Reduced Tillage & Cover Crops or the use of a Nutrient Management and Reduced Tillage. A weighted average pollutant reduction efficiency was determined for this category based on expected implementation rates of combinations of practices. See Appendix F.

5.5 NEPA Concerns and Compliance

The National Environmental Policy Act (NEPA) was signed into law in 1970. The law requires federal agencies to assess the environmental impacts of their proposed actions prior to making decisions. This law also applies to watershed planning activities. As part of the planning process the NRCS is required to evaluate the individual and cumulative effects of proposed actions. Any project that has significant environmental impacts must be evaluated with and Environmental Assessment (EA) or Environmental Impact Statement (EIS) unless the activities are eligible under a categorical exclusion or already covered by and existing EA or EIS.

The NRCS utilizes a planning process that incorporates an evaluation of potential environmental impacts using an Environmental Evaluation Worksheet. There are several NRCS conservation practices and activities that fall under a categorical exclusion. A categorical exclusion is a category of actions that do not normally create a significant individual or cumulative effects on the human environment. There are 21 NRCS approved conservation or restoration categorical exclusions identified in GM190 §410.6. These categorical exemptions include practices that reduce soil erosion, involve planting vegetation and restoring areas to natural ecological systems.[9]

This watershed plan calls for conservation practices that control soil erosion and runoff from agricultural fields and structural practices to address runoff and waste management issues on farmsteads. Many of these practices are covered by either a categorical exclusion or may be included in an existing environmental assessment. A list of practices likely to be used to implement the plan is listed in Table 15.

Each planned practice and practices system will be evaluated to determine if it meets the criteria of categorical exclusions and any existing Environmental assessments. Any adverse impacts from practices will first try to be avoided then minimized or mitigated as necessary. It is not anticipated that the practices planned for the Bear Lake- Little Lower Wolf River Watershed will require an Environmental Assessment or an Environmental Impact Statement.

[9] Additional information on the NRCS environmental evaluation process, categorical exclusions, and compliance with NEPA can be found at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_034836.pdf .

6. Information and Education

This information and education plan is designed to increase participation in conservation programs and implementation of conservation practices by informing the landowners of assistance and tools available to them and providing information on linkages between land management and downstream effects on water quality.

A survey was developed and mailed to landowners in the Bear Lake-Little Wolf River Watershed area to gather information on knowledge of water quality, conservation practices, willingness to participate in programs, and where landowners obtain their information. Results from the survey were used to develop goals and recommended information and education actions. Survey results can be seen in Appendix G . Input from the Technical Advisory Group members and watershed stakeholders was also taken into account in identifying I&E goals and information and education actions. Meeting agendas from Technical Advisory Group and Stakeholder meetings can be viewed in Appendix H and I.

<u>Goals of the information and education plan</u>: Create public awareness of water quality issues in the watershed, increase public involvement in watershed stewardship, and increase communication and coordination among municipal officials, businesses, and agricultural community.

<u>Objectives</u>

- Educate local officials about the watershed plan. Encourage amendments to municipal comprehensive plans, codes, and ordinances.
- Develop targeted educational materials to appropriate audience in the watershed.
- Host workshops, meetings, and events that landowners can attend to learn about conservation practices.
- Increase landowners' adoption of conservation practices.
- Inform public of current water quality issues in the Upper Fox and Wolf River Watershed basin and how the Bear Lake-Little Wolf watershed contributes.
- Get local schools involved in watershed activities.

Target Audience

There are multiple target audiences that will need to be addressed in this watershed. Target audiences in this watershed will be agricultural land owners and operators, local government officials, agricultural businesses and organizations, urban home owners, and schools. Focused attention will be on agricultural land owners and operators since the main source of pollutant loading in the watershed is from agricultural land. Non-operator agricultural landowners are also an important subset of this group as they are usually not focused on and are less likely to participate in conservation programs.

I&E Plan Recommended Actions

An Information and Education Plan matrix (Table 17) was developed as a tool to help implement the I&E plan. The matrix includes recommended action campaigns, target audience, package for delivery of message, schedule, outcomes, estimated costs, and supporting organizations.

Evaluation

The I&E plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Section 9.3 describes milestones related to watershed education activities that can be used to evaluate I&E plan implementation efforts.

Table 17. Information and Education Plan Implementation Matrix.

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Inform the public on watershed project.	General Public	• Completed plan posted on county website. • Present plan to public at a public meeting. • Create a web page (Facebook, page on County website) for watershed project. • Develop exhibits for use at libraries, government offices, and local events (County Fairs and Farm Shows).	0-3 years	General public is aware of watershed implementation plan and has better understanding of how they can impact water quality.	$1,200	LWCD, NRCS, Fox-Wolf Watershed Alliance
Educate landowners on watershed project and progress.	Private landowners, agricultural landowners/ operators	Bi-annual/annual newsletter including watershed updates as well as information on new practices and programs. (Expansion of Basin Buzz or development of similar newsletter) Issues of Basin Buzz newsletter can be viewed at http://fwwa.org/buzz/	0-10 years	Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available.	$7,000	LWCD, NRCS, Fox-Wolf Watershed Alliance

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance and funding available.	Agricultural landowners/ operators	• Distribute educational materials on conservation practices and programs. • One on one contact with individual landowners to provide tools and resources. • Orchestrate group meetings with agricultural landowners in watershed to share knowledge and foster community connections for long term solutions. • Offer workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources. • Establish & tour local demonstration farms and other sites that have implemented conservation practices. Hold field days at demonstration sites to demonstrate new equipment and practices.	0-10 years	• Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them. • Increase in interest in utilizing and installing conservation practices. • Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners. • Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality. • Agricultural landowners see success of conservation practices as well as problems that can be expected.	$20,000	LWCD,NRCS, UWEX

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Reach out to non-operator land owners.	Non-operator agricultural landowners	• Distribute educational materials targeted to non-operator agricultural landowners. • One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions. • Hold workshop for non-operator land owners.	0-5 years	Non-operator landowners are informed on conservation practices. Increased participation rates in conservation activities from non-operator land owners.	$3,500	LWCD, NRCS, UWEX
Educate homeowners on actions they can take to reduce polluted runoff from their yards.	Homeowners	Distribute educational materials to homeowners on how to reduce polluted stormwater runoff from their yards.	0-5 years	Homeowners are aware of the impact they can have on water quality and actions they can take to reduce pollutions from their yards.	$1,000	UWEX, LWCD, Fox Wolf Watershed Alliance

Information and Education Plan Implementation Matrix						
Information and Education Action	**Target Audience**	**Recommendations**	**Schedule**	**Outcomes**	**Cost**	**Implementation**
Educate local agricultural businesses and organizations on objectives of watershed project.	Agronomists, Co-ops, Seed/Equipment dealers	Meetings with local agricultural organizations to share goals of project and planned conservation practices and outreach needed.	0-3 years	Local agricultural organizations are aware of watershed project and can assist landowners with conservation needs as well as help deliver common message to protect water quality in watershed area.	$1,500	UWEX, LWCD
Educate local officials about the completed plan. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives.	Elected officials in Waupaca County, City of Manawa, Town of Little Wolf, Town of Lebanon, Town of Bear Creek, Town of Royalton, and Town of St. Lawrence.	Present project plan to officials and conduct meetings with government officials.	0-3 years	Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives.	No cost using existing resources.	LWCD
Outcome of information and education plan.	Agricultural landowners/ operators	Survey agricultural landowners on water quality awareness, knowledge of conservation practices, and participation on conservation practices.	7-10 years	Increased awareness of water quality and conservation practices in the watershed area in comparison to 2017 survey.	$3,000	LWCD, UWEX

7. Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Cost share rates for conservation practices vary depending on state, local, or federal funding programs. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be $8,202,598.

Summary of Cost Analysis:

- $5,998,950 to implement best management practices.
- $1,844,323 needed for technical assistance.
- $82,825 needed for information and education.
- $26,500 for water quality monitoring.
- $250,000 for new innovative farming equipment.

Table 18. Estimated costs for best management practice implementation.

Best Management Practice	Unit	Quantity	Total Practice Cost per unit	Total Estimated Cost	NRCS Payment per unit	NRCS Total Cost
No-till/Reduced Tillage[1]	ac	5,300	18.50	294,150.0	15.12	240,408.00
Cover Crops[1]	ac	5,000	70.00	1,050,000.0	62.48	937,200.00
Grassed Waterway	ln ft	5,200	5.00	26,000.0	3.64	18,928.00
Filter Strip/Riparian Buffer	ac	83	4,000.00	332,000.0	511.20	42,429.60
Water and Sediment Control Basin *(System including underground outlet)*	each	20	7,000.00	140,000.0	varies*	NA
Critical Area Planting (*gully and concentrated flow stabilization*)	ac	20	200.00	4,000.0	140.45	2,809.00
Prescribed Grazing[2]	ac	500	30.00	45,000.0	21.75	32,625.00
Nutrient Management[3]	ac	4,300	10.00	172,000.0	25.97	335,013.00
Wetland Restoration/Creation	ac	15	15,000.00	225,000.0	varies*	NA
Low Disturbance Manure Injection	ac	900	58.00	52,200.0	NA	NA

Best Management Practice	Unit	Quantity	Total Practice Cost per unit	Total Estimated Cost	NRCS Payment per unit	NRCS Total Cost
Barnyard Runoff Management *(roof runoff, diversion, vegetative treatment area, heavy use area protection, fencing, critical area planting, waste treatment, etc)*[4]	each	19	40,000.00	760,000.0	varies*	NA
Waste Storage Systems*(Waste Storage Facility including Waste Transfer)*[4]	each	9	320,000.00	2,880,000.0	varies*	NA
Conservation Cover	ac	15	680.00	10,200.0	510.19	7,652.85
Tree/Shrub Establishment	ac	15	560.00	8,400.0	419.57	6,293.55
			Total	**5,998,950.0**		**1,623,359.0**

1. *Cost based on cost sharing for 3 year time period. These practices become an option during the corn silage years of a typical dairy rotation as well as anytime in a cash grain rotation. Within the 10-years of this plan implementation, it is assumed that all dairy rotation land will have a 3-yr window to implement these soil health strategies.*
2. *Cost based on up to 3 years of cost sharing of approved grazing management plan.*
3. *Cost based on cost sharing for 3-4 years depending on cost share program. The state cost share program provides cost sharing for 4 years and the NRCS program provides cost sharing for up to 3 years.*
4. *Many of these practices (Waste Storage/Transfer, Heavy Use Protection, Vegetated Treatment Area, Waste Treatment) require an accepted Comprehensive Nutrient Management Plan in order to receive NRCS EQIP funding.*

** NRCS Cost share rates vary for these practices based on site conditions and design.*

Table 19. Estimated costs for technical assistance.

Technical Assistance	Quantity	Cost/Unit ($)	Total Cost ($)
Conservation/Project Technician*	1	78,000	999,008
Agronomist*	1	66,000	845,315

**Costs based on employment for 10 years including benefits and 3 % increase per year for salary and fringe costs.*

Table 20. Information and education costs.

Information and Education	Cost ($)
Staff hours (1,300 hours of staff time for 5 years)	45,625
Materials and Equipment (Postage, printing costs, paper costs, presentation materials/equipment, meeting space and equipment)	37,200

Operation & Maintenance

This plan will require a land owner to agree to a 10 year maintenance period for practices such as vegetated buffers, grassed waterways, water and sediment control basins, wetland restoration/creation, barnyard runoff control, manure storage and fencing. For annual practices that require re-installation of management each year such as conservation tillage, cover crops, and nutrient management, landowners are required to maintain the practice for each period that cost sharing is available. Therefore annual assistance may be required for certain practices. Upon completion of the operation and maintenance period, point sources may be able to work with operators and landowners to continue implementation of the BMP's under a pollutant trading agreement (non EPA 319 monies).

Innovative Equipment

One of the major hurdles for farmers to be able to adopt new cropping management practices is the cost of new farming equipment and lack of access to new farming equipment. This plan recommends finding ways to make innovative equipment such as low disturbance manure injectors, no-till drills and interseeders available for use and demonstration in the subwatershed. Options to achieve this include purchasing equipment if funds can be acquired, working with local co-ops and agricultural equipment dealers to acquire equipment and working with neighboring counties on borrowing equipment.

Cost-Benefit Analysis

Recommended practices were analyzed for cost effectiveness based on the cost to reduce one lb of phosphorus and one ton of sediment (Table 21). Vegetative buffers and practices applied to cropland are most cost effective at reducing phosphorus at a cost of about $223/lb P for buffers and $325/lb of P for cropping practices. Farmstead practices such as waste storage and barnyard runoff management are the least cost effective at reducing phosphorus. Although waste storage is a high cost practice it is necessary on most farms in the ability to follow nutrient management plans and to reduce manure runoff from crop fields and the farmstead. Gully stabilization practices and vegetative buffers are most cost effective at reducing sediment at a cost of $1,288/ton sediment for gully stabilization practices and $1,711/ton sediment for riparian buffers. Some practices that are more cost efficient at reducing phosphorus may not necessarily be the most cost effective at reducing sediment loads in the watershed and vice versa. Therefore, there may not be much flexibility to maximize phosphorus and sediment reduction based on cost.

Table 21. Cost-benefit analysis for planned management practices.

Management Measure Category	Total Units (size/length)	Total Cost($)	Cost($/lb P)	Cost($/ton TSS)
Vegetative Riparian Buffers	83 acres	332,000.00	222.67	1,711.34
Farmstead Practices *(vegetated treatment area, waste storage including transfer, clean water diversions, fencing, waste treatment, roof runoff management, critical area plantings maintenance/repair of existing practices, etc)*	20 Sites	3,640,000.00	4,721.14	NA
Practices applied to Cropland *(Conservation Tillage/Residue Management, Cover Crops, Nutrient Management, Low Disturbance Manure Injection, Prescribed Grazing)*[1]	7,800 acres	1,613,350.00	324.62	2,151.13
Gully/Concentrated Flow Stabilization *(Grassed Waterways, Critical Area Planting, Lined Waterway, WASCOBs, etc)*	44,781 ft/ 20 WASCOBs	170,000.00	1,287.88	674.60
Wetland Restoration/Creation	15 acres	225,000.00	1,323.53	5,113.64
Upland Habitat Restoration *(Conservation cover and tree plantings)*	30 acres	18,600.00	775.00	3,720.00

8. Funding Sources

There are many state and federal programs that currently provide funding sources for conservation practices. Recently the option of adaptive management, water quality trading, and phosphorus variance has become another option for funding of practices.

8.1 Federal and State Funding Programs

A brief description of current funding programs available and their acronyms are listed below:

Environmental Quality Incentives Program (EQIP) - Program provides financial and technical assistance to implement conservation practices that address resource concerns. Farmers receive flat rate payments for installing and implementing runoff management practices.

Conservation Reserve Program (CRP) - A land conservation program administered by the Farm Service Agency. Farmers enrolled in the program receive a yearly rental payment for environmentally sensitive land that they agree to remove from production. Contracts are 10-15 years in length. Eligible practices include buffers for wildlife habitat, wetlands buffer, riparian buffer, wetland restoration, filter strips, grass waterways, shelter belts, living snow fences, contour grass strips, and shallow water areas for wildlife.

Conservation Reserve Enhancement Program (CREP) - Program provides funding for the installation, rental payments, and an installation incentive. A 15 year contract or perpetual contract conservation easement can be entered into. Eligible practices include filter strips, riparian buffers, wetland restoration, and grassed waterways.

ACEP- Agricultural Conservation Easement Program - New program that consolidates three former programs (Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranchlands Protection Program). Under this program NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agriculture use and conservation values of eligible land.

Land and Water Resource Management (LWRM) Grants- The Wisconsin Department of Agriculture, Trade and Consumer Protection awards annual Land and Water Resource Management grants to county land and water conservation committees and cooperators to help pay for county staff and finance cost-sharing for landowners who install conservation practices with county assistance.

Targeted Runoff Management Grant Program (TRM) - Program offers competitive grants for local governments for controlling nonpoint source pollution. Grants reimburse costs for agriculture or urban runoff management practices in critical areas with surface or groundwater quality concerns. The cost-share rate for TRM projects is up to 70% of eligible costs.

Conservation Stewardship Program (CSP) – Program offers funding for participants that take additional steps to improve resource condition. Program provides two types of funding through 5 year contracts; annual payments for installing new practices and maintaining existing practices as well as supplemental payments for adopting a resource conserving crop rotation.

Great Lakes Restoration Initiative (GLRI) - Program is the largest funding program investing in the Great Lakes. Under the initiative nonfederal governmental entities (state agencies, interstate agencies, local governments, non- profits, universities, and federally recognized Indian tribes) can apply for funding for projects related to restoring the Great Lakes.

Farmable Wetlands Program (FWP) - Program designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. The Farm Service Agency runs the program through the Conservation Reserve Program with assistance from other government agencies and local conservation groups.

Land Trusts- Landowners also have the option of working with a land trust to preserve land. Land trusts preserve private land through conservation easements, purchase land from owners, and accept donated land.

Producer -Led Watershed Protection Grants- Grant program administered by DATCP. The grants go to projects that focus on ways to prevent and reduce runoff from farm fields and that work to increase farm participation in these voluntary efforts.

8.2 Adaptive Management and Water Quality Trading

Adaptive management and water quality trading are potential sources of funding in this watershed if there are interested point sources. Adaptive management and water quality trading can be easily confused. Adaptive management and water quality trading can provide a more economically feasible option for point source dischargers to meet their waste load allocation limits. Point sources provide funding for best management practices to be applied in a watershed and receive credit for the reduction from that practice. Adaptive management focuses on compliance with phosphorus criteria while water quality trading focuses on compliance with a discharge limit.

Table 22. Comparison of adaptive management and water quality trading.

Adaptive Management	Water Quality Trading
Receiving water is exceeding phosphorous loading criteria.	The end of pipe discharge is exceeding the allowable limit.
More flexible and adaptive to allow cropland practices to show reductions over extended time period.	Not as flexible, needs to show stable reductions year to year.
Does not use "trade ratios" as modeling factor.	Uses "trade ratios" as margin of error factor.
Uses stream monitoring to show compliance.	Uses models such as SNAP+ or BARNY to show compliance with reduction in loading.
Typically used for phosphorus compliance only.	Can be used for a variety of pollutants, not just phosphorus.
Can be used to quantify phosphorus reductions for up to 15 years.	Can be used to demonstrate compliance indefinitely as long as credits are generated.
Wetland restoration, bank stabilization, and other similar practices can count towards compliance.	Wetland restoration, bank stabilization, and other similar practices can count towards compliance if reductions are quantifiable.

8.3 Phosphorus Multi- Discharger Variance (MDV) (Wisconsin Act 378)

In April of 2014, Act 378 was enacted; this act required the Wisconsin Department of Administration in consultation with the Department of Natural Resources to determine if complying with phosphorus limits causes Wisconsin substantial and economic hardship. It was determined that costs associated with waste water treatment to remove phosphorus would cause a substantial and widespread economic impact on the state.

The DNR is working with the EPA to implement a Multi-discharger Phosphorus Variance to help point sources comply with phosphorus standards in a more economically viable way. A multi- discharger variance extends the timeline for complying with low level phosphorus limits. In exchange, point sources agree to step wise reduction of phosphorus within their effluent as well as helping to address nonpoint source of phosphorus from farm fields, cities or natural areas by paying $50 per pound plus inflation that has occurred since 2015 to implement projects designed to improve water quality. A permittee that chooses to make payments for phosphorus reduction will make payments to each county that is participating in the program and has territory within the basin in which the point source is located in proportion to the amount of territory each county has within the basin. A county will then use the payments to provide cost sharing for projects to reduce the amount of phosphorus entering the waters of the state, for staff to implement phosphorus reduction projects, and/or for modeling or monitoring to evaluate the amount of phosphorus in the waters of the state for planning purposes. The final Multi-Discharger Variance package was submitted to the EPA on March 30, 2016 and approved by the EPA on February 6, 2017.

9. Measuring Plan Progress and Success

Monitoring of plan progress will be an essential component of achieving the desired water quality goals. Plan progress and success will be tracked by water quality improvement, progress of best management practice implementation, and by participation rates in public awareness and education efforts.

9.1 Water Quality Monitoring

In order to measure the progress and effectiveness of the watershed plan, water quality monitoring will need to be conducted throughout the plan term. Physical, chemical, and biological data will need to be collected to see if the water quality is meeting TMDL standards and designated use standards. This plan calls for the continuation of current monitoring programs.

Stream Water Quality Monitoring

The WDNR Lower Little Wolf River Targeted Watershed Assessment recommends the continued monitoring of temperature and phosphorus, nitrate, and sediment concentrations in the Lower Little Wolf River watershed. In accordance with DNR recommendations this plan calls for continued monitoring of the locations in the watershed that were sampled in 2017 (Figure 19) for baseline condition monitoring. Water quality monitoring sampling for nutrients should be conducted on an annual basis with samples collected from May- October. Samples will be analyzed for Total Suspended Sediment, Total Phosphorus, and Nitrates at a state certified lab. These sites should also be evaluated for macroinvertebrate and fish biotic integrity after 7 years of implementation and at the end of plan schedule (10 years). Water quality sampling will be done either by Waupaca County LWCD or WDNR depending on funding and staff availability.

9.2 Tracking Plan Progress and Success

Progress and success of the Bear Lake- Little Wolf River Watershed Project will be tracked by the following components:

1) Information and education activities and participation
2) Pollution reduction evaluation based on BMP's installed
3) Water quality monitoring
4) Administrative review

Waupaca County LWCD Department and NRCS will be responsible for tracking progress of the plan. Waupaca County LWCD department will need to work with NRCS staff to track progress and implement projects. Reports will be completed annually, and a final report will be prepared at the end of the project.

1) Information and education reports will include:
   a) Number of landowners/operators in the watershed plan area.
   b) Number of eligible landowners/operators in the watershed plan area.

c) Number of landowners/operators contacted.
d) Number of cost-share agreements signed.
e) Number and type of information and education activities held, who led the activity, how many invited, how many attended, and any measurable results of I&E activities.
f) Number of informational flyers/brochures distributed per given time period.
g) Number of one on one contacts made with landowners in the watershed.
h) Comments or suggestions for future activities.

2) Installed best management practices will be mapped using GIS. Pollution reductions from completed projects will be evaluated using models and spreadsheet tools such as STEPL and SnapPlus for upland practices and the BERT/BARNY model for barnyard practices. The annual report will include:
a) Planned and completed BMP's.
b) Pollutant load reductions and percent of goal planned and achieved.
c) Cost-share funding source of planned and installed BMP's.
d) Numbers of checks to make sure management plans (nutrient management, grazing management) are being followed by landowners.
e) Number of checks to make sure practices are being operated and maintained properly.
f) The fields and practices selected and funded by a point source (adaptive management or water quality trading) compliance options will be carefully tracked to assure that Section 319 funds are not being used to implement practices that are part of a point source permit compliance strategy.

3) Water Quality Monitoring Reporting Parameters:
    a) Phosphorus and sediment concentrations from WDNR/County sampling.
    b) Fish IBI and Macroinvertebrate IBI from WDNR/County sampling.
    c) Discharge data from USGS gauging station.

4) Administrative Review tracking and reporting will include:
a) Status of grants relating to project.
b) Status of project administration including data management, staff training, and BMP monitoring.
c) Status of nutrient management planning, and easement acquisition and development.
d) Number of cost-share agreements.
e) Total amount of money on cost-share agreements.
f) Total amount of landowner reimbursements made.
g) Staff salary and fringe benefits expenditures.
h) Staff travel expenditures.
i) Information and education expenditures.
j) Equipment, materials, and supply expenses.

k) Professional services and staff support costs.
l) Total expenditures for the county.
m) Total amount paid for installation of BMP's and amount encumbered for cost-share agreements.
n) Number of Water Quality Trading/Adaptive Management contracts.

Water Quality Indicators

Plan progress will also be measured by water quality data. Median summer phosphorus concentrations, macroinvertebrate index of biotic integrity and fish index of biotic integrity will be used to determine improvement in water quality. Water quality monitoring indicators for success are shown in Table 23. Estimated load reductions from implemented best management practices on agricultural land will also be used to determine if interim water quality goals are being met (Table 24).

Table 23. Water quality monitoring indicators for success.

Monitoring Recommendations	Indicators	Current Value	Target Value	Short Term (3 yrs)	Mid Term (7 yrs)	Long Term (10 yrs)
WDNR/County LWCD Monitoring-Thiel Creek	summer median total phosphorus (mg/l)	0.2958	0.075	0.23	0.14	0.075
	Fish IBI	Poor	Good	-	Fair	Good
	Macroinvertebrate IBI	Fair	Good	-	Good	Good
WDNR/County LWCD Monitoring-Little Creek	summer median total phosphorus (mg/l)	0.2123	0.075	0.17	0.12	0.075
	Fish IBI	Poor	Good	-	Fair	Good
	Macroinvertebrate IBI	Fair	Good	-	Good	Good

Table 24. Interim phosphorus and sediment reduction goals for Bear Lake-Little Wolf River Watershed.

Indicators	Estimated Current Value	Target Value	Short Term (3 yrs)	Mid Term (7 yrs)	Long Term (10 yrs)
lbs phosphorus/year	14,867	7,558	12,674	9,751	7,558
tons of sediment/year	2,323	1,240	1,998	1,565	1,240

9.3 Progress Evaluation

Due to the uncertainty of models and the efficiency of best management practices, an adaptive management approach should be taken with this subwatershed (Figure 36). Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Plan milestones are based on the implementation schedule with short term (0-3 years), medium term (3-7 years) and long term (7-10 years) milestones. After the implementation of practices and monitoring of water quality, plan progress and success should be evaluated after each milestone period. In addition to the annual report an additional progress report should be completed at the end of each milestone period. The progress report will be used to identify and track plan implementation to ensure that progress is being made and to make corrections as necessary. Plan progress will be determined by minimum progress criteria for management practices, water quality monitoring, and information and education activities held. The methods described in EPA's technical memorandum "Adjusting for Depreciation of Land Treatment When Planning Watershed Projects" will be used to evaluate implementation progress over time (Appendix L). If lack of progress is demonstrated, factors resulting in milestones not being met should be included in the report. Adjustments should be made to the plan based on plan progress and any additional new data and/or watershed tools.

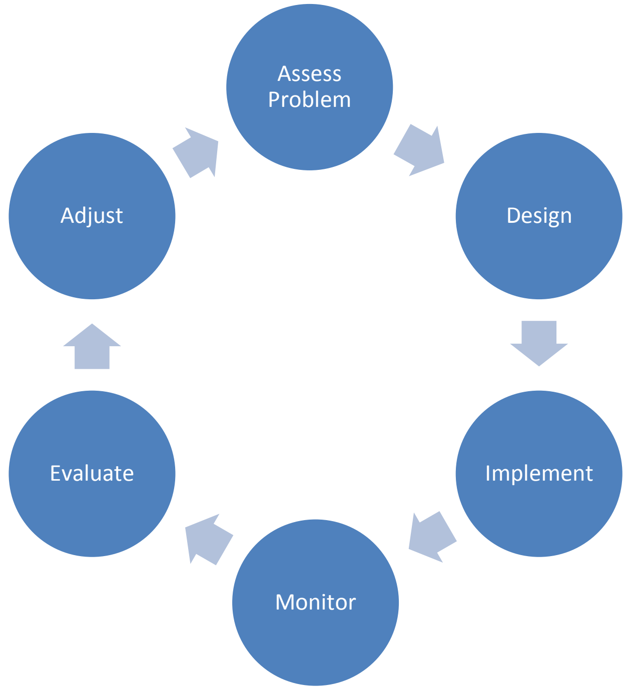

Figure 36. Adaptive management process.

Water Quality Monitoring Progress Evaluation

This implementation plan recognizes that estimated pollutant load reductions and expected improvement in water quality or aquatic habitat may not occur immediately following implementation of practices due to several factors (described below) that will need to be taken into consideration when evaluating water quality data. These factors can affect or mask progress that plan implementation has made elsewhere. Consultation with the DNR and Water Quality biologists will be critical when evaluating water quality or aquatic habitat monitoring results. Milestones for pollutant load reductions are shown in Table 23 and 24. If the target values/goals for water quality improvement for the milestone period are not being achieved, the water quality targets or timetable for pollutant reduction will need to be evaluated and adjusted as necessary.

The following criteria will be evaluated when water quality and aquatic habitat monitoring is completed after implementation of practices:

- Changes in land use or crop rotations within the same watershed where practices are implemented. (Increase in cattle numbers, corn silage acres, and/or urban areas can negatively impact stream quality and water quality efforts)
- Location in watershed where land use changes or crop rotations occur. (Where are these changes occurring in relation to implemented practices?)
- Watershed size, location where practices are implemented and location of monitoring sites.
- Climate, precipitation and soil conditions that occurred before and during monitoring periods. (Climate and weather patterns can significantly affect growing season, soil conditions, and water quality)
- Frequency and timing of monitoring.
- Percent of watershed area (acres) or facilities (number) meeting NR 151 performance standards and prohibitions.
- Percent of watershed area (acres) or facilities (number) that maintain implemented practices over time.
- Extent of gully erosion on crop fields within watershed over time. How many are maintained in perennial vegetation vs. plowed under each year?
- How "Legacy' sediments already within the stream and watershed may be contributing P and sediment loads to stream?
- Presence and extent of drain tiles in watershed area in relation to monitoring locations. Do these drainage systems contribute significant P and sediment loads to receiving streams?
- Does monitored stream meet IBI and habitat criteria but does not meet TMDL water quality criteria?
- Are targets reasonable? Load reductions predicted by models could be overly optimistic.

Management Measures/Information and Education Implementation Progress Evaluation

Implementation milestones for management measures are shown in the 10 Year Management Measures Plan Matrix (Table 15) and milestones for Information and Education Plan implementation are shown in Table 25. If less than 70% of the implementation milestones are being met for each milestone period, the plan will need to be evaluated and revised to either change the milestone(s) or to implement projects or actions to achieve the milestone(s) that are not being met.

Table 25. Information and education implementation goal milestones.

Information and Education Plan Implementation Goal Milestones	
	Short Term (0-3 years)
a)	Completed watershed plan posted on county website.
b)	Facebook/Website/or Page on county website developed for watershed information and updates.
c)	One exhibit displayed or used at local library, government office, and/or local event.
d)	Direct mailing of informational materials on watershed project and available funding and programs for conservation practices to all eligible land owners.
e)	At least 30 one on one contacts made with agricultural landowners.
f)	At least 2 meetings held with agricultural landowners.
g)	At least 2 educational workshops/demonstrations held at a demonstration farm.
h)	At least three issues of "Basin Buzz" newsletter or similar newsletter distributed.
i)	At least 2 meetings to share goals of watershed project have been held with local agricultural businesses and organizations.
j)	At least one workshop held for non-operator landowners.
	Medium Term (3-7 years)
a)	Direct mailing to all eligible landowners notifying them of watershed project progress and available funding and programs for conservation practices.
b)	At least 4 educational workshops/demonstrations held.
c)	At least 3 meetings held with agricultural landowners.
d)	At least 2 municipalities/governing bodies in watershed adopt/amend current code or ordinance to match goals of watershed plan.
e)	At least 10 people attend each educational workshop and meeting.
f)	At least 4 issues of "Basin Buzz" newsletter or similar newsletter distributed.
	Long Term (7-10 years)
a)	Conduct survey of agricultural landowners on watershed issues (At least 75% surveyed can identify the major source of water pollution in the watershed and methods to protect water quality).
b)	At least three issues of "Basin Buzz" newsletter or similar newsletter distributed.

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Appendix A. Wisconsin DNR Lake Type Descriptions.

Wisconsin Tourism - http://www.travelwisconsin.com/

National Lake Information
(North American Lake Management Society) - http://www.nalms.org/

Lake Variability and Descriptions

Each lake has qualities which make it unique, much like people with distinct personalities. Lakes vary based on physical characteristics, such as size, depth, configuration, chemical characteristics (such as soft versus hard water), water clarity, or the types of plant and animal life present. For example, hard water lakes have higher levels of dissolved minerals such as calcium, iron and magnesium than soft water lakes. Some lakes, especially those near acidic wetlands like bogs, are stained with tannic acid that leaches from surrounding vegetation. The water in these "tannin lakes" may range in color from a dark brown "coffee" color to light brown.

Natural lakes in Wisconsin frequently are classified by the source of water supply. Based on water source and outflows, four categories of lakes have been identified in this publication:

1. Drainage lakes - These lakes have both an inlet and outlet where the main water source is stream drainage. Most major rivers in Wisconsin have drainage lakes along their course. Drainage lakes owing one-half of their maximum depth to a dam are considered to be artificial lakes or impoundments.

2. Seepage lakes - These lakes do not have an inlet or an outlet, and only occasionally overflow. As landlocked waterbodies, the principal source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. Since seepage lakes commonly reflect groundwater levels and rainfall patterns, water levels may fluctuate seasonally. Seepage lakes are the most common lake type in Wisconsin.

3. Spring lakes - These lakes have no inlet, but do have an outlet. The primary source of water for spring lakes is groundwater flowing into the bottom of the lake from inside and outside the immediate surface drainage area. Spring lakes are the headwaters of many streams and are a fairly common type of lake in northern Wisconsin.

4. Drained lakes - These lakes have no inlet, but like spring lakes, have a continuously flowing outlet. Drained lakes are not groundwater-fed. Their primary source of water is from precipitation and direct drainage from the surrounding land. Frequently, the water levels in drained lakes will fluctuate depending on the supply of water. Under severe conditions, the outlets from drained lakes may become intermittent. Drained lakes are the least common lake type found in Wisconsin.

Appendix B. STEPL Baseline Condition Inputs.

Land Use:

Urban: 2,606 acres

Cropland: 14,159 acres

Pastureland: 288 acres

Forest: 10,306 acres

Agriculture Animals:

Beef Cattle: 132

Dairy Cattle: 4,906

Horse: 26

# of months manure applied: 3

USLE Parameters:

Cropland: R 110, K 0.29, LS 0.244, C 0.16, P 0.920

Pastureland: R 110, K 0.217, LS 0.347, C 0.040, P 1.00

Forest/Natural Background: R 110, K 0.217, LS 0.347, C 0.003, P 1.00

Average Soil Hydrologic Group: C

Baseline Cropland Conditions Assumptions:

Nutrient Management (4,250 acres)

No-Till/Reduced Tillage & Nutrient Management (2,830 acres)

Baseline BMP Efficiency applied to 50% (7,080 acres) of Cropland:

Phosphorus: 0.549

Sediment: 0.300

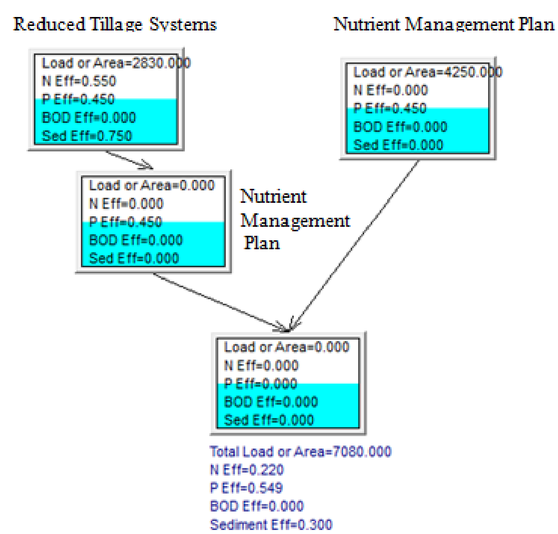
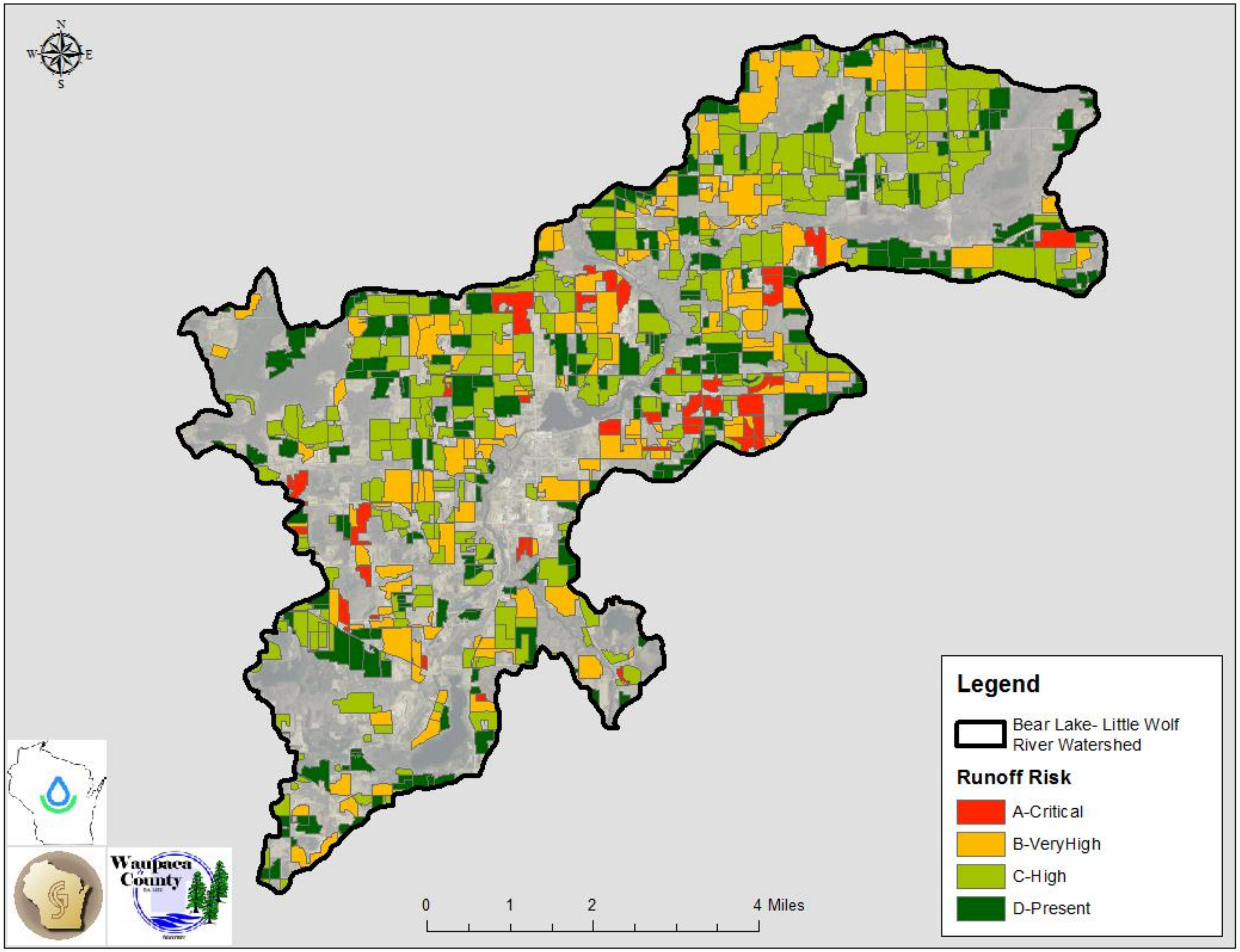
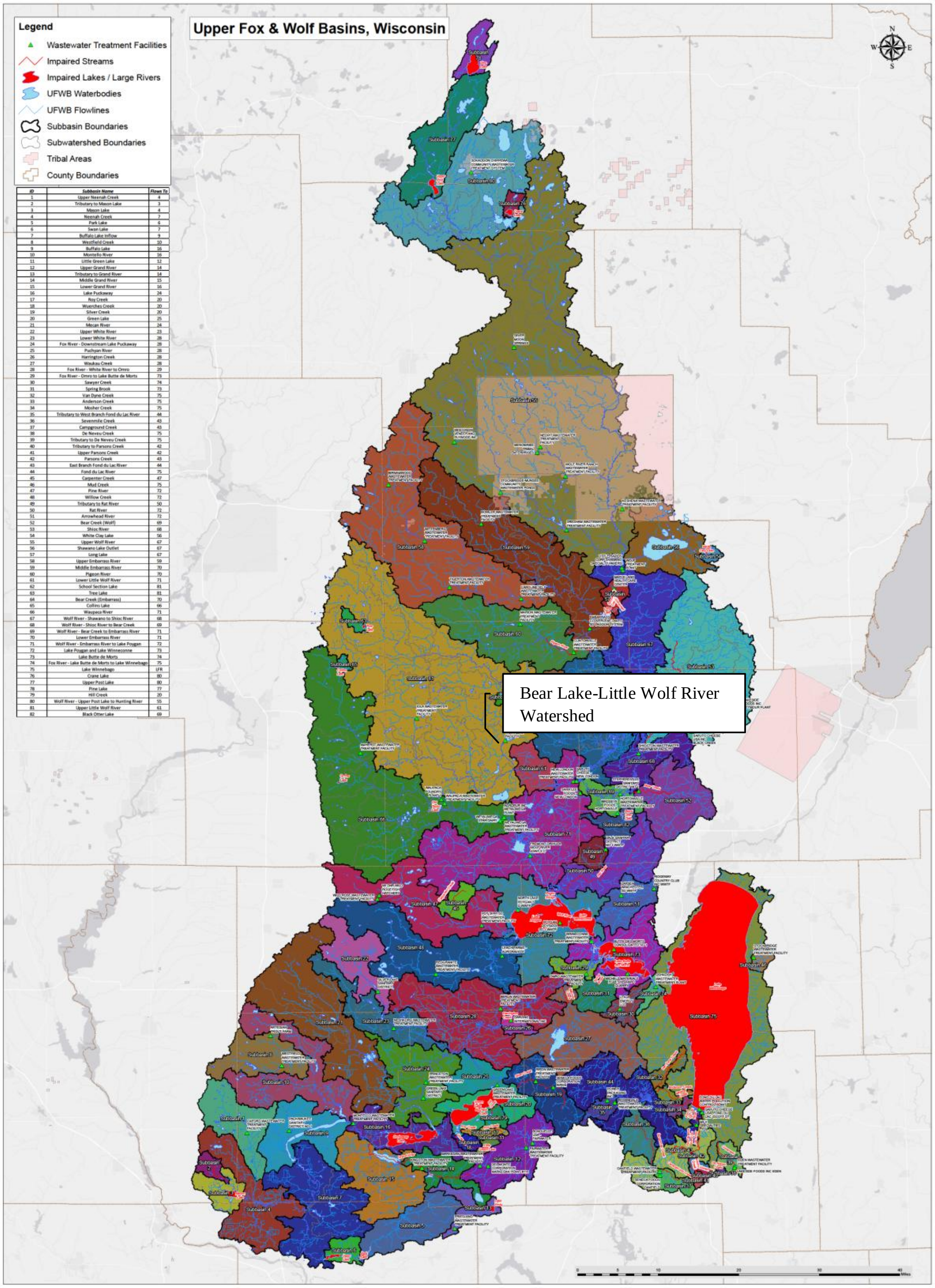


Figure 37. STEPL BMP Calculator configuration for baseline conditions for cropland.

Appendix C. ACPF Runoff Risk.



Appendix D. Draft TMDL Upper Fox & Wolf Basins and Impaired Waters.



Appendix E. BMP Practice Efficiencies.

Practice	Practice Efficiency		Source
	Phosphorus (%)	Sediment (%)	
Individual Practices			
Cropland			
Cover Crops	32	15	Pennsylvania State University[1]
Conservation Tillage	45	75	STEPL V4.3
Filter Strip	75	65	STEPL V4.3
Manure Injection	20	N/A	Kansas State Research and Extension[2]
Nutrient Management	45	N/A	STEPL V4.4
Prescribed Grazing	68	76	STEPL V4.4
Wetland Detention	44	75	STEPL V4.3
Farmstead Practices			
Waste Storage Facility	60	N/A	STEPL V4.3
Diversion	70	N/A	STEPL V4.3
Practice Systems			
Cropland			
Cover Crops & Conservation Tillage	62.6	78.8	STEPL BMP Calculator
Cover Crop & Manure Injection	45.6	15	STEPL BMP Calculator
Cover Crop, Conservation Tillage & Manure Injection	70.1	78.8	STEPL BMP Calculator
Nutrient Management & Cover Crops	62.6	15	STEPL BMP Calculator
Nutrient Management, Cover Crop, Conservation Tillage	79.4	78.8	STEPL BMP Calculator
Nutrient Management & Conservation Tillage	69.7	75	STEPL BMP Calculator
Farmstead Practices			
Runoff Management System	82.5	N/A	STEPL V4.3
Waste Management System	90	N/A	STEPL V4.3

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2. Tomlinson et al. 2015. Water Quality Best Management Practices, Effectiveness, and Cost for Reducing Contaminant Losses from Cropland. Kansas State University.

Appendix F. STEPL Inputs & Results for Best Management Practices.

Upland Practices applied to Cropland:

A weighted combined Best Management Practice efficiency of 63.81 % for total phosphorus and 60.14% for total sediment was used for conservation practices applied to cropland. This assumes that a combination of practices will be applied to 55% of the crop fields most vulnerable to erosion and runoff in the watershed. Estimated implementation rates of each practice combination are shown in Table 26.

Table 26. Cropland best management practices scenario and efficiencies.

Acres	Percent Implementation of Cropland	Practice Combination	% reduction (phosphorus)	Weighted % reduction phosphorus	% reduction (sediment)	Weighted % reduction sediment
1,100	8	Cover Crop & Reduced Tillage	62.60	8.83	78.80	11.11
1,100	8	NMP & Reduced Tillage	69.70	9.83	75.00	10.58
1,700	12	NMP, Reduced Tillage, & Cover Crops	79.40	17.31	78.80	17.17
800	6	NMP & Cover Crops	62.60	6.42	15.00	1.54
900	6	Cover Crop & Low Disturbance Manure Injection/Enhanced NM & Reduced Tillage	70.10	8.09	78.80	9.09
500	4	Reduced Tillage	45.00	2.88	75.00	4.81
700	5	Nutrient Management	45.00	4.04	NA	NA
500	4	Cover Crop	32.00	2.05	15.00	0.96
500	4	Prescribed Grazing	68.00	4.36	76.00	4.87
Combined BMP Efficiency			**NA**	**63.81**	**NA**	**60.14**

Table 27. STEPL inputs for combined cropland practices and load reductions.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND =No DATA					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.35	0.33	Combined BMPs-Calculated	55	4,970	750

Vegetative Filter Strips:

In order to determine load reductions from vegetative filter strips in the STEPL model, the amount of land the filter strips will be treating is needed. A GIS hydrology analysis tool was used to determine the catchment area of each proposed riparian buffer needed (Figure 38). A total of 1,912 acres would be treated with needed a vegetated filter strip which is 15% of cropland and 83 acres of cropland would be taken out of production.

Figure 38. Vegetative filter strip catchment.

Table 28. STEPL inputs for vegetative filter strips and load reductions.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND =No DATA					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.11	0.091	Filter Strip	15	1,433	184

Wetland Restoration/Creation:

Reductions from wetland creations/restorations were determined assuming that 1 acre of restored wetland would be treating 20 acres of cropland. Therefore, fifteen acres of restored wetland would be treating approximately 300 acres of cropland. Additional load reduction was also calculated for the conversion of cropland to wetland.

Table 29. STEPL inputs for wetland creation/restoration and load reductions.

1. BMPs and efficiencies for different pollutants on CROPLAND, ND =No DATA					Load Reductions	
Watershed	Cropland				P Reduction	Sediment Reduction
	P	Sediment	BMPs	% Area BMP Applied	lb/year	t/year
W1	0.01	0.01628	Wetland Detention	2.1	158	42

Gully/Concentrated Flow Stabilization:

Load reductions for gully and concentrated flow stabilization practices (grassed waterway, WASCOB, critical area planting, etc) were estimated by assuming an average height and width for gullies identified by the stream power index and air photo interpretation. A total 44,781 feet of gullies and concentrated flow paths were identified in this analysis. A 70% sediment delivery ratio was applied to the load reduction with the assumption that not all sediment from eroding gullies will reach the Little Wolf River.

Table 30. STEPL inputs for gully/concentrated flow stabilization and load reductions.

1. Gully dimensions in the different watersheds												
Watershed	**Gully**	**Top Width (ft)**	**Bottom Width (ft)**	**Depth (ft)**	**Length (ft)**	**Years to Form**	**BMP Efficiency (0-1)**	**Soil Textural Class**	**Soil Dry Weight (ton/ft3)**	**Nutrient Correction Factor**	**Annual Load (ton)**	**Load Reduction (ton)**
W1	Gully1	0.75	0.75	0.5	16,860	1	0.95	Loams, sandy clay loams	0.045	0.85	284.51	270.27
W1	Gully2	0.5	0.1	0.25	27,921	1	0.95	Loams, sandy clay loams	0.045	0.85	94.23	89.52

Appendix G. Landowner Survey Responses Summary.

Surveys were mailed out to 60 landowners in the Bear Lake- Little Wolf River Watershed to gauge landowner willingness to participate in conservation programs, determine best methods of communication and where landowners get information on water quality and agricultural practices. The county received a total of 14 completed surveys.

Questions and Responses:

1. Do you have enough storage for your manure?
   Yes: 6
   No: 4
   Maybe: 1
   N/A:3

2. If no or maybe would you be interested in expanding it or building new?
   Yes: 3
   No: 2
   Maybe: 0

3. How do you manage the manure/nutrients on your farm?
   - Spread and inject different fields each year
   - Liquid applied by custom applicator. Bedded pack manure spread by myself.
   - Spread on field.
   - We daily haul and use NMP 590 to manage where manure needs to go and so we don’t over applicate.
   - Spread on fields in spring directly before tillage.
   - Crop Consultant.

4. Do you have a nutrient management plan?
   Yes: 7
   No: 4
   Maybe: 2

5. Do you make most of the decisions about where manure goes on your farm?
   Yes: 10
   No: 1
   Maybe: 1

6. How well are you able to follow your nutrient management plan?
   - 100%-5 responses

- 40%
- 90%, winter is a challenge, land is tight
- 90%

7. Do you keep records of where manure went?
   Yes: 8
   No: 2
   Maybe: 0

8. What do you think about the conservation programs currently being offered?
   - I don't like CRP.
   - They help a lot.
   - Helpful if they apply to your farming practices.
   - I would like more detail to know exactly what these programs offer.
   - Could be tweaked.

9. Are there times you may consider doing conservation even if it costs you extra time and money? Why?
   - Yes, it saves fertilizers and nutrients.
   - Yes, to prevent ponding or erosion in certain fields.
   - Yes, to prevent erosion/contain nutrients.
   - No, milk price low.
   - Yes to improve crop production and to minimize my farming footprint.
   - Good for the water table.
   - Yes, building soil health.
   - Somewhat, to prevent erosion.
   - Yes, water protection.

10. What is the best way to get farmer input to help form new strategies /practices for conservation?
    - Meetings
    - The old fashion way of one on one visits
    - Questionnaires
    - Surveys, meetings, farm visits by county staff
    - Through the FSA
    - Work with FSA
    - Field days
    - Education/incentive

11. Would you be willing to share input on conservation practices in a group setting?
    Yes: 2
    No: 3
    Maybe: 8

12. Would you ever consider being part of a bigger group effort to solve water quality problems?
    Yes: 5
    No: 3
    Maybe: 5

13. Do you feel the water quality in area streams has improved, remained the same or declined in your lifetime?
    Improved: 2
    Same: 5
    Decline: 6

14. To what degree would you value demonstration farms for conservation education?
    Not at all: 1
    Slightly: 3
    Moderately: 4
    Very Much: 5

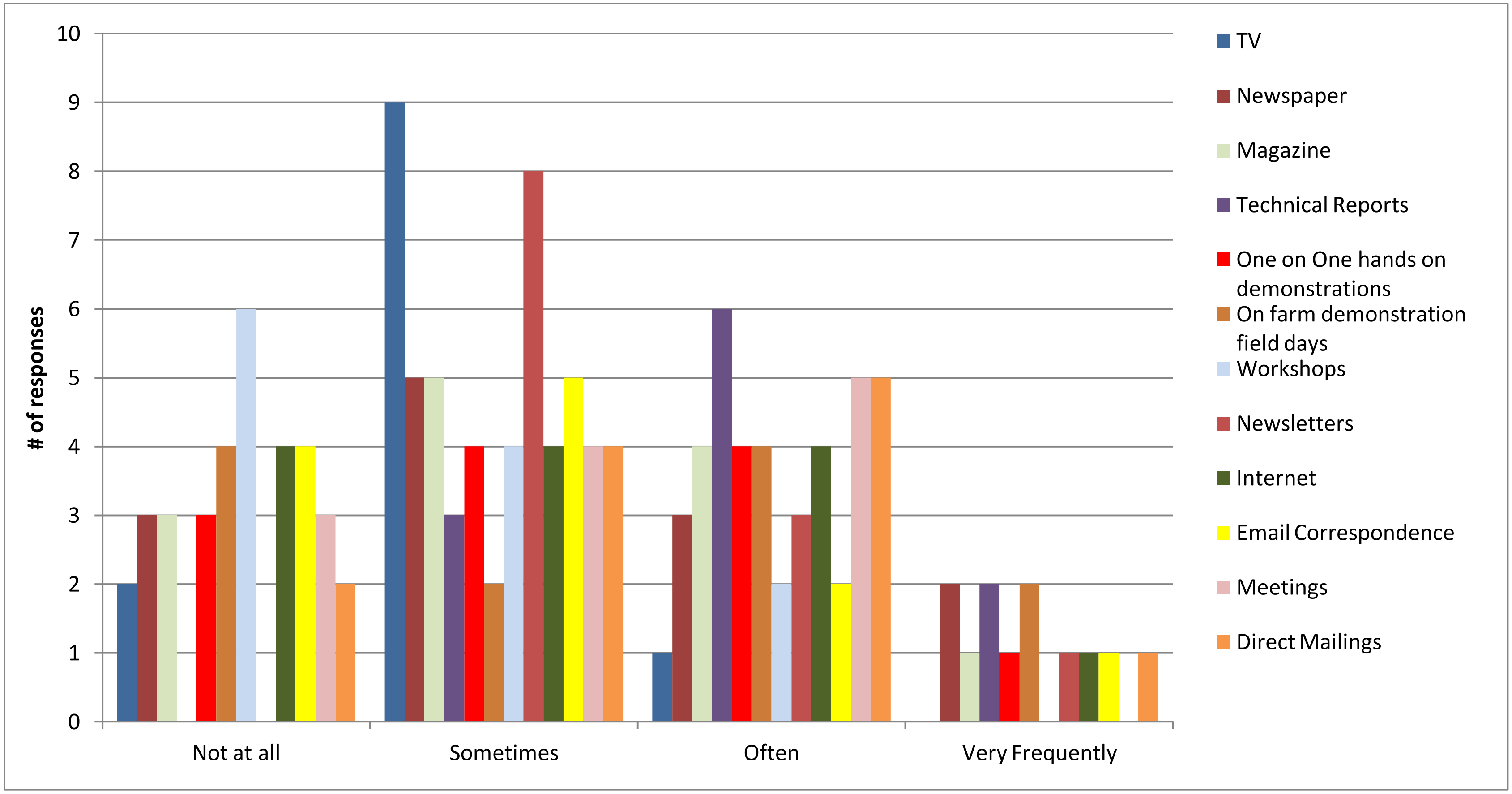
15. What would you like to see at demonstration farms/field days?
    - How well it works
    - What works and what doesn't work
    - Show part of field worked old way and part with new practices to see the difference
    - To keep a green growing crop year around
    - Publicity
16. What do you not need to see?
    - Fancy facilities.
    - Bare soil.

17. What follow up would you like?
    - Benefits to the environment, costs, etc.
    - Proof it worked.

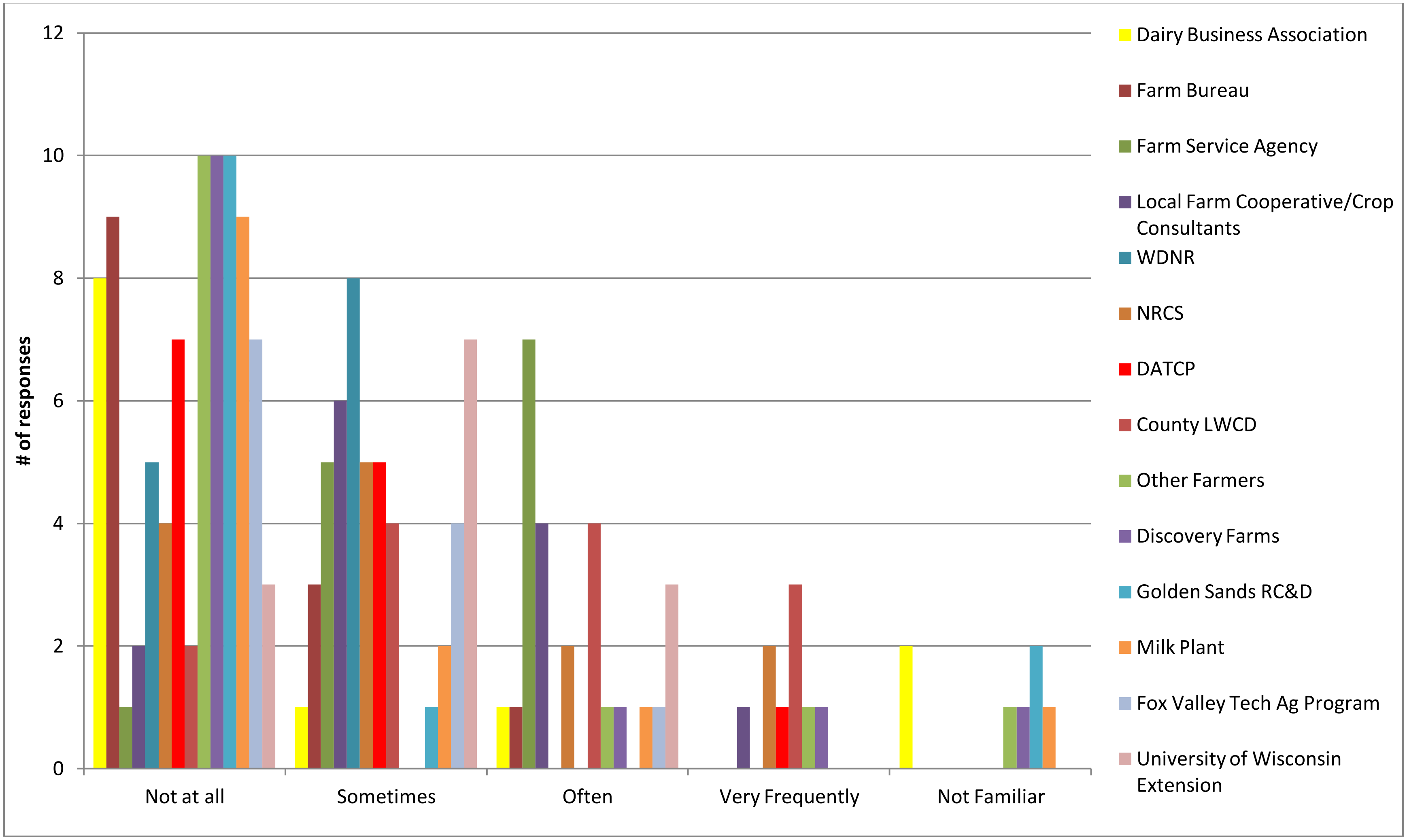
18. Responses to what conservation practices landowners use/have used, are willing to try or not willing to try, and what practices they would like more information on.

Typical Practices	Currently use or have used in past	Willing to try	Not willing to try	Would like more information
1. Using grass waterways	8	1	1	0
2. Managing tile drainage to control the flow of nutrients	5	2	1	0
3. Using no-tillage farm practices	7	2	1	1
4. Using reduced tillage farm practices	10	0	1	1
5. Using a nutrient management plan for applying fertilizers and manure	9	2	1	0
6. Keeping my livestock from entering streams (fencing, etc.)	10	0	0	0
7. Planting or maintaining vegetative buffers along streams	2	2	1	1
8. Using cover crops	3	4	2	2
9. Containing leachate from bunker silos	0	1	2	2
10. Managed/ rotational grazing	3	1	5	0
11. Reducing phosphorus in dairy feeds	1	1	2	2
14. Capping abandoned wells	6	0	1	0
15. Waste Storage	10	0	1	1
16. Terraces	2	1	3	0
17. Contour strip farming	2	1	3	0
18. Sediment Basin	4	0	1	1
19. Roofed Barnyard	4	2	1	2
18. Treatment Wetlands	1	0	2	4
19. Biofilters at outlets of drain tiles	1	0	2	3
20. Nutrient capturing technology/digester	0	0	3	2
21. Low Disturbance Manure Injection	2	2	2	2

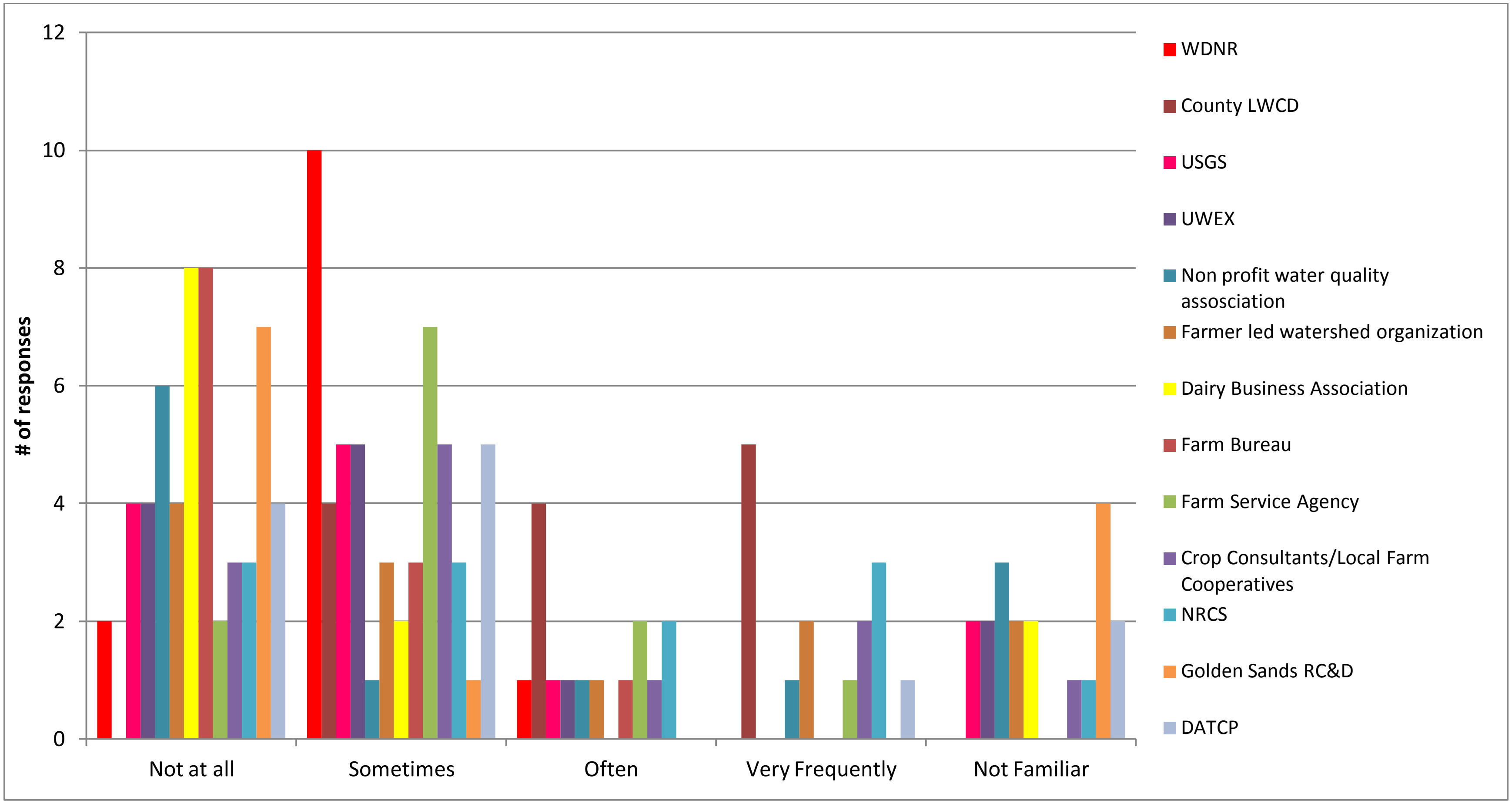
19. Where do you prefer to get information regarding water quality issues/conservation practices?



20. Who do you look to for farm improvement tactics/advice?



21. Who would you go for information about water quality?



Appendix H. Stakeholder Meeting Agenda and Attendance.

USDA

Natural Resources
Conservation Service
Waupaca Field Office

1337C Royalton Street
Waupaca, WI 54981
Phone: 715-258-8380
Fax: 855-814-3121

AGENDA

STAKEHOLDER MEETING
BEAR LAKE – LOWER LITTLE WOLF RIVER PILOT WATERSHED
NATIONAL WATER QUALITY INITIATIVE
APRIL 17, 2107
12:30 – 1:30
Little Wolf Town Hall, Manawa, WI

1. Welcome and introduction (LWCD and NRCS Staff)
2. Overview of the NWQI Program, past projects and the Pilot Project (Lisa)
3. Discussion of DNR's TMDL effort, water quality statistics of the Bear Lake watershed (Brian)
4. Bear Lake watershed characteristics: topography, drainage patterns, etc. Aerial overview. Description of EVAAL tool (Dan)
5. Description of Stream Power Index, explanation of goals of the Pilot Project (including acres needed to reach goal, which practices could be more effective, use of the STEPL model, the I & E component of the project). (Sarah)
6. Question and answer session with attendees

- Sign In Sheet
- 4-17-17
- NWQI Stakeholder meeting

Name

[illegible]
Leo Johnson
Wayne Gierach
[illegible]
[illegible]
[illegible]
Ronald Riedman
[illegible]
Anthony Hass
Rodney Hass
[illegible]
Jeff Henschel
Dan Boerst

Appendix I. Technical Advisory Group Meeting Agenda.

AGENDA

TECHNICAL ADVISORY GROUP
BEAR LAKE – LITTLE WOLF RIVER WATERSHED

Date:	**October 13th, 2017**
Time:	**11:30 -1:00 pm (lunch provided)**
Place:	**Room 1037 - main level**
	Waupaca Co. courthouse
	811 Harding St., Waupaca, WI 54981

1. Introduction and Purpose

2. Review goals of the watershed plan/project

3. Discuss implementation strategies
   a. Which practices are most needed/applicable?
   b. How can we implement clean water practices?
   b. What can we do to help your clients meet their goals?
   c. What type of outreach will be most effective?

4. Discuss the next steps of the effort

Note: Please RSVP by October 11th – 715-258-6245

Appendix J. GIS Data Sources.

GIS/Data Type	Source Agency	Source Location/Metadata Link
Land Use,Land Cover, and ortho-photos	Waupaca County Land Information	https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/
	US Dept of Agriculture (USDA)-FSA	NASS 2015 Cropland. 2015 NAIP: https://nassgeodata.gmu.edu/CropScape/ https://gdg.sc.egov.usda.gov/
Soil Types (SSURGO)	USDA-NRCS	http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
Elevation (LIDAR)	Waupaca County Land Information	https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/
Hydrography- 303(d) Impaired surface waters	WI Dept. of Natural Resources	ftp://dnrftp01.wi.gov/geodata/Impaired_Waters/
Hydrography	WI Dept. of Natural Resources (watershed boundary)	ftp://dnrftp01.wi.gov/geodata/watersheds/
	WI Dept. of Natural Resources (surface waters)	ftp://dnrftp01.wi.gov/geodata/hydro_24k/
	Waupaca County Land Information	https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/
Political/municipal boundaries	Waupaca County Land Information	https://data2017-04-05t135915451z-waupacacounty.opendata.arcgis.com/
Wetlands	WI Department of Natural Resources	https://data-wi-dnr.opendata.arcgis.com/
	Environmental Protection Agency	Potentially Restorable Wetlands: https://www.epa.gov/enviroatlas/enviroatlas-data-download-step-2
	US Fish and Wildlife Service	https://www.fws.gov/wetlands/Data/Data-
Groundwater	WI Department of Natural Resources	https://data-wi-dnr.opendata.arcgis.com/
Satellite Imagery	United States Geological Survey	https://earthexplorer.usgs.gov/

Appendix K. Glossary of Terms and Acronyms.

Animal Unit (AU) - a standard unit used in calculation of the relative grazing impact of different kinds and classes of livestock. One animal unit is defined as a 1,000 lb beef cow.

BARNY- Wisconsin adapted version of the ARS feedlot runoff model that estimates amount of phosphorus runoff from feedlots.

Barnyard Evaluation Rating Tool (BERT)- Rating tool for concentrated livestock areas to determine if the area is resource concern.

Baseline –An initial set of observations or data used for comparison or as a control.

Best Management Practice (BMP) – A method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Concentrated Animal Feeding Operation (CAFO)-

Cost-Sharing- Financial assistance provided to a landowner to install and/or use applicable best management practices.

Clean Water Act (CWA) - The primary federal law in the United States governing water pollution enacted in 1972.

Ephemeral gully- Voided areas that occur in the same location every year that are crossable with farm equipment and are often partially filled in by tillage.

Eutrophic- A body of water, lake or pond, which has high biological productivity due to excessive nutrients. These water bodies are able to support an abundance of aquatic plants or algae, resulting in a reduction of dissolved oxygen.

Geographic Information System (GIS) – A tool that links spatial features commonly seen on maps with information from various sources ranging from demographics to pollutant sources.

Index of Biotic Integrity (IBI) – An indexing procedure commonly used by academia, agencies, and groups to assess watershed condition based on the composition of a biological community in a water body.

Mesotrophic- Lakes with an intermediate level of productivity that have medium-level nutrients and are usually clear water with submerged aquatic plants.

Natural Resources Conservation Service (NRCS) - Provides technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land.

Riparian – Relating to or located on the bank of a natural watercourse such as a river, stream, lake or tidewater

Soil Nutrient Application Manager (SNAP) – Wisconsin's nutrient management planning software.

Spreadsheet Tool for Estimating Pollutant Load (STEPL) - Model that calculates nutrient loads (Phosphorus, Nitrogen, and Biological Oxygen Demand) by land use type and aggregated by watershed.

Stream Power Index (SPI) – Measures the erosive power of overland flow as a function of local slope and upstream drainage area.

Total Phosphorus (TP) - A measure of all the forms of phosphorus, dissolved or particulate, that are found in a sample.

Total Suspended Sediment (TSS) - The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Total Maximum Daily Load (TMDL) - A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

United States Geological Survey (USGS) – Science organization that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems.

United States Environmental Protection Agency (USEPA) – Government agency to protect human health and the environment.

University of Wisconsin Extension (UWEX) – UW-Extension works with UW- System campuses, Wisconsin counties, tribal governments, and other public and private organizations to help address economic, social, and environmental issues.

Waste Load Allocation (WLA) - a portion of a receiving water's assimilative capacity that is allocated to one of its existing or future point sources of pollution. WLAs establish water quality based effluent limits for point source discharge facilities.

Waste Water Treatment Facility (WWTF) - A facility where wastewater is processed to remove or breakdown pollutants and treated water is returned back to the water cycle.

Wisconsin Department of Natural Resources (WDNR) – State organization that works with citizens and businesses to preserve and enhance the natural resources of Wisconsin.

Appendix L. EPA Technical Memorandum #1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects.

United States Environmental Protection Agency

Technical Memorandum #1

Adjusting for Depreciation of Land Treatment When Planning Watershed Projects

This Technical Memorandum is one of a series of publications designed to assist watershed projects, particularly those addressing nonpoint sources of pollution. Many of the lessons learned from the Clean Water Act Section 319 National Nonpoint Source Monitoring Program are incorporated in these publications.

October 2015

Donald W. Meals and Steven A. Dressing. 2015. Technical Memorandum #1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects, October 2015. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 16 p. Available online at https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/watershed-approach-technical-resources.

Introduction

Fields near Seneca Lake, New York.

Watershed-based planning helps address water quality problems in a holistic manner by fully assessing the potential contributing causes and sources of pollution, then prioritizing restoration and protection strategies to address the problems (USEPA 2013). The U.S. Environmental Protection Agency (EPA) requires that watershed projects funded directly under section 319 of the Clean Water Act implement a watershed-based plan (WBP) addressing the nine key elements identified in EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters (USEPA 2008)*. EPA further recommends that all other watershed plans intended to address water quality impairments also include the nine elements. The first element calls for the identification of causes and sources of impairment that must be controlled to achieve needed load reductions. Related elements include a description of the nonpoint source (NPS) management measures—or best management practices (BMPs)—needed to achieve required pollutant load reductions, a description of the critical areas in which the BMPs should be implemented, and an estimate of the load reductions expected from the BMPs.

Once the causes and sources of water resource impairment are assessed, identifying the appropriate BMPs to address the identified problems, the best locations for additional BMPs, and the pollutant load reductions likely to be achieved with the BMPs depends on accurate information on the performance levels of both BMPs already in place and BMPs to be implemented as part of the watershed project. All too often, watershed managers and Agency staff have assumed that, once certified as installed or adopted according to specifications, a BMP continues to perform its pollutant reduction function at the same efficiency (percent pollutant reduction) throughout its design or contract life, sometimes longer. An important corollary to this assumption is that BMPs in place during project planning are performing as originally intended. Experience in NPS watershed projects across the nation, however, shows that, without diligent operation and maintenance, BMPs and their effects probably will depreciate over time, resulting in less efficient pollution reduction. Recognition of this fact is important at the project planning phase, for both existing and planned BMPs.

Knowledge of land treatment depreciation is important to ensure project success through the adaptive management process (USEPA 2008). BMPs credited during the planning phase of a watershed project will be expected to achieve specific load reductions or other water quality benefits as part of the overall plan to protect or restore a water body. Verification that BMPs are still performing their functions at anticipated levels is essential to keeping a project on track to achieve its overall goals. Through adaptive management, verification results can be used to inform decisions about needs for additional BMPs or maintenance or repair of existing BMPs. In a watershed project that includes short-term (3–5 years) monitoring, subtle changes in BMP performance level might not be detectable or critical, but planners must account for catastrophic failures, BMP removal or discontinuation, and major maintenance shortcomings. Over the longer term, however, gradual changes in BMP performance level can be significant in terms of BMP-specific pollutant control or the role of single BMPs within a BMP system or train. The weakest link in a BMP train can be the driving force in overall BMP performance.

Application of and methods for BMP tracking in NPS watershed projects are described in detail in *Tech Notes 11* (Meals et al. 2014).

This technical memorandum addresses the major causes of land treatment depreciation, ways to assess the extent of depreciation, and options for adjusting for depreciation. While depreciation occurs throughout the life of a watershed project, the emphasis is on the planning phase and the short term (i.e., 3–5 years).

Causes of Depreciation

Depreciation of land treatment function occurs as a result of many factors and processes. Three of the primary causes are natural variability, lack of proper maintenance, and unforeseen consequences.

Natural Variability

Climate and soil variations across the nation influence how BMPs perform. Tiessen et al. (2010), for example, reported that management practices designed to improve water quality by reducing sediment and sediment-bound nutrient export from agricultural fields can be less effective in cold, dry regions where nutrient export is primarily snowmelt driven and in the dissolved form, compared to similar practices in warm, humid regions. Performance levels of vegetation-based BMPs in both agricultural and urban settings can vary significantly through the year due to seasonal dormancy. In a single locale, year-to-year variation in precipitation affects both agricultural management and BMP performance levels. Drought, for example, can suppress crop yields, reduce nutrient uptake, and result in nutrient surpluses left in the soil after harvest where they are vulnerable to runoff or leaching loss despite careful nutrient management. Increasing incidence of extreme weather and intense storms can overwhelm otherwise well-designed stormwater management facilities in urban areas.

Lack of Proper Maintenance

Most BMPs—both structural and management—must be operated and maintained properly to continue to function as designed. Otherwise, treatment effectiveness can depreciate over time. For example, in a properly functioning detention pond, sediment typically accumulates in the forebay. Without proper maintenance to remove accumulated sediment, the capacity of the BMP to contain and treat stormwater is diminished. Similarly, a nutrient management plan is only as effective as its implementation. Failure to adhere to phosphorus (P) application limits, for example, can result in soil P buildup and increased surface and subsurface losses of P rather than the loss reductions anticipated.

Jackson-Smith et al. (2010) reported that over 20 percent of implemented BMPs in a Utah watershed project appeared to be no longer maintained or in use when evaluated just 5 years after project completion. BMPs related to crop production enterprises and irrigation systems had the lowest rate of continued use and maintenance (~75 percent of implemented BMPs were still in use), followed by pasture and grazing planting and management BMPs (81 percent of implemented BMPs were still in use). Management practices (e.g., nutrient management) were found to be particularly susceptible to failure.

Practices are sometimes simply abandoned as a result of changes in landowner circumstances or attitudes. In a Kansas watershed project, farmers abandoned a nutrient management program because of perceived restrictive reporting requirements (Osmond et al. 2012).

Abandoned waste storage structure.

In the urban arena, a study of more than 250 stormwater facilities in Maryland found that nearly one-third of stormwater BMPs were not functioning as designed and that most needed maintenance (Lindsey et al. 1992). Sedimentation was a major problem and had occurred at nearly half of the facilities; those problems could have been prevented with timely maintenance.

Hunt and Lord (2006) describe basic maintenance requirements for bioretention practices and the consequences of failing to perform those tasks. For example, they indicate that mulch should be removed every 1–2 years to both maintain available water storage volume and increase the surface infiltration rate of fill soil. In addition, biological films might need to be removed every 2–3 years because they can cause the bioretention cell to clog.

In plot studies, Dillaha et al. (1986) observed that vegetative filter strip-effectiveness for sediment removal appeared to decrease with time as sediment accumulated within the filter strips. One set of the filters was almost totally inundated with sediment during the cropland experiments and filter effectiveness dropped 30–60 percent between the first and second experiments. Dosskey et al. (2002) reported that up to 99 percent of sediment was removed from cropland runoff when uniformly distributed over a buffer area, but as concentrated flow paths developed over time (due to lack of maintenance), sediment removal dropped to 15–45 percent. In the end, most structural BMPs have a design life (i.e., the length of time the item is expected to work within its specified parameters). This period is measured from when the BMP is placed into service until the end of its full pollutant reduction function.

Unforeseen Consequences

The effects of a BMP can change directly or indirectly due to unexpected interactions with site conditions or other activities. Incorporating manure into cropland soils to reduce nutrient runoff, for example, can increase erosion and soil loss due to soil disturbance, especially in comparison

to reduced tillage. On the other hand, conservation tillage can result in accumulation of fertilizer nutrients at the soil surface, increasing their availability for loss in runoff (Rhoton et al. 1993). Long-term reduction in tillage also can promote the formation of soil macropores, enhancing leaching of soluble nutrients and agrichemicals into ground water (Shipitalo et al. 2000). Stutter et al. (2009) reported that establishment of vegetated buffers between cropland and a watercourse led to enhanced rates of soil P cycling within the buffer, increasing soil P solubility and the potential for leaching to watercourses.

Despite widespread adoption of conservation tillage and observed reductions in particulate P loads, a marked increase in loads of dissolved bioavailable P in agricultural tributaries to Lake Erie has been documented since the mid-1990s. This shift has been attributed to changes in application rates, methods, and timing of P fertilizers on cropland in conservation tillage not subject to annual tillage (Baker 2010; Joosse and Baker 2011). Further complicating matters, recent research on fields in the St. Joseph River watershed in northeast Indiana has demonstrated that about half of both soluble P and total P losses from research fields occurred via tile discharge, indicating a need to address both surface and subsurface loads to reach the goal of 41 percent reduction in P loading for the Lake Erie Basin (Smith et al. 2015).

Several important project planning lessons were learned from the White Clay Lake, Wisconsin, demonstration projects in the 1970s, including the need to accurately assess pollutant inputs and the performance levels of BMPs (NRC 1999). Regarding unforeseen consequences, the project learned through monitoring that a manure storage pit built according to prevailing specifications actually caused ground water contamination that threatened a farmer's well water. This illustrates the importance of monitoring implemented practices over time to ensure that they function properly and provide the intended benefits.

Control of urban stormwater runoff (e.g., through detention) has been widely implemented to reduce peak flows from large storms in order to prevent stream channel erosion. Research has shown, however, that although large peak flows might be controlled effectively by detention storage, stormflow conditions are extended over a longer period of time. Duration of erosive and bankfull flows are increased, constituting channel-forming events. Urbonas and Wulliman (2007) reported that, when captured runoff from a number of individual detention basins in a stream system is released over time, the flows accumulate as they travel downstream, actually increasing peak flows along the receiving waters. This situation can diminish the collective effectiveness of detention basins as a watershed management strategy.

Assessment of Depreciation

The first—and possibly most important—step in adjusting for depreciation of implemented BMPs is to determine its extent and magnitude through BMP verification.

BMP Verification

At its core, BMP verification confirms that a BMP is in place and functioning properly as expected based on contract, permit, or other implementation evidence. A BMP verification process that documents the presence and function of BMPs over time should be included in all NPS watershed projects.

At the project planning phase, verification is important both to ensure accurate assessment of existing BMP performance levels and to determine additional BMP and maintenance needs. Verification over time is necessary to determine if BMPs are maintained and operated during the period of interest.

Documenting the presence of a BMP is generally simpler than determining how well it functions, but both elements of verification must be considered to determine if land treatment goals are being met and whether BMP performance is depreciating. Although land treatment goals might not be highly specific in many watershed projects, it is important to document what treatment is implemented. Verification is described in detail in *Tech Notes 11* (Meals et al. 2014). This technical memorandum focuses on specific approaches to assessing depreciation within the context of an overall verification process.

Methods for Assessing BMP Presence and Performance Level

Whether a complete enumeration or a statistical sampling approach is used, methods for tracking BMPs generally include direct measurements (e.g., soil tests, onsite inspections, remote sensing) and indirect methods (e.g., landowner self-reporting or third-party surveys). Several of these methods are discussed in *Tech Notes 11* (Meals et al. 2014). Two general factors must be considered when verifying a BMP: the presence of the BMP and its pollutant removal efficiency. Different types of BMPs require different verification methods, and no single approach is likely to provide all the information needed in planning a watershed project.

Certification

The first step in the process is to determine whether BMPs have been designed and installed/adopted according to appropriate standards and specifications. Certification can either be the final step in a contract between a landowner and a funding agency or be a component of a permit requirement.

Certification provides assurance that a BMP is fully functional for its setting at a particular time. For example, a stormwater detention pond or water and sediment control basin must be properly sized for its contributing area and designed for a specific retention-and-release performance level. A nutrient management plan must account for all sources of nutrients, consider current soil nutrient levels, and support a reasonable yield goal. A cover crop must be planted in a particular time window to provide erosion control and/or nutrient uptake during a critical time of year. Some jurisdictions might apply different nutrient reduction efficiency credits for cover crops based on planting date. Some structural BMPs like parallel tile outlet terraces require up to 2 years to fully settle and achieve full efficiency; in those cases, certification is delayed until full stability is reached. Knowledge that a BMP has been applied according to a specific standard supports an assumption that the BMP will perform at a certain level of pollutant reduction efficiency, providing a baseline against which future depreciation can be compared. Practices voluntarily implemented by landowners without any technical or financial assistance could require special efforts to determine compliance with applicable specifications (or functional equivalence). Pollution reduction by practices not meeting specifications might need to be discounted or not counted at all even when first installed.

Depreciation assessment indicators

Ideally, assessment of BMP depreciation would be based on actual measurement of each BMP's performance level (e.g., monitoring of input and output pollutant loads for each practice). Except in very rare circumstances, this type of monitoring is impractical. Rather, a watershed project generally must depend on the use of indicators to assess BMP performance level.

The most useful indicators for assessing depreciation are determined primarily by the type of BMP and pollutants controlled, but indicators might be limited by the general verification approach used. For example, inflow and outflow measurements of pollutant load can be used to determine the effectiveness of constructed wetlands, but a verification effort that uses only visual observations will not provide that data or other information about wetland functionality. A central challenge, therefore, is to identify meaningful indicators of BMP performance level that can be tracked under different verification schemes. This technical memorandum provides examples of how to accomplish that end.

Nonvegetative structural practices

Performance levels of nonvegetative structural practices—such as animal waste lagoons, digesters, terraces, irrigation tailwater management, stormwater detention ponds, and pervious pavement—can be assessed using the following types of indicators:

- Measured on-site performance data (e.g., infiltration capacity of pervious pavement),
- Structural integrity (e.g., condition of berms or other containment structures), and
- Water volume capacity (e.g., existing pond volume vs. design) and mass or volume of captured material removed (e.g., sediment removed from stormwater pond forebay at cleanout).

In some cases, useful indicators can be identified directly from practice standards. For example, the Natural Resources Conservation Service lists operation and maintenance elements for a water and sediment control basin (WASCoB) (*USDA-NRCS 2008*) that include:

- Maintenance of basin ridge height and outlet elevations,
- Removal of sediment that has accumulated in the basin to maintain capacity and grade,
- Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin, and
- Regular mowing and control of trees and brush.

These elements suggest that ridge and outlet elevations, sediment accumulation, inlet integrity, and vegetation control would be important indicators of WASCoB performance level.

Required maintenance checklists contained in stormwater permits also can suggest useful indicators. For example, the *Virginia Stormwater Management Handbook* (VA DCR 1999) provides an extensive checklist for annual operation and maintenance inspection of wet ponds. The list includes many elements that could serve as BMP performance level indicators:

- Excessive sediment, debris, or trash accumulated at inlet,
- Clogging of outlet structures,

- Cracking, erosion, or animal burrows in berms, and
- More than 1 foot of sediment accumulated in permanent pool.

Assessment of these and other indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Vegetative structural practices

Performance levels of vegetative structural practices—such as constructed wetlands, swales, rain gardens, riparian buffers, and filter strips—can be assessed using the following types of indicators:

Parking lot rain garden.

- Extent and health of vegetation (e.g., measurements of soil cover or plant density),
- Quality of overland flow filtering (e.g., evidence of short-circuiting by concentrated flow or gullies through buffers or filter strips),
- On-site capacity testing of rain gardens using infiltrometers or similar devices, and
- Visual observations (e.g., presence of water in swales and rain gardens).

As for non-vegetative structural practices, assessment of these indicators would require on-site inspection and/or measurement by landowners, permit-holders, or oversight agencies.

Nonstructural vegetative practices

Performance levels of nonstructural vegetative practices—such as cover crops, reforestation of logged tracts, and construction site seeding—can be assessed using the following types of indicators:

- Density of cover crop planting (e.g., plant count),
- Percent of area covered by cover crop, and
- Extent and vitality of tree seedlings.

These indicators could be assessed by on-site inspection or, in some cases, by remote sensing, either from satellite imagery or aerial photography.

Management practices

Performance levels of management practices—such as nutrient management, conservation tillage, pesticide management, and street sweeping—can be assessed using the following types of indicators:

- Records of street sweeping frequency and mass of material collected,
- Area or percent of cropland under conservation tillage,

- Extent of crop residue coverage on conservation tillage cropland, and
- Fertilizer and/or manure application rates and schedules, crop yields, soil test data, plant tissue test results, and fall residual nitrate tests.

Illustration of line-transect method for residue.

Assessment of these indicators would generally require reporting by private landowners or municipalities, reporting that is required under some regulatory programs. Visual observation of indicators such as residue cover, however, can also be made by on-site inspection or windshield survey.

Data analysis

Data on indicators can be expressed and analyzed in several ways, depending on the nature of the indicators used. Indicators reporting continuous numerical data—such as acres of cover crop or conservation tillage, manure application rates, miles of street sweeping, mass of material removed from catch basins or detention ponds, or acres of logging roads/landings revegetated—can be expressed either in the raw form (e.g., acres with 30 percent or more residue cover) or as a percentage of the design or target quantity (e.g., percent of contracted acres achieving 30 percent or more of residue cover). These metrics can be tracked year to year as a measure of BMP depreciation (or achievement). During the planning phase of a watershed project, it might be appropriate to collect indicator data for multiple years prior to project startup to enable calculation of averages or ranges to better estimate BMP performance levels over crop rotation cycles or variable weather conditions.

Indicators reporting categorical data—such as maintenance of detention basin ridge height and outlet elevations, condition of berms or terraces, or observations of water accumulation and flow—are more difficult to express quantitatively. It might be necessary to establish an ordinal scale (e.g., condition rated on a scale of 1–10) or a binary yes/no condition, then use best professional judgment to assess influence on BMP performance.

In some cases, it might be possible to use modeling or other quantitative analysis to estimate individual or watershed-level BMP performance levels based on verification data. In an analysis of stormwater BMP performance levels, Tetra Tech (2010) presented a series of BMP performance curves based on monitoring and modeling data that relate pollutant removal efficiency to depth of runoff treated (Figure 1). Where depreciation indicators track changes in depth of runoff treated as the capacity of a BMP decreases (e.g., from sedimentation), resulting changes in pollutant removal could be determined from a performance curve. This type of information can be particularly useful during the planning phase of a watershed project to estimate realistic performance levels for existing BMPs that have been in place for a substantial portion of their expected lifespans.

The performance levels of structural agricultural BMPs in varying condition can be estimated by altering input parameters in the *Soil and Water Assessment Tool* (SWAT) model (Texas A&M University 2015a); other models such as the *Agricultural Policy/Environmental eXtender* (APEX) model (Texas A&M

University 2015b) also can be used in this way (including application to some urban BMPs). For urban stormwater, engineering models like *HydroCAD* (HydroCAD Software Solutions 2011) can be used to simulate hydrologic response to stormwater BMPs with different physical characteristics (e.g., to compare performance levels under actual vs. design conditions). Even simple spreadsheet models such as the Spreadsheet Tool for Estimating Pollutant Load (*STEPL*) (USEPA 2015) can be used to quantify the effects of BMP depreciation by varying the effectiveness coefficients in the model.

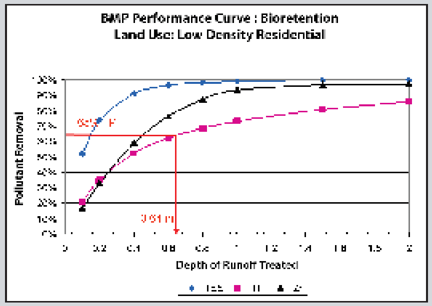


Figure 1. BMP Performance Curve for Bioretention BMP (Tetra Tech 2010).

Data from verification efforts and analysis of the effects of depreciation on BMP performance levels must be qualified based on data confidence. "Confidence" refers mainly to a quantitative assessment of the accuracy of a verification result. For example, the number of acres of cover crops or the continuity of streamside buffers on logging sites determined from aerial photography could be determined by ground-truthing to be within +10 percent of the true value at the 95 percent confidence level. Confidence also can refer to the level of trust that BMPs previously implemented continue to function (e.g., the proportion of BMPs still in place and meeting performance standards). For example, reporting that 75 percent of planned BMPs have been verified is a measure of confidence that the desired level of treatment has been applied.

While specific methods to evaluate data confidence are beyond the scope of this memo, it is essential to be able to express some degree of confidence in verification results—both during the planning phase and over time as the project is implemented. For example, an assessment of relative uncertainty of BMP performance during the planning phase can be used as direct follow-up to verification efforts to those practices for which greater quantification of performance level is needed. In addition, plans to implement new BMPs also can be developed with full consideration of the reliability of BMPs already in place.

Adjusting for Depreciation

Information on BMP depreciation can be used to improve both project management and project evaluation.

Project Planning and Management

Establishing baseline conditions

Baseline conditions of pollutant loading include not only pollutant source activity but also the influence of BMPs already in place at the start of the project. Adjustments based on knowledge of BMP depreciation can provide a more realistic estimate of baseline pollutant loads than assuming that existing land treatment has reduced NPS pollutant loads by some standard efficiency value.

Establishing an accurate starting point will make load reduction targets—and, therefore, land treatment design—more accurate. Selecting appropriate BMPs, identifying critical source areas, and prioritizing land treatment sites will all benefit from an accurate assessment of baseline conditions. Knowledge of depreciation of existing BMPs can be factored into models used for project planning (e.g., by adjusting pollutant removal efficiencies), resulting in improved understanding of overall baseline NPS loads and their sources.

While not a depreciation issue per se, when a BMP is first installed—especially a vegetative BMP like a buffer or filter strip—it usually takes a certain amount of time before its pollutant reduction capacity is fully realized. For example, Dosskey et al. (2007) reported that the nutrient reduction performance of newly established vegetated filter strips increased over the first 3 years as dense stands of vegetation grew in and soil infiltration improved; thereafter, performance level was stable over a decade. When planning a watershed project, vegetative practices should be examined to determine the proper level of effectiveness to assume based on growth stage. Also, because of weather or management conditions, some practices (e.g., trees) might take longer to reach their full effectiveness or might never reach it. The Stroud Preserve, Pennsylvania, section 319 National Nonpoint Source Monitoring Program (NNPSMP) project (1992–2007) found that slow tree growth in a newly established riparian forest buffer delayed significant NO_3–N (nitrate) removal from ground water until about 10 years after the trees were planted (Newbold et al. 2008).

The performance of practices can change in multiple ways over time. For example, excessive deposition in a detention pond that is not properly maintained could reduce overall percent removal of sediment because of reduced capacity as illustrated in Figure 1. The relative and absolute removal efficiencies for various particle size fractions (and associated pollutants) also can change due to reduced hydraulic retention time. Fine particles generally require longer settling times than larger particles, so removal efficiency of fine particles (e.g., silt, clay) can be disproportionally reduced as a detention pond or similar BMP fills with sediment and retention time deteriorates. Expert assessment of the condition and likely current performance level of existing BMPs, particularly those for which a significant amount of pollutant removal is assumed, is essential to establishing an accurate baseline for project planning.

Adaptive watershed management

Watershed planning and management is an iterative process; project goals might not all be fully met during the first project cycle and management efforts usually need to be adjusted in light of ongoing changes. In many cases, several cycles—including mid-course corrections—might be needed for a project to achieve its goals. Consequently, EPA recommends that watershed projects pursue a dynamic and adaptive approach so that implementation of a watershed plan can proceed and be modified as new information becomes available (USEPA 2008). Measures of BMP implementation commonly used as part of progress assessment should be augmented with indicators of BMP depreciation. Combining this information with other relevant project data can provide reliable progress assessments that will indicate gaps and weaknesses that need to be addressed to achieve project goals.

BMP design and delivery system

Patterns in BMP depreciation might yield information on systematic failures in BMP design or management that can be addressed through changes to standards and specifications, contract terms, or permit requirements. This information could be particularly helpful during the project planning phase when both the BMPs and their implementation mechanisms are being considered. For example, a cost-sharing schedule that has traditionally provided all or most funding upon initial installation of a BMP could be adjusted to distribute a portion of the funds over time if operation and maintenance are determined to be a significant issue based on pre-project information. Some BMP components, on the other hand, might need to be dropped or changed to make them more appealing to or easier to manage by landowners. Within the context of a permit program, for example, corrective actions reports might indicate specific changes that should be made to BMPs to ensure their proper performance.

Project Evaluation

Monitoring

Although short-term (3–5 year) NPS watershed projects will not usually have a sufficiently long data record to evaluate incremental project effects, data on BMP depreciation might still improve interpretation of collected water quality data. Even in the short term, water quality monitoring data might reflect cases in which BMPs have suffered catastrophic failures (e.g., an animal waste lagoon breach), been abandoned, or been maintained poorly. Meals (2001), for example, was able to interpret unexpected spikes in stream P and suspended sediment concentrations by walking the watershed and discovering that a landowner had over-applied manure and plowed soil directly into the stream.

Longer-term efforts (e.g., total maximum daily loads[1]) might engage in sustained monitoring beyond individual watershed project lifetime(s). The extended monitoring period will generally allow detection of more subtle water quality impacts for which interpretation could be enhanced with information on BMP depreciation. While not designed as BMP depreciation studies, the following two examples illustrate how changes in BMP performance can be related to water quality.

In a New York dairy watershed treated with multiple BMPs, Lewis and Makarewicz (2009) reported that the suspension of a ban on winter manure application 3 years into the monitoring study led to dramatic increases in stream nitrogen and phosphorus concentrations. First and foremost, knowledge of that suspension provided a reasonable explanation for the observed increase in nutrient levels. Secondly, the study was able to use data from the documented depreciation of land treatment to determine that the winter spreading ban had yielded 60–75 percent reductions in average stream nutrient concentrations.

The Walnut Creek, Iowa, Section 319 NNPSMP project promoted conversion of row crop land to native prairie to reduce stream NO_3-N levels and used simple linear regression to show association of two monitored variables: tracked conversion of row crop land to restored prairie vegetation and stream NO_3-N concentrations (Schilling and Spooner 2006). Because some of the restored prairie was plowed back into cropland during the project period—and because that change was

[1] "Total maximum daily loads" as defined in §303(d) of the Clean Water Act.

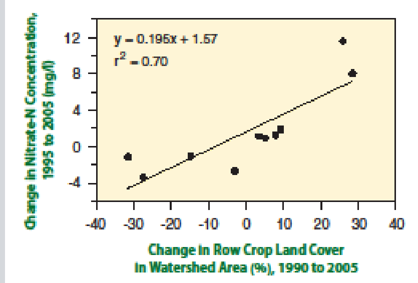


Figure 2. Relating Changes in Stream Nitrate Concentrations to Changes in Row Crop Land Cover in Walnut Creek, Iowa (Schilling and Spooner 2006)).

documented—the project was able to show not only that converting crop land to prairie reduced stream NO_3-N concentrations but also that increasing row crop land led to increased NO_3-N levels (Figure 2).

Modeling

When watershed management projects are guided or supported by modeling, knowledge of BMP depreciation should be part of model inputs and parameterization.

The magnitude of implementation (e.g., acres of treatment) and the spatial distribution of both annual and structural BMPs should be part of model input and should not be static parameters. Where BMPs are represented by pollutant reduction efficiencies, those percentages can be adjusted based on verification of land treatment performance levels in the watershed. Incorporating BMP depreciation factors into models might require setting up a tiered approach for BMP efficiencies (e.g., different efficiency values for BMPs determined to be in fair, good, or excellent condition) rather than the currently common practice of setting a single efficiency value for a practice assumed to exist. This approach could be particularly important for management practices such as agricultural nutrient management or street sweeping, in which degree of treatment is highly variable. For structural practices, a depreciation schedule could be incorporated into the project, similar to depreciating business assets. In the planning phase of a watershed project, multiple scenarios could be modeled to reflect the potential range of performance levels for BMPs already in place.

Recommendations

The importance of having accurate information on BMP depreciation varies across projects and during the timeline of a single project. During the project planning phase, when plans for the achievement of pollutant reduction targets rely heavily on existing BMPs, it is essential to obtain good information on the level of performance of the BMPs to ensure that plan development is properly informed. If existing BMPs are a trivial part of the overall watershed plan, knowledge of BMP depreciation might not be critical during planning. As projects move forward, however, the types of BMPs implemented, their relative costs and contributions to achievement of project pollutant reduction goals, and the likelihood that BMP depreciation will occur during the period of interest will largely determine the type and extent of BMP verification required over time. The following recommendations should be considered within this context:

- For improved characterization of overall baseline NPS loads, better identification of critical source areas, and more effective prioritization of new land treatment during project planning, collect accurate and complete information about:
  - Land use,

- Land management, and
- The implementation and operation of existing BMPs. This information should include:
  - Original BMP installation dates,
  - Design specifications of individual BMPs,
  - Data on BMP performance levels if available, and
  - The spatial distribution of BMPs across the watershed.
- Track the factors that influence BMP depreciation in the watershed, including:
  - Variations in weather that influence BMP performance levels,
  - Changes in land use, land ownership, and land management,
  - Inspection and enforcement activities on permitted practices, and
  - Operation, maintenance, and management of implemented practices.
- Develop and use observable indicators of BMP status/performance that:
  - Are tailored to the set of BMPs implemented in the watershed and practical within the scope of the watershed project's resources,
  - Can be quantified or scaled to document the extent and magnitude of treatment depreciation, and
  - Are able to be paired with water quality monitoring data.
- After the implementation phase of the NPS project, conduct verification activities to document the continued existence and function of implemented practices to assess the magnitude of depreciation and provide a basis for corrective action. The verification program should:
  - Identify and locate all BMPs of interest, including cost-shared, non-cost-shared, required, and voluntary practices;
  - Capture information on structural, annual, and management BMPs;
  - Obtain data on BMP operation and maintenance activities; and
  - Include assessment of data accuracy and confidence.
- To adjust for depreciation of land treatment, apply verification data to watershed project management and evaluation by:
  - Applying results directly to permit compliance programs,
  - Relating documented changes in land treatment performance levels to observed water quality,
  - Incorporating measures of depreciated BMP effectiveness into modeling efforts, and
  - Using knowledge of treatment depreciation to correct problems and target additional practices as necessary to meet project goals in an adaptive watershed management approach.

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