# Upper Duck Creek Nonpoint Source Watershed Implementation Plan

Prepared by:

Outagamie County Land Conservation Department

2016

(This page intentionally left blank)

# Upper Duck Creek Nonpoint Source Watershed Implementation Plan


Prepared By:

Outagamie County Land Conservation Department

3365 W. Brewster St.

Appleton, WI 54914


May 2016

(This page intentionally left blank)

## Table of Contents

# List of Figures

# List of Tables

# List of Appendices

*Acknowledgements*

Funding for the development of the Upper Duck Creek Watershed plan was provided by an EPA-319 grant. Outagamie County Land Conservation Department staff conducted analysis, summarized results, and authored the Upper Duck Creek Watershed plan.

Primary Authors and Contributors to the Nonpoint Source Watershed Implementation Plan:

**Outagamie County Land Conservation Department-** Sarah Francart, Greg Baneck, Jeremy Freund, Traci Meulmans, Sarah Minniecheske

**Alliance for the Great Lakes-** Olga Lyandres, Aritree Samanta, Todd Brennan

**Wisconsin Department of Natural Resources**- Andrew Craig

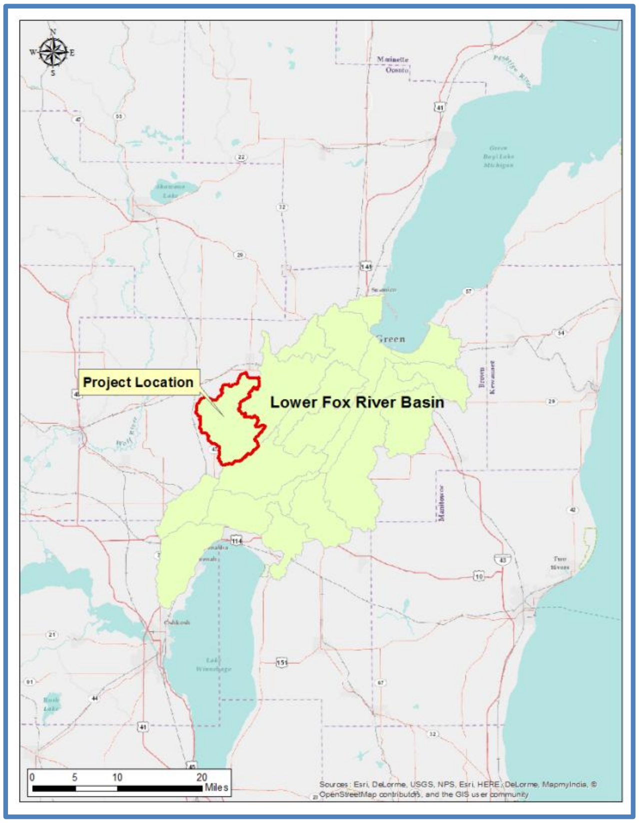
*A special acknowledgement and thank you to all the landowners that participated in the Alliance for the Great Lakes Survey and the local agronomists and consultants who helped administer the survey.*

(This page intentionally left blank)

## *Upper Duck Watershed Implementation Plan*

*Executive Summary*

The Upper Duck Creek Watershed is a subwatershed of the Lower Fox River Basin and is located in east central Wisconsin in Outagamie County. Duck Creek starts in the Town of Black Creek, flows through the Town of Center, Osborn, Freedom, and Oneida before flowing into the Bay of Green Bay in Hobart. The Duck Creek watershed is further divided into the Upper, Middle and Lower Duck Creek subwatersheds. Oneida Creek and Trout Creek are also tributaries to the Duck Creek Watershed. The Upper Duck Creek Watershed drains approximately 30,854 acres.




Historically, the land in this area was forested with many wetlands. The Lower Fox River Basin was home to many Native American cultures before Europeans began to settle in the area in the early 1800's. The farming and paper industry in the area has led to clearing of forests and natural areas and draining of wetlands in the Lower Fox River Basin. Farming, industry, and urban development in the Lower Fox River Basin has led to poor water quality in the Fox River and Bay of Green Bay.

Excessive sediment loads and increased algal blooms in the Lower Fox River and Bay of Green Bay prompted the need for action to be taken in the Lower Fox River Basin. A Total Maximum Daily Load was approved for the Lower Fox River and Lower Green Bay and its tributaries in 2012. The development of implementation plans for the subwatersheds of the Lower Fox River Basin are necessary to meet the assigned daily loads of the TMDL.

Agriculture is the dominant land use in the Upper Duck Creek watershed and is the main contributor to poor water quality. An inventory of the stream banks indicates that streambank erosion is not a major contributor of sediment or nutrients. The extent of tile drainage in this watershed area may also play a factor into the amount nutrient and sediment loading.

The Upper Duck Creek Watershed plan provides a framework to accomplish the following goals:

Goal #1: Improve surface water quality to meet the TMDL limits for total phosphorus and sediment.

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.

Challenges and sources in the watershed:

The dominant land use in the watershed is agriculture and is responsible for 94 % of the sediment and 91% of the phosphorus loading in the watershed. The majority of cropland in the watershed is drained via subsurface drainage and an extensive agricultural drainage network. Agricultural runoff and erosion as well as subsurface drainage are likely the main contributors to nutrient and sediment loading in the watershed.

Concentrated flow causing sediment erosion in Upper Duck Watershed. Spring 2015

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 cost, potential funding sources, agencies responsible for implementation, and a measure of success.

Recommended Management Practices:

- Reduced Tillage Methods (Strip/Zone till, No till, Mulch till)
- Cover Crops
- Vegetated Buffers
- Wetland Restoration
- Grassed Waterways
- Nutrient Management
- Vertical Manure Injection
- Exploring new technologies/practices (soil amendments, tile drainage water management, phosphorus removal structures, etc)

Education and Information Recommendations:

- Provide educational workshops and tours on how to implement best management practices.
- Engage landowners in planning and implementing conservation on their land and ensuring they know what technical tools and financial support is 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.

## Conclusion

Meeting the goals for the Upper Duck Creek watershed will be challenging. Watershed planning and implementation is primarily a voluntary effort with limited enforcement for “non-compliant” 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 area.

(This page intentionally left blank)

## List of Acronyms

**AM-** Adaptive Management

**BMP-** Best Management Practice

**CAFO-** Concentrated Animal Feeding Operation

**CLU**- Common Land Unit

**GBMSD-** Green Bay Metropolitan Sewerage District (NEW Water)

**GLRI**- Great Lakes Restoration Initiative

**GIS**- Geographic Information System

**HSG-**Hydrologic Soil Group

**IBI**- Index of Biotic Integrity

**LFRWMP**- Lower Fox River Watershed Monitoring Program

**LWCD/LCD**- Land and Water Conservation Department/ Land Conservation Department

**MS4**- Municipal Separate Storm Sewer System

**NRCS**-Natural Resource Conservation Service

**PI**- Phosphorus Index

**USEPA**- United States Environmental Protection Agency

**UWEX**- University of Wisconsin Extension

**USDA**- United States Department of Agriculture

**USGS**-United States Geologic Service

**UWGB-**University of Wisconsin-Green Bay

**WDNR**-Wisconsin Department of Natural Resources

**WPDES**- Wisconsin Pollutant Discharge Elimination System

**WWTF**- Waste Water Treatment Facility

**TMDL-**Total Maximum Daily Load

**TP**- Total Phosphorus

**TSS**- Total Suspended Solids

**WQT**- Water Quality Trading

***Note*****: Lower Fox River TMDL plan-** Refers to the report "*Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay"* prepared by the Cadmus Group that was approved in 2012 by WDNR and EPA.

## 1.0 Introduction

### *1.1 Upper Duck Watershed Setting*

The Upper Duck Creek Watershed is a sub watershed of the Duck Creek Watershed and Lower Fox River Basin in Wisconsin. The Duck Creek watershed is subdivided into Lower Duck, Middle Duck, Upper Duck, and Oneida Creek. The Upper Duck watershed is located in entirely Outagamie County, while the Middle and Lower Duck watershed are in Brown County. The Upper Duck watershed drains a total area of 30,854 acres. The watershed is located North of Lake Winnebago and Southwest of the Bay of Green Bay. Duck Creek flows directly into Bay of Green Bay in Howard, Wisconsin. The watershed is predominately agricultural land and includes portions of the Towns of Black Creek, Center, Freedom, Osborn, and Oneida.

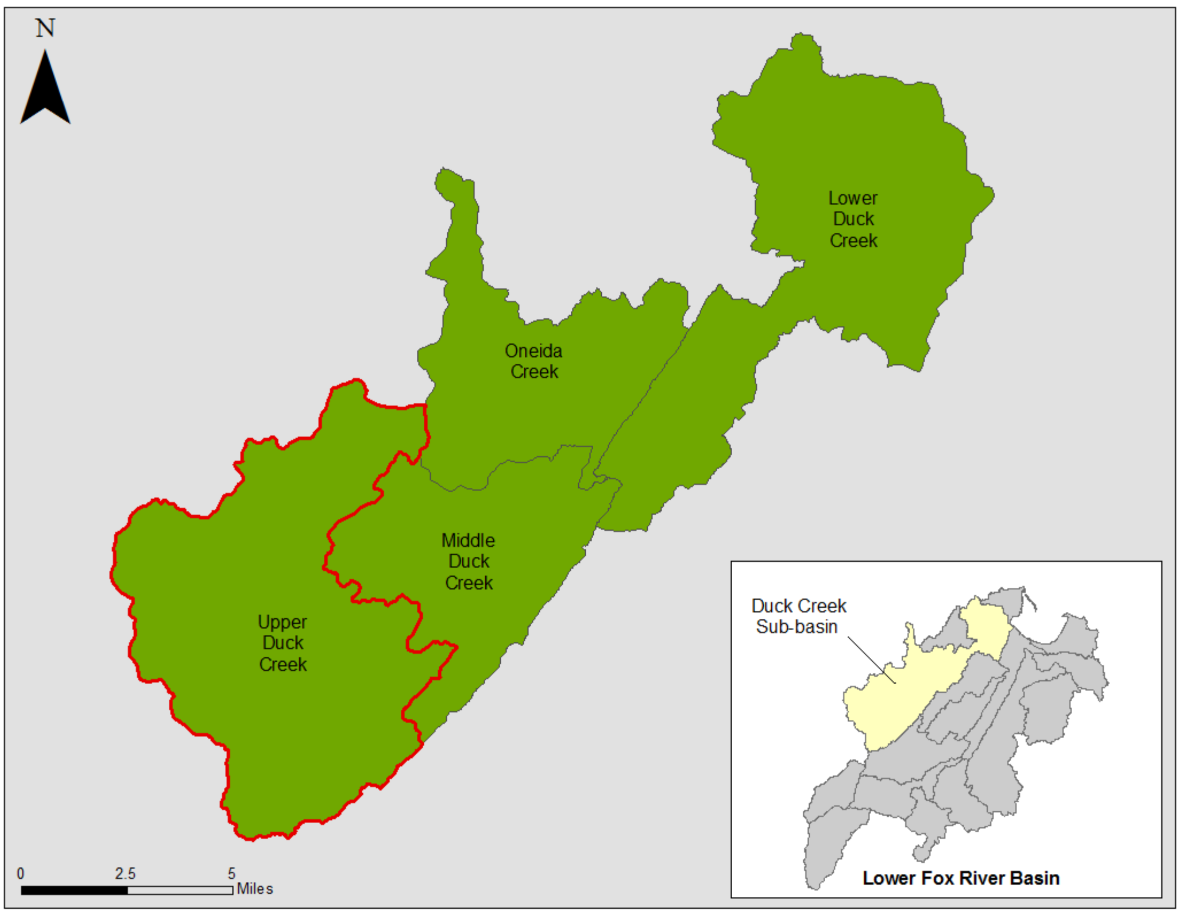



**Figure 1.** Upper Duck Creek Watershed.

### *1.2 Purpose*

Excessive sediment and nutrient loading to the Lower Fox River and Bay of Green Bay has led to increased algal blooms, oxygen depletion, water clarity issues, and degraded habitat. Algal blooms can be toxic to humans and costly to a local economy. Estimated annual economic losses due to eutrophication in the United States are as follows: recreation ($1 billion), waterfront property value ($0.3-2.8 million), recovery of threatened and endangered species ($44 million) and drinking water ($813 million) (Dodds, et al 2009). Due to the impairments of the Lower Fox River Basin, a TMDL (Total Maximum Daily Load) was developed for the Lower Fox River basin and its tributaries that was approved in 2012. The purpose of this project is to develop an implementation plan for the Upper Duck Creek subwatershed to meet the requirements of the TMDL. The Lower Fox River TMDL requires that any tributaries to the Lower Fox River meet a median summer total phosphorus limit of 0.075 mg/l or less. A median total suspended solids limit has not been determined for tributaries but is set at 18 mg/l for the outlet of the Fox River.

**Figure 2.** Mouth of the Fox River emptying into the Bay of Green Bay, April 2011. Photo Credit: Steve Seilo.

### *1.3 US EPA Watershed Plan Requirements*

In 1987, Congress enacted the Section 319 of the Clean Water Act which established a national program to control nonpoint sources of water pollution. Section 319 grant funding is available to states, tribes, and territories for the restoration of impaired waters and to protect unimpaired/high quality waters. Watershed plans funded by Clean Water Act section 319 funds must address nine key elements that the EPA has identified as critical for achieving improvements in water quality (USEPA 2008). The nine elements from the USEPA Nonpoint Source Program and Grants Guidelines for States and Territories are as follows:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level along with estimates of the extent to which they are present in the watershed

2. An estimate of the load reductions expected from management measures.

3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in element 2, and a description of the critical areas in which those measures will be needed to implement this plan.

4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

5. An information and education component used to enhance public understanding of the plan and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.

9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element 8.

### *1.4 Prior Studies, Projects, and Existing Resource Management and Comprehensive Plans*

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

Total Maximum Daily Load & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay -2012

The *TMDL & Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay* was prepared by the Cadmus Group for the EPA and WDNR and was approved in 2012. This plan set a TMDL for the Lower Fox River and its tributaries as well as estimated current pollutant loading and loading reductions needed to meet the TMDL for each subwatershed in the Lower Fox River Basin.

Lower Fox River Watershed Monitoring Program

The Lower Fox River Watershed Monitoring Program is a watershed education and stream monitoring program that involves coordination from university students and researchers from University of Wisconsin-Green Bay, University of Wisconsin-Milwaukee, Green Bay Metropolitan Sewerage District (GBMSD/New Water), Cofrin Center for Biological Diversity, and the United States Geological Survey. The program also involves area high school teachers and students.

Lake Michigan Lakewide Management Plan-2008

Plan developed by the Lake Michigan Technical Committee with assistance from the Lake Michigan Forum and other agencies and organizations. The plan focuses on improving water quality and habitat in the Lake Michigan basin including reducing pollutant loads from its tributaries.

Lower Green Bay Remedial Action Plan-1993

The Lower Green Bay Remedial Action Plan is a long term strategy for restoring water quality to the Lower Green Bay and Fox River. Two of the top five priorities for the Remedial Action Plan are to reduce suspended sediments and phosphorus.

Hydrology, Phosphorus, and Suspended Solids in Five Agricultural Streams in the Lower Fox River and Green Bay Watersheds, Wisconsin, Water Years 2004-2006

A 3-year study done by the U.S. Geological Survey and University of Wisconsin-Green Bay to characterize water quality in agricultural streams in the Fox/Wolf watershed and provided information to assist in the calibration of a watershed model for the area.

Nonpoint Source Control Plan for the Duck, Apple, and Ashwaubenon Creeks Priority Watershed Project-1997

Nonpoint watershed plan developed for the Duck, Apple, and Ashwaubenon Creeks Watersheds 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 2010. A moratorium on signing agreements for non-structural practices was placed on September 5, 2001 which put the upland sediment goal of the plan out of reach. A final project report also concluded that the watershed would also benefit from more buffered areas between cropland and streams.

Temporal Assessment of Management Practices and Water Quality in the Duck Creek Watershed, Wisconsin-2010

A study completed by the University of Wisconsin-Green Bay for the Oneida Nation of Wisconsin. The study was conducted to determine progress in reducing phosphorus and sediment in Duck Creek from implementation of best management practices during the Duck, Apple, and Ashwaubenon Creeks Priority Watershed Project. The study analyzed 20 years of water quality data broken down into three time periods (1989-1995), (1996-2003), and (2004-2008). Analysis of suspended solids data was not achievable with this study due to different laboratory processing methods. Four of the statistical procedures in the study led to the general conclusion that both TP and DP concentrations decreased significantly during the 20 year time period, with decreases occurring primarily in the beginning (1989-1995).

Phosphorus and TSS Trends in Duck Creek, Northeastern Wisconsin-2014

Study completed by the University of Wisconsin-Green Bay to determine phosphorus and TSS trends in Duck Creek from the most recent period (2004-2013). Evidence indicates TP, DP, and TSS concentrations declined during the 2004 to 2013 period. Median concentration of TP was 0.179 mg/l from June 2010 to October 2013, still well above TMDL target of 0.075 mg/l.

### *1.5 Wisconsin Ecoregion*

Ecoregions are based on biotic and abiotic 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. Omerik of the USGS. The Upper Duck Creek watershed is located in the Southeastern Wisconsin Till Plains ecoregion and in the Lake Michigan Lacustrine clay sub ecoregion. The Southeastern Wisconsin Till Plains supports a variety of vegetations types from hardwood forests to tall grass prairies. Land used in this region is mostly used for cropland and has a higher plant hardiness value than in ecoregions to the north and west.

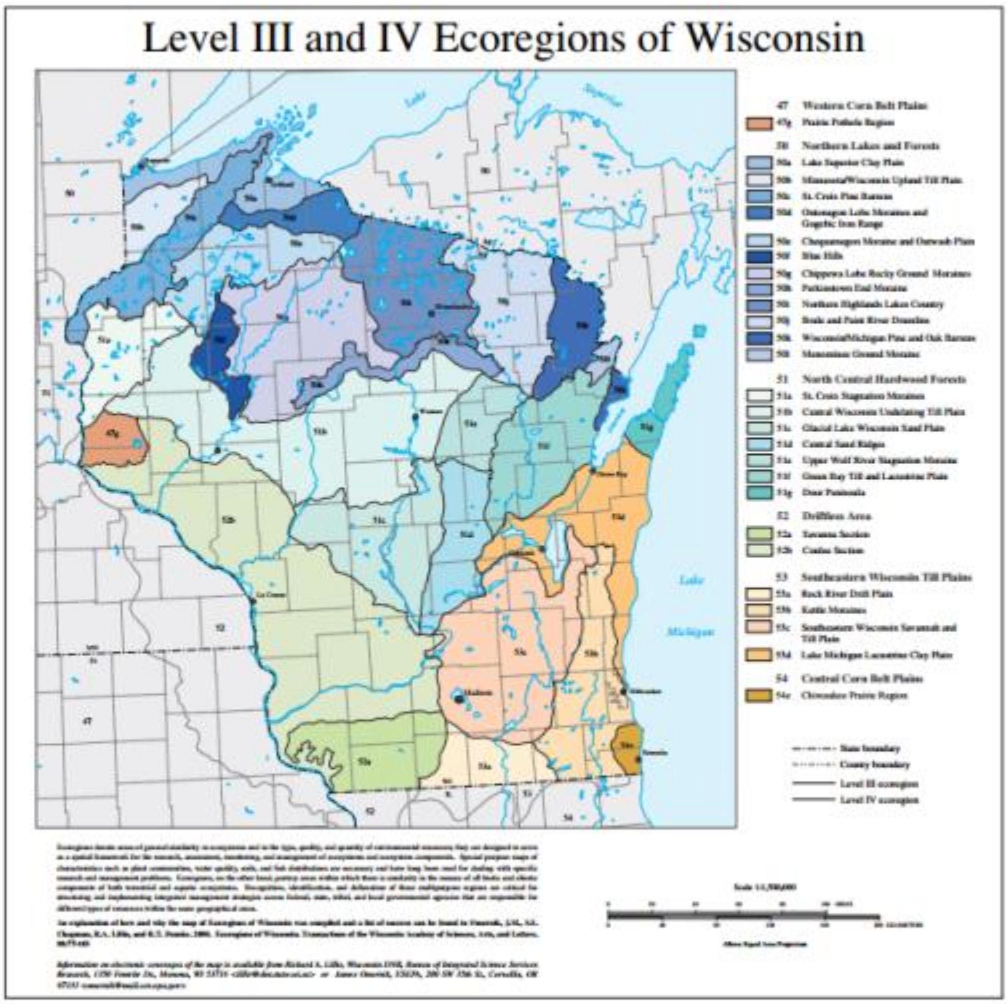



**Figure 3.** Map of Ecoregions of Wisconsin. Source: Omerik et al 2000.

### *1.6 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 30 inches a year in the watershed area. The climate in central and southern Wisconsin is favorable for dairy farming, where corn, small grains, hay, and vegetables are the primary crops.

### *1.7 Topology and geology*

The Upper Duck Creek watershed lies in the Eastern Ridges and Lowlands geographical province of Wisconsin. The Upper Duck Creek 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, and lake plain. The highest point in the watershed area is 905 ft above sea level in the Northwest portion of the watershed and the lowest point in the watershed is 720 feet above sea level in the Southeast corner (Figure 5). There is a 185 foot change in elevation from highest and lowest point in the watershed.


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

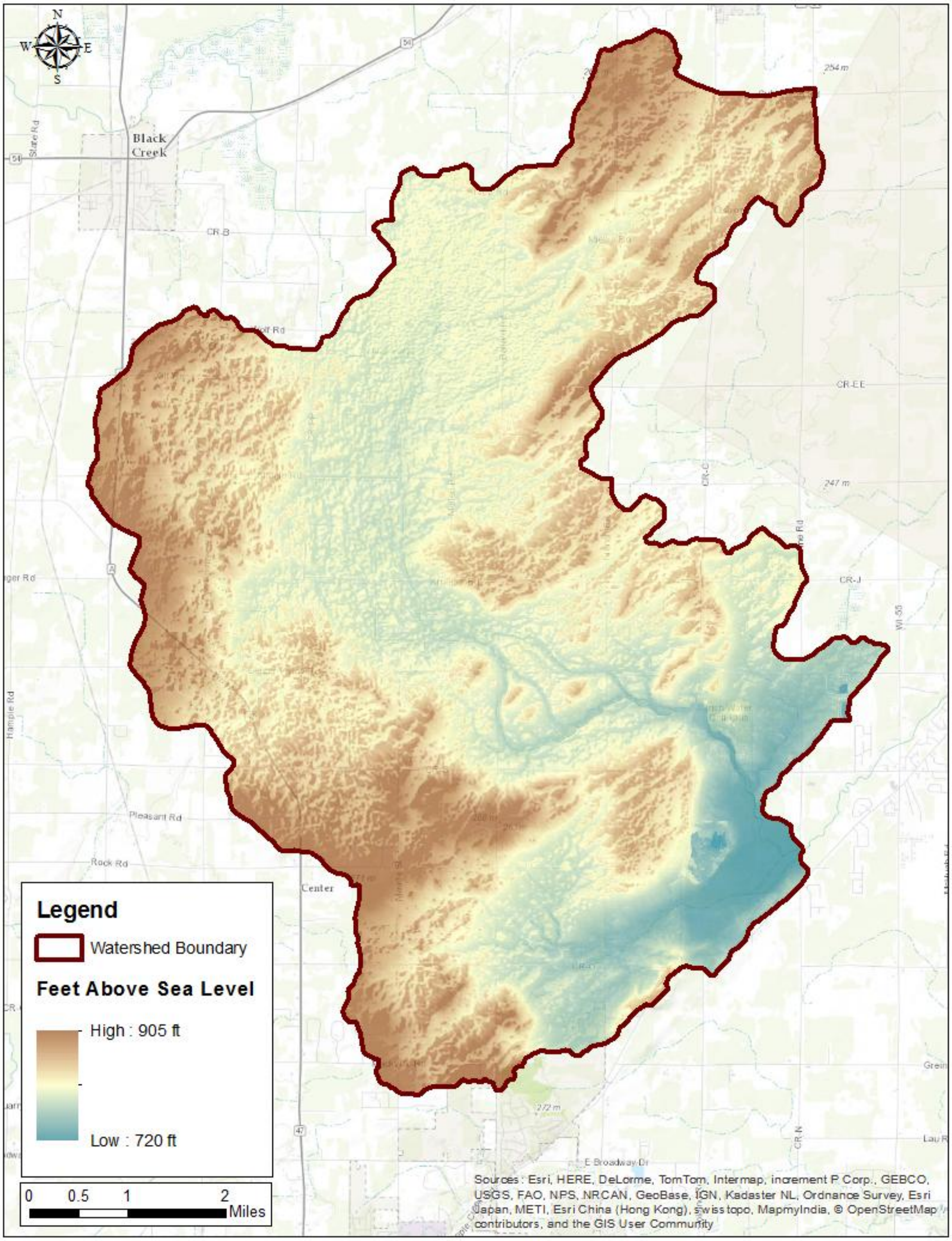



**Figure 5.** Digital Elevation Model.

### *1.8 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 silt loam (52.94%), Symco silt loam (14.60 %), and Carbondale muck (5.6%).

**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. Table 2 summarizes the acreage and percent of each group present in the watershed and Figure 6 shows the location of each hydrologic soil group. The dominant hydrologic soil group in the watershed is Group C (59.95%). Group D soils have the highest runoff potential followed by group C. Soils with high runoff potentials account for 78.19% of the soils in the watershed.

**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 |

**Table 2.** Hydrologic Soil Group.

| Hydrologic Soil Group | Acres | Percent |
|---|---|---|
| A | 164.2 | 0.5 |
| A/D | 2,260.0 | 7.4 |
| B | 777.4 | 2.5 |
| B/D | 3,344.7 | 10.9 |
| C | 18,403.2 | 59.9 |
| C/D | 5,216.0 | 17.0 |
| D | 533.8 | 1.7 |
| **Total** | **30,699.3** | 100.0 |

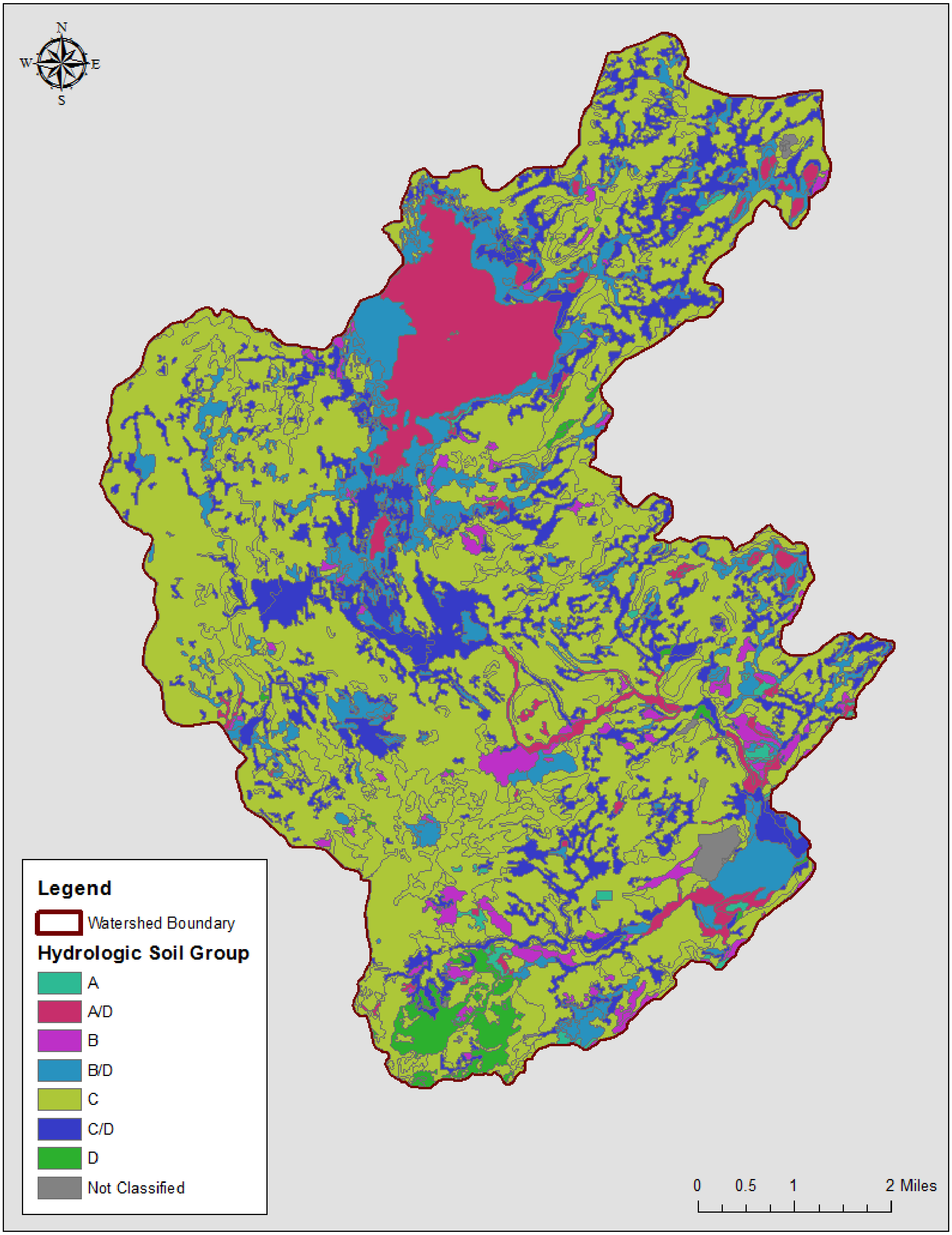



**Figure 6.** Soil Hydrologic Groups.

## 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 more susceptible to erosion than fine textured soils such as clay. 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) 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. The majority of the soils in the Upper Duck Creek watershed have moderate to high values for erodibility (K) (Figure 7).

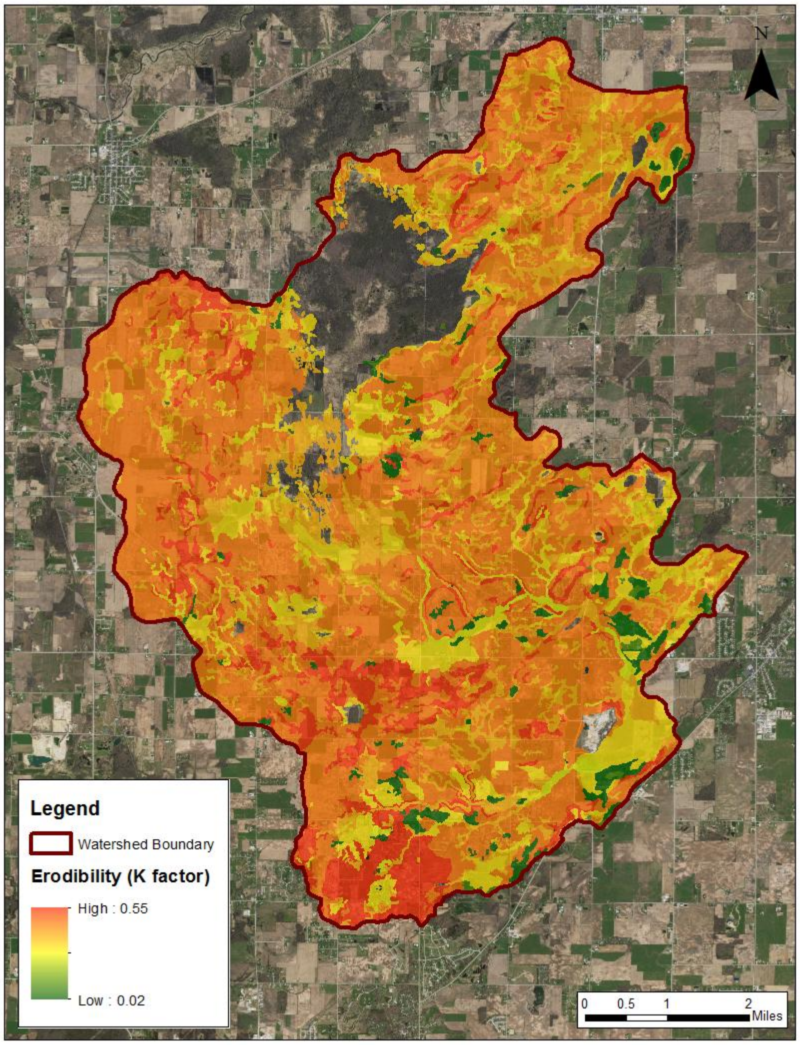



**Figure 7.** Soil erodibility.

(This page intentionally left blank)

## 2.0 Watershed Jurisdictions, Demographics, and Transportation Network

### *2.1 Watershed Jurisdictions*

The Upper Duck Creek Watershed is located entirely in Outagamie County. The Town of Freedom, Town of Center, Town of Osborn, Town of Black Creek, and the City of Appleton are located in the watershed area. A small portion of the Oneida Reservation also resides in the northeast corner of the watershed.

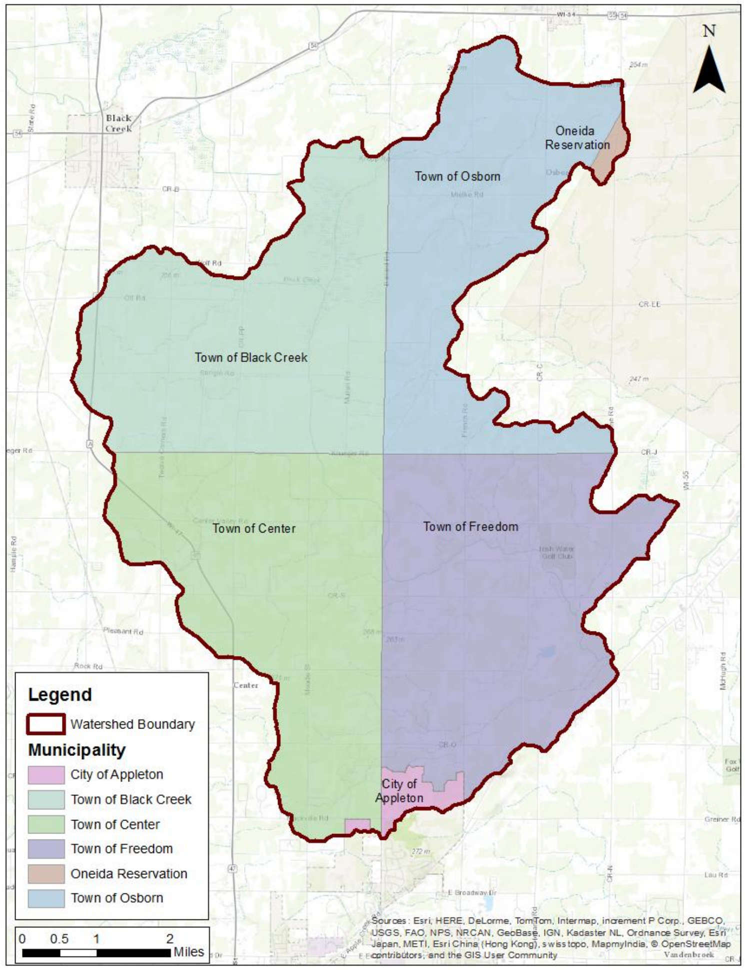



**Figure 8.** Watershed Jurisdictions.

**Table 3.** Watershed Jurisdictions.

| Jurisdiction | Acres | Percent |
|---|---|---|
| **County** | | |
| Outagamie County | 30,854.0 | 100.0 |
| **Municipality** | | |
| Town of Freedom | 8,265.0 | 26.8 |
| Town of Center | 7,835.0 | 25.4 |
| Oneida Reservation | 145.0 | 0.5 |
| Town of Osborn | 6,352.0 | 20.6 |
| Town of Black Creek | 7,846.0 | 25.4 |
| City of Appleton | 411.0 | 1.3 |

*2.2 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. Outagamie County has ordinances relating to Shoreland and Wetland Zoning, Animal Waste Management & Runoff management, Erosion Control, and Stormwater. The Oneida Reservation is governed by its own set of rules and regulations. In addition to county-level regulations, each municipality has their own regulations. Municipalities may or may not provide additional watershed protection above and beyond existing watershed ordinances under local municipal codes.

Much of the Upper Duck Creek is in a legal drainage district and is under jurisdiction of the drainage board. A drainage district is a local governmental district which is organized to drain lands for agricultural or other purposes. Landowners who benefit from drainage must pay assessments to cover the cost of constructing, maintaining, and repairing the district drains. The county drainage board is required to ensure that all drainage districts under its jurisdiction comply with the standards in the drainage rule (Ch. ATCP 48, Wis. Admin Code) and statue (Ch. 88, Wis. Stats.).

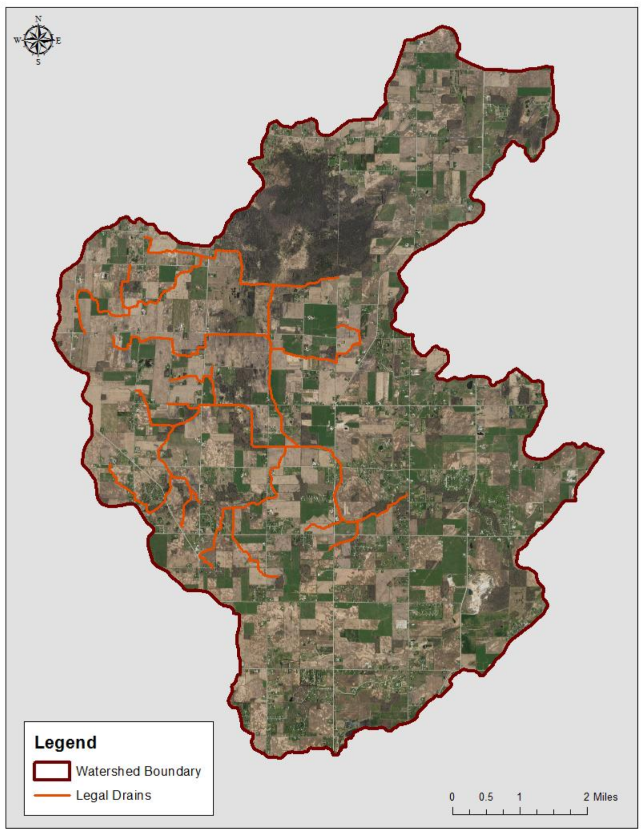



**Figure 9.** Up Duck Creek Legal Drains.

The Northeast Wisconsin Stormwater Consortium (NEWSC) is a private entity in the watershed area that provides a technical advisory role. In 2002, Fox Wolf Watershed Alliance began exploring the creation of an organization to assist local and county governments in cooperative efforts to address storm water management, which led to the creation of the Northeast Wisconsin Stormwater Consortium. Outagamie County, Brown County, Calumet County, and the City of

Kaukauna have representatives in the organization. Northeast Wisconsin Stormwater Consortium facilitates efficient implementation of stormwater programs that meet DNR and EPA regulatory requirements and maximize the benefit of stormwater activities to the watershed by fostering partnerships, and by providing technical, administrative, and financial assistance to its members.

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, Department of Transportation.

### 2.3 Transportation

The major roads that run through the Upper Duck Creek watershed include County Highways EE, S, PP, and C. Hwy S runs east-west across the southern half of the watershed Hwy C runs north-south on the eastern edge of the watershed. County Hwy EE runs north south and changes direction east west near the northern half of the watershed. The Newton Blackmour State Trail is located north of the watershed and County Hwy 47 runs north-south on the west side of the watershed.

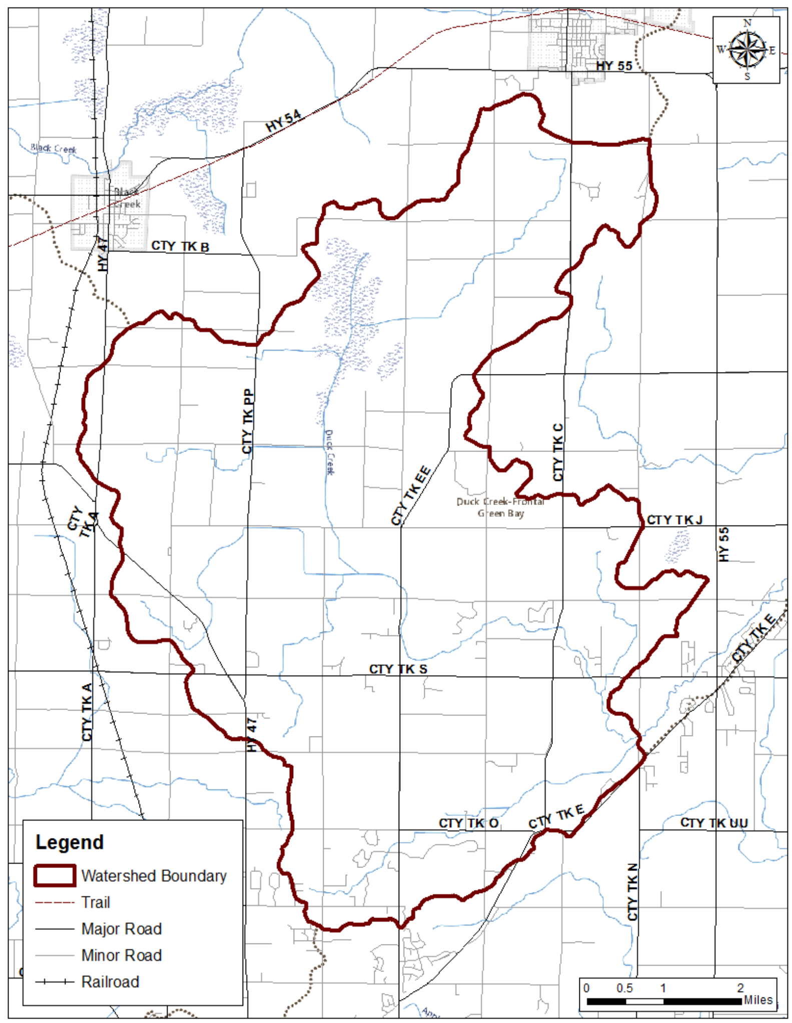



**Figure 10.** Transportation.

### *2.4 Population Demographics*

The Upper Duck Creek Watershed is a rural, low density populated area but is located just over 2 miles north of the Fox Valley. Wisconsin population projections were developed by the Wisconsin Department of Administration's Demographic Services Center in 2013 and were based on the 2010 Census. Outagamie County's population is predicted to increase 18% from 2010 to the year 2030 (Table 4). Urban sprawl from the Fox Valley area could further impact the amount of land available for agriculture in the area in the future as well as negatively impact the water quality.

**Table 4.** Population Projections. Source: Wisconsin Department of Administration Demographic Services Center (Eagan-Robertson 2013)

| County Name | April 2010 Census | April 2020 Projection | April 2030 Projection | Total Change |
|---|---|---|---|---|
| Outagamie | 176,695 | 191,635 | 208,730 | 32,035 |

Median annual income data was collected from 2008-2012 by the American Community Survey. Population data for municipalities and counties are from the 2010 US Census. Median annual income in the municipalities in the watershed is above the county averages for the area.

**Table 5.** Population and Median House Hold Income. Source: U.S. Census Bureau (US Census Bureau 2010 & 2008-2012 US Census Bureau American Community Survey 5 Year Estimates)

| **Municipality** | **Population** | **Median Income** |
|---|---|---|
| Town of Freedom | 5,842 | 72,386 |
| Town of Center | 3,402 | 69,482 |
| Oneida Reservation | 4,678 | 49,030 |
| Town of Osborn | 1,170 | 81,875 |
| Town of Black Creek | 1259 | 59,911 |
| City of Appleton | 53,183 | 72,623 |
| **County** | | |
| Outagamie | 176,695 | 58,318 |

## 3.0 Land Use/Land Cover

### *3.1 Existing Land Use/Land Cover*

Land Cover and land use data for the watershed area was obtained from the National Land Cover Database 2011 (NLCD 2011). The land cover data was created by the Multi-resolution Land Characteristics (MRLC) Consortium. The NLCD 2011 has 16 land cover classifications and a spatial resolution of 30 meters. The classification of land use is based on 2011 Landsat satellite data. Land cover and land use for the watershed is shown in Table 6 & Figure 11.

The dominant land use in the watershed is agriculture at 78.9% including cultivated crops (56.34%) and pasture/hay (22.56%). Developed land accounts for just 6.45% of the land in the watershed. Natural areas such as wetlands, forest, and grassland make up the remaining 14.65 % of the watershed area.

**Table 6.** Land Use/Land Cover. Source: NLCD 2011.

| Land Use | Acres | Percent |
|---|---|---|
| Open Water | 14.6 | 0.0 |
| Developed, Open Space | 1,044.0 | 3.4 |
| Developed, Low Intensity | 896.6 | 2.9 |
| Developed, Medium Intensity | 36.3 | 0.1 |
| Developed, High Intensity | 12.1 | 0.0 |
| Barren Land | 151.0 | 0.5 |
| Deciduous Forest | 2,736.8 | 8.9 |
| Evergreen Forest | 11.9 | 0.0 |
| Mixed Forest | 71.4 | 0.2 |
| Shrub/Scrub | 66.5 | 0.2 |
| Herbaceous | 109.0 | 0.4 |
| Hay/Pasture | 6,960.4 | 22.6 |
| Cultivated Crops | 17,384.6 | 56.3 |
| Woody Wetlands | 991.8 | 3.2 |
| Emergent Herbaceous Wetlands | 366.4 | 1.2 |
| **Total** | **30,853.5** | **100.0** |

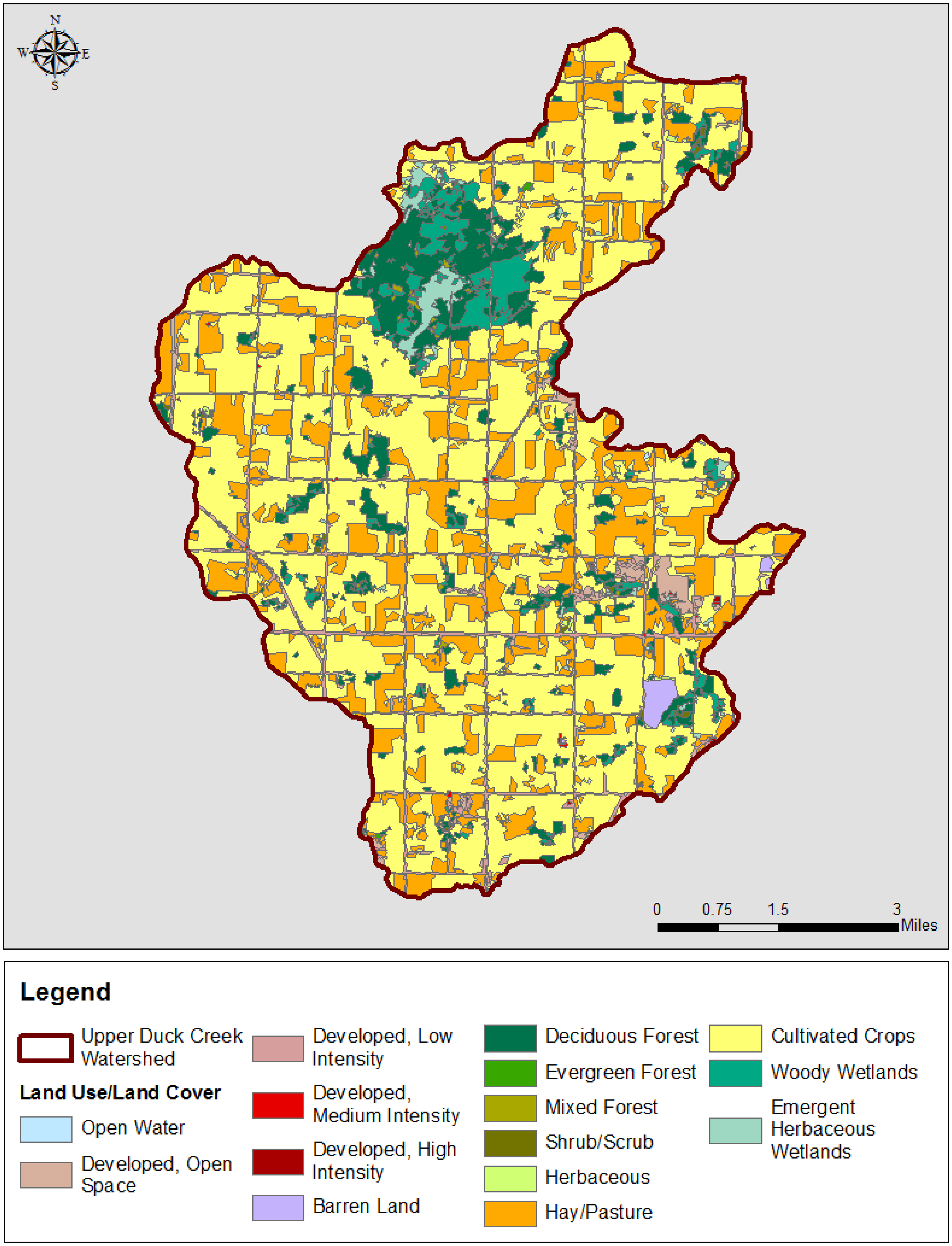



**Figure 11.** NLCD 2011 Land Use.

### *3.2 Crop Rotation*

Cropland data was obtained from the USDA National Agriculture Statistics Service. NASS produced 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 2014 was analyzed to obtain a crop rotation. Crop rotations for the watershed are shown in Table 7 and Figure 12.

Dairy and Cash grain are the dominant rotations in the watershed at 43.59% and 37.14% respectively followed by Pasture/Hay/Grassland at 18.31%. 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 7.** Crop Rotation.

| Crop Rotation | Acres | Percent |
|---|---|---|
| Pasture/Hay/Grassland | 4,265.2 | 18.3 |
| Dairy Rotation | 10,156.4 | 43.6 |
| Cash Grain | 8,654.6 | 37.1 |
| Potato/Grain/Vegetable Rotation | 10.8 | 0.0 |
| Continuous Corn | 213.0 | 0.9 |
| **Total** | **23,300.0** | **100.0** |

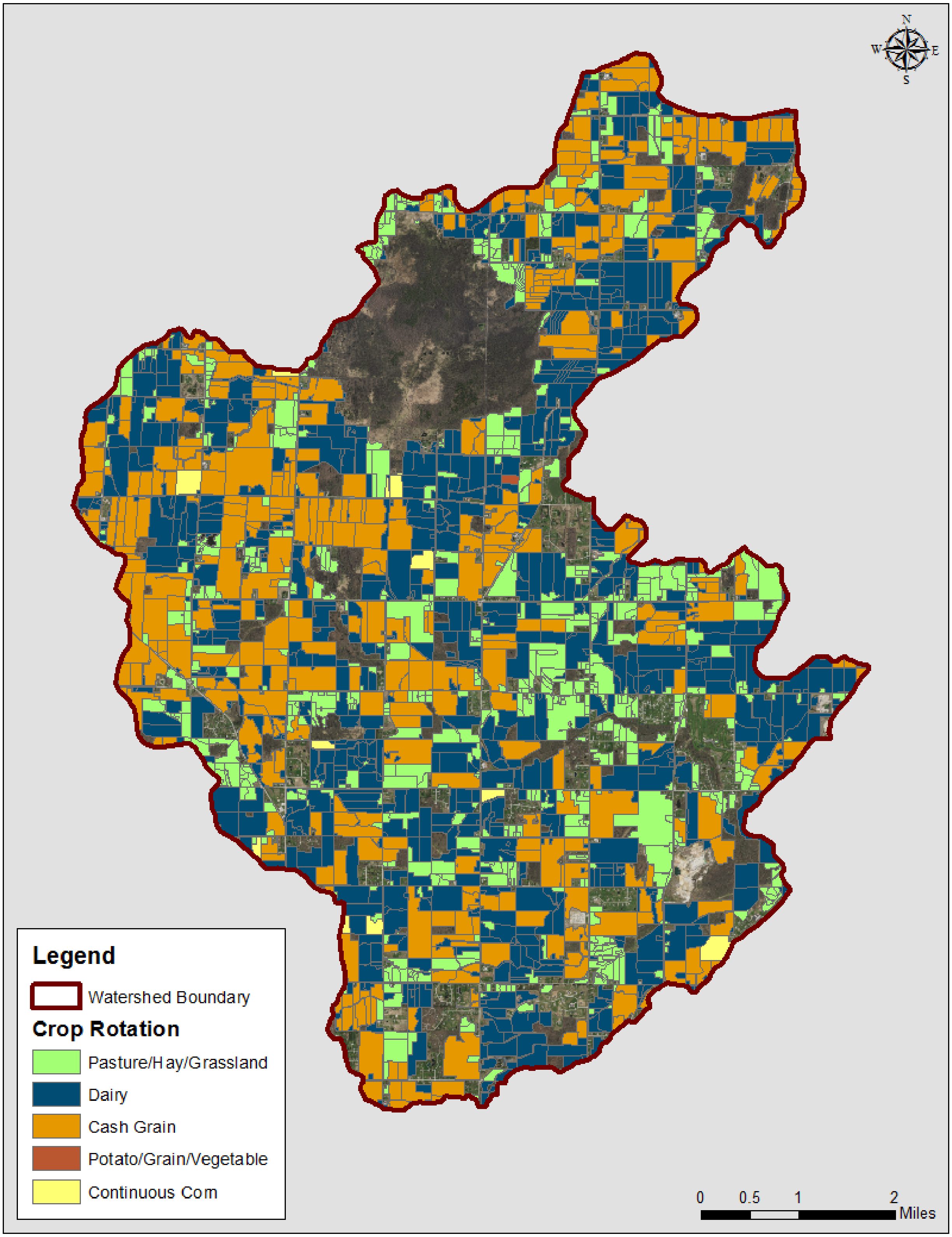



**Figure 12.** Crop rotation in Upper Duck Creek Watershed 2009-2014.

## 4.0 Water Quality

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 sit-specific conditions, or adopt criteria based on other scientifically defensible methods. Water quality standards require assigning a designated use to the water body.

### *4.1 Designated Use and Impairments*

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". Duck Creek was first listed as an impaired waterway in 1998. Duck Creek is impaired due to excess phosphorus, sediment loading, and mercury. The Lower Fox River TMDL only addresses phosphorus and sediment loading in the Lower Fox River tributaries. Figure 13 shows stream segments in the Upper Duck Creek watershed listed as impaired.

Streams and Rivers in Wisconsin are assessed for the following use designations: Fish and Aquatic Life, Recreational Use, Fish Consumption (Public Health and Welfare), and General Uses. The Upper Duck Creek is designated for Fish and Aquatic Life. The Fish and Aquatic Life (FAL) designations for streams and rivers are categorized into subcategories. Upper Duck Creek is currently designated to the Warmwater Forage Fish (WWFF) Community but is capable of attaining Warm Water Sport Fish (WWSF) category. Streams in the WWFF category are capable of supporting a warm water dependent forage fishery. Aquatic life communities in this category usually require cool or warm temperatures and concentrations of Dissolved Oxygen (DO) that do not drop below 5 mg/l.

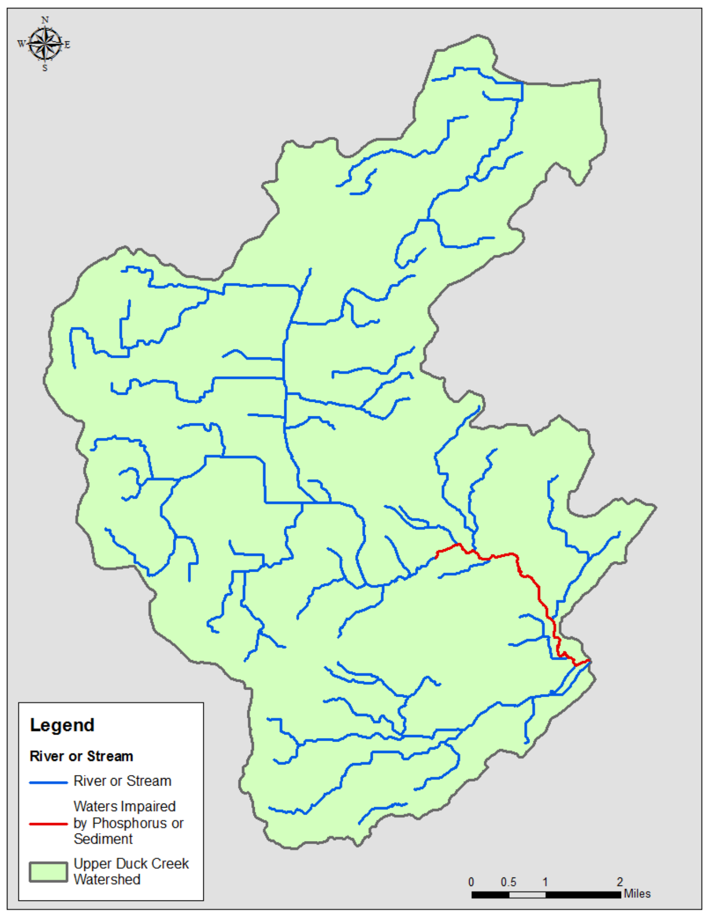



**Figure 13.** Impaired stream segments.

Streams and rivers are also being evaluated for placement in a revised aquatic life use classification system where the subclasses are referred to as Natural Communities. Duck Creek's natural community is not yet identified under the state's Natural Community Determinations.

### *4.2 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 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 are no Municipal or Industrial WPDES permit holders in the Upper Duck Creek Watershed.

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. Municipal permits require storm water management programs to reduce polluted storm water runoff. Outagamie County has a general MS4 permit # WI-S050075-2. 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. Examples of stormwater best management practices used by municipalities to meet permits include: detention basins, street sweeping, filter strips, and rain gardens.

### *4.3 Nonpoint Sources*

The majority of pollutants in the Upper Duck Creek 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 non point source. Agriculture is the dominant land use in the Upper Duck Creek watershed and accounts for approximately 90% of the total phosphorus loading and total suspended sediment loading. Other nonpoint sources in the watershed include erosion from stream banks and construction sites as well as runoff from lawns and impervious surfaces.

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.

## 4.4 Water Quality Monitoring

The Lower Fox River TMDL set total phosphorus concentration limits for tributaries as well as phosphorus and suspended sediment loading rates for each subwatershed. The allowable summer median (May-October) phosphorus concentration for tributaries is 0.075 mg/l and allowable suspended sediment concentration for the mouth of the Fox River is 18 mg/l. The allocated TMDL loading rates are 38.63 lbs of P/day and 9.71 tons of sediment/day for the Duck Creek.

Duck Creek is part of the Lower Fox River Watershed Monitoring Program. Currently teachers and students from Green Bay Southwest High School monitor water quality in Duck Creek. Green Bay Southwest High School monitors at a USGS site and 1 mile upstream at the Overland Bridge. Duck Creek monitoring locations are shown in Figure 14. Green Bay Southwest High School analyzes the following water quality parameters: nitrogen, phosphorus, pH, conductivity, dissolved oxygen, temperature, stream flow, turbidity, habitat, and macroinvertebrates. Phosphorus and turbidity data from 2003-2014 at the LFRWMP sites on Duck Creek are shown in Figure 15 & Figure 16.

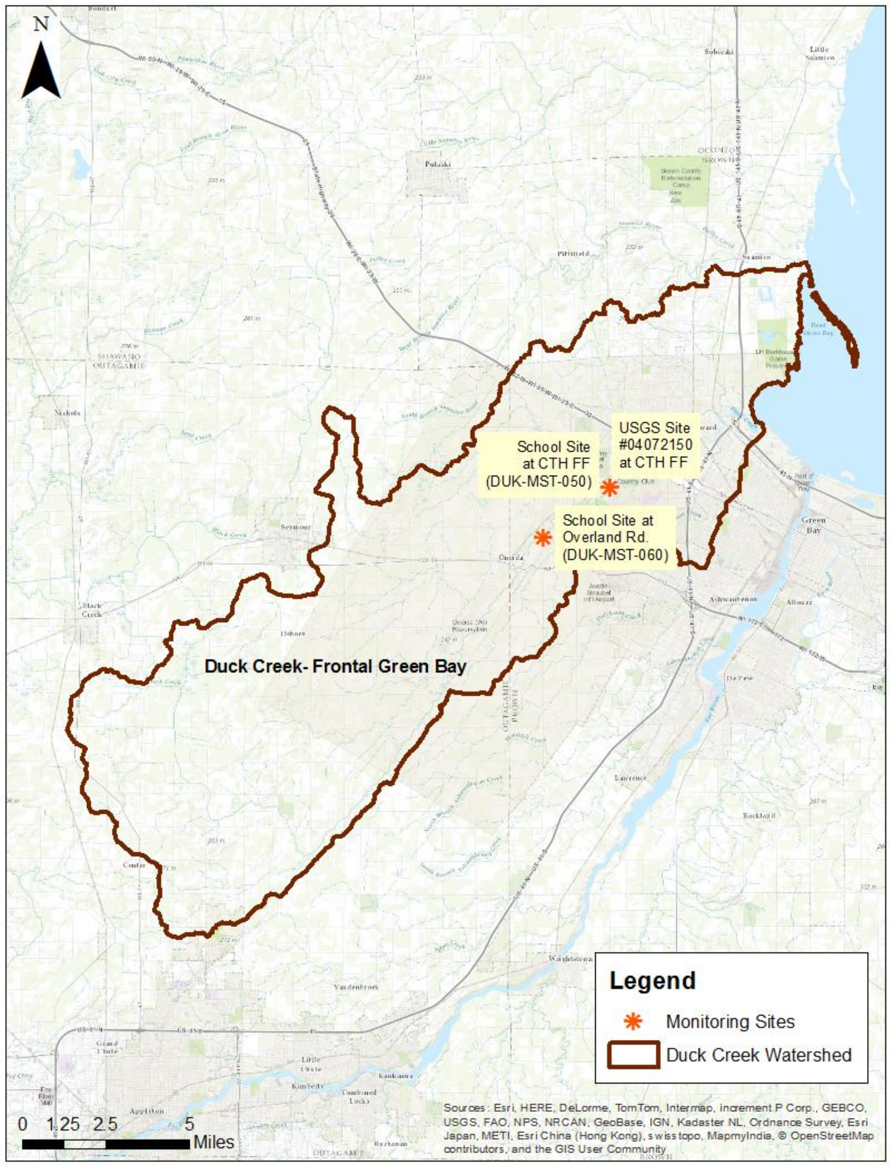



**Figure 14.** Duck Creek Monitoring Sites.

Macroinvertebrate data collected from the Green Bay Southwest High School on Duck Creek from 2004-2014 is shown in Figure 17. The macroinvertebrate index of biotic integrity is a biological indicator for impairment classification. Different types of macroinvertebrates are more tolerant of poor water quality than others. The number and type of macroinvertebrates present in a stream can provide an indicator of water quality. The mean macroinvertebrate index for Duck Creek fell into the fair category for all years except 2011 in which the mean IBI was good.

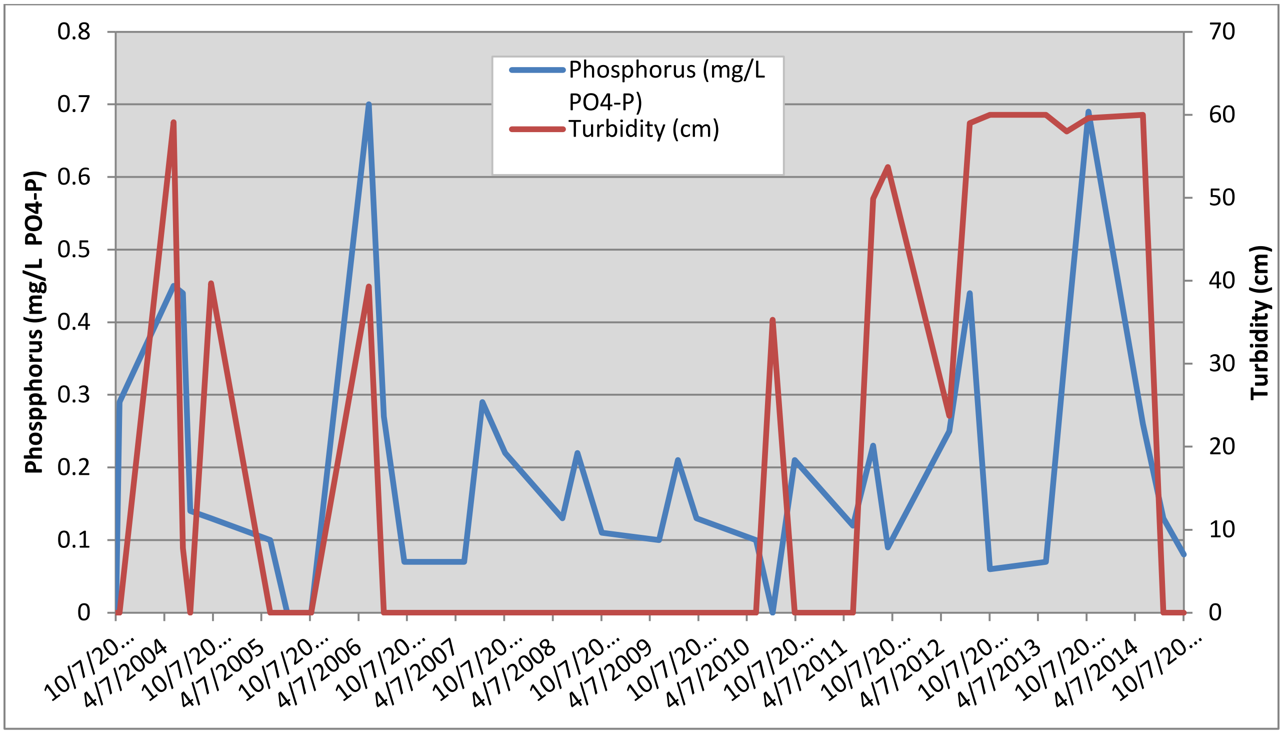



**Figure 15.** LFRWMP Phosphorus and Turbidity data at Cth FF location 2003-2014.

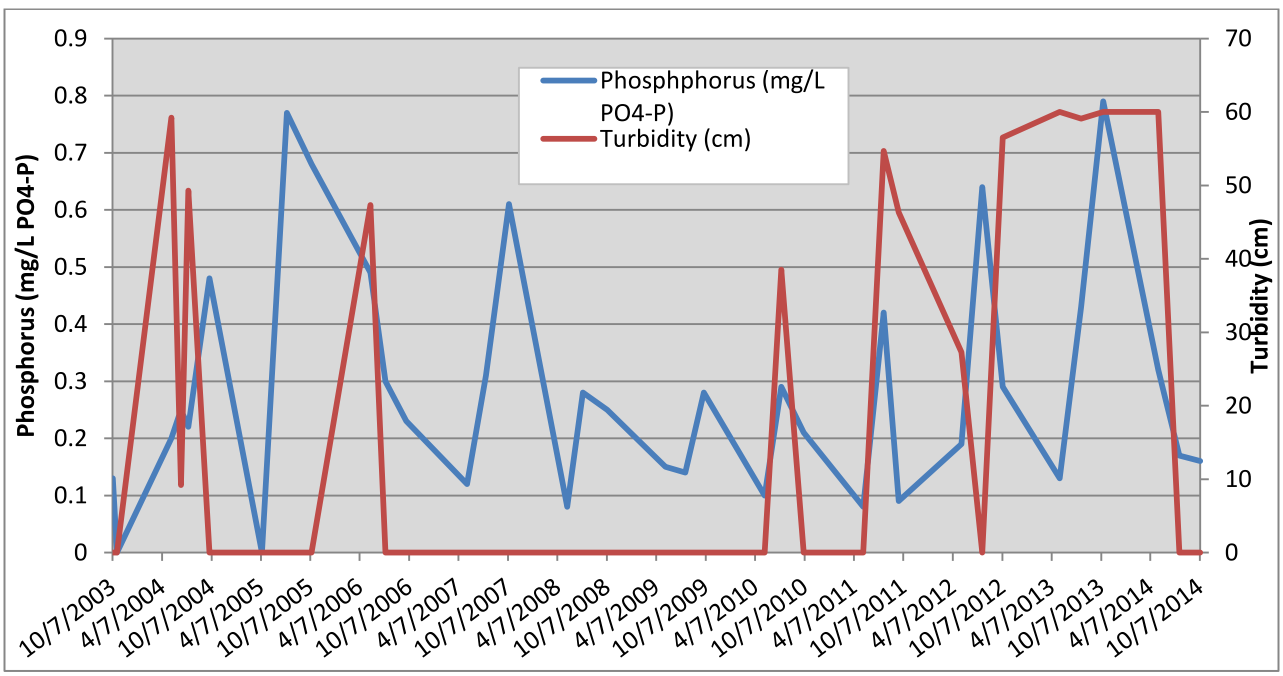



**Figure 16.** LFRWMP Phosphorus and Turbidity data Overland Rd Location 2003-2014.

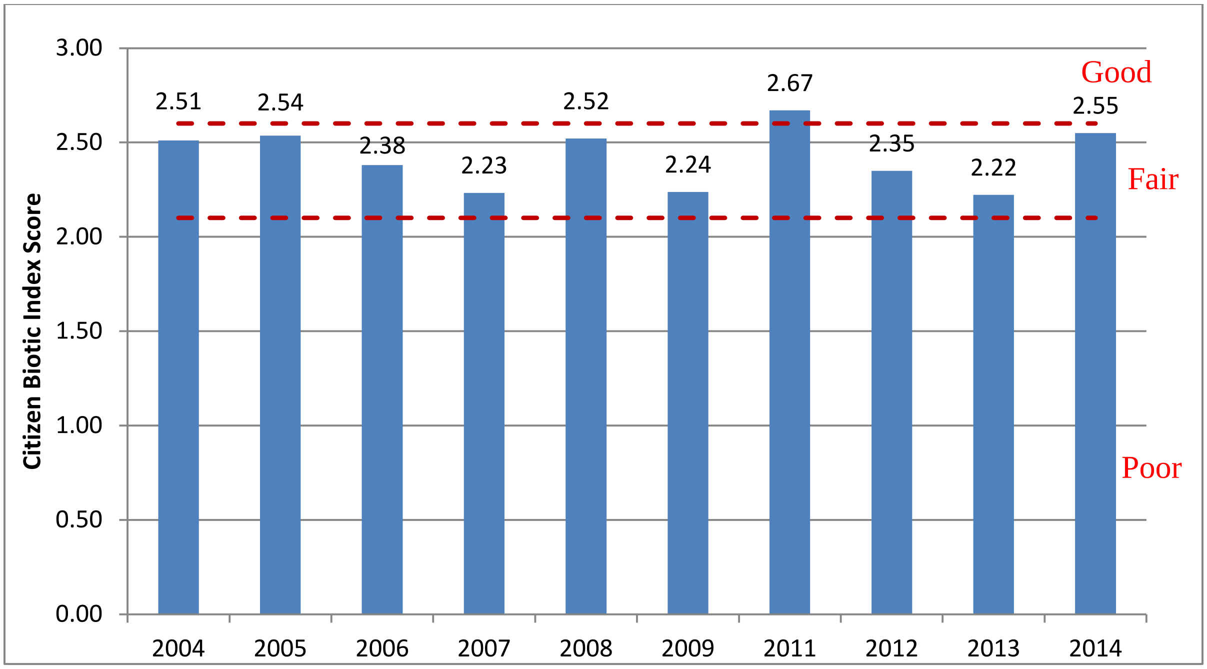



**Figure 17.** LFRWMP Macroinvertebrate Citizen Biotic Index Score 2004-2014, Duck Creek, WI.

Currently the USGS site near Howard, WI measures discharge, gage height, water temperature, specific conductance, and NO3+NO2. In August of 2014, phosphorus data collection resumed for this site. Phosphorus and suspended sediment data was collected from this site from 2004-2008. Annual water quality statistics from 2004-2008 at the Howard, WI site are shown in Table 8.

**Table 8.** Annual water quality statistics Duck Creek near Howard, WI 2004-2008 (USGS 04072150)

| Water year | 91055, Suspended solids dried at 105 degrees Celsius, water, unfiltered, tons per day | 91050, Phosphorus, water, unfiltered, pounds per day | 00530, Suspended solids, water, unfiltered, milligrams per liter |
|---|---|---|---|
| 2004 | 27.81 | 186.0 | 21.3 |
| 2005 | 9.60 | 107.3 | 8.4 |
| 2006 | 2.31 | 45.37 | 8.9 |
| 2007 | 2.96 | 29.38 | 7.8 |
| 2008 | 7.53 | 94.78 | 7.4 |

The WDNR monitors water quality of aquatic resources in the state through various monitoring programs. There is WDNR water quality data available for Duck Creek dating back to 1976 from various monitoring programs. WDNR water quality data for Duck Creek can be viewed at http://dnr.wi.gov/water/watershedsearch.aspx. Phosphorus and sediment data from the UWGB study done for the WDNR, *Analysis of Phosphorus and TSS Trends in Duck Creek, Northeastern Wisconsin*, is shown in Figure 18. Analysis of data collected from 2011-2013 showed a median phosphorus concentration of 0.179 mg/l which is well above the TMDL limit.

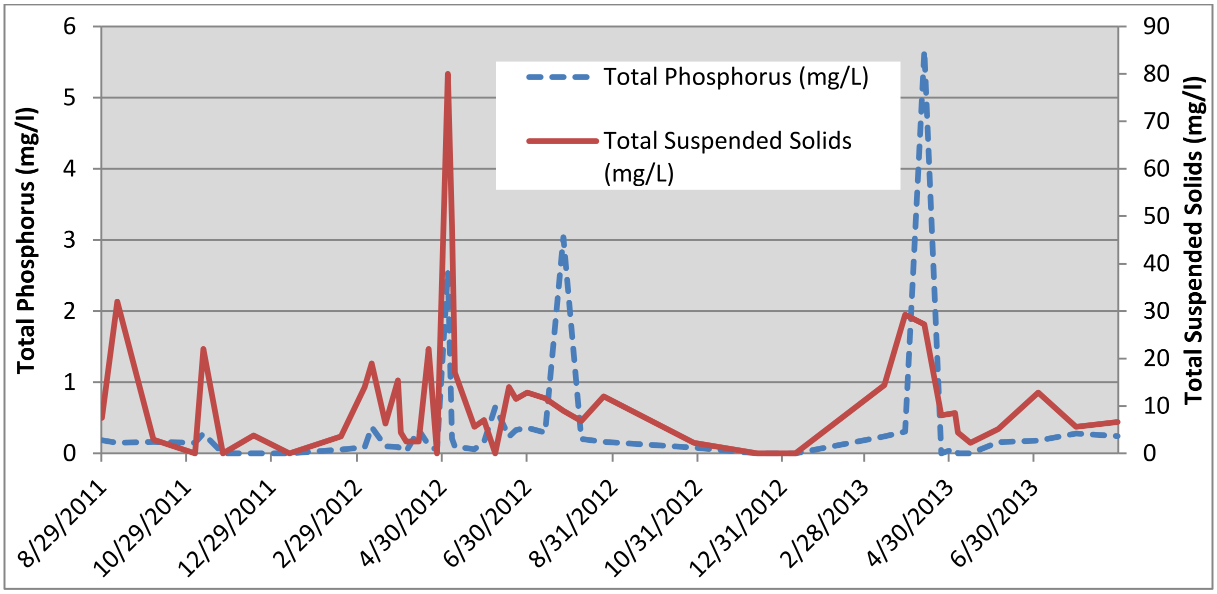



**Figure 18.** Water quality data from Duck Creek at Cth FF(Hillcrest Rd) WDNR Station ID 053690 from 2011-2013.

(This page intentionally left blank)

## 5.0 Pollutant Loading Model

The developers of the Lower Fox River TMDL plan ran the Soil and Water Assessment Tool (SWAT) for all subwatersheds in the Lower Fox River Basin. The SWAT model is able to predict the impact of land use management on the transport of nutrients, water, sediment, and pesticides. Actual cropping, tillage and nutrient management practices typical to Wisconsin were input into the model. Other data inputs into the model include: climate data, hydrography, soil types, elevation, land use, contours, political/municipal boundaries, MS4 boundaries, vegetated buffer strips, wetlands, point source loads, and WDNR-Enhanced USGS 1:24K DRG topographic maps. The model was calibrated with water quality data taken at USGS sites from the East River, Duck Creek, Baird Creek, Ashwaubenon Creek, and Apple Creek in the Lower Fox River Basin.

The SWAT model from the Lower Fox River TMDL was run on the entire Duck Creek sub basin which consists of Upper, Middle, and Lower Duck Creek and Oneida Creek watersheds (Figure 19). To characterize the loading in just the Upper Duck Creek subwatershed the STEPL model was used. STEPL[1] (Spreadsheet Tool for Estimating Pollutant Load) is another watershed model that calculates nutrient loads based on land use, soil type, and agricultural animal concentrations. The SWAT model analysis for the entire Duck Creek Watershed can be seen in Appendix B. STEPL loading results are shown in Table 9.

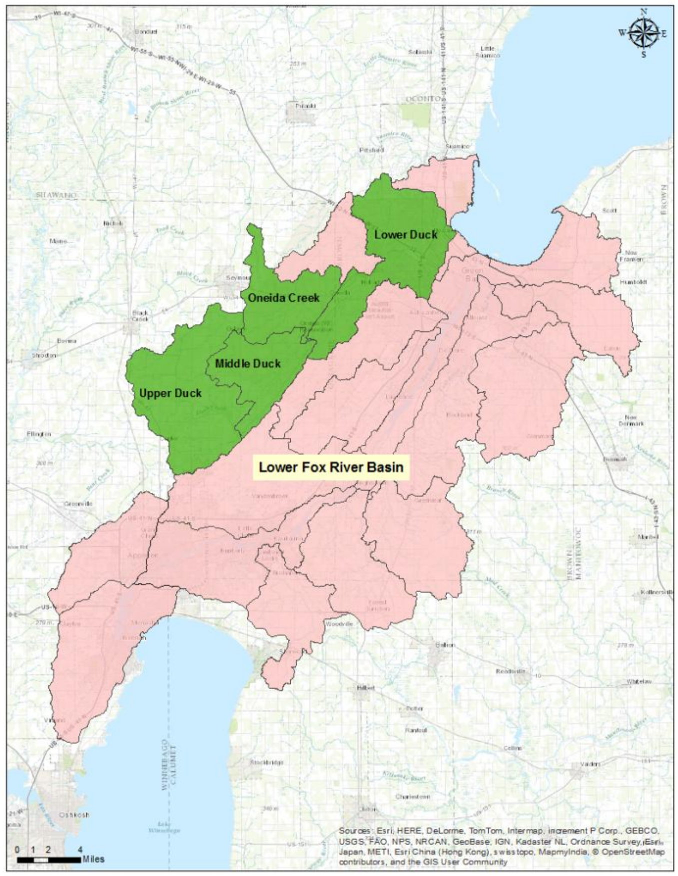



**Figure 19.** Duck Creek subbasin used for SWAT model.

Both loading models indicate that agriculture is the main contributor of phosphorus and sediment in the watershed. According to the STEPL model the Upper Duck Creek Watershed contributes an estimated 27,726 lbs of phosphorus and 5,339 tons of sediment to the Duck Creek per year. The SWAT model estimated 63,172 lbs of phosphorus and 12,697 tons of sediment per year for the entire Duck Creek Subbasin (Upper, Middle, and Lower Duck Creek

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

and Oneida Creek). Therefore, the Upper Duck subwatershed is estimated to be responsible for 44% of TP and 41% of TSS in the Duck Creek Basin. Agriculture including pasture land and barnyards contributes 91% of the phosphorus loading in the Upper Duck Creek Watershed. Agriculture including pastures and gullies contributes 94 % of the sediment loading in the Upper Duck Creek Watershed.

**Table 9**. STEPL model TP & TSS baseline loading results.

| Sources | Phosphorus Load (lb/yr) | Sediment Load (t/yr) |
|---|---|---|
| Urban | 1,972.24 | 292.75 |
| Cropland | 21,472.48 | 3,933.15 |
| Pastureland | 2,210.05 | 46.38 |
| Forest | 406.71 | 30.32 |
| Feedlots | 1,026.26 | 0.00 |
| Gully | 638.26 | 1,036.13 |
| **Total** | **27,726.00** | **5,338.73** |

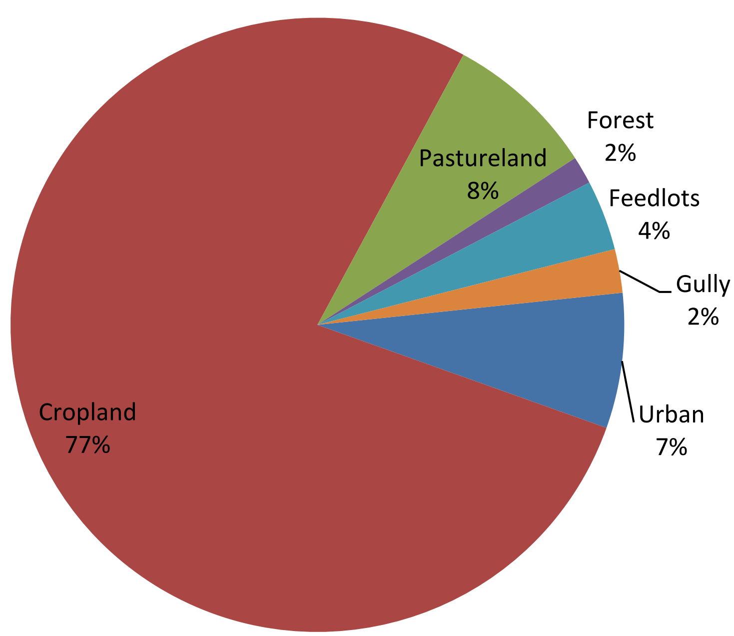



**Figure 20.** Sources of baseline TP in Upper Duck Creek Watershed.

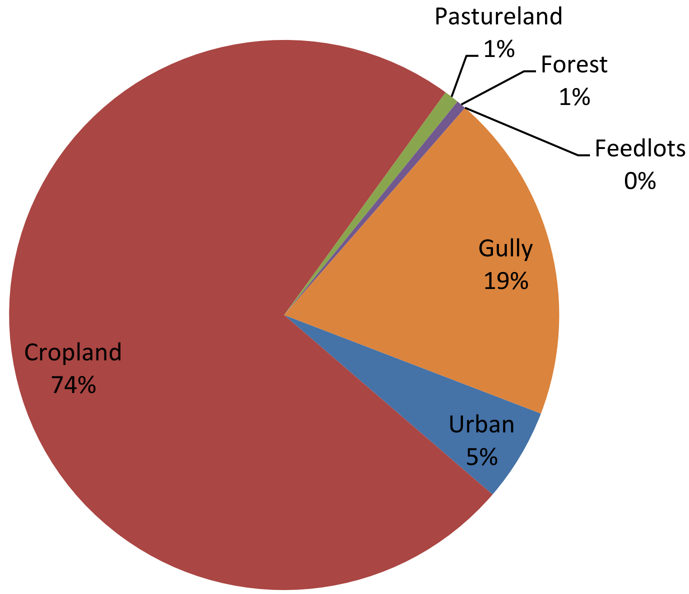



**Figure 21.** Sources of baseline TSS loading in the Upper Duck Creek Watershed.

(This page intentionally left blank)

# 6.0 Watershed Inventory

## *6.1 Barnyard Inventory Results*

Location and data on current livestock operations was compiled through existing Land Conservation Department data, air photo interpretation, and windshield surveys. Additional barnyard data was collected by meetings with farm owners. There are a total of 49 active livestock operations with an estimated 4,700 livestock animals including dairy, beef, swine, and veal farms. There is one CAFO in the southeast edge of the watershed. All CAFO's were assumed to have zero discharge from their production area. Locations of livestock operations in the watershed are shown in Figure 22.

Barnyard data was entered in to the NRCS BARNY spreadsheet tool to estimate phosphorus loading. According to the BARNY calculations an estimated 967 lbs of phosphorus per year can be attributed to barnyard runoff. STEPL model loading estimates barnyard phosphorus loading slightly higher at 1,227 lbs of phosphorus. Barnyard runoff accounts for approximately 4% of the total phosphorus loading from agriculture. Many farm sites have already had runoff management measures and waste storage installed during the Duck, Apple, Ashwaubenon Priority Watershed Project that ended in 2010. Barnyard runoff is not a significant source of phosphorus in this watershed. Barnyards that exceed the annual phosphorus discharge limit of 15 lbs/year will be eligible for cost share assistance to obtain necessary reductions in phosphorus loading. Estimated phosphorus loadings per farm site over 15 lbs P/year are shown in Table 10.

**Table 10.** Farms with >15 lbs P/year loading.

| Farm # | Phosphorus (lbs/yr) |
|---|---|
| 3327 | 109.0 |
| 3365 | 90.0 |
| 3060 | 76.2 |
| 3351 | 66.0 |
| 3113 | 56.0 |
| 3132 | 45.5 |
| 3293 | 42.1 |
| 3290 | 39.0 |
| 4020 | 35.8 |
| 3300 | 34.9 |
| 3321 | 33.9 |
| 3262 | 31.6 |
| 3129 | 30.3 |
| 3120 | 22.5 |
| 3035 | 22.0 |
| 3326 | 20.3 |
| 3018 | 20.2 |
| 3306 | 20.2 |
| 3136 | 20.0 |
| 3359 | 19.7 |
| 3032 | 18.0 |

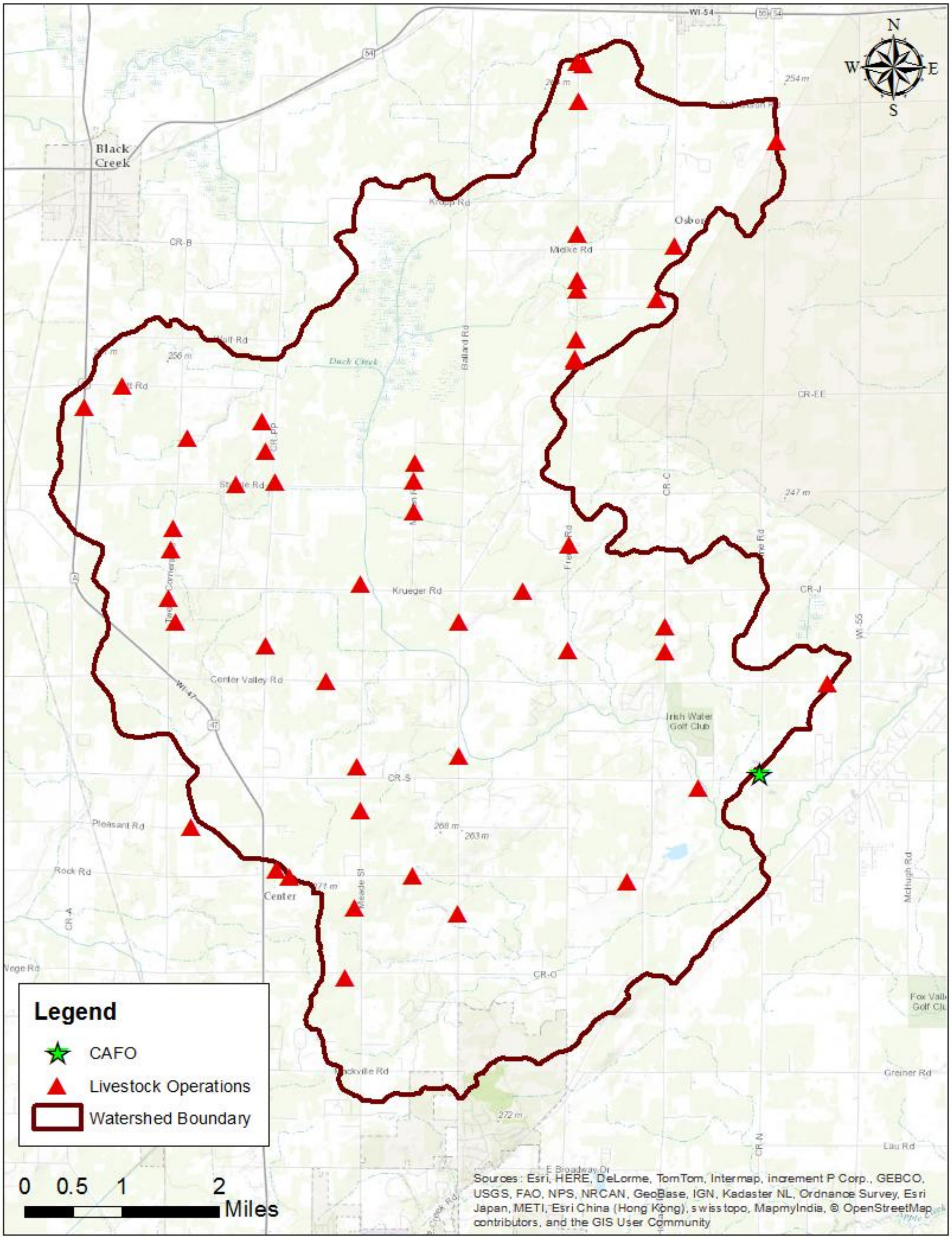



**Figure 22.** Location of active livestock operations in Upper Duck Creek Watershed.

### *6.2 Streambank Inventory Results*

**Figure 23.** Duck Creek from Cty TK S Bridge looking south.

The Wisconsin DNR 24K Hydrography data set was used to determine the location of perennial and intermittent streams in the watershed area. There are approximately 94 miles of perennial and intermittent streams in the Upper Duck Creek watershed including its tributaries. Many of the intermittent and perennial streams in Upper Duck Creek are legal drains that are inspected annually by the drainage board. The remaining portion of the mainstem Upper Duck Creek was inventoried for stream bank erosion. Stream bank erosion was inventoried by walking the stream with an Ipad using the ArcCollector application. Information on lateral recession, soil type, height, and length were collected with the app as well as GPS located photos. A total of 2.4 miles of stream bank was inventoried from Vine Rd to Cty Rd C. The majority of the stream appeared very stable and had little to no signs of erosion occurring. Inventoried streambank segments and erosion sites are shown in Figure 24. Inventory data indicates that stream bank erosion is not a significant source of sediment in this subwatershed.

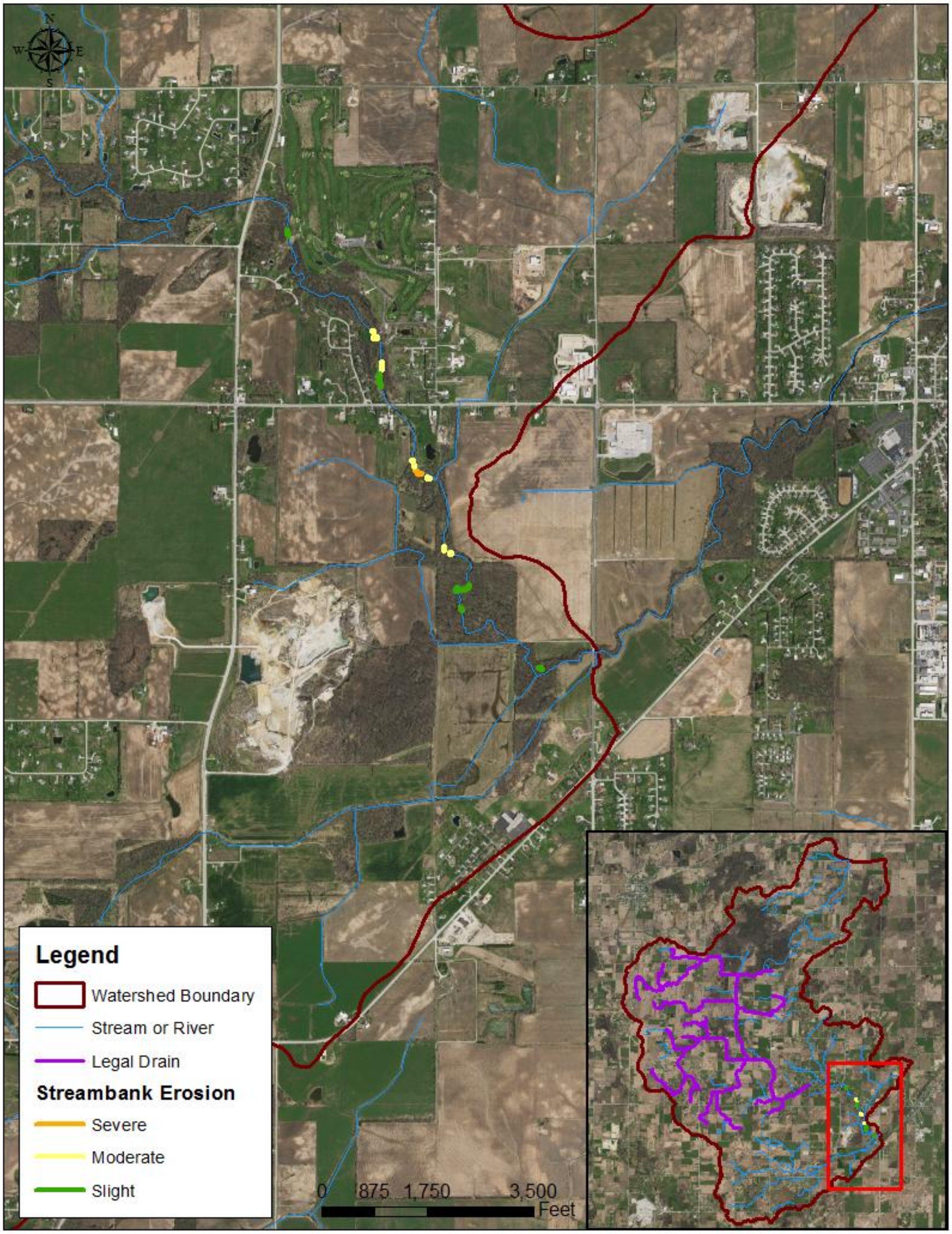



**Figure 24.** Streambank Inventory data.

## *6.3 Upland Inventory*

Agricultural uplands were inventoried by windshield survey, use of GIS data and tools, and with aerial photography. The use of a tool developed by the WDNR called EVAAL (Erosion Vulnerability Assessment for Agricultural Lands) and its data sets were used to determine priority areas for best management practices in the watershed. The tool estimates the vulnerability of a field to erosion and can be used to determine internally draining areas, potential for gully erosion, and potential for sheet and rill erosion. Other GIS methods also used to determine priority areas include the Compound Topographic Wetness Index and Normalized Difference Tillage Index.

### Tillage Practices and Residue Management

Data was analyzed from the Conservation Technology Information Center (CTIC) Conservation Tillage Reports (Transect Surveys) from Brown, Outagamie, Calumet, and Winnebago Counties to determine primary tillage practices for the SWAT model input for the Lower Fox River TMDL. Baseline tillage conditions were based on data averages from 1999, 2000, and 2002. The baseline tillage conditions for a dairy rotation were determined to be 83.1% Conventional Tillage, 15.2 % Mulch Till, and 1.7% No till and 75.9 % Conventional Tillage, 20.2 % Mulch Till, and 3.9% No till for Cash Crop Rotation (WDNR 2012).

**Figure 25.** Field in watershed with little crop residue (3/19/2015).

It is likely that these baseline tillage conditions have changed in the past 10 years so a newer method of analyzing tillage practices and crop residue was used as well. 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 March 19, 2015; May 28, 2015, and April 26, 2015 were used to calculate a minimum Normalized Difference Tillage Index (NDTI). The NDTI estimates crop residue levels based on shortwave infrared wavelengths. A windshield survey of crop residue was also conducted in spring of 2015 to provide a more accurate correlation between minNDTI values and percent residue (Figure 26). Estimated crop residue percent in fields were recorded by GPS and then correlated with mean minNDTI calculated for that field. The mean minNDTI values per agricultural field for the spring of 2015 are shown in Figure 27.

This analysis of imagery can be used to identify areas needing BMP's as well as a way to track implementation of practices since satellites regularly circle the earth.

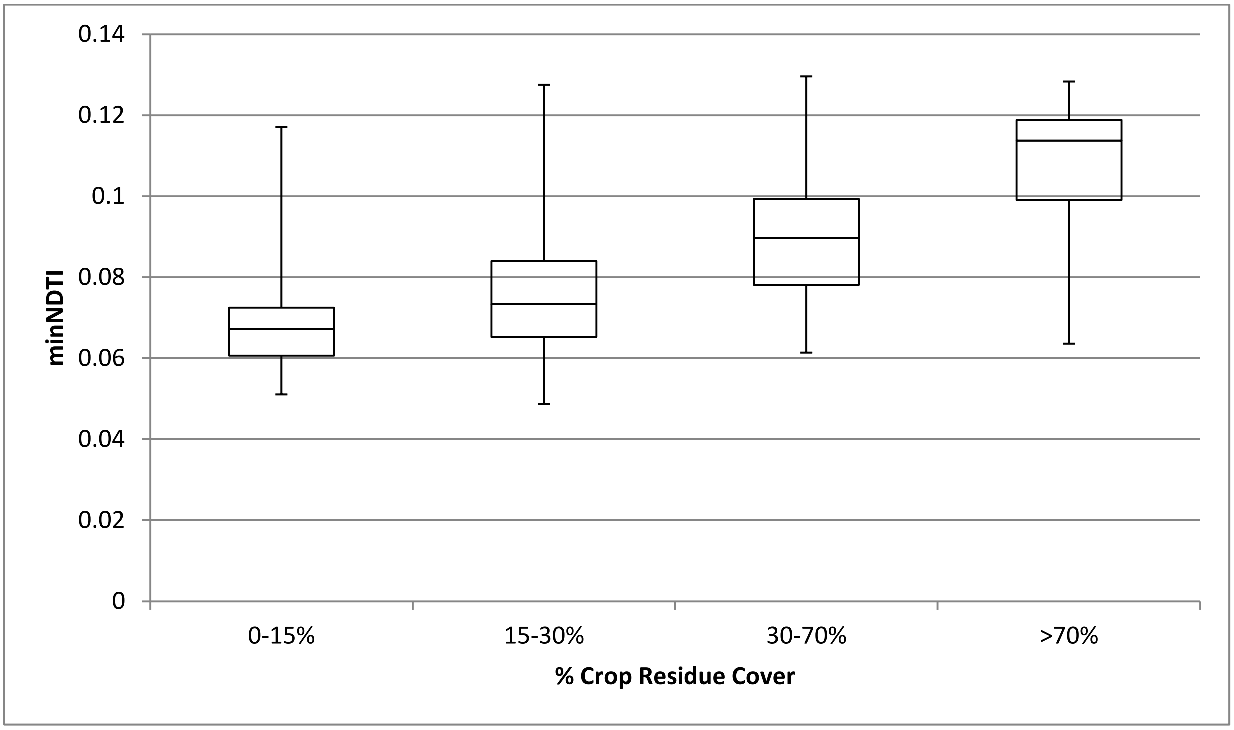



**Figure 26.** Correlation between observed crop residue cover and minNDTI values in Upper Duck Creek Watershed in Spring of 2015.

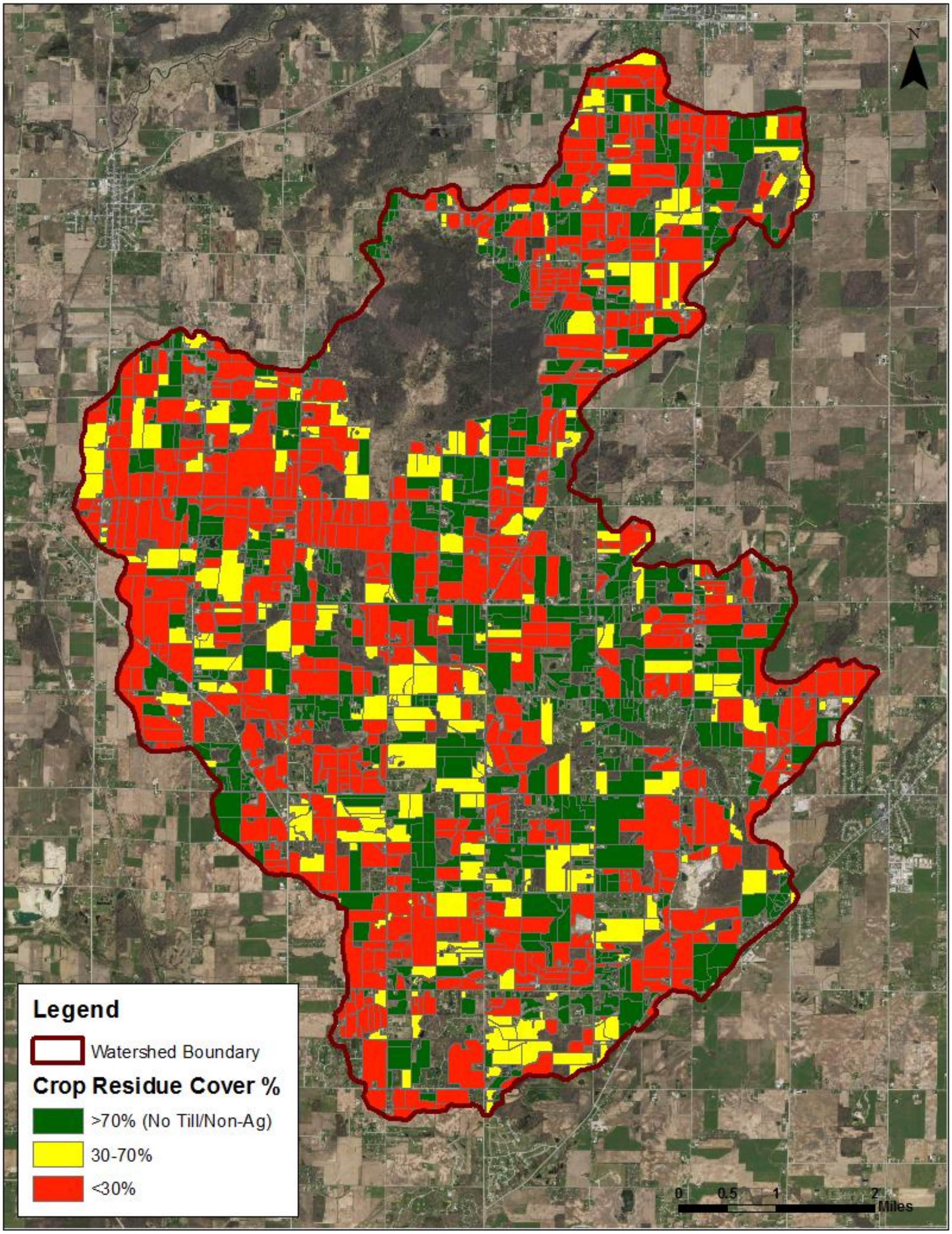



**Figure 27.** Crop Residue Cover Estimates based on Normalize Difference Tillage Index (March 2015-May 2015).

## Erosion Vulnerability

The EVAAL[2] (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, and elevation data. The resulting outputs of the tool are an Erosion Score, Stream Power Index, and Soil Loss Index. Figure 28 shows the EVAAL erosion score indicating which fields are more susceptible to erosion based on USLE[3], 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 29). 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.

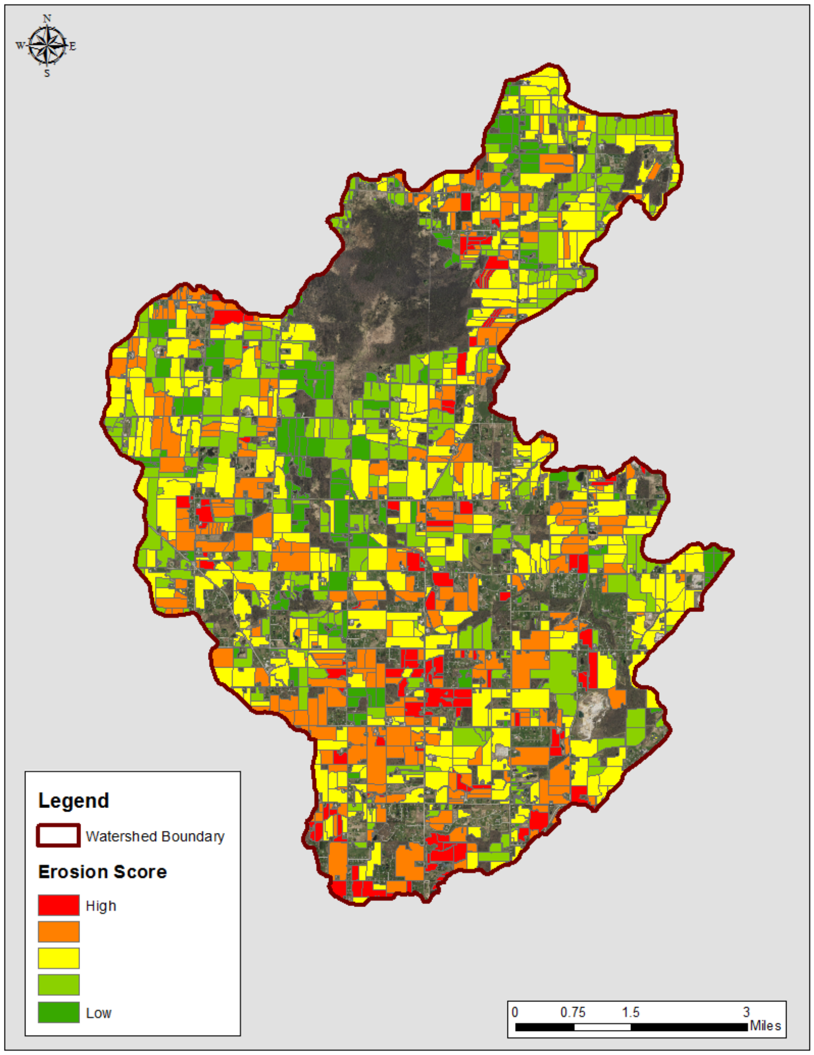



**Figure 28.** Erosion vulnerability.

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

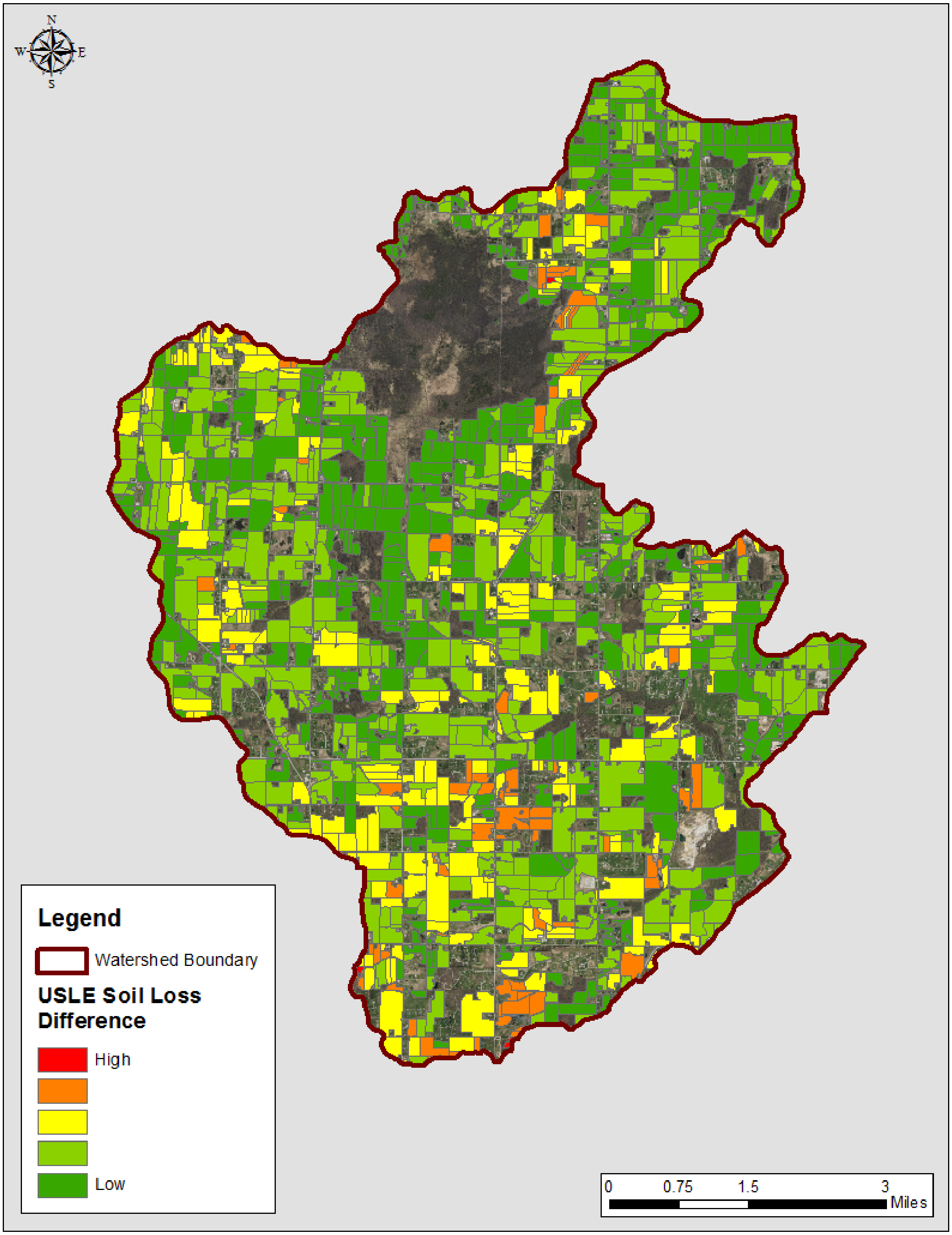



**Figure 29.** USLE (Low Cover-High Cover) Soil Loss Difference.

### 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.

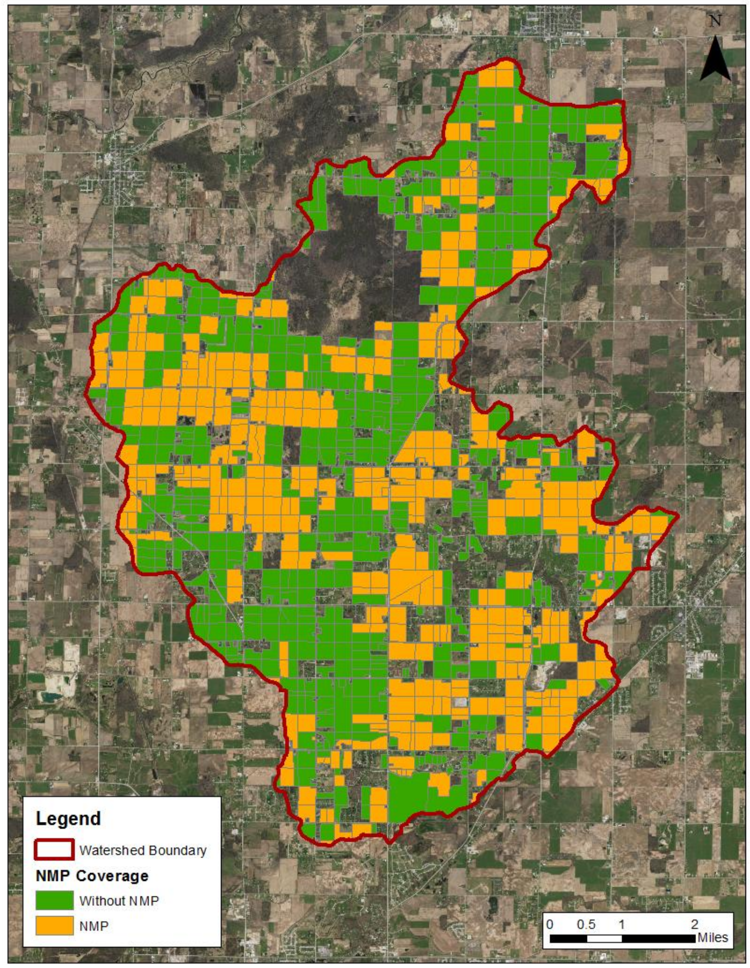



**Figure 30.** Nutrient Management Plan coverage.

A little more than half of the agricultural land in the Upper Duck Creek Watershed is covered under a nutrient management plan. Nutrient management coverage is shown by parcel in Figure 30. There are approximately 11,347 acres covered by a NMP and 8,331 acres not covered in the watershed.  Even though a large amount of land in this watershed is covered by nutrient management plans water quality still remains poor. This may be attributed to additional nutrient management planning needed and/ or the current use of nutrient management planning may not be adequate enough to improve water quality. Alternative ways of handling manure and improved nutrient management in this watershed will likely need to be implemented to meet TMDL reductions in phosphorus.

## Phosphorus Index and Soil Test Phosphorus

Phosphorus Index and phosphorus concentrations for fields under Nutrient Management plans were mapped by Outagamie County in 2013. Phosphorus Index values and soil test phosphorus concentrations in Outagamie County fields are shown in Figure 31 . The majority of the mapped fields in the watershed meet the Phosphorus Index of 6. Tracking of soil test phosphorus concentrations and P Index in the watershed will be useful in prioritizing fields for improved management practices.

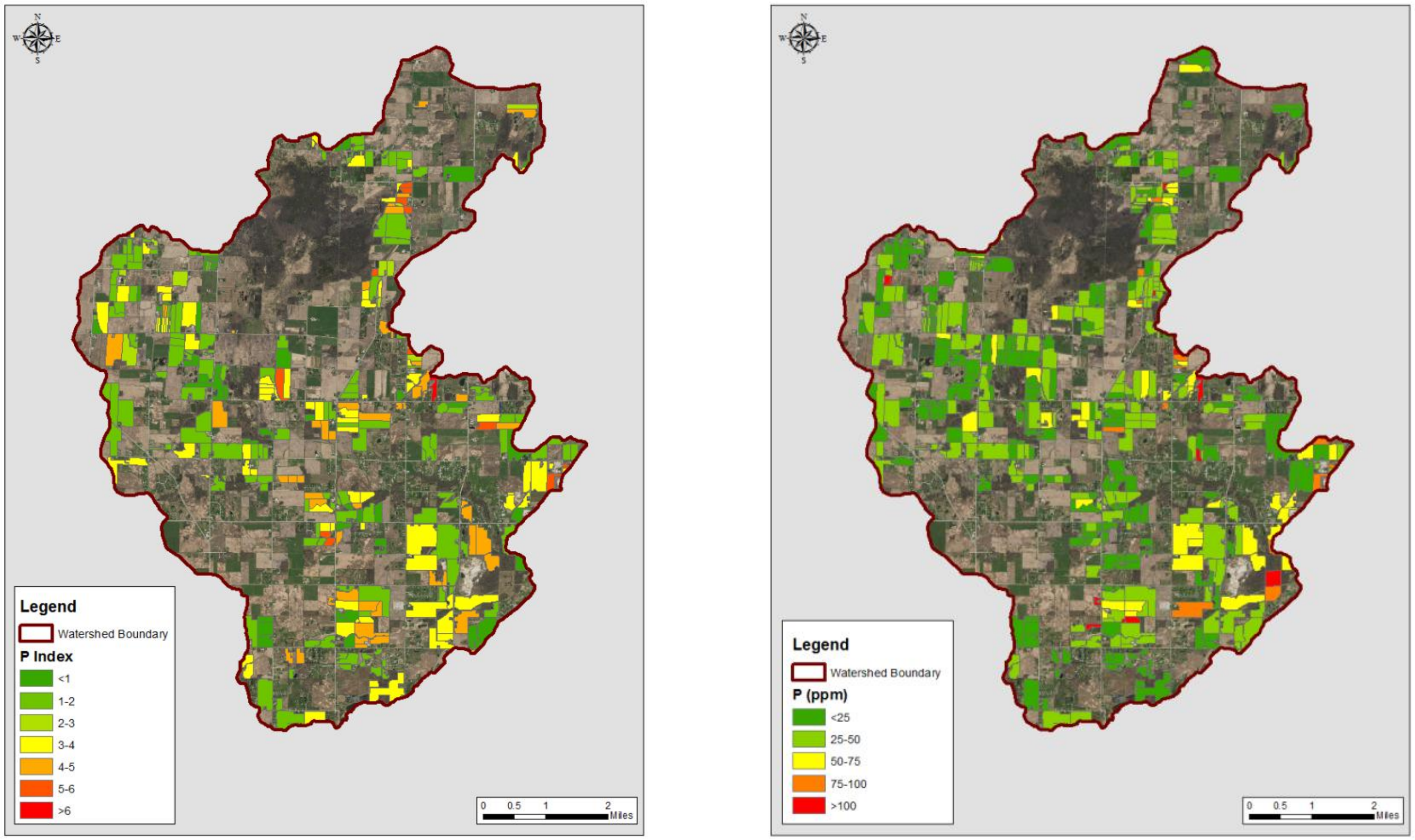



**Figure 31.** Soil test phosphorus concentration (left) and soil Phosphorus Index (right).

**Grazing/Pastureland Management**

By doing one on one inventory with farms in the area we were also able to determine how many farms grazed or pastured their livestock. Approximately 125 acres in the watershed area is 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.

According to the EVAAL analysis of crop rotations from satellite imagery in the watershed there are 4,265 acres of land in the category of pasture/hay/grassland. Based on our farm site visits and air photo analysis the majority of the land in the pasture/hay/grassland is not pasture but mostly hay fields and grassland. The STEPL model estimated 2,210 lbs of phosphorus/year and 46 tons of sediment per year can be attributed to the pasture/hay/grass land use category. The majority of the phosphorus loading in this category is likely from hay fields. Encouraging smaller farms to convert cropland or land used for hay to managed grazing land could result in pollutant reductions but reductions are not likely to be significant. 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.

**Tile Drainage**

Fields with tile drainage were inventoried by using aerial photographs and then mapped using ArcGIS. There were 15,412 acres of fields that had visible signs of tile drainage in the watershed area (Figure 32), which is approximately 75% of the cropland in the watershed. Tile drains in fields can act as a conduit for nutrient transport to streams if not managed properly. An average of 0.9 lbs P/acre/yr and 240 lbs sediment/acre/yr was found to be leaving via tile drainage on a UW Discovery Farm study in Kewaunee County, Wisconsin (Cooley et al, 2010). The UW Discovery Farm study compared surface phosphorus loss to tile phosphorus loss and found that the tile drainage was 34% of the total phosphorus lost. It is likely that a significant amount of phosphorus loading in the Upper Duck Creek area may be attributed to the extent of subsurface tile drain usage. Treating tile drainage at the outlet and better management of nutrient/manure applications on fields can reduce the amount of phosphorus reaching Duck Creek. 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. Visible tile drain outlets were also noted while doing stream bank and drainage district inventory in Spring of 2015 (Figure 32). Since the majority of land in the Upper Duck Creek watershed is drained by tile, additional research of tile drain phosphorus loss in this watershed may be necessary.

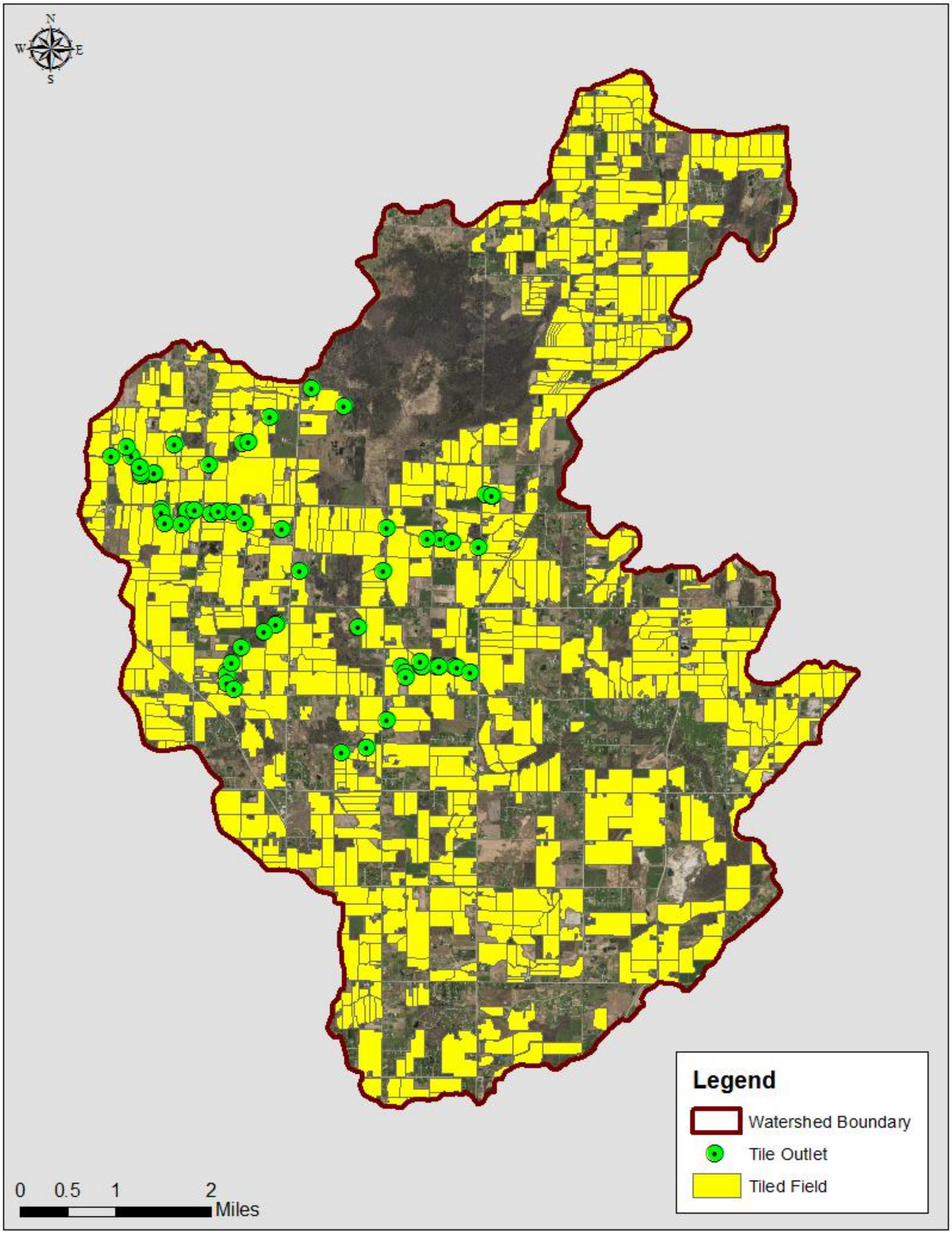



**Figure 32.** Tiled fields in Upper Duck Creek Watershed.

## Vegetative Buffer Strips

### *Riparian Buffers*

Riparian buffers filter out sediment and nutrients from water before reaching a stream channel. Buffers also reduce 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. Any stream without a 35 ft buffer will be considered a priority buffer area. In addition to meeting the standard 35 ft buffer some priority area buffers may need to be extended to 50 ft to provide necessary reductions in pollutant loads. Priority riparian buffer areas were determined using aerial photography, the DNR 24K Hydrography data set, and USGS topography maps (Figure 33). The Duck Creek Drainage District requires a 20 ft tillage setback from any of the legal drains to allow for annual inspection and maintenance of the legal drains. Encouraging land owners along the drainage district ditches to increase the tillage setback to 35 ft or more and to improve the quality of vegetation in the setback will also help in nutrient and sediment reductions in the watershed. These buffer areas in the drainage district could also open up opportunities for treatment of tile drainage. There may be additional streams, drainage ditches, and channels not delineated that could also have vegetated buffer strips installed to improve water quality and riparian habitat. Areas along perennial and intermittent streams and legal drains needing buffers are shown in Figure 33.

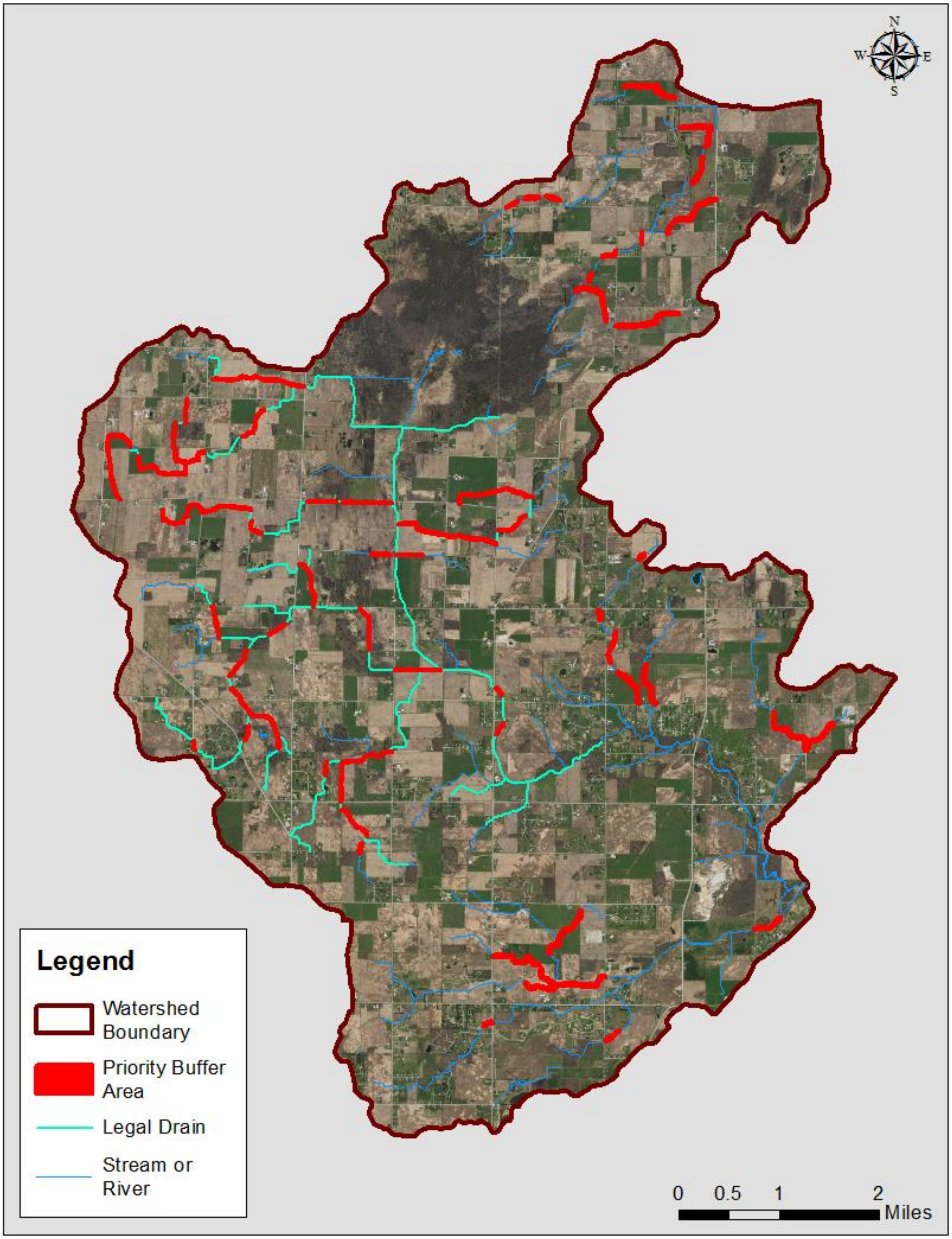



**Figure 33.** Priority riparian and legal drain buffer restoration sites.

*Tillage Setback and Field Borders*

During windshield surveys of the watershed area there were many fields noted that did not have any tillage setback from drainage ditches. Enforcement of the NR 151.03 tillage setback standard in this watershed where there are resource protection concerns will be necessary in reducing nutrient and sediment loading. The NR 151.03 tillage setback performance standard states that no tillage operation may be conducted within 5 ft from the top of the channel of surface waters[4], and tillage setbacks greater than 5 ft but no more than 20 feet may be required to meet this standard. In addition to meeting the tillage setback to surface waters, additional field borders may be needed along artificial drainage ditches if there is a resource concern.

**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 34. Stream power index data for the watershed can be found in Appendix D. A high stream power index was used to determine where grassed waterways may be necessary in the watershed. Priority areas for grassed waterways determined by GIS methods and windshield survey are shown in Figure 36. Concentrated flow areas that have less severe erosion should also be stabilized but do not necessarily require a grassed waterway. 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. In addition to using grassed waterways and concentrated flow area planting, water and sediment control basins will also be necessary in some locations. Water and sediment control basins


**Figure 34.** High stream power index indicating potential gully erosion.

[4] "Surface waters" means all natural and artificial named and unnamed lakes and all naturally flowing streams within the boundaries of the state, but not including cooling lakes, farm ponds and facilities constructed for the treatment of wastewaters (NR102.03(7)).

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.

**Figure 35.** Areas of concentrated flow causing gully and sheet erosion in Upper Duck Creek Watershed (3/20/15).

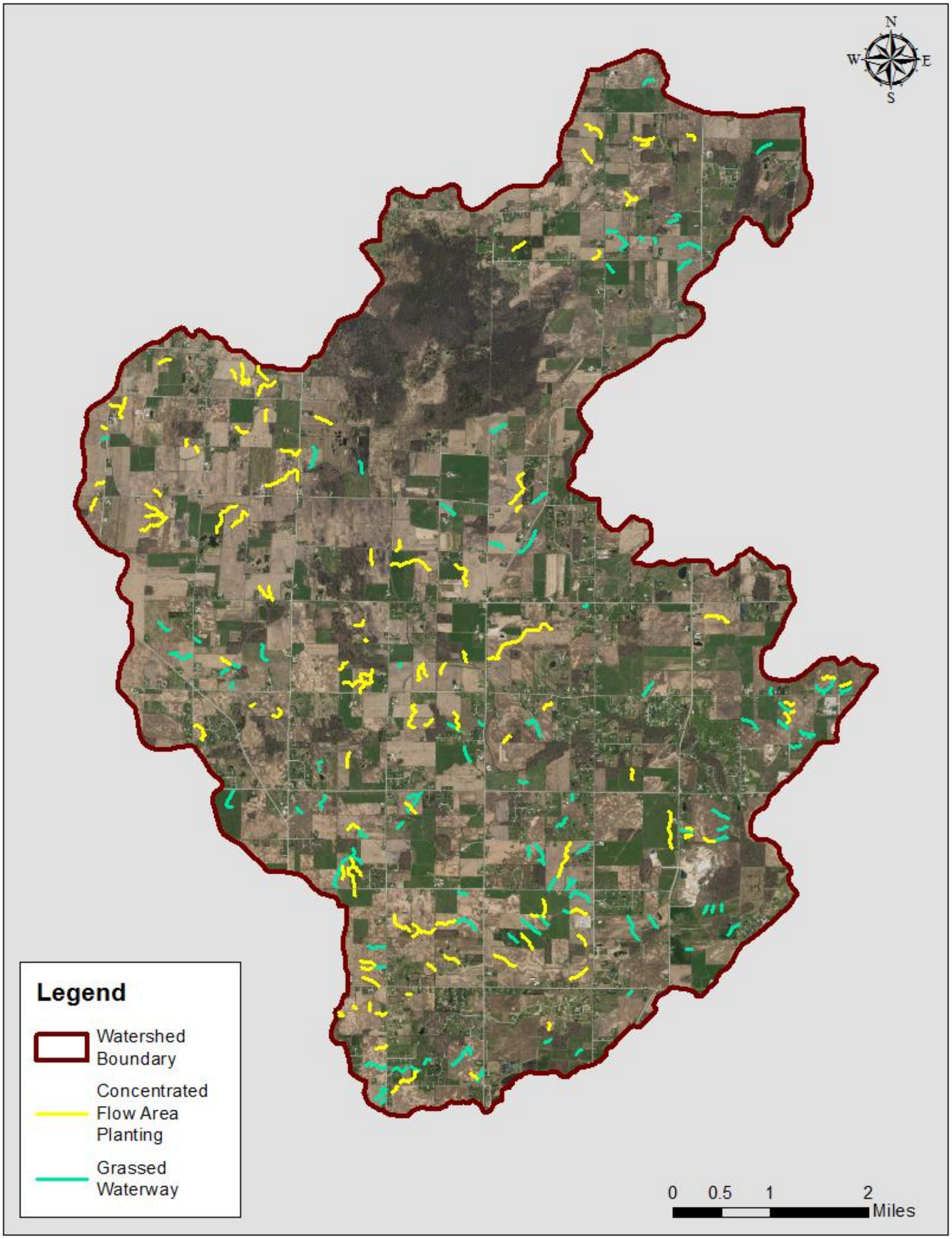



**Figure 36.** Priority locations for grassed waterways and concentrated flow area plantings.

### Current Management Practices/Projects

There have been a number of conservation projects installed within the Upper Duck Creek Watershed over the last several years. These projects include barnyard runoff control systems, grade stabilization, waste storage facilities, buffers, wetland restoration, and nutrient management planning. Manure storage facilities have already been installed at 31 of the production sites in the watershed area. Nutrient management coverage in the watershed is shown in Figure 30 in Chapter 6.3. Many of the conservation practices were installed during the Duck, Apple, and Ashwaubenon Creeks Priority Watershed Project. A moratorium on signing agreements for non-structural practices was placed on September 5, 2001 about halfway through the watershed project term. Therefore implementation of upland practices ceased and did not meet watershed project goals.

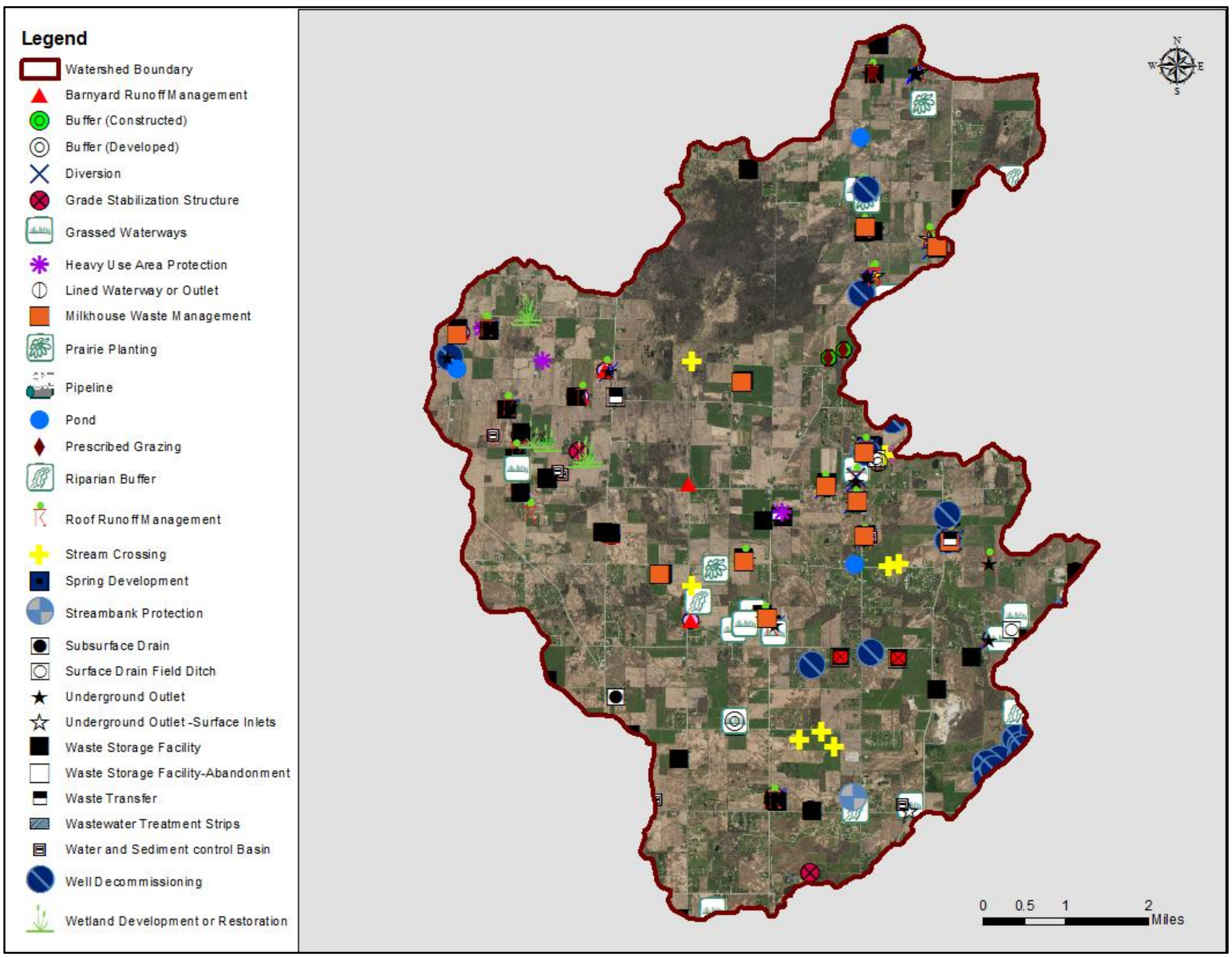



**Figure 37.** Previous conservation practices installed in the Upper Duck Creek.

## *6.4 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). 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 3,870 acres of existing wetlands and 2,036 acres of potentially restorable wetlands in the Upper Duck Creek watershed according to the WDNR wetlands and potentially restorable wetland layer (Figure 38).

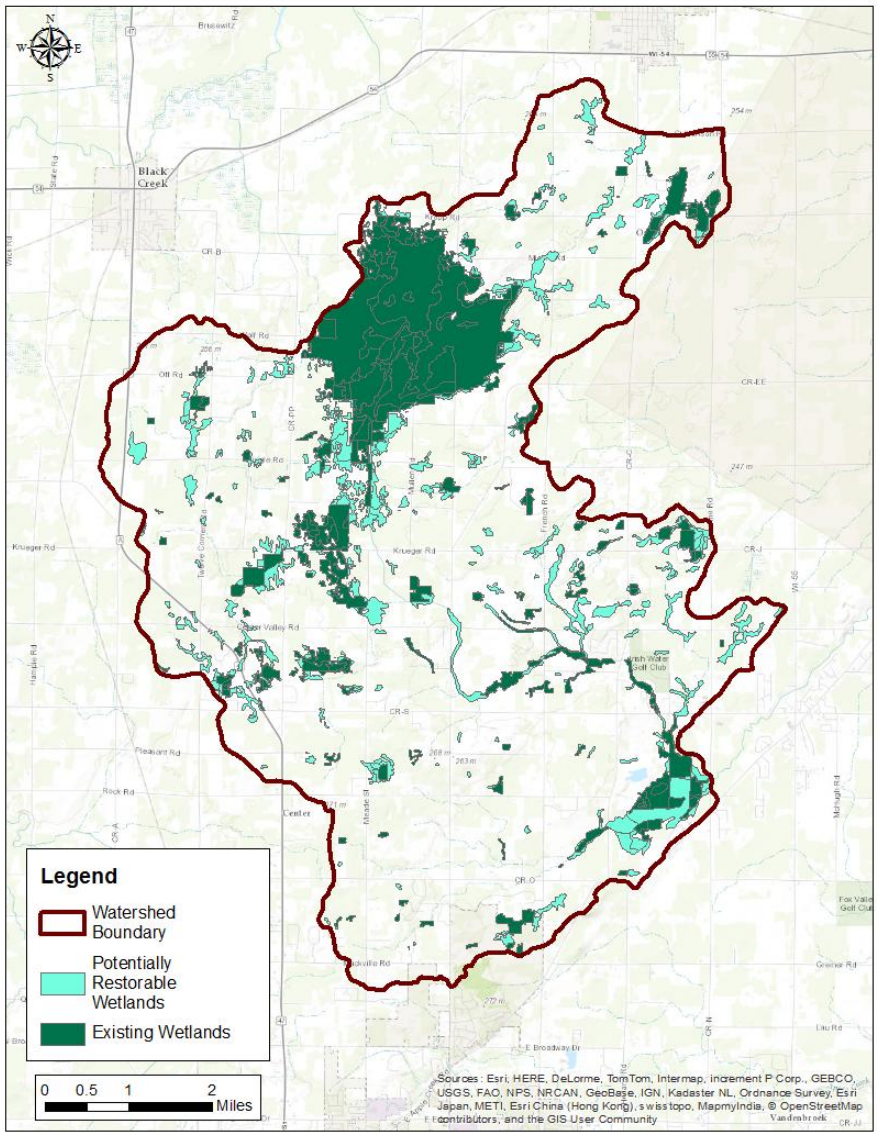



**Figure 38.** Existing and Potentially Restorable Wetlands (Wisconsin Department of Natural Resources)

In 2012, The Nature Conservancy and Environmental Law Institute finished the Duck-Pensaukee Watershed Approach: Mapping Wetland Services, Meeting Watershed Needs project (Miller et al, 2012). The intent of the project was to assess preservation and restoration needs in the Duck-Pensaukee

Watershed and to identify sites that have the greatest potential to meet those needs. This project analyzed existing and potentially restorable wetlands based on several wetland services (wildlife/fish habitat, water quality protection, flood abatement, surface water supply, carbon storage, and shoreline protection). Potentially restorable wetland sites were ranked at moderate, high, or exceptional for each service and were also ranked based on a sum of all of the services performed at a high level. The resulting data from the analysis will be used to prioritize were wetland restorations will have the greatest benefit in the watershed area. Figure 39 shows the sum of services performed at a high level for the potentially restorable wetlands in the Upper Duck Creek watershed. Potentially restorable wetlands ranking high and exceptional for flood abatement and water quality protection are shown in Figure 40 & Figure 41.

Since the most of Upper Duck Creek is legal drainage district, the majority of the potentially restorable wetlands would be difficult to restore due to the amount of artificial drainage in the area and intention of the drainage district to drain wet land to increase agricultural productivity. Potentially restorable wetland sites located outside of the drainage district will likely be easier to restore.

Potentially restorable wetlands were assessed for feasibility for restoration using 2014 aerial imagery and landowner parcel data. Feasibility was based on location, size, and number of landowners. Any PRW that was located in an urban area, encompassed more than one landowner, or was already a natural area was eliminated. Approximately 250 acres of the PRW's were considered feasible, with 98 acres located in the legal drainage district and 151 residing outside of the drainage district. Potentially restorable wetlands ranking high or exceptional for both flood abatement and water quality will be a priority for restoration in the Upper Duck Watershed.

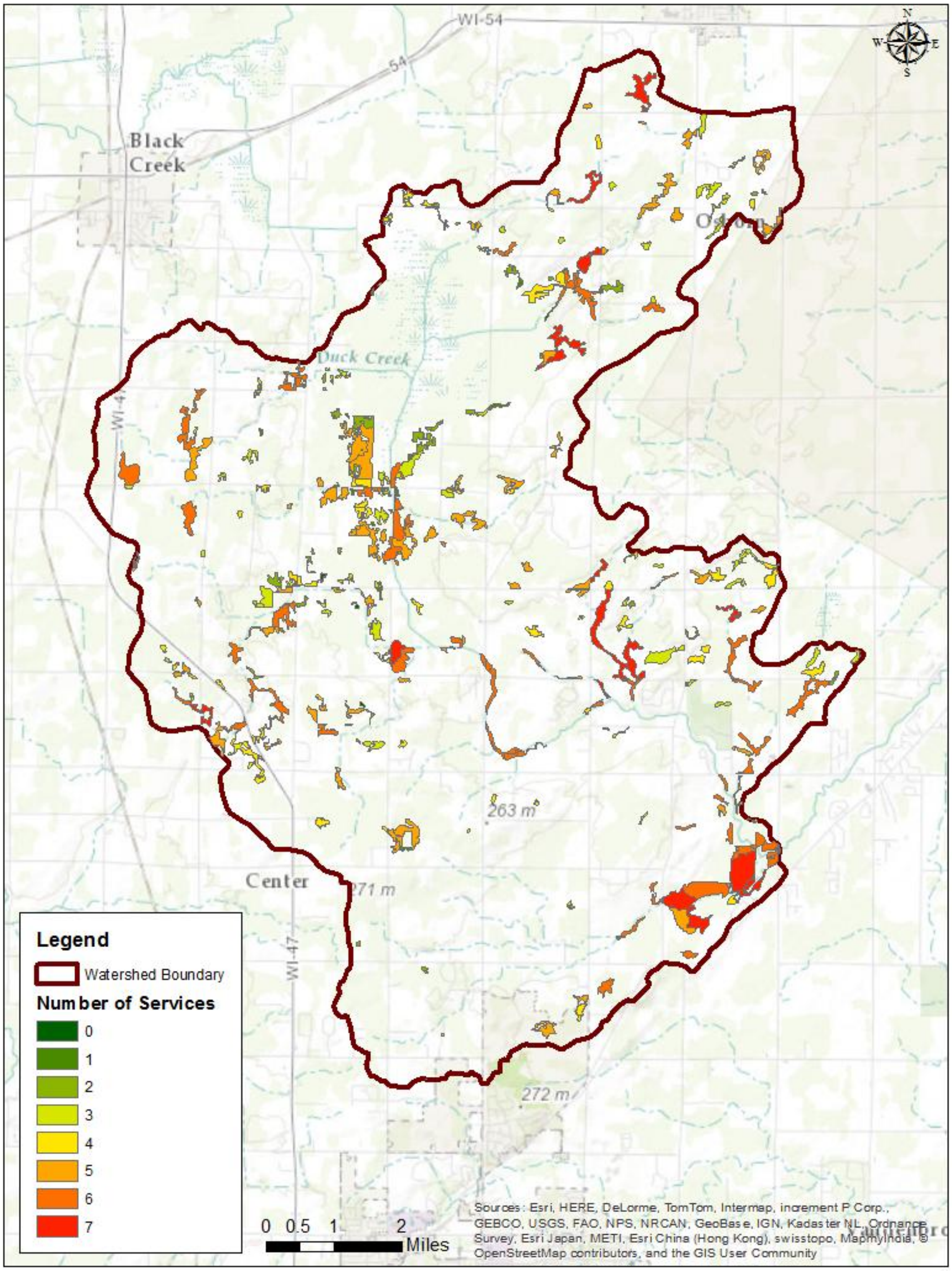



**Figure 39.** Duck-Pensaukee Wetland Assessment of Number of Services for Potentially Restorable Wetlands. (The Nature Conservancy & Environmental Law Institute)

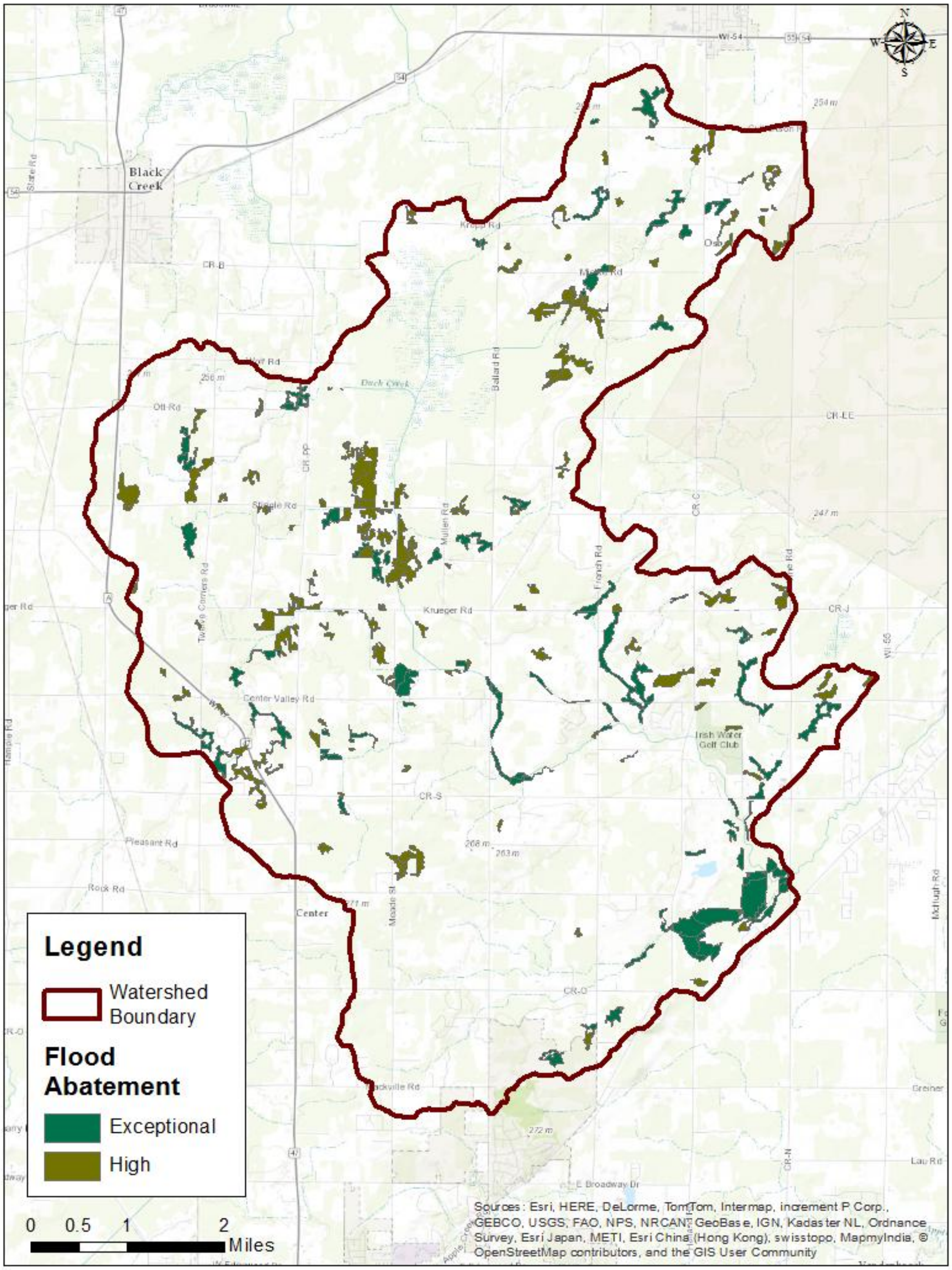



**Figure 40.** Duck-Pensaukee Wetland assessment of flood abatement services for potentially restorable wetlands. (The Nature Conservancy & Environmental Law Institute)

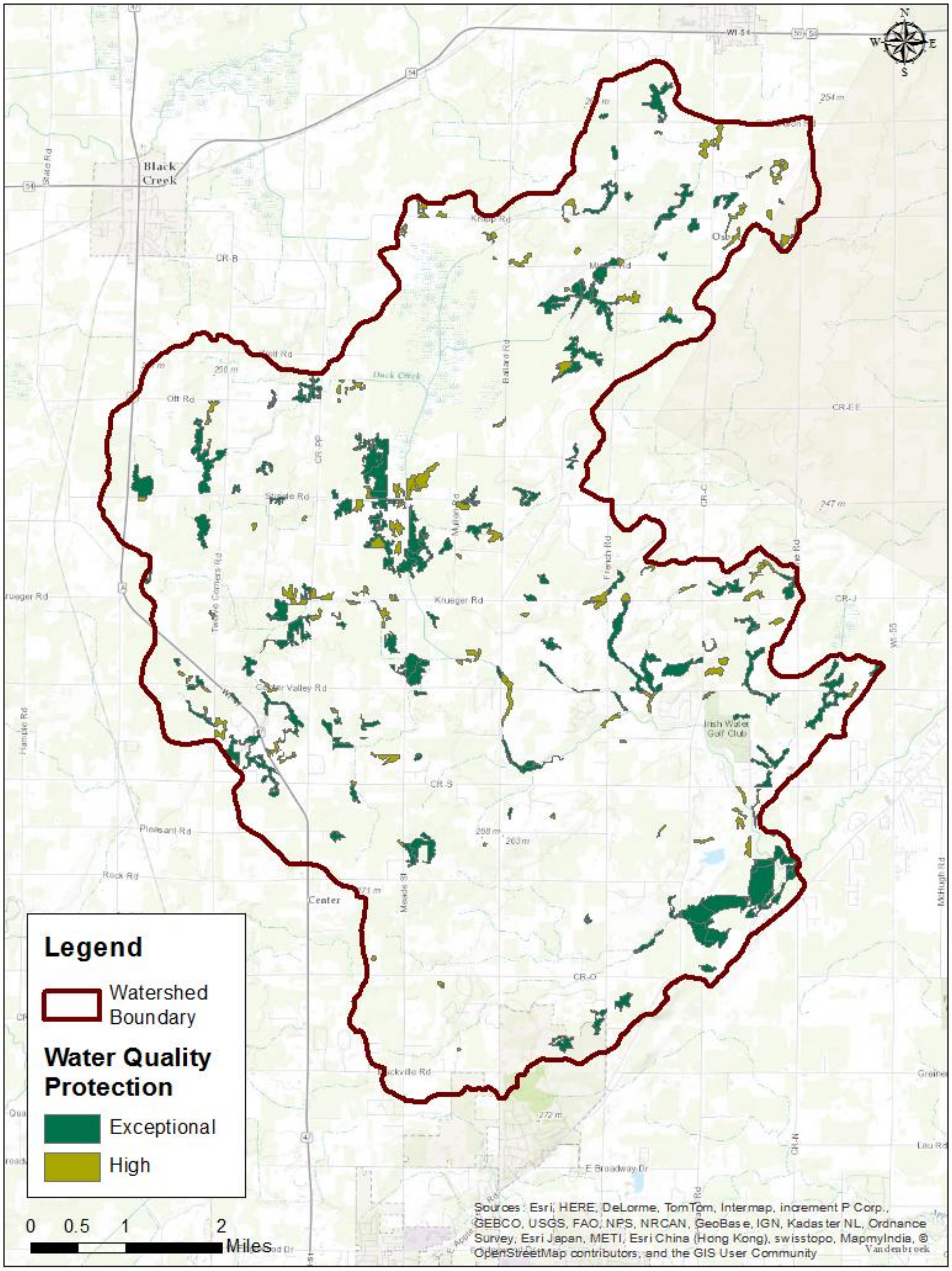



**Figure 41.** Duck-Pensaukee wetland assessment of water quality protection for potentially restorable wetlands. (The Nature Conservancy & Environmental Law Institute

## 7.0 Watershed Goals and Management Objectives

The main focus of the watershed project is to meet the limits set by the Lower Fox River TMDL. Additional goals were set that address critical issues in the watershed area based on watershed inventory results. Management objectives address the sources that need to be addressed in order to meet the watershed goals.

**Table 11.** Watershed Goals and Management Objectives.

| Goal | Indicators | Cause or Source of Impact | Management Objective |
|---|---|---|---|
| Improve surface water quality to achieve DNR/EPA water quality standards. | Total Phosphorus, Total Suspended Sediment | High phosphorus levels causing algal growth and decreased dissolved oxygen. Cropland and barnyard runoff. | Reduce the amount of sediment and phosphorus loads from cropland. Reduce the amount of phosphorus runoff from livestock facilities. |
| Citizens of the watershed area are aware of water quality issues and are involved in the stewardship of the watersheds. | Interview/Questionnaire results | 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. Increase soil infiltration. |

(This page intentionally left blank)

## 8.0 Management Measures Implementation

The Upper Duck Creek 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. 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. 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. County Land Conservation and NRCS departments 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.

Many alternative and new conservation technologies and methods are currently being developed and evaluated. Incorporation of new and alternative technologies and management methods into the implementation plan will be necessary to achieve desired water quality targets. Newer practices will need to be evaluated for effectiveness and feasibility before incorporation into the plan. Examples of new technologies and methods that may be needed to reach reduction goals in the Upper Duck include the following, but are not limited to:

- Application of soil amendments to fields such as Gypsum, Fly ash, or Polyacryamide (PAM): Soil amendments can reduce phosphorus solubility.
- ROWBOT: Small robot that can travel between corn rows that can apply fertilizer in sync with corn needs, inter-seed cover crops into tall corn, and collect data.
- Saturated Buffer: Diversion of tile drainage to riparian buffer area reducing nutrient loading.
- Phosphorus removal structures: A large landscape scale filter intended to trap dissolved phosphorus. The structure contains a solid phosphorus sorption material that is able to be removed and replaced after it is no longer effective.
- Constructed Treatment Wetlands.

**Table 12.** Management Measures Implementation 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 fields and uplands. | | | | | | | |
| a) Application of conservation practices to cropland. These practices include:<br>• Utilization of strip cropping and/or contour cropping practices on fields.<br>• Increase acreage of conservation tillage (No till, Strip till, Mulch Till) in watershed area. Fields must meet 30% residue.<br>• Implement use of cover crops.<br>• Installation of field borders.<br>• Enforcement of NR151.03 standard for tillage setback from surface waters where necessary.<br>• Use of vertical manure injection on fields with cover crops & reduced tillage.<br>• Prescribed grazing | # acres cropland with conservation practices applied | 4,000 | 5,900 | 4,375 | 0-10 years | EQIP, TRM, GLRI, CSP, AM, WQT | NRCS, LCD |
| b) Installation of grassed waterways in priority areas. | # of linear feet of grassed waterways installed | 15,500 | 20,600 | 16,650 | 0-10 years | EQIP, CREP, AM, WQT | NRCS, LCD |

| *Recommendations* | *Indicators* | *Milestones* | | | *Timeline* | *Funding Sources* | *Implementation* |
|---|---|---|---|---|---|---|---|
| | | *0-3 years* | *3-7 years* | *7-10 years* | | | |
| c) Concentrated flow path seedings of cover that can be planted through. | # acres of concentrated flow area seedings | 30 | 40 | 30 | 0-10 years | GLRI | NRCS, LCD |
| d) Installation of vegetative buffers along perennial and intermittent streams and legal drains. | # acres of buffers installed | 35 | 48 | 32 | 0-10 years | CREP/CRP, EQIP, GLRI, AM, WQT | NRCS, LCD |
| e) Nutrient Management: Sign up remaining landowners for nutrient management. | # of landowners signed up for nutrient management plans | 7 | 8 | 5 | 0-10 years | EQIP, TRM, SEG, AM, WQT | NRCS, LCD |
| f) Checks to make sure installed practices and management plans are being maintained and properly followed. | # of farms checked | 15 | 20 | 15 | 0-10 years | N/A | LCD |
| g) Enforcement of NR 151.03 standard for tillage setback from surface waters where necessary | % of fields meeting standard tillage setback | 25% | 50% | 100% | 0-10 years | N/A | LCD |
| h) Construct treatment wetlands to treat and store water from agriculture runoff and tile drainage | # of treatment wetlands installed | – | 2 | 2 | 0-10 years | GLRI, AM, WQT | Nature Conservancy, NRCS, LCD |
| i) Use of new technologies and innovative practices to reduce phosphorus and sediment loading from cropland. (Examples include: phosphorus removal structures, saturated buffers, soil amendment applications, interseeding cover crops) | # sites where new technologies have been used and assessed for effectiveness and feasibility | 0 | 2 | 1 | 0-10 years | GLRI, NRCS, Other Federal/State/Private funding | LCD,NRCS |

| *Recommendations* | *Indicators* | *Milestones* | | | *Timeline* | *Funding Sources* | *Implementation* |
|---|---|---|---|---|---|---|---|
| | | *0-3 years* | *3-7 years* | *7-10 years* | | | |
| **2) Management Objective:** Slow the flow of runoff from upland areas to watershed streams | | | | | | | |
| a) Increase water storage by restoring wetlands. | # of acres of wetlands restored | 2 | 5 | 8 | 0-10 years | EQIP, CREP/CRP, WQT, AM | NRCS, LCD |
| b) Install Water and Sediment Control basins to store and slow flow of runoff. | # of WASCOBS installed | 3 | 4 | 3 | 0-10 years | EQIP, AM, WQT | NRCS, LCD |
| c) Increase soil infiltration by implementing practices (a-i) under Management Objective 1. | – | – | – | – | – | – | – |
| **3) Management Objective:** Reduce phosphorus runoff from barnyards | | | | | | | |
| a) Retrofit barnyard sites with necessary runoff control structures (gutters, filter strips, settling basins, clean water diversions) | # of barnyard sites addressed and retrofitted with necessary runoff control measures | 4 | 5 | 3 | 0-10 years | EQIP, AM, WQT | NRCS, LCD |
| b) Manure management on livestock operation sites. | # of new or updated manure storage facilities | 1 | 2 | 1 | 0-10 years | EQIP, AM, WQT | NRCS, LCD |

*1. A combination of the listed practices will be applied to agricultural fields to get the desired reductions required by the TMDL. 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 C.*

## 9.0 Load Reductions

Load reductions for agricultural best management practices were estimated using STEPL (Spreadsheet Tool for Estimating Pollutant Loading) and load reductions from barnyards were estimated using the BARNY model. Percent reduction was based on the STEPL model agricultural baseline loading of 25,347 lbs TP/yr and 5,016 tons TSS/year. The Lower Fox River TMDL calls for 58.6 % reduction of TSS and 76.9% reduction of TP from agriculture in the Duck Creek Watershed. An estimated 56% reduction in TP and 65% reduction in TSS are expected for planned management measures in the Upper Duck Creek watershed. Expected load reductions from planned activities are shown in Table 13.

These estimated reductions show that the TMDL suspended sediment reduction goal is likely to be achieved but phosphorus reductions fall short of the TMDL goal. Recent studies are showing that significant amounts of phosphorus are leaving via tile drainage where in the past only nitrogen leaving tile drainage was a concern. A study comparing 4 UW Discovery Farm sites showed that tile drainage can represent between 17 and 52% of the total phosphorus loss from a field (Ruark et al, 2012). Since the majority of cropland in the Upper Duck Creek is tile drained, it is likely that significant amount of phosphorus loss in this watershed may be attributed to tile drainage. Additional innovative practices will need to be researched and implemented in the watershed to address tile drainage if reduction goals are to be achieved. See Appendix E for strategy to achieve the phosphorus reduction needed.

Another challenge that presents itself 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.

Land use changes in the future could also further exacerbate phosphorus loading in the watershed. In a study done by Duan et al (2013), significantly higher particulate phosphorus loads were found in watershed effluent following residential development of agricultural land. If urbanization were to increase in the Upper Duck Creek watershed it is likely that water quality conditions could decline or remain stagnant despite implementing conservation practices on agricultural land.

**Table 13.** Expected load reductions from recommended best management practices.

| Management Measure Category | Total Units (size/length) | Total Cost | Estimated Load Reduction | | | |
|---|---|---|---|---|---|---|
| | | | TP (lbs/yr) | Percent | TSS (t/yr) | Percent |
| ***Vegetative Riparian Buffers*** | 116 acres | 464,000.00 | 1,392.6 | 5.5 | 207.1 | 4.1 |
| ***Barnyard Retrofits*** *(filter strips, waste storage, clean water diversions, maintenance/repair of existing practices, etc)* | 13 sites | 505,370.00 | 497.0 | 2.0 | NA | NA |
| ***Practices applied to Cropland*** *(Conservation Tillage/Residue Management,Cover Crops, Nutrient Management, Contour Cropping, Strip Cropping, Tillage Setback, Field Border, Vertical Manure Injection, Prescribed Grazing)* 1 | 14,275 acres | 3,260,692.50 | 11,536.0 | 45.5 | 2,182.0 | 43.5 |
| ***Gully Stabilization*** *(Grassed Waterways, Concentrated Flow Area Seedings, WASCOBS)* | 147,327 ft/10 WASCOB | 391,220.00 | 515.0 | 2.0 | 836.5 | 16.7 |
| ***Use of new technologies and innovative pracices to reduce phosphorus and sediment loading from cropland*** *(Instream treatment in drainage ditches, saturated buffers, water control stuctures for tile outlets, phosphorus removal structures, soil amendment applications)* 2 | unknown | N/A | unknown | N/A | unknown | N/A |
| ***Constructed Treatment Wetlands*** | 4 sites | 60,000.00 | 92.1 | 0.4 | 19.2 | 0.4 |
| ***Wetland Restoration*** | 15 acres | 150,000.00 | 219.0 | 0.9 | 46.0 | 0.9 |
| ***Totals*** | | **4,831,282.50** | **14,251.7** | **56.2** | **3,271.6** | **65.2** |

1. *This category* <u>*does not*</u> *indicate that all these practices will be applied to all 14,275 acres of cropland. A combination of conservation practices applied to a majority of the cropland in the watershed is necessary to get the desired pollutant load reductions suggested by the TMDL. 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 Field Border 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 C.*
2. *The amount of new technologies and management measures needed has not been determined, as well as, expected load reductions and cost. If new management measures/technologies prove effective and feasible they will be incorporated into the plan with more accurate load reductions, cost, and amount needed. Depending on the efficiencies realized by new innovative practices, the number or combinations of other field practices required may be reduced.*

(This page intentionally left blank)

## 10.0 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.

### *10.1 Alliance for the Great Lakes Survey*

The Alliance for the Great Lakes developed an interview and questionnaire that was given to landowners in the Lower Fox River Watershed area in Spring and Summer of 2014 by County Land and Water Conservation Departments and local agronomists. Data from the questionnaires and interviews was analyzed by subwatershed. The survey and questionnaire gathered information on the knowledge of conservation and water quality issues, willingness to participate in conservation programs, and where landowners obtain their information. Moreover, many landowners of all farm sizes did not recognize the severity of water quality issues impacting the Lower Fox River Basin and the extent to which agricultural sources contribute to nutrient and sediment loadings to the River and the Bay of Green Bay. Providing information on available conservation programs, technical assistance, and education will be a very critical component of implementing the management plan.

Selected Results from Survey

**Knowledge and Thoughts on Current Conservation Programs:**

One of the interview questions asked respondents to reflect on the conservation programs currently being offered. The responses were organized by themes and further by subwatersheds to gain a better understanding of what landowners think about conservation programs and whether responses differ across different areas of the Lower Fox River watershed. A total of 28 themes were identified (ranging from “Willing to try them” to “More exist than necessary”) with the most frequently mentioned theme being “Not familiar with programs” as shown in Figure 42 below. This is in contrast to the most frequently mentioned themes by the other subwatersheds. For comparison, among respondents in Duck/Trout Creeks subwatershed most frequently mentioned theme was “involved in them”, in Apple/Ashwaubenon/Dutchman Creeks, it was “going well-good programs”, and in East River/Baird/Bower Creeks, both “involved in them” and going well-good programs” were both at the top of the list.

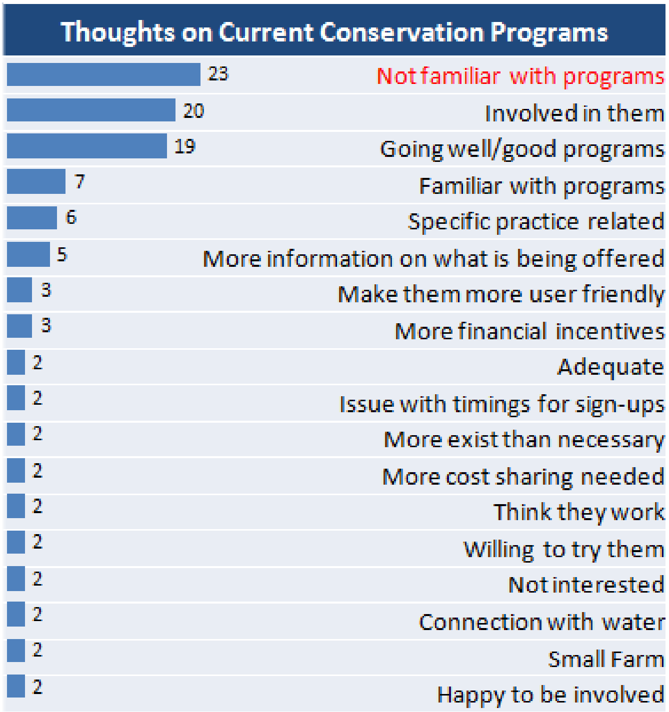



**Figure 42.** Survey results on Thoughts on Current Conservation Programs in all subwatersheds. (Alliance for the Great Lakes)

**Information/Communication:**

A number of the questions in the interview and questionnaire were designed to get a better understanding regarding what organizations or entities landowners go to for information and how they prefer to receive/exchange information. The results listed below reflect some of the responses most relevant to this plan:

1. Many respondents want to see the County Land and Water Conservation Departments conduct more education and provide information on practices.
2. 89% Moderately to very interested in demonstration farms as information sources in the Duck/Trout Creeks subwatershed.
3. 77% Moderately to very interested in sharing information in a group setting in the Duck/Trout Creek subwatershed.
4. The preferred methods of communication were: newsletters, on farm demonstrations/field days, one on one hands on demonstrations, and magazines (based on responses from the entire Lower Fox River watershed).
5. Landowners go to similar organizations for both farming advice and water quality information (% indicates the percentage of respondents who named this organization as important).

a. For agronomic information in Duck/Trout Creeks watersheds, these include: Local Farm Cooperatives/Crop Consultants (72%); NRCS (67%); County Land and Water Conservation Department (56%)
b. For water quality information in Duck/Trout Creeks watersheds, these include: Local Farm Cooperatives/Crop Consultants (93%); County Land and Water Conservation Department (86%); NRCS (57%)

**Severity of sources of pollution in your area:**

The survey asked several questions related to water quality in the Lower Fox River watershed and Green Bay, specifically on impacts, particular pollutants, and sources of the pollutants. Overall, consequences of poor water quality in the area were mostly rated as slight to moderate problems. Similarly, among the sources listed, most were perceived to be slightly or moderately problematic. Notably:

- Respondents perceived the most serious source of water pollution coming from non-agricultural sources.
    - 65 % identified "excessive use of lawn fertilizers and pesticides" as a moderate to severe problem
    - Next three most problematic pollutant sources were stormwater runoff from urban areas, discharges from sewage treatment plants, and discharges from industry.
- Of the six agricultural pollution sources, the one perceived as most severe was "soil erosion from fields" with 37% followed by "land application of animal waste" with 19%. By comparison, 31% identified waterfowl droppings as a moderate to severe problem.

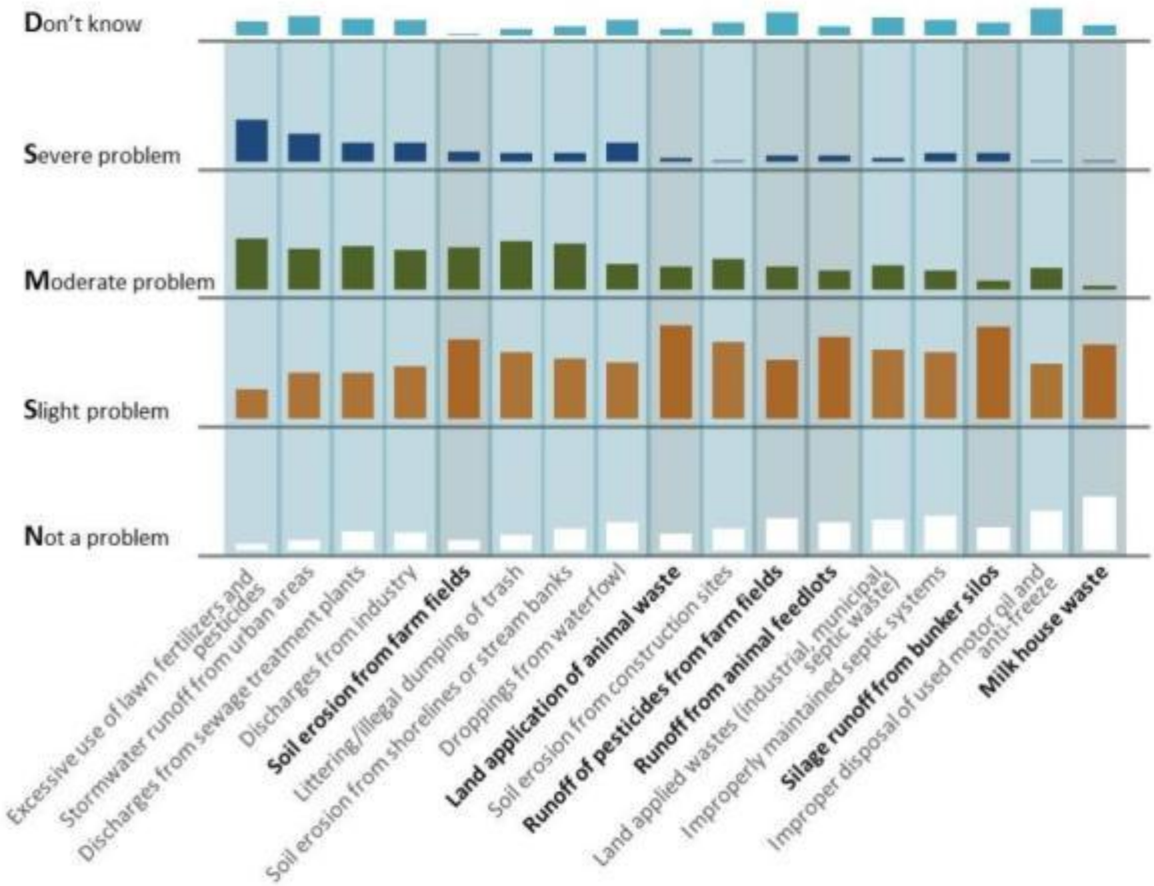



**Figure 43.** Survey responses to severity of sources of pollution in the Lower Fox River and Bay of Green Bay. (Alliance for the Great Lakes)

### *10.2 Recommended Information and Education Campaigns*

Goals for the Information and education plan and recommended actions were based on the results from the survey. An effective Information and Education Plan includes the following components as referenced in USEPA's "*Handbook for Developing Watershed Plans to Restore and Protect our Waters*" (USEPA 2008):

- Define I&E goals and objectives
- Identify and analyze the target audiences
- Create the messages for each audience
- Package the message to various audiences
- Distribute the message
- Evaluate the I&E program

Goals of the information and education plan: 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.

Objectives

- 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 Lower Fox River Watershed basin and how the Upper Duck Creek watershed contributes.
- Get local high schools and colleges 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 an important subset of this group as they are usually not focused on and are less likely to participate in conservation programs. The 1999 Agricultural Economics and Land Ownership survey showed that 34 % of farmland in Wisconsin was owned by non-operator landlords (USDA 1999). Studies have shown that non-operators tend to be older, less likely to live on the farm, and less likely to participate in conservation programs (Nickerson et al 2012). Non-operator land owners in the watershed area need to be addressed as they control a significant amount of agricultural land but tend to leave the management of the land up to the tenant.

**Existing Education Campaigns**:

*Fox- Wolf Watershed Alliance*: A nonprofit organization that identifies issues and advocates effective policies and actions to protect and restore the water resources of Wisconsin's Fox-Wolf River watershed. They hold events such as river clean-ups, workshops, presentations at Annual Watershed Conferences, and meetings with other organizations to outreach to the public.

*Northeast Wisconsin Stormwater Consortium*: A subsidiary of the Fox-Wolf Watershed Alliance composed of municipal members and business partners working to address stormwater issues and to educate residents on best management practices, ordinances and other storm water concerns and programs.

*Demonstration Farm Project*: Currently there is a demonstration farm project to establish 4 demonstration farms in the Lower Fox River Watershed. The goal of the demonstration project is to test new conservation methods and to educate other farmers. The demonstration farm project holds field days for local farmers and agency members to learn about the different practices being tested.

*Silver Creek Adaptive Management Project:* NEW Water formerly, Green Bay Metropolitan Sewerage District, is working on a phosphorus reduction plan to reduce its discharges to the Fox River. NEW Water is implementing a pilot adaptive management project in the Silver Creek Subwatershed.

**I&E Plan Recommended Actions**

An Information and Education Plan matrix (Table 14) 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 13.3 describes milestones related to watershed education activities that can be used to evaluate the I&E plan implementation efforts.

**Table 14.** 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 | • Public notice in local newspaper upon completion of watershed plan.<br>• Present plan to public at a public meeting.<br>• Create a web page (Facebook, page on County website) for watershed project.<br>• 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 | LCD |
| 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. | 0-10 years | Landowners are informed on project and progress. Landowners can stay up to date on new practices and strategies available. | $7,000 | LCD, Fox Wolf Watershed Alliance |
| Educate agricultural landowners and operators about the plan, its recommendation actions, and technical assistance | Agricultural landowners/ operators | • Distribute educational materials on conservation practices and programs.<br>• One on one contact with individual landowners to provide tools and resources. | 0-10 years | • Agricultural landowners are informed about conservation practices, cost share programs, and technical assistance available to them.<br>• Increase in interest in utilizing and installing | $15,000 | LCD,NRCS,UW EX |

| Information and Education Plan Implementation Matrix | | | | | | |
|---|---|---|---|---|---|---|
| **Information and Education Action** | **Target Audience** | **Recommendations** | **Schedule** | **Outcomes** | **Cost** | **Implementation** |
| and funding available. | | • Orchestrate group meetings with agricultural landowners in watershed to share knowledge and foster community connections for long term solutions.<br>• Offer workshops to agricultural landowners to educate them on conservation practices that should be used to preserve the land and protect water resources.<br>• Tour local demonstration farm and other sites that have implemented conservation practices. | | conservation practices.<br>• Improved communication between agricultural landowners, willingness to share ideas, and learn from other agricultural landowners.<br>• Agricultural landowners recognize the benefit of conservation farming practices and how it improves water quality.<br>• Agricultural landowners see success of conservation practices as well as problems that can be expected. | | |
| Reach out to non-operator land owners. | Non-operator agricultural landowners | • Distribute educational materials targeted to non-operator agricultural landowners.<br>• One on one contact and group meetings with non-operator agricultural land owners to share knowledge and foster community connections for long term solutions.<br>• Hold workshop for non-operator female | 0-5 years | Non-operator landowners are informed on conservation practices. Increased participation rates in conservation activities from non-operator land owners. | $3,500 | LCD, NRCS, UWEX |

| Information and Education Plan Implementation Matrix | | | | | | |
|---|---|---|---|---|---|---|
| **Information and Education Action** | **Target Audience** | **Recommendations** | **Schedule** | **Outcomes** | **Cost** | **Implementation** |
| | | land owners based on Women Caring for the Land Handbook (WFAN, 2012). | | | | |
| 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 Outagamie County, Town of Freedom, Town of Center, Town of Osborn, and Town of Black Creek | Present project plan to officials and conduct meetings with government officials. | 1-2 years | Local municipalities adopt plan and amend ordinances, codes, and plans to include watershed plan goals and objectives. | No cost using existing resources. | LWCD |
| 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, LCD, Fox Wolf Watershed Alliance |
| Educate local agricultural businesses and organizations on objectives of watershed project. | Agronomists, Co-ops, Seed dealers | Meetings with local agricultural organizations to share goals of project and planned conservation practices and outreach needed. | 0-5 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, LCD |

| Information and Education Plan Implementation Matrix | | | | | | |
|---|---|---|---|---|---|---|
| **Information and Education Action** | **Target Audience** | **Recommendations** | **Schedule** | **Outcomes** | **Cost** | **Implementation** |
| 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. | 5-7 years | Increased awareness of water quality and conservation practices in the watershed area in comparison to 2014 survey. | $3,000 | LCD, UWEX |

## 11.0 Cost Analysis

Cost estimates were based on current cost-share rates, incentives payments to get necessary participation, and current conservation project installation rates. Current conservation project installation rates were obtained through conversations with county conservation technicians. Landowners will be responsible for maintenance costs associated with installed practices. The total cost to implement the watershed plan is estimated to be $7,030,371 with an additional 2 million in new technology costs.

Summary of Cost Analysis

- $4,831,282 to implement best management practices.
- $1,287,640 needed for technical assistance.
- $123,449 needed for information and education.
- $788,000 for water quality monitoring.
- $2 million for new innovative practices.

**Table 15.** Cost estimates for implementation of best management practices.

| BMP | Quantity | Cost /Unit ($) | Total Cost ($) |
|---|---|---|---|
| Upland Control | | | |
| Conservation Tillage (ac)[1] | 12,325 | 18.50 | 684,038 |
| Cover Crops (ac)[1] | 9,870 | 70.00 | 2,072,700 |
| Grass Waterways (ln ft) | 61,544 | 5.00 | 307,720 |
| Concentrated Flow Area Seeding (ac) | 100 | 135.00 | 13,500 |
| Vegetative Buffers (ac) | 116 | 4,000.00 | 464,000 |
| Nutrient Mgmt (ac)[1] | 6,775 | 15.00 | 304,875 |
| Wetland Restoration (ac) | 15 | 10,000.00 | 150,000 |
| Treatment Wetlands (sites) | 4 | 15,000.00 | 60,000 |
| Water and Sediment Control Basin (ea) | 10 | 7,000.00 | 70,000 |
| Contour Farming (ac) | 1,200 | 7.62 | 9,144 |

| BMP | Quantity | Cost /Unit ($) | Total Cost ($) |
|---|---|---|---|
| Field Borders (ac) | 10 | 4,000.00 | 40,000 |
| Vertical Manure Injection (ac) | 2,200 | 58.00 | 127,600 |
| Prescribed Grazing (ac) | 200 | 50.00 | 10,000 |
| Strip Cropping (ac) | 1,200 | 10.28 | 12,336 |
| Barnyard Runoff Control | | | |
| Filter Strip/ Wall (ea) | 5 | 25,000.00 | 125,000 |
| Roof Gutters (ln ft) | 1,165 | 10.00 | 11,650 |
| Waste Storage (ea) | 5 | 70,000.00 | 350,000 |
| Milkhouse Waste Treatment (ea) | 2 | 4,860.00 | 9,720 |
| Technical Assistance | | | |
| Conservation/Project Technician[2] | 1 | 54,525.00 | 643,820 |
| Agronomist[2] | 1 | 54,525.00 | 643,820 |

1. Cost based on cost sharing for 3 year time period.
2. Cost based on employment for 10 years including benefits and 3% increase per year for salary and fringe costs.

**Table 16.** Information and Education Costs.

| Information and Education | Cost |
|---|---|
| Staff hours (2,600 hours of staff time for 5 years) | 91,249 |
| Materials (Postage, printing costs, paper costs, and other presentation materials) | 32,200 |

**Table 17.** Water Quality Monitoring Costs.

| Water Quality Monitoring Activity | Cost($) |
| --- | --- |
| USGS Automated Monitoring Station (Equipment & Installation) | 20,000 |
| Subcontract and lab analysis cost USGS automated station (10 years of monitoring) | 200,000 |
| 2 Edge of field monitoring sites (equipment/installation) | 128,000 |
| Subcontract and lab analysis for 2 edge of field monitoring sites (USGS/UWGB subcontract 5 years) | 440,000 |
| **Total** | **788,000** |

Estimated Costs of new/alternative practices:

Cost of new technologies/management methods was not included in this estimate since the quantity of these technologies that may be needed is not yet known. Approximate costs for a selected few new technologies are as follows:

- $10-15/acre for ROWBOT when used as a service.
- $25-45/ton gypsum. Typical application rate to improve soil physical properties, water infiltration/percolation, and water quality is 1,000-9,000 lbs/acre (Ohio State University 2011).
- Drainage water management structure for tile drains: $500-$2,000 each unit or $20-$110/acre.
- Cost of a P- removal structure varies depending on site characteristics, target removal, phosphorus sorbing material characteristics. Oklahoma State University found that the total cost of P removal can be $30-100 per lb of P removed. The NRCS recently developed a national standard for phosphorus removal structures (Code 782), so that construction of P removal structures may be cost shared.

## 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, treatment wetlands, wetland restoration, barnyard runoff control, manure storage, and streambank stabilization including crossings 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).

## 12.0 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.

### *12.1 Federal and State Funding Sources*

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, buffer strips, wetland restoration, tall grass prairie and oak savanna restoration, grassed waterway, and permanent native grasses.

**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.

**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. Currently the Lower Fox River watershed is one of three priority watersheds in the Great Lakes Restoration Initiative Action Plan. 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.

### *12.2 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 18.** 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. |

### *12.3 Phosphorus Multi- Discharger Variance (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 applying with phosphorus causes Wisconsin substantial and economic hardship. If so, DNR will work with the EPA to implement a phosphorus 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 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.

(This page intentionally left blank)

## 13.0 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.

### *13.1 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 with additional monitoring recommendations.

<u>Stream Water Quality Monitoring</u>

Surface water samples will be collected on a monthly basis from the mouth of the Duck Creek from May through October starting in 2015 as part of the Lower Fox River Monitoring program. On each sampling date, volunteers will collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). Volunteers will also utilize transparency tubes to assess and document the transparency of each stream on each date. Macroinvertebrate sampling will also be performed by volunteers on the Duck Creek during September or October and will be delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3-5 years. All sampling will be conducted in accordance with WDNR protocol. A summary of the Lower Fox River Monitoring Strategy is shown in Appendix D.

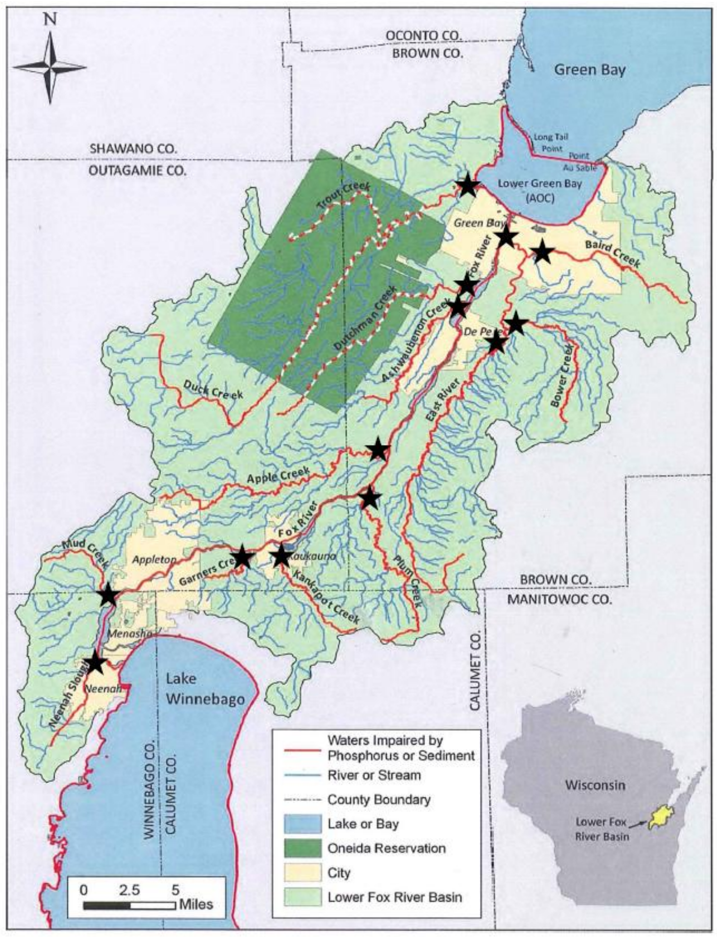



**Figure 44.** Approximate sample locations for the Lower Fox River Volunteer Monitoring.

Current water quality monitoring activities on the Duck Creek all occur near the mouth of Duck Creek. To obtain more accurate data on water quality changes due to implementation of practices in the Upper Duck subwatershed an additional automated USGS continuous monitoring station near the confluence of Upper Duck is recommended. An additional monitoring station near the confluence of Upper Duck into Middle Duck would better show any changes in water quality from implementation in the Upper Duck Creek than just measuring water quality downstream near the outlet into the Bay of Green Bay.

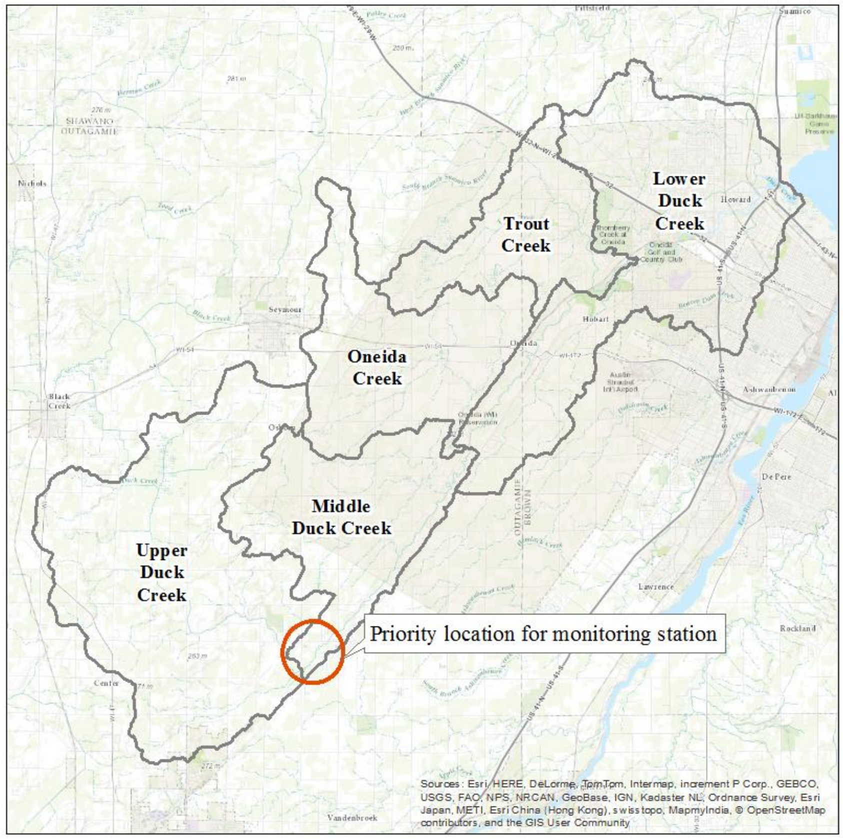



**Figure 45.** Priority location for additional monitoring station on Duck Creek.

USGS automated monitoring stations record precipitation, gage height, and discharge. Automated samplers installed at a continuous monitoring station also take water samples. This plan calls for low flow samples and event samples to be collected from the proposed site. As streamflow increases due to runoff events, automated samplers installed at the stations take water samples. Samples from monitoring stations will be collected weekly May-October and monthly for the remaining months. Samples will be analyzed for total phosphorus and total suspended solids. One- half of the low flow samples will be analyzed for dissolved phosphorus in addition to TP and TSS and approximately 25 event samples per site will be analyzed for dissolved phosphorus. All samples will be analyzed at a certified lab, and all data from the sites will be stored in the USGS National Information System (NWIS) data base.

Edge of Field Monitoring

A minimum of two edge of field sites in the watershed should be chosen for monitoring the effectiveness of new tile drainage water treatment practices such as the use of saturated buffers, phosphorus removal structures, or water control structures. Two constructed treatment wetlands with water quality monitoring are planned in the Plum and Kankapot watersheds of the Lower Fox, therefore other tile drainage water treatment methods should be tested in the Upper Duck watershed. Discharge and water quality will be monitored at inlets and outlets of treatment practices. Water quality and flow data will be used to compute daily phosphorus and suspended sediment loads and to evaluate the treatment effectiveness of the practice. An appropriate quality assurance plan will be developed for the edge of field monitoring work and samples will be analyzed at a certified lab. Edge of field monitoring will begin once sites and desired practices are identified and constructed, which shall occur within the first 2 years of implementation.

Water Quality Indicators

Plan progress will also be measured by water quality data. Median summer phosphorus concentrations, annual phosphorus and suspended sediment loading rates, and macroinvertebrate index of biotic integrity values will be used to determine improvement in water quality. Water quality monitoring indicators for success are shown in Table 19. The target values are based off of the 58.6% TSS and 76.9% TP reduction from agriculture sources stated in the Lower Fox River TMDL.

**Table 19.** Water quality monitoring indicators for success.

| Monitoring Recommendation | Indicators | Current Values (STEPL) | Target Value or Goal for Up Duck Creek Watershed (Upper Duck) | Milestones from Implementation in Upper Duck Creek Subwatershed | | | Implementation | Funding |
|---|---|---|---|---|---|---|---|---|
| | | | | Short Term (3 yrs) | Medium Term (7 yrs) | Long Term (10 yrs) | | |
| ***Upper Duck Creek*** | | | | | | | | |
| Monitoring Station at confluence of Upper Duck | # lbs phosphorus/yr | 27,726 | 8,234 | 21,878 | 14,082 | 8,234 | USGS/UWGB | GLRI |
| | # tons total suspended sediment/yr | 5,339 | 2,400 | 4,457 | 3,282 | 2,400 | | |
| Lower Fox River Surface Water Monitoring | % of sites with a Good IBI rating | Fair | Good | 50% | 75% | 100% | WDNR | WDNR |

### *13.2 Tracking of Progress and Success of Plan*

Progress and success of the Upper Duck Creek 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

Outagamie County Land Conservation Departments will be responsible for tracking progress of the plan. Land Conservation departments 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 lead 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) Number of municipalities that adopt municipal comprehensive plans, codes, and ordinances, supportive of watershed plan goals and objectives.
   i) 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 SNAP Plus[5] for upland practices and the 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.

[5] SNAP (Soil Nutrient Application Planner) Plus is Wisconsin's nutrient management software that calculates potential soil and phosphorus runoff losses on field basis while assisting in the economic planning of manure and fertilizer applications. Additional information can be found on the website http://snapplus.wisc.edu/.

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.
g) Number of new and alternative technologies and management measures assessed for feasibility, used, and incorporated into plan.

3) Water Quality Monitoring Reporting Parameters:
   a) Annual summer median total phosphorus and total suspended solids concentrations and loading values from USGS stream monitoring stations.
   b) Annual mean discharge and peak flow discharge from USGS stream monitoring stations.
   c) Total phosphorus, dissolved reactive phosphorus, total suspended solids, and clarity data from volunteer grab sampling (Lower Fox River Watershed Monitoring Program).
   d) Edge of field monitoring results.
   e) Macroinvertebrate Index of Biotic Integrity.

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.

### *13.3 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 46). Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals over given time periods. Milestones are based on the plan 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. 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.

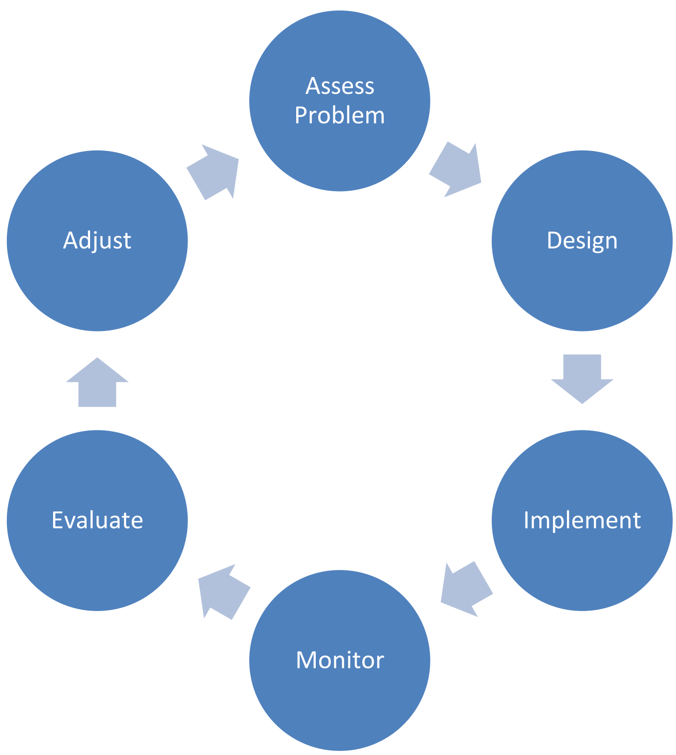



**Figure 46.** Adaptive Management Process

**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 19. 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 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?
- Stability of bank sediments and how much this sediment may be contributing P and TSS to the stream
- 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 optimist

**Management Measures/Information and Education Implementation Progress Evaluation**

Implementation milestones for management measures are shown in the 10 Year Management Measures Plan Matrix (Table 12) and milestones for Information and Education Plan implementation are shown in Table 20. 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 20.** Information and Education Plan Implementation Goal Milestones

| Information and Education Plan Implementation Goal Milestones |
|---|
| ***Short Term (0-3 years)*** |
| a) Notice in local newspaper on completion of watershed plan. |
| b) Facebook/Website/or Page on county website developed for watershed information and updates. |
| c) 1 exhibit displayed or used at local library, government office, and/or local event. |
| d) Distribution of informational materials on watershed project and 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/tours held at a demonstration farm. |
| h) Annual newsletter developed and at least three issues 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) At least 4 educational workshops held. |
| b) At least 3 meetings held with agricultural landowners. |
| c) At least one workshop held for non-operator 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 1 meeting between groups conducting education in the Lower Fox Basin to assess effectiveness of various education methods. |
| g) At least 4 issues of annual 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 annual newsletter distributed. |

If it has been determined that implementation milestones are not being met the following questions should be evaluated and included in the progress report:

- Did weather related causes postpone implementation?
- Was there a shortfall in anticipated funding for implementing management measures?
- Was there a shortage of technical assistance?
- Was the amount of time needed to install some of the practices misjudged?
- Were cultural barriers to adoption accounted for?

(This page intentionally left blank)

## 14.0 Literature Cited


Cibulka, Daniel, Paul Baumgart, and Kevin Fermanich. 2010. Temporal Assessment of Management Practices and Water Quality in the Duck Creek Watershed, Wisconsin. A report to the Environmental Health and Safety Division Oneida Tribe of Indians of Wisconsin. University of Wisconsin Green Bay.

Cooley, Eric, Dennis Frame, and Aaron Wunderlin. 2010. Understanding Nutrient & Sediment Loss at Pagel's Ponderosa Dairy-Fact Sheet Series. University of Wisconsin-Discovery Farms.

Chen, Liming, and Warren Dick. 2011 .Gypsum as an Agricultural Amendment, General Use Guidelines. Ohio State University. Bulletin 945.

Dodds, W.K., W.W. Bouska, J.L. Eitzman, T.J. Pilger, K.L. Pitts, A.J. Riley, J.T. Schoesser, and D.J. Thornbrugh. 2009. Eutrophication of U. S. freshwaters: analysis of potential economic damages. Environmental Science and Technology 43: 12-19. doi: 10.1021/es801217q

Duan S., S.S. Kaushal, P.M. Groffman, L.E. Band, and K.T. Belt. 2012. Phosphorus export across an urban to rural gradient in the Chesapeake Bay watershed. J. Geophys. Res. 117: G0102510. Doi: 1029/2011JG001782.

Eagan-Robertson, David. December 2013. Wisconsin's Future Population: Projections for the State, its counties and municipalities, 2010-2040. Wisconsin Department of Administration Demographic Services Center. Retrieved from http://www.doa.state.wi.us/divisions/intergovernmental-relations/demographic-services-center/projections

Jacobson, Marty, Kevin Fermanich, and Paul Baumgart. Phosphorus and TSS Trends in Duck Creek, Northeastern Wisconsin. Presented at the Wisconsin AWRA Meeting, Wisconsin Dells, March 13-14, 2014.

Miller, Nick, Tom Bernthal, John Wagner, Mike Grimm, Gary Casper, and Joanne Kline. March 2012. The Duck-Pensaukee Watershed Approach: Mapping Wetland Services, Meeting Watershed Needs. The Nature Conservancy and Environmental Law Institute. Madison, WI.

Nickerson, Cynthia, Mitchell Morehart, Todd Kuethe, Jayson Beckman, Jennifer Ifft, and Ryan Williams. February 2012. Trends in U.S. Farmland Values and Ownership. EIB-92. United States Department of Agriculture, Economic Research Service.

Omernik, J.M., S.S. Chapman, R.A. Lillie, and R.T. Dumke. 2000. "Ecoregions of Wisconsin." Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. 88 :77-103.

Oklahoma State University. n.d. Phosphorus Removal Structures: A new best management practice to help improve water quality [brochure]. Stillwater, Oklahoma. Retrieved from http://phrog.okstate.edu/#Problem

Ruark, Matt, Allison Madison, Eric Cooley, Tott Stuntebeck, and Matt Komiskey. 2012. Phosphorus Loss from Tile Drains: Should We Be Concerned? Proceedings of the 2012 Wisconsin Crop Management Conference.

Sharpley, Andrew, Helen Jarvie, Anthony Buda, Linda May, Bryan Spears, and Peter Kleinman. 2013. Phosphorus Legacy: Overcoming the Effects of Past Management Practices to Mitigate Future Water Quality Impairment. J. Environ.Qual. 42. 1308-1326. doi:10.2134/jeq2013.03.0098

U.S. Census Bureau/American Fact Finder. "DP-1-Profile of General Population and Housing Characteristics: 2010." *2010 Demographic Profile Data*. U.S. Census Bureau, 2010. Accessed September 8, 2014: http://factfinder2.census.gov

U.S. Census Bureau/ American Fact Finder. "S1901-Income in the Past 12 Months." *2008-2012 American Community Survey 5-Year Estimates*. U.S. Census Bureau's American Community Survey Office, 2012. Accessed September 8, 2014: http://factfinder2.census.gov

U.S. Department of Agriculture National Agricultural Statistics Service (USDA NASS). 1999. Agricultural Economics and Land Ownership Survey. Retrieved from http://www.agcensus.usda.gov/Publications/1997/Agricultural_Economics_and_Land_Ownership/

U.S. Environmental Protection Agency (USEPA). March 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. EPA 841-B-08-002.

U.S. Environmental Protection Agency (USEPA). May 2006. Wetlands: Protecting Life and Property from Flooding. EPA843-F-06-001. Retrieved from: http://water.epa.gov/type/wetlands/outreach/upload/Flooding.pdf.

Wisconsin Department of Natural Resources (WDNR). March 2012. Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay. Wisconsin Department of Natural Resources. Madison, WI

Wisconsin Department of Natural Resources (WDNR). September 2013. Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM).

## Appendix A. Glossary of Terms and Acronyms.

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

**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.

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

**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.

**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** – 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.

**Lateral Recession Rate-** the thickness of soil eroded from a bank surface (perpendicular to the face) in an average year, given in feet per year.

**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.

**Phosphorus Index (PI)** – The phosphorus index is used in nutrient management planning. It is calculated by estimating average runoff phosphorus delivery from each field to the nearest surface water in a year given the field's soil conditions, crops, tillage, manure and fertilizer applications, and long term weather patterns. The higher the number the greater the likely hood that the field is contributing phosphorus to local water bodies.

**Riparian** – Relating to or located on the bank of a natural watercourse such as a river or sometimes of a 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.

**Soil and Water Assessment Tool (SWAT)** – A small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. Model is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds.

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

**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.

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

## Appendix B. Pollutant load allocations for Duck Creek Subbasin. (Obtained from: Total Maximum Daily Load and Watershed Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay)

DUCK CREEK SUB-BASIN

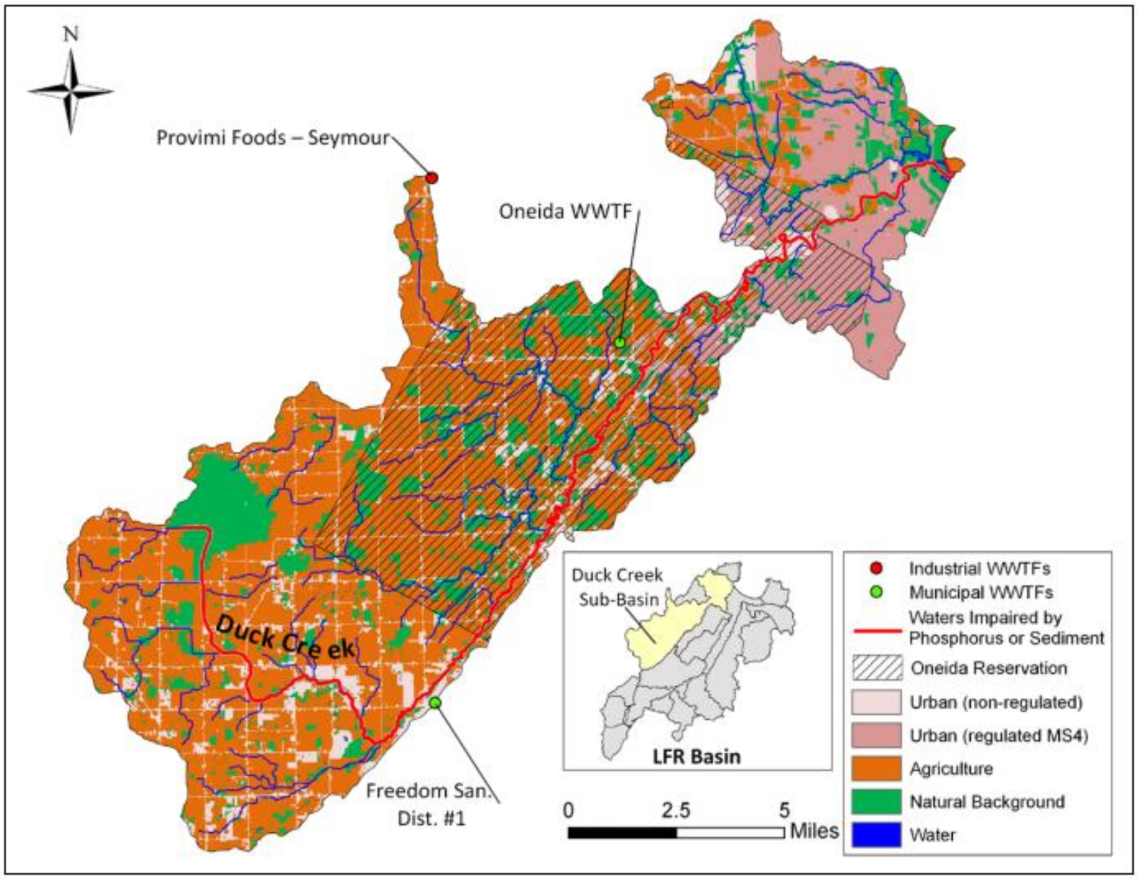



**Figure 47.** Pollutant load allocation map for Duck Creek.

**DUCK CREEK**
**TOTAL PHOSPHORUS**

| Sub-basin Loading Summary (lbs/yr) | |
|---|---|
| Baseline | 63,172 |
| TMDL | 23,252 |
| Reduction | 39,920 |
| % Reduction Needed | 63.2% |
| Daily TMDL (lbs/day) | 63.66 |

| Land Use | Acres | | | % of |
|---|---|---|---|---|
| | State | Oneida | Total | Total |
| Agriculture | 30,098 | 18760 | 48,858 | 56.0% |
| Urban (non-regulated) | 5,407 | 3585 | 8,992 | 10.3% |
| Urban (MS4) | 7,512 | 4570 | 12,082 | 13.8% |
| Construction | 214 | 131 | 345 | 0.4% |
| Natural Background | 8,972 | 8020 | 16,992 | 19.5% |
| TOTAL | 52,203 | 35,066 | 87,269 | 100.0% |

| Sources from State Land | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Agriculture | 30,382 | 7,028 | 23,354 | 76.9% | 19.24 |
| Urban (non-regulated) | 2,070 | 2,070 | - | - | 5.67 |
| Natural Background | 790 | 790 | - | - | 2.16 |
| LOAD ALLOCATION | 33,242 | 9,888 | 23,354 | 70.3% | 27.07 |
| Urban (MS4) | 4,076 | 2,853 | 1,223 | 30.0% | 7.81 |
| Construction | 532 | 532 | - | - | 1.46 |
| General Permits | 224 | 224 | - | - | 0.61 |
| WWTF-Industrial | 74 | 74 | - | - | 0.20 |
| WWTF-Municipal | 542 | 542 | - | - | 1.48 |
| WASTELOAD ALLOCATION | 5,448 | 4,225 | 1,223 | 22.4% | 11.56 |
| TOTAL (WLA + LA) | 38,690 | 14,113 | 24,577 | 63.5% | 38.63 |

| Urban (MS4) | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Appleton | 2 | 1.40 | 0.60 | 30.0% | - |
| Ashwaubenon | 302 | 211.39 | 90.61 | 30.0% | 0.58 |
| Green Bay | 474 | 331.79 | 142.21 | 30.0% | 0.91 |
| Hobart | - | - | - | - | - |
| Howard | 2,790 | 1,952.92 | 837.08 | 30.0% | 5.35 |
| Suamico | 508 | 355.58 | 152.42 | 30.0% | 0.97 |

| WWTP-Industrial | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Provimi Foods - Seymour | 74 | 74 | - | - | 0.20 |

| WWTF-Municipal | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Freedom San. Dist. #1 | 542 | 542 | - | - | 1.48 |

| Sources from Oneida Reservation | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Agriculture | 18,937 | 4,380 | 14,557 | 76.9% | 11.99 |
| Urban (non-regulated) | 1,372 | 1,372 | - | - | 3.76 |
| Natural Background | 707 | 707 | - | - | 1.94 |
| NONPOINT SOURCES | 21,016 | 6,459 | 14,557 | 69.3% | 17.69 |
| Urban (MS4) | 2,620 | 1,834 | 786 | 30.0% | 5.02 |
| Construction | 326 | 326 | - | - | 0.89 |
| General Permits | 137 | 137 | - | - | 0.38 |
| WWTF-Industrial | - | - | - | - | - |
| WWTF-Municipal | 383 | 383 | - | - | 1.05 |
| POINT SOURCES | 3,466 | 2,680 | 786 | 22.7% | 7.34 |
| TOTAL (PS + NPS) | 24,482 | 9,139 | 15,343 | 62.7% | 25.03 |

| Urban (MS4) | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Appleton | - | - | - | - | - |
| Ashwaubenon | - | - | - | - | - |
| Green Bay | 1,290 | 903.0 | 387.0 | 30.0% | 2.47 |
| Hobart | 1,316 | 921.2 | 394.8 | 30.0% | 2.52 |
| Howard | 14 | 9.8 | 4.2 | 30.0% | 0.03 |
| Suamico | - | - | - | - | - |

| WWTF-Municipal | Total Phosphorus Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Oneida (regulated via EPA NPDES) | 383 | 383 | - | - | 1.05 |

**DUCK CREEK**
**TOTAL SUSPENDED SOLIDS**

| Sub-basin Loading Summary (lbs/yr) | |
|---|---|
| Baseline | 25,394,165 |
| TMDL | 11,416,475 |
| Reduction | 13,977,690 |
| % Reduction Needed | 55.0% |

| | |
|---|---|
| Daily TMDL (lbs/day) | 31,257 |

| Land Use | Acres | | | % of |
|---|---|---|---|---|
| | State | Oneida | Total | Total |
| Agriculture | 30,098 | 18760 | 48,858 | 56.0% |
| Urban | 5,407 | 3585 | 8,992 | 10.3% |
| Urban-MS4 | 7,512 | 4570 | 12,082 | 13.8% |
| Construction | 214 | 131 | 345 | 0.4% |
| Natural Background | 8,972 | 8020 | 16,992 | 19.5% |
| **TOTAL** | **52,203** | **35,066** | **87,269** | **100.0%** |

| Sources from State Land | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Agriculture | 12,724,387 | 5,273,111 | 7,451,276 | 58.6% | 14,437 |
| Urban (non-regulated) | 478,796 | 478,796 | - | - | 1,311 |
| Natural Background | 114,410 | 114,410 | - | - | 313 |
| **LOAD ALLOCATION** | **13,317,593** | **5,866,317** | **7,451,276** | **56.0%** | **16,061.00** |
| Urban (MS4) | 1,655,931 | 993,559 | 662,372 | 40.0% | 2,720 |
| Construction | 671,326 | 134,265 | 537,061 | 80.0% | 368 |
| General Permits | 97,759 | 97,759 | - | - | 268 |
| WWTF-Industrial | 544 | 544 | - | - | 1 |
| WWTF-Municipal | 2,953 | 2,953 | - | - | 8 |
| **WASTELOAD ALLOCATION** | **2,428,513** | **1,229,080** | **1,199,433** | **49.4%** | **3,365** |
| **TOTAL (WLA + LA)** | **15,746,106** | **7,095,397** | **8,650,709** | **54.9%** | **19,426** |

| Urban (MS4) | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Appleton | 456 | 274 | 182 | 40.0% | 1 |
| Ashwaubenon | 123,637 | 74,182 | 49,455 | 40.0% | 203 |
| Green Bay | 189,004 | 113,402 | 75,602 | 40.0% | 310 |
| Hobart | - | - | - | - | - |
| Howard | 1,164,267 | 698,560 | 465,707 | 40.0% | 1,913 |
| Suamico | 178,567 | 107,140 | 71,427 | 40.0% | 293 |

| WWTP-Industrial | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Provimi Foods - Seymour | 544 | 544 | - | - | 1 |

| WWTF-Municipal | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Freedom San. Dist. #1 | 2,953 | 2,953 | - | - | 8 |

| Sources from Oneida Reservation | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Agriculture | 7,931,075 | 3,286,715 | 4,644,360 | 58.6% | 8,999 |
| Urban (non-regulated) | 317,456 | 317,456 | - | - | 869 |
| Natural Background | 102,270 | 102,270 | - | - | 280 |
| **NONPOINT SOURCES** | **8,350,801** | **3,706,441** | **4,644,360** | **55.6%** | **10,148** |
| Urban (MS4) | 884,650 | 530,790 | 353,860 | 40.0% | 1,453 |
| Construction | 410,952 | 82,191 | 328,761 | 80.0% | 225 |
| General Permits | - | - | - | - | - |
| WWTF-Industrial | - | - | - | - | - |
| WWTF-Municipal | 1,656 | 1,656 | - | - | 5 |
| **POINT SOURCES** | **1,297,258** | **614,637** | **682,621** | **52.6%** | **1,683** |
| **TOTAL (PS + NPS)** | **9,648,059** | **4,321,078** | **5,326,981** | **55.2%** | **11,831** |

| Urban (MS4) | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Appleton | - | - | - | - | - |
| Ashwaubenon | - | - | - | - | - |
| Green Bay | 514,879 | 308,928 | 205,952 | 40.0% | 846 |
| Hobart | 363,933 | 218,360 | 145,573 | 40.0% | 598 |
| Howard | 5,838 | 3,503 | 2,335 | 40.0% | 10 |
| Suamico | - | - | - | - | - |

| WWTF-Municipal | Total Suspended Solids Load (lbs/yr) | | | % Reduction | Allocated |
|---|---|---|---|---|---|
| | Baseline | Allocated | Reduction | from Baseline | (lbs/day) |
| Oneida (regulated via EPA NPDES) | 1,656 | 1,656 | - | - | 5 |

## Appendix C. STEPL Inputs & Results for best management practices.

**Upland Practices applied to Cropland:**

A weighted Best Management Practice efficiency of 63% for total phosphorus and 74% for total sediment was used for conservation practices applied to cropland. This assumes that a combination of practices will be applied to the majority (≈75%) of the crop fields in the watershed. Estimated implementation rates of each practice combination are shown in Table 21.

**Table 21.** Cropland Best Management practices reduction efficiencies.

| Acres | % Implementation on cropland | Practice Combination | % reduction (phosphorus) | Weighted % reduction phosphorus | % reduction (sediment) | Weighted % reduction sediment |
|---|---|---|---|---|---|---|
| 800 | 4.2 | Contour/Strip Farming & Reduced Tillage | 75.2 | 4.2 | 85.1 | 4.8 |
| 2,850 | 15.0 | Cover Crop & Reduced Tillage | 58.7 | 11.7 | 83.7 | 16.7 |
| 2,075 | 10.9 | NMP & Reduced Tillage | 60.4 | 8.8 | 75.0 | 10.9 |
| 3,350 | 17.6 | NMP, Reduced Tillage, & Cover Crops | 70.3 | 16.5 | 83.7 | 19.6 |
| 950 | 5.0 | NMP & Cover Crops | 51.0 | 3.4 | 15.0 | 1.0 |
| 400 | 2.1 | NMP & Contour/Strip Farming | 55.0 | 1.5 | 40.5 | 1.1 |
| 810 | 4.3 | Reduced Tillage | 45.0 | 2.6 | 75.0 | 4.3 |
| 400 | 2.1 | Cover Crop | 32.0 | 0.9 | 15.0 | 0.4 |
| 2,200 | 11.6 | Cover Crop & Vertical Manure Injection & Reduced Tillage | 70.1 | 10.8 | 78.8 | 12.1 |
| 120 | 0.6 | Field Border & Reduced Tillage | 86.3 | 0.7 | 91.3 | 0.8 |
| 120 | 0.6 | Field Border & Reduced Tillage & Cover Crops | 90.6 | 0.8 | 92.6 | 0.8 |
| 200 | 1.1 | Prescribed Grazing | 68.0 | 1.0 | 76.0 | 1.1 |
| **Average Practice Efficiency** | | | **63.6** | **62.8** | **67.6** | **73.6** |

**Table 22.** 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 |
| | N | P | BOD | Sediment | BMPs | % Area BMP Applied | lb/year | t/year |
| W1 | 0 | 0.4725 | 0 | 0.555 | Combined BMPs-Calculated | 75 | 11,536.38 | 2,182.90 |

**Riparian Buffers:**

In order to determine load reductions from riparian buffers in the STEPL model, the amount of land the buffers are treating is needed. A GIS hydrology analysis tool was used to determine the catchment area of each riparian buffer needed (Figure 48). A total of 1,537 acres would be treated with needed riparian buffers which is 8.1% of cropland.

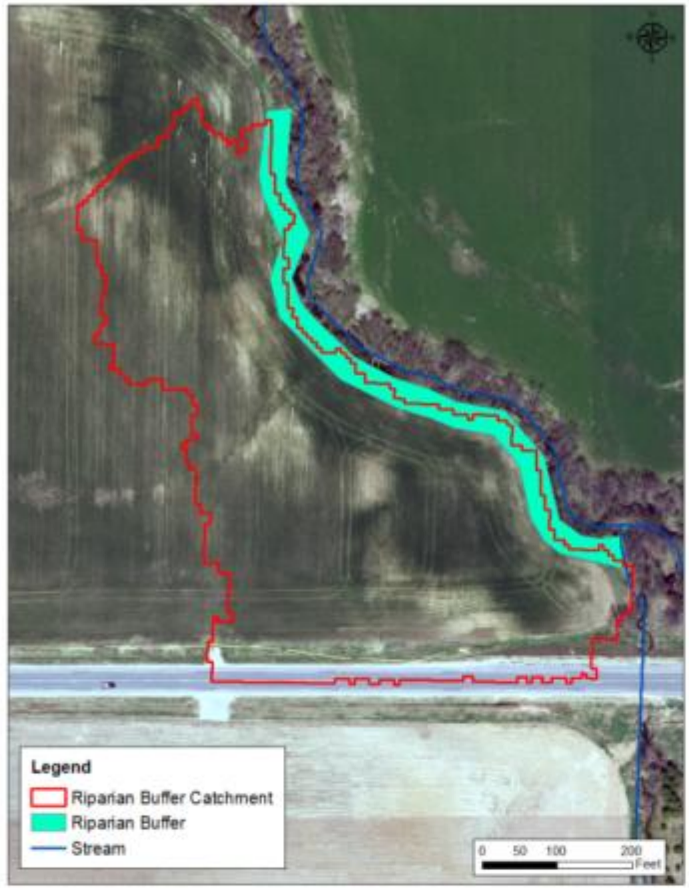



**Figure 48.** Riparian buffer catchment.

**Table 23.** STEPL inputs for Vegetative Buffers and Load Reductions.

| 1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Watershed | Cropland | | | | | | P Reduction | Sediment Reduction |
| | N | P | BOD | Sediment | BMPs | % Area BMP Applied | lb/year | t/year |
| W1 | 0.057 | 0.06075 | ND | 0.05265 | Filter strip | 8.1 | 1,392.60 | 207.08 |

**Wetland Restoration:**

Reductions from wetland 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.

**Table 24.** STEPL inputs and load reductions for wetland restoration.

| 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 | 0.0066 | 0.011625 | Wetland Detention | 1.5 | 219.38 | 45.69 |

**Constructed Treatment Wetland to treat agricultural runoff/subsurface drainage:**

Reductions from Constructed Treatment wetlands to treat tile drainage were determined by a assuming that one ½-1 acre size treatment wetland would treat 30 acres.

**Table 25.** STEPL inputs and load reductions for treatment wetlands.

| 1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data | | | | | | | Load Reductions | |
|---|---|---|---|---|---|---|---|---|
| Watershed | Cropland | | | | | | P Reduction | Sediment Reduction |
| | N | P | BOD | Sediment | BMPs | % Area BMP Applied | lb/year | t/year |
| W1 | 0 | 0.002772 | 0 | 0.004883 | Wetland Detention | 0.63 | 92.140381 | 19.1912524 |

**Gully/Concentrated Flow Stabilization:**

Load reductions from grassed waterways, WASCOBS, and concentrated flow area seedings were estimated by assuming an average height and width for gullies identified by the stream power index, windshield survey, and air photo interpretation. A total 173,325 feet of gullies and concentrated flow paths were identified in this analysis. An 85% implementation rate was assumed equating to approximately 61,847 ft of grassed waterways installed in the watershed. A 70% sediment delivery ratio was applied to the load reduction with the assumption that not all sediment from eroding gullies will reach the Duck Creek.

**Table 26.** STEPL inputs for gully dimensions and load reductions from grassed waterways/WASCOB's.

| 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) | Annual Load (ton)-ncf | Load Reduction (ton)-ncf |
| W1 | Gully1 | 0.75 | 0.75 | 0.5 | 61848 | 1 | 0.95 | Silt Loam | 0.04 | 1.00 | 985.70 | 936.42 | 985.70 | 936.42 |

**Table 27.** STEPL inputs for gullies/concentrated flow and load reductions from concentrated flow area planting.

| 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) | Annual Load (ton)-ncf | Load Reduction (ton)-ncf |
| W1 | Gully2 | 0.5 | 0.1 | 0.25 | 85479 | 1 | 0.95 | Silt Loam | 0.04 | 1.00 | 272.46 | 258.84 | 272.46 | 258.84 |

## Appendix D. Lower Fox River Surface Water Monitoring Summary

A summary of the WDNR Lower Fox River Surface Water Monitoring Strategy provided by Keith Marquardt (WDNR) on September 25, 2014:

**Surface Water Monitoring for the Lower Fox TMDL**

The primary objective for the Lower Fox River Basin monitoring project is to identify long term trends for phosphorus and suspended solids loading to the Fox River and Green Bay from major tributaries. This will provide an early warning of rising trends, and information for management issues that may arise. The principal water quality parameter of interest is total phosphorus, which is typically the limiting nutrient that affects aquatic plant growth and recreational water uses. Data collected for this project may also be used in the future to support the following objectives:

- Determining water quality standards attainment
- Identifying causes and sources of water quality impairments
- Supporting the implementation of water management programs
- Supporting the evaluation of program effectiveness

To this end, in 2013, the Wisconsin Department of Natural Resources (WDNR) convened a Lower Fox Monitoring Committee to develop and subsequently implement a surface water monitoring plan to evaluate the effectiveness of TMDL implementation in the Lower Fox River Basin. The Lower Fox River Basin comprises approximately 640 sq. miles, and, in general, extends from the outlet of Lake Winnebago to Green Bay. In general, the Basin contains 39 miles of the Fox River (referred to as the main stem) and 13 streams (referred to as tributaries) flowing into the Fox River.

The Lower Fox TMDL Monitoring Committee included representation from the University of Wisconsin Green Bay, (UWGB), the United States Geological Survey (USGS), the Oneida Nation, the WDNR, and municipal wastewater representatives.

The Committee noted that due to the size of the basin and complexity of source inputs (both point and nonpoint source pollution including urban runoff, rural runoff, and discharges) and the lack of currently available funding for surface water monitoring, that the scope of monitoring may be limited at the start. However, the current and proposed monitoring is sufficient to provide a baseline network (framework) that can be expanded upon in the future to accommodate implementation efforts occurring in the basin [for example, if conservation practices are focused in a particular sub-watershed, additional monitoring activities should accompany the implementation efforts].

Surface water monitoring in the Lower Fox was divided into two (2) components: the **Main Stem** (the Fox River itself) and the **Tributaries** (13 total).

Page 1 of 2

**Main Stem**

The Lower Fox River Main Stem monitoring includes the weekly collection of water samples from 3 or 4 monitoring locations from roughly March through October for a total of 35 weeks. Water samples will be analyzed at the Wisconsin State Laboratory of Hygiene (or a state certified laboratory) for analysis of total suspended solids (TSS), total phosphorus (TP), dissolved P, volatile organic solids, chlorophyll A, and dissolved oxygen (D.O.) . In addition, flow data will be collected at each of the four (4) main stem locations. The four (4) monitoring locations on the Main Stem include: the Lake Winnebago outlet (Neenah – Menasha dam), the De Pere dam, the mouth of the Fox River, and a proposed location near Wrightstown bridge.

**Tributaries**

For the 13 streams flowing into the Fox River, surface water quality monitoring will be conducted at one location at each of the 13 tributary sites on a monthly basis from May through October 2015 (for a total of 6 monthly monitoring events at 13 locations).

On each sampling date, volunteers will collect and ship surface water samples to the Wisconsin State Laboratory of Hygiene for the analysis of TP, TSS, and dissolved reactive phosphorus (DRP). In addition, volunteers will utilize transparency tubes to assess and document the transparency of each stream on each date.

See location map.

**BIOLOGICAL ASSESSMENT and Secchi**

Currently, volunteers are anticipated to perform Secchi depth and conduct submergent aquatic vegetation surveys in Lower Green Bay on a periodic basis.
To assess the biological health of the streams, macroinvertebrate samples will be collected during September or October and delivered to UW-Superior for identification to lowest taxonomic level on a periodic basis, currently proposed to be every 3 to 5 years.

**Other**

When warranted, based on water quality results, additional monitoring may be required. The WDNR will perform monitoring for confirmation prior to delisting the impaired water segments.

All sampling will be conducted in accordance with WDNR protocol.

## Appendix E. Strategy to meet Lower Fox TMDL phosphorus reduction target.

As described on pages 63-65, this plan estimates, using STEPL, a 56.2% reduction in P loading(N = 14,251.7 lbs. P) will be achieved when a combination of practices are implemented on 75% (N = 14,275 ac) of cropland acres and reductions from other sources (e.g., barnyard retrofits, pastures) are achieved in the Upper Duck Creek watershed. This P reduction falls short of the Lower Fox TMDL non-point agricultural P load reduction of 76.9% (N= 19,491.88 lbs. P). Using STEPL, the estimated amount of additional P reduction needed to meet 76.9% TMDL P reduction goal is 5,240 lbs. P.

The remaining amount of P reduction (5,240 lbs. P) will be achieved via the two measures listed below.

1. Implementation of practices described in plan on 6,500 additional cropland/pasture/hay acres (NOTE: the number of additional acres was determined from this plan's estimated 14,251.7 lbs. P reduction on 11,536 acres = 0.8 lbs./P average reduction; 6,550 acres x 0.8 lbs./P = 5,240 lbs. P).
2. Implementation of new practices or technologies (described on pages 59-61) that is either currently under development or has not yet been evaluated/measured for effectiveness.

These two measures may or may not be implemented within this plan's ten year schedule. As this plan is implemented not only will actual implemented practices and pollutant load reductions be calculated and compared to plan milestones, but new or additional practices (e.g., aerial cover crop seeding, gypsum applications, tile line outlet treatment structures) are planned for evaluation to determine feasibility and pollutant reduction efficiencies (see table 12). Once determined, this information will be incorporated into the plan and may help meet the overall TMDL P reduction goal for this watershed. This plan contains several milestones to complete adaptive management by incorporating new information, over time. If it becomes clear from such evaluation, that the 84% TMDL P reduction will not be met within the plan's ten year schedule, this plan will be revised with a new schedule (and revised load reduction estimates) to include additional or new practices to achieve the Lower Fox TMDL P reduction goal.